

**SOIL INVESTIGATION AND HUMAN HEALTH RISK
ASSESSMENT FOR THE RODNEY STREET
COMMUNITY: PORT COLBORNE (2001)**

**STANDARDS DEVELOPMENT BRANCH
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**Ministry
of the
Environment**

SUMMARY

Soil Investigation and Human Health Risk Assessment Report for the Rodney Street Neighbourhood, Port Colborne, March 2001

Conclusions

The 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 further action. The recommendations for further action follows completion of a comprehensive soil investigation and human health risk assessment that examined over 1,300 soil samples to determine the safety of metal levels at 179 properties in the Rodney Street neighbourhood. The health risk assessment reviewed concentrations of eight metals found in surface soils and has recommended that an intervention level of 10,000 parts per million (ppm) also referred to as $\mu\text{g/g}$ (micrograms per gram or one millionth of a gram) be set for nickel and an intervention level of 1,000 ppm be set for lead. No further action for the remaining six metals (arsenic, antimony, beryllium, cadmium, copper or cobalt) is required.

In carrying out the investigation and assessment, the Ministry of the Environment identified nickel levels in excess of 10,000 ppm at 16 of 179 properties. As a result of historical emissions from INCO, these nearby properties were found to have nickel soil concentrations in the upper 30 cm of soil. The ministry also found lead levels in excess of 1,000 ppm at 10 of the 179 properties, including two that had already been identified as having elevated nickel levels. Similar lead levels are known to be found in older, established urban neighbourhoods resulting from the historical use of lead based paints, leaded gasoline and discarded lead-acid batteries.

The study's key findings for the Rodney Street Community, include:

1. 16 of 179 properties have elevated nickel levels in excess of 10,000 ppm;
2. 10 of 179 properties have elevated lead levels, in excess of 1,000 ppm, including two that were previously identified as having high nickel concentrations;
3. A total of 24 properties warrant further action;
4. Stringent nickel cleanup levels, specific to the Rodney Street neighbourhood, have been developed based on exposure for young children;
5. Nickel levels in the neighbourhood do not pose any immediate or long term risks to adults;
6. No further action is warranted for the remaining six metals (Arsenic, Antimony, Beryllium, Cadmium, Copper and Cobalt).

Introduction

INCO operated a base metal refinery from 1918 to 1984 in the City of Port Colborne. Emissions from this facility have resulted in soils covering a wide area northeast of this facility having concentrations of nickel, copper and cobalt above the ministry's soil remediation criteria. The remediation criteria are based on potential impact to sensitive plant species. INCO is undertaking a Community Based Risk Assessment (CBRA) to address the remediation of this area. A Public

area. A Public Liaison Committee has been formed for ongoing public consultation on the proposed Community Based Risk Assessment, and on November 30, 2000, endorsed the Scope of Work for the CBRA.

Previously, the Ministry of the Environment and the Regional Niagara Public Health Department, conducted a health risk assessment in 1997, to determine if exposure to elevated nickel, cobalt and copper soil concentrations in Port Colborne may result in the potential for adverse health effects. The report concluded that no adverse health effects are anticipated. Furthermore, the review of population health data did not indicate any adverse health effects which may have resulted from environmental exposures.

Following the release of this 1997 health risk assessment the ministry undertook additional soil sampling studies in 1998 and 1999. These additional studies involved a more extensive soil sampling program and resulted in a better understanding of the extent of soil metal contamination in the Port Colborne area. The 1998 and 1999 soil surveys did not find any more serious soil contamination than in previous surveys therefore, the health risk study conclusions from 1997 are still applicable to the 1998 and 1999 soil investigations.

In September 2000, soil nickel levels from a single Rodney Street property were found to exceed the maximum nickel level used in the 1997 health risk assessment. Subsequently soil from 17 properties, on or in the vicinity of Rodney Street, was collected and analyzed for 20 metals and metalloid elements. Preliminary results in October 2000 indicated that surface soil nickel levels ranged up to 17,000 ppm, and that the soil metal levels were extremely variable between properties. In November 2000, the ministry sampled soil from the residential properties south of Louis Street to the lake, and east of the Welland Canal to INCO, to determine the extent of this contamination. Sampling results for these 179 properties, in what has become known as the Rodney Street neighbourhood, follow below.

In addition to the extensive soil survey the ministry undertook a new health risk assessment. The results of the soil survey and health risk assessment have been provided to the Rodney Street neighbourhood homeowners and the Regional Niagara Public Health Department, and will be considered in the proposed Health Study for the Rodney Street community, announced December 11, 2000.

Soil Investigation Results

Soil nickel levels varied substantially between properties. The maximum soil nickel level found was 17,000 ppm while the average was 2,545 ppm. Sixteen properties exceeded the maximum value used in the 1997 human health risk assessment (9,750 ppm) and all but one property had soil nickel levels that exceeded the MOE generic effects-based soil guideline (200 ppm) which is based on potential impact on sensitive plant species which are used because they show adverse effects at lower concentrations than other organisms.

Other metals levels above ministry guidelines (lead, cobalt, copper, beryllium, arsenic, zinc, antimony, selenium) were found on some or all of the properties, and are also presented in the

ministry report. Soil metal concentrations tended to increase with depth to a maximum at between 10 cm to 20 cm, and based on limited digging, are unlikely to be found deeper than 30 cm on most properties.

Nickel, copper, cobalt, and arsenic soil contamination in the Rodney Street Community is unquestionably related to INCO, and selenium and zinc soil contamination is likely INCO related. The source of the nickel, copper, cobalt, arsenic, selenium, and zinc soil contamination across the Rodney Street neighbourhood is believed to be fugitive emissions (i.e. emissions from vents, windows, doors) from INCO that occurred early in the refinery's history, possibly before the construction of the stack in 1929. The highest nickel, copper, cobalt, and arsenic soil concentrations occurred on properties along the southeast end of the neighbourhood on Rodney, Mitchell, and Davis Streets.

The randomly scattered lead contamination observed in the Rodney Street neighbourhood is related to domestic residential lead sources and not to INCO emissions. Lead-contaminated properties often had elevated concentrations of cadmium, chromium, barium, zinc, copper, and antimony. Lead and antimony soil contamination is an indication that batteries may have been stored or disposed of on the property, whereas lead in conjunction with barium, cadmium, chromium, copper, and zinc is an indication of soil contaminated by exterior lead-based paint.

With the exception of one property where elevated beryllium levels occurred with high lead and other heavy metal levels, the marginally higher beryllium soil concentrations across the Rodney Street neighbourhood are a combination of naturally higher levels in local shale formations and extensive historical use of slag in local road construction.

The "patchwork" pattern of high and low soil contaminant concentrations on residential properties in the Rodney Street neighbourhood is related to property maintenance and landscaping. It also indicates that the source of the soil contamination is largely historic, probably before the stack was erected, or at least that recent deposition was substantially lower, as more recently landscaped properties have not become re-contaminated to the levels found on undisturbed properties.

The "solubility" of the soil contaminants found in the Rodney Street neighbourhood is very low, ranging from less than 1 per cent for most metals to 3.8 per cent for lead. This means the metals are relatively immobile in the soil and do not readily react with the environment, which accounts for the remarkably minor amount of nickel damage observed on sensitive plant species and why there is no consistent relationship between nickel in vegetable produce and soil nickel levels in residential vegetable gardens.

Human Health Risk Assessment

A human health risk assessment of the elevated concentrations of eight metals (antimony, arsenic, beryllium, cadmium, cobalt, copper, lead and nickel) found in the surface soils (0-30 cm) of the Rodney Street neighbourhood was also conducted by the ministry. The health risk assessment for nickel was peer reviewed by an international panel of experts. Peer reviewer

agencies included:

- Toxicological Excellence for Risk Assessment (*TERA*), Cincinnati, Ohio;
- Agency for Toxic Substances and Disease Registry (ATSDR), Atlanta, Georgia;
- United States - Environmental Protection Agency (US-EPA), Washington, D.C.; and
- Norwegian National Institute of Occupational Health, Oslo, Norway.

A human health risk assessment is conducted when chemical contaminants are found at levels that raise concerns about potential risk in the community. The multimedia approach to health risk assessment examines total exposure to contaminants through a number of possible pathways, such as air, soil, drinking water and food.

While this study is health-based, it is not a community health study. This health-based risk assessment is directed at assessing exposure to selected metals in Rodney Street neighbourhood properties. The assessment evaluated whether health-based exposure limits are exceeded and whether any exposure level (or soil concentration) warrants further actions (including soil remediation) to reduce exposure. The results of the health risk assessment have been provided to Regional Niagara Public Health Department and will be considered in the Health Study for the Rodney Street community, that was announced December 11, 2000.

Nickel

The plausible "worst case" exposure model indicates that when the Rodney Street community nickel exposure from all sources is averaged over a lifetime, the resulting chronic daily intake (CDI) estimate is about 8 µg/kg/day or 40 per cent of the United States Environmental Protection Agency's reference dose (*RfD*) of 20 µg/kg/day. However, when exposure is broken down by age group, the highest exposures are for the infant and toddler age groups (up to 5 years old). Worst case exposures for this age group exceed the U.S. EPA reference dose. The major contributor to daily intakes of nickel is supermarket food found in Canada as determined by Health Canada which is independent of any local nickel exposures in the Rodney Street community.

The "reference dose" is defined as the level below which lifetime average exposures would not be expected to result in adverse human health effects. This means that short term exposures to levels above the reference dose would not be expected to result in adverse health effects, provided that the exposures are not high enough to cause acute effects and provided that the dose experienced over a life-time did not exceed the reference dose. It should be further noted that an exceedance of the reference dose does not mean that adverse health effects will occur. However, the potential of adverse effects occurring increases as the life-time average daily dose rises above the reference dose.

As a result, a stringent site-specific soil intervention level of 10,000 ppm of nickel for soil was developed specific for the Rodney Street neighbourhood based on ensuring toddler exposure was below the U.S. EPA reference dose.

Three independent sets of analyses of Port Colborne soils, carried out by the Ontario Ministry of

Mines and Northern Development, INCO and Jacques Whitford Environmental Limited, have shown that nickel oxide is the predominant form of nickel present in Port Colborne soil. Minor amounts of elemental nickel and nickel-copper alloys were also reported. Nickel sulphate and nickel sulfide were not found to be present.

Lead

Lead in soil has long been recognized as posing potential risk, particularly to younger children up to 5 years of age, who may play in backyards and parks. Therefore, young children were considered the most sensitive to exposures for direct soil/dust ingestion.

Reported lead levels for the Rodney Street community were compared with other neighbourhoods in Ontario where community blood lead studies were undertaken. Average soil lead levels in the Rodney Street community (mean of 204 ppm in surface samples) are essentially no greater than, and in many cases less than, those expected for other urban residential sites in Ontario. As a result, estimated exposures (and hence blood lead levels) are predicted to be similar to those for other urban Ontario populations.

It is prudent, however, to conclude that in the 10 residences with reported soil lead levels higher than 1000 ppm there may be some possibility for exposures and higher blood lead levels in children who routinely play in these areas.

As a result, the report recommends an intervention level be established for this community at a soil lead level of 400 ppm for children play areas **with bare soil** on residential properties or in public areas, and at a level of 1000 ppm for all other areas of these properties **covered by sod or grass** to which children have access. Residents at properties exceeding 1000 ppm lead in soil should be advised to avoid contact and to not consume vegetables from backyard gardens. Additional ways to reduce exposure to the lead in soil are presented in the ministry's fact sheet, "*Frequently Asked Questions About Lead Contamination*".

The Regional Niagara Public Health Department also has information on how to reduce exposure to lead in soil. The Medical Officer of Health is providing blood lead screening tests to anyone living or frequently spending time in the area and strongly recommending that pregnant women, of reproductive age, pregnant women and children under seven, participate in the blood lead level screening tests by calling the heavy metal health hotline at 1-905-688-1068.

Arsenic

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

It is concluded that the measured levels of arsenic in the Rodney Street community soils do not pose an undue health risk to residents of this community based on consideration of: the very low 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, plausible worst case exposure estimates were modeled using the maximum reported levels of each metal in the Rodney Street neighbourhood surface soil, Port Colborne municipal drinking water, ambient air, supermarket food and Rodney Street neighbourhood backyard produce.

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 U.S. EPA, 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 for these metals for the Rodney Street community.

Study Participants

The Rodney Street Community study involved many scientists and technicians from the Ministry of the Environment. The following staff of the Standards Development Branch Ecological Standards and Toxicology Section (Phytotoxicology) participated in sample collection and sample processing: Marius Marsh, Murray Dixon, Bill Gizyn, Bob Emerson, Ron Hall, Danuta Roszak, Deborah Terry, Melanie Appleton, Richard Chong-Kit, Mike Mueller, and Al Kuja. Randall Jones co-ordinated the geo-referencing of the soil samples and the soil data base, and prepared the contaminant contour maps. Al Kuja and Dave McLaughlin were the principal authors of Part A of this report.

The Human Health Risk Assessment was conducted by toxicologists of the Human Toxicology and Air Standards Section. Brendan Birmingham co-ordinated this effort and is the principal author of Part B of this report. Contributing toxicologists included Scott Fleming, Satish Deshpande, Marko Pagliarulo, and Audrey Wagenaar. Bryan Leece of Dillon Consulting Ltd. provided technical assistance.

Laboratory Services Branch personnel provided critical laboratory support. Liz Pastorek administered the contract for the private laboratory that conducted the soil analysis. Tender evaluation was conducted by Peter Drouin. The initial quality control check was handled by Sathi Seliah. Rusty Moody and Jim Howden provided data monitoring and data management duties. The in-house laboratory analysis required to ensure data quality was conducted by Lian Liu and Julie Uzonyi (ICP - metals) and Hung Sing Chiu and Regina Pearce (hydrides).

Jacques Whitford Environmental Limited providing vegetable produce and garden soil data for the Rodney St. community and Port Colborne in general, and air monitoring data for selected schools.

Paul Niewegloski and Bob Slattery of the Niagara District Office provided liaison between the Ministry's Operations Division and the Environmental Science and Standards Division. Rick Day was the communications officer.

Peer reviewers of the Part B Human Health Risk Assessment for nickel were:

- Dr. John Wheeler, Agency for Toxic Substances and Disease Registry (ATSDR), Atlanta, Georgia,
- Ms. Ambika Bathija, U.S. EPA, Washington, D.C.,
- Dr. Lynne Haber, Toxicological Excellence for Risk Assessment (*TERA*), Cincinnati, Ohio,
- Dr. Tor Norseth, Norwegian National Institute of Occupational Health, Oslo, Norway.

Laura Morra of the Ecological Standards and Toxicology Section and Tony Ho of the Drinking Water, Wastewater, and Watershed Standards Section provided internal document review.

Overall project management was provided by George Crawford, Dale Henry, Dave McLaughlin, and Paul Niewegloski.

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Soil Investigation and Human Health Risk Assessment for the Rodney Street Community: Port Colborne (2001) Part A: Soil Investigation

BACKGROUND

From 1918 to 1984, the International Nickel Company Limited (INCO) operated a base metal refinery in the city of Port Colborne. Between the years 1972 and 1999, the Ontario Ministry of the Environment (MOE) conducted numerous investigations to document the impact of INCO's emissions on soil and vegetation in and around Port Colborne. These investigations concluded that 65 years of nickel refining has resulted in extensive heavy metal soil contamination in the Port Colborne area. Nickel, copper, and cobalt concentrations in surface soil exceed the MOE Table A effects-based generic soil remediation criteria (see *Guideline for Use at Contaminated Sites in Ontario*, Appendix D, reference 6) in residential communities adjacent to INCO and for considerable distances downwind (northeasterly). In addition to these three heavy metals, soil arsenic, selenium, and zinc concentrations are also elevated at some sample sites. However, unlike nickel, copper, and cobalt concentrations that are consistently and substantially elevated over a large area, the soil arsenic, zinc, and selenium levels exceed normal Ontario background ranges only in a few areas close to INCO.

Extensive sampling and modelling conducted by the MOE in the city of Pt. Colborne and the surrounding area in 1998 and 1999 demonstrated that soil nickel concentrations exceed the MOE Table F soil background-based guideline up to 28 km downwind of the refinery, covering a 345 km² area of the Niagara peninsula [1, 2]. Furthermore, the MOE Table A effects-based soil nickel guideline is exceeded for a distance of up to 3 km downwind of INCO over an area of almost 29 km². In addition, copper and cobalt also exceed their corresponding effects-based Table A soil guidelines in smaller areas of the community, mainly immediately east and northeast of the refinery. The MOE guideline criteria for nickel, copper, and cobalt are all based on phytotoxicity (injury to vegetation). Numerous MOE studies conducted on Port Colborne farms in the 1970s and 1980s documented toxicity to agricultural crops as a result of heavy metal soil contamination [7,8,9]. A human health risk assessment conducted by the MOE in 1997 and reviewed by the Regional Niagara Public Health Department concluded 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 area* [3]. The highest soil nickel level used in that health risk assessment was 9,750 µg/g (dry wt).

The Rodney St. community is located due west of INCO. Like other residential neighbourhoods in Port Colborne, the Rodney St. community has been directly impacted by INCO stack emissions. Also, because of its close proximity to the refinery, the Rodney St. community was also likely subjected to extensive fugitive emissions, which would have been particularly significant early in INCO's history and prior to the construction of the stack in 1929. Fugitive emissions are process emissions that "leak" out of windows, doors, vents, or other openings. Fugitive emissions tend to impact areas very close to the manufacturing site, whereas emissions

from a stack can have an impact over a much greater area and at much further distances. Previous MOE surface soil sampling in the vicinity of the Rodney St. community to the west and northwest of INCO found that soil nickel concentrations in the general area averaged less than 5,000 µg/g. However, very few surface soil samples were collected and little depth sampling (greater than 5 cm) was done in this part of Port Colborne (the highest soil Ni concentration at 5-10 cm was 2,750 µg/g). No properties on Rodney St. itself were sampled.

During a public information forum held in January 2000 at the Pt. Colborne city hall, a resident of Rodney St. requested that the MOE sample soil on his property. MOE Phytotoxicology scientists sampled the front and back yards of the property in June 2000. Analysis of the soil samples revealed that soil nickel concentrations at depth (10-15 cm) were very high (16,000 µg/g). In addition, soil copper, cobalt, arsenic, lead, and zinc concentrations at depth also exceeded their respective MOE Table A guideline criteria. MOE human health toxicologists conducted a screening level risk assessment on the soil data and determined that the health-based nickel reference dose was exceeded for the maximum nickel concentration found in the front yard of this Rodney St. property. The reference dose calculations incorporate considerable safety factors, and although an exceedence of the nickel reference dose does not automatically mean that an adverse health effect will occur, it does erode the confidence that an adverse effect will not occur, and therefore further investigation is warranted.

As a result of the findings for the single Rodney St. property, the Medical Officer of Health requested that the soil be sampled on the remaining residential properties on Rodney St. This additional sampling of front and back yards was completed on October 3rd and 4th, 2000. A preliminary analysis of the results showed a wide variance in soil nickel concentrations from one property to the next. On some properties the nickel concentrations were highest in the surface soil and lower at depth, on other properties the reverse was observed. Properties with higher soil metal levels were sometimes adjacent to properties with much lower metal concentrations. Soil nickel concentrations tended to be much higher in the front yards of Rodney St. properties than the back yards. In addition to unexpectedly high nickel, copper, and cobalt levels, the soil zinc, arsenic, and lead concentrations were also elevated and were inconsistent with levels observed elsewhere in the Port Colborne area from the previous MOE soil investigations. While collecting soil from the Rodney St. properties it was observed that some yards had considerable non-soil material, such as concrete rubble, cinders, slag, ash, and metal pieces. This suggested that some areas of what is now Rodney St. may have received fill, possibly residential refuse or industrial process waste.

The sources of the soil metal contamination found on some Rodney St. properties could be both stack and fugitive emissions from the INCO refinery, or historic emissions and/or disposal of process waste from INCO or other local industries. In addition, it could be related to contaminated backfill from sewer or water line construction, or from an oil pipeline that was constructed in 1957 and runs from the Welland canal, along the centre of Rodney St., up Davis St., and into INCO [Dave Reed, personal communication]. The long time use of leaded gasoline, improper disposal of batteries, and the weathering or removal of lead-based paint from exterior walls of residential dwellings may have contributed to the elevated soil lead concentrations.

The extent of the unexpectedly high soil metal levels was anticipated to be quite limited if the source was contaminated fill, and could be more extensive if fugitive or stack emissions were the source. In addition, the variability of the soil metal levels between properties made it difficult to judge the extent of the contamination. Therefore, in order to determine with certainty if the elevated soil metal concentrations are due to contaminated fill and limited only to Rodney St., 179 residential properties in the neighbourhood immediately west of the INCO refinery were sampled by MOE scientists and technicians from November 8th to 17th, 2000. The properties in this neighbourhood have been referred to in the extensive local media coverage, and will be referred to in this report, as “the Rodney St. community”. In addition to the residential sampling, soil trenches were dug at several locations in the vicinity of Rodney St. to determine if soil at depth was contaminated. Also, the city of Port Colborne requested that the MOE sample fill material that was used in the construction of a playground located on Welland St. north of Nickel St., and therefore trenches were dug in this park.

METHODS

Soil Sampling Strategy

In response to the request of the Medical Officer of Health, on October 3rd and 4th, 2000, MOE Phytotoxicology scientists sampled the front and back yards of the remaining 16 residential properties on Rodney St., and the baseball diamond at the southeast corner of Davis St. and Rodney St. Soil was sampled in duplicate at three sampling depths (0-5cm, 5-10 cm, and 10-15 cm) and placed in labelled polyethylene bags. Standard MOE sampling protocols were followed [4]. Tomato and pepper fruits, as well as surface soil (0-5 cm depth), were collected from a vegetable garden located in the backyard of one of the Rodney St. properties.

As a result of unexpectedly elevated soil metal levels from these 17 Rodney St. properties, the decision was made to sample soil in the front and back yards of the 179 properties situated in the ten block area located north of Rodney St. The sampling area consisted of all residential properties on the south side of Louis St. south to the lake and from Welland St. east to INCO, including; Rodney St., Welland St., Davis St., Fares St., Mitchell St., Kinnear St., Nickel St., Decew St., and the south side of Louis St. This neighbourhood has become known as the Rodney St. community. The sampling was conducted from November 8th to 17th, 2000.

At each of the 179 properties, a soil corer was utilized to collect soil samples from three depth intervals (0-5 cm, 5-10 cm, and 10-20 cm) from the front and back yards. Approximately ten to twelve cores were taken per soil depth increment while walking a grid pattern across the designated sampling area in each yard. Soil cores were placed in labelled polyethylene bags. All yards on all properties in the Rodney St. community were sampled, unless conditions made it impossible to collect a sample. For example, sampling to the 20 cm depth was not possible on every property, as occasionally very rocky fill was encountered. Also, some yards were covered with gravel, asphalt, concrete, or debris, which physically prevented the investigators from sampling both front and back yards on every property. In total 25 properties in the Rodney St. community were not sampled. Because of the large number of properties and the multiple

sample depths, on most properties only single samples were collected so that all samples could be analysed in a reasonable time (more than 1,300 samples were collected). Triplicate samples were collected at two properties on each block. This limited replicate sampling was done to provide a measure of sampling variability. All soil samples were collected at least 1 metre away from driveways, building structures, and fences.

Trench Sampling

Several 2 metre long by 0.5 metre wide trenches were dug using a backhoe supplied by the city of Port Colborne. The purpose of the trenches was to obtain soil samples at depth to determine how deep the contamination extended, and to observe the soil profile for signs of fill, refuse, or process waste. Trenches were excavated to a depth at which contact was made with natural clay, which was about 1 metre in all trenches. Duplicate soil samples were removed from the sides of each trench using a trowel at three depths: 30 cm, 60 cm (which were within what appeared to be layers of coarse fill material), and 90-100 cm, which coincided with the top of the natural clay soil. Soil samples were placed in labelled, polyethylene bags.

Seven trenches were excavated from four areas: 1) the baseball diamond, 2) a vacant lot, 3) the shoulder of Rodney St., and 4) a park. Two trenches were excavated in the baseball diamond at the southeast corner of Davis St. and Rodney St. One trench was located on the outfield side of second base, the second trench was dug in the middle of the outfield. Two trenches were excavated in the undeveloped grassy field situated on the south side of Rodney St. between Welland St. and Fares St. One trench was about 10 metres in from the northeast corner, and the second was about 10 metres in from the northwest corner. Two trenches were excavated on the west side of the playground located between Welland St. and Fares St., north of Nickel St. (the parkette is not named). In addition, 0-5 cm, 5-10 cm, and 10-15 cm duplicate soil samples were collected from eight sites along a sod-covered berm running around the north and west perimeter of the basketball court located in the parkette. Finally, a single trench was excavated on the north shoulder of the road, directly in front of the residence at 124 Rodney St.

Soil Sample Analyses

a) Analysis of metals and hydrides

All soil samples were stored in locked vehicles until they were delivered to the Ecological Standards and Toxicology Section laboratory for processing using standard MOE procedures [4]. The samples were air-dried and ground to pass through a 2mm sieve where vegetation and stoney debris were removed, and then ground a second time to pass through a 355 micron sieve. The fine soil fraction was transferred to the MOE Laboratory Services Branch (LSB). Because of the need to have the analyses conducted as quickly as possible, and with respect for competing laboratory workload commitments for other MOE projects and other communities, LSB arranged to have the Rodney St. community soil samples analysed by an accredited private environmental laboratory. LSB imposed a strict quality management regime on the private lab to ensure data

integrity. The soil samples were analysed for the following inorganic metals: aluminum, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, strontium, vanadium, and zinc. In addition, the hydrides arsenic, antimony, and selenium were also included in the soil analysis.

b) Determination of Soil pH

For the purpose of interpreting the bio-availability of the soil contaminant concentrations, soil pH was determined for a subset of soil samples collected from twenty properties across the ten blocks of the Rodney St. community. Generally, the selected properties were situated near intersections. MOE standard procedures for determining soil pH were followed [10].

c) Simulated Stomach Acid Leach Test

Ten soil samples containing very high nickel concentrations were selected for simulated stomach acid leach tests for estimating bio-availability for use in the human health risk assessment. Because this procedure is not a standard MOE/LSB protocol, it is described in detail. From each soil sample, 20 g of dried, sieved material was added to 400 ml of 0.17N HCl (pH 1.0) and agitated for 24 hours on a rotary extractor. The mixture was then filtered through a 0.45 micron membrane filter and the filtrate was analysed for the aforementioned metals and hydrides using standard LSB analytical protocols. For each sample, 'percentage leached' was then calculated by dividing the metal concentration ($\mu\text{g/g}$) in the filtrate by the total soil metal concentration ($\mu\text{g/g}$) and multiplying the ratio by 100.

d) Data Management and Laboratory Quality Control

In order to expedite the analysis of the 1300 plus soil samples collected from the Rodney St. community the MOE retained the services of an accredited private laboratory. The management of the contract lab was carried out by senior scientists and managers of the MOE LSB. The contract with Agat Laboratories was signed only after a thorough review of their proposal and laboratory procedures and a successful analysis of a pre-selected test sample. The MOE analysed the first 100 soil samples from the Rodney St. community. These same 100 samples were then analysed by Agat and the results compared. This initial comparison was done by staff of the MOE LSB Quality Management Unit. The acceptance criterion was 20%, which is similar to the criterion used for in-house quality control duplicate samples. In other words, each of the Agat Laboratory results had to be within 20% of the corresponding MOE results for the same sample. Only after this first quality assurance target was met successfully were the remaining Rodney St community samples sent to Agat.

All sample submissions sent to Agat contained at least four "check" samples which had been previously analysed as part of the original 100 samples. Each submission also contained field

replicate samples which could be used to measure repeatability of the sampling and analytical processes. The acceptance criteria were 20% for the check samples and 50% for the field replicates. The field replicates had a higher acceptance bracket because it was known from previous work in Port Colborne that between-replicate variability increased as the soil contaminant concentration increased. This is a common occurrence for non-homogeneous samples. Data checking was performed by the manager and a senior scientist of the MOE LSB Spectroscopy Section, as well as Phytotoxicology scientists. If the results for the "check" samples and the replicate data were acceptable, then the rest of the data were checked for outliers. Generally, outliers were found to be due to the improper use of dilution factors. Outlier sample results were either re-calculated or Agat was required to repeat the analyses. Once all these criteria were met, the data were released to the principal authors for use in the preparation of this report.

Several sample submissions were repeated because the ratios of certain elements did not match the observed general trend. In almost all cases, repeat analysis by Agat, and in some cases by MOE, confirmed the original result. Repeat analysis was continued until the data either matched the original "check" samples or were confirmed by MOE analysis. The requirement to conduct repeat analysis to insure data quality resulted in a 3 week delay in the scheduled completion of this phase of the program.

RESULTS

Nickel Speciation

In all previous MOE reports pertaining to soil contamination in Port Colborne the metal concentrations have been reported in $\mu\text{g/g}$ dry weight as total contaminant. "Total" refers to all the metal that can be extracted from the soil via the standard MOE LSB hot acid digestion process. This is a standard process used in all analytical labs for soil analysis. The recent MOE soil studies in Port Colborne made no attempt to determine the various metal compounds or metal species in local soil. This can be important for ecological and human health risk assessment because some metal compounds or species are more bioavailable or more toxic than others, and therefore pose a greater potential risk. For example, nickel chloride is much more soluble than nickel oxide. If most of the total nickel were present as nickel chloride then vegetation injury would be more likely to occur and more nickel would be absorbed into vegetable produce grown in nickel-contaminated soil and through the skin or the human gastrointestinal (GI) tract. The relative toxicities of nickel oxide, nickel chloride, and nickel subsulphide are discussed in more detail in the *Part B Human Health Risk Assessment* portion of this report.

Speciation of metals in soil is both a time consuming process because it requires specialized laboratory equipment and specially trained equipment operators/scientists. Because of the need for special equipment and operators the cost per sample can be several thousand dollars. In addition, it cannot confidently be done on soil samples unless the metal content is quite high (usually above 0.5% or 5,000 $\mu\text{g/g}$). For these reasons metal Speciation is not routinely

conducted in environmental investigations, and was not previously done on Port Colborne soil samples.

Nickel Speciation was conducted on selected soil samples collected from the Rodney St. community independently by both the Ministry of Northern Development and Mines (MNDM) Geoscience Laboratory in Sudbury [11] and by INCO [12]. Jacques Whitford Environmental Ltd. also submitted selected soil samples from across Port Colborne for metal Speciation as part of their sampling to determine Contaminants of Concern for the Community Based Risk Assessment currently underway in Port Colborne [14]. The MNDM report concluded that nickel oxide was detected in the magnetic fraction of each sample, and that no other nickel phase was detected in either the magnetic or non-magnetic fractions of any of the samples. The INCO report had similar conclusions: the only forms of nickel identified in the Rodney St. soil samples were elemental nickel, nickel alloys (e.g., nickel-copper alloy), and nickel oxide, but specifically neither sulfidic nor halide forms of nickel were detected. The Jacques Whitford results concurred with both the MNDM and INCO reports, in that nickel oxide was the only nickel compound detected, with no evidence of either sulphate or sulphide forms. In addition, correspondence in MOE files cites a 1978 INCO report of analyses of Port Colborne refinery dusts [13]. This report provides elemental analysis of dust collected from the Cottrell Precipitator, which captured dust from the Anode Reverb Furnaces during charging, smelting, and on-stream periods of operation, and so should represent stack emissions in the 1970s. The dust was 38.7% nickel, 10.5% lead, 7.6% copper, 7.1% sulphur, 0.66% cobalt, 0.61% iron, 0.38% arsenic, and 0.14% zinc. The main nickel component was nickel oxide, the main lead component was lead sulphate, and "minor phases" (not quantified) of hydrated nickel and copper sulphate were identified. Therefore, most of the nickel in stack emissions in the 1970s was nickel oxide, and three independent laboratories examining soil from the Rodney St. community and elsewhere across town concluded that nickel oxide, elemental nickel, and nickel metal alloys were the only nickel species found in Port Colborne soil in 2000: specifically, nickel chloride and nickel subsulphide were not identified in any samples.

The oxide form is the most common species of metal in soil around point sources of metal pollution. This is because the metals are either oxidized by the industrial processes or oxidized in the soil by sunlight, heat, moisture, and micro-organisms. Over time the more soluble and unstable metal forms are weathered away leaving the more insoluble and more stable metal oxides. Considering the nature of the refining process and the length of time the nickel has been in the soil it wasn't surprising that nickel oxide is the predominant form of nickel in soil in Port Colborne.

Soil Results

Soil analysis results for all 179 residential properties are summarized in Appendix Table A-1. Soil data in this table are summarized by front and back yards for all three sampling depths, and are identified by MOE/Phytotoxicology station number only. The property addresses that correspond to the station numbers are maintained in MOE files. Property owners/occupiers will

be informed of the station number that corresponds to their property when they receive their copy of this report, which will allow them to “decode” the data in Appendix A-1 and determine the contaminant status of their property. Soil results for samples collected from the trenches are summarized in Appendix Table A-2. Soil levels in Appendix A that exceed MOE Table A generic effects-based guidelines are identified by bold type face and are underlined. Soil concentrations that exceed human health risk-based soil intervention levels, where established, are shaded. Soil pH results for the ten selected soil samples containing very high soil nickel concentrations are listed in Appendix Table A-3. Results of the simulated stomach acid leach tests performed on these same ten soil samples are summarized in Appendix A-4. The mean soil pH and mean percent leach values are summarized in Table 1.

In Table 1 it is seen that soil pH is in the neutral range at all three sampling depths. This is consistent with fine-textured mineral soil and common in surface soil in southern Ontario.

The mean percentages of soil metal concentrations leached from the selected soil samples are very low. Specifically, on average only 0.82% of the nickel could be leached out of the soil samples, only 0.96% of the cobalt was leachable, and only 1.9% of the copper could be leached by simulated stomach acid. This is consistent with nickel being in the form of the very insoluble nickel oxide, and suggests the other metals are also present as insoluble metal oxides or metal alloys. The availability of lead was only slightly higher, averaging 3.8%. Considering the rigorousness of the leach process, it was designed to mimic the conditions and residency time of the human GI tract, the very low leachability indicates that bioavailability is very low. That means only a very small fraction, generally less than 4%, of the total amount of the contaminant in the soil can interact with the environment.

Very low bioavailability would also explain the rarity of nickel injury symptoms on vegetation in the Rodney St. community specifically and the Port Colborne area in general. If less than 1% of the total nickel in the soil is removed by a simulated stomach acid leach than substantially less would be dissolved in ambient soil water. In order for nickel to injure vegetation it must be dissolved in soil water, taken up through the roots, and translocated throughout the plant. With such low bioavailability there would be very little dissolved nickel in soil water resulting in a small potential for vegetation uptake and injury. The low soil bioavailability would also explain the poor relationship between soil nickel levels and nickel levels in residential garden produce (i.e., the nickel levels in garden produce were not consistently higher from properties that had high soil nickel concentrations).

DISCUSSION

a) Soil Results for Residential Properties

Table A effects-based generic criteria (residential/parkland landuses - medium/fine textured soils) were exceeded in soil on one or more of the residential properties in the Rodney St. community for the following 10 inorganic parameters: antimony, arsenic, beryllium, cadmium, cobalt, copper, lead, nickel, selenium, and zinc (refer to Appendix Table A-1). Table A criteria

for lead, antimony, and beryllium are based on human health, the criterion for selenium is based on the protection of grazing animals, the criteria for arsenic, cadmium, cobalt, copper, nickel, and zinc are based on ecological protection, specifically plant growth. Table 2 summarizes the number of properties in the study area for which soil concentrations exceeded MOE Table A generic effects-based criteria and the human health risk-based soil intervention level, as determined by the MOE human health risk assessment (Part B of this report).

Table 2 shows that soil nickel concentrations exceeded the Table A generic criterion on all but one of the properties in the Rodney St. community. It was evident from the condition of this one property that it had undergone extensive landscaping, so the contaminated soil had either been buried below the 20 cm sampling depth, or had been removed and replaced with clean soil. Very elevated soil nickel levels were expected in this area, since the contaminant contour maps prepared for the 1998 and 1999 MOE Port Colborne soil investigations indicated that soil nickel concentrations could range up to 5,000 µg/g in this community. Similarly, soil cobalt and copper concentrations were expected to be high, and 61% and 54% of the properties, respectively, in the Rodney St. community exceeded the Table A criteria for these two elements. A high percentage (80%) of the properties sampled in this investigation also had soil lead levels above the Table A criterion. Surprisingly, soil beryllium levels on almost one half (49%) of the properties exceeded the Table A criterion. The effects-based criteria for arsenic and zinc were exceeded on about one quarter of the properties, 29% and 17%, respectively. Exceedences were rare for antimony, cadmium, and selenium, occurring on only 3 properties (2%) for antimony, and one property each (1%) for cadmium and selenium.

Sixteen properties (9% of the total) exceeded the nickel intervention soil level of 10,000 µg/g. Ten properties (6%) exceeded the 1,000 µg/g lead intervention level, and 56 properties (31%) exceeded the toddler-specific bare soil 400 µg/g lead intervention level. The human health risk assessment concluded that there were no intervention levels for the other eight elements that exceeded the MOE Table A criteria. An explanation of how these intervention levels were derived is provided in the *Part B Human Health Risk Assessment* portion of this report.

Statistical analysis was carried out on the samples collected from the two properties on each block that were sampled in triplicate (single samples were collected from all other properties). Within-site sampling/analytical variability was acceptable for most elements (excluding antimony and selenium), in that standard deviation of the replicates was less than <20% of the mean value for the property. The standard deviations of the replicate samples for antimony and selenium, expressed as percentages of the mean concentration, were 24.2% and 24.6%, respectively. The concentrations of both antimony and selenium are naturally very low in soil, usually less than 0.5 µg/g. The high variability between sample replicates for these two elements was related to the difficulty that the contract laboratory had in consistently obtaining detection limits that were in the 0.5 µg/g range.

To illustrate the spatial distribution of soil contamination in the Rodney St. community, contaminant contour maps were created for selected elements using Surfer and ArcView computer mapping programmes. Because of the technical complexities associated with creating

contour maps from a very large data base, and because no spacial pattern was evident for some elements, maps were created only for the elements that exceeded the MOE Table A guidelines and for which the guideline rationale was health-based. Therefore, maps were prepared for nine of the ten elements identified in Table 2. Zinc was excluded, because with few exceptions the exceedences of the Table A criteria were marginal, and the rationale for the guideline is not health-based. A separate contaminant contour map was produced for each of the three sampling depths (0-5 cm, 5-10 cm, and 10-20 cm) for the nine contaminants antimony, arsenic, beryllium, cadmium, cobalt, copper, lead, nickel, and selenium. These maps are located in Appendices B1 to B27.

These maps are a very helpful tool for identifying spacial trends, particularly for very large data sets, such as the 35,000 parameters generated by the 1,300 plus samples collected from the 179 properties from the Rodney St. community. Although useful and generally quite accurate, particularly with a high sampling density as used in this study, the contour maps are still only estimates of soil concentrations based on a statistical model. The actual soil concentration is known with certainty only at the sites where the samples were collected. In addition, the contaminant contours may be skewed towards the edges of the maps because there are no sample points beyond the map borders and the computer model cannot "close" the contour loops. This is particularly evident in the area south of Rodney St. where there were only a few samples from the trenches, and in the northeast corner of Louis and Davis Sts.

It is evident from the contaminant contour maps, and the data in Appendix A, that soil contamination in the Rodney St. community, although extensive for some elements, is very patchy. Properties with much lower soil contaminant levels were often encountered between properties with much higher concentrations. Conversely, single properties with significantly elevated concentrations of some elements were surrounded by properties with much lower contaminant levels. This patchwork pattern is characteristic of neighbourhoods that have experienced historic atmospheric deposition that resulted in fairly uniform soil contamination relative to distance and direction from the source, and with substantial abatement of emissions, continued deposition did not result in further accumulation of contaminants in the soil. Over time with property landscaping or redevelopment, the contaminated soil is either diluted by coverage with clean soil or removed and replaced by clean soil. Landscaping need not be elaborate to substantially alter the surface soil contaminant levels. Simply filling low spots in a lawn with topsoil or re-sodding can add enough clean soil to dilute the residual contamination. The contamination status of undisturbed properties remains unchanged to create the soil contamination patchwork pattern that was observed across the Rodney St. community.

Regardless of the patchiness some contaminant contour gradients were obvious. The most consistent were nickel, copper, cobalt, arsenic, and selenium. These five elements tended to be highest in the easterly and southeasterly areas of the Rodney St. community, adjacent to the INCO refinery. The patterns of nickel (Maps B22-B24), copper (Maps B16-B18), and cobalt (Maps B13-B15) soil contamination were particularly similar, with the higher concentrations restricted to properties along Rodney, Davis, and Mitchell Sts. The maximum soil nickel level was 17,000 µg/g detected in the 5-10 cm depth of a property on Rodney St. The maximum soil

copper concentration was 2,720 µg/g in a sample from the 10-20 cm depth of a Mitchell St. property. The highest soil cobalt concentration, also from a Mitchell St. property, was 262 µg/g in the 5-10 cm soil profile. Although properties with high nickel levels also had elevated copper and cobalt concentrations, the maxima for these elements did not occur on the same property. Soil nickel, copper, and cobalt concentrations tended to be slightly higher in the lower sample depths.

The patterns of soil arsenic (Maps B4-B6) and selenium (Maps B25-B27) contamination were similar, with the highest levels centred on Rodney St., with scattered properties along Mitchell St., and a few on Davis St. Unlike nickel, copper, and cobalt, which exceeded their respective Table A guidelines on the majority of properties in the Rodney St. community, the extent of arsenic and selenium contamination was much more restricted with concentrations that were proportionately much lower. The maximum soil arsenic concentration was 350 µg/g in the 0-5 cm depth from a property on Rodney St. However, most soil arsenic levels were much lower, generally considerably less than 100 µg/g, with 71% of the properties in the Rodney St. community being below the Table A guideline of 20 µg/g. Although a soil selenium gradient was evident, only 1 property had selenium levels that exceeded the Table A guideline with a maximum concentration of 19.4 µg/g in soil collected from the 5-10 cm depth of a property on Mitchell St. Soil selenium levels are naturally low and therefore any elevation above background is noticeable, a fact that allowed for a contaminant gradient to become evident. Even though soil beryllium levels exceeded the Table A guideline of 1.2 µg/g on 49% of the properties in the Rodney St. community, unlike the other 8 elements for which maps were constructed, the beryllium contaminant contour maps (Maps B7-B9) did not indicate any spacial pattern. The highest soil beryllium level was 4.6 µg/g, which was detected in the 10-20 cm depth at a property on Mitchell St. Like the other metals, soil beryllium levels tended to be slightly higher at depth.

The contaminant contour maps for lead (Maps B19-B21), and to a lesser degree for cadmium (Maps B10-B12) and antimony (Maps B1-B3), did not illustrate a spacial pattern relative to INCO or specific streets, but rather identified numerous apparently random "hot spots". Soil lead levels exceeded the MOE Table A guideline of 200 µg/g at 80% of the properties, whereas cadmium and antimony exceeded the MOE guidelines on 1% and 2% of the properties, respectively. Even though the three elements were spatially related to each other (same general patterns on the contour maps) the soil lead concentrations were far higher than either the cadmium or antimony levels and the maximum concentrations did not occur on the same properties. For example, the maximum soil lead level was 1,800 µg/g, which occurred on Mitchell St. The maximum soil antimony level was 35 µg/g, encountered on a Louis St. property. The maximum soil cadmium concentration was also 35 µg/g, which occurred on Davis St. Like the other metals, these elements tended to be slightly higher at depth.

b) Statistical Analysis of Chemical Relationships

Results of Pearson Product Correlation Tests on the soil data from all depths are summarized in

tabular form in Appendix C. Due to the very large number of degrees of freedom (1300 plus) all r values greater than 0.08 are significantly correlated at the 95% level. The higher the r value the stronger the correlation between the elements. Negative r values indicate an inverse relationship (i.e., one soil concentration increases as the other decreases).

Nickel, copper, and cobalt in surface soil in the Port Colborne area is unquestionably associated with INCO emissions. Of these three elements, nickel is a "signature" contaminant, meaning that it is present in the highest concentration, is the most extensive in area, and has the most consistent concentration gradient relative to distance and direction from INCO. Therefore, elements that are highly correlated with nickel are also likely related to INCO emissions. Aluminum is not associated with INCO emissions, or any other known current or historic pollution source in the area of the Rodney St. community, but it is the second most abundant element in the earth's crust. Therefore, elements that are highly correlated with aluminum are likely natural in origin.

Soil nickel concentrations in soil in the Rodney St community are very highly correlated with soil cobalt ($r = 0.93$), copper ($r=0.87$), iron ($r=0.82$), selenium ($r=0.77$), zinc ($r=0.71$), and arsenic ($r=0.60$) levels, suggesting that INCO emissions may also be the source of these elements. The high statistical correlation is corroborated by the contaminant contour maps which clearly illustrate a strong spatial relationship between nickel, copper, cobalt, and to a lesser extent arsenic and selenium (zinc and iron were not mapped). Previous MOE soil sampling in the Port Colborne area identified elevated soil copper and cobalt levels as having originated from INCO emissions. However zinc, arsenic, selenium, and iron levels in soil in areas other than the Rodney St. community have not been consistently elevated above MOE guidelines and there is little evidence of a spatial relationship to INCO.

Soil aluminum levels in the Rodney St. community are very highly correlated with vanadium ($r=0.89$) and beryllium ($r=0.79$). This, and the lack of a consistent soil spatial pattern, suggests the elevated beryllium concentrations detected on some properties are natural in origin.

Soil lead levels are highly correlated with zinc ($r=0.75$) and barium ($r=0.74$). These three elements are common components of older lead-based paint. Also, the historic use of leaded gasoline has substantially added to the soil lead levels in all urban areas. Even though lead was emitted from the INCO stack (it made up about 10% of the precipitator dust in the 1970s [13]) the lack of a consistent soil spatial pattern in the Rodney St. community suggests that most of the lead is associated with residential use of lead-based exterior paint.

Scatter plots were created to illustrate the relationship between nickel and many of the other elements (see Appendix C-1 to C-14). The scatter plots, in conjunction with the Pearson correlation coefficients ($r>0.50$) and principal component analysis suggest three distinct soil contaminant groupings in the Rodney St. community, with overlap for a few chemicals:

- 1) the nickel group, consisting of nickel, cobalt, copper, iron, selenium, zinc, and arsenic, are related to nickel with a correlation coefficient of at least 0.50,

2) the lead group, consisting of lead, zinc, barium, and copper, are related to lead with a correlation coefficient of at least 0.50, and

3) the aluminum group, consisting of aluminum, vanadium, and beryllium, are related to aluminum with a correlation coefficient of at least 0.50.

c) Results of Trench Samples

The results of chemical analysis of soil samples removed from the walls of the various trenches are summarized in Appendix Table A-2. Based on visual identification in the field, all seven of the trenches contained some fill material, including rocks, brick pieces, coal and coal ash, metal debris, cinders, slag, and unidentified coarse-textured lighter coloured material. The natural clay layer was encountered at about 1 metre in all trenches. The main contaminants in the trench soil were nickel, copper, cobalt, zinc, iron, and to a lesser lead, arsenic, and beryllium. The iron concentrations were quite elevated in some samples, ranging up to almost 17% (170,000 $\mu\text{g/g}$ at 60 cm depth from the trench on the shoulder of Rodney St.). These high iron levels possibly reflect the abundance of metal debris observed in some trench layers.

The two trenches from the ball diamond park at the south end of Rodney St. were contaminated with nickel to the bottom of the trench, a depth of about 1 metre, with concentrations ranging from 304 $\mu\text{g/g}$ to 6,680 $\mu\text{g/g}$. The maximum arsenic level was 33.1 $\mu\text{g/g}$, the maximum copper level was 524 $\mu\text{g/g}$, and the maximum cobalt concentration was 88.8 $\mu\text{g/g}$. The nickel, copper, cobalt, and arsenic levels all tended to be higher at depth. Most other elements, notably lead, were quite low.

The trench excavated on the shoulder of Rodney St. and the two trenches excavated in the vacant lot on the southwest corner of Rodney and Fares Sts. were similar in that the maximum contaminant levels tended to be closer to the surface. For example, in the Rodney St. trench the soil nickel levels ranged between 8,900 $\mu\text{g/g}$ and 9,730 $\mu\text{g/g}$ to approximately 35 cm and then dropped to 204 $\mu\text{g/g}$ at approximately 60 cm. Similarly, the arsenic concentrations ranged from 30.7 $\mu\text{g/g}$ and 43.1 $\mu\text{g/g}$ in the top 65 cm, then fell to background below this depth. The contaminant loading in the trenches from the vacant field tended to be lower than in the Rodney St. and ball diamond park trenches. Unlike the ball diamond park trenches, which had high nickel levels at all depths, the trench on the shoulder of Rodney St. and both trenches in the vacant field had the highest metal levels near the surface, with the layer of contamination abruptly ending between 30 and 60 cms.

The two trenches excavated in the parkette on the east side of Welland St. tended to have lower soil contaminant levels than the other trenches. Although nickel levels were elevated to the bottom in the west trench, all other contaminants were confined to the top 65 cm. Similarly, in the east trench all the contamination was confined to the top 65 cm, falling to virtually background levels below this depth. By comparison, the soil from the trenches from the two sodded berms located on the perimeter of the parkette's basketball court was much cleaner than

the other trenches. Only a few samples exceeded the MOE Table F background-based guidelines, and only a single sample exceeded the Table A effects-based guideline for beryllium.

Soil contamination was deepest in the baseball park, suggesting this area had received at least 1 m of metal-contaminated fill. Judging by the presence of debris in the other trenches, it was evident those areas had also been filled, although metal-contamination was mostly confined to the upper 30 to 60 cm. Therefore, outside of the baseball park metal-contaminated material was used as top-spread, rather than as fill, perhaps to level the ground in preparation for or subsequent to building. It is also possible that, outside of the obvious deep fill in the baseball park, the soil metal contamination in the area of the trenches is from atmospheric deposition because it is confined to the near surface layer. If this is the case, then the soil contamination in the Rodney St. community can be expected to extend to at least 30 cm in depth.

Soil Contamination: Source Allocation

The soil heavy metal levels in the Rodney St. community are higher than have currently been detected elsewhere in Port Colborne. The soil contamination could be related to 1) historic fugitive emissions from INCO, 2) INCO stack emissions, 3) emissions from other historic industries in the area (eg. Algoma Steel/Canada Furnace), 4) contaminated fill from local or unknown industrial, municipal or construction waste, 5) domestic residential sources, or 6) some combination of these.

The soil nickel, copper, and cobalt contamination documented in Port Colborne and the surrounding area in the 1998 and 1999 MOE investigations [1,2] is unquestionably related to long term atmospheric deposition of INCO's emissions. The area to the northeast of INCO is the zone of maximum deposition. The nickel:copper and nickel:cobalt soil ratios from this area are 9.9:1 (nickel:copper) and 56:1 (nickel:cobalt), and are remarkably consistent to soil ratios from all the samples collected in the Rodney St. community, 10.1:1 (nickel:copper) and 51:1 (nickel:cobalt), and the trench samples, 9.5:1 (nickel:copper) and 44:1 (nickel:cobalt). By comparison, using the natural background levels for Ontario soil (Table F in the MOE *Guideline for Use at Contaminated sites in Ontario* [6]) the ratios for these three elements in uncontaminated soil are 0.5:1 (nickel:copper) and 2.0:1 (nickel:cobalt), which illustrates the unique soil contaminant signature of INCO's Port Colborne refinery. This is very strong evidence that the nickel, copper, and cobalt contamination detected in the Rodney St. community is related to atmospheric emissions from INCO. Because of the very high correlation coefficients between nickel and arsenic ($r=0.60$), nickel and selenium ($r=0.77$), and nickel and zinc ($r=0.71$), the elevated concentrations of these three elements in soil in the Rodney St. community are concluded to have originated from INCO emissions. This is corroborated by the 1978 report [13] that identified arsenic as 0.38% (3,800 $\mu\text{g/g}$) and zinc as 0.14% (1,400 $\mu\text{g/g}$) of INCO's stack dust. However, soil zinc contamination can also be associated with residential sources, and so not all of the soil zinc contamination in the Rodney St. community is related to INCO.

The spatial distribution of the nickel, copper, cobalt, arsenic, selenium, and zinc soil contamination is consistent with a source to the south and east of the Rodney St. community, as the soil concentrations are highest on Rodney St. and Davis St., and to a lesser degree on Mitchell St. The zinc pattern tends to be a little more scattered but a southeasterly gradient is still apparent. In addition, the observation that the highest soil contaminant levels tended to be just below the surface in the 5-10 cm or even 10-20 cm depth is consistent with an atmospheric deposition source that was much greater in the past. With the cessation of atmospheric deposition heavy metals do move down through the surface soil, although this can take decades and the downward movement is usually only a few centimetres. If the amount of metal contaminant falling onto the soil were constant, the upper-most soil layer would have the highest metal concentration because the rate of accumulation at the surface exceeds the rate of downward percolation. Fugitive emissions from INCO in the early years of operation, particularly before the stack was constructed in 1929, would have been very substantial. The Rodney St. community is immediately adjacent to the refinery and would have been significantly impacted by high levels of atmospheric metal loading and deposition resulting in rapid accumulation of heavy metals in surface soil. When the stack was constructed, the fugitive emissions would have been somewhat abated and the rate of deposition to soil in the Rodney St. community would have been reduced. Eventually, the rate of accumulation in the surface soil fell below the rate of downward percolation resulting in a slow but consistent downward migration of the heavy metal contamination out of the top 5 cm of the surface soil and into the near-surface and sub-surface soil layers at a depth of 10 to 20 cm.

This is exactly the pattern observed in soil lead levels in Toronto. In the 1970s, lead from leaded gasoline combustion was ubiquitous in the Toronto airshed resulting in high ambient air lead levels and subsequent deposition and accumulation of lead in surface soil. MOE soil sampling confirmed the lead concentration in 0-5 cm surface soil in Toronto in 1971 averaged 196 $\mu\text{g/g}$ and 125 $\mu\text{g/g}$ in the 10-15 cm depth. Leaded gasoline was phased out in the early 1980s resulting in substantial reductions in ambient air lead levels and a virtual cessation of lead deposition to soil. A repeat sampling of the same sites in 1991 showed that with the elimination of lead deposition from the air the lead had moved down into the soil such that the lead levels in the 10-15 cm samples were higher (311 $\mu\text{g/g}$) than the 0-5 cm samples (185 $\mu\text{g/g}$).

The elevated lead levels in soil in the Rodney St. community are not related to INCO emissions. The pattern of lead contamination is not spatially similar to nickel, copper, or cobalt, and there is no southeasterly concentration gradient towards INCO. Instead high lead levels are randomly scattered throughout the community. Lead levels in soil are highly correlated with barium, copper, cadmium, cobalt, chromium, and zinc, and notably poorly correlated with nickel. These elements (nickel excepted) were common anti-mildew and anti-fungal additives in paint manufactured up to the mid 1970s. Previous Phytotoxicology investigations have clearly linked residential soil contaminated by these elements to the erosion, weathering, and/or removal of exterior leaded paint. Paint chips from flaking paint are often visible on the soil. Analysis of these chips collected from residential yards of older urban homes in Toronto showed that the paint contained up to 33% lead (310,000 $\mu\text{g/g}$), 12.4% zinc (124,000 $\mu\text{g/g}$), and 0.85% chromium (8,500 $\mu\text{g/g}$) [15]. The soil lead and zinc concentrations of these yards ranged up to

890 µg/g and 445 µg/g, respectively. Almost every year Phytotoxicology scientists assist MOE District Environmental Officers and local health unit inspectors in the investigation of blood lead poisoning of very young children. In almost every case the lead source is found to be lead-contaminated soil from flaking or eroded exterior lead-based paint.

On a few properties in the Rodney St. community high soil lead levels are spatially correlated with high soil antimony concentrations. Antimony is commonly alloyed with lead as a hardening agent, and was used extensively in battery manufacture, particularly automotive lead-acid batteries. Phytotoxicology investigations around secondary lead smelters that used lead-acid batteries in their feed stock and around battery manufacturers routinely identified soil lead and antimony contamination.

Lead is an ubiquitous soil contaminant that is generally higher in urban communities because of the historic use of leaded gasoline. The combination of historic deposition of lead from leaded gasoline and the chronic deposition of flaking and peeling exterior leaded paint has resulted in consistently elevated soil lead levels in urban communities across Ontario. Older urban communities have the highest soil lead levels because the soil has been exposed to greater numbers of vehicles for a longer period of time. In addition, older urban communities have older homes that may have been painted many times over the years, and therefore have had a longer time to accumulate weathered paint in the soil. In the Rodney St. community of Port Colborne 80% of the properties exceeded the MOE Table A generic effects-based soil lead guideline, and the average soil lead level was 222 µg/g. In Toronto the MOE has been monitoring environmental lead levels for 25 years in a community that has no known industrial source of lead pollution. In this community, which is similar to the Rodney St community in age and style of home construction, 78% of the residential properties exceed the MOE Table A lead criterion and the average soil lead level is 486 µg/g.

Soil lead concentrations in the 1,000 µg/g range, such as detected at a few scattered properties in the Rodney St. community, are entirely consistent with residential lead sources typical of older urban communities rather than related either to INCO emissions or contaminated fill material. Lead comprised 10.5% of the Cottrell Precipitator dust in 1978, and the precipitator dust nickel:lead ratio was approximately 4:1 [13]. If nickel and lead went up the stack in a 4:1 ratio then they should be present in soil downwind of the stack in about the same ratio. Based on the 1998 and 1999 MOE soil investigation reports in Port Colborne, at sample sites with soil nickel levels greater than 1,000 µg/g the average soil nickel level was 2,120 µg/g and the average soil lead concentration is 98 µg/g, which is a nickel:lead ratio of about 22:1. Similarly, the average soil nickel level in the Rodney St. community (excluding the trench data) is 2,545 µg/g, and the average soil lead concentration is 222 µg/g, for a nickel:lead ratio of 12:1. Clearly the soil lead levels in both the Rodney St. community and elsewhere in Port Colborne where soil nickel levels are elevated are much lower than anticipated if lead were co-emitted with nickel at the rate suggested by the precipitator dust. The 1978 document identifies nickel oxide as the most prevalent nickel compound, and lead sulphate as the most prevalent lead compound. Nickel oxide is very insoluble and therefore would not readily be leached from the soil. In contrast, lead sulphate is much more soluble and would likely be leached from the soil more readily than nickel

oxide. Current levels of lead in soil in Port Colborne in general, and the Rodney St. community specifically, have no spacial relationship relative to INCO and are not consistently statistically correlated with nickel. Although INCO emissions may have contributed to the overall soil lead burden in the Rodney St. community, historic vehicle emissions from the combustion of leaded gasoline and residential sources, such as weathered exterior lead-based paint, are both far more significant and known lead sources that could account entirely for the soil lead levels encountered in this study.

The MOE has recently become aware of circumstances where elevated concentrations of naturally-occurring beryllium were found to be associated with shale deposits. In view of the suspected toxicity of the metal, the presence of numerous deposits of shale in Ontario, and the practice of using shale as fill material, in 1997 MOE Phytotoxicology scientists undertook a province-wide sampling program of representative shale deposits in Ontario. Seven of the 12 shale formations sampled, or 58%, had beryllium concentrations in the shale rock and the adjacent soil overburden that exceeded the MOE Table A health-based guideline of 1.2 µg/g [5].

Although the average soil beryllium concentration in the Rodney St. community was 0.98 µg/g, which is consistent with typical Ontario background levels, a surprising number of properties (49%) had soil beryllium concentrations that exceeded the MOE Table A guideline (1.2 µg/g). The highest beryllium concentration found in the province-wide shale study was 3.4 µg/g, detected in samples collected from the Animikie-Gunflint shale formation in the Thunder Bay area. The Queenston and Rockcliffe shale formations, closer to Port Colborne, had beryllium concentrations ranging up to 2.3 µg/g. Only two soil samples of the 1,300 samples collected from the Rodney St. community had beryllium levels greater than 2.3 µg/g. The marginally elevated soil beryllium levels in this community are entirely consistent with naturally-occurring beryllium in soil derived from shale, although the number of properties with beryllium concentrations higher than the provincial background was unexpected. In addition, the soil beryllium concentrations in the Rodney St. community are very highly correlated with soil aluminum levels ($r=0.79$, $p<0.001$), which implies the beryllium is natural in origin.

Slag has a beryllium concentration that routinely ranges from 1 to 3 µg/g. Historic photographs of the Rodney St. community show most of the roads in place by 1917. Anecdotal information suggests that slag was a common material for roadbed construction in this community. Slag was observed on road shoulders, in some of the trench samples, and was frequently encountered while sampling the residential properties. Slag was identified in the scanning electron microscope photographs of soil samples collected from several Rodney St. properties. It is evident that slag is present at the surface in the Rodney St. community, and this presence could also account for the generally higher than expected soil beryllium levels.

The highest soil beryllium concentration detected in the Rodney St. community was 4.6 µg/g, which occurred at the same property that had significantly elevated soil lead levels (877 µg/g). This property also had high arsenic, barium, nickel, cobalt, copper, and zinc concentrations. Although soil lead levels and soil beryllium levels across the Rodney St. community are not highly correlated ($r=0.29$), the spacial relationship between beryllium and lead at this single

property is not likely co-incidental (compare beryllium Maps B7, B8, and B9 with lead Maps B190, B20, and B21 in Appendix B). It is certain that the beryllium levels on this property are not related to INCO emissions because the statistical relationships between soil beryllium and soil nickel ($r=0.08$), copper ($r=0.16$), and cobalt ($r=0.11$) are less significant than the beryllium and lead relationship. In addition, beryllium and arsenic soil levels are actually inversely related (negative correlation coefficient, $r = -0.03$, as arsenic levels increase beryllium levels decrease, and visa versa). Soil beryllium levels are more highly correlated with barium ($r=0.60$) than with antimony ($r=0.10$), which suggests that the elevated lead and beryllium levels on this property are related to paint rather than batteries. Although the high beryllium levels in soil on this property appear to be related to leaded paint, that is not the case elsewhere in the Rodney St. community because other than this single property there is no consistent spacial relationship between soil beryllium and soil lead concentrations. With the exception of this one property, the marginally elevated beryllium levels in soil in the Rodney St. community are a combination of high natural levels because of local shale deposits and slag.

Conclusions

The average soil nickel concentration in the Rodney St. community was 2,545 $\mu\text{g/g}$. This is consistent with the 1998 and 1999 MOE soil investigations that predicted this area of Port Colborne could have between 2,000 $\mu\text{g/g}$ and 4,000 $\mu\text{g/g}$ nickel in surface soil. However, property by property sampling revealed substantial variation in both the numbers of contaminants and the soil contaminant concentrations. Of the 1,300 plus samples collected from 179 properties, 99% of the properties had soil nickel levels that exceeded the MOE Table A effects-based criterion of 200 $\mu\text{g/g}$ and 16 properties (about 9%) exceeded the 9,750 $\mu\text{g/g}$ risk-based value used in the 1997 MOE/Regional Niagara Public Health Department Human Health Risk Assessment report. The maximum soil nickel level was 17,000 $\mu\text{g/g}$. In addition to nickel, the MOE Table A guidelines were exceeded for lead on 80% of the properties, cobalt on 62% of the properties, copper on 54% of the properties, beryllium on 49% of the properties, arsenic on 29% of the properties, zinc on 17% of the properties, antimony on 2% of the properties, and 1 % of the properties had soil levels exceeding the selenium and cadmium MOE guidelines. For most elements on most properties, the soil contaminant concentrations tended to increase with depth. If the trenches excavated in the vacant lot south of Rodney St. and the park east of Welland St. are representative of the soil profiles across the community then soil contamination on residential properties in the Rodney St. community may extend to 30 cm, but should rapidly fall to background levels below that depth.

Soil nickel, copper, cobalt, and arsenic contamination in the Rodney St. community is unquestionably related to INCO. Because of the high degree of spacial and statistical relationship with these four elements, elevated soil selenium and possibly zinc levels are also likely related to INCO. Although there is evidence to suggest that the baseball park at the southeast corner of Rodney and Davis Sts. may have been created from metal-contaminated fill, the source of the soil nickel, copper, cobalt, arsenic, and to a lesser degree selenium and zinc contamination, across the community is believed to be fugitive INCO emissions that occurred

early in the refinery's operating history, perhaps before the construction of the stack in 1929. Although some post-stack fugitive and stack emissions likely contributed to the soil metal contamination, atmospheric heavy metal deposition to the Rodney St. community would have been reduced after 1929. The height of the stack, in conjunction with the strong non-snow season southwesterly prevailing winds, dispersed most of the emissions to the northeast after the stack was built.

The highest soil nickel, copper, cobalt, arsenic, selenium, and zinc soil concentrations occurred on properties in the southeastern area of the Rodney St. community along Rodney, Mitchell, and Davis Sts. Based on the contaminant contour maps it is likely that elevated soil metal levels may extend slightly further along Davis St. north of Louis St. Further soil sampling is also warranted in the residential communities immediately adjacent to the north northwest, north, and north northeast of INCO, to ensure the previous MOE investigations have not underestimated the soil metal levels in these areas of Port Colborne.

The randomly scattered soil lead contamination observed in the Rodney St. community is related to domestic residential lead sources and not to INCO 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 St. community are not unique either in extent or concentration. On properties where the soil lead levels were elevated the concentrations of cadmium, chromium, copper, barium, and zinc often were proportionately elevated. 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. Antimony was another element that was highly correlated with lead, although it exceeded MOE guidelines on only 3 properties. Antimony is commonly alloyed with lead, particularly in lead-acid batteries. Lead and antimony soil contamination is an indication that batteries may have been stored or disposed of on the property, whereas lead and barium, and lead and zinc soil contamination is a signature of lead-based paint.

Although the average soil beryllium level in the Rodney St. community was comparable to the provincial soil background concentration, almost one-half of the properties exceeded the MOE Table A guideline. Soil beryllium levels marginally above the guideline are not unusual, because the guideline and the upper end of the background range are the same (1.2 µg/g). Also, MOE investigations have documented that shale, and soil derived from shale, regularly exceed the guideline. In addition, slag has a beryllium concentration that is above the guideline, and slag is present at the surface across the Rodney St. community. With the exception of one property where elevated beryllium levels were concurrent with high lead and other heavy metals, the marginally elevated soil beryllium concentrations across the Rodney St. community are related to the presence of slag and local shale deposits.

Considerable variability in soil contaminant levels was evident between adjacent properties. This "patchwork" pattern of high and low soil contamination on neighbouring lots is related to property maintenance and landscaping. Adding topsoil or mulch, re-sodding, building, and

cultivated 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.

The bioavailability of the soil contaminants found in the Rodney St. community is very low, in the range of 1% for most metals and up to 3.8% for lead. This means the contaminants are relatively immobile in the soil, so they are not easily dissolved in soil water and therefore are not readily taken up by plants. This low Bioavailability accounts for the remarkably minor amount of nickel injury observed on species of vegetation known to be sensitive to nickel in areas of Port Colborne where the soil nickel levels are substantially above the MOE ecotox-based soil guideline. Most, if not all, of the nickel in soil in Port Colborne is present as nickel oxide.

With the cessation of atmospheric deposition, contaminants should no longer accumulate at the soil surface and the fact that soil contaminant levels in the Rodney St. community tend to be higher in subsurface soil layers is a further indication that the sources of contamination are historic. However, this does not imply that over time the contaminants will continue to move downwards in the soil profile and eventually be deep enough so that they no longer pose a potential ecological or human health concern. Soil is a dynamic chemical, mechanical, and biological ecosystem, and at the microcosm scale, soil is constantly in flux. Limited MOE studies in other communities where soil has been contaminated by historic industrial air emissions have indicated that soil contaminants can move upwards through the soil column with soil water through evapotranspiration and they can move downwards through the soil by gravity and soil water percolating down through soil pores, root, and insect channels. In addition soil contaminants can be brought back to the surface from considerable depth as a result of tunnelling by ants, earthworms, and other soil macro- and microorganisms. The result is that over time, likely decades, soil contaminants that originated on the surface tend to get uniformly mixed into the top 30 or so centimetres of soil.

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Table 1: Summary of soil pH and Percent Leach* Data (means of ten soil samples)

| Chemical Parameter | 0 - 5 cm depth | 5 - 10 cm depth | 10 - 20 cm depth |
|--|---|---|--|
| Mean Soil pH | 7.19 | 7.23 | 7.49 |
| | | | |
| | Mean Total Soil Concentration (µg/g) | Mean Leach Soil Concentration (µg/g) | % Leach Estimate of Bioavailability |
| Aluminum | 8780 | 108 | 1.3 |
| Antimony | 2.28 | 0.0031 | 0.14 |
| Arsenic | 48 | 0.53 | 1.1 |
| Barium | 159 | 4.8 | 3.2 |
| Cadmium | 0.2<W | 0.006 | nc |
| Calcium | 21700 | 992 | 4.61 |
| Chromium | 41 | 0.21 | 0.51 |
| Cobalt | 174 | 1.64 | 0.96 |
| Copper | 897 | 17 | 1.9 |
| Iron | 84600 | 209 | 0.26 |
| Lead | 361 | 13.7 | 3.8 |
| Magnesium | 6940 | 251 | 3.56 |
| Manganese | 1016 | 33 | 3.23 |
| Nickel | 12600 | 101 | 0.82 |
| Selenium | 8.6 | nc | nc |
| Strontium | 71 | 2.9 | 4.03 |
| Vanadium | 33 | 0.36 | 1.1 |
| Zinc | 918 | 20 | 2.21 |
| * simulated stomach acid leach nc - not calculated, leach data below analytical detection limit | | | |

Table 2: Number and percentage of properties in the Rodney St. community with soil concentrations exceeding MOE Table A generic criteria and human health-based risk levels in one or more of the three sampling depths (0-5cm, 5-10cm or 10-20cm). Total number of properties is 179.

| Chemical Parameter | Number of properties where soil exceeds Table A criterion | Percentage of properties where soil exceeds Table A criterion | Number of properties where soil exceeds intervention level | Percentage of properties where soil exceeds intervention level |
|--------------------|---|---|--|--|
| Antimony | 3 | 2% | 0 | 0% |
| Arsenic | 51 | 29% | 0 | 0% |
| Beryllium | 87 | 49% | 0 | 0% |
| Cadmium | 1 | 1% | 0 | 0% |
| Cobalt | 110 | 62% | 0 | 0% |
| Copper | 97 | 54% | 0 | 0% |
| Lead | 143 | 80% | 10 ¹ (56) ² | 6% (31%) |
| Nickel | 178 | 99% | 16 ³ | 9% |
| Selenium | 1 | 1% | 0 | 0% |
| Zinc | 30 | 17% | 0 | 0% |

1 - 1,000 µg/g
 2 - 400 µg/g
 3 - 10,000 µg/g
 See Part B Human Health Risk Assessment for an explanation of the soil intervention levels.

Table 3: Ratios of Nickel, Copper, and Cobalt from Three Areas in Port Colborne

| Area | Mean Soil Metal Concentration (µg/g) | | | Metal Soil Ratios | |
|-----------------------------------|--------------------------------------|-----|----|-------------------|-------|
| | Ni | Cu | Co | Ni:Cu | Ni:Co |
| NE of INCO ¹ | 1809 | 182 | 32 | 9.9:1 | 56:1 |
| Rodney St. Community ² | 2545 | 250 | 50 | 10.1:1 | 51:1 |
| Trench Samples ³ | 1401 | 148 | 32 | 9.5:1 | 44:1 |
| Natural Background ⁴ | 43 | 85 | 21 | 0.5:1 | 2.0:1 |

1 - mean of 8 1998/1999 MOE sample sites to the NE of INCO in the maximum deposition zone
 2 - mean of all Rodney St. Community samples
 3 - mean of all trench samples, excluding the park berms
 4 - MOE Table F

Appendix A: Results of Chemical Analysis

Interpretation of Table A1 and A2

The results of the analysis for twenty inorganic parameters in soil from the 179 residential properties in the Rodney St. Community west of INCO sampled in the fall of 2000 are summarized in Table A1. In order to fit all of the results from each sampling location onto one table for comparison purposes, the standard chemical abbreviation had to be used. To help interpret the data in Table A1 the chart below gives the full chemical name and it's standard chemical abbreviation.

| Chemical | Abreviation | Chemical | Abreviation | Chemical | Abreviation |
|-----------------|--------------------|-----------------|--------------------|-----------------|--------------------|
| Aluminum | Al | Antimony | Sb | Arsenic | As |
| Barium | Ba | Beryllium | Be | Cadmium | Cd |
| Calcium | Ca | Chromium | Cr | Cobalt | Co |
| Copper | Cu | Iron | Fe | Lead | Pb |
| Magnesium | Mg | Manganese | Mn | Molybdenum | Mo |
| Nickel | Ni | Selenium | Se | Strontium | Sr |
| Vanadium | V | Zinc | Zn | | |

Bold faced and underlined data exceed the MOE Table A generic effects-based guideline for residential/parkland landuses, medium/fine textured soils.

An asterisk (*) in the soil depth column, indicates the sample was analyzed more than once for quality assurance purposes and the results reported are the average of all of the analysis.

“nd” indicates no data, either because the sample was lost or the container broke.

Soil from the 17 Rodney St. properties was not analyzed for antimony (“na”), as these samples were collected and analyzed before the other properties in the general Rodney St. community were collected.

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|----|-------|-----|-------|-------|-------|----|-----|-----|--------|-----|------|------|-------|-------|------|-----|----|------|
| 2022013 (Front yard) | 0-5 cm | 5200 | na | 35.0 | 100 | <0.25 | 0.50 | 11000 | 35 | 120 | 510 | 58000 | 290 | 3200 | 800 | 2.1 | 6400 | 5.70 | 41 | 24 | 660 |
| | 0-5 cm | 5200 | na | 37.0 | 110 | <0.25 | 0.70 | 12000 | 37 | 110 | 470 | 53000 | 300 | 3400 | 800 | 2.2 | 5500 | 5.70 | 38 | 24 | 620 |
| | 5-10 cm | 5500 | na | 65.0 | 130 | 0.6 | <0.10 | 9900 | 49 | 220 | 990 | 130000 | 400 | 3200 | 1200 | 3.7 | 16000 | 6.90 | 37 | 34 | 1100 |
| | 5-10 cm | 5800 | na | 110.0 | 140 | 0.6 | 0.40 | 11000 | 44 | 150 | 770 | 90000 | 480 | 3300 | 1100 | 3.0 | 9200 | 8.70 | 41 | 29 | 990 |
| | 10-15 cm | 7300 | na | 30.0 | 99 | <0.25 | <0.10 | 11000 | 19 | 57 | 430 | 38000 | 190 | 4000 | 560 | <0.25 | 4900 | 3.90 | 36 | 24 | 420 |
| 2022014 (Back yard) | 10-15 cm | 7500 | na | 42.0 | 140 | 0.6 | <0.10 | 12000 | 36 | 84 | 660 | 51000 | 240 | 3900 | 740 | 1.4 | 7100 | 5.10 | 42 | 25 | 620 |
| | 15-20 cm | 7100 | na | 18.0 | 90 | <0.25 | 0.50 | 17000 | 20 | 30 | 200 | 26000 | 100 | 4400 | 400 | 1.3 | 2100 | 2.50 | 45 | 21 | 260 |
| | 15-20 cm | 6800 | na | 13.0 | 78 | <0.25 | 0.30 | 16000 | 15 | 18 | 130 | 17000 | 140 | 4000 | 300 | <0.25 | 1200 | 2.10 | 42 | 19 | 170 |
| | 0-5 cm | 7800 | na | 15.0 | 67 | <0.25 | 0.50 | 14000 | 22 | 48 | 210 | 30000 | 93 | 4800 | 470 | 0.8 | 2400 | 2.80 | 49 | 24 | 340 |
| | 0-5 cm | 6700 | na | 20.0 | 68 | <0.25 | 0.60 | 14000 | 24 | 49 | 240 | 30000 | 99 | 4700 | 500 | 1.2 | 2600 | 3.80 | 49 | 21 | 330 |
| 2022501 (Front yard) | 5-10 cm | 5900 | na | 20.0 | 74 | <0.25 | 0.40 | 15000 | 23 | 58 | 260 | 31000 | 110 | 4500 | 490 | 1.1 | 2800 | 3.90 | 59 | 21 | 390 |
| | 5-10 cm | 5500 | na | 32.0 | 87 | <0.25 | <0.10 | 16000 | 28 | 96 | 420 | 53000 | 170 | 4400 | 640 | 1.5 | 5100 | 8.70 | 64 | 24 | 520 |
| | 10-15 cm | 6800 | na | 28.0 | 100 | 0.6 | 0.50 | 20000 | 29 | 110 | 390 | 45000 | 180 | 5400 | 650 | 1.9 | 4300 | 5.20 | 86 | 28 | 550 |
| | 10-15 cm | 5600 | na | 29.0 | 99 | <0.25 | 0.40 | 16000 | 27 | 100 | 410 | 47000 | 220 | 3700 | 650 | 1.5 | 4400 | 5.50 | 82 | 26 | 550 |
| | 15-20 cm | 7900 | na | 39.0 | 150 | 0.7 | 0.50 | 25000 | 35 | 150 | 580 | 56000 | 260 | 5700 | 930 | 2.3 | 5600 | 5.80 | 140 | 32 | 720 |
| 2022502 (Back yard) | 15-20 cm | 5500 | na | 38.0 | 100 | <0.25 | <0.10 | 18000 | 24 | 110 | 410 | 50000 | 240 | 3700 | 610 | 1.0 | 5500 | 5.50 | 87 | 27 | 600 |
| | 0-5 cm | 7100 | na | 14.0 | 90 | <0.25 | 0.90 | 16000 | 19 | 36 | 160 | 26000 | 98 | 6800 | 530 | 0.8 | 1700 | 2.70 | 42 | 23 | 320 |
| | 0-5 cm | 8100 | na | 13.0 | 80 | 0.6 | 1.00 | 17000 | 20 | 39 | 170 | 27000 | 110 | 7200 | 550 | 0.6 | 1700 | 2.80 | 45 | 26 | 330 |
| | 5-10 cm | 7100 | na | 16.0 | 72 | <0.25 | 1.10 | 17000 | 23 | 41 | 180 | 30000 | 95 | 7000 | 550 | 0.9 | 1800 | 2.80 | 41 | 25 | 340 |
| | 5-10 cm | 8400 | na | 15.0 | 82 | 0.6 | 1.10 | 18000 | 21 | 44 | 190 | 29000 | 110 | 7400 | 580 | 0.8 | 1800 | 2.60 | 47 | 27 | 360 |
| 2022502 (Front yard) | 5-10 cm | 8700 | na | 18.0 | 87 | 0.6 | 0.90 | 20000 | 22 | 56 | 250 | 35000 | 120 | 7700 | 670 | <0.25 | 2800 | 2.80 | 49 | 29 | 430 |
| | 10-15 cm | 8800 | na | 18.0 | 93 | 0.7 | 1.10 | 20000 | 26 | 50 | 230 | 32000 | 120 | 7600 | 650 | 1.2 | 2300 | 3.30 | 51 | 28 | 410 |
| | 0-5 cm | 10000 | na | 23.0 | 100 | 0.6 | 1.10 | 8400 | 30 | 58 | 260 | 40000 | 130 | 3900 | 700 | 1.4 | 3100 | 4.60 | 26 | 32 | 410 |
| | 0-5 cm | 9500 | na | 19.0 | 84 | 0.6 | 0.90 | 8800 | 29 | 51 | 240 | 36000 | 120 | 3800 | 620 | <0.25 | 2700 | 4.20 | 27 | 29 | 360 |
| | 5-10 cm | 10000 | na | 26.0 | 89 | 0.6 | 0.80 | 7500 | 30 | 57 | 290 | 42000 | 120 | 3900 | 690 | 1.1 | 3300 | 5.10 | 23 | 31 | 400 |
| 2022501 (Front yard) | 5-10 cm | 10000 | na | 23.0 | 86 | 0.6 | 0.50 | 8700 | 32 | 57 | 290 | 44000 | 130 | 3900 | 720 | 1.4 | 3300 | 5.00 | 26 | 31 | 430 |
| | 10-15 cm | 16000 | na | 16.0 | 110 | 0.8 | 0.80 | 6900 | 30 | 42 | 180 | 35000 | 84 | 4800 | 700 | 0.8 | 2200 | 3.40 | 23 | 39 | 270 |
| | 10-15 cm | 13000 | na | 16.0 | 93 | 0.7 | 0.70 | 9700 | 31 | 49 | 220 | 38000 | 110 | 4800 | 660 | 0.9 | 2800 | 2.80 | 27 | 34 | 330 |
| | 0-5 cm | 8700 | na | 11.0 | 83 | <0.25 | 0.40 | 15000 | 17 | 38 | 170 | 24000 | 100 | 5700 | 400 | 0.8 | 1900 | 2.30 | 71 | 25 | 250 |
| | 0-5 cm | 8500 | na | 10.0 | 77 | <0.25 | 0.40 | 14000 | 17 | 34 | 150 | 22000 | 94 | 5400 | 370 | <0.25 | 1600 | 2.40 | 58 | 23 | 230 |
| 2022501 (Front yard) | 5-10 cm | 6600 | na | 22.0 | 87 | <0.25 | 0.60 | 18000 | 25 | 63 | 280 | 36000 | 120 | 6700 | 540 | 1.3 | 3100 | 3.70 | 88 | 27 | 350 |
| | 5-10 cm | 8600 | na | 20.0 | 100 | 0.6 | 0.60 | 18000 | 23 | 70 | 300 | 34000 | 130 | 6800 | 590 | 1.1 | 3200 | 3.90 | 84 | 29 | 340 |
| | 10-15 cm | 6100 | na | 43.0 | 88 | <0.25 | 0.30 | 16000 | 34 | 110 | 500 | 55000 | 160 | 5700 | 750 | 1.9 | 5700 | 4.70 | 78 | 28 | 590 |
| | 10-15 cm | 7300 | na | 45.0 | 120 | 0.6 | 0.40 | 18000 | 36 | 150 | 640 | 72000 | 180 | 6200 | 870 | 2.6 | 8400 | 5.40 | 80 | 32 | 610 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|----|------|-----|-------|-------|-------|----|----|-----|-------|-----|------|-----|-------|------|------|-----|----|-----|
| 2022602 (Back yard) | 0-5 cm | 10000 | na | 5.6 | 78 | <0.25 | 0.60 | 35000 | 16 | 20 | 61 | 17000 | 61 | 1100 | 430 | <0.25 | 330 | 1.00 | 120 | 26 | 110 |
| | 0-5 cm | 10000 | na | 4.2 | 73 | <0.25 | 0.50 | 32000 | 16 | 18 | 50 | 16000 | 53 | 1000 | 390 | <0.25 | 300 | 1.00 | 120 | 26 | 98 |
| | 5-10 cm | 8700 | na | 5.9 | 66 | <0.25 | 0.60 | 30000 | 15 | 29 | 82 | 15000 | 77 | 1100 | 380 | <0.25 | 580 | 1.60 | 97 | 26 | 110 |
| | 5-10 cm | 8500 | na | 5.4 | 62 | <0.25 | 0.50 | 29000 | 15 | 17 | 55 | 15000 | 57 | 1000 | 320 | <0.25 | 380 | 1.20 | 92 | 26 | 91 |
| | 10-15 cm | 9700 | na | 6.1 | 83 | 0.6 | 0.40 | 35000 | 17 | 25 | 85 | 16000 | 79 | 1200 | 350 | <0.25 | 570 | 1.30 | 130 | 28 | 110 |
| 2022701 (Front yard) | 10-15 cm | 14000 | na | 10.0 | 120 | 0.9 | 1.50 | 37000 | 25 | 51 | 170 | 25000 | 170 | 1300 | 490 | 1.1 | 1200 | 2.70 | 250 | 40 | 260 |
| | 0-5 cm | 8800 | na | 15.0 | 88 | <0.25 | 0.80 | 11000 | 20 | 41 | 190 | 28000 | 150 | 3900 | 430 | <0.25 | 2200 | 3.40 | 46 | 23 | 350 |
| | 0-5 cm | 8400 | na | 15.0 | 86 | <0.25 | 0.70 | 10000 | 23 | 41 | 180 | 28000 | 140 | 3900 | 410 | 1.3 | 2200 | 3.50 | 45 | 23 | 330 |
| | 5-10 cm | 9100 | na | 18.0 | 88 | <0.25 | 0.60 | 9400 | 27 | 46 | 220 | 32000 | 150 | 3700 | 470 | 0.9 | 2700 | 3.80 | 41 | 24 | 360 |
| | 5-10 cm | 9500 | na | 24.0 | 120 | 0.6 | 0.80 | 11000 | 32 | 68 | 320 | 44000 | 200 | 4100 | 550 | 1.6 | 4300 | 5.20 | 47 | 27 | 500 |
| 2022702 (Back yard) | 10-15 cm | 6700 | na | 27.0 | 110 | <0.25 | 0.70 | 13000 | 21 | 47 | 280 | 32000 | 210 | 4300 | 470 | 1.5 | 3200 | 5.20 | 48 | 20 | 440 |
| | 10-15 cm | 7000 | na | 39.0 | 120 | <0.25 | 1.00 | 13000 | 27 | 60 | 340 | 42000 | 250 | 3800 | 600 | 0.9 | 4100 | 5.90 | 53 | 21 | 590 |
| | 0-5 cm | 9100 | na | 14.0 | 110 | <0.25 | 0.90 | 6900 | 21 | 47 | 210 | 23000 | 170 | 2600 | 350 | 0.8 | 2400 | 3.70 | 39 | 24 | 370 |
| | 0-5 cm | 8300 | na | 13.0 | 100 | <0.25 | 0.60 | 6000 | 18 | 36 | 160 | 19000 | 130 | 2300 | 280 | 0.8 | 1700 | 3.60 | 36 | 20 | 330 |
| | 5-10 cm | 12000 | na | 21.0 | 130 | 0.6 | 1.10 | 7100 | 29 | 61 | 270 | 32000 | 180 | 3000 | 450 | 1.1 | 3000 | 4.60 | 43 | 30 | 460 |
| 2022801 (Front yard) | 5-10 cm | 12000 | na | 15.0 | 130 | 0.6 | 0.90 | 6900 | 25 | 49 | 220 | 27000 | 150 | 2900 | 390 | 1.1 | 2500 | 3.70 | 42 | 28 | 390 |
| | 10-15 cm | 12000 | na | 20.0 | 130 | 0.6 | 1.20 | 7500 | 27 | 58 | 280 | 33000 | 180 | 3100 | 440 | <0.25 | 3000 | 4.40 | 47 | 28 | 440 |
| | 10-15 cm | 12000 | na | 20.0 | 150 | 0.7 | 1.20 | 7700 | 29 | 60 | 280 | 34000 | 190 | 3300 | 470 | 0.8 | 3200 | 4.30 | 49 | 30 | 450 |
| | 0-5 cm | 8400 | na | 11.0 | 75 | <0.25 | 0.40 | 13000 | 18 | 33 | 140 | 24000 | 90 | 5400 | 460 | 0.8 | 1700 | 2.00 | 40 | 25 | 200 |
| | 0-5 cm | 8000 | na | 9.5 | 76 | <0.25 | 0.50 | 14000 | 16 | 33 | 140 | 23000 | 86 | 5500 | 420 | 1.1 | 1600 | 2.10 | 41 | 24 | 190 |
| 2022802 (Back yard) | 5-10 cm | 7600 | na | 26.0 | 92 | 0.6 | 0.60 | 16000 | 26 | 66 | 300 | 45000 | 170 | 6000 | 650 | 1.6 | 3800 | 4.10 | 61 | 26 | 460 |
| | 5-10 cm | 7800 | na | 23.0 | 95 | 0.6 | 0.30 | 17000 | 25 | 71 | 300 | 45000 | 170 | 6200 | 610 | 1.4 | 4100 | 4.00 | 52 | 27 | 400 |
| | 10-15 cm | 7700 | na | 34.0 | 97 | 0.6 | <0.10 | 17000 | 31 | 91 | 410 | 61000 | 180 | 5700 | 710 | 2.3 | 6200 | 4.80 | 59 | 28 | 540 |
| | 10-15 cm | 8900 | na | 24.0 | 110 | 0.7 | 0.30 | 19000 | 20 | 59 | 300 | 36000 | 150 | 6400 | 550 | 0.7 | 4000 | 3.90 | 64 | 28 | 340 |
| | 0-5 cm | 15000 | na | 13.0 | 120 | 1 | 0.70 | 35000 | 27 | 56 | 190 | 27000 | 130 | 1400 | 490 | 1.0 | 1700 | 2.80 | 170 | 39 | 210 |
| 2022802 (Back yard) | 0-5 cm | 14000 | na | 15.0 | 120 | 1 | 0.60 | 38000 | 25 | 59 | 210 | 29000 | 140 | 1400 | 530 | <0.25 | 1900 | 3.10 | 190 | 37 | 240 |
| | 5-10 cm | 18000 | na | 13.0 | 140 | 1.1 | 0.50 | 37000 | 29 | 44 | 160 | 28000 | 120 | 1500 | 460 | 0.6 | 1400 | 2.70 | 190 | 41 | 190 |
| | 5-10 cm | 18000 | na | 12.0 | 140 | 1.1 | 0.60 | 46000 | 30 | 41 | 170 | 29000 | 120 | 1700 | 500 | 1.0 | 1300 | 2.40 | 240 | 40 | 180 |
| | 10-15 cm | 19000 | na | 10.0 | 140 | 1.1 | 0.50 | 43000 | 69 | 29 | 120 | 27000 | 89 | 1500 | 420 | 9.8 | 940 | 2.10 | 260 | 43 | 140 |
| | 10-15 cm | 20000 | na | 11.0 | 150 | 1.2 | 0.70 | 49000 | 28 | 31 | 140 | 27000 | 99 | 1800 | 470 | 0.9 | 1100 | 2.00 | 210 | 42 | 170 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|----|------|-----|-------|-------|-------|----|-----|-----|-------|-----|------|-----|-------|------|------|-----|----|-----|
| 2022901 (Front yard) | 0-5 cm | 8200 | na | 14.0 | 100 | <0.25 | 0.50 | 7200 | 22 | 36 | 140 | 20000 | 96 | 2900 | 290 | <0.25 | 1700 | 1.70 | 27 | 22 | 240 |
| | 0-5 cm | 7900 | na | 13.0 | 81 | <0.25 | 0.50 | 7300 | 16 | 34 | 130 | 20000 | 87 | 3000 | 280 | 0.6 | 1600 | 1.90 | 27 | 22 | 230 |
| | 5-10 cm | 7000 | na | 18.0 | 85 | <0.25 | 0.30 | 8400 | 19 | 52 | 200 | 29000 | 120 | 3300 | 390 | 1.0 | 2600 | 2.80 | 27 | 23 | 320 |
| | 5-10 cm | 8800 | na | 14.0 | 99 | <0.25 | 0.50 | 8200 | 19 | 48 | 180 | 24000 | 120 | 3300 | 380 | 1.0 | 2300 | 1.80 | 29 | 24 | 300 |
| | 10-15 cm | 7500 | na | 62.0 | 130 | 0.6 | 0.40 | 14000 | 32 | 97 | 470 | 55000 | 230 | 4700 | 710 | 1.8 | 5800 | 5.60 | 46 | 28 | 690 |
| | 10-15 cm | 7300 | na | 60.0 | 130 | 0.6 | 0.40 | 13000 | 33 | 100 | 480 | 59000 | 230 | 4400 | 720 | 2.2 | 6000 | 6.30 | 42 | 27 | 710 |
| 2023001 (Front yard) | 0-5 cm | 6700 | na | 16.0 | 140 | <0.25 | 0.90 | 79000 | 45 | 47 | 220 | 29000 | 240 | 5900 | 430 | 1.3 | 2400 | 2.90 | 580 | 22 | 400 |
| | 0-5 cm | 7500 | na | 16.0 | 140 | 0.6 | 1.10 | 91000 | 21 | 45 | 210 | 29000 | 200 | 5800 | 450 | 0.8 | 2200 | 3.20 | 690 | 24 | 380 |
| | 5-10 cm | 6200 | na | 24.0 | 150 | 0.6 | 0.30 | 77000 | 26 | 72 | 340 | 48000 | 220 | 5600 | 580 | 1.6 | 4700 | 4.30 | 590 | 26 | 480 |
| | 5-10 cm | 6800 | na | 33.0 | 160 | 0.6 | 0.60 | 74000 | 25 | 73 | 400 | 48000 | 250 | 6200 | 670 | 1.4 | 4500 | 4.90 | 560 | 26 | 550 |
| | 10-15 cm | 5700 | na | 39.0 | 180 | 0.6 | 0.50 | 39000 | 28 | 79 | 480 | 50000 | 320 | 5400 | 690 | 1.6 | 5500 | 5.10 | 270 | 25 | 650 |
| | 10-15 cm | 5800 | na | 40.0 | 190 | 0.6 | <0.10 | 34000 | 32 | 110 | 550 | 68000 | 330 | 6700 | 830 | 2.0 | 8000 | 4.10 | 220 | 28 | 730 |
| 2023101 (Front yard) | 0-5 cm | 4800 | na | 14.0 | 77 | <0.25 | 0.40 | 12000 | 17 | 33 | 180 | 18000 | 130 | 4100 | 310 | 1.2 | 1700 | 2.60 | 31 | 17 | 280 |
| | 0-5 cm | 4300 | na | 14.0 | 68 | <0.25 | 1.00 | 10000 | 17 | 29 | 150 | 18000 | 110 | 3500 | 300 | 0.8 | 1500 | 2.40 | 27 | 16 | 250 |
| | 5-10 cm | 4400 | na | 19.0 | 92 | <0.25 | <0.10 | 14000 | 19 | 52 | 260 | 28000 | 170 | 4400 | 420 | 0.8 | 2800 | 3.00 | 34 | 19 | 380 |
| | 5-10 cm | 4400 | na | 15.0 | 94 | <0.25 | 0.40 | 14000 | 19 | 55 | 280 | 32000 | 180 | 4400 | 440 | 1.1 | 3200 | 2.90 | 36 | 22 | 380 |
| | 10-15 cm | 5000 | na | 18.0 | 120 | <0.25 | <0.10 | 16000 | 23 | 72 | 360 | 48000 | 200 | 4800 | 570 | 1.5 | 5100 | 3.40 | 43 | 33 | 470 |
| | 10-15 cm | 4300 | na | 17.0 | 120 | <0.25 | <0.10 | 15000 | 20 | 58 | 330 | 34000 | 180 | 4500 | 460 | 1.0 | 4000 | 3.00 | 38 | 23 | 400 |
| 2023102 (Back yard) | 0-5 cm | 4100 | na | 22.0 | 100 | <0.25 | 0.30 | 9500 | 21 | 64 | 330 | 38000 | 250 | 2600 | 490 | 1.4 | 4000 | 4.40 | 39 | 20 | 500 |
| | 0-5 cm | 3700 | na | 22.0 | 100 | <0.25 | <0.10 | 8300 | 18 | 63 | 320 | 33000 | 270 | 2100 | 470 | 1.3 | 3900 | 5.80 | 36 | 17 | 480 |
| | 5-10 cm | 4200 | na | 36.0 | 120 | <0.25 | <0.10 | 10000 | 26 | 91 | 460 | 52000 | 330 | 2700 | 610 | 1.6 | 6100 | 5.50 | 43 | 24 | 610 |
| | 5-10 cm | 4400 | na | 37.0 | 120 | <0.25 | 0.30 | 9700 | 28 | 95 | 480 | 56000 | 310 | 2400 | 640 | 2.4 | 6100 | 5.60 | 42 | 25 | 630 |
| | 10-15 cm | 4200 | na | 39.0 | 130 | <0.25 | <0.10 | 11000 | 31 | 88 | 460 | 48000 | 360 | 2500 | 630 | 2.3 | 6100 | 5.80 | 51 | 22 | 600 |
| | 10-15 cm | 3900 | na | 44.0 | 110 | <0.25 | <0.10 | 9900 | 21 | 91 | 420 | 45000 | 310 | 2400 | 540 | 1.6 | 6400 | 5.40 | 41 | 20 | 540 |
| 2023201 (Front yard) | 0-5 cm | 10000 | na | 30.0 | 120 | 0.7 | 0.30 | 19000 | 27 | 79 | 350 | 41000 | 160 | 6200 | 640 | 1.6 | 4200 | 5.80 | 66 | 31 | 420 |
| | 0-5 cm | 9600 | na | 26.0 | 120 | 0.7 | 0.40 | 19000 | 28 | 84 | 360 | 46000 | 170 | 6400 | 680 | 3.2 | 4400 | 5.50 | 57 | 31 | 450 |
| | 5-10 cm | 10000 | na | 37.0 | 120 | 0.7 | <0.10 | 18000 | 29 | 86 | 410 | 48000 | 160 | 5500 | 690 | 1.5 | 5800 | 6.50 | 64 | 29 | 460 |
| | 5-10 cm | 9700 | na | 49.0 | 120 | 0.7 | <0.10 | 17000 | 31 | 110 | 480 | 61000 | 200 | 5400 | 750 | 1.7 | 7700 | 5.80 | 56 | 31 | 520 |
| | 10-15 cm | 11000 | na | 20.0 | 180 | 1.1 | <0.10 | 32000 | 17 | 50 | 300 | 36000 | 130 | 6100 | 680 | <0.25 | 4300 | 3.90 | 97 | 28 | 320 |
| | 10-15 cm | 13000 | na | 28.0 | 240 | 1.5 | <0.10 | 40000 | 18 | 63 | 430 | 39000 | 180 | 6500 | 850 | 0.6 | 5400 | 4.80 | 120 | 28 | 420 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|----|-------|-----|-------|-------|-------|-----|-----|------|--------|-----|------|------|-------|-------|------|-----|----|------|
| 2023202 (Back yard) | 0-5 cm | 8900 | na | 11.0 | 96 | <0.25 | 0.50 | 13000 | 17 | 30 | 140 | 21000 | 100 | 3800 | 440 | 0.9 | 1500 | 2.60 | 37 | 27 | 240 |
| | 0-5 cm | 8700 | na | 9.9 | 110 | <0.25 | 0.60 | 14000 | 17 | 26 | 120 | 19000 | 110 | 3800 | 440 | 0.8 | 1300 | 2.90 | 38 | 25 | 220 |
| | 5-10 cm | 7300 | na | 12.0 | 92 | <0.25 | 0.30 | 17000 | 18 | 36 | 170 | 24000 | 140 | 4000 | 460 | <0.25 | 2000 | 2.50 | 44 | 28 | 260 |
| | 5-10 cm | 7300 | na | 10.0 | 80 | <0.25 | 0.40 | 18000 | 16 | 29 | 120 | 22000 | 110 | 3600 | 440 | <0.25 | 1500 | 2.10 | 42 | 26 | 190 |
| | 10-15 cm | 5800 | na | 30.0 | 100 | <0.25 | 0.40 | 12000 | 21 | 51 | 240 | 33000 | 160 | 3900 | 410 | 0.9 | 3000 | 5.00 | 37 | 29 | 370 |
| | 10-15 cm | 5700 | na | 18.0 | 93 | <0.25 | 0.60 | 14000 | 22 | 40 | 190 | 24000 | 210 | 3600 | 370 | 0.8 | 2200 | 4.00 | 39 | 26 | 280 |
| 2023301 (Front yard) | 0-5 cm | 5900 | na | 37.0 | 99 | 0.6 | <0.10 | 16000 | 31 | 140 | 540 | 67000 | 220 | 5800 | 830 | 2.4 | 7000 | 5.90 | 40 | 30 | 590 |
| | 0-5 cm | 6200 | na | 61.0 | 110 | 0.6 | 0.40 | 16000 | 42 | 170 | 670 | 78000 | 240 | 5600 | 1000 | 3.2 | 8000 | 8.10 | 43 | 34 | 700 |
| | 5-10 cm | 6100 | na | 85.0 | 120 | 0.6 | <0.10 | 14000 | 46 | 230 | 970 | 130000 | 360 | 5500 | 1100 | 3.9 | 17000 | 7.90 | 37 | 30 | 1000 |
| | 5-10 cm | 5900 | na | 78.0 | 94 | <0.25 | 0.30 | 16000 | 32 | 120 | 640 | 66000 | 290 | 5900 | 800 | 2.9 | 8800 | 7.40 | 37 | 24 | 700 |
| | 10-15 cm | 5900 | na | 25.0 | 70 | <0.25 | <0.10 | 21000 | 19 | 72 | 350 | 45000 | 130 | 6700 | 500 | 1.6 | 5100 | 3.70 | 44 | 22 | 360 |
| | 10-15 cm | 5700 | na | 25.0 | 67 | <0.25 | <0.10 | 19000 | 15 | 51 | 280 | 32000 | 95 | 6700 | 420 | 0.8 | 3500 | 4.40 | 37 | 19 | 290 |
| 2023302 (Back yard) | 0-5 cm | 4700 | na | 19.0 | 68 | <0.25 | <0.10 | 7300 | 22 | 84 | 290 | 39000 | 140 | 2000 | 490 | 1.2 | 3500 | 4.40 | 25 | 26 | 360 |
| | 0-5 cm | 3900 | na | 29.0 | 65 | <0.25 | <0.10 | 6200 | 22 | 84 | 280 | 30000 | 120 | 1400 | 450 | 1.7 | 3100 | 4.80 | 24 | 17 | 310 |
| | 5-10 cm | 4700 | na | 55.0 | 100 | <0.25 | 0.30 | 9400 | 34 | 110 | 500 | 66000 | 330 | 2100 | 660 | 2.6 | 6800 | 6.20 | 31 | 23 | 630 |
| | 5-10 cm | 3900 | na | 30.0 | 69 | <0.25 | <0.10 | 5500 | 25 | 66 | 330 | 41000 | 140 | 1400 | 470 | 2.2 | 4300 | 4.10 | 22 | 16 | 400 |
| | 10-15 cm | 4200 | na | 20.0 | 46 | <0.25 | <0.10 | 5300 | 17 | 44 | 200 | 27000 | 120 | 1300 | 300 | 1.0 | 2800 | 3.20 | 21 | 19 | 260 |
| | 10-15 cm | 3200 | na | 9.5 | 30 | <0.25 | <0.10 | 3900 | 9 | 19 | 97 | 12000 | 59 | 990 | 180 | <0.25 | 1100 | 1.70 | 15 | 12 | 130 |
| 2023401 (Back yard) | 0-5 cm | 9100 | na | 350.0 | 180 | 0.7 | <0.10 | 18000 | 150 | 160 | 860 | 57000 | 280 | 3800 | 860 | 2.0 | 6600 | 3.40 | 66 | 33 | 710 |
| | 0-5 cm | 7300 | na | 77.0 | 130 | 0.7 | <0.10 | 11000 | 54 | 160 | 580 | 68000 | 160 | 2400 | 860 | 2.2 | 7000 | 6.30 | 44 | 31 | 590 |
| | 5-10 cm | 12000 | na | 69 | 310 | 1 | 0.50 | 15000 | 63 | 220 | 970 | 99000 | 390 | 4100 | 1300 | 3.7 | 11000 | 7.8 | 67 | 44 | 1200 |
| | 5-10 cm | 10000 | na | 52 | 150 | 0.8 | <0.10 | 9500 | 49 | 150 | 580 | 98000 | 190 | 3400 | 1000 | 3.7 | 8700 | 7.5 | 41 | 37 | 780 |
| | 10-15 cm | 13000 | na | 69 | 160 | 0.9 | <0.10 | 13000 | 47 | 120 | 630 | 72000 | 230 | 5100 | 900 | 2.4 | 7600 | 6.6 | 53 | 40 | 650 |
| | 10-15 cm | 14000 | na | 32 | 160 | 0.8 | <0.10 | 13000 | 31 | 91 | 470 | 55000 | 160 | 4800 | 640 | 0.9 | 5700 | 6 | 50 | 37 | 470 |
| 2023501 (Front yard) | 0-5 cm | 9000 | na | 35.0 | 180 | 0.7 | 0.30 | 29000 | 33 | 120 | 530 | 49000 | 310 | 1100 | 850 | 2.1 | 6200 | 7.30 | 100 | 32 | 670 |
| | 0-5 cm | 8500 | na | 37.0 | 180 | 0.8 | <0.10 | 28000 | 40 | 150 | 660 | 69000 | 370 | 1100 | 1000 | 2.6 | 8500 | 7.50 | 85 | 35 | 810 |
| | 5-10 cm | 11000 | na | 67.0 | 210 | 1 | <0.10 | 30000 | 57 | 200 | 1000 | 90000 | 400 | 1000 | 1200 | 3.4 | 14000 | 8.60 | 95 | 39 | 1100 |
| | 5-10 cm | 12000 | na | 53.0 | 200 | 1 | <0.10 | 28000 | 45 | 180 | 840 | 93000 | 370 | 1000 | 1000 | 3.7 | 13000 | 8.40 | 100 | 41 | 1000 |
| | 10-15 cm | 12000 | na | 48.0 | 200 | 0.9 | <0.10 | 33000 | 36 | 130 | 1000 | 60000 | 300 | 1000 | 960 | 1.7 | 12000 | 7.10 | 100 | 36 | 830 |
| | 10-15 cm | 9500 | na | 48.0 | 190 | 0.8 | <0.10 | 29000 | 27 | 140 | 980 | 62000 | 350 | 8400 | 1100 | 2.3 | 11000 | 6.00 | 110 | 32 | 840 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------------------|------------|-------|----|-------|-----|-------|-------|-------|----|-----|------|-------|-----|------|-----|-------|-------|------|-----|----|-----|
| 2023502 (Back yard) | 0-5 cm | 9800 | na | 22.0 | 240 | 0.7 | 0.70 | 17000 | 28 | 70 | 450 | 38000 | 460 | 3900 | 510 | 1.7 | 5000 | 5.20 | 90 | 29 | 720 |
| | 0-5 cm | 9700 | na | 21.0 | 220 | 0.6 | 0.60 | 15000 | 26 | 65 | 400 | 37000 | 400 | 3700 | 470 | 1.9 | 4400 | 4.90 | 81 | 28 | 680 |
| | 5-10 cm | 11000 | na | 19.0 | 240 | 0.7 | 0.30 | 17000 | 27 | 68 | 430 | 37000 | 410 | 3900 | 490 | 1.8 | 4700 | 5.20 | 90 | 30 | 660 |
| | 5-10 cm | 9900 | na | 20.0 | 200 | 0.6 | 0.40 | 16000 | 25 | 64 | 390 | 34000 | 380 | 3600 | 450 | 1.0 | 4300 | 4.60 | 82 | 28 | 600 |
| | 10-15 cm | 10000 | na | 20.0 | 230 | 0.7 | 0.60 | 25000 | 28 | 69 | 390 | 40000 | 380 | 4800 | 510 | 1.5 | 4400 | 6.80 | 94 | 30 | 620 |
| | 10-15 cm | 12000 | na | 17.0 | 210 | 0.7 | <0.10 | 39000 | 26 | 54 | 300 | 35000 | 310 | 6700 | 540 | 1.0 | 3400 | 3.50 | 110 | 31 | 480 |
| 2023601 (Rodney St ball diamond) | 0-5 cm | 5100 | na | 29.0 | 72 | <0.25 | <0.10 | 10000 | 20 | 140 | 560 | 43000 | 110 | 2700 | 440 | 1.4 | 7700 | 6.20 | 42 | 25 | 400 |
| | 0-5 cm | 5300 | na | 29.0 | 71 | <0.25 | <0.10 | 10000 | 20 | 130 | 540 | 39000 | 110 | 2700 | 450 | 1.1 | 6400 | 5.40 | 46 | 25 | 390 |
| | 5-10 cm | 5000 | na | 33.0 | 72 | <0.25 | <0.10 | 13000 | 21 | 150 | 630 | 49000 | 110 | 3600 | 460 | 1.3 | 8600 | 6.20 | 52 | 27 | 420 |
| | 5-10 cm | 5500 | na | 32.0 | 74 | <0.25 | <0.10 | 14000 | 21 | 140 | 640 | 42000 | 110 | 3800 | 460 | 1.1 | 7500 | 6.50 | 62 | 25 | 430 |
| | 10-15 cm | 5500 | na | 33.0 | 75 | <0.25 | <0.10 | 16000 | 22 | 130 | 610 | 42000 | 100 | 4500 | 410 | 1.7 | 7400 | 6.70 | 74 | 26 | 400 |
| | 10-15 cm | 6100 | na | 35.0 | 74 | <0.25 | <0.10 | 20000 | 21 | 130 | 500 | 41000 | 99 | 5600 | 430 | 1.3 | 7300 | 7.00 | 97 | 27 | 370 |
| 2023701 (Front yard) | 0-5 cm | 10000 | na | 16.0 | 110 | 0.6 | <0.10 | 20000 | 23 | 71 | 290 | 29000 | 160 | 7200 | 480 | <0.25 | 3900 | 3.90 | 54 | 30 | 370 |
| | 0-5 cm | 10000 | na | 16.0 | 120 | 0.7 | <0.10 | 23000 | 23 | 85 | 340 | 31000 | 170 | 8200 | 530 | 1.0 | 4200 | 4.60 | 61 | 30 | 420 |
| | 5-10 cm | 12000 | na | 22.0 | 130 | 0.7 | <0.10 | 23000 | 25 | 85 | 340 | 32000 | 200 | 7500 | 510 | 1.2 | 4500 | 4.30 | 64 | 32 | 430 |
| | 5-10 cm | 9700 | na | 23.0 | 120 | 0.6 | <0.10 | 25000 | 23 | 95 | 400 | 34000 | 200 | 7500 | 530 | 1.6 | 5600 | 4.70 | 68 | 30 | 440 |
| | 10-15 cm | 10000 | na | 73.0 | 160 | 0.8 | <0.10 | 22000 | 42 | 210 | 1000 | 77000 | 350 | 6600 | 980 | 3.0 | 14000 | 8.30 | 68 | 34 | 930 |
| | 10-15 cm | 10000 | na | 56.0 | 150 | 0.7 | <0.10 | 23000 | 29 | 160 | 780 | 48000 | 310 | 6500 | 720 | 2.5 | 11000 | 8.80 | 81 | 31 | 690 |
| 2023702 (Back yard) | 0-5 cm | 9000 | na | 13.0 | 110 | 0.7 | <0.10 | 23000 | 18 | 53 | 230 | 23000 | 160 | 7400 | 400 | 0.9 | 2600 | 5.20 | 120 | 29 | 320 |
| | 0-5 cm | 7300 | na | 11.0 | 90 | <0.25 | <0.10 | 18000 | 14 | 48 | 190 | 25000 | 130 | 6200 | 370 | 0.8 | 2700 | 2.90 | 73 | 26 | 270 |
| | 5-10 cm | 7900 | na | 12.0 | 100 | 0.6 | <0.10 | 24000 | 17 | 45 | 190 | 24000 | 200 | 7800 | 400 | 0.8 | 2600 | 2.20 | 120 | 27 | 280 |
| | 5-10 cm | 9000 | na | 15.0 | 110 | 0.7 | <0.10 | 27000 | 16 | 45 | 210 | 25000 | 130 | 8000 | 440 | 1.1 | 2500 | 2.70 | 100 | 29 | 310 |
| | 10-15 cm | 8100 | na | 12.0 | 120 | 0.6 | 0.30 | 27000 | 15 | 39 | 180 | 23000 | 280 | 8000 | 380 | <0.25 | 2300 | 2.30 | 140 | 27 | 280 |
| | 10-15 cm | 9200 | na | 14.0 | 120 | 0.7 | 0.30 | 26000 | 16 | 53 | 230 | 25000 | 200 | 7200 | 430 | 1.0 | 2700 | 2.70 | 98 | 30 | 340 |
| 2023801 (Front yard) | 0-5 cm | 18000 | na | 12.0 | 120 | 0.9 | 0.70 | 9900 | 27 | 47 | 150 | 25000 | 91 | 6000 | 390 | 1.0 | 1800 | 2.30 | 37 | 40 | 190 |
| | 0-5 cm | 20000 | na | 130.0 | 120 | 0.9 | 0.60 | 7900 | 27 | 43 | 130 | 24000 | 83 | 5000 | 360 | 0.8 | 1600 | 2.10 | 36 | 41 | 180 |
| | 5-10 cm | 21000 | na | 100.0 | 120 | 0.9 | 0.40 | 7100 | 26 | 29 | 89 | 25000 | 50 | 5900 | 410 | <0.25 | 1000 | 1.50 | 29 | 43 | 140 |
| | 5-10 cm | 22000 | na | 82.0 | 130 | 0.9 | 0.70 | 5500 | 28 | 19 | 61 | 26000 | 39 | 5600 | 400 | <0.25 | 600 | 1.10 | 27 | 45 | 110 |
| | 10-15 cm | 22000 | na | 110.0 | 130 | 0.9 | 0.50 | 6100 | 27 | 25 | 90 | 27000 | 46 | 5900 | 400 | <0.25 | 1000 | 1.30 | 29 | 45 | 130 |
| | 10-15 cm | 21000 | na | 130.0 | 130 | 0.9 | <0.10 | 6200 | 27 | 24 | 93 | 27000 | 43 | 6000 | 400 | 0.8 | 1100 | 1.20 | 28 | 45 | 130 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|---------------------|------------|-------|----|------|-----|-----|-------|-------|----|-----|-----|-------|-----|------|-----|-------|-------|------|-----|----|-----|
| 2023802 (Back yard) | 0-5 cm | 16000 | na | 16.0 | 190 | 0.9 | 0.90 | 14000 | 26 | 79 | 320 | 30000 | 320 | 5800 | 480 | 1.2 | 4300 | 3.80 | 51 | 36 | 520 |
| | 0-5 cm | 17000 | na | 18.0 | 200 | 0.9 | 0.70 | 13000 | 30 | 83 | 340 | 32000 | 300 | 5700 | 480 | 1.3 | 4600 | 5.30 | 55 | 39 | 530 |
| | 5-10 cm | 19000 | na | 15.0 | 200 | 1 | 0.40 | 12000 | 30 | 75 | 310 | 33000 | 280 | 6300 | 520 | 1.0 | 4200 | 3.20 | 44 | 43 | 470 |
| | 5-10 cm | 18000 | na | 20.0 | 210 | 0.9 | 0.50 | 13000 | 28 | 84 | 460 | 34000 | 300 | 6300 | 550 | 0.6 | 4700 | 0.30 | 48 | 41 | 540 |
| | 10-15 cm | 15000 | na | 32.0 | 230 | 1 | 0.30 | 18000 | 27 | 110 | 530 | 41000 | 410 | 6200 | 580 | 1.7 | 7500 | 0.30 | 66 | 37 | 690 |
| 2023901 (Back yard) | 10-15 cm | 13000 | na | 42.0 | 270 | 1.1 | 0.50 | 23000 | 37 | 140 | 740 | 49000 | 550 | 5700 | 640 | 2.1 | 11000 | 0.40 | 110 | 35 | 940 |
| | 0-5 cm | 12000 | na | 6.5 | 80 | 0.6 | <0.10 | 24000 | 18 | 46 | 120 | 18000 | 36 | 9200 | 460 | <0.25 | 1100 | <0.1 | 42 | 30 | 110 |
| | 0-5 cm | 12000 | na | 10.0 | 84 | 0.6 | <0.10 | 21000 | 17 | 47 | 170 | 20000 | 38 | 7700 | 510 | <0.25 | 1400 | <0.1 | 39 | 30 | 130 |
| | 5-10 cm | 19000 | na | 7.7 | 110 | 0.9 | 0.70 | 24000 | 24 | 29 | 88 | 23000 | 27 | 1200 | 460 | <0.25 | 780 | <0.1 | 56 | 40 | 97 |
| | 5-10 cm | 20000 | na | 11.0 | 120 | 0.9 | 0.50 | 22000 | 26 | 40 | 130 | 25000 | 35 | 1200 | 540 | <0.25 | 1200 | <0.1 | 49 | 42 | 110 |
| 2024101 (Back yard) | 10-15 cm | 18000 | na | 11.0 | 110 | 0.9 | 0.40 | 30000 | 42 | 39 | 150 | 24000 | 39 | 1300 | 480 | 0.8 | 1500 | <0.1 | 60 | 39 | 110 |
| | 10-15 cm | 20000 | na | 11.0 | 120 | 1 | 0.30 | 17000 | 29 | 64 | 240 | 29000 | 48 | 9800 | 540 | <0.25 | 2300 | <0.1 | 43 | 44 | 140 |
| | 0-5 cm | 11000 | na | 13 | 120 | 0.6 | <0.10 | 14000 | 22 | 70 | 250 | 21000 | 140 | 5500 | 360 | 0.9 | 3000 | 4.2 | 43 | 26 | 310 |
| | 0-5 cm | 13000 | na | 11 | 130 | 0.7 | 1.00 | 15000 | 25 | 70 | 260 | 23000 | 150 | 6200 | 410 | <0.25 | 3100 | 3.1 | 43 | 30 | 300 |
| | 5-10 cm | 14000 | na | 14 | 140 | 0.8 | 0.40 | 20000 | 26 | 64 | 270 | 27000 | 160 | 9200 | 420 | 0.9 | 3200 | 3.7 | 47 | 34 | 350 |
| 2024201 (Side yard) | 5-10 cm | 12000 | na | 14 | 130 | 0.7 | <0.10 | 21000 | 23 | 61 | 260 | 24000 | 130 | 8200 | 390 | <0.25 | 3500 | 3.2 | 45 | 30 | 260 |
| | 10-15 cm | 12000 | na | 34 | 180 | 0.8 | 0.30 | 19000 | 28 | 87 | 450 | 43000 | 280 | 6900 | 640 | 1.3 | 5900 | 3.9 | 57 | 33 | 520 |
| | 10-15 cm | 14000 | na | 19 | 160 | 0.8 | 0.30 | 28000 | 25 | 60 | 330 | 31000 | 140 | 1100 | 480 | <0.25 | 3600 | 3 | 60 | 36 | 370 |
| | 15-20 cm | 8900 | na | 27 | 120 | 0.6 | <0.10 | 17000 | 24 | 80 | 490 | 37000 | 160 | 5600 | 550 | 0.9 | 6100 | 5.2 | 62 | 33 | 380 |
| | 15-20 cm | 9200 | na | 38 | 260 | 0.6 | <0.10 | 16000 | 26 | 97 | 670 | 38000 | 210 | 5500 | 520 | 1.6 | 7800 | 5.2 | 58 | 33 | 450 |
| 2024201 (Side yard) | 0-5 cm | 13000 | na | 29.0 | 190 | 1 | 0.50 | 30000 | 38 | 84 | 400 | 34000 | 420 | 9200 | 620 | 1.4 | 5000 | 4.40 | 89 | 33 | 540 |
| | 0-5 cm | 13000 | na | 28.0 | 180 | 1 | 0.50 | 32000 | 36 | 90 | 410 | 35000 | 330 | 9800 | 620 | 1.3 | 5300 | 4.20 | 85 | 33 | 540 |
| | 5-10 cm | 10000 | na | 27.0 | 200 | 0.8 | <0.10 | 28000 | 31 | 110 | 530 | 38000 | 440 | 7800 | 590 | 1.3 | 8200 | 5.30 | 74 | 27 | 610 |
| | 5-10 cm | 12000 | na | 29.0 | 200 | 0.9 | <0.10 | 30000 | 34 | 96 | 450 | 38000 | 440 | 8700 | 620 | 1.1 | 7600 | 5.80 | 81 | 30 | 540 |
| | 10-15 cm | 12000 | na | 29.0 | 190 | 0.9 | <0.10 | 32000 | 26 | 96 | 450 | 39000 | 330 | 8100 | 630 | 1.2 | 9600 | 5.00 | 77 | 28 | 610 |
| 2024201 (Side yard) | 10-15 cm | 18000 | na | 20.0 | 200 | 1.2 | <0.10 | 33000 | 29 | 55 | 250 | 31000 | 230 | 1100 | 600 | <0.25 | 3800 | 3.50 | 84 | 37 | 380 |
| | 15-20 cm | 19000 | na | 18.0 | 200 | 1.4 | 0.40 | 31000 | 26 | 45 | 220 | 31000 | 340 | 8300 | 550 | <0.25 | 3500 | 3.40 | 100 | 35 | 370 |
| | 15-20 cm | 18000 | na | 18.0 | 190 | 1.2 | <0.10 | 37000 | 35 | 54 | 250 | 33000 | 300 | 1100 | 620 | <0.25 | 3200 | 2.60 | 90 | 35 | 360 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|------|
| 2024601 (Back yard) | 0-5 cm | 12000 | na | 17.0 | 390 | 0.8 | 2.20 | 24000 | 36 | 38 | 370 | 31000 | 650 | 6500 | 450 | 1.3 | 2300 | 3.80 | 130 | 33 | 1200 |
| | 0-5 cm | 12000 | na | 21.0 | 420 | 0.8 | 2.40 | 25000 | 41 | 41 | 380 | 31000 | 740 | 6900 | 480 | 0.9 | 2200 | 4.50 | 140 | 34 | 1300 |
| | 5-10 cm | 11000 | na | 17.0 | 400 | 0.8 | 2.30 | 26000 | 36 | 36 | 360 | 30000 | 600 | 6900 | 410 | 1.3 | 1900 | 3.60 | 140 | 32 | 1100 |
| | 5-10 cm | 11000 | na | 19.0 | 360 | 0.9 | 2.20 | 22000 | 34 | 42 | 430 | 38000 | 650 | 6400 | 430 | 1.6 | 3000 | 4.80 | 130 | 33 | 1200 |
| | 10-15 cm | 12000 | na | 19.0 | 580 | 0.8 | 2.60 | 29000 | 44 | 35 | 430 | 40000 | 890 | 8700 | 500 | 1.8 | 2000 | 4.40 | 170 | 36 | 1300 |
| 2292316 (Front yard) | 10-15 cm | 10000 | na | 20.0 | 340 | 0.9 | 2.20 | 22000 | 34 | 38 | 410 | 34000 | 670 | 6500 | 400 | 1.5 | 2400 | 4.50 | 150 | 33 | 1000 |
| | 15-20 cm | 14000 | na | 19.0 | 400 | 1.2 | 2.60 | 22000 | 38 | 35 | 420 | 38000 | 700 | 6400 | 470 | 1.1 | 2200 | 4.20 | 180 | 42 | 960 |
| | 15-20 cm | 10000 | na | 23.0 | 380 | 0.9 | 2.60 | 21000 | 34 | 48 | 410 | 46000 | 870 | 5700 | 460 | 1.9 | 3200 | 5.10 | 160 | 33 | 1100 |
| | 0-5 cm | 15000 | <0.4 | 9.0 | 154 | 1.1 | 0.75 | 27600 | 23 | 22 | 104 | 22500 | 213 | 1300 | 461 | 4.5 | 401 | <0.3 | 113 | 33 | 183 |
| | 0-5 cm | 17000 | <0.4 | 10.5 | 150 | 1 | 1.41 | 17700 | 32 | 48 | 235 | 22500 | 236 | 7740 | 459 | 3.7 | 1680 | <0.3 | 63 | 34 | 394 |
| 2292317 (Front yard) | 5-10 cm | 19100 | <0.4 | 9.7 | 159 | 1.2 | 1.37 | 17100 | 32 | 48 | 246 | 24700 | 206 | 7850 | 463 | 3.7 | 1670 | <0.3 | 64 | 39 | 368 |
| | 10-20 cm | 25100 | <0.4 | 10.5 | 201 | 1.5 | 1.29 | 17500 | 37 | 43 | 337 | 30100 | 188 | 9150 | 420 | 3.7 | 1570 | <0.3 | 75 | 50 | 379 |
| | 0-5 cm | 19300 | <0.4 | 10.0 | 184 | 1.2 | 1.36 | 18100 | 32 | 35 | 164 | 26800 | 192 | 6820 | 446 | 3.9 | 1320 | <0.3 | 71 | 38 | 314 |
| | 5-10 cm | 21100 | <0.4 | 9.4 | 179 | 1.2 | 1.17 | 22900 | 32 | 31 | 139 | 27300 | 154 | 7290 | 437 | 3.7 | 1080 | <0.3 | 70 | 41 | 263 |
| | 10-20 cm | 20200 | <0.4 | 12.2 | 196 | 1.2 | 1.51 | 16600 | 33 | 36 | 174 | 28900 | 184 | 6940 | 412 | 3.7 | 1670 | <0.3 | 69 | 40 | 318 |
| 2292319 (Front yard) | 0-5 cm | 17500 | <0.4 | 10.9 | 145 | 1.1 | 1.34 | 19400 | 28 | 49 | 231 | 24700 | 201 | 8220 | 520 | 3.7 | 1850 | <0.3 | 58 | 35 | 291 |
| | 5-10 cm | 19800 | <0.4 | 11.4 | 153 | 1.1 | 1.37 | 23100 | 29 | 50 | 236 | 26800 | 203 | 9020 | 555 | 3.8 | 1920 | <0.3 | 65 | 39 | 287 |
| | 10-20 cm | 18700 | <0.4 | 15.1 | 174 | 1.2 | 1.56 | 22500 | 28 | 57 | 301 | 28300 | 249 | 8880 | 538 | 4.0 | 2700 | 0.50 | 75 | 37 | 327 |
| | 0-5 cm | 20800 | <0.4 | 17.3 | 288 | 1.6 | 2.17 | 19400 | 35 | 51 | 333 | 29400 | 377 | 7320 | 466 | 3.9 | 2300 | <0.3 | 114 | 43 | 593 |
| | 5-10 cm | 19900 | <0.4 | 17.8 | 293 | 1.5 | 2.13 | 20300 | 34 | 52 | 391 | 30700 | 369 | 7220 | 497 | 4.2 | 2670 | 0.30 | 116 | 40 | 610 |
| 2292320 (Back yard) | 10-20 cm | 19600 | <0.4 | 21.2 | 267 | 1.5 | 2.10 | 24500 | 31 | 46 | 390 | 30700 | 336 | 7400 | 486 | 3.9 | 2790 | 0.60 | 125 | 39 | 498 |
| | 0-5 cm | 16000 | <0.4 | 8.8 | 118 | 0.9 | 1.39 | 14000 | 26 | 61 | 242 | 20300 | 159 | 6300 | 397 | 3.5 | 1580 | <0.3 | 41 | 35 | 248 |
| | 5-10 cm | 16700 | <0.4 | 6.7 | 106 | 0.9 | 0.95 | 11200 | 22 | 40 | 156 | 20000 | 124 | 5570 | 351 | 3.2 | 1200 | <0.3 | 35 | 34 | 198 |
| | 10-20 cm | 18000 | <0.4 | 6.7 | 119 | 1.1 | 0.99 | 18800 | 23 | 32 | 124 | 20400 | 170 | 6710 | 361 | 3.6 | 976 | <0.3 | 50 | 36 | 224 |
| | 0-5 cm | 17700 | <0.4 | 8.6 | 165 | 1.1 | 1.32 | 20600 | 25 | 33 | 152 | 22700 | 231 | 9120 | 382 | 3.8 | 1210 | <0.3 | 407 | 35 | 339 |
| 2292322 (Back yard) | 5-10 cm | 19500 | <0.4 | 7.8 | 172 | 1.7 | 1.23 | 21200 | 27 | 33 | 154 | 26400 | 314 | 9310 | 438 | 3.8 | 1130 | <0.3 | 87 | 37 | 404 |
| | 10-20 cm | 19200 | <0.4 | 8.4 | 231 | 1.2 | 0.97 | 34700 | 27 | 26 | 119 | 24600 | 589 | 1300 | 484 | 4.3 | 974 | <0.3 | 97 | 36 | 588 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292323 (Front yard) | 0-5 cm | 19900 | <0.4 | 9.7 | 169 | 1.2 | 1.35 | 15300 | 30 | 38 | 211 | 26000 | 165 | 7020 | 578 | 3.6 | 1380 | <0.3 | 59 | 40 | 298 |
| | 0-5 cm | 19100 | <0.4 | 9.5 | 158 | 1.2 | 1.09 | 13100 | 28 | 37 | 196 | 24100 | 143 | 6560 | 484 | 3.8 | 1280 | <0.3 | 50 | 38 | 268 |
| | 0-5 cm | 21000 | <0.4 | 8.0 | 155 | 1.2 | 1.05 | 13500 | 30 | 35 | 179 | 26700 | 155 | 6700 | 588 | 3.9 | 1310 | <0.3 | 53 | 42 | 299 |
| | 5-10 cm | 19300 | <0.4 | 9.9 | 158 | 1.1 | 1.19 | 12900 | 27 | 39 | 217 | 25500 | 156 | 6360 | 494 | 3.6 | 1520 | <0.3 | 51 | 37 | 272 |
| | 5-10 cm | 19800 | <0.4 | 10.8 | 162 | 1.2 | 1.13 | 12300 | 30 | 39 | 219 | 27100 | 161 | 6410 | 517 | 3.7 | 1550 | <0.3 | 48 | 38 | 265 |
| | 5-10 cm | 21900 | <0.4 | 8.6 | 168 | 1.2 | 1.09 | 12500 | 30 | 39 | 218 | 27300 | 167 | 6410 | 517 | 3.6 | 1480 | <0.3 | 52 | 42 | 263 |
| | 10-20 cm | 17800 | <0.4 | 14.1 | 153 | 1.2 | 1.50 | 15900 | 26 | 38 | 245 | 29200 | 144 | 6420 | 633 | 3.5 | 1850 | <0.3 | 56 | 34 | 396 |
| | 10-20 cm | 20600 | <0.4 | 11.9 | 150 | 1.2 | 1.13 | 14100 | 29 | 40 | 236 | 27000 | 146 | 6600 | 559 | 3.4 | 1790 | <0.3 | 49 | 40 | 261 |
| | 10-20 cm | 19800 | <0.4 | 11.8 | 152 | 1.2 | 1.20 | 14000 | 27 | 39 | 223 | 29800 | 137 | 6340 | 697 | 3.6 | 1840 | <0.3 | 51 | 38 | 314 |
| | 0-5 cm | 13600 | <0.4 | 13.2 | 185 | 1.1 | 2.07 | 14500 | 23 | 42 | 210 | 22900 | 256 | 5770 | 541 | 3.7 | 1820 | 0.30 | 78 | 31 | 394 |
| 2292324 (Back yard) | 0-5 cm | 15100 | <0.4 | 1.3 | 188 | 1 | 1.45 | 13600 | 25 | 39 | 203 | 23600 | 224 | 5230 | 464 | 3.7 | 1920 | <0.3 | 69 | 33 | 364 |
| | 0-5 cm | 15700 | <0.4 | 14.4 | 194 | 1.2 | 1.84 | 15000 | 27 | 44 | 227 | 25500 | 263 | 5610 | 438 | 3.8 | 2060 | 0.50 | 76 | 35 | 384 |
| | 5-10 cm | 15700 | <0.4 | 15.5 | 216 | 1.2 | 2.12 | 17000 | 27 | 48 | 246 | 27800 | 276 | 6630 | 611 | 4.0 | 2340 | 0.60 | 89 | 33 | 446 |
| | 5-10 cm | 15900 | 0.4 | 13.8 | 211 | 1.1 | 1.57 | 15700 | 27 | 43 | 223 | 25900 | 266 | 6080 | 503 | 3.9 | 2230 | 0.50 | 77 | 35 | 418 |
| | 5-10 cm | 15900 | <0.4 | 18.4 | 219 | 1.3 | 2.37 | 17000 | 28 | 50 | 266 | 26800 | 344 | 6000 | 492 | 3.9 | 2650 | 0.60 | 87 | 35 | 424 |
| | 10-20 cm | 15600 | 1.0 | 20.0 | 266 | 1.8 | 1.78 | 21900 | 26 | 42 | 241 | 24400 | 263 | 6220 | 504 | 4.1 | 2320 | 0.30 | 170 | 34 | 433 |
| | 10-20 cm | 16700 | <0.4 | 17.8 | 207 | 1.2 | 1.58 | 19500 | 28 | 41 | 230 | 26400 | 260 | 6700 | 494 | 3.8 | 2360 | 0.70 | 92 | 35 | 412 |
| | 10-20 cm | 15500 | <0.4 | 18.0 | 224 | 1.2 | 1.72 | 22000 | 28 | 43 | 245 | 28000 | 237 | 6570 | 431 | 4.2 | 2400 | 0.80 | 109 | 35 | 391 |
| | 0-5 cm | 13500 | <0.4 | 7.2 | 99 | 0.7 | 0.81 | 18900 | 20 | 25 | 120 | 16600 | 95 | 7760 | 321 | 4.0 | 894 | <0.3 | 59 | 30 | 158 |
| | 5-10 cm | 13500 | <0.4 | 7.9 | 94 | 0.7 | 0.83 | 13500 | 19 | 32 | 143 | 15800 | 104 | 5380 | 278 | 3.6 | 1070 | <0.3 | 46 | 29 | 163 |
| 2292325 (Front yard) | 10-20 cm | 13100 | <0.4 | 9.8 | 92 | 0.7 | 0.87 | 12000 | 20 | 38 | 184 | 17800 | 88 | 4780 | 293 | 3.7 | 1700 | <0.3 | 40 | 27 | 183 |
| | 0-5 cm | 11300 | <0.4 | 10.4 | 111 | 0.6 | 1.18 | 16000 | 23 | 28 | 160 | 16000 | 148 | 6380 | 269 | 3.8 | 939 | <0.3 | 43 | 24 | 294 |
| | 5-10 cm | 10400 | <0.4 | 10.0 | 109 | 0.6 | 1.11 | 13500 | 19 | 28 | 158 | 16100 | 143 | 5740 | 246 | 3.6 | 1130 | <0.3 | 43 | 23 | 315 |
| | 10-20 cm | 11900 | <0.4 | 11.2 | 141 | 0.7 | 0.94 | 15000 | 20 | 31 | 242 | 16700 | 173 | 5890 | 244 | 3.6 | 1170 | <0.3 | 49 | 24 | 329 |
| | 0-5 cm | 28200 | <0.4 | 12.1 | 218 | 1.3 | 1.63 | 20700 | 37 | 72 | 303 | 28900 | 210 | 1050 | 453 | 4.8 | 3340 | <0.3 | 64 | 52 | 351 |
| | 5-10 cm | 29500 | <0.4 | 15.0 | 234 | 1.3 | 2.03 | 27100 | 42 | 96 | 438 | 32100 | 216 | 1220 | 497 | 4.7 | 4710 | 0.45 | 69 | 54 | 432 |
| | 10-20 cm* | 20200 | 0.6 | 21.2 | 183 | 1 | 0.90 | 47825 | 31 | 76 | 416 | 33100 | 175 | 1867 | 590 | 3.2 | 5785 | 2.58 | 83 | 39 | 331 |
| | 0-5 cm | 26900 | <0.4 | 12.2 | 192 | 1.3 | 1.76 | 30200 | 33 | 61 | 286 | 32700 | 212 | 1170 | 724 | 4.8 | 2820 | <0.3 | 73 | 48 | 331 |
| | 5-10 cm | 26100 | <0.4 | 9.4 | 161 | 1.2 | 1.28 | 35500 | 31 | 48 | 207 | 29700 | 133 | 1560 | 604 | 5.0 | 2280 | <0.3 | 70 | 46 | 255 |
| | 10-20 cm | 21500 | <0.4 | 9.5 | 141 | 1 | 0.77 | 51700 | 27 | 32 | 155 | 26100 | 94 | 2120 | 550 | 5.0 | 1820 | <0.3 | 81 | 39 | 175 |
| 2292329 (Front yard) | 0-5 cm | 24600 | <0.4 | 13.7 | 203 | 1.3 | 1.85 | 21200 | 36 | 71 | 292 | 28800 | 261 | 9280 | 596 | 4.8 | 3310 | <0.3 | 73 | 52 | 430 |
| | 5-10 cm | 25200 | <0.4 | 14 | 205 | 1 | 1.90 | 21200 | 36 | 82 | 344 | 30500 | 228 | 9270 | 596 | 5 | 4120 | 1 | 75 | 53 | 406 |
| | 10-20 cm* | 25025 | 0.5 | 17.5 | 208 | 1.2 | 1.21 | 17725 | 35 | 71 | 328 | 30450 | 199 | 8538 | 709 | 2.7 | 3593 | 1.41 | 65 | 51 | 344 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|------|-------|-------|----|-----|-------|-------|------|------|-----|------|------|------|----|-----|-----|
| 2292330 (Back yard) | 0-5 cm | 25900 | <0.4 | 8.6 | 162 | 1.3 | 0.90 | 17900 | 32 | 35 | 136 | 27800 | 109 | 8120 | 459 | 4.4 | 1440 | <0.3 | 69 | 48 | 213 |
| | 5-10 cm | 31100 | <0.4 | 8.2 | 182 | 1.5 | 0.87 | 32700 | 36 | 35 | 128 | 32700 | 93 | 1000 | 538 | 4.6 | 1310 | <0.3 | 81 | 55 | 192 |
| | 10-20 cm* | 20400 | 0.5 | 13.8 | 143 | 1.1 | 0.79 | 15425 | 28 | 42 | 198 | 25700 | 99 | 5823 | 444 | 2.6 | 2088 | 1.18 | 71 | 43 | 218 |
| 2292331 (Side yard) | 0-5 cm | 23800 | <0.4 | 13.0 | 119 | 1.1 | 1.04 | 24400 | 34 | 67 | 243 | 30000 | 169 | 9020 | 774 | 4.7 | 2880 | <0.3 | 36 | 49 | 270 |
| | 5-10 cm | 26600 | <0.4 | 12 | 138 | 1 | 0.90 | 49500 | 34 | 49 | 188 | 29900 | 337 | 9310 | 744 | 5 | 2100 | <0.3 | 43 | 51 | 245 |
| 2292332 (Back yard) | 10-20 cm | 25700 | <0.4 | 9.0 | 109 | 1.1 | 0.58 | 80100 | 28 | 23 | 63 | 25200 | 73 | 8080 | 682 | 5.3 | 524 | 0.34 | 49 | 46 | 111 |
| | 0-5 cm | 19400 | <0.4 | 8.7 | 122 | 0.8 | 0.83 | 14600 | 28 | 27 | 107 | 19300 | 91 | 7490 | 386 | 4.0 | 1130 | <0.3 | 49 | 35 | 194 |
| | 5-10 cm* | 19400 | 0.5 | 10.9 | 124 | 0.8 | 0.74 | 15325 | 28 | 29 | 127 | 18375 | 94 | 7445 | 355 | 2.4 | 1248 | 0.60 | 53 | 36 | 212 |
| 2292333 (Front yard) | 10-20 cm* | 16050 | 0.5 | 13.8 | 121 | 0.8 | 0.77 | 33750 | 24 | 32 | 156 | 17275 | 123 | 1742 | 323 | 3.0 | 1615 | 0.70 | 83 | 31 | 243 |
| | 0-5 cm | 18700 | <0.4 | 13.1 | 141 | 0.9 | 1.44 | 12600 | 32 | 70 | 305 | 26500 | 261 | 6760 | 619 | 4.1 | 3320 | 1.00 | 42 | 40 | 412 |
| | 5-10 cm* | 16700 | 0.6 | 16.4 | 131 | 0.8 | 0.99 | 12200 | 29 | 65 | 318 | 25800 | 246 | 6555 | 605 | 2.5 | 3650 | 1.48 | 37 | 38 | 380 |
| 2292334 (Back yard) | 10-20 cm* | 16275 | 0.5 | 18.2 | 135 | 0.8 | 0.91 | 13075 | 27 | 58 | 315 | 26175 | 234 | 6495 | 612 | 2.3 | 3693 | 2.35 | 38 | 36 | 341 |
| | 0-5 cm* | 16475 | 0.4 | 11.0 | 104 | 0.7 | 0.69 | 9180 | 24 | 35 | 149 | 19875 | 90 | 4635 | 315 | 2.2 | 1620 | 0.65 | 36 | 34 | 215 |
| | 5-10 cm | 18500 | <0.4 | 9 | 101 | 1 | 0.78 | 9600 | 23 | 32 | 132 | 21700 | 78 | 4950 | 340 | 4 | 1530 | <0.3 | 36 | 37 | 183 |
| 2292335 (Front yard) | 10-20 cm* | 17125 | 0 | 14 | 112 | 1 | 0.66 | 13125 | 24 | 32 | 173 | 20775 | 89 | 5543 | 326 | 2 | 1703 | 1 | 46 | 35 | 214 |
| | 0-5 cm | 21300 | <0.4 | 8.6 | 125 | 0.9 | 0.99 | 12100 | 32 | 64 | 208 | 22700 | 179 | 6160 | 427 | 4.1 | 2140 | <0.3 | 44 | 42 | 267 |
| | 5-10 cm | 21100 | <0.4 | 8.4 | 123 | 0.9 | 0.98 | 13300 | 30 | 76 | 237 | 23600 | 172 | 6640 | 439 | 4.1 | 2600 | <0.3 | 43 | 42 | 273 |
| 2292336 (Back yard) | 10-20 cm* | 20550 | 0.5 | 22.3 | 121 | 1 | 0.85 | 10363 | 32 | 100 | 441 | 29425 | 164 | 5645 | 500 | 2.5 | 5913 | 3.15 | 42 | 41 | 307 |
| | 0-5 cm* | 13100 | 0.4 | 11.3 | 102 | 0.6 | 1.27 | 13400 | 43 | 65 | 239 | 21775 | 170 | 5835 | 416 | 2.6 | 2598 | 2.23 | 45 | 34 | 349 |
| | 5-10 cm | 15800 | <0.4 | 13 | 104 | 1 | 1.55 | 12000 | 31 | 89 | 376 | 36400 | 171 | 5660 | 482 | 4 | 4670 | 3 | 43 | 36 | 430 |
| 2292337 (Front yard) | 10-20 cm* | 13600 | 0.3 | 6.2 | 75 | 0.5 | 0.50 | 30010 | 19 | 21 | 90 | 21475 | 55 | 4580 | 325 | 1.9 | 1165 | 0.56 | 30 | 36 | 142 |
| | 0-5 cm | 21200 | <0.4 | 18.6 | 157 | 1.1 | 1.60 | 11900 | 34 | 112 | 384 | 28800 | 208 | 6850 | 615 | 4.0 | 4680 | 1.56 | 39 | 48 | 401 |
| | 5-10 cm | 18000 | <0.4 | 14 | 116 | 1 | 1.10 | 9130 | 27 | 57 | 242 | 26900 | 101 | 6260 | 636 | 4 | 3090 | 0 | 28 | 42 | 227 |
| 2292338 (Back yard) | 10-20 cm* | 17650 | 0.4 | 14.4 | 104 | 0.8 | 0.58 | 9745 | 27 | 48 | 231 | 25125 | 86 | 5995 | 569 | 2.2 | 3133 | 1.58 | 28 | 39 | 204 |
| | 0-5 cm | 22700 | <0.4 | 12.5 | 186 | 1.1 | 1.26 | 11100 | 33 | 55 | 249 | 28200 | 153 | 5770 | 555 | 4.1 | 2820 | 0.30 | 53 | 47 | 328 |
| | 5-10 cm | 18500 | <0.4 | 12 | 138 | 1 | 0.92 | 9200 | 26 | 40 | 178 | 21700 | 95 | 4780 | 485 | 4 | 2000 | <0.3 | 43 | 37 | 230 |
| 10-20 cm* | 18800 | 0.4 | 14.9 | 168 | 1 | 0.67 | 11058 | 28 | 45 | 226 | 23625 | 112 | 5068 | 434 | 2.3 | 2698 | 0.92 | 49 | 40 | 250 | |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|-------|------|-----|-----|------|-------|----|-----|-----|-------|-----|------|------|-----|------|------|-----|----|-----|
| 2292339 (Front yard) | 0-5 cm | 24700 | <0.4 | 16.5 | 339 | 1.2 | 1.46 | 14000 | 36 | 99 | 345 | 26700 | 425 | 7590 | 474 | 0.8 | 3390 | 0.40 | 56 | 52 | 694 |
| | 0-5 cm | 22800 | 0.5 | 21.4 | 348 | 1.2 | 1.68 | 14400 | 36 | 152 | 497 | 25700 | 431 | 7610 | 464 | 0.9 | 4730 | 1.51 | 58 | 50 | 717 |
| | 0-5 cm | 23900 | <0.4 | 17 | 356 | 1 | 1.38 | 12600 | 34 | 114 | 380 | 26000 | 465 | 7240 | 490 | 1 | 3650 | 1 | 53 | 50 | 661 |
| | 5-10 cm | 29900 | 1 | 31 | 326 | 1 | 2.07 | 16000 | 43 | 222 | 694 | 32800 | 352 | 8870 | 494 | 1 | 7000 | 2 | 66 | 59 | 697 |
| | 5-10 cm | 28000 | 1 | 27 | 250 | 1 | 1.55 | 15900 | 38 | 188 | 616 | 30300 | 251 | 8740 | 493 | 1 | 6330 | 1 | 62 | 56 | 523 |
| | 5-10 cm | 28600 | <0.4 | 24.4 | 305 | 1.4 | 1.63 | 14500 | 42 | 179 | 561 | 29500 | 312 | 8070 | 491 | 0.8 | 5610 | 0.88 | 63 | 55 | 553 |
| 2292340 (Back yard) | 10-20 cm* | 28675 | 1.1 | 30.2 | 243 | 1.4 | 1.28 | 17650 | 42 | 162 | 654 | 32275 | 224 | 8638 | 464 | 2.0 | 7540 | 3.58 | 68 | 54 | 600 |
| | 10-20 cm* | 25800 | 1.2 | 36.9 | 269 | 1.3 | 1.19 | 17225 | 45 | 214 | 871 | 35200 | 282 | 8295 | 500 | 2.1 | 9025 | 5.83 | 69 | 52 | 914 |
| | 10-20 cm | 28075 | 1.1 | 31.2 | 243 | 1.4 | 1.24 | 19500 | 45 | 174 | 718 | 33825 | 249 | 8930 | 486 | 2.1 | 8363 | 3.65 | 69 | 53 | 605 |
| | 0-5 cm | 15700 | <0.4 | 26.5 | 143 | 0.9 | 1.12 | 15000 | 25 | 31 | 165 | 20700 | 184 | 5840 | 466 | 0.4 | 1230 | <0.3 | 62 | 37 | 273 |
| | 0-5 cm* | 13475 | 0.3 | 12.4 | 97 | 0.7 | 0.58 | 10048 | 21 | 24 | 116 | 19175 | 76 | 4945 | 516 | 1.2 | 935 | 0.65 | 41 | 32 | 211 |
| | 0-5 cm* | 11700 | 0.4 | 11.6 | 101 | 0.7 | 0.60 | 12250 | 19 | 26 | 148 | 18425 | 113 | 4860 | 441 | 1.3 | 857 | 0.69 | 46 | 30 | 231 |
| 2292341 (Front yard) | 5-10 cm* | 15075 | 0.5 | 32.5 | 120 | 0.8 | 0.78 | 15525 | 24 | 32 | 175 | 21150 | 184 | 5828 | 473 | 1.3 | 1480 | 0.58 | 52 | 36 | 227 |
| | 5-10 cm* | 11375 | <0.47 | 7.8 | 62 | 0.5 | 0.34 | 8195 | 15 | 16 | 63 | 17700 | 39 | 4250 | 568 | 1.0 | 486 | 0.45 | 28 | 27 | 104 |
| | 5-10 cm* | 11750 | 0 | 11 | 79 | 1 | 0.54 | 12500 | 17 | 23 | 110 | 18325 | 78 | 4883 | 519 | 1 | 865 | 1 | 39 | 29 | 169 |
| | 10-20 cm* | 13825 | 0.4 | 27.5 | 128 | 0.9 | 0.69 | 14325 | 23 | 32 | 180 | 19725 | 156 | 5323 | 426 | 1.3 | 1665 | 0.50 | 61 | 34 | 235 |
| | 10-20 cm* | 12950 | 0.4 | 17.5 | 115 | 0.8 | 0.69 | 12925 | 20 | 31 | 167 | 19525 | 96 | 4938 | 476 | 1.2 | 1425 | 0.60 | 56 | 32 | 220 |
| | 10-20 cm* | 11375 | 0.4 | 15.8 | 117 | 0.7 | 0.70 | 14000 | 19 | 35 | 221 | 19050 | 152 | 4745 | 428 | 1.0 | 1680 | 0.63 | 53 | 30 | 261 |
| 2292342 (Back yard) | 0-5 cm | 25600 | <0.4 | 23.2 | 235 | 1.7 | 2.45 | 19400 | 38 | 66 | 320 | 26900 | 244 | 8540 | 489 | 5.4 | 2970 | 6.30 | 77 | 53 | 422 |
| | 5-10 cm | 28700 | <0.4 | 16 | 205 | 2 | 1.52 | 29800 | 37 | 49 | 208 | 31500 | 153 | 1280 | 613 | 6 | 2060 | 0 | 77 | 56 | 294 |
| | 10-20 cm* | 24500 | 0.6 | 44.3 | 227 | 1.4 | 2.42 | 24575 | 38 | 100 | 566 | 36400 | 321 | 9285 | 777 | 2.9 | 6733 | 2.65 | 77 | 48 | 546 |
| | 0-5 cm | 26100 | <0.4 | 31.8 | 261 | 1.6 | 2.37 | 17700 | 40 | 64 | 372 | 25700 | 283 | 7300 | 401 | 5.1 | 3110 | 1.20 | 90 | 54 | 434 |
| | 5-10 cm | 23500 | <0.4 | 44 | 253 | 2 | 2.83 | 18100 | 39 | 69 | 392 | 25200 | 315 | 7290 | 390 | 5 | 3710 | 1 | 92 | 51 | 479 |
| | 10-20 cm* | 22850 | 0.8 | 47.6 | 287 | 1.4 | 1.97 | 19275 | 38 | 67 | 433 | 27400 | 367 | 6773 | 281 | 2.6 | 4570 | 1.68 | 102 | 46 | 525 |
| 2292343 (Front yard) | 0-5 cm | 17900 | <0.4 | 18.8 | 282 | 1.4 | 2.16 | 27100 | 37 | 107 | 469 | 29900 | 622 | 1030 | 589 | 6.3 | 5230 | 2.40 | 92 | 44 | 618 |
| | 5-10 cm | 16700 | <0.4 | 32.1 | 288 | 1.5 | 2.44 | 32000 | 35 | 116 | 621 | 34600 | 596 | 1040 | 704 | 6.5 | 7740 | <0.3 | 109 | 36 | 638 |
| | 10-20 cm* | 18700 | 0.8 | 25.3 | 277 | 1.4 | 1.30 | 32400 | 33 | 60 | 423 | 30600 | 511 | 7990 | 635 | 2.7 | 5670 | 1.84 | 123 | 37 | 472 |
| | 0-5 cm | 23300 | <0.4 | 13.5 | 188 | 1.4 | 1.44 | 16700 | 33 | 43 | 220 | 24900 | 159 | 6880 | 432 | 5.5 | 2080 | 0.50 | 80 | 48 | 325 |
| | 5-10 cm | 23400 | <0.4 | 14.1 | 188 | 1.4 | 1.47 | 16300 | 33 | 47 | 236 | 25900 | 176 | 6900 | 431 | 5.3 | 2330 | <0.3 | 80 | 48 | 331 |
| | 10-20 cm | 25100 | <0.4 | 17.0 | 200 | 1.5 | 1.58 | 18000 | 36 | 50 | 265 | 26900 | 177 | 7410 | 434 | 5.3 | 2580 | <0.3 | 87 | 51 | 334 |
| 2292345 (Front yard) | 0-5 cm | 20200 | <0.4 | 14.5 | 179 | 1.4 | 1.59 | 30800 | 32 | 58 | 288 | 27900 | 179 | 1200 | 612 | 5.7 | 2770 | 0.40 | 82 | 43 | 387 |
| | 5-10 cm | 24200 | <0.4 | 21 | 209 | 2 | 1.86 | 30600 | 36 | 74 | 406 | 36400 | 185 | 1250 | 985 | 6 | 4380 | 1 | 79 | 47 | 438 |
| | 10-20 cm* | 24325 | 1 | 22 | 270 | 2 | 2.04 | 38000 | 35 | 52 | 311 | 48400 | 211 | 1142 | 1648 | 3 | 3620 | 2 | 112 | 44 | 699 |
| | 0-5 cm | 17000 | 9.2 | 6.3 | 160 | 1.1 | 1.83 | 34400 | 32 | 40 | 142 | 21600 | 189 | 1530 | 819 | 6.2 | 999 | <0.3 | 117 | 42 | 402 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|-----|------|------|-----|-------|------|-----|-------|-----|
| 2292347 (Front yard) | 5-10 cm | 18900 | 9.3 | 8.0 | 177 | 1.3 | 2.45 | 36200 | 32 | 47 | 166 | 26100 | 217 | 1370 | 1540 | 6.0 | 1240 | <0.3 | 139 | 44 | 610 |
| | 0-5 cm | 17700 | 6.9 | 10.8 | 152 | 1 | 1.55 | 24600 | 33 | 55 | 272 | 25900 | 196 | 9980 | 489 | 5.7 | 2650 | <0.3 | 76 | 41 | 374 |
| | 5-10 cm | 19500 | 8 | 14 | 170 | 1 | 1.74 | 23300 | 33 | 64 | 314 | 28000 | 260 | 9790 | 479 | 6 | 3070 | <0.3 | 78 | 43 | 395 |
| 2292348 (Back yard) | 10-20 cm* | 18550 | 3 | 16 | 163 | 1 | 1.55 | 24075 | 31 | 53 | 274 | 26550 | 184 | 9155 | 475 | 3 | 2655 | 1 | 73 | 39 | 333 |
| | 0-5 cm | 23100 | 7.2 | 11.0 | 194 | 1.2 | 2.90 | 24500 | 48 | 66 | 318 | 27200 | 241 | 1260 | 457 | 5.8 | 2620 | <0.3 | 69 | 49 | 536 |
| | 5-10 cm | 26700 | 7.7 | 14.9 | 210 | 1.4 | 3.31 | 22000 | 48 | 84 | 389 | 30900 | 287 | 1100 | 480 | 5.7 | 3680 | <0.3 | 65 | 53 | 631 |
| 2292349 (Back yard) | 10-20 cm* | 24700 | 2.9 | 16.8 | 189 | 1.3 | 2.14 | 26650 | 40 | 55 | 300 | 30375 | 164 | 1157 | 445 | 3.3 | 2963 | 1.35 | 75 | 48 | 405 |
| | 0-5 cm* | 16200 | 1.9 | 7.1 | 156 | 0.8 | 1.22 | 22050 | 25 | 24 | 134 | 20925 | 134 | 7238 | 409 | 3.0 | 859 | 0.65 | 106 | 32275 | |
| | 5-10 cm | 21900 | 8 | 8 | 201 | 1 | 1.40 | 23300 | 33 | 33 | 178 | 25700 | 189 | 7800 | 456 | 5 | 1110 | <0.3 | 136 | 40 | 351 |
| 2292350 (Front yard) | 10-20 cm* | 21200 | 3 | 12 | 312 | 1 | 1.82 | 30500 | 34 | 44 | 345 | 28450 | 270 | 8108 | 437 | 3 | 1960 | 1 | 179 | 39 | 509 |
| | 0-5 cm* | 17375 | 1.3 | 6.2 | 96 | 0.7 | 0.77 | 7375 | 25 | 25 | 89 | 19750 | 87 | 4853 | 430 | 2.5 | 832 | 0.63 | 28 | 36 | 154 |
| | 5-10 cm* | 16750 | 1.3 | 5.6 | 89 | 0.7 | 0.71 | 6853 | 23 | 25 | 89 | 19450 | 77 | 4525 | 428 | 2.4 | 811 | 0.58 | 25 | 35 | 133 |
| 2292351 (Back yard) | 10-20 cm* | 17325 | 1.0 | 8.6 | 98 | 0.7 | 0.84 | 7020 | 24 | 36 | 148 | 22075 | 92 | 4890 | 474 | 2.3 | 1465 | 0.80 | 25 | 36 | 162 |
| | 0-5 cm* | 18250 | 1.9 | 9.6 | 157 | 1 | 0.97 | 14525 | 31 | 31 | 124 | 23000 | 167 | 8130 | 446 | 2.9 | 1285 | 0.68 | 57 | 40 | 232 |
| | 5-10 cm* | 21250 | 2 | 10 | 162 | 1 | 0.98 | 14800 | 32 | 33 | 134 | 25775 | 198 | 8368 | 478 | 3 | 1328 | 1 | 63 | 42 | 234 |
| 2292352 (Back yard) | 10-20 cm* | 21450 | 2.2 | 10.0 | 162 | 1 | 0.85 | 16375 | 30 | 32 | 126 | 26150 | 196 | 8383 | 476 | 3.0 | 1275 | 0.68 | 65 | 42 | 215 |
| | 0-5 cm | 19300 | 0.8 | 12.7 | 128 | 0.8 | 1.25 | 14000 | 38 | 64 | 455 | 25100 | 164 | 6360 | 591 | 1.1 | 2300 | <0.3 | 45 | 44 | 343 |
| | 5-10 cm | 19500 | 0.8 | 14.4 | 123 | 0.9 | 1.13 | 13200 | 29 | 69 | 569 | 25800 | 122 | 6310 | 624 | 0.8 | 2570 | 0.90 | 44 | 44 | 316 |
| 2292353 (Front yard) | 10-20 cm | 21600 | <0.4 | 13.2 | 120 | 0.9 | 0.98 | 11900 | 33 | 54 | 516 | 26700 | 100 | 6360 | 612 | 0.8 | 2040 | <0.3 | 45 | 47 | 284 |
| | 0-5 cm | 10400 | 3.2 | 13.5 | 166 | 0.5 | 2.33 | 66300 | 30 | 77 | 299 | 29400 | 562 | 3190 | 478 | 2.3 | 2590 | 0.70 | 104 | 27 | 721 |
| | 0-5 cm | 18900 | 0.7 | 12.1 | 137 | 0.8 | 1.01 | 10800 | 31 | 118 | 342 | 26000 | 123 | 6180 | 553 | 0.9 | 3900 | 1.50 | 54 | 46 | 290 |
| 2292354 (Front yard) | 5-10 cm | 22600 | <0.4 | 13.0 | 131 | 1 | 0.93 | 8720 | 29 | 92 | 303 | 27300 | 86 | 6200 | 537 | 0.7 | 3190 | <0.3 | 56 | 50 | 225 |
| | 10-20 cm | 14300 | <0.4 | 7.2 | 64 | 0.5 | 0.40 | 3550 | 21 | 32 | 120 | 21000 | 30 | 3470 | 564 | 0.2 | 1420 | <0.3 | 24 | 36 | 131 |
| | 0-5 cm | 13500 | <0.4 | 8.3 | 61 | 0.4 | 0.52 | 6690 | 17 | 51 | 148 | 21900 | 63 | 3300 | 328 | 0.5 | 2150 | <0.3 | 22 | 33 | 164 |
| 2292355 (Front yard) | 5-10 cm | 15400 | <0.4 | 5.4 | 48 | 0.4 | 0.36 | 4910 | 17 | 30 | 85 | 17100 | 34 | 2980 | 269 | 0.5 | 974 | <0.3 | 16 | 34 | 92 |
| | 10-20 cm | 15200 | 1.7 | 43.0 | 162 | 1 | 2.04 | 15800 | 32 | 167 | 792 | 59700 | 333 | 6200 | 627 | 2.0 | 12000 | 6.10 | 56 | 43 | 743 |
| | 0-5 cm | 16100 | 0.4 | 12.7 | 176 | 0.8 | 1.15 | 10200 | 29 | 46 | 193 | 22600 | 166 | 3750 | 319 | 0.9 | 2070 | 0.40 | 54 | 38 | 350 |
| 2292356 (Back yard) | 5-10 cm | 19700 | 1.0 | 18.8 | 290 | 1.4 | 1.87 | 9100 | 34 | 60 | 284 | 28800 | 282 | 3730 | 343 | 1.7 | 3100 | 0.40 | 101 | 44 | 542 |
| | 10-20 cm | 23300 | 5.3 | 38.6 | 569 | 2.4 | 2.30 | 15100 | 53 | 87 | 619 | 42600 | 540 | 4440 | 477 | 2.8 | 6300 | 2.20 | 219 | 55 | 923 |
| | 0-5 cm | 14100 | 1.1 | 25.5 | 212 | 0.7 | 1.77 | 26400 | 47 | 143 | 581 | 34800 | 327 | 1080 | 577 | 1.5 | 6770 | 4.30 | 59 | 39 | 467 |
| 2292357 (Front yard) | 5-10 cm | 12600 | 1.1 | 36.7 | 161 | 0.7 | 2.13 | 30900 | 35 | 163 | 775 | 49000 | 295 | 1040 | 646 | 1.7 | 10600 | 5.80 | 63 | 38 | 568 |
| | 10-20 cm | 15500 | 2.3 | 33.9 | 259 | 0.9 | 2.21 | 32000 | 34 | 111 | 751 | 41700 | 329 | 9680 | 665 | 1.2 | 9300 | 4.50 | 86 | 40 | 886 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|------|------|------|-----|-------|------|-----|----|------|
| 2292358 (Back yard) | 0-5 cm | 16300 | 1.0 | 24.1 | 178 | 1 | 1.47 | 12900 | 28 | 83 | 407 | 38800 | 212 | 5820 | 472 | 1.0 | 5300 | 3.60 | 59 | 49 | 565 |
| | 0-5 cm | 16200 | 1.2 | 26.1 | 206 | 0.9 | 1.73 | 13300 | 28 | 87 | 437 | 40600 | 257 | 5710 | 496 | 0.9 | 6010 | 3.80 | 63 | 48 | 654 |
| | 0-5 cm | 15100 | 0.5 | 20.4 | 152 | 0.7 | 1.19 | 12400 | 25 | 73 | 349 | 30100 | 176 | 5430 | 407 | 0.8 | 4550 | 1.30 | 50 | 40 | 406 |
| | 5-10 cm | 18500 | 1.8 | 35.3 | 212 | 1.2 | 1.77 | 16500 | 31 | 78 | 460 | 49400 | 221 | 6300 | 519 | 1.3 | 5470 | 2.40 | 79 | 56 | 754 |
| | 5-10 cm | 15800 | 1.5 | 31.3 | 191 | 1.2 | 1.72 | 16000 | 26 | 67 | 393 | 58100 | 195 | 5550 | 553 | 1.5 | 4740 | 1.10 | 89 | 62 | 944 |
| 2292359 (Front yard) | 5-10 cm | 17500 | 0.7 | 29.8 | 192 | 0.9 | 1.33 | 15400 | 31 | 84 | 457 | 36800 | 249 | 6280 | 482 | 0.7 | 6250 | 0.80 | 60 | 44 | 511 |
| | 10-20 cm | 17100 | 1.3 | 27.7 | 224 | 1.1 | 1.38 | 17800 | 26 | 57 | 366 | 43900 | 206 | 6000 | 464 | 1.0 | 4110 | 1.20 | 78 | 52 | 637 |
| | 10-20 cm | 16800 | 0.9 | 27.3 | 175 | 1 | 1.28 | 17200 | 30 | 63 | 355 | 39100 | 168 | 5840 | 448 | 0.9 | 4390 | 1.50 | 74 | 48 | 572 |
| | 10-20 cm | 18000 | 0.5 | 30.7 | 197 | 0.9 | 1.41 | 17600 | 33 | 78 | 455 | 37100 | 237 | 6470 | 455 | 0.8 | 5820 | 0.80 | 67 | 44 | 529 |
| | 0-5 cm | 18200 | <0.4 | 3.6 | 95 | 0.6 | 0.25 | 14600 | 22 | 13 | 31 | 19000 | 23 | 6570 | 422 | 0.3 | 162 | <0.3 | 48 | 42 | 74 |
| 2292360 (Back yard) | 5-10 cm | 18800 | <0.4 | 4.0 | 95 | 0.6 | 0.29 | 13300 | 32 | 12 | 29 | 20100 | 22 | 6100 | 472 | 0.3 | 117 | <0.3 | 46 | 43 | 73 |
| | 10-20 cm | 19600 | <0.4 | 5.6 | 108 | 0.7 | 0.34 | 20900 | 24 | 18 | 68 | 23600 | 47 | 9150 | 495 | 0.5 | 532 | <0.3 | 62 | 45 | 101 |
| | 0-5 cm | 20800 | <0.4 | 7.7 | 169 | 0.8 | 0.62 | 27100 | 25 | 25 | 116 | 25700 | 117 | 9670 | 518 | 0.5 | 1000 | <0.3 | 67 | 44 | 175 |
| | 5-10 cm | 32800 | <0.4 | 11.3 | 224 | 1.3 | 0.62 | 38900 | 35 | 35 | 152 | 42800 | 117 | 1480 | 722 | 0.7 | 1550 | <0.3 | 90 | 63 | 238 |
| | 10-20 cm | 32500 | 0.7 | 23.4 | 377 | 1.4 | 1.18 | 25600 | 43 | 77 | 390 | 48500 | 292 | 1250 | 599 | 1.2 | 5210 | 0.70 | 86 | 67 | 491 |
| 2292361 (Front yard) | 0-5 cm | 20300 | <0.4 | 5.6 | 121 | 0.7 | 0.42 | 20500 | 24 | 21 | 73 | 21300 | 37 | 9660 | 478 | 0.6 | 528 | <0.3 | 73 | 44 | 111 |
| | 5-10 cm | 23400 | <0.4 | 6.8 | 148 | 0.8 | 0.45 | 31700 | 28 | 28 | 118 | 27100 | 64 | 1450 | 571 | 0.8 | 1190 | <0.3 | 82 | 49 | 166 |
| | 10-20 cm | 28400 | <0.4 | 10.3 | 199 | 1.1 | 0.63 | 38800 | 34 | 56 | 231 | 32700 | 99 | 1690 | 541 | 1.1 | 2540 | <0.3 | 90 | 58 | 200 |
| | 0-5 cm | 24400 | <0.4 | 7.0 | 159 | 0.9 | 0.38 | 26400 | 28 | 24 | 98 | 26400 | 85 | 1140 | 415 | 0.5 | 954 | <0.3 | 65 | 50 | 155 |
| | 5-10 cm | 35800 | <0.4 | 9.9 | 242 | 1.4 | 0.47 | 34500 | 40 | 31 | 131 | 39600 | 111 | 1530 | 620 | 0.8 | 1300 | <0.3 | 88 | 68 | 197 |
| 2292362 (Back yard) | 10-20 cm | 34900 | <0.4 | 9.3 | 232 | 1.4 | 0.40 | 38100 | 37 | 31 | 150 | 36900 | 106 | 1490 | 561 | 0.7 | 1320 | <0.3 | 95 | 66 | 197 |
| | 0-5 cm | 15300 | <0.4 | 3.7 | 102 | 0.5 | 0.42 | 13700 | 20 | 11 | 41 | 16800 | 19 | 5770 | 432 | 0.4 | 161 | <0.3 | 51 | 34 | 80 |
| | 5-10 cm | 21400 | <0.4 | 5.7 | 158 | 0.7 | 0.49 | 19100 | 27 | 17 | 67 | 22900 | 39 | 9390 | 518 | 0.7 | 454 | <0.3 | 77 | 46 | 113 |
| | 10-20 cm | 29600 | <0.4 | 7.5 | 203 | 1.1 | 0.56 | 34600 | 36 | 28 | 132 | 30600 | 78 | 1690 | 593 | 0.8 | 1120 | <0.3 | 119 | 58 | 147 |
| | 0-5 cm | 28000 | 0.5 | 9.8 | 214 | 1.1 | 0.72 | 29100 | 34 | 32 | 176 | 32100 | 154 | 1220 | 481 | 0.6 | 1350 | <0.3 | 80 | 55 | 241 |
| 2292364 (Back yard) | 5-10 cm | 32000 | <0.4 | 10.2 | 227 | 1.3 | 0.47 | 37600 | 35 | 31 | 146 | 35600 | 136 | 1490 | 519 | 0.6 | 1530 | <0.3 | 91 | 62 | 209 |
| | 10-20 cm | 31800 | <0.4 | 11.9 | 272 | 1.3 | 0.56 | 39200 | 36 | 46 | 217 | 37000 | 254 | 1560 | 557 | 0.8 | 2120 | <0.3 | 101 | 63 | 251 |
| | 0-5 cm | 16000 | 5.3 | 33.2 | 447 | 1.5 | 5.08 | 33000 | 45 | 175 | 720 | 43400 | 1130 | 8140 | 819 | 2.2 | 6930 | 8.70 | 129 | 48 | 1590 |
| | 5-10 cm | 20000 | 6.0 | 47.7 | 557 | 2.2 | 4.19 | 43500 | 47 | 177 | 977 | 72100 | 1290 | 7700 | 954 | 2.9 | 12100 | 6.30 | 192 | 46 | 1440 |
| | 10-20 cm | 33100 | <0.4 | 32.3 | 579 | 4.6 | 4.35 | 93400 | 50 | 88 | 917 | 47600 | 877 | 7390 | 1440 | 6.7 | 8680 | 1.30 | 393 | 33 | 1390 |
| 2292366 (Front yard) | 0-5 cm | 19400 | <0.4 | 23.4 | 160 | 0.7 | 1.69 | 16400 | 40 | 115 | 462 | 43200 | 213 | 8830 | 669 | 5.2 | 6970 | 3.40 | 56 | 42 | 587 |
| | 5-10 cm | 22200 | <0.4 | 41.2 | 193 | 0.8 | 2.41 | 15200 | 48 | 147 | 671 | 57400 | 245 | 8460 | 804 | 5.9 | 10500 | 6.60 | 51 | 43 | 836 |
| | 10-20 cm | 24400 | <0.4 | 24.2 | 171 | 0.9 | 1.57 | 15100 | 40 | 78 | 384 | 39500 | 157 | 8620 | 654 | 4.8 | 5380 | 3.00 | 52 | 48 | 463 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|-----|------|-----|-----|------|------|----|----|-----|
| 2292367 (Back yard) | 0-5 cm | 22400 | <0.4 | 26.7 | 190 | 0.9 | 1.78 | 13800 | 37 | 81 | 357 | 35500 | 207 | 6480 | 671 | 4.4 | 4240 | 1.80 | 68 | 46 | 441 |
| | 5-10 cm | 21200 | <0.4 | 30.0 | 178 | 0.9 | 1.60 | 10500 | 36 | 68 | 336 | 36300 | 168 | 5950 | 606 | 4.4 | 4610 | 1.00 | 61 | 43 | 392 |
| | 10-20 cm | 22700 | <0.4 | 33.4 | 198 | 1 | 1.68 | 13200 | 38 | 58 | 319 | 36600 | 189 | 6420 | 582 | 4.7 | 4180 | 0.70 | 75 | 45 | 381 |
| 2292368 (Front yard) | 0-5 cm | 17300 | <0.4 | 8.3 | 109 | 0.6 | 0.83 | 15200 | 25 | 32 | 153 | 20300 | 66 | 7120 | 409 | 4.0 | 1470 | <0.3 | 54 | 36 | 190 |
| | 5-10 cm | 17200 | <0.4 | 9.0 | 123 | 0.6 | 0.99 | 16800 | 26 | 46 | 212 | 22200 | 100 | 7400 | 453 | 4.1 | 1860 | <0.3 | 55 | 36 | 259 |
| | 10-20 cm | 19100 | <0.4 | 30.3 | 184 | 0.8 | 2.17 | 20900 | 38 | 129 | 745 | 46500 | 252 | 9270 | 680 | 5.4 | 9120 | 5.10 | 64 | 39 | 745 |
| 2292369 (Back yard) | 0-5 cm | 16200 | <0.4 | 18.2 | 162 | 0.7 | 1.43 | 21900 | 31 | 73 | 370 | 30300 | 213 | 7350 | 520 | 4.7 | 4310 | 1.70 | 70 | 33 | 405 |
| | 5-10 cm | 17200 | <0.4 | 24.0 | 163 | 0.7 | 1.47 | 22600 | 33 | 83 | 434 | 34000 | 205 | 7990 | 538 | 4.7 | 5430 | 1.80 | 69 | 33 | 414 |
| | 10-20 cm | 18500 | <0.4 | 23.8 | 177 | 0.8 | 1.46 | 26900 | 31 | 72 | 433 | 33900 | 206 | 8070 | 542 | 4.7 | 5100 | 1.80 | 78 | 35 | 420 |
| 2292370 (Front yard) | 0-5 cm | 17700 | <0.4 | 8.9 | 128 | 0.6 | 1.01 | 18700 | 27 | 42 | 176 | 24800 | 115 | 8290 | 505 | 4.4 | 1660 | <0.3 | 59 | 35 | 239 |
| | 5-10 cm | 17100 | <0.4 | 10.8 | 131 | 0.6 | 1.09 | 16000 | 31 | 50 | 204 | 26500 | 135 | 7600 | 550 | 4.5 | 2060 | <0.3 | 43 | 34 | 261 |
| | 10-20 cm | 22500 | <0.4 | 17.1 | 165 | 0.8 | 1.30 | 20100 | 39 | 56 | 276 | 36600 | 153 | 9070 | 644 | 4.7 | 3190 | 0.30 | 50 | 40 | 321 |
| 2292371 (Back yard) | 0-5 cm | 16300 | <0.4 | 16.1 | 198 | 0.9 | 1.51 | 18200 | 28 | 58 | 335 | 27600 | 206 | 5990 | 548 | 4.5 | 3030 | 1.20 | 69 | 32 | 413 |
| | 5-10 cm | 17100 | <0.4 | 20.5 | 233 | 0.8 | 1.56 | 19800 | 31 | 66 | 411 | 31900 | 224 | 6500 | 588 | 4.6 | 3750 | 0.30 | 74 | 34 | 461 |
| | 10-20 cm | 17400 | <0.4 | 20.5 | 231 | 0.8 | 1.50 | 20900 | 34 | 61 | 454 | 31900 | 235 | 6270 | 619 | 4.8 | 3600 | 0.30 | 82 | 33 | 465 |
| 2292372 (Front yard) | 0-5 cm | 21700 | <0.4 | 12.7 | 136 | 0.7 | 2.16 | 17700 | 35 | 51 | 214 | 27900 | 117 | 8140 | 444 | 4.8 | 2130 | <0.3 | 60 | 41 | 274 |
| | 0-5 cm | 20600 | <0.4 | 14.8 | 154 | 0.7 | 2.86 | 19200 | 33 | 55 | 231 | 27800 | 145 | 8810 | 463 | 4.8 | 2280 | 0.50 | 64 | 39 | 328 |
| | 0-5 cm | 20500 | <0.4 | 12.9 | 129 | 0.6 | 2.32 | 16000 | 31 | 49 | 207 | 28300 | 109 | 7340 | 411 | 4.5 | 2270 | <0.3 | 55 | 37 | 263 |
| 2292373 (Back yard) | 5-10 cm | 25700 | <0.4 | 12.5 | 145 | 0.8 | 1.95 | 12500 | 35 | 50 | 202 | 30700 | 105 | 7140 | 451 | 4.4 | 2130 | <0.3 | 51 | 45 | 253 |
| | 5-10 cm | 22500 | <0.4 | 13.9 | 148 | 0.8 | 3.94 | 14600 | 36 | 61 | 230 | 30200 | 139 | 7900 | 480 | 4.3 | 2380 | <0.3 | 54 | 42 | 337 |
| | 5-10 cm | 23100 | <0.4 | 13.2 | 140 | 0.7 | 1.84 | 13000 | 33 | 47 | 201 | 29900 | 106 | 6370 | 440 | 4.2 | 2270 | <0.3 | 51 | 41 | 258 |
| 2292373 (Back yard) | 10-20 cm | 23100 | <0.4 | 16.4 | 150 | 0.8 | 2.19 | 16600 | 36 | 62 | 284 | 32800 | 136 | 7460 | 501 | 4.6 | 3360 | <0.3 | 57 | 41 | 357 |
| | 10-20 cm | 21600 | <0.4 | 23.9 | 160 | 0.8 | 3.40 | 19600 | 38 | 90 | 423 | 41300 | 177 | 8880 | 567 | 5.3 | 5360 | 2.20 | 64 | 39 | 482 |
| | 10-20 cm | 21000 | <0.4 | 20.6 | 176 | 0.7 | 2.08 | 17900 | 43 | 73 | 339 | 36100 | 180 | 7010 | 485 | 4.9 | 4180 | 1.30 | 59 | 37 | 377 |
| 2292373 (Back yard) | 0-5 cm | 19200 | <0.4 | 10.7 | 149 | 0.7 | 1.30 | 13200 | 30 | 46 | 197 | 26900 | 188 | 5190 | 408 | 4.3 | 2060 | <0.3 | 48 | 38 | 287 |
| | 0-5 cm | 18200 | <0.4 | 9.1 | 154 | 0.8 | 1.17 | 17900 | 29 | 43 | 184 | 26100 | 162 | 6070 | 415 | 4.3 | 1890 | <0.3 | 53 | 37 | 301 |
| | 0-5 cm | 18300 | <0.4 | 10.2 | 155 | 0.9 | 1.25 | 14700 | 31 | 47 | 204 | 26600 | 183 | 5890 | 426 | 4.2 | 1960 | <0.3 | 53 | 38 | 345 |
| 2292373 (Back yard) | 5-10 cm | 20300 | <0.4 | 11.7 | 174 | 1 | 1.27 | 11400 | 32 | 48 | 218 | 28400 | 207 | 5990 | 440 | 4.1 | 2200 | <0.3 | 53 | 40 | 390 |
| | 5-10 cm | 19200 | <0.4 | 10.2 | 152 | 0.8 | 1.07 | 11900 | 30 | 40 | 169 | 25300 | 158 | 5720 | 418 | 3.9 | 1660 | <0.3 | 46 | 39 | 289 |
| | 5-10 cm | 20100 | <0.4 | 11.5 | 171 | 0.9 | 1.23 | 10900 | 32 | 49 | 204 | 28300 | 188 | 5930 | 435 | 4.1 | 2170 | <0.3 | 51 | 40 | 355 |
| 2292373 (Back yard) | 10-20 cm | 23500 | <0.4 | 18.8 | 311 | 1.2 | 1.67 | 19200 | 41 | 65 | 376 | 41300 | 438 | 7440 | 534 | 5.0 | 4260 | <0.3 | 78 | 43 | 559 |
| | 10-20 cm | 19300 | <0.4 | 13.8 | 203 | 1 | 1.28 | 26700 | 37 | 48 | 262 | 31300 | 236 | 7250 | 483 | 4.9 | 2780 | <0.3 | 75 | 39 | 385 |
| | 10-20 cm | 21900 | <0.4 | 23.5 | 301 | 1.2 | 1.89 | 21400 | 49 | 69 | 443 | 38400 | 453 | 7830 | 516 | 5.1 | 4470 | 0.90 | 86 | 44 | 615 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|------|-------|------|------|-----|-----|------|------|-----|----|-----|
| 2292374 (Front yard) | 0-5 cm | 18400 | <0.4 | 10.2 | 137 | 0.8 | 2.07 | 20700 | 31 | 55 | 206 | 30000 | 133 | 1030 | 485 | 4.6 | 2170 | <0.3 | 59 | 38 | 323 |
| | 5-10 cm | 20800 | <0.4 | 16.9 | 165 | 1 | 2.83 | 24000 | 37 | 73 | 300 | 40000 | 171 | 1170 | 679 | 5.0 | 3440 | 1.10 | 68 | 43 | 441 |
| | 10-20 cm | 21200 | <0.4 | 17.0 | 169 | 1.1 | 2.38 | 27400 | 36 | 56 | 276 | 40800 | 156 | 1260 | 623 | 5.0 | 3190 | <0.3 | 78 | 43 | 397 |
| 2292375 (Back yard) | 0-5 cm | 22700 | <0.4 | 6.7 | 157 | 0.9 | 1.64 | 12800 | 32 | 42 | 153 | 27000 | 138 | 7080 | 522 | 4.1 | 1350 | <0.3 | 48 | 44 | 278 |
| | 5-10 cm | 24400 | <0.4 | 7.1 | 161 | 1 | 1.69 | 10700 | 35 | 44 | 163 | 29600 | 130 | 6880 | 588 | 3.8 | 1440 | <0.3 | 44 | 47 | 276 |
| 2292376 (Front yard) | 10-20 cm | 22800 | <0.4 | 4.7 | 145 | 0.9 | 1.36 | 9950 | 33 | 33 | 121 | 28800 | 97 | 6540 | 602 | 3.9 | 1100 | <0.3 | 38 | 45 | 225 |
| | 0-5 cm | 20000 | <0.4 | 13.1 | 174 | 0.9 | 1.44 | 22000 | 36 | 68 | 319 | 32500 | 329 | 1010 | 470 | 4.7 | 3340 | 0.90 | 69 | 41 | 403 |
| | 5-10 cm | 25400 | <0.4 | 17.4 | 212 | 1.1 | 1.63 | 24200 | 42 | 73 | 375 | 40000 | 188 | 1100 | 537 | 4.9 | 4050 | 1.10 | 77 | 49 | 452 |
| 2292377 (Back yard) | 10-20 cm | 30800 | 1.6 | 23.1 | 267 | 1.7 | 1.16 | 29300 | 40 | 52 | 303 | 42200 | 199 | 1300 | 533 | 1.2 | 2950 | 0.40 | 100 | 64 | 362 |
| | 0-5 cm | 17200 | 1.5 | 14.6 | 190 | 1.1 | 1.56 | 45500 | 28 | 55 | 275 | 25900 | 174 | 2330 | 470 | 1.3 | 2300 | 1.00 | 111 | 40 | 380 |
| | 5-10 cm | 16300 | 2.9 | 16.4 | 178 | 1 | 1.67 | 18200 | 26 | 50 | 252 | 22800 | 393 | 7550 | 343 | 0.7 | 2300 | 0.70 | 100 | 39 | 381 |
| 2292378 (Back yard) | 10-20 cm | 15300 | 3.7 | 17.1 | 186 | 1 | 1.69 | 19300 | 26 | 52 | 328 | 23800 | 490 | 7700 | 363 | 0.7 | 2290 | 0.90 | 96 | 38 | 395 |
| | 5-10 cm | 17500 | 8.7 | 42.9 | 307 | 1.3 | 3.17 | 22000 | 40 | 117 | 694 | 43300 | 1140 | 8850 | 563 | 1.6 | 6670 | 3.80 | 130 | 48 | 938 |
| | 0-5 cm | 11800 | 1.5 | 14.6 | 135 | 0.7 | 1.40 | 41400 | 33 | 130 | 640 | 22600 | 205 | 2140 | 514 | 1.3 | 3870 | 1.60 | 89 | 36 | 281 |
| 2292379 (Front yard) | 5-10 cm | 14800 | 2.2 | 31.6 | 176 | 1 | 2.51 | 31200 | 38 | 220 | 1120 | 33400 | 331 | 1600 | 613 | 1.8 | 6320 | 4.30 | 82 | 47 | 501 |
| | 10-20 cm | 23400 | 1.5 | 28.4 | 226 | 1.4 | 2.30 | 31700 | 43 | 146 | 816 | 46600 | 246 | 1460 | 682 | 1.6 | 6060 | 1.00 | 93 | 54 | 470 |
| | 0-5 cm | 29200 | 2.0 | 9.9 | 221 | 1.5 | 0.96 | 21300 | 42 | 41 | 163 | 35200 | 298 | 1290 | 605 | 1.0 | 1070 | <0.3 | 149 | 61 | 256 |
| 2292380 (Back yard) | 5-10 cm | 30600 | 1.2 | 9.0 | 208 | 1.5 | 0.78 | 26100 | 46 | 36 | 132 | 34900 | 172 | 1510 | 612 | 1.1 | 869 | <0.3 | 147 | 63 | 225 |
| | 10-20 cm | 32800 | <0.4 | 9.3 | 206 | 1.6 | 0.69 | 24400 | 47 | 34 | 113 | 36200 | 131 | 1330 | 616 | 0.9 | 768 | <0.3 | 131 | 67 | 204 |
| | 0-5 cm | 14900 | 2.8 | 10.9 | 297 | 0.8 | 2.84 | 54400 | 35 | 47 | 204 | 25500 | 594 | 2350 | 502 | 1.8 | 962 | 0.30 | 149 | 31 | 635 |
| 2292381 (Back yard) | 0-5 cm | 11900 | <0.4 | 9.1 | 115 | 0.8 | 0.81 | 26700 | 21 | 31 | 162 | 22800 | 103 | 1090 | 476 | 5.1 | 1060 | <0.3 | 79 | 25 | 179 |
| | 5-10 cm | 21000 | 0.4 | 7.3 | 197 | 1.3 | 0.92 | 26300 | 32 | 28 | 113 | 30300 | 140 | 1040 | 594 | 4.6 | 666 | <0.3 | 99 | 37 | 208 |
| | 10-20 cm | 23800 | 0.5 | 5.7 | 219 | 1.5 | 0.89 | 26800 | 33 | 31 | 120 | 31900 | 160 | 1070 | 602 | 4.5 | 703 | <0.3 | 100 | 41 | 224 |
| 2292382 (Back yard) | 5-10 cm | 24200 | 0.4 | 6.7 | 192 | 1.4 | 0.80 | 25600 | 34 | 28 | 108 | 30400 | 158 | 1020 | 541 | 4.7 | 520 | <0.3 | 108 | 43 | 200 |
| | 10-20 cm | 11200 | <0.4 | 6.2 | 90 | 0.7 | 0.54 | 23000 | 18 | 15 | 73 | 16200 | 114 | 8530 | 322 | 4.1 | 563 | <0.3 | 73 | 23 | 136 |
| | 0-5 cm | 11100 | <0.4 | 8.4 | 96 | 0.7 | 0.57 | 24900 | 17 | 16 | 78 | 17300 | 105 | 8640 | 328 | 4.2 | 626 | <0.3 | 84 | 23 | 141 |
| 2292383 (Front yard) | 5-10 cm | 10800 | <0.4 | 6.8 | 97 | 0.7 | 0.55 | 24700 | 17 | 17 | 74 | 16700 | 106 | 8120 | 314 | 4.1 | 702 | <0.3 | 92 | 23 | 132 |
| | 10-20 cm | 18000 | <0.4 | 5.3 | 135 | 1 | 0.58 | 21800 | 25 | 20 | 69 | 22500 | 95 | 9030 | 448 | 4.0 | 502 | <0.3 | 90 | 34 | 151 |
| | 0-5 cm | 20800 | 0.4 | 5.9 | 144 | 1.1 | 0.57 | 23900 | 28 | 21 | 71 | 26400 | 103 | 9820 | 508 | 4.2 | 511 | <0.3 | 94 | 37 | 146 |
| 2292384 (Front yard) | 5-10 cm | 21700 | 1.0 | 6.1 | 163 | 1.2 | 0.64 | 24000 | 31 | 23 | 84 | 27100 | 119 | 9830 | 477 | 4.4 | 576 | <0.3 | 110 | 40 | 170 |
| | 10-20 cm | 11400 | <0.4 | 5.2 | 81 | 0.7 | 0.47 | 22800 | 17 | 13 | 52 | 15000 | 71 | 9150 | 275 | 3.9 | 400 | <0.3 | 81 | 23 | 114 |
| | 0-5 cm | 12000 | <0.4 | 5.5 | 86 | 0.7 | 0.48 | 24800 | 17 | 14 | 54 | 15700 | 76 | 9460 | 317 | 4.1 | 465 | <0.3 | 90 | 24 | 115 |
| 2292385 (Back yard) | 5-10 cm | 9710 | <0.4 | 6.4 | 86 | 0.6 | 0.43 | 26200 | 15 | 13 | 48 | 16400 | 66 | 1030 | 371 | 4.0 | 435 | <0.3 | 102 | 21 | 100 |
| | 10-20 cm | | | | | | | | | | | | | | | | | | | | |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292387 (Back yard) | 0-5 cm | 13600 | <0.4 | 5.7 | 107 | 0.8 | 0.57 | 23100 | 21 | 17 | 64 | 19700 | 82 | 7780 | 378 | 4.1 | 489 | <0.3 | 97 | 26 | 140 |
| | 5-10 cm | 17700 | <0.4 | 7.1 | 135 | 1.1 | 0.56 | 25900 | 28 | 18 | 64 | 22500 | 89 | 8850 | 414 | 4.0 | 454 | <0.3 | 107 | 32 | 137 |
| | 10-20 cm | 14400 | <0.4 | 5.5 | 103 | 0.9 | 0.46 | 21500 | 20 | 15 | 50 | 19600 | 76 | 7360 | 349 | 3.7 | 418 | <0.3 | 91 | 29 | 112 |
| 2292388 (Front yard) | 0-5 cm | 12300 | <0.4 | 5.4 | 86 | 0.8 | 0.51 | 19900 | 18 | 14 | 53 | 16100 | 69 | 6930 | 331 | 3.8 | 478 | <0.3 | 76 | 24 | 127 |
| | 5-10 cm | 12300 | <0.4 | 5.9 | 88 | 0.8 | 0.55 | 21300 | 18 | 15 | 56 | 17200 | 70 | 7120 | 321 | 3.8 | 507 | <0.3 | 82 | 24 | 140 |
| | 10-20 cm | 13100 | <0.4 | 5.5 | 99 | 0.8 | 0.57 | 23800 | 19 | 15 | 66 | 17400 | 76 | 7030 | 338 | 3.9 | 523 | <0.3 | 99 | 25 | 139 |
| 2292389 (Back yard) | 0-5 cm | 9470 | <0.4 | 6.4 | 93 | 0.8 | 0.77 | 24500 | 15 | 18 | 79 | 18500 | 102 | 5300 | 442 | 3.8 | 851 | <0.3 | 76 | 18 | 203 |
| | 5-10 cm | 8940 | <0.4 | 7.8 | 91 | 0.8 | 0.75 | 25500 | 15 | 16 | 75 | 16900 | 104 | 5480 | 397 | 3.7 | 707 | <0.3 | 82 | 17 | 190 |
| | 10-20 cm | 10600 | <0.4 | 10.0 | 138 | 1.3 | 0.95 | 41700 | 17 | 22 | 110 | 20400 | 151 | 8030 | 487 | 4.4 | 1100 | <0.3 | 138 | 17 | 234 |
| 2292390 (Front yard) | 0-5 cm | 10200 | <0.4 | 5.0 | 79 | 0.6 | 0.46 | 22800 | 16 | 12 | 51 | 15300 | 49 | 6160 | 352 | 3.9 | 401 | <0.3 | 71 | 20 | 109 |
| | 5-10 cm | 11100 | <0.4 | 5.7 | 84 | 0.7 | 0.52 | 22300 | 18 | 15 | 58 | 17200 | 59 | 6860 | 365 | 3.7 | 527 | <0.3 | 73 | 23 | 130 |
| | 10-20 cm | 11400 | <0.4 | 6.7 | 87 | 0.8 | 0.53 | 24500 | 17 | 16 | 61 | 18300 | 66 | 7220 | 347 | 3.8 | 595 | <0.3 | 86 | 23 | 129 |
| 2292391 (Back yard) | 0-5 cm | 11000 | <0.4 | 7.8 | 121 | 1 | 1.02 | 28900 | 18 | 22 | 102 | 20600 | 174 | 6470 | 432 | 4.0 | 1030 | <0.3 | 96 | 20 | 256 |
| | 5-10 cm | 12100 | <0.4 | 9.2 | 132 | 1 | 1.02 | 32000 | 18 | 22 | 108 | 20300 | 171 | 7050 | 478 | 4.4 | 986 | <0.3 | 113 | 21 | 260 |
| | 10-20 cm | 10300 | <0.4 | 8.9 | 126 | 0.9 | 0.98 | 30000 | 18 | 26 | 112 | 21800 | 221 | 6600 | 470 | 4.5 | 1280 | <0.3 | 104 | 20 | 263 |
| 2292392 (Front yard) | 0-5 cm | 7180 | <0.4 | 14.6 | 155 | 0.7 | 1.85 | 43700 | 22 | 43 | 214 | 24200 | 278 | 2020 | 485 | 5.5 | 1910 | 1.30 | 149 | 17 | 442 |
| | 5-10 cm | 7450 | 0.4 | 19.8 | 161 | 0.7 | 2.56 | 47300 | 26 | 60 | 299 | 35700 | 282 | 1930 | 644 | 5.8 | 3010 | 1.70 | 149 | 18 | 488 |
| | 10-20 cm | 8780 | <0.4 | 17.6 | 201 | 0.8 | 1.70 | 32400 | 20 | 34 | 215 | 25700 | 304 | 7830 | 511 | 4.7 | 2190 | 0.60 | 132 | 16 | 422 |
| 2292393 (Back yard) | 0-5 cm | 10400 | <0.4 | 6.9 | 98 | 0.6 | 0.86 | 12900 | 18 | 26 | 111 | 22200 | 117 | 4550 | 491 | 3.8 | 1070 | <0.3 | 41 | 25 | 285 |
| | 5-10 cm | 8820 | 0.9 | 16.1 | 145 | 0.6 | 1.79 | 19700 | 24 | 48 | 242 | 32800 | 230 | 5480 | 596 | 4.4 | 2440 | 1.60 | 61 | 23 | 577 |
| | 10-20 cm | 7140 | 1.0 | 23.8 | 268 | 0.6 | 2.32 | 27800 | 24 | 42 | 293 | 33100 | 383 | 6240 | 574 | 4.7 | 2420 | 1.20 | 88 | 15 | 910 |
| 2292394 (Front yard) | 0-5 cm | 10300 | <0.4 | 14.2 | 120 | 0.7 | 1.51 | 18800 | 25 | 46 | 217 | 32700 | 196 | 7040 | 537 | 4.6 | 2420 | 1.20 | 63 | 24 | 370 |
| | 5-10 cm | 13100 | 0.4 | 19.2 | 152 | 0.9 | 2.02 | 20700 | 31 | 54 | 284 | 37000 | 253 | 7500 | 662 | 4.7 | 2890 | 1.90 | 67 | 26 | 467 |
| | 10-20 cm | 11500 | <0.4 | 17.2 | 148 | 0.8 | 1.64 | 23300 | 25 | 43 | 280 | 33200 | 229 | 6910 | 563 | 4.5 | 2820 | 0.70 | 64 | 25 | 442 |
| 2292395 (Back yard) | 0-5 cm | 13400 | <0.4 | 6.1 | 101 | 0.7 | 0.64 | 13900 | 18 | 18 | 70 | 18600 | 84 | 4830 | 491 | 3.8 | 589 | <0.3 | 46 | 27 | 169 |
| | 5-10 cm | 11300 | <0.4 | 13.3 | 136 | 0.7 | 1.17 | 19700 | 22 | 35 | 164 | 25500 | 166 | 5810 | 611 | 4.2 | 1400 | 0.40 | 62 | 27 | 329 |
| | 10-20 cm | 8770 | 0.7 | 19.2 | 188 | 0.7 | 1.62 | 27500 | 25 | 39 | 229 | 33700 | 253 | 6940 | 513 | 4.8 | 2120 | 0.70 | 75 | 22 | 491 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292396 (Front yard) | 0-5 cm | 18300 | 0.5 | 8.4 | 137 | 1 | 1.07 | 13500 | 28 | 32 | 141 | 28500 | 299 | 6470 | 493 | 4.1 | 1270 | <0.3 | 43 | 37 | 269 |
| | 0-5 cm | 18900 | 0.6 | 9.5 | 153 | 1 | 1.22 | 16600 | 29 | 36 | 162 | 29500 | 311 | 7390 | 514 | 4.4 | 1510 | <0.3 | 47 | 39 | 298 |
| | 0-5 cm | 19400 | 0.8 | 10.3 | 143 | 1 | 1.13 | 15400 | 30 | 36 | 164 | 32600 | 332 | 7010 | 551 | 4.3 | 1700 | <0.3 | 49 | 38 | 295 |
| | 5-10 cm | 22700 | 0.8 | 8.6 | 156 | 1.1 | 1.06 | 11900 | 32 | 34 | 145 | 31400 | 283 | 6890 | 529 | 3.9 | 1420 | <0.3 | 41 | 43 | 266 |
| | 5-10 cm | 26800 | 1.0 | 6.7 | 179 | 1.3 | 0.99 | 12200 | 35 | 30 | 127 | 32600 | 261 | 7580 | 591 | 4.0 | 1130 | <0.3 | 103 | 49 | 240 |
| | 5-10 cm | 21200 | 1.0 | 10.0 | 148 | 1 | 1.10 | 14600 | 31 | 37 | 178 | 33400 | 349 | 7220 | 581 | 4.3 | 1690 | <0.3 | 46 | 40 | 295 |
| | 10-20 cm | 15600 | 0.8 | 19.9 | 168 | 1 | 2.10 | 20800 | 36 | 65 | 312 | 47000 | 666 | 7570 | 657 | 5.0 | 3690 | 1.90 | 54 | 31 | 534 |
| | 10-20 cm | 15500 | 1.0 | 18.9 | 161 | 0.9 | 1.79 | 28100 | 32 | 56 | 290 | 43900 | 462 | 8560 | 726 | 5.1 | 3260 | 0.50 | 63 | 29 | 483 |
| | 10-20 cm | 19300 | 0.9 | 17.0 | 164 | 1 | 1.66 | 21800 | 35 | 52 | 270 | 42000 | 580 | 8060 | 663 | 4.8 | 2910 | <0.3 | 56 | 35 | 449 |
| | 0-5 cm | 9060 | 1.7 | 27.1 | 236 | 0.6 | 2.37 | 22900 | 25 | 46 | 240 | 31500 | 448 | 5120 | 524 | 4.4 | 2630 | 1.30 | 94 | 22 | 726 |
| 2292397 (Back yard) | 0-5 cm | 7640 | 0.8 | 25.0 | 183 | 0.6 | 2.56 | 24100 | 24 | 44 | 239 | 29200 | 393 | 5800 | 563 | 4.5 | 2260 | 1.90 | 93 | 20 | 556 |
| | 0-5 cm | 10000 | 1.8 | 30.1 | 235 | 0.7 | 2.48 | 24500 | 29 | 47 | 262 | 29500 | 510 | 5630 | 572 | 4.7 | 2380 | 3.00 | 107 | 23 | 683 |
| | 5-10 cm | 7060 | 1.5 | 37.2 | 238 | 0.6 | 2.48 | 31900 | 28 | 47 | 293 | 35400 | 464 | 6370 | 554 | 4.9 | 3010 | 1.10 | 116 | 17 | 752 |
| | 5-10 cm | 7490 | 1.6 | 41.9 | 284 | 0.7 | 2.95 | 36000 | 27 | 46 | 325 | 32400 | 549 | 6560 | 580 | 5.0 | 2840 | 3.20 | 141 | 15 | 719 |
| | 5-10 cm | 7320 | 2.9 | 38.9 | 248 | 0.7 | 2.61 | 31800 | 27 | 49 | 309 | 35800 | 583 | 6410 | 568 | 5.0 | 3230 | 2.40 | 119 | 17 | 685 |
| | 10-20 cm | 6240 | 1.2 | 29.4 | 217 | 0.6 | 2.02 | 37500 | 23 | 34 | 250 | 27800 | 408 | 6450 | 484 | 4.7 | 2220 | 0.80 | 146 | 14 | 570 |
| | 10-20 cm | 6070 | 1.2 | 27.3 | 225 | 0.5 | 2.05 | 35300 | 22 | 33 | 237 | 28200 | 405 | 6370 | 485 | 4.7 | 2140 | 1.90 | 131 | 14 | 589 |
| | 10-20 cm | 5930 | 1.5 | 29.3 | 244 | 0.6 | 2.01 | 35900 | 25 | 37 | 249 | 31600 | 454 | 6520 | 480 | 4.7 | 2550 | 1.80 | 136 | 14 | 709 |
| | 0-5 cm* | 15550 | 0.4 | 9.2 | 126 | 0.8 | 0.96 | 15100 | 24 | 33 | 158 | 28600 | 197 | 6805 | 481 | 4.1 | 1575 | <0.3 | 54 | 33 | 260 |
| | 5-10 cm* | 16300 | 0.5 | 12.4 | 135 | 0.9 | 1.12 | 16350 | 26 | 37 | 186 | 32100 | 223 | 6735 | 497 | 4.2 | 1955 | 0.33 | 54 | 32 | 294 |
| 2292398 (Front yard) | 10-20 cm* | 16850 | 0.3 | 14.0 | 149 | 0.9 | 1.19 | 24000 | 28 | 39 | 242 | 34350 | 246 | 8580 | 526 | 4.5 | 2165 | 0.38 | 69 | 33 | 385 |
| | 0-5 cm* | 10045 | <0.4 | 13.5 | 92 | 0.5 | 1.00 | 13450 | 19 | 24 | 117 | 19550 | 137 | 3910 | 331 | 3.5 | 1130 | 0.28 | 55 | 23 | 235 |
| | 5-10 cm* | 10435 | <0.4 | 16.7 | 100 | 0.5 | 1.09 | 16300 | 20 | 24 | 124 | 20550 | 143 | 4330 | 343 | 3.6 | 1200 | <0.3 | 60 | 22 | 235 |
| | 10-20 cm* | 7935 | <0.4 | 24.1 | 148 | 0.5 | 1.44 | 25300 | 22 | 28 | 177 | 24250 | 199 | 5310 | 401 | 3.9 | 1660 | 0.66 | 99 | 17 | 311 |
| | 0-5 cm | 17800 | 0.5 | 14.5 | 116 | 1 | 1.23 | 10100 | 27 | 36 | 177 | 28000 | 135 | 4170 | 581 | 3.7 | 1880 | 0.40 | 56 | 35 | 259 |
| | 5-10 cm | 19200 | 0.4 | 17.7 | 134 | 1 | 1.33 | 11400 | 29 | 38 | 193 | 31200 | 156 | 4430 | 626 | 4.0 | 2160 | 0.80 | 67 | 36 | 286 |
| | 10-20 cm | 14300 | 0.9 | 22.9 | 149 | 0.8 | 1.49 | 16800 | 27 | 45 | 246 | 35500 | 208 | 4420 | 528 | 4.2 | 3190 | 2.00 | 95 | 28 | 351 |
| | 0-5 cm | 17400 | 1.0 | 10.3 | 131 | 0.9 | 1.05 | 13200 | 26 | 30 | 137 | 29900 | 182 | 4930 | 680 | 4.4 | 1380 | <0.3 | 59 | 35 | 299 |
| | 5-10 cm | 16700 | 1.0 | 10.1 | 127 | 0.9 | 1.03 | 12400 | 22 | 27 | 134 | 29800 | 190 | 5120 | 689 | 4.2 | 1360 | <0.3 | 54 | 27 | 283 |
| | 10-20 cm | 11700 | 0.6 | 11.5 | 165 | 0.8 | 1.09 | 21700 | 22 | 27 | 164 | 29600 | 230 | 5420 | 527 | 4.2 | 1650 | 0.40 | 93 | 27 | 362 |
| 2292402 (Front yard) | 0-5 cm | 20800 | 1.0 | 8.0 | 169 | 1 | 0.96 | 28300 | 31 | 24 | 99 | 29200 | 279 | 8640 | 536 | 4.7 | 818 | <0.3 | 85 | 39 | 253 |
| | 5-10 cm | 29000 | 0.8 | 4.9 | 198 | 1.3 | 0.79 | 27800 | 35 | 22 | 75 | 32300 | 215 | 9840 | 627 | 4.5 | 552 | <0.3 | 88 | 50 | 202 |
| | 10-20 cm | 29500 | <0.4 | 6.2 | 174 | 1.3 | 0.76 | 24800 | 35 | 27 | 92 | 34400 | 114 | 9260 | 660 | 4.4 | 742 | <0.3 | 79 | 51 | 166 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|------|-------|-----|------|-----|-----|------|------|-----|----|------|
| 2292403 (Back yard) | 0-5 cm | 18100 | 0.8 | 4.1 | 99 | 0.8 | 0.83 | 19200 | 22 | 14 | 57 | 19800 | 76 | 8870 | 587 | 4.2 | 191 | <0.3 | 83 | 34 | 171 |
| | 5-10 cm | 17500 | <0.4 | 3.0 | 92 | 0.8 | 0.71 | 21400 | 22 | 13 | 47 | 19100 | 59 | 8860 | 575 | 4.1 | 170 | <0.3 | 93 | 33 | 139 |
| | 10-20 cm | 17600 | 0.7 | 2.6 | 89 | 0.7 | 0.56 | 23700 | 21 | 12 | 44 | 18500 | 48 | 8560 | 539 | 4.2 | 137 | <0.3 | 114 | 33 | 118 |
| 2292404 (Front yard) | 0-5 cm | 23100 | <0.4 | 4.3 | 140 | 1.1 | 0.60 | 46500 | 28 | 21 | 64 | 24900 | 68 | 1530 | 544 | 4.9 | 295 | <0.3 | 109 | 40 | 148 |
| | 5-10 cm | 23700 | <0.4 | 6.1 | 145 | 1.2 | 0.78 | 47800 | 29 | 28 | 87 | 27600 | 98 | 1590 | 571 | 4.7 | 509 | <0.3 | 119 | 42 | 182 |
| | 10-20 cm | 14300 | <0.4 | 10.6 | 109 | 0.8 | 1.10 | 28900 | 24 | 36 | 136 | 23800 | 148 | 9250 | 497 | 4.4 | 952 | <0.3 | 90 | 30 | 260 |
| 2292405 (Back yard) | 0-5 cm | 16800 | 0.5 | 3.3 | 97 | 0.7 | 0.50 | 12000 | 20 | 11 | 41 | 19500 | 65 | 5700 | 387 | 3.5 | 170 | <0.3 | 51 | 32 | 114 |
| | 5-10 cm | 16300 | 0.4 | 6.5 | 126 | 0.7 | 0.75 | 19400 | 21 | 16 | 60 | 22300 | 121 | 7000 | 433 | 3.8 | 432 | <0.3 | 65 | 31 | 195 |
| | 10-20 cm | 6830 | 1.9 | 19.6 | 264 | 0.5 | 2.15 | 28800 | 23 | 32 | 219 | 31900 | 417 | 6190 | 550 | 4.3 | 1660 | 1.10 | 95 | 16 | 635 |
| 2292406 (Front yard) | 0-5 cm | 18300 | 0.5 | 3.1 | 93 | 0.8 | 0.52 | 12400 | 21 | 14 | 55 | 18200 | 53 | 5590 | 366 | 3.5 | 313 | <0.3 | 69 | 35 | 102 |
| | 5-10 cm | 22500 | <0.4 | 5.9 | 132 | 1 | 0.69 | 21200 | 26 | 21 | 108 | 21400 | 80 | 7820 | 403 | 3.9 | 639 | <0.3 | 106 | 42 | 140 |
| | 10-20 cm | 24600 | 0.7 | 7.6 | 155 | 1.2 | 0.98 | 30200 | 30 | 23 | 122 | 25100 | 111 | 1000 | 448 | 4.5 | 721 | <0.3 | 162 | 44 | 201 |
| 2292407 (Back yard) | 0-5 cm | 16300 | <0.4 | 13.9 | 233 | 1.1 | 1.64 | 21000 | 30 | 32 | 187 | 29400 | 258 | 6520 | 536 | 4.2 | 1400 | <0.3 | 115 | 33 | 465 |
| | 5-10 cm | 16100 | 2.1 | 22.2 | 373 | 1.3 | 2.41 | 27800 | 40 | 48 | 325 | 43200 | 394 | 7130 | 740 | 5.2 | 2580 | 1.00 | 163 | 32 | 743 |
| | 10-20 cm | 16400 | 3.1 | 37.9 | 451 | 1.4 | 3.25 | 32900 | 59 | 52 | 392 | 49200 | 617 | 6960 | 852 | 5.8 | 3070 | 1.80 | 215 | 30 | 1000 |
| 2292408 (Front yard) | 0-5 cm | 23200 | <0.4 | 5.9 | 124 | 1.1 | 0.84 | 15900 | 34 | 25 | 95 | 29000 | 99 | 8800 | 534 | 4.2 | 769 | <0.3 | 57 | 45 | 176 |
| | 5-10 cm | 26400 | <0.4 | 5.8 | 136 | 1.3 | 0.81 | 16900 | 37 | 25 | 94 | 30000 | 96 | 9470 | 552 | 4.1 | 710 | <0.3 | 58 | 49 | 169 |
| | 10-20 cm | 29200 | <0.4 | 4.7 | 144 | 1.3 | 0.61 | 19800 | 37 | 20 | 63 | 30400 | 68 | 1100 | 561 | 4.2 | 461 | <0.3 | 55 | 52 | 131 |
| 2292409 (Back yard) | 0-5 cm | 19900 | <0.4 | 12.2 | 173 | 1 | 1.62 | 15400 | 32 | 31 | 203 | 30300 | 285 | 6780 | 514 | 4.4 | 1250 | <0.3 | 94 | 40 | 383 |
| | 5-10 cm | 23600 | 0.4 | 15.6 | 210 | 1.2 | 1.76 | 15200 | 37 | 34 | 190 | 36300 | 259 | 6410 | 526 | 4.6 | 1630 | <0.3 | 117 | 43 | 402 |
| | 10-20 cm | 17000 | 1.3 | 29.7 | 699 | 1.1 | 2.82 | 23900 | 43 | 49 | 1620 | 47300 | 534 | 5480 | 628 | 5.5 | 2800 | 2.20 | 209 | 30 | 923 |
| 2292410 (Front yard) | 0-5 cm | 17800 | <0.4 | 5.5 | 119 | 0.9 | 0.81 | 26100 | 26 | 19 | 95 | 22200 | 119 | 1130 | 497 | 4.1 | 600 | <0.3 | 83 | 35 | 181 |
| | 5-10 cm | 18400 | 0.4 | 7.8 | 132 | 0.9 | 0.97 | 26900 | 30 | 18 | 86 | 24350 | 125 | 1100 | 578 | 3.1 | 593 | 0.51 | 86 | 37 | 207 |
| | 10-20 cm | 22850 | 0.5 | 11.9 | 190 | 1.2 | 0.93 | 25350 | 34 | 25 | 133 | 30375 | 201 | 1060 | 605 | 3.1 | 1218 | 0.55 | 136 | 45 | 246 |
| 2292411 (Back yard) | 0-5 cm | 13650 | 1.8 | 8.6 | 99 | 0.5 | 1.07 | 26300 | 27 | 14 | 72 | 18825 | 91 | 1000 | 500 | 2.9 | 361 | 0.38 | 80 | 29 | 189 |
| | 5-10 cm | 12950 | 2 | 7 | 101 | 1.0 | 1.40 | 37950 | 30 | 13 | 83 | 20450 | 124 | 1377 | 562 | 3 | 469 | 0 | 83 | 28 | 242 |
| | 10-20 cm | 12975 | 2.3 | 7.5 | 130 | 0.6 | 1.69 | 47175 | 33 | 16 | 116 | 22325 | 276 | 1727 | 571 | 3.9 | 618 | 0.40 | 132 | 28 | 302 |
| 2292412 (Back yard) | 0-5 cm | 16700 | <0.4 | 7.5 | 229 | 1 | 1.95 | 27800 | 30 | 45 | 226 | 23500 | 307 | 1200 | 420 | 4.4 | 1540 | <0.3 | 87 | 46 | 493 |
| | 5-10 cm | 17100 | <0.4 | 8 | 223 | 1.0 | 2.07 | 29800 | 28 | 46 | 241 | 24700 | 341 | 1270 | 436 | 4 | 1530 | <0.3 | 89 | 63 | 489 |
| | 10-20 cm | 15600 | 2.5 | 13.0 | 318 | 1 | 2.38 | 37300 | 31 | 50 | 326 | 25275 | 446 | 1477 | 463 | 3.7 | 2318 | 1.25 | 111 | 54 | 637 |
| 2292413 (Back yard) | 0-5 cm | 21600 | <0.4 | 11.0 | 194 | 1 | 1.07 | 24200 | 35 | 49 | 210 | 24100 | 173 | 1020 | 463 | 4.6 | 1290 | <0.3 | 63 | 41 | 354 |
| | 5-10 cm | 25000 | <0.4 | 11 | 223 | 1.0 | 1.18 | 18700 | 36 | 43 | 208 | 26900 | 190 | 8080 | 485 | 4 | 1510 | <0.3 | 62 | 47 | 386 |
| | 10-20 cm | 23525 | 1.9 | 15.7 | 202 | 1 | 1.11 | 18025 | 35 | 43 | 217 | 27550 | 174 | 7343 | 540 | 3.0 | 1863 | 1.10 | 58 | 43 | 388 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|------|-------|-------|----|-----|-------|-------|------|------|-----|------|------|------|-----|-----|-----|
| 2292414 (Back yard) | 0-5 cm | 20300 | 1.0 | 21.8 | 285 | 1.2 | 2.00 | 21200 | 35 | 83 | 427 | 31100 | 254 | 8500 | 468 | 4.2 | 3540 | 1.40 | 92 | 42 | 636 |
| | 5-10 cm | 20700 | 0.8 | 20.3 | 282 | 1.1 | 1.92 | 17900 | 34 | 82 | 426 | 29900 | 257 | 7170 | 469 | 4.2 | 3280 | 1.40 | 77 | 42 | 638 |
| | 10-20 cm* | 20150 | 2.5 | 22.3 | 288 | 1 | 1.78 | 16400 | 36 | 95 | 438 | 31750 | 280 | 6850 | 525 | 3.1 | 3893 | 2.03 | 70 | 43 | 813 |
| 2292415 (Front yard) | 0-5 cm* | 8523 | 1.2 | 3.9 | 82 | 0.4 | 0.26 | 42950 | 12 | 7 | 34 | 14125 | 14 | 6463 | 595 | 2.3 | 48 | 0.23 | 81 | 20 | 66 |
| | 5-10 cm* | 11975 | 1.3 | 4.3 | 90 | 0.5 | 0.43 | 32325 | 18 | 16 | 57 | 16625 | 31 | 6193 | 562 | 2.2 | 272 | 0.38 | 69 | 26 | 97 |
| | 10-20 cm | 20900 | <0.4 | 5.3 | 134 | 1 | 0.93 | 21300 | 30 | 42 | 143 | 22800 | 89 | 6650 | 492 | 3.9 | 1000 | <0.3 | 64 | 42 | 161 |
| 2292416 (Back yard) | 0-5 cm | 30300 | <0.4 | 10.6 | 205 | 1.5 | 1.28 | 12900 | 42 | 69 | 265 | 29500 | 182 | 6520 | 441 | 3.9 | 2210 | 0.70 | 71 | 56 | 274 |
| | 5-10 cm | 32500 | <0.4 | 11.1 | 224 | 1.7 | 1.03 | 13700 | 40 | 58 | 251 | 33100 | 183 | 7740 | 464 | 3.7 | 2430 | <0.3 | 68 | 59 | 259 |
| | 10-20 cm | 29200 | <0.4 | 19.9 | 255 | 1.6 | 1.35 | 18100 | 41 | 61 | 345 | 37600 | 260 | 7660 | 471 | 4.1 | 3930 | 0.80 | 87 | 54 | 404 |
| 2292417 (Front yard) | 0-5 cm | 19800 | <0.4 | 7.6 | 133 | 1 | 0.85 | 25600 | 29 | 67 | 246 | 23500 | 169 | 1460 | 471 | 4.2 | 2120 | <0.3 | 143 | 41 | 246 |
| | 0-5 cm | 19400 | 1.3 | 17.5 | 254 | 1.3 | 1.96 | 24000 | 40 | 93 | 396 | 32100 | 308 | 9760 | 504 | 4.7 | 4030 | 2.20 | 95 | 42 | 699 |
| | 5-10 cm | 22400 | 1.7 | 18.7 | 330 | 1.6 | 1.77 | 30800 | 49 | 67 | 328 | 32600 | 334 | 1230 | 492 | 5.5 | 3470 | 1.20 | 140 | 49 | 825 |
| 2292418 (Back yard) | 0-5 cm | 28200 | <0.4 | 13.0 | 232 | 1.5 | 1.12 | 24600 | 41 | 54 | 254 | 33800 | 204 | 1410 | 496 | 4.5 | 2510 | <0.3 | 90 | 53 | 341 |
| | 10-20 cm | 15200 | <0.4 | 12.0 | 167 | 0.8 | 1.64 | 15400 | 32 | 134 | 388 | 23500 | 324 | 6920 | 492 | 3.7 | 3750 | 2.80 | 47 | 37 | 400 |
| | 5-10 cm | 16600 | 0.5 | 15.6 | 145 | 0.9 | 1.80 | 13000 | 31 | 122 | 421 | 25800 | 256 | 5940 | 469 | 3.7 | 4320 | 4.40 | 43 | 38 | 360 |
| 2292420 (Back yard) | 0-5 cm | 19500 | <0.4 | 15.0 | 135 | 1 | 1.17 | 11700 | 30 | 74 | 329 | 30200 | 129 | 6050 | 588 | 3.7 | 4190 | 1.60 | 40 | 40 | 266 |
| | 0-5 cm | 15000 | 0.5 | 12.5 | 148 | 0.8 | 2.17 | 16100 | 30 | 103 | 364 | 24400 | 176 | 6950 | 480 | 3.7 | 2990 | 2.70 | 102 | 32 | 289 |
| | 5-10 cm | 15500 | <0.4 | 14.6 | 132 | 0.9 | 2.25 | 14200 | 29 | 93 | 367 | 25300 | 144 | 6750 | 531 | 3.6 | 3210 | 2.20 | 84 | 32 | 269 |
| 2292421 (Front yard) | 0-5 cm | 16400 | <0.4 | 15.0 | 157 | 0.9 | 1.11 | 19500 | 26 | 141 | 459 | 27100 | 151 | 7750 | 472 | 3.8 | 3660 | 1.40 | 131 | 32 | 240 |
| | 0-5 cm | 22500 | 1.1 | 15.0 | 178 | 1.2 | 1.73 | 11900 | 42 | 151 | 514 | 32000 | 292 | 7090 | 738 | 4.1 | 5080 | 2.90 | 44 | 46 | 573 |
| | 5-10 cm | 26100 | <0.4 | 10.4 | 161 | 1.4 | 1.27 | 10800 | 35 | 79 | 288 | 30300 | 153 | 7960 | 838 | 3.7 | 2860 | 0.70 | 37 | 47 | 407 |
| 2292422 (Back yard) | 0-5 cm | 26600 | 0.7 | 15.2 | 172 | 1.4 | 1.17 | 15100 | 38 | 71 | 337 | 33700 | 176 | 9650 | 680 | 4.4 | 4210 | 2.10 | 42 | 46 | 370 |
| | 0-5 cm | 16700 | <0.4 | 5.0 | 103 | 0.8 | 0.79 | 15800 | 22 | 29 | 105 | 18400 | 101 | 7680 | 344 | 3.4 | 963 | <0.3 | 45 | 33 | 150 |
| | 5-10 cm | 17900 | <0.4 | 5.9 | 111 | 0.9 | 0.85 | 17500 | 23 | 31 | 115 | 20300 | 111 | 8440 | 378 | 3.4 | 1070 | <0.3 | 47 | 34 | 157 |
| 2292423 (Front yard) | 0-5 cm | 15700 | <0.4 | 7.8 | 99 | 0.8 | 0.79 | 22900 | 21 | 29 | 120 | 20100 | 127 | 9230 | 389 | 3.7 | 1360 | <0.3 | 59 | 31 | 162 |
| | 0-5 cm | 19800 | 3.0 | 15.1 | 180 | 1.3 | 1.74 | 19300 | 36 | 90 | 394 | 32300 | 201 | 7010 | 492 | 4.4 | 4400 | 1.90 | 76 | 40 | 374 |
| | 5-10 cm | 22100 | 2.1 | 13.0 | 178 | 1.4 | 1.25 | 17800 | 30 | 53 | 268 | 29700 | 160 | 6470 | 422 | 3.6 | 2740 | 0.90 | 76 | 40 | 277 |
| 2292424 (Front yard) | 0-5 cm | 25100 | 5.8 | 23.3 | 276 | 1.8 | 1.55 | 23700 | 40 | 63 | 354 | 39900 | 324 | 7200 | 465 | 4.5 | 4780 | <0.3 | 125 | 42 | 408 |
| | 0-5 cm | 16200 | 0.6 | 12.1 | 169 | 1.1 | 1.28 | 24200 | 31 | 68 | 301 | 26300 | 205 | 9480 | 476 | 4.2 | 3140 | 0.70 | 83 | 36 | 377 |
| | 5-10 cm | 18500 | 1.3 | 18.2 | 207 | 1.5 | 1.47 | 24100 | 34 | 77 | 400 | 29300 | 246 | 9260 | 474 | 4.2 | 4060 | 1.30 | 124 | 38 | 514 |
| 2292425 (Back yard) | 0-5 cm | 16600 | 1.6 | 26.7 | 201 | 1.3 | 1.63 | 25600 | 34 | 82 | 454 | 33700 | 223 | 9650 | 428 | 4.4 | 5580 | 2.20 | 117 | 38 | 453 |
| | 0-5 cm | 19800 | <0.4 | 6.0 | 161 | 1.1 | 1.45 | 20800 | 28 | 44 | 149 | 23500 | 155 | 6750 | 482 | 3.6 | 1200 | <0.3 | 71 | 37 | 257 |
| | 5-10 cm | 25000 | <0.4 | 5.3 | 184 | 1.3 | 0.99 | 22400 | 31 | 38 | 125 | 27600 | 130 | 1030 | 519 | 3.6 | 967 | <0.3 | 74 | 43 | 221 |
| 10-20 cm | 20900 | <0.4 | 7.7 | 141 | 1.1 | 0.88 | 24000 | 26 | 40 | 163 | 26800 | 93 | 1030 | 477 | 3.7 | 1550 | <0.3 | 61 | 37 | 185 | |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|------|------|-----|-----|------|------|-----|----|-----|
| 2292426 (Front yard) | 0-5 cm | 20000 | <0.4 | 4.3 | 123 | 1 | 0.70 | 20700 | 27 | 32 | 106 | 22000 | 99 | 1270 | 456 | 3.9 | 799 | <0.3 | 73 | 41 | 168 |
| | 5-10 cm | 20200 | <0.4 | 4.5 | 119 | 1.1 | 0.62 | 22500 | 27 | 30 | 94 | 22000 | 89 | 1330 | 478 | 3.9 | 687 | <0.3 | 66 | 41 | 152 |
| | 10-20 cm | 19800 | <0.4 | 4.3 | 121 | 1 | 0.86 | 23200 | 27 | 27 | 103 | 23300 | 131 | 1390 | 554 | 4.1 | 894 | <0.3 | 57 | 39 | 173 |
| 2292427 (Front yard) | 0-5 cm | 19700 | <0.4 | 5.0 | 119 | 1 | 0.80 | 13900 | 26 | 34 | 143 | 21300 | 96 | 6960 | 357 | 3.7 | 1120 | <0.3 | 55 | 40 | 196 |
| | 5-10 cm | 24500 | <0.4 | 6.4 | 143 | 1.2 | 0.86 | 11900 | 32 | 40 | 163 | 24700 | 110 | 6820 | 438 | 3.6 | 1320 | <0.3 | 53 | 46 | 226 |
| | 10-20 cm | 24500 | <0.4 | 6.5 | 152 | 1.2 | 0.82 | 11900 | 31 | 42 | 185 | 25400 | 160 | 6890 | 422 | 3.7 | 1680 | <0.3 | 50 | 44 | 219 |
| 2292428 (Back yard) | 0-5 cm | 22100 | <0.4 | 7.9 | 201 | 1.2 | 2.65 | 14400 | 32 | 39 | 206 | 25400 | 154 | 6480 | 364 | 4.0 | 1690 | <0.3 | 83 | 43 | 312 |
| | 5-10 cm | 29100 | <0.4 | 9.6 | 266 | 1.6 | 1.60 | 15900 | 41 | 49 | 256 | 30100 | 206 | 7360 | 431 | 4.1 | 2000 | <0.3 | 101 | 51 | 400 |
| | 10-20 cm | 29500 | <0.4 | 14.1 | 330 | 1.7 | 1.85 | 13600 | 41 | 56 | 276 | 33000 | 189 | 7180 | 460 | 4.2 | 2830 | <0.3 | 123 | 52 | 401 |
| 2292429 (Front yard) | 0-5 cm | 10300 | <0.4 | 5.3 | 68 | 0.6 | 0.49 | 11800 | 17 | 30 | 124 | 16300 | 95 | 5630 | 402 | 3.4 | 1080 | <0.3 | 34 | 29 | 143 |
| | 5-10 cm | 10600 | <0.4 | 3.4 | 61 | 0.6 | 0.44 | 9450 | 16 | 23 | 93 | 14800 | 73 | 4620 | 391 | 3.1 | 719 | <0.3 | 30 | 28 | 105 |
| | 10-20 cm | 11300 | <0.4 | 8.6 | 102 | 0.7 | 0.77 | 13900 | 19 | 48 | 217 | 19700 | 134 | 6250 | 443 | 3.5 | 2010 | 0.50 | 39 | 30 | 225 |
| 2292430 (Back yard) | 0-5 cm | 16300 | 0.6 | 17.1 | 242 | 1.2 | 2.09 | 19300 | 34 | 82 | 366 | 30000 | 623 | 7230 | 500 | 4.5 | 3360 | 2.80 | 87 | 37 | 625 |
| | 5-10 cm | 20600 | 1.5 | 26.9 | 352 | 1.4 | 2.56 | 21000 | 39 | 91 | 516 | 36700 | 797 | 7470 | 555 | 4.7 | 5070 | 2.80 | 103 | 43 | 742 |
| | 10-20 cm | 23700 | 5.7 | 28.5 | 565 | 1.8 | 2.27 | 28900 | 49 | 74 | 522 | 37500 | 1460 | 8130 | 576 | 4.7 | 4960 | 1.40 | 209 | 47 | 916 |
| 2292431 (Front yard) | 0-5 cm | 16400 | <0.4 | 16.0 | 182 | 1 | 1.36 | 20300 | 31 | 79 | 414 | 30100 | 401 | 7940 | 492 | 4.1 | 3400 | 1.60 | 70 | 41 | 639 |
| | 5-10 cm | 16200 | <0.4 | 19.7 | 155 | 1 | 1.38 | 19800 | 29 | 84 | 442 | 31600 | 325 | 8180 | 507 | 4.3 | 4120 | 2.50 | 65 | 41 | 533 |
| | 10-20 cm | 15600 | <0.4 | 21.2 | 168 | 1 | 1.21 | 19200 | 26 | 62 | 419 | 31100 | 250 | 6540 | 496 | 3.9 | 3380 | 2.00 | 76 | 39 | 403 |
| 2292432 (Back yard) | 0-5 cm | 19800 | <0.4 | 17.3 | 244 | 1.2 | 1.91 | 16500 | 37 | 74 | 408 | 31200 | 386 | 6450 | 548 | 4.4 | 3920 | 1.20 | 78 | 42 | 592 |
| | 5-10 cm | 22100 | 1.4 | 20.0 | 274 | 1.4 | 2.16 | 15000 | 39 | 84 | 465 | 34400 | 531 | 6190 | 635 | 4.3 | 4730 | 1.90 | 82 | 45 | 632 |
| | 10-20 cm | 21900 | 1.1 | 24.7 | 292 | 1.4 | 1.90 | 16100 | 36 | 75 | 468 | 34700 | 485 | 6060 | 618 | 4.1 | 4890 | 2.20 | 91 | 44 | 571 |
| 2292433 (Front yard) | 0-5 cm | 19400 | 1.9 | 10.6 | 168 | 1.2 | 1.54 | 28400 | 33 | 60 | 299 | 23800 | 274 | 1230 | 439 | 4.6 | 2290 | 0.80 | 114 | 34 | 494 |
| | 5-10 cm | 21700 | 1.7 | 8.8 | 174 | 1.3 | 1.52 | 23900 | 38 | 60 | 278 | 24000 | 257 | 9710 | 449 | 4.3 | 2240 | <0.3 | 95 | 37 | 505 |
| | 10-20 cm | 23200 | 3.2 | 8.9 | 196 | 1.3 | 1.69 | 24300 | 39 | 62 | 288 | 24100 | 313 | 1030 | 466 | 4.4 | 2180 | 0.30 | 97 | 41 | 605 |
| 2292433 (Front yard) | 5-10 cm | 22400 | 2.1 | 12.5 | 198 | 1.4 | 1.70 | 28600 | 41 | 78 | 382 | 26900 | 348 | 1260 | 483 | 4.7 | 2930 | 1.30 | 118 | 38 | 598 |
| | 5-10 cm | 23200 | 2.4 | 11.8 | 203 | 1.4 | 1.74 | 24400 | 39 | 81 | 360 | 27800 | 347 | 1080 | 482 | 4.5 | 3010 | <0.3 | 97 | 41 | 629 |
| | 5-10 cm | 26200 | 4.6 | 15.0 | 215 | 1.5 | 2.14 | 27300 | 50 | 120 | 489 | 29800 | 518 | 1280 | 564 | 4.7 | 3640 | 1.40 | 104 | 49 | 930 |
| 2292433 (Front yard) | 10-20 cm | 29700 | 3.0 | 16.1 | 248 | 1.8 | 1.85 | 27900 | 44 | 89 | 493 | 35300 | 358 | 1220 | 519 | 4.6 | 4900 | 1.00 | 161 | 45 | 705 |
| | 10-20 cm | 25400 | 2.9 | 22.4 | 231 | 1.6 | 2.27 | 27000 | 43 | 132 | 597 | 40500 | 383 | 1190 | 587 | 4.9 | 6310 | 2.00 | 110 | 43 | 801 |
| | 10-20 cm | 28900 | 4.6 | 19.6 | 285 | 1.8 | 2.20 | 25400 | 47 | 122 | 564 | 38100 | 459 | 1160 | 555 | 4.8 | 5430 | 1.30 | 116 | 49 | 839 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|------|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292434 (Back yard) | 0-5 cm | 21900 | 0.8 | 11.0 | 164 | 1.3 | 1.05 | 10300 | 29 | 65 | 278 | 29400 | 209 | 4030 | 482 | 3.8 | 2870 | 1.00 | 61 | 38 | 358 |
| | 0-5 cm | 21300 | 0.7 | 10.4 | 169 | 1.2 | 1.08 | 10300 | 27 | 63 | 261 | 28500 | 194 | 3910 | 458 | 3.7 | 2700 | 0.70 | 62 | 37 | 363 |
| | 0-5 cm | 23300 | 0.5 | 10.9 | 178 | 1.3 | 1.12 | 10400 | 30 | 70 | 283 | 30300 | 209 | 4370 | 466 | 3.8 | 3080 | 0.70 | 62 | 43 | 365 |
| | 5-10 cm | 23700 | 1.4 | 12.7 | 192 | 1.5 | 1.09 | 11100 | 32 | 66 | 326 | 34700 | 219 | 4160 | 547 | 3.9 | 3530 | 1.10 | 68 | 39 | 380 |
| | 5-10 cm | 23300 | 0.9 | 12.6 | 192 | 1.4 | 1.19 | 11300 | 30 | 72 | 312 | 34800 | 253 | 4270 | 577 | 3.7 | 3480 | 0.60 | 69 | 38 | 461 |
| | 5-10 cm | 26300 | 0.7 | 15.8 | 200 | 1.5 | 1.28 | 11700 | 33 | 71 | 329 | 34300 | 226 | 4680 | 542 | 3.9 | 3510 | 0.80 | 70 | 44 | 391 |
| 2292435 (Back yard) | 10-20 cm | 27800 | 0.6 | 11.1 | 258 | 1.6 | 0.97 | 15100 | 35 | 46 | 270 | 33600 | 251 | 5040 | 521 | 4.0 | 2660 | <0.3 | 89 | 43 | 355 |
| | 10-20 cm | 26900 | 0.4 | 8.8 | 194 | 1.4 | 0.83 | 10300 | 32 | 44 | 200 | 32200 | 172 | 4760 | 520 | 3.8 | 2180 | <0.3 | 68 | 43 | 301 |
| | 10-20 cm | 30600 | 0.6 | 15.6 | 321 | 1.8 | 1.26 | 13900 | 39 | 59 | 325 | 38900 | 320 | 5560 | 505 | 4.1 | 3910 | 0.30 | 106 | 50 | 434 |
| | 0-5 cm | 25900 | 5.1 | 17.8 | 258 | 1.4 | 2.32 | 17300 | 38 | 84 | 471 | 33400 | 315 | 6870 | 549 | 4.2 | 3590 | 1.70 | 90 | 48 | 516 |
| | 5-10 cm | 29500 | 1.2 | 22.5 | 238 | 1.6 | 1.95 | 17000 | 41 | 98 | 571 | 38900 | 473 | 7190 | 666 | 4.4 | 4880 | 1.20 | 93 | 52 | 459 |
| | 10-20 cm | 31700 | 0.8 | 23.2 | 297 | 1.8 | 1.73 | 25000 | 58 | 149 | 1230 | 41400 | 261 | 7720 | 540 | 4.3 | 6390 | 1.60 | 149 | 48 | 503 |
| 2292436 (Back yard) | 0-5 cm | 13400 | <0.4 | 7.1 | 125 | 0.7 | 1.50 | 16000 | 22 | 29 | 103 | 20200 | 228 | 7270 | 543 | 3.4 | 809 | <0.3 | 62 | 27 | 213 |
| | 0-5 cm | 14100 | 1.6 | 7.1 | 87 | 0.7 | 0.77 | 15750 | 23 | 30 | 134 | 20800 | 84 | 7185 | 556 | 2.3 | 984 | 0.60 | 42 | 34 | 140 |
| | 0-5 cm | 14700 | 1.6 | 8.9 | 91 | 0.7 | 0.82 | 15300 | 24 | 33 | 147 | 21925 | 93 | 7015 | 621 | 2.2 | 1085 | 0.58 | 42 | 34 | 144 |
| | 10-20 cm | 14125 | 1.5 | 6.8 | 79 | 0.7 | 0.63 | 16250 | 21 | 21 | 96 | 21350 | 57 | 6175 | 625 | 2.1 | 590 | 0.48 | 42 | 32 | 102 |
| | 0-5 cm | 14775 | 1.5 | 8.8 | 90 | 0.8 | 0.82 | 19150 | 22 | 28 | 124 | 19450 | 123 | 6338 | 512 | 2.3 | 1230 | 0.73 | 52 | 31 | 204 |
| | 5-10 cm | 14900 | 1.9 | 10.9 | 121 | 0.8 | 0.83 | 18750 | 23 | 29 | 130 | 20500 | 127 | 6560 | 519 | 2.3 | 1313 | 0.73 | 52 | 33 | 214 |
| 2292438 (Back yard) | 10-20 cm | 15425 | 1.9 | 12.2 | 135 | 0.9 | 0.76 | 20925 | 23 | 30 | 148 | 21950 | 142 | 7028 | 509 | 2.9 | 1565 | 0.68 | 61 | 34 | 219 |
| | 0-5 cm | 21200 | <0.4 | 10 | 135 | 1.0 | 0.97 | 13400 | 29 | 56 | 216 | 25400 | 106 | 8380 | 471 | 5 | 2190 | 2 | 42 | 44 | 216 |
| | 5-10 cm | 24300 | <0.4 | 10.0 | 150 | 1.4 | 0.89 | 15900 | 31 | 48 | 187 | 27700 | 95 | 9830 | 531 | 5.1 | 1900 | <0.3 | 42 | 47 | 192 |
| | 10-20 cm | 25900 | 0.4 | 10.4 | 171 | 1.3 | 0.76 | 28350 | 34 | 39 | 184 | 29825 | 79 | 1180 | 601 | 2.8 | 1683 | 0.73 | 65 | 48 | 206 |
| | 0-5 cm | 16300 | <0.4 | 17.1 | 185 | 1.2 | 1.41 | 15600 | 25 | 40 | 202 | 20900 | 202 | 6300 | 401 | 5.0 | 1930 | 0.90 | 75 | 35 | 322 |
| | 5-10 cm | 15650 | 0.5 | 18.8 | 191 | 1 | 1.26 | 18075 | 25 | 40 | 219 | 20200 | 223 | 6223 | 403 | 2.5 | 2098 | 1.04 | 82 | 34 | 338 |
| 2292440 (Back yard) | 10-20 cm | 18700 | 0.7 | 27.6 | 261 | 1.3 | 1.53 | 19625 | 30 | 48 | 233 | 23775 | 272 | 6490 | 459 | 2.6 | 2853 | 1.75 | 118 | 39 | 408 |
| | 0-5 cm | 21900 | <0.4 | 15.2 | 171 | 1.4 | 1.54 | 23600 | 33 | 71 | 322 | 23900 | 144 | 1030 | 452 | 5.8 | 3050 | 1.10 | 70 | 48 | 282 |
| | 0-5 cm | 21200 | <0.4 | 16.5 | 174 | 1.4 | 1.65 | 24400 | 35 | 74 | 343 | 24200 | 151 | 1060 | 430 | 5.7 | 3240 | 2.20 | 73 | 47 | 286 |
| | 0-5 cm | 22100 | <0.4 | 19.2 | 186 | 1.4 | 1.65 | 24000 | 33 | 80 | 385 | 24800 | 151 | 1020 | 424 | 5.6 | 3950 | 0.90 | 71 | 47 | 304 |
| | 5-10 cm | 22800 | <0.4 | 20 | 182 | 1.0 | 1.73 | 23400 | 33 | 84 | 426 | 27200 | 157 | 1030 | 467 | 6 | 4480 | 3 | 74 | 49 | 329 |
| | 5-10 cm | 22300 | <0.4 | 21.0 | 180 | 1.4 | 1.77 | 23800 | 34 | 87 | 427 | 28000 | 201 | 1010 | 485 | 5.6 | 4580 | 2.90 | 70 | 48 | 318 |
| 2292441 (Front yard) | 5-10 cm | 21100 | <0.4 | 24 | 172 | 1.0 | 2.11 | 24300 | 35 | 110 | 507 | 29600 | 187 | 1080 | 472 | 6 | 6330 | 4 | 69 | 46 | 356 |
| | 10-20 cm | 22700 | 1 | 24 | 182 | 1.0 | 0.92 | 26200 | 33 | 78 | 456 | 28400 | 146 | 9867 | 472 | 2 | 5077 | 3 | 77 | 47 | 314 |
| | 10-20 cm | 19733 | 0.6 | 24.4 | 179 | 1.1 | 1.05 | 25433 | 30 | 92 | 462 | 27567 | 170 | 9583 | 453 | 2.5 | 5440 | 3.00 | 71 | 43 | 346 |
| | 10-20 cm | 21925 | 0.5 | 22.8 | 176 | 1.2 | 1.06 | 24025 | 32 | 92 | 460 | 28650 | 148 | 9103 | 441 | 2.8 | 5328 | 1.70 | 72 | 45 | 302 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|-----|-----|-----|-------|------|------|-----|-----|------|------|-----|----|-----|
| 2292442 (Back yard) | 0-5 cm* | 14900 | 0.5 | 13.6 | 122 | 0.9 | 1.14 | 14933 | 23 | 36 | 192 | 17500 | 118 | 6197 | 289 | 2.2 | 1813 | 1.77 | 61 | 33 | 264 |
| | 0-5 cm | 13700 | <0.4 | 13.0 | 107 | 0.9 | 1.12 | 13900 | 20 | 36 | 177 | 16400 | 100 | 5790 | 273 | 4.7 | 1680 | 1.10 | 52 | 31 | 230 |
| | 0-5 cm | 14700 | <0.4 | 12.2 | 122 | 1 | 1.21 | 14800 | 22 | 36 | 171 | 17900 | 102 | 6150 | 282 | 4.8 | 1670 | 0.90 | 59 | 34 | 231 |
| | 5-10 cm* | 16200 | 0.5 | 16.0 | 134 | 1 | 1.14 | 15933 | 24 | 38 | 214 | 18333 | 136 | 6500 | 294 | 2.1 | 2017 | 1.63 | 68 | 35 | 271 |
| | 5-10 cm* | 13775 | 1 | 15 | 118 | 1.0 | 0.98 | 16150 | 21 | 38 | 207 | 16825 | 117 | 6308 | 271 | 2 | 2045 | 1 | 58 | 31 | 263 |
| 2292443 (Front yard) | 5-10 cm | 15200 | <0.4 | 14 | 127 | 1 | 1.32 | 14700 | 23 | 45 | 223 | 18800 | 114 | 6450 | 301 | 5 | 2300 | 2 | 61 | 35 | 245 |
| | 10-20 cm* | 13400 | 1 | 17 | 143 | 1 | 1.11 | 20567 | 22 | 32 | 205 | 17633 | 124 | 7067 | 281 | 2 | 1990 | 1 | 88 | 29 | 291 |
| | 10-20 cm* | 10400 | 0.4 | 16.4 | 102 | 0.7 | 0.84 | 18700 | 18 | 36 | 237 | 15625 | 91 | 6108 | 238 | 2.3 | 2145 | 1.14 | 65 | 25 | 258 |
| | 10-20 cm* | 13800 | 0.5 | 21.6 | 157 | 0.9 | 1.34 | 19950 | 23 | 37 | 233 | 18075 | 125 | 7093 | 278 | 2.6 | 2198 | 1.19 | 71 | 29 | 312 |
| | 0-5 cm | 21800 | <0.4 | 16.0 | 153 | 1.3 | 1.68 | 13700 | 34 | 83 | 356 | 27200 | 170 | 8090 | 593 | 5.6 | 3670 | 1.10 | 42 | 49 | 522 |
| 2292444 (Back yard) | 5-10 cm | 20300 | <0.4 | 29.7 | 159 | 1.3 | 2.71 | 15300 | 38 | 164 | 709 | 37700 | 218 | 8930 | 712 | 5.9 | 8900 | 5.20 | 40 | 49 | 789 |
| | 10-20 cm* | 19000 | 1 | 21 | 145 | 1 | 0.97 | 18600 | 29 | 72 | 493 | 27367 | 158 | 8257 | 551 | 2 | 5387 | 2 | 43 | 42 | 414 |
| | 0-5 cm | 19700 | <0.4 | 9.2 | 135 | 1.2 | 0.95 | 13500 | 29 | 32 | 148 | 22300 | 98 | 7970 | 483 | 4.9 | 1240 | 1.50 | 49 | 43 | 255 |
| | 5-10 cm | 19800 | <0.4 | 12.1 | 142 | 1.2 | 1.00 | 16300 | 29 | 35 | 162 | 23100 | 97 | 9250 | 490 | 5.1 | 1400 | <0.3 | 51 | 42 | 255 |
| | 10-20 cm* | 14033 | 0.7 | 17.6 | 159 | 0.9 | 0.78 | 20133 | 26 | 39 | 240 | 21933 | 240 | 7203 | 341 | 2.6 | 2287 | 0.95 | 76 | 36 | 329 |
| 2292445 (Front yard) | 0-5 cm | 28000 | 1.2 | 16.0 | 245 | 1.7 | 1.84 | 19700 | 154 | 56 | 314 | 27000 | 179 | 9040 | 447 | 5.5 | 2910 | 1.30 | 93 | 54 | 626 |
| | 5-10 cm | 28600 | 1.7 | 18.6 | 270 | 1.8 | 2.09 | 19900 | 245 | 63 | 359 | 28300 | 187 | 9410 | 449 | 5.5 | 3390 | 0.90 | 90 | 55 | 827 |
| | 10-20 cm* | 26475 | 1.1 | 19.1 | 242 | 1.5 | 1.42 | 20525 | 183 | 52 | 323 | 27100 | 167 | 8980 | 440 | 2.8 | 3170 | 1.59 | 89 | 50 | 673 |
| | 0-5 cm* | 15250 | 0.4 | 8.2 | 136 | 1.2 | 0.88 | 17975 | 29 | 24 | 134 | 19875 | 120 | 8393 | 526 | 2.8 | 1085 | 0.63 | 121 | 34 | 339 |
| | 5-10 cm* | 15300 | 0.4 | 7.8 | 127 | 1.3 | 0.87 | 19650 | 28 | 24 | 120 | 19925 | 110 | 8833 | 529 | 2.7 | 1038 | 0.58 | 135 | 34 | 319 |
| 2292447 (Front yard) | 10-20 cm* | 19800 | 1 | 16 | 243 | 3 | 1.14 | 20900 | 35 | 31 | 195 | 22067 | 224 | 8070 | 462 | 4 | 1527 | 1 | 273 | 45 | 451 |
| | 0-5 cm | 20400 | 9.4 | 7.6 | 216 | 1.1 | 1.20 | 20000 | 32 | 43 | 179 | 25200 | 524 | 9330 | 539 | 4.5 | 1620 | <0.3 | 63 | 41 | 311 |
| | 5-10 cm | 21200 | 8.8 | 7.5 | 178 | 1.1 | 1.05 | 18300 | 31 | 40 | 157 | 25800 | 360 | 8730 | 460 | 4.2 | 1430 | <0.3 | 56 | 41 | 246 |
| | 10-20 cm | 17800 | 8.0 | 7.9 | 153 | 1 | 1.44 | 28000 | 27 | 35 | 153 | 26200 | 278 | 1110 | 479 | 4.4 | 1570 | <0.3 | 65 | 35 | 222 |
| | 0-5 cm | 26200 | 23.6 | 9.7 | 409 | 1.4 | 1.60 | 27600 | 40 | 43 | 225 | 32700 | 1340 | 9600 | 505 | 4.5 | 2190 | <0.3 | 102 | 48 | 583 |
| 2292448 (Back yard) | 5-10 cm | 26300 | 19.1 | 8.5 | 329 | 1.4 | 1.45 | 23100 | 38 | 42 | 210 | 31900 | 1010 | 8650 | 463 | 4.5 | 2000 | <0.3 | 96 | 48 | 490 |
| | 10-20 cm | 25500 | 18.7 | 12.0 | 366 | 1.4 | 1.83 | 25600 | 41 | 49 | 312 | 35600 | 1130 | 9520 | 512 | 4.6 | 2650 | <0.3 | 101 | 47 | 645 |
| | 0-5 cm* | 16175 | 2.6 | 15.0 | 147 | 0.9 | 1.38 | 25775 | 30 | 43 | 224 | 30500 | 177 | 1100 | 532 | 3.5 | 1975 | 1.39 | 86 | 36 | 335 |
| | 5-10 cm* | 19075 | 2.7 | 14.6 | 154 | 1 | 1.30 | 28500 | 31 | 38 | 188 | 32025 | 155 | 1190 | 550 | 3.4 | 1790 | 0.90 | 77 | 40 | 297 |
| | 10-20 cm* | 19075 | 2.6 | 13.4 | 139 | 1 | 1.04 | 24850 | 29 | 32 | 159 | 31375 | 126 | 1025 | 524 | 3.4 | 1610 | 0.83 | 64 | 39 | 260 |
| 2292450 (Back yard) | 0-5 cm* | 9820 | 2.2 | 15.6 | 160 | 0.6 | 1.39 | 22350 | 23 | 28 | 175 | 23625 | 227 | 6805 | 417 | 2.6 | 1470 | 1.23 | 115 | 28 | 353 |
| | 5-10 cm | 9610 | 6.9 | 16.0 | 138 | 0.7 | 1.35 | 21500 | 24 | 28 | 151 | 24100 | 207 | 6600 | 442 | 5.0 | 1310 | 0.55 | 105 | 29 | 316 |
| | 10-20 cm* | 9593 | 2.4 | 17.8 | 149 | 0.6 | 1.26 | 23275 | 21 | 28 | 180 | 24400 | 205 | 6700 | 413 | 2.6 | 1548 | 0.87 | 120 | 26 | 319 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292451 (Front yard) | 0-5 cm* | 13750 | 1.7 | 7.1 | 87 | 0.7 | 1.00 | 14400 | 22 | 21 | 106 | 20150 | 95 | 5813 | 360 | 2.4 | 909 | 0.60 | 58 | 30 | 172 |
| | 5-10 cm* | 13725 | 1.7 | 7.6 | 84 | 0.7 | 0.98 | 14525 | 22 | 22 | 112 | 20125 | 105 | 5760 | 351 | 2.3 | 895 | 0.60 | 58 | 30 | 166 |
| | 10-20 cm* | 12375 | 1.9 | 13.3 | 104 | 0.6 | 1.43 | 14450 | 23 | 38 | 211 | 27350 | 162 | 4838 | 430 | 2.8 | 1933 | 1.13 | 64 | 27 | 295 |
| 2292452 (Front yard) | 0-5 cm | 19900 | 5.6 | 7.8 | 188 | 1 | 0.98 | 17400 | 32 | 23 | 100 | 22300 | 167 | 9180 | 428 | 5.0 | 567 | <0.3 | 70 | 42 | 255 |
| | 5-10 cm* | 19975 | 1.7 | 7.9 | 152 | 0.9 | 1.00 | 11750 | 28 | 21 | 93 | 22950 | 158 | 6735 | 427 | 2.4 | 585 | 0.58 | 58 | 41 | 235 |
| | 10-20 cm* | 20000 | 1.8 | 6.9 | 152 | 0.9 | 0.96 | 10148 | 28 | 20 | 88 | 23725 | 162 | 6135 | 409 | 2.2 | 607 | 0.50 | 47 | 40 | 229 |
| 2292453 (Back yard) | 0-5 cm* | 12900 | 2.0 | 10.8 | 186 | 0.6 | 1.19 | 10875 | 23 | 18 | 130 | 18450 | 309 | 3833 | 445 | 2.6 | 606 | 0.58 | 76 | 34 | 343 |
| | 5-10 cm* | 12775 | 1.4 | 9.1 | 182 | 0.6 | 1.10 | 10528 | 21 | 18 | 115 | 18850 | 266 | 3640 | 482 | 2.1 | 601 | 0.63 | 74 | 33 | 302 |
| | 10-20 cm* | 12400 | 1.6 | 9.6 | 188 | 0.6 | 0.93 | 10650 | 20 | 18 | 160 | 18600 | 242 | 3463 | 433 | 2.6 | 650 | 0.55 | 72 | 32 | 287 |
| 2292454 (Front yard) | 0-5 cm* | 12725 | 1.4 | 10.8 | 111 | 0.6 | 1.01 | 16825 | 21 | 28 | 136 | 19575 | 166 | 7175 | 402 | 2.7 | 1078 | 0.73 | 66 | 29 | 249 |
| | 5-10 cm* | 13750 | 1.3 | 9.0 | 90 | 0.5 | 0.86 | 11975 | 19 | 27 | 118 | 18875 | 129 | 5863 | 361 | 2.5 | 922 | 0.68 | 47 | 29 | 200 |
| | 10-20 cm* | 14200 | 2.0 | 18.0 | 152 | 0.8 | 1.21 | 23225 | 25 | 45 | 227 | 30425 | 199 | 1082 | 571 | 3.6 | 2350 | 1.89 | 88 | 30 | 324 |
| 2292455 (Back yard) | 0-5 cm* | 12225 | 1.0 | 5.8 | 75 | 0.4 | 0.72 | 6853 | 18 | 17 | 73 | 14625 | 208 | 2713 | 236 | 2.3 | 438 | 0.60 | 41 | 26 | 237 |
| | 5-10 cm | 13600 | 3.0 | 3.4 | 64 | 0.5 | 0.64 | 5040 | 17 | 16 | 57 | 16300 | 103 | 2480 | 239 | 2.9 | 380 | <0.3 | 33 | 28 | 158 |
| | 10-20 cm | 14200 | 2.9 | 4.9 | 77 | 0.6 | 0.66 | 5660 | 18 | 17 | 83 | 16700 | 106 | 2610 | 221 | 2.9 | 558 | <0.3 | 45 | 27 | 148 |
| 2292456 (Front yard) | 0-5 cm | 11200 | 4.9 | 19.1 | 215 | 0.9 | 1.96 | 32700 | 33 | 49 | 293 | 28500 | 462 | 1310 | 513 | 5.1 | 2280 | 2.53 | 143 | 30 | 520 |
| | 5-10 cm | 11700 | 5.0 | 25.4 | 291 | 1.1 | 2.27 | 32600 | 37 | 56 | 371 | 37200 | 575 | 1050 | 595 | 5.3 | 3260 | 2.91 | 183 | 31 | 629 |
| | 10-20 cm | 12400 | 6.6 | 31.7 | 311 | 1.2 | 2.53 | 30000 | 40 | 68 | 435 | 48100 | 662 | 9930 | 672 | 5.4 | 4830 | 4.37 | 195 | 32 | 692 |
| 2292457 (Back yard) | 0-5 cm | 13100 | 3.1 | 5.0 | 66 | 0.5 | 0.81 | 8580 | 18 | 17 | 70 | 16300 | 104 | 3740 | 285 | 3.3 | 487 | <0.3 | 46 | 29 | 176 |
| | 5-10 cm | 13000 | 2.6 | 4.0 | 56 | 0.5 | 0.64 | 7130 | 17 | 15 | 59 | 15700 | 84 | 3540 | 255 | 3.2 | 425 | <0.3 | 35 | 28 | 146 |
| | 10-20 cm | 12300 | 3.1 | 5.7 | 78 | 0.6 | 0.75 | 8450 | 19 | 17 | 87 | 17600 | 175 | 3520 | 259 | 3.3 | 665 | <0.3 | 48 | 26 | 182 |
| 2292458 (Front yard) | 0-5 cm | 22600 | <0.4 | 5.5 | 134 | 1.1 | 0.94 | 11500 | 33 | 30 | 120 | 19900 | 93 | 7030 | 448 | 4.0 | 709 | <0.3 | 48 | 49 | 161 |
| | 5-10 cm | 22300 | <0.4 | 4.6 | 127 | 1.1 | 0.80 | 11200 | 30 | 26 | 101 | 19400 | 76 | 6970 | 400 | 3.6 | 601 | <0.3 | 46 | 47 | 138 |
| | 10-20 cm | 22400 | <0.4 | 5.7 | 124 | 1.1 | 0.74 | 12200 | 30 | 26 | 102 | 21500 | 71 | 7520 | 466 | 4.0 | 696 | <0.3 | 49 | 46 | 142 |
| 2292459 (Back yard) | 0-5 cm | 15000 | <0.4 | 6.2 | 90 | 0.7 | 0.98 | 6050 | 21 | 26 | 118 | 17900 | 101 | 3150 | 289 | 3.2 | 864 | <0.3 | 27 | 33 | 212 |
| | 5-10 cm | 14400 | <0.4 | 4.2 | 71 | 0.7 | 0.67 | 4580 | 18 | 17 | 67 | 14500 | 61 | 2650 | 229 | 2.6 | 442 | <0.3 | 22 | 30 | 132 |
| | 10-20 cm | 17100 | <0.4 | 12.7 | 137 | 1 | 1.57 | 11600 | 27 | 35 | 180 | 24200 | 149 | 4960 | 383 | 3.8 | 1670 | <0.3 | 48 | 35 | 319 |
| 2292460 (Front yard) | 0-5 cm | 16100 | <0.4 | 4.9 | 89 | 0.9 | 0.57 | 9700 | 23 | 18 | 91 | 21100 | 61 | 5600 | 520 | 3.5 | 579 | <0.3 | 35 | 34 | 123 |
| | 5-10 cm | 16500 | <0.4 | 6.2 | 92 | 0.9 | 0.59 | 10200 | 24 | 20 | 98 | 22400 | 71 | 5790 | 546 | 3.6 | 655 | <0.3 | 38 | 34 | 129 |
| | 10-20 cm | 19000 | <0.4 | 9.0 | 111 | 1.1 | 0.89 | 14000 | 30 | 31 | 178 | 27200 | 113 | 7280 | 511 | 4.0 | 1310 | <0.3 | 52 | 39 | 192 |
| 2292461 (Back yard) | 0-5 cm | 17000 | <0.4 | 8.5 | 105 | 1 | 0.91 | 13600 | 26 | 26 | 114 | 20700 | 74 | 6240 | 393 | 3.9 | 1070 | <0.3 | 71 | 37 | 164 |
| | 5-10 cm | 18200 | <0.4 | 8.6 | 110 | 1.1 | 0.91 | 13200 | 26 | 26 | 113 | 21400 | 72 | 6130 | 377 | 3.7 | 1020 | <0.3 | 75 | 38 | 160 |
| | 10-20 cm | 21700 | <0.4 | 8.0 | 122 | 1.2 | 0.91 | 11400 | 29 | 25 | 110 | 23800 | 76 | 6040 | 425 | 3.8 | 1100 | <0.3 | 72 | 41 | 165 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|----|----|-----|
| 2292462 (Front yard) | 0-5 cm | 15700 | <0.4 | 7.6 | 97 | 0.9 | 0.78 | 12100 | 25 | 22 | 95 | 21100 | 91 | 6740 | 435 | 4.2 | 749 | <0.3 | 39 | 35 | 187 |
| | 5-10 cm | 17300 | <0.4 | 8.0 | 101 | 0.9 | 0.74 | 12500 | 25 | 23 | 102 | 22700 | 87 | 7590 | 459 | 3.9 | 780 | <0.3 | 42 | 38 | 177 |
| | 10-20 cm | 18500 | <0.4 | 10.8 | 117 | 1 | 0.99 | 15400 | 28 | 30 | 144 | 26800 | 119 | 9160 | 469 | 4.2 | 1250 | <0.3 | 53 | 39 | 234 |
| 2292463 (Back yard) | 0-5 cm | 14400 | <0.4 | 9.0 | 92 | 0.8 | 1.01 | 12500 | 21 | 22 | 109 | 17900 | 77 | 4500 | 407 | 3.7 | 903 | <0.3 | 59 | 33 | 174 |
| | 5-10 cm | 13900 | <0.4 | 9.5 | 91 | 0.8 | 0.93 | 11000 | 21 | 23 | 109 | 18000 | 71 | 4610 | 374 | 3.4 | 987 | <0.3 | 57 | 33 | 161 |
| | 10-20 cm | 15200 | <0.4 | 8.1 | 91 | 0.8 | 0.78 | 9810 | 21 | 19 | 91 | 17900 | 53 | 4480 | 361 | 3.3 | 790 | <0.3 | 54 | 33 | 143 |
| 2292464 (Front yard) | 0-5 cm | 19600 | <0.4 | 8.3 | 125 | 1.1 | 0.99 | 15300 | 30 | 27 | 111 | 24200 | 91 | 8710 | 436 | 4.3 | 884 | <0.3 | 69 | 42 | 216 |
| | 0-5 cm | 24800 | <0.4 | 8.5 | 141 | 1.3 | 1.01 | 12500 | 36 | 28 | 113 | 26900 | 89 | 7350 | 468 | 4.4 | 937 | <0.3 | 60 | 53 | 212 |
| | 0-5 cm | 24400 | <0.4 | 8.9 | 144 | 1.3 | 1.05 | 12800 | 37 | 29 | 116 | 26100 | 104 | 7660 | 426 | 4.2 | 956 | <0.3 | 61 | 53 | 254 |
| | 5-10 cm | 22300 | <0.4 | 8.6 | 133 | 1.2 | 0.99 | 13700 | 32 | 28 | 116 | 27100 | 88 | 8180 | 453 | 4.3 | 972 | <0.3 | 65 | 45 | 210 |
| | 5-10 cm | 26400 | <0.4 | 7.7 | 154 | 1.4 | 0.97 | 11100 | 38 | 29 | 112 | 29900 | 86 | 7540 | 487 | 4.1 | 934 | <0.3 | 61 | 58 | 204 |
| | 5-10 cm | 27800 | <0.4 | 7.1 | 152 | 1.3 | 0.97 | 10900 | 37 | 27 | 103 | 28500 | 86 | 7440 | 486 | 4.0 | 812 | <0.3 | 61 | 56 | 219 |
| | 10-20 cm | 21700 | <0.4 | 11.0 | 138 | 1.2 | 1.01 | 13400 | 32 | 31 | 136 | 28500 | 96 | 7520 | 443 | 4.0 | 1240 | <0.3 | 60 | 44 | 226 |
| | 10-20 cm | 27900 | <0.4 | 8.9 | 154 | 1.4 | 1.01 | 12000 | 38 | 30 | 121 | 30300 | 88 | 7780 | 468 | 4.2 | 1070 | <0.3 | 60 | 57 | 207 |
| | 10-20 cm | 26900 | <0.4 | 10.3 | 155 | 1.4 | 1.03 | 11300 | 37 | 30 | 124 | 30000 | 97 | 7350 | 451 | 4.0 | 1150 | <0.3 | 62 | 55 | 226 |
| | 0-5 cm | 20100 | <0.4 | 7.1 | 121 | 1.1 | 1.00 | 12800 | 29 | 21 | 93 | 20200 | 80 | 6060 | 356 | 3.9 | 618 | <0.3 | 74 | 44 | 214 |
| 2292465 (Back yard) | 0-5 cm | 18900 | <0.4 | 7.6 | 116 | 1 | 0.95 | 13200 | 28 | 20 | 86 | 19000 | 71 | 6200 | 327 | 3.8 | 577 | <0.3 | 72 | 42 | 191 |
| | 0-5 cm | 19700 | <0.4 | 6.8 | 119 | 1 | 0.93 | 12800 | 29 | 21 | 88 | 19400 | 94 | 6090 | 338 | 3.8 | 604 | <0.3 | 77 | 43 | 193 |
| | 5-10 cm | 19400 | <0.4 | 6.6 | 114 | 1 | 0.93 | 13400 | 27 | 21 | 90 | 19200 | 74 | 6140 | 360 | 3.8 | 638 | 0.30 | 71 | 42 | 180 |
| | 5-10 cm | 20600 | <0.4 | 7.3 | 125 | 1.1 | 0.96 | 14500 | 30 | 22 | 93 | 20600 | 76 | 6660 | 359 | 3.8 | 636 | <0.3 | 81 | 45 | 201 |
| | 5-10 cm | 20400 | <0.4 | 7.3 | 123 | 1.1 | 0.98 | 13400 | 29 | 22 | 92 | 19800 | 76 | 6340 | 349 | 3.9 | 689 | <0.3 | 84 | 45 | 190 |
| | 10-20 cm | 19600 | <0.4 | 7.8 | 115 | 1 | 0.91 | 14500 | 28 | 20 | 84 | 19800 | 68 | 6190 | 344 | 3.8 | 622 | <0.3 | 79 | 43 | 174 |
| | 10-20 cm | 20100 | <0.4 | 8.1 | 125 | 1.1 | 0.94 | 15300 | 28 | 21 | 93 | 19600 | 73 | 6600 | 339 | 3.9 | 594 | <0.3 | 85 | 42 | 193 |
| | 10-20 cm | 21100 | <0.4 | 8.2 | 125 | 1.1 | 0.96 | 14100 | 29 | 21 | 91 | 20500 | 74 | 6240 | 347 | 3.8 | 700 | <0.3 | 90 | 44 | 189 |
| | 0-5 cm | 16100 | <0.4 | 5.4 | 88 | 0.8 | 0.60 | 12900 | 23 | 20 | 71 | 21600 | 64 | 6350 | 447 | 3.8 | 545 | <0.3 | 38 | 37 | 140 |
| | 5-10 cm | 17900 | <0.4 | 5.7 | 97 | 0.9 | 0.64 | 9910 | 25 | 22 | 75 | 22800 | 65 | 5810 | 490 | 3.8 | 562 | <0.3 | 30 | 41 | 138 |
| 2292466 (Front yard) | 0-5 cm | 22700 | <0.4 | 4.7 | 155 | 1.2 | 0.52 | 21100 | 32 | 18 | 55 | 26200 | 161 | 9330 | 590 | 4.4 | 274 | <0.3 | 77 | 48 | 158 |
| | 5-10 cm | 24100 | <0.4 | 6.0 | 174 | 1.3 | 0.59 | 23900 | 34 | 22 | 67 | 28600 | 143 | 1030 | 597 | 4.5 | 413 | <0.3 | 91 | 50 | 188 |
| | 10-20 cm | 18600 | <0.4 | 8.3 | 172 | 1.1 | 0.83 | 20900 | 30 | 26 | 108 | 26700 | 197 | 9080 | 524 | 4.7 | 804 | <0.3 | 93 | 41 | 250 |
| 2292468 (Front yard) | 0-5 cm | 16500 | <0.4 | 9.4 | 118 | 1 | 0.91 | 17000 | 25 | 29 | 147 | 24800 | 119 | 7170 | 597 | 4.4 | 1160 | <0.3 | 52 | 38 | 218 |
| | 5-10 cm | 17400 | <0.4 | 10.5 | 130 | 1.1 | 1.15 | 17400 | 28 | 33 | 168 | 26200 | 133 | 7410 | 646 | 4.6 | 1250 | <0.3 | 57 | 41 | 246 |
| | 10-20 cm | 14200 | <0.4 | 7.3 | 85 | 0.8 | 0.79 | 10900 | 22 | 27 | 120 | 24900 | 90 | 5190 | 601 | 3.9 | 1030 | <0.3 | 36 | 33 | 181 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292469 (Back yard) | 0-5 cm | 14100 | <0.4 | 14.6 | 175 | 0.8 | 1.40 | 24100 | 31 | 24 | 158 | 21000 | 271 | 6940 | 487 | 4.7 | 974 | <0.3 | 97 | 32 | 332 |
| | 5-10 cm | 15200 | <0.4 | 18.0 | 220 | 1.1 | 1.71 | 24400 | 32 | 30 | 217 | 26100 | 389 | 6930 | 567 | 4.4 | 1360 | <0.3 | 108 | 35 | 396 |
| | 10-20 cm | 14600 | <0.4 | 14.0 | 167 | 0.9 | 1.13 | 14800 | 26 | 24 | 125 | 24500 | 296 | 5990 | 583 | 4.1 | 979 | <0.3 | 73 | 32 | 270 |
| | 0-5 cm | 13100 | <0.4 | 7.7 | 133 | 0.8 | 1.19 | 24700 | 24 | 27 | 148 | 17700 | 234 | 9220 | 395 | 4.3 | 775 | <0.3 | 77 | 32 | 243 |
| | 0-5 cm | 11100 | <0.4 | 6.4 | 118 | 0.7 | 0.89 | 20500 | 21 | 23 | 122 | 15600 | 192 | 7870 | 333 | 4.1 | 720 | <0.3 | 62 | 30 | 203 |
| | 0-5 cm | 12300 | <0.4 | 7.9 | 121 | 0.8 | 1.27 | 23400 | 24 | 27 | 147 | 18600 | 203 | 9730 | 394 | 4.4 | 840 | <0.3 | 74 | 32 | 235 |
| 2292470 (Front yard) | 5-10 cm | 13700 | <0.4 | 7.6 | 134 | 0.8 | 1.04 | 22500 | 25 | 28 | 156 | 18000 | 232 | 7850 | 385 | 4.2 | 805 | <0.3 | 69 | 34 | 236 |
| | 5-10 cm | 14900 | <0.4 | 8.8 | 150 | 0.9 | 1.28 | 23600 | 27 | 32 | 177 | 20000 | 271 | 8250 | 425 | 4.3 | 996 | <0.3 | 74 | 36 | 267 |
| | 5-10 cm | 14100 | <0.4 | 9.3 | 138 | 0.9 | 1.18 | 23800 | 26 | 33 | 185 | 21900 | 238 | 8930 | 434 | 4.7 | 1090 | <0.3 | 72 | 35 | 265 |
| | 10-20 cm | 14600 | <0.4 | 7.6 | 135 | 0.9 | 1.03 | 17000 | 27 | 33 | 161 | 20100 | 228 | 6660 | 431 | 3.8 | 1040 | <0.3 | 52 | 34 | 237 |
| | 10-20 cm | 16200 | <0.4 | 8.9 | 167 | 1 | 1.24 | 17900 | 29 | 34 | 203 | 21400 | 269 | 6870 | 468 | 4.0 | 1120 | <0.3 | 60 | 38 | 273 |
| | 10-20 cm | 16400 | <0.4 | 10.7 | 160 | 1 | 1.38 | 20600 | 31 | 38 | 208 | 23800 | 258 | 8080 | 504 | 4.6 | 1300 | <0.3 | 66 | 39 | 294 |
| | 0-5 cm | 15100 | <0.4 | 6.5 | 140 | 1 | 1.17 | 18500 | 25 | 25 | 113 | 18600 | 207 | 6960 | 386 | 4.1 | 712 | <0.3 | 64 | 38 | 221 |
| | 0-5 cm | 15200 | <0.4 | 7.4 | 132 | 0.9 | 1.23 | 17700 | 24 | 26 | 117 | 19000 | 188 | 6840 | 395 | 4.0 | 725 | <0.3 | 62 | 37 | 202 |
| | 0-5 cm | 16700 | <0.4 | 8.3 | 143 | 1 | 1.57 | 19500 | 30 | 29 | 123 | 20600 | 205 | 7480 | 412 | 4.3 | 734 | <0.3 | 68 | 39 | 227 |
| | 5-10 cm | 16200 | <0.4 | 7.3 | 137 | 1 | 1.13 | 18700 | 25 | 27 | 114 | 19600 | 188 | 6960 | 386 | 4.0 | 726 | <0.3 | 65 | 38 | 202 |
| 2292471 (Back yard) | 5-10 cm | 16200 | <0.4 | 6.9 | 132 | 1 | 1.19 | 17500 | 24 | 27 | 120 | 20300 | 176 | 6650 | 390 | 3.9 | 768 | <0.3 | 61 | 39 | 186 |
| | 5-10 cm | 17600 | <0.4 | 8.2 | 143 | 1 | 1.45 | 19000 | 28 | 29 | 126 | 21600 | 184 | 7350 | 407 | 4.2 | 825 | <0.3 | 69 | 42 | 212 |
| | 10-20 cm | 19600 | <0.4 | 7.5 | 143 | 1.1 | 1.22 | 15700 | 28 | 27 | 114 | 23400 | 191 | 6770 | 461 | 3.9 | 814 | <0.3 | 58 | 43 | 187 |
| | 10-20 cm | 18100 | <0.4 | 7.1 | 136 | 1.1 | 1.14 | 16900 | 26 | 29 | 125 | 22500 | 161 | 6770 | 459 | 3.7 | 908 | <0.3 | 58 | 41 | 177 |
| | 10-20 cm | 21200 | <0.4 | 8.9 | 164 | 1.2 | 1.50 | 20500 | 31 | 34 | 146 | 24900 | 191 | 8030 | 478 | 4.3 | 966 | <0.3 | 72 | 47 | 223 |
| | 0-5 cm | 16500 | <0.4 | 3.7 | 97 | 0.8 | 0.49 | 15300 | 31 | 15 | 49 | 20000 | 61 | 6380 | 501 | 3.8 | 291 | <0.3 | 40 | 31 | 116 |
| | 5-10 cm | 19500 | <0.4 | 3.1 | 98 | 0.9 | 0.38 | 23100 | 23 | 14 | 34 | 22700 | 50 | 8040 | 564 | 3.5 | 166 | <0.3 | 46 | 35 | 86 |
| | 10-20 cm | 21300 | <0.4 | 5.5 | 127 | 1 | 0.54 | 28600 | 27 | 21 | 71 | 27000 | 73 | 8600 | 651 | 3.8 | 446 | <0.3 | 66 | 39 | 155 |
| | 0-5 cm | 19500 | <0.4 | 5.2 | 130 | 0.9 | 0.92 | 11700 | 26 | 29 | 135 | 22600 | 140 | 6270 | 584 | 3.6 | 906 | <0.3 | 45 | 37 | 282 |
| | 5-10 cm | 22600 | <0.4 | 4.5 | 128 | 1 | 0.82 | 9220 | 27 | 28 | 139 | 24500 | 120 | 5830 | 662 | 3.5 | 765 | <0.3 | 41 | 40 | 208 |
| 2292472 (Back yard) | 10-20 cm | 19800 | <0.4 | 7.0 | 127 | 0.9 | 0.99 | 12600 | 25 | 32 | 193 | 23300 | 140 | 5880 | 537 | 3.7 | 1050 | <0.3 | 56 | 37 | 234 |
| | 0-5 cm | 24400 | <0.4 | 10.9 | 232 | 1.2 | 1.34 | 17400 | 32 | 44 | 225 | 30700 | 324 | 7700 | 450 | 3.7 | 1880 | <0.3 | 56 | 42 | 407 |
| | 5-10 cm | 24500 | <0.4 | 15.6 | 264 | 1.3 | 1.50 | 19800 | 34 | 45 | 257 | 34600 | 365 | 8050 | 481 | 4.0 | 2290 | <0.3 | 62 | 41 | 451 |
| | 10-20 cm | 22100 | 0.4 | 18.2 | 267 | 1.2 | 1.45 | 26500 | 30 | 40 | 224 | 35700 | 413 | 7810 | 461 | 4.1 | 2440 | 0.53 | 74 | 38 | 504 |
| 2292475 (Back yard) | 0-5 cm | 10200 | <0.4 | 1.6 | 75 | 0.4 | 0.44 | 9860 | 11 | 6 | 15 | 9890 | 33 | 3340 | 170 | 2.7 | 87 | <0.3 | 23 | 20 | 87 |
| | 5-10 cm | 10600 | <0.4 | 2.0 | 174 | 0.5 | 0.42 | 10200 | 12 | 7 | 18 | 11200 | 37 | 3150 | 192 | 2.7 | 144 | <0.3 | 24 | 22 | 82 |
| | 10-20 cm | 16000 | <0.4 | 3.6 | 956 | 0.8 | 0.46 | 20500 | 20 | 11 | 34 | 17300 | 86 | 5970 | 316 | 3.4 | 232 | <0.3 | 49 | 30 | 113 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|------|------|-----|-----|------|------|-----|----|-----|
| 2292476 (Front yard) | 0-5 cm | 20700 | <0.4 | 4.9 | 136 | 0.9 | 0.80 | 23400 | 27 | 33 | 143 | 24000 | 183 | 9760 | 419 | 3.9 | 1020 | <0.3 | 55 | 37 | 220 |
| | 5-10 cm | 23900 | <0.4 | 6.2 | 150 | 1.1 | 0.81 | 23300 | 27 | 32 | 145 | 25800 | 172 | 9490 | 417 | 3.8 | 1100 | <0.3 | 56 | 40 | 218 |
| | 10-20 cm | 19900 | <0.4 | 6.7 | 130 | 1 | 0.69 | 27900 | 24 | 30 | 134 | 25000 | 138 | 1040 | 459 | 3.7 | 1100 | <0.3 | 58 | 35 | 198 |
| 2292477 (Back yard) | 0-5 cm | 22300 | 5.7 | 12.7 | 246 | 1.2 | 1.54 | 13500 | 39 | 38 | 253 | 34800 | 847 | 5840 | 504 | 4.1 | 1910 | 0.30 | 59 | 40 | 565 |
| | 5-10 cm | 21900 | 11.3 | 13.0 | 253 | 1.2 | 1.50 | 13300 | 37 | 36 | 223 | 34500 | 960 | 5890 | 496 | 4.0 | 1810 | 0.38 | 58 | 38 | 507 |
| | 10-20 cm | 23200 | 9.6 | 16.3 | 372 | 1.3 | 1.76 | 17600 | 41 | 43 | 331 | 38700 | 1170 | 6440 | 502 | 4.3 | 2540 | 0.82 | 77 | 39 | 643 |
| 2292478 (Front yard) | 0-5 cm | 27000 | <0.4 | 6.3 | 164 | 1.2 | 0.98 | 15000 | 32 | 38 | 173 | 25600 | 156 | 7240 | 371 | 4.0 | 1380 | <0.3 | 58 | 45 | 240 |
| | 5-10 cm | 29000 | <0.4 | 6.8 | 173 | 1.2 | 0.99 | 13300 | 32 | 39 | 170 | 26600 | 169 | 7000 | 379 | 3.7 | 1410 | <0.3 | 57 | 45 | 242 |
| | 10-20 cm | 25900 | <0.4 | 11.2 | 193 | 1.2 | 1.17 | 16400 | 34 | 47 | 259 | 31000 | 187 | 7200 | 469 | 4.2 | 2570 | <0.3 | 57 | 41 | 310 |
| 2292479 (Back yard) | 0-5 cm | 17200 | 0.9 | 16.7 | 264 | 1.4 | 1.69 | 18500 | 29 | 50 | 295 | 28900 | 299 | 5280 | 418 | 4.0 | 2520 | 1.10 | 115 | 36 | 579 |
| | 5-10 cm | 18900 | 0.5 | 21.0 | 378 | 1.9 | 1.84 | 24300 | 33 | 50 | 357 | 29000 | 387 | 5210 | 423 | 4.4 | 2970 | 0.95 | 199 | 37 | 750 |
| | 10-20 cm | 14400 | 1.3 | 17.0 | 420 | 1.8 | 1.47 | 30300 | 28 | 41 | 377 | 26900 | 483 | 5090 | 372 | 4.4 | 2530 | 0.34 | 219 | 30 | 733 |
| 2292480 (Front yard) | 0-5 cm | 21400 | <0.4 | 5.2 | 117 | 1 | 0.65 | 16800 | 25 | 24 | 94 | 22400 | 75 | 8500 | 378 | 3.7 | 785 | <0.3 | 44 | 38 | 147 |
| | 5-10 cm | 23300 | <0.4 | 4.5 | 127 | 1.1 | 0.61 | 16500 | 27 | 24 | 91 | 23600 | 73 | 8790 | 404 | 3.7 | 739 | <0.3 | 43 | 40 | 144 |
| | 10-20 cm | 23000 | <0.4 | 4.6 | 125 | 1 | 0.68 | 15600 | 26 | 28 | 107 | 24600 | 84 | 8490 | 409 | 3.7 | 956 | <0.3 | 41 | 39 | 152 |
| 2292481 (Back yard) | 0-5 cm | 18000 | <0.4 | 5.4 | 113 | 0.9 | 0.72 | 13400 | 23 | 20 | 83 | 18600 | 75 | 5940 | 257 | 3.1 | 577 | <0.3 | 60 | 35 | 164 |
| | 5-10 cm | 21700 | <0.4 | 6.7 | 128 | 1.1 | 0.89 | 16600 | 28 | 24 | 100 | 21600 | 89 | 6740 | 296 | 3.4 | 793 | <0.3 | 77 | 39 | 193 |
| | 10-20 cm | 19100 | <0.4 | 6.6 | 125 | 1 | 0.81 | 19800 | 25 | 23 | 104 | 20100 | 85 | 7080 | 288 | 3.5 | 811 | <0.3 | 77 | 35 | 189 |
| 2292482 (Front yard) | 0-5 cm | 17000 | <0.4 | 8.6 | 112 | 1 | 0.80 | 13700 | 24 | 49 | 181 | 23600 | 93 | 6400 | 440 | 3.5 | 1700 | 0.47 | 46 | 36 | 208 |
| | 5-10 cm | 17300 | <0.4 | 8.3 | 117 | 1 | 0.86 | 14100 | 26 | 50 | 184 | 24800 | 101 | 6700 | 465 | 3.7 | 1800 | 0.35 | 46 | 37 | 219 |
| | 10-20 cm | 19100 | <0.4 | 8.4 | 143 | 1.2 | 0.93 | 15400 | 30 | 48 | 182 | 25900 | 106 | 7540 | 495 | 4.0 | 1580 | <0.3 | 53 | 49 | 238 |
| | 0-5 cm | 24400 | <0.4 | 8.5 | 146 | 1.3 | 0.88 | 14100 | 32 | 50 | 185 | 28200 | 92 | 7660 | 481 | 3.6 | 1800 | <0.3 | 47 | 45 | 208 |
| | 5-10 cm | 26400 | <0.4 | 6.3 | 155 | 1.4 | 0.79 | 14200 | 32 | 43 | 161 | 27800 | 88 | 8090 | 493 | 3.9 | 1390 | <0.3 | 58 | 51 | 210 |
| | 10-20 cm | 32800 | <0.4 | 4.8 | 183 | 1.7 | 0.70 | 14100 | 38 | 39 | 134 | 30800 | 82 | 9530 | 475 | 3.8 | 1160 | <0.3 | 53 | 60 | 191 |
| 2292482 (Front yard) | 0-5 cm | 20200 | <0.4 | 8.7 | 132 | 1.2 | 0.72 | 17700 | 26 | 38 | 150 | 27400 | 77 | 7370 | 500 | 3.6 | 1520 | <0.3 | 48 | 39 | 180 |
| | 5-10 cm | 27000 | <0.4 | 5.4 | 156 | 1.4 | 0.67 | 16100 | 32 | 35 | 129 | 28700 | 80 | 8680 | 480 | 3.7 | 1180 | <0.3 | 52 | 52 | 177 |
| | 10-20 cm | 28600 | <0.4 | 6.2 | 168 | 1.5 | 0.67 | 18000 | 32 | 38 | 141 | 28700 | 75 | 9090 | 496 | 3.9 | 1200 | <0.3 | 56 | 54 | 177 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292483 (Back yard) | 0-5 cm | 25400 | <0.4 | 7.8 | 162 | 1.4 | 0.79 | 14300 | 31 | 28 | 108 | 23000 | 87 | 6380 | 369 | 3.6 | 977 | <0.3 | 65 | 46 | 186 |
| | 0-5 cm | 24800 | <0.4 | 6.9 | 164 | 1.3 | 0.77 | 13600 | 28 | 27 | 109 | 22900 | 96 | 6180 | 367 | 3.6 | 930 | <0.3 | 63 | 45 | 187 |
| | 0-5 cm | 25800 | <0.4 | 7.4 | 167 | 1.4 | 0.81 | 14000 | 31 | 28 | 111 | 23900 | 89 | 6390 | 381 | 4.0 | 929 | <0.3 | 64 | 47 | 188 |
| | 5-10 cm | 27900 | <0.4 | 8.9 | 197 | 1.5 | 0.77 | 14700 | 32 | 29 | 110 | 24400 | 86 | 6730 | 374 | 3.7 | 963 | <0.3 | 68 | 49 | 187 |
| | 5-10 cm | 26800 | <0.4 | 6.8 | 168 | 1.4 | 0.80 | 14600 | 30 | 29 | 113 | 23900 | 89 | 6530 | 380 | 3.5 | 975 | <0.3 | 65 | 48 | 191 |
| 2292484 (Front yard) | 5-10 cm | 26300 | <0.4 | 7.9 | 164 | 1.4 | 0.76 | 12800 | 30 | 28 | 107 | 23700 | 83 | 6380 | 362 | 3.4 | 942 | <0.3 | 61 | 48 | 183 |
| | 10-20 cm | 28500 | <0.4 | 9.6 | 183 | 1.5 | 0.79 | 16300 | 32 | 27 | 107 | 25200 | 95 | 6860 | 367 | 3.9 | 998 | <0.3 | 72 | 49 | 187 |
| | 10-20 cm | 24700 | <0.4 | 8.0 | 159 | 1.3 | 0.68 | 14700 | 28 | 24 | 97 | 22300 | 75 | 6300 | 331 | 3.4 | 834 | <0.3 | 61 | 44 | 169 |
| | 10-20 cm | 27100 | <0.4 | 9.6 | 171 | 1.4 | 0.76 | 15100 | 32 | 26 | 104 | 24400 | 82 | 6650 | 355 | 3.6 | 930 | <0.3 | 69 | 48 | 178 |
| | 0-5 cm | 19700 | <0.4 | 8.7 | 122 | 1.1 | 0.87 | 17700 | 28 | 22 | 89 | 21500 | 134 | 9220 | 423 | 5.5 | 629 | <0.3 | 62 | 43 | 182 |
| 2292485 (Back yard) | 5-10 cm | 21900 | <0.4 | 6.1 | 130 | 1.2 | 0.83 | 14800 | 29 | 24 | 89 | 23600 | 125 | 8250 | 454 | 5.3 | 648 | <0.3 | 61 | 47 | 179 |
| | 10-20 cm | 20500 | <0.4 | 6.0 | 115 | 1.1 | 0.80 | 13800 | 27 | 24 | 89 | 23100 | 114 | 7200 | 480 | 5.5 | 738 | <0.3 | 61 | 43 | 163 |
| | 0-5 cm | 15400 | <0.4 | 17.8 | 181 | 0.9 | 1.93 | 22600 | 32 | 23 | 131 | 20500 | 313 | 9490 | 312 | 6.2 | 765 | <0.3 | 89 | 36 | 375 |
| | 5-10 cm | 17800 | <0.4 | 15.1 | 202 | 1.3 | 2.20 | 24500 | 32 | 26 | 139 | 22000 | 372 | 8540 | 338 | 6.0 | 871 | <0.3 | 95 | 40 | 390 |
| | 10-20 cm | 28400 | <0.4 | 11.2 | 228 | 1.5 | 1.81 | 25600 | 39 | 27 | 220 | 28900 | 259 | 1170 | 383 | 6.1 | 703 | <0.3 | 104 | 56 | 316 |
| 2292486 (Front yard) | 0-5 cm | 14300 | <0.4 | 9.3 | 160 | 1 | 1.20 | 32500 | 26 | 29 | 145 | 21000 | 277 | 1420 | 458 | 6.7 | 1010 | <0.3 | 79 | 37 | 274 |
| | 5-10 cm | 17300 | <0.4 | 9.3 | 178 | 1.1 | 1.33 | 35700 | 28 | 31 | 151 | 23400 | 271 | 1630 | 490 | 6.7 | 1010 | <0.3 | 80 | 42 | 279 |
| | 10-20 cm | 17500 | <0.4 | 10.9 | 185 | 1 | 1.04 | 45500 | 26 | 31 | 145 | 24300 | 406 | 2030 | 491 | 7.0 | 1300 | <0.3 | 84 | 38 | 253 |
| | 0-5 cm | 14300 | <0.4 | 2.2 | 83 | 0.8 | 1.26 | 9400 | 21 | 17 | 58 | 18200 | 92 | 5700 | 630 | 4.9 | 207 | <0.3 | 40 | 34 | 155 |
| | 5-10 cm | 13500 | <0.4 | 1.4 | 54 | 0.7 | 0.62 | 4650 | 17 | 12 | 34 | 18300 | 44 | 4210 | 542 | 4.1 | 99 | <0.3 | 24 | 31 | 75 |
| 2292488 (Front yard) | 10-20 cm | 12900 | <0.4 | 1.5 | 46 | 0.7 | 0.44 | 2880 | 15 | 10 | 20 | 17400 | 25 | 3630 | 587 | 3.4 | 46 | <0.3 | 17 | 28 | 52 |
| | 0-5 cm | 19500 | <0.4 | 7.7 | 143 | 1.1 | 1.10 | 16000 | 28 | 28 | 129 | 22100 | 168 | 7320 | 374 | 5.7 | 970 | <0.3 | 62 | 44 | 232 |
| | 5-10 cm | 22600 | <0.4 | 7.8 | 159 | 1.2 | 1.17 | 17300 | 30 | 30 | 130 | 24600 | 160 | 8220 | 411 | 5.7 | 968 | <0.3 | 64 | 49 | 232 |
| | 10-20 cm | 27100 | <0.4 | 7.0 | 172 | 1.4 | 0.85 | 27700 | 33 | 30 | 130 | 29700 | 125 | 1120 | 466 | 6.1 | 917 | <0.3 | 85 | 53 | 187 |
| | 0-5 cm | 26300 | <0.4 | 8.3 | 192 | 1.4 | 1.13 | 22600 | 35 | 24 | 104 | 26300 | 153 | 8940 | 492 | 5.7 | 644 | <0.3 | 82 | 54 | 246 |
| 2292489 (Back yard) | 5-10 cm | 28700 | <0.4 | 8.8 | 200 | 1.5 | 1.98 | 22600 | 36 | 23 | 89 | 29700 | 148 | 1060 | 471 | 6.0 | 586 | <0.3 | 73 | 57 | 658 |
| | 10-20 cm | 33900 | <0.4 | 6.0 | 249 | 1.7 | 0.96 | 20600 | 41 | 27 | 95 | 32800 | 158 | 1040 | 541 | 5.8 | 637 | <0.3 | 76 | 64 | 256 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292490 (Front yard) | 0-5 cm | 21900 | <0.4 | 6.7 | 157 | 1.3 | 1.87 | 12700 | 41 | 32 | 134 | 32400 | 178 | 5870 | 521 | 5.8 | 953 | <0.3 | 57 | 47 | 334 |
| | 0-5 cm | 19100 | <0.4 | 7.9 | 140 | 1.2 | 1.87 | 14600 | 38 | 31 | 140 | 30300 | 182 | 6060 | 502 | 5.8 | 926 | <0.3 | 60 | 41 | 339 |
| | 0-5 cm | 21400 | <0.4 | 8.0 | 150 | 1.3 | 2.23 | 14400 | 38 | 30 | 132 | 29700 | 169 | 6160 | 562 | 5.9 | 921 | <0.3 | 59 | 44 | 303 |
| | 5-10 cm | 24200 | <0.4 | 7.3 | 149 | 1.4 | 1.67 | 11900 | 43 | 31 | 130 | 30500 | 152 | 6060 | 497 | 5.8 | 971 | <0.3 | 54 | 50 | 284 |
| | 5-10 cm | 20100 | <0.4 | 7.6 | 129 | 1.2 | 1.60 | 12000 | 36 | 29 | 125 | 28900 | 147 | 5680 | 467 | 5.5 | 918 | <0.3 | 51 | 41 | 278 |
| | 5-10 cm | 22000 | <0.4 | 7.3 | 140 | 1.3 | 1.64 | 11900 | 37 | 29 | 128 | 28600 | 150 | 5780 | 491 | 5.8 | 907 | <0.3 | 52 | 44 | 272 |
| | 10-20 cm | 22200 | <0.4 | 13.7 | 180 | 1.6 | 2.38 | 22700 | 43 | 36 | 220 | 48900 | 264 | 5950 | 736 | 7.2 | 1200 | 0.40 | 106 | 39 | 561 |
| | 10-20 cm | 22200 | <0.4 | 13.8 | 172 | 1.6 | 2.34 | 21400 | 40 | 34 | 174 | 37800 | 224 | 6050 | 671 | 6.4 | 1230 | <0.3 | 93 | 42 | 436 |
| | 10-20 cm | 20500 | <0.4 | 12.3 | 167 | 1.5 | 2.11 | 20700 | 36 | 32 | 164 | 34600 | 227 | 5680 | 588 | 6.0 | 1250 | <0.3 | 90 | 39 | 387 |
| | 0-5 cm | 23200 | <0.4 | 7.5 | 154 | 1.3 | 0.74 | 30200 | 30 | 21 | 79 | 26200 | 93 | 1460 | 523 | 6.2 | 484 | <0.3 | 87 | 47 | 169 |
| 2292491 (Back yard) | 0-5 cm | 20000 | <0.4 | 8.6 | 146 | 1.2 | 1.02 | 23900 | 28 | 22 | 92 | 25600 | 115 | 1150 | 484 | 6.0 | 617 | <0.3 | 85 | 42 | 207 |
| | 0-5 cm | 20200 | <0.4 | 9.5 | 147 | 1.2 | 1.02 | 26000 | 28 | 23 | 98 | 24800 | 128 | 1190 | 469 | 5.8 | 677 | <0.3 | 97 | 43 | 212 |
| | 5-10 cm | 19800 | <0.4 | 8.3 | 147 | 1.2 | 0.76 | 35900 | 26 | 21 | 84 | 25300 | 91 | 1530 | 536 | 6.6 | 541 | <0.3 | 100 | 40 | 185 |
| | 5-10 cm | 24700 | <0.4 | 6.2 | 157 | 1.3 | 0.74 | 36000 | 31 | 21 | 83 | 28600 | 113 | 1390 | 503 | 5.8 | 553 | <0.3 | 104 | 46 | 163 |
| | 5-10 cm | 21700 | <0.4 | 8.8 | 150 | 1.3 | 0.97 | 24900 | 29 | 23 | 91 | 26700 | 99 | 1110 | 512 | 6.1 | 648 | <0.3 | 95 | 45 | 186 |
| | 10-20 cm | 20600 | <0.4 | 7.9 | 141 | 1.2 | 0.60 | 37000 | 26 | 18 | 68 | 25200 | 78 | 1430 | 494 | 6.5 | 396 | <0.3 | 98 | 40 | 128 |
| | 10-20 cm | 22900 | <0.4 | 8.4 | 163 | 1.3 | 0.87 | 25100 | 30 | 24 | 94 | 28100 | 113 | 1160 | 583 | 6.0 | 662 | <0.3 | 92 | 46 | 191 |
| | 10-20 cm | 26600 | <0.4 | 7.0 | 160 | 1.4 | 0.80 | 33200 | 33 | 21 | 77 | 30000 | 91 | 1250 | 504 | 5.7 | 529 | <0.3 | 118 | 50 | |
| | 0-5 cm | 14100 | <0.4 | 3.5 | 61 | 0.6 | 0.47 | 4800 | 15 | 11 | 38 | 13000 | 56 | 2390 | 160 | 3.8 | 296 | <0.3 | 21 | 26 | 83 |
| | 5-10 cm | 13400 | <0.4 | 2.4 | 52 | 0.5 | 0.41 | 3760 | 13 | 10 | 30 | 11600 | 47 | 1970 | 137 | 3.3 | 221 | <0.3 | 17 | 24 | 68 |
| 2292492 (Front yard) | 10-20 cm | 14900 | <0.4 | 2.8 | 49 | 0.5 | 0.40 | 3090 | 13 | 9 | 25 | 12600 | 39 | 1890 | 131 | 3.2 | 192 | <0.3 | 14 | 25 | 61 |
| | 0-5 cm | 17400 | <0.4 | 17.9 | 191 | 1.3 | 1.42 | 30200 | 27 | 27 | 160 | 22800 | 219 | 1240 | 354 | 6.4 | 1080 | <0.3 | 180 | 42 | 267 |
| | 5-10 cm | 14600 | <0.4 | 13.9 | 149 | 1.1 | 1.20 | 23500 | 24 | 25 | 139 | 19900 | 207 | 1030 | 308 | 6.3 | 1010 | <0.3 | 134 | 38 | 242 |
| | 0-5 cm | 20500 | <0.4 | 6.7 | 127 | 1.1 | 1.09 | 10200 | 29 | 23 | 96 | 23500 | 120 | 5910 | 495 | 4.9 | 725 | <0.3 | 41 | 44 | 209 |
| | 5-10 cm | 20400 | <0.4 | 4.8 | 122 | 1.1 | 0.90 | 9670 | 27 | 22 | 87 | 23400 | 101 | 5720 | 526 | 5.0 | 662 | <0.3 | 39 | 43 | 181 |
| | 10-20 cm | 24000 | <0.4 | 9.8 | 139 | 1.2 | 0.57 | 14000 | 29 | 23 | 101 | 27400 | 106 | 7280 | 492 | 1.7 | 786 | <0.3 | 52 | 46 | 206 |
| | 0-5 cm | 16900 | 0.4 | 11.8 | 114 | 0.8 | 0.68 | 8500 | 22 | 19 | 95 | 18800 | 116 | 3810 | 308 | 1.7 | 637 | <0.3 | 54 | 36 | 212 |
| | 5-10 cm | 17400 | 0.5 | 13.2 | 118 | 0.8 | 0.67 | 8190 | 22 | 20 | 97 | 19400 | 113 | 3860 | 309 | 1.4 | 702 | <0.3 | 54 | 37 | 196 |
| | 10-20 cm | 19000 | <0.4 | 13.9 | 124 | 0.8 | 0.65 | 8020 | 23 | 19 | 87 | 19400 | 114 | 4060 | 311 | 1.4 | 620 | <0.3 | 56 | 39 | 185 |
| | 0-5 cm | 26000 | 0.8 | 13.5 | 177 | 1.2 | 1.22 | 13700 | 36 | 38 | 150 | 27300 | 221 | 7140 | 437 | 2.3 | 1070 | <0.3 | 68 | 56 | 374 |
| 2292496 (Front yard) | 5-10 cm | 27700 | 0.7 | 14.5 | 197 | 1.3 | 1.32 | 12800 | 36 | 40 | 156 | 29200 | 210 | 7350 | 744 | 2.3 | 1110 | <0.3 | 67 | 58 | 351 |
| | 10-20 cm | 21900 | 0.6 | 27.7 | 153 | 1 | 1.36 | 15300 | 30 | 30 | 129 | 26500 | 270 | 6930 | 372 | 2.2 | 1070 | <0.3 | 64 | 50 | 338 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|------|------|-----|-----|------|------|-----|----|-----|
| 2292497 (Back yard) | 0-5 cm | 15300 | 1.3 | 14.4 | 200 | 0.8 | 1.51 | 21600 | 26 | 24 | 127 | 20100 | 469 | 8590 | 309 | 2.1 | 1100 | <0.3 | 86 | 37 | 419 |
| | 5-10 cm | 15400 | 3.1 | 17.3 | 298 | 0.8 | 1.51 | 24400 | 29 | 26 | 204 | 20400 | 1200 | 8050 | 339 | 2.0 | 1770 | <0.3 | 94 | 37 | 556 |
| | 10-20 cm | 20100 | 1.4 | 18.8 | 258 | 1.1 | 1.33 | 22300 | 30 | 25 | 145 | 23800 | 385 | 7840 | 329 | 2.3 | 1180 | <0.3 | 126 | 44 | 407 |
| 2292498 (Front yard) | 0-5 cm | 27100 | 0.7 | 12.0 | 187 | 1.3 | 0.95 | 14800 | 40 | 36 | 161 | 27800 | 221 | 7780 | 495 | 2.3 | 1180 | <0.3 | 58 | 55 | 289 |
| | 5-10 cm | 24900 | 0.5 | 11.4 | 186 | 1.2 | 1.00 | 13100 | 38 | 32 | 146 | 26500 | 194 | 7020 | 452 | 2.0 | 1170 | <0.3 | 52 | 51 | 248 |
| | 10-20 cm | 25000 | 0.5 | 14.1 | 177 | 1.2 | 0.69 | 18700 | 35 | 34 | 166 | 29000 | 245 | 8000 | 477 | 2.1 | 1600 | <0.3 | 66 | 50 | 268 |
| 2292499 (Back yard) | 0-5 cm | 30600 | <0.4 | 19.3 | 189 | 1.3 | 1.20 | 12400 | 37 | 24 | 109 | 24300 | 123 | 6350 | 484 | 2.1 | 640 | <0.3 | 100 | 58 | 220 |
| | 5-10 cm | 30800 | 0.6 | 20.0 | 189 | 1.3 | 1.24 | 11400 | 36 | 23 | 106 | 24700 | 122 | 5960 | 496 | 2.1 | 624 | <0.3 | 102 | 58 | 207 |
| | 10-20 cm | 33000 | 0.7 | 21.1 | 198 | 1.4 | 1.23 | 13400 | 37 | 23 | 110 | 26500 | 126 | 6380 | 449 | 1.9 | 653 | <0.3 | 117 | 60 | 200 |
| 2292500 (Front yard) | 0-5 cm | 31100 | 0.5 | 9.3 | 185 | 1.3 | 1.04 | 17000 | 39 | 32 | 137 | 24300 | 194 | 8270 | 379 | 2.1 | 1060 | <0.3 | 62 | 58 | 238 |
| | 5-10 cm | 32300 | 0.5 | 10.5 | 199 | 1.3 | 1.43 | 12500 | 40 | 33 | 143 | 24100 | 210 | 7790 | 371 | 2.0 | 1060 | <0.3 | 59 | 59 | 245 |
| | 10-20 cm | 33000 | 0.5 | 11.2 | 189 | 1.3 | 0.97 | 12800 | 38 | 30 | 135 | 26400 | 171 | 8170 | 419 | 2.0 | 1220 | <0.3 | 63 | 58 | 214 |
| 2292501 (Back yard) | 0-5 cm | 37700 | <0.4 | 8.4 | 225 | 1.7 | 1.13 | 14300 | 46 | 28 | 109 | 27000 | 124 | 8530 | 359 | 2.2 | 642 | <0.3 | 87 | 68 | 227 |
| | 5-10 cm | 40000 | 0.4 | 8.7 | 243 | 1.7 | 1.29 | 16500 | 46 | 26 | 100 | 29300 | 118 | 9320 | 395 | 2.1 | 515 | <0.3 | 92 | 70 | 207 |
| | 10-20 cm | 34900 | 0.5 | 7.5 | 237 | 1.6 | 0.88 | 21100 | 42 | 23 | 68 | 33200 | 93 | 1070 | 518 | 2.0 | 340 | <0.3 | 89 | 62 | 196 |
| 2292502 (Front yard) | 0-5 cm | 25200 | 0.8 | 17.0 | 177 | 1.3 | 0.81 | 15200 | 36 | 36 | 177 | 28400 | 204 | 7630 | 409 | 2.3 | 1450 | <0.3 | 78 | 51 | 340 |
| | 5-10 cm | 27300 | 0.8 | 19.1 | 204 | 1.4 | 0.80 | 15000 | 38 | 38 | 177 | 31900 | 210 | 8350 | 467 | 2.1 | 1620 | <0.3 | 79 | 54 | 342 |
| | 10-20 cm | 25700 | 0.9 | 26.7 | 190 | 1.3 | 0.75 | 15300 | 35 | 39 | 207 | 31600 | 197 | 8300 | 456 | 2.4 | 1980 | <0.3 | 90 | 51 | 300 |
| 2292503 (Back yard) | 0-5 cm | 19900 | 1.5 | 18.2 | 317 | 1.1 | 1.05 | 24800 | 36 | 35 | 173 | 28300 | 259 | 8080 | 410 | 2.7 | 1390 | 0.40 | 134 | 48 | 492 |
| | 5-10 cm | 23000 | 1.8 | 26.1 | 380 | 1.3 | 1.36 | 24800 | 43 | 40 | 208 | 31700 | 280 | 8240 | 457 | 2.7 | 1630 | 0.40 | 160 | 54 | 575 |
| | 10-20 cm | 23300 | 1.9 | 25.0 | 384 | 1.4 | 1.29 | 26300 | 40 | 36 | 215 | 31600 | 268 | 8030 | 454 | 2.8 | 1480 | <0.3 | 178 | 54 | 540 |
| 2292504 (Back yard) | 0-5 cm | 20700 | 1.7 | 18.3 | 251 | 1.3 | 2.78 | 26600 | 40 | 58 | 269 | 32300 | 330 | 1020 | 576 | 3.1 | 1970 | 0.70 | 114 | 55 | 992 |
| | 5-10 cm | 22400 | 1.6 | 18.6 | 263 | 1.4 | 1.98 | 25500 | 38 | 47 | 237 | 33900 | 236 | 9380 | 540 | 2.8 | 2010 | <0.3 | 128 | 52 | 727 |
| | 10-20 cm | 22800 | 1.7 | 17.7 | 295 | 1.5 | 1.13 | 30800 | 35 | 37 | 279 | 31500 | 213 | 1000 | 497 | 2.5 | 1540 | <0.3 | 153 | 49 | 561 |
| 2292505 (Front yard) | 0-5 cm | 18600 | 0.4 | 12.1 | 197 | 0.9 | 0.95 | 29100 | 28 | 24 | 115 | 23100 | 152 | 9220 | 548 | 2.2 | 801 | 0.40 | 82 | 39 | 343 |
| | 5-10 cm | 19800 | 0.7 | 15.7 | 198 | 1 | 1.10 | 23100 | 30 | 31 | 154 | 26200 | 183 | 9340 | 502 | 2.3 | 1300 | <0.3 | 73 | 44 | 343 |
| | 10-20 cm | 19600 | 1.2 | 14.8 | 194 | 1 | 0.84 | 22600 | 30 | 34 | 241 | 28300 | 289 | 9270 | 552 | 2.1 | 1470 | 0.50 | 74 | 45 | 327 |
| 2292506 (Back yard) | 0-5 cm | 26500 | <0.4 | 8.1 | 195 | 1.3 | 1.42 | 19800 | 35 | 23 | 113 | 25200 | 138 | 8930 | 349 | 5.5 | 683 | <0.3 | 90 | 50 | 296 |
| | 5-10 cm | 22700 | <0.4 | 9.7 | 188 | 1.1 | 0.75 | 44600 | 30 | 21 | 95 | 26200 | 117 | 1910 | 440 | 2.1 | 560 | <0.3 | 131 | 45 | 228 |
| | 10-20 cm | 28600 | <0.4 | 8.1 | 204 | 1.5 | 1.52 | 27500 | 38 | 24 | 103 | 25800 | 113 | 1380 | 396 | 6.4 | 641 | <0.3 | 107 | 52 | 290 |
| 2292507 (Front yard) | 0-5 cm | 18300 | <0.4 | 10.0 | 152 | 1.1 | 1.41 | 23400 | 31 | 32 | 148 | 24900 | 248 | 1030 | 484 | 6.0 | 1120 | <0.3 | 67 | 42 | 330 |
| | 5-10 cm | 21500 | <0.4 | 13.4 | 194 | 1.3 | 1.63 | 23400 | 37 | 39 | 196 | 29200 | 302 | 1070 | 526 | 6.4 | 1640 | <0.3 | 73 | 45 | 369 |
| | 10-20 cm | 21700 | <0.4 | 14.5 | 183 | 1.3 | 1.58 | 23300 | 33 | 37 | 176 | 30300 | 260 | 1000 | 511 | 6.0 | 1700 | <0.3 | 83 | 44 | 350 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|------|-------|------|------|------|------|------|------|-----|----|------|
| 2292508 (Back yard) | 0-5 cm | 25500 | <0.4 | 9.5 | 180 | 1.4 | 1.49 | 14200 | 36 | 25 | 102 | 26500 | 160 | 7600 | 430 | 5.6 | 603 | <0.3 | 59 | 52 | 256 |
| | 5-10 cm | 26800 | <0.4 | 7.2 | 168 | 1.4 | 1.38 | 12300 | 35 | 25 | 93 | 27100 | 122 | 8030 | 432 | 5.3 | 563 | <0.3 | 51 | 53 | 216 |
| | 10-20 cm | 26900 | <0.4 | 9.8 | 178 | 1.5 | 1.48 | 14000 | 36 | 23 | 99 | 26000 | 143 | 7920 | 404 | 5.4 | 608 | <0.3 | 61 | 53 | 226 |
| 2292509 (Front yard) | 0-5 cm | 13200 | <0.4 | 4.3 | 82 | 0.7 | 0.63 | 9870 | 21 | 15 | 51 | 16900 | 94 | 4810 | 392 | 4.6 | 290 | <0.3 | 32 | 31 | 140 |
| | 5-10 cm | 13700 | <0.4 | 5.4 | 99 | 0.7 | 0.62 | 14500 | 20 | 16 | 54 | 17900 | 125 | 5350 | 410 | 5.0 | 352 | 0.80 | 40 | 32 | 150 |
| | 10-20 cm | 15000 | <0.4 | 5.9 | 111 | 0.8 | 0.78 | 12900 | 25 | 22 | 74 | 20900 | 126 | 5830 | 462 | 5.0 | 578 | 0.40 | 44 | 36 | 190 |
| 2292510 (Back yard) | 0-5 cm | 13700 | <0.4 | 6.7 | 149 | 0.7 | 1.00 | 15400 | 23 | 17 | 70 | 15800 | 260 | 6430 | 329 | 5.2 | 429 | <0.3 | 53 | 30 | 276 |
| | 5-10 cm | 14100 | <0.4 | 6.7 | 165 | 0.8 | 1.11 | 17500 | 24 | 18 | 75 | 17500 | 313 | 7060 | 380 | 5.4 | 474 | <0.3 | 61 | 33 | 311 |
| | 10-20 cm | 14200 | <0.4 | 7.9 | 160 | 0.8 | 1.18 | 18200 | 24 | 18 | 86 | 17900 | 320 | 7110 | 360 | 5.8 | 461 | <0.3 | 64 | 32 | 302 |
| 2292511 (Back yard) | 0-5 cm | 16000 | <0.4 | 5.7 | 94 | 0.6 | 0.44 | 12400 | 23 | 16 | 49 | 20100 | 74 | 6480 | 405 | 5.6 | 357 | <0.3 | 47 | 40 | 136 |
| | 5-10 cm | 17500 | <0.4 | 5.3 | 95 | 0.7 | 0.35 | 14800 | 24 | 17 | 48 | 21300 | 63 | 7230 | 455 | 5.6 | 337 | <0.3 | 63 | 44 | 125 |
| | 10-20 cm | 11800 | <0.4 | 4.4 | 61 | 0.4 | 0.29 | 18500 | 20 | 17 | 49 | 20400 | 47 | 7200 | 415 | 5.5 | 421 | 0.30 | 60 | 42 | 141 |
| 2292512 (Front yard) | 0-5 cm | 16500 | <0.4 | 8.9 | 132 | 0.9 | 0.89 | 28400 | 27 | 33 | 174 | 21500 | 214 | 1270 | 472 | 6.1 | 1010 | <0.3 | 91 | 41 | 314 |
| | 5-10 cm | 18500 | <0.4 | 10.5 | 139 | 1 | 0.92 | 29700 | 28 | 36 | 211 | 23200 | 277 | 1300 | 490 | 6.6 | 1120 | <0.3 | 96 | 44 | 416 |
| | 10-20 cm | 22200 | 0.5 | 11.6 | 144 | 1.1 | 0.77 | 24300 | 30 | 33 | 153 | 27000 | 247 | 1050 | 573 | 7.4 | 1090 | <0.3 | 88 | 47 | 297 |
| 2292513 (Back yard) | 0-5 cm | 15300 | 6.8 | 15.3 | 446 | 0.7 | 2.10 | 15100 | 28 | 25 | 1100 | 21500 | 1350 | 5380 | 534 | 6.8 | 847 | <0.3 | 77 | 39 | 1210 |
| | 5-10 cm | 18400 | 2.5 | 25.7 | 284 | 1.3 | 1.84 | 21000 | 34 | 38 | 277 | 30500 | 352 | 6310 | 539 | 8.4 | 1930 | 0.40 | 131 | 43 | 583 |
| | 10-20 cm | 15900 | 1.5 | 15.3 | 187 | 0.7 | 1.13 | 14000 | 27 | 26 | 201 | 22800 | 251 | 5020 | 480 | 6.8 | 990 | <0.3 | 69 | 38 | 370 |
| 2292514 (Front yard) | 0-5 cm | 17400 | 1.0 | 14.4 | 197 | 1.1 | 1.17 | 35400 | 32 | 51 | 281 | 26300 | 290 | 1280 | 686 | 8.0 | 1590 | <0.3 | 130 | 46 | 409 |
| | 5-10 cm | 16100 | 1.0 | 15.2 | 190 | 1.1 | 1.19 | 35000 | 29 | 49 | 323 | 26100 | 302 | 1240 | 753 | 8.2 | 1600 | <0.3 | 173 | 45 | 396 |
| | 10-20 cm | 15000 | 1.2 | 16.3 | 174 | 0.9 | 0.77 | 31800 | 30 | 47 | 255 | 31200 | 269 | 9950 | 769 | 8.3 | 2160 | 0.40 | 110 | 40 | 356 |
| 2292515 (Back yard) | 0-5 cm | 17100 | 3.5 | 17.2 | 511 | 2.2 | 1.43 | 62100 | 32 | 44 | 226 | 34500 | 414 | 1100 | 2030 | 9.7 | 1950 | 0.80 | 151 | 39 | 643 |
| | 5-10 cm | 14600 | 4.5 | 21.3 | 534 | 1.8 | 1.55 | 52900 | 34 | 39 | 222 | 42100 | 587 | 7950 | 3880 | 11.4 | 2050 | 1.20 | 169 | 33 | 685 |
| | 10-20 cm | 14400 | 3.2 | 20.0 | 397 | 1.5 | 1.57 | 45500 | 35 | 28 | 175 | 37200 | 461 | 7260 | 2500 | 10.2 | 1330 | 0.50 | 179 | 32 | 544 |
| 2292516 (Front yard) | 0-5 cm | 19000 | <0.4 | 8.4 | 124 | 0.8 | 0.52 | 15100 | 26 | 22 | 100 | 21400 | 137 | 6390 | 381 | 5.9 | 688 | <0.3 | 55 | 42 | 177 |
| | 5-10 cm | 21400 | <0.4 | 9.5 | 139 | 1 | 0.53 | 15400 | 29 | 26 | 120 | 22700 | 132 | 7020 | 399 | 6.4 | 735 | <0.3 | 55 | 45 | 185 |
| | 10-20 cm | 21300 | <0.4 | 8.6 | 129 | 0.9 | 0.47 | 15500 | 28 | 28 | 132 | 23400 | 116 | 7030 | 440 | 6.9 | 772 | <0.3 | 50 | 46 | 175 |
| 2292517 (Front yard) | 0-5 cm | 26100 | 0.7 | 11.0 | 170 | 1.2 | 0.55 | 14900 | 35 | 43 | 199 | 28900 | 197 | 8410 | 522 | 8.1 | 1090 | <0.3 | 61 | 60 | 545 |
| | 5-10 cm | 29700 | <0.4 | 9.1 | 172 | 1.3 | 0.54 | 9960 | 38 | 32 | 128 | 30900 | 128 | 7980 | 554 | 7.9 | 688 | <0.3 | 47 | 61 | 301 |
| | 10-20 cm | 27800 | 1.4 | 12.0 | 256 | 1.3 | 0.62 | 16700 | 39 | 34 | 152 | 33100 | 363 | 9610 | 571 | 8.8 | 1210 | <0.3 | 62 | 55 | 590 |
| 2292518 (Back yard) | 0-5 cm | 14900 | <0.4 | 5.8 | 90 | 0.6 | 0.61 | 8930 | 20 | 16 | 62 | 16600 | 164 | 4030 | 324 | 5.4 | 380 | <0.3 | 34 | 35 | 173 |
| | 5-10 cm | 15100 | <0.4 | 5.7 | 87 | 0.5 | 0.60 | 7720 | 20 | 16 | 59 | 16000 | 184 | 3510 | 296 | 5.3 | 368 | <0.3 | 30 | 35 | 155 |
| | 10-20 cm | 16900 | <0.4 | 6.8 | 113 | 0.7 | 0.72 | 9260 | 21 | 16 | 61 | 17000 | 162 | 4390 | 302 | 5.4 | 412 | <0.3 | 35 | 36 | 169 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|------|
| 2292519 (Front yard) | 0-5 cm | 21400 | <0.4 | 8.6 | 142 | 0.9 | 0.31 | 19300 | 28 | 35 | 193 | 22200 | 121 | 9310 | 418 | 6.6 | 1270 | <0.3 | 102 | 48 | 189 |
| | 5-10 cm | 23000 | 0.6 | 11.6 | 146 | 1.1 | 0.03 | 25400 | 30 | 60 | 356 | 21900 | 101 | 1100 | 351 | 6.9 | 2690 | <0.3 | 116 | 49 | 161 |
| | 10-20 cm | 23800 | <0.4 | 10.0 | 166 | 1.1 | 0.17 | 23900 | 32 | 39 | 217 | 24000 | 126 | 1030 | 497 | 7.4 | 1420 | <0.3 | 161 | 51 | 193 |
| 2292520 (Back yard) | 0-5 cm | 18500 | <0.4 | 10.0 | 135 | 0.9 | 0.03 | 24800 | 25 | 41 | 254 | 22500 | 94 | 9250 | 397 | 6.4 | 1870 | <0.3 | 100 | 40 | 174 |
| | 5-10 cm | 18600 | <0.4 | 10.2 | 133 | 0.9 | 0.03 | 27100 | 25 | 44 | 274 | 22800 | 90 | 1030 | 383 | 6.7 | 1990 | <0.3 | 111 | 40 | 163 |
| | 10-20 cm | 20800 | <0.4 | 9.3 | 158 | 1 | 0.14 | 33400 | 27 | 31 | 198 | 25400 | 92 | 1070 | 496 | 7.2 | 1260 | <0.3 | 152 | 43 | 188 |
| 2292521 (Front yard) | 0-5 cm | 11600 | 2.3 | 10.2 | 163 | 0.7 | 0.92 | 25100 | 22 | 25 | 141 | 19000 | 370 | 8240 | 444 | 6.0 | 713 | <0.3 | 89 | 29 | 316 |
| | 5-10 cm | 12300 | 1.1 | 12.0 | 174 | 0.7 | 0.93 | 25100 | 23 | 27 | 165 | 19500 | 444 | 7700 | 476 | 6.3 | 843 | <0.3 | 90 | 31 | 316 |
| | 10-20 cm | 11300 | <0.4 | 10.2 | 114 | 0.6 | 0.49 | 25000 | 21 | 33 | 222 | 18400 | 221 | 9660 | 496 | 6.2 | 928 | <0.3 | 72 | 30 | 197 |
| 2292522 (Back yard) | 0-5 cm | 17100 | <0.4 | 6.4 | 115 | 0.9 | 0.50 | 23100 | 23 | 14 | 41 | 21400 | 60 | 8860 | 385 | 6.3 | 202 | <0.3 | 96 | 37 | 130 |
| | 5-10 cm | 29900 | <0.4 | 7.9 | 188 | 1.4 | 0.42 | 29400 | 37 | 21 | 45 | 34600 | 68 | 1250 | 563 | 8.2 | 208 | <0.3 | 144 | 57 | 136 |
| | 10-20 cm | 33100 | <0.4 | 8.2 | 197 | 1.5 | 0.29 | 35700 | 38 | 21 | 45 | 37600 | 73 | 1280 | 609 | 8.7 | 203 | <0.3 | 166 | 58 | 135 |
| 2292523 (Front yard) | 0-5 cm | 19900 | 0.8 | 13.5 | 201 | 1.1 | 1.26 | 16100 | 34 | 44 | 248 | 23400 | 222 | 7220 | 385 | 6.6 | 1430 | <0.3 | 86 | 45 | 358 |
| | 5-10 cm | 25800 | 0.7 | 15.7 | 230 | 1.3 | 1.48 | 16000 | 40 | 51 | 319 | 25000 | 246 | 7650 | 406 | 7.0 | 1590 | <0.3 | 99 | 51 | 365 |
| | 10-20 cm | 24200 | 1.0 | 15.5 | 219 | 1.2 | 1.13 | 14500 | 36 | 36 | 208 | 27100 | 199 | 6780 | 387 | 7.1 | 1600 | <0.3 | 105 | 44 | 305 |
| 2292524 (Back yard) | 0-5 cm | 20200 | 0.9 | 19.9 | 164 | 1.1 | 1.07 | 15300 | 30 | 30 | 170 | 25500 | 160 | 5550 | 379 | 6.5 | 1280 | <0.3 | 147 | 43 | 347 |
| | 5-10 cm | 19200 | 1.1 | 19.1 | 155 | 1.1 | 0.89 | 13800 | 28 | 29 | 158 | 24100 | 148 | 5320 | 347 | 6.0 | 1260 | <0.3 | 135 | 41 | 304 |
| | 10-20 cm | 18700 | 2.4 | 20.5 | 204 | 1.1 | 1.00 | 17200 | 31 | 32 | 212 | 29700 | 228 | 5980 | 367 | 6.8 | 1620 | 0.30 | 153 | 39 | 381 |
| 2292525 (Front yard) | 0-5 cm | 11000 | 1.1 | 11.1 | 173 | 0.8 | 1.29 | 29800 | 27 | 38 | 249 | 21400 | 244 | 1150 | 470 | 5.5 | 1110 | <0.3 | 73 | 33 | 314 |
| | 5-10 cm | 12500 | 1.3 | 16.5 | 203 | 0.9 | 1.86 | 38200 | 33 | 50 | 507 | 23700 | 315 | 1410 | 534 | 6.4 | 1690 | 0.60 | 92 | 34 | 351 |
| | 10-20 cm | 11800 | 1.7 | 15.4 | 347 | 0.9 | 1.70 | 49900 | 31 | 47 | 393 | 24100 | 317 | 1430 | 492 | 6.4 | 1680 | 0.70 | 113 | 31 | 433 |
| 2292526 (Back yard) | 0-5 cm | 15800 | <0.4 | 6.4 | 156 | 0.8 | 0.63 | 14700 | 26 | 15 | 70 | 19300 | 164 | 7020 | 368 | 5.1 | 310 | <0.3 | 61 | 35 | 208 |
| | 5-10 cm | 17200 | <0.4 | 6.7 | 174 | 0.9 | 0.70 | 18700 | 29 | 17 | 74 | 20400 | 192 | 8370 | 384 | 5.0 | 318 | <0.3 | 78 | 37 | 229 |
| | 10-20 cm | 16200 | 0.9 | 7.6 | 212 | 0.9 | 1.10 | 25400 | 33 | 17 | 97 | 22700 | 252 | 1020 | 431 | 5.8 | 365 | <0.3 | 106 | 37 | 306 |
| 2292527 (Front yard) | 0-5 cm | 10600 | 0.7 | 9.8 | 191 | 0.7 | 0.93 | 26800 | 20 | 26 | 153 | 19500 | 328 | 9420 | 337 | 5.9 | 972 | 0.30 | 92 | 32 | 283 |
| | 5-10 cm | 10400 | 0.5 | 9.6 | 184 | 0.8 | 0.91 | 26600 | 19 | 24 | 141 | 18000 | 314 | 8690 | 340 | 5.1 | 816 | <0.3 | 88 | 30 | 267 |
| | 10-20 cm | 13200 | 1.4 | 13.7 | 287 | 0.9 | 1.23 | 36500 | 35 | 30 | 184 | 24300 | 458 | 9620 | 394 | 6.7 | 1260 | 0.50 | 124 | 34 | 379 |
| 2292528 (Back yard) | 0-5 cm | 14200 | 0.9 | 7.2 | 135 | 0.8 | 0.71 | 11800 | 51 | 21 | 94 | 18600 | 174 | 4950 | 307 | 5.3 | 585 | <0.3 | 62 | 32 | 339 |
| | 5-10 cm | 16500 | 0.6 | 7.0 | 134 | 0.9 | 0.64 | 11200 | 34 | 19 | 89 | 17900 | 168 | 4910 | 286 | 5.3 | 538 | <0.3 | 62 | 33 | 247 |
| | 10-20 cm | 17800 | 0.6 | 7.9 | 170 | 1.1 | 1.00 | 11000 | 25 | 17 | 81 | 17700 | 169 | 4700 | 315 | 5.5 | 399 | <0.3 | 82 | 34 | 1750 |
| 2292529 (Front yard) | 0-5 cm | 12700 | <0.4 | 5.5 | 100 | 0.6 | 0.52 | 7030 | 18 | 14 | 55 | 17100 | 156 | 3760 | 361 | 4.7 | 273 | <0.3 | 31 | 29 | 185 |
| | 5-10 cm | 14200 | <0.4 | 5.8 | 109 | 0.6 | 0.57 | 7510 | 28 | 16 | 66 | 18200 | 174 | 4020 | 396 | 5.0 | 349 | <0.3 | 36 | 32 | 193 |
| | 10-20 cm | 13500 | <0.4 | 9.4 | 152 | 0.7 | 0.76 | 12700 | 24 | 25 | 125 | 21900 | 314 | 5570 | 452 | 5.9 | 784 | <0.3 | 88 | 35 | 316 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292530 (Back yard) | 0-5 cm | 13700 | <0.4 | 7.3 | 110 | 0.7 | 0.62 | 8580 | 18 | 13 | 71 | 13400 | 99 | 3230 | 189 | 4.0 | 355 | <0.3 | 53 | 29 | 148 |
| | 5-10 cm | 16700 | <0.4 | 9.9 | 150 | 0.9 | 0.76 | 10000 | 21 | 15 | 83 | 15400 | 139 | 3590 | 226 | 4.9 | 482 | <0.3 | 64 | 34 | 184 |
| | 10-20 cm | 18900 | <0.4 | 13.8 | 170 | 1 | 0.84 | 13000 | 26 | 18 | 102 | 20300 | 177 | 4900 | 289 | 5.1 | 641 | <0.3 | 74 | 39 | 234 |
| 2292531 (Front yard) | 0-5 cm | 18900 | <0.4 | 9.7 | 168 | 1.1 | 0.79 | 15700 | 30 | 28 | 131 | 22800 | 246 | 6640 | 399 | 5.3 | 687 | <0.3 | 66 | 45 | 266 |
| | 0-5 cm | 17700 | <0.4 | 7.9 | 156 | 1 | 0.75 | 16900 | 26 | 27 | 136 | 22200 | 200 | 7000 | 404 | 5.7 | 650 | <0.3 | 66 | 42 | 223 |
| | 0-5 cm | 17300 | 0.7 | 9.8 | 162 | 1.1 | 0.85 | 15900 | 27 | 31 | 163 | 21900 | 246 | 6820 | 376 | 6.2 | 844 | <0.3 | 64 | 42 | 257 |
| 2292532 (Back yard) | 5-10 cm | 21600 | <0.4 | 9.2 | 186 | 1.2 | 0.75 | 15300 | 31 | 29 | 129 | 24600 | 252 | 7020 | 417 | 5.7 | 656 | <0.3 | 67 | 49 | 259 |
| | 5-10 cm | 19900 | 0.5 | 8.5 | 169 | 1.1 | 0.76 | 16600 | 29 | 31 | 145 | 23700 | 210 | 7340 | 452 | 6.4 | 762 | <0.3 | 68 | 46 | 237 |
| | 5-10 cm | 21400 | 0.5 | 9.8 | 181 | 1.3 | 0.76 | 13800 | 31 | 31 | 141 | 23900 | 223 | 6740 | 372 | 6.3 | 720 | <0.3 | 63 | 48 | 247 |
| 2292533 (Front yard) | 10-20 cm | 21500 | <0.4 | 7.9 | 212 | 1.2 | 0.51 | 20000 | 29 | 24 | 82 | 26700 | 257 | 7530 | 426 | 5.9 | 470 | <0.3 | 69 | 47 | 227 |
| | 10-20 cm | 19900 | 0.7 | 8.4 | 205 | 1.2 | 0.82 | 20800 | 29 | 30 | 138 | 23000 | 264 | 7930 | 364 | 5.9 | 772 | <0.3 | 75 | 44 | 245 |
| | 10-20 cm | 21100 | <0.4 | 8.3 | 190 | 1.3 | 0.76 | 13800 | 29 | 29 | 136 | 23300 | 228 | 6700 | 367 | 5.9 | 685 | <0.3 | 63 | 46 | 242 |
| 2292534 (Back yard) | 0-5 cm | 11400 | 2.1 | 20.0 | 263 | 0.9 | 1.59 | 25100 | 27 | 30 | 220 | 24800 | 442 | 5550 | 432 | 6.4 | 1400 | 1.10 | 121 | 37 | 527 |
| | 0-5 cm | 8830 | 2.1 | 14.6 | 194 | 0.7 | 1.07 | 19200 | 21 | 24 | 168 | 19600 | 354 | 4660 | 339 | 5.6 | 1070 | 0.70 | 88 | 30 | 399 |
| | 0-5 cm | 9530 | 2.0 | 16.0 | 205 | 0.8 | 1.38 | 19400 | 26 | 25 | 167 | 21100 | 386 | 4730 | 349 | 6.0 | 1030 | 1.00 | 92 | 31 | 429 |
| 2292535 (Front yard) | 5-10 cm | 11700 | 2.4 | 22.9 | 287 | 0.9 | 1.42 | 24300 | 28 | 32 | 232 | 25800 | 480 | 5300 | 446 | 6.3 | 1420 | 1.30 | 113 | 37 | 573 |
| | 5-10 cm | 10300 | 2.1 | 18.7 | 247 | 0.8 | 1.32 | 21900 | 24 | 26 | 202 | 21200 | 409 | 4630 | 378 | 6.4 | 1170 | 1.10 | 101 | 32 | 475 |
| | 5-10 cm | 11700 | 2.5 | 22.7 | 288 | 0.9 | 1.57 | 24000 | 27 | 31 | 211 | 30200 | 542 | 5360 | 451 | 7.9 | 1320 | 1.60 | 107 | 36 | 540 |
| 2292536 (Back yard) | 10-20 cm | 9630 | 1.8 | 20.0 | 269 | 0.7 | 1.11 | 23600 | 23 | 23 | 189 | 22700 | 406 | 4950 | 361 | 5.6 | 1030 | 1.10 | 109 | 35 | 439 |
| | 10-20 cm | 9490 | 2.0 | 20.0 | 360 | 0.8 | 1.19 | 23500 | 26 | 22 | 190 | 20900 | 637 | 4380 | 376 | 6.2 | 1060 | 1.20 | 111 | 31 | 452 |
| | 10-20 cm | 8990 | 2.2 | 16.8 | 211 | 0.8 | 1.09 | 20100 | 20 | 23 | 157 | 20100 | 343 | 4440 | 347 | 6.0 | 1110 | 0.90 | 92 | 29 | 404 |
| 2292537 (Front yard) | 0-5 cm | 11700 | 0.4 | 10.6 | 132 | 0.8 | 0.65 | 26900 | 20 | 33 | 198 | 18600 | 183 | 9920 | 360 | 5.3 | 1150 | <0.3 | 73 | 29 | 242 |
| | 5-10 cm | 10900 | 0.4 | 11.2 | 129 | 0.8 | 0.58 | 27200 | 21 | 39 | 205 | 20700 | 189 | 9530 | 367 | 5.8 | 1540 | 0.40 | 68 | 30 | 264 |
| | 10-20 cm | 12300 | 0.5 | 14.4 | 170 | 0.9 | 0.69 | 26600 | 22 | 39 | 219 | 21800 | 233 | 9490 | 385 | 6.2 | 1500 | 0.70 | 83 | 31 | 341 |
| 2292538 (Back yard) | 0-5 cm | 11000 | 0.8 | 18.5 | 256 | 0.9 | 1.14 | 21200 | 37 | 24 | 152 | 19200 | 303 | 5970 | 297 | 6.0 | 997 | <0.3 | 102 | 31 | 451 |
| | 5-10 cm | 15500 | 1.6 | 23.5 | 345 | 1.3 | 1.59 | 26000 | 30 | 30 | 201 | 23000 | 444 | 6890 | 365 | 6.6 | 1260 | 0.40 | 142 | 37 | 650 |
| | 10-20 cm | 12000 | 0.9 | 18.9 | 232 | 1 | 1.19 | 24900 | 22 | 22 | 151 | 19000 | 302 | 5990 | 280 | 5.7 | 1020 | 0.30 | 124 | 30 | 502 |
| 2292539 (Front yard) | 0-5 cm | 15400 | 0.4 | 8.4 | 106 | 0.8 | 0.53 | 19900 | 25 | 26 | 157 | 19200 | 135 | 8270 | 357 | 5.6 | 877 | <0.3 | 72 | 33 | 171 |
| | 5-10 cm | 15300 | <0.4 | 8.3 | 99 | 0.8 | 0.40 | 18400 | 23 | 23 | 130 | 19100 | 110 | 7200 | 343 | 5.8 | 812 | <0.3 | 66 | 32 | 150 |
| | 10-20 cm | 15100 | <0.4 | 16.8 | 149 | 1 | 1.68 | 38600 | 33 | 71 | 524 | 26400 | 344 | 1600 | 542 | 5.6 | 2330 | 2.10 | 91 | 37 | 319 |
| 2292540 (Back yard) | 0-5 cm | 18600 | <0.4 | 16.6 | 350 | 1.2 | 2.03 | 24000 | 42 | 33 | 211 | 25900 | 400 | 7320 | 379 | 4.5 | 1420 | 1.10 | 122 | 44 | 566 |
| | 5-10 cm | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| | 10-20 cm | 16000 | <0.4 | 10.8 | 156 | 1 | 1.22 | 24900 | 29 | 32 | 187 | 23200 | 225 | 1030 | 488 | 4.6 | 1010 | <0.3 | 71 | 37 | 311 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292537 (Front yard) | 0-5 cm | 20600 | <0.4 | 12.9 | 185 | 1.2 | 1.40 | 29000 | 31 | 34 | 197 | 27100 | 259 | 1090 | 545 | 4.7 | 1130 | <0.3 | 82 | 43 | 382 |
| | 5-10 cm | 20200 | <0.4 | 13.6 | 195 | 1.2 | 1.40 | 29300 | 32 | 35 | 200 | 27100 | 267 | 1120 | 565 | 4.8 | 1160 | <0.3 | 81 | 42 | 386 |
| | 10-20 cm | 19000 | <0.4 | 16.4 | 181 | 1.1 | 1.47 | 26300 | 31 | 37 | 219 | 27900 | 309 | 9920 | 541 | 4.7 | 1400 | <0.3 | 87 | 41 | 364 |
| 2292538 (Back yard) | 0-5 cm | 20900 | <0.4 | 17.1 | 224 | 1.3 | 2.51 | 20200 | 38 | 54 | 304 | 27700 | 525 | 7850 | 440 | 4.7 | 1770 | 0.90 | 125 | 50 | 603 |
| | 5-10 cm | 22000 | <0.4 | 17.6 | 236 | 1.3 | 2.28 | 16900 | 37 | 42 | 237 | 31000 | 438 | 7050 | 429 | 4.4 | 1770 | 0.50 | 107 | 44 | 527 |
| | 10-20 cm | 20100 | <0.4 | 16.4 | 240 | 1.2 | 1.56 | 22500 | 32 | 26 | 155 | 27600 | 487 | 7470 | 413 | 4.3 | 1020 | <0.3 | 121 | 40 | 363 |
| 2292539 (Front yard) | 0-5 cm | 20700 | <0.4 | 6 | 122 | 1 | 1.00 | 10700 | 29 | 23 | 83 | 26300 | 94 | 6330 | 481 | 5 | 666 | <0.3 | 38 | 45 | 187 |
| | 5-10 cm | 19700 | <0.4 | 5.0 | 112 | 1 | 0.75 | 8140 | 26 | 20 | 67 | 23700 | 79 | 5540 | 467 | 4.7 | 544 | <0.3 | 32 | 42 | 152 |
| | 10-20 cm | 19300 | <0.4 | 3.7 | 101 | 1 | 0.61 | 7260 | 25 | 16 | 48 | 22300 | 56 | 5430 | 437 | 4.4 | 388 | <0.3 | 28 | 40 | 126 |
| 2292540 (Back yard) | 0-5 cm | 20500 | <0.4 | 2.5 | 90 | 0.7 | 0.43 | 3180 | 25 | 9 | 15 | 17400 | 51 | 3310 | 165 | 3.3 | 110 | <0.3 | 27 | 36 | 80 |
| | 5-10 cm | 19700 | <0.4 | 1.1 | 78 | 0.7 | 0.29 | 1920 | 23 | 7 | 4 | 15800 | 31 | 2880 | 137 | 2.8 | 35 | <0.3 | 17 | 34 | 52 |
| | 10-20 cm | 21800 | <0.4 | 3.6 | 110 | 0.8 | 0.60 | 5120 | 28 | 14 | 43 | 19600 | 89 | 3890 | 230 | 4.2 | 282 | <0.3 | 35 | 39 | 129 |
| 2292541 (Front yard) | 0-5 cm | 20000 | <0.4 | 14.5 | 165 | 1 | 1.89 | 24700 | 33 | 82 | 337 | 34800 | 171 | 9600 | 604 | 4.4 | 4240 | 1.45 | 84 | 39 | 398 |
| | 5-10 cm | 23000 | <0.4 | 21.7 | 182 | 1.2 | 2.43 | 20000 | 38 | 115 | 477 | 45500 | 236 | 8730 | 781 | 4.6 | 5720 | 2.25 | 79 | 43 | 435 |
| | 10-20 cm | 22900 | 0.6 | 24.3 | 173 | 1.1 | 2.15 | 18500 | 46 | 100 | 474 | 55200 | 176 | 8520 | 720 | 5.2 | 6630 | 2.45 | 75 | 41 | 518 |
| 2292542 (Back yard) | 0-5 cm | 18600 | <0.4 | 8.8 | 144 | 0.8 | 1.22 | 18700 | 27 | 26 | 137 | 22400 | 190 | 7620 | 503 | 3.7 | 1020 | <0.3 | 58 | 37 | 275 |
| | 5-10 cm | 19400 | <0.4 | 12.5 | 167 | 0.9 | 1.42 | 22600 | 29 | 28 | 175 | 23300 | 272 | 8800 | 469 | 3.7 | 1200 | <0.3 | 66 | 39 | 325 |
| | 10-20 cm | 18600 | 1.4 | 20.3 | 195 | 1 | 1.96 | 19800 | 36 | 64 | 339 | 37600 | 345 | 7310 | 511 | 4.4 | 3480 | 1.27 | 69 | 37 | 486 |
| 2292543 (Front yard) | 0-5 cm | 20500 | <0.4 | 6.2 | 127 | 1 | 0.82 | 17300 | 26 | 36 | 138 | 22600 | 102 | 9910 | 474 | 3.7 | 1440 | <0.3 | 55 | 41 | 179 |
| | 5-10 cm | 21600 | <0.4 | 6.8 | 128 | 1.1 | 0.80 | 18200 | 27 | 32 | 127 | 23400 | 92 | 1030 | 516 | 3.9 | 1240 | <0.3 | 53 | 42 | 164 |
| | 10-20 cm | 24600 | <0.4 | 6.8 | 150 | 1.2 | 0.81 | 24800 | 29 | 33 | 151 | 26100 | 109 | 1320 | 549 | 4.1 | 1410 | <0.3 | 71 | 46 | 179 |
| 2292544 (Back yard) | 0-5 cm | 20300 | <0.4 | 7.5 | 122 | 1 | 0.96 | 8050 | 29 | 35 | 142 | 26100 | 164 | 6060 | 486 | 3.4 | 1340 | <0.3 | 36 | 42 | 268 |
| | 5-10 cm | 22400 | <0.4 | 6.7 | 127 | 1.1 | 0.95 | 11100 | 31 | 35 | 146 | 28100 | 151 | 7810 | 497 | 3.7 | 1350 | <0.3 | 39 | 44 | 258 |
| | 10-20 cm | 20700 | 1.5 | 16.2 | 261 | 1.1 | 1.91 | 15500 | 47 | 61 | 326 | 39600 | 406 | 8040 | 566 | 4.2 | 3520 | 0.92 | 61 | 40 | 673 |
| 2292545 (Front yard) | 0-5 cm | 15900 | <0.4 | 14.0 | 166 | 0.9 | 1.24 | 23800 | 26 | 46 | 203 | 27100 | 219 | 1080 | 517 | 4.3 | 2410 | 0.55 | 166 | 32 | 406 |
| | 5-10 cm | 17700 | <0.4 | 12.7 | 164 | 1 | 1.12 | 22900 | 26 | 40 | 177 | 25600 | 194 | 1130 | 467 | 4.0 | 1910 | <0.3 | 157 | 35 | 346 |
| | 10-20 cm | 17600 | <0.4 | 13.8 | 181 | 1 | 1.20 | 24200 | 28 | 41 | 184 | 26700 | 216 | 1130 | 519 | 4.3 | 2060 | <0.3 | 351 | 35 | 397 |
| 2292546 (Back yard) | 5-10 cm | 19200 | <0.4 | 15.7 | 184 | 1 | 1.35 | 25700 | 30 | 52 | 229 | 30900 | 271 | 1160 | 588 | 4.3 | 2790 | 0.52 | 189 | 38 | 456 |
| | 5-10 cm | 17800 | <0.4 | 17.6 | 183 | 1.1 | 1.39 | 26100 | 30 | 51 | 239 | 29300 | 243 | 1180 | 530 | 4.3 | 2790 | <0.3 | 200 | 35 | 454 |
| | 5-10 cm | 19700 | <0.4 | 13.4 | 178 | 1.1 | 1.21 | 23600 | 29 | 40 | 185 | 28200 | 197 | 1130 | 545 | 4.2 | 2010 | <0.3 | 198 | 39 | 375 |
| 2292547 (Front yard) | 10-20 cm | 14500 | 0.8 | 27.2 | 271 | 0.9 | 2.22 | 22900 | 32 | 86 | 403 | 38000 | 598 | 8280 | 595 | 4.5 | 5370 | 2.71 | 208 | 31 | 901 |
| | 10-20 cm | 14600 | 0.9 | 24.2 | 265 | 0.9 | 2.15 | 26200 | 34 | 83 | 387 | 36600 | 515 | 9570 | 602 | 4.7 | 4700 | 2.26 | 247 | 32 | 793 |
| | 10-20 cm | 15900 | <0.4 | 23.3 | 235 | 1 | 1.81 | 24200 | 31 | 75 | 344 | 34700 | 412 | 8730 | 601 | 4.5 | 4190 | 2.21 | 247 | 33 | 699 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|-----|------|-----|-----|------|------|-----|----|------|
| 2292546 (Back yard) | 0-5 cm | 13600 | <0.4 | 29.2 | 151 | 0.7 | 1.96 | 17200 | 25 | 61 | 310 | 32700 | 190 | 4900 | 517 | 4.0 | 3900 | 2.10 | 91 | 26 | 499 |
| | 0-5 cm | 13500 | 0.5 | 30.4 | 156 | 0.7 | 2.06 | 17700 | 26 | 70 | 352 | 37600 | 208 | 4930 | 582 | 4.1 | 4790 | 2.47 | 94 | 27 | 522 |
| | 0-5 cm | 14100 | 0.5 | 29.8 | 160 | 0.8 | 2.02 | 17900 | 28 | 66 | 336 | 35400 | 252 | 4870 | 547 | 4.4 | 4320 | 2.65 | 96 | 28 | 526 |
| | 5-10 cm | 13600 | <0.4 | 31.8 | 151 | 0.7 | 2.03 | 17700 | 28 | 68 | 333 | 36300 | 196 | 5020 | 542 | 4.2 | 4560 | 2.37 | 88 | 27 | 502 |
| | 5-10 cm | 13100 | <0.4 | 32.8 | 153 | 0.7 | 2.06 | 17000 | 26 | 68 | 346 | 35800 | 198 | 4570 | 547 | 4.3 | 4600 | 2.59 | 100 | 26 | 507 |
| 2292547 (Front yard) | 5-10 cm | 12100 | 0.4 | 30.7 | 145 | 0.6 | 1.92 | 15700 | 24 | 63 | 323 | 32900 | 206 | 4160 | 514 | 3.9 | 4160 | 2.38 | 80 | 24 | 479 |
| | 10-20 cm | 14200 | 0.7 | 37.6 | 170 | 0.8 | 2.31 | 18900 | 29 | 74 | 370 | 39900 | 217 | 4890 | 601 | 4.3 | 5060 | 3.11 | 102 | 27 | 553 |
| | 10-20 cm | 14400 | 0.4 | 45.3 | 188 | 0.8 | 2.65 | 21500 | 30 | 74 | 428 | 37800 | 259 | 4860 | 626 | 4.4 | 4740 | 4.16 | 123 | 28 | 627 |
| | 10-20 cm | 13200 | 1.1 | 43.8 | 186 | 0.8 | 2.56 | 20000 | 32 | 89 | 459 | 42800 | 246 | 4600 | 634 | 4.6 | 6590 | 4.26 | 111 | 26 | 621 |
| | 0-5 cm | 16500 | <0.4 | 21.1 | 146 | 1 | 1.74 | 16800 | 36 | 82 | 379 | 39600 | 239 | 7030 | 550 | 5.1 | 5090 | 4.09 | 58 | 35 | 486 |
| 2292548 (Back yard) | 5-10 cm | 17300 | <0.4 | 24.6 | 141 | 1 | 1.73 | 19600 | 33 | 79 | 372 | 41600 | 182 | 8670 | 577 | 4.5 | 5420 | 3.48 | 56 | 36 | 458 |
| | 10-20 cm | 17300 | <0.4 | 22.8 | 137 | 1 | 1.74 | 19300 | 32 | 81 | 372 | 42800 | 181 | 8570 | 573 | 4.6 | 5530 | 2.86 | 56 | 37 | 454 |
| | 0-5 cm | 13100 | 1.7 | 31.9 | 267 | 1 | 2.68 | 19600 | 36 | 112 | 548 | 47000 | 431 | 5550 | 631 | 4.8 | 7360 | 4.85 | 102 | 32 | 872 |
| | 5-10 cm | 13500 | 1.8 | 41.9 | 301 | 1 | 3.47 | 22300 | 42 | 109 | 645 | 53500 | 437 | 5580 | 719 | 5.3 | 7580 | 4.70 | 111 | 31 | 1090 |
| | 10-20 cm | 11700 | 2.4 | 24.9 | 283 | 0.9 | 2.08 | 20700 | 29 | 54 | 373 | 34500 | 339 | 4800 | 453 | 4.2 | 3730 | 2.97 | 111 | 27 | 727 |
| 2292549 (Front yard) | 0-5 cm | 34500 | <0.4 | 14.1 | 196 | 1.6 | 1.46 | 11300 | 41 | 59 | 292 | 26900 | 94 | 7940 | 343 | 3.9 | 2790 | <0.3 | 74 | 59 | 271 |
| | 5-10 cm | 36700 | <0.4 | 15.2 | 214 | 1.8 | 1.55 | 9480 | 44 | 57 | 295 | 29200 | 100 | 7150 | 361 | 3.8 | 2790 | <0.3 | 72 | 63 | 239 |
| | 10-20 cm | 20700 | <0.4 | 15.4 | 158 | 1 | 1.54 | 17700 | 32 | 63 | 287 | 34400 | 224 | 6200 | 487 | 4.2 | 3530 | 0.73 | 75 | 39 | 364 |
| | 0-5 cm | 16400 | <0.4 | 13.3 | 256 | 1.2 | 1.41 | 18000 | 42 | 39 | 264 | 28800 | 228 | 4620 | 465 | 4.3 | 2030 | <0.3 | 133 | 33 | 503 |
| | 5-10 cm | 19100 | 0.8 | 12.9 | 268 | 1.3 | 1.50 | 16400 | 45 | 43 | 247 | 29200 | 245 | 4750 | 466 | 4.3 | 2190 | <0.3 | 132 | 39 | 502 |
| 2292550 (Back yard) | 10-20 cm | 16100 | 1.0 | 22.5 | 408 | 1.9 | 2.21 | 22300 | 44 | 78 | 485 | 44000 | 429 | 5030 | 564 | 5.3 | 5000 | 2.13 | 232 | 38 | 870 |
| | 0-5 cm | 15500 | <0.4 | 11.0 | 126 | 0.8 | 1.24 | 15600 | 26 | 49 | 202 | 28200 | 138 | 5630 | 458 | 4.0 | 2400 | 1.25 | 78 | 31 | 304 |
| | 5-10 cm | 18700 | <0.4 | 12.2 | 147 | 0.9 | 1.30 | 15800 | 28 | 54 | 267 | 31800 | 152 | 5350 | 454 | 4.1 | 2610 | 1.27 | 92 | 36 | 321 |
| | 10-20 cm | 18100 | <0.4 | 12.4 | 148 | 0.9 | 1.21 | 14800 | 28 | 51 | 237 | 35200 | 135 | 5450 | 466 | 3.9 | 2920 | 0.95 | 88 | 34 | 320 |
| | 0-5 cm | 13600 | <0.4 | 9.0 | 147 | 0.7 | 0.96 | 10600 | 23 | 32 | 145 | 24100 | 144 | 4230 | 464 | 3.5 | 1560 | <0.3 | 39 | 28 | 320 |
| 2292552 (Back yard) | 5-10 cm | 13400 | <0.4 | 8.9 | 133 | 0.7 | 0.90 | 10200 | 24 | 32 | 141 | 23600 | 130 | 4170 | 447 | 3.5 | 1530 | <0.3 | 36 | 28 | 308 |
| | 10-20 cm | 15300 | <0.4 | 13.8 | 187 | 0.8 | 1.48 | 15500 | 32 | 52 | 269 | 32300 | 215 | 5470 | 481 | 4.0 | 2870 | 1.18 | 59 | 31 | 505 |
| | 0-5 cm | 14200 | 3.0 | 14.4 | 140 | 0.8 | 1.68 | 17900 | 28 | 73 | 289 | 30600 | 206 | 5760 | 493 | 4.3 | 3370 | 1.88 | 71 | 32 | 429 |
| | 5-10 cm | 12300 | 4.3 | 24.0 | 153 | 0.8 | 1.89 | 18300 | 26 | 85 | 382 | 36500 | 211 | 5090 | 579 | 4.3 | 4980 | 3.47 | 76 | 27 | 476 |
| | 10-20 cm | 12700 | 7.2 | 35.7 | 176 | 0.9 | 2.36 | 19400 | 28 | 84 | 471 | 40800 | 341 | 5290 | 650 | 4.6 | 5860 | 4.15 | 85 | 25 | 593 |
| 2292554 (Back yard) | 0-5 cm | 14200 | <0.4 | 28.6 | 112 | 0.7 | 1.65 | 10200 | 27 | 86 | 398 | 36800 | 121 | 3480 | 490 | 3.8 | 4940 | 3.74 | 88 | 30 | 341 |
| | 5-10 cm | 15200 | <0.4 | 27.8 | 116 | 0.8 | 1.43 | 9990 | 29 | 60 | 322 | 38200 | 106 | 3540 | 445 | 3.7 | 4180 | 2.58 | 98 | 27 | 327 |
| | 10-20 cm | 14900 | <0.4 | 13.1 | 93 | 0.6 | 0.79 | 7710 | 22 | 27 | 162 | 19600 | 55 | 3470 | 230 | 3.0 | 1650 | <0.3 | 73 | 28 | 155 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292555 (Back yard) | 0-5 cm | 14300 | 1.5 | 21.5 | 255 | 1 | 2.17 | 19900 | 34 | 68 | 408 | 36700 | 362 | 5310 | 526 | 4.2 | 4410 | 2.38 | 124 | 29 | 578 |
| | 5-10 cm | 14600 | 2.8 | 25.4 | 274 | 1.1 | 2.40 | 20100 | 35 | 78 | 462 | 42700 | 336 | 5420 | 575 | 4.3 | 5280 | 4.73 | 137 | 28 | 648 |
| | 10-20 cm | 14500 | 1.2 | 25.3 | 287 | 1.1 | 2.12 | 21200 | 33 | 65 | 420 | 38000 | 800 | 5170 | 522 | 4.2 | 4640 | 2.00 | 151 | 28 | 609 |
| 2292556 (Front yard) | 0-5 cm | 14400 | <0.4 | 6.7 | 97 | 0.7 | 0.66 | 15300 | 19 | 21 | 84 | 17400 | 66 | 7090 | 480 | 3.6 | 720 | <0.3 | 50 | 30 | 130 |
| | 5-10 cm | 17500 | <0.4 | 8.4 | 116 | 0.9 | 0.69 | 12200 | 21 | 24 | 99 | 19300 | 82 | 6580 | 464 | 3.4 | 851 | <0.3 | 46 | 34 | 133 |
| | 10-20 cm | 18100 | <0.4 | 5.6 | 123 | 0.9 | 0.62 | 17100 | 23 | 19 | 70 | 20700 | 150 | 7690 | 483 | 3.7 | 528 | <0.3 | 49 | 35 | 130 |
| 2292557 (Back yard) | 0-5 cm | 10700 | <0.4 | 8.0 | 83 | 0.5 | 0.65 | 16900 | 17 | 23 | 112 | 16800 | 53 | 4040 | 386 | 3.5 | 1040 | <0.3 | 54 | 22 | 141 |
| | 5-10 cm | 12000 | <0.4 | 11.4 | 81 | 0.6 | 0.81 | 8710 | 20 | 27 | 133 | 18400 | 65 | 3470 | 341 | 2.9 | 1270 | <0.3 | 43 | 24 | 156 |
| | 10-20 cm | 11800 | <0.4 | 18.5 | 95 | 0.6 | 1.06 | 8880 | 20 | 34 | 190 | 21200 | 82 | 3170 | 364 | 3.0 | 1680 | 0.43 | 56 | 24 | 210 |
| 2292558 (Front yard) | 0-5 cm | 8810 | <0.4 | 10.6 | 89 | 0.5 | 1.01 | 19000 | 18 | 30 | 133 | 18900 | 110 | 6280 | 392 | 3.6 | 1410 | <0.3 | 63 | 21 | 230 |
| | 0-5 cm | 9650 | <0.4 | 11.0 | 102 | 0.6 | 1.13 | 19000 | 18 | 36 | 162 | 21000 | 134 | 6660 | 441 | 3.8 | 1670 | 0.47 | 57 | 22 | 280 |
| | 0-5 cm | 9070 | <0.4 | 10.5 | 91 | 0.5 | 1.25 | 18400 | 18 | 32 | 143 | 19200 | 119 | 6650 | 415 | 3.9 | 1490 | 0.45 | 51 | 20 | 283 |
| 2292559 (Back yard) | 5-10 cm | 9230 | <0.4 | 13.7 | 98 | 0.6 | 1.31 | 17400 | 20 | 41 | 189 | 22500 | 168 | 6450 | 422 | 3.9 | 2060 | 0.56 | 62 | 21 | 299 |
| | 5-10 cm | 10100 | <0.4 | 14.7 | 107 | 0.6 | 1.30 | 18000 | 19 | 44 | 200 | 24900 | 152 | 6310 | 459 | 3.8 | 2320 | 0.57 | 66 | 23 | 310 |
| | 5-10 cm | 9680 | <0.4 | 13.5 | 100 | 0.6 | 1.26 | 17300 | 19 | 42 | 198 | 23200 | 148 | 6580 | 413 | 4.0 | 2170 | 0.54 | 52 | 22 | 291 |
| 2292560 (Front yard) | 10-20 cm | 8860 | 0.7 | 18.1 | 129 | 0.7 | 1.64 | 21900 | 27 | 53 | 254 | 29900 | 224 | 6470 | 471 | 4.3 | 2680 | 1.48 | 99 | 20 | 370 |
| | 10-20 cm | 8700 | <0.4 | 17.5 | 137 | 0.7 | 1.70 | 22600 | 21 | 61 | 276 | 33100 | 286 | 7080 | 493 | 4.5 | 3440 | 1.53 | 105 | 20 | 377 |
| | 10-20 cm | 10000 | <0.4 | 18.8 | 146 | 0.8 | 1.73 | 23900 | 23 | 57 | 273 | 31600 | 280 | 7750 | 504 | 4.3 | 2810 | 1.54 | 90 | 23 | 396 |
| 2292561 (Front yard) | 0-5 cm | 11800 | <0.4 | 9.5 | 90 | 0.6 | 1.35 | 15200 | 20 | 24 | 113 | 17600 | 118 | 5440 | 289 | 3.5 | 983 | <0.3 | 64 | 26 | 213 |
| | 0-5 cm | 12800 | <0.4 | 7.7 | 107 | 0.7 | 1.33 | 19100 | 21 | 24 | 122 | 17600 | 280 | 7920 | 343 | 3.8 | 878 | <0.3 | 75 | 25 | 239 |
| | 0-5 cm | 12700 | <0.4 | 8.4 | 96 | 0.7 | 1.29 | 17900 | 23 | 23 | 106 | 17400 | 119 | 7220 | 294 | 3.6 | 994 | <0.3 | 68 | 27 | 220 |
| 2292560 (Front yard) | 5-10 cm | 12700 | <0.4 | 14.8 | 95 | 0.6 | 1.37 | 15900 | 23 | 25 | 115 | 18200 | 122 | 5870 | 316 | 3.6 | 948 | <0.3 | 76 | 27 | 208 |
| | 5-10 cm | 12800 | <0.4 | 6.8 | 105 | 0.6 | 1.22 | 21600 | 22 | 22 | 116 | 17600 | 138 | 8960 | 313 | 3.9 | 780 | <0.3 | 86 | 27 | 207 |
| | 5-10 cm | 12500 | <0.4 | 7.0 | 89 | 0.6 | 0.89 | 14100 | 48 | 20 | 142 | 15100 | 88 | 6080 | 263 | 3.5 | 751 | <0.3 | 86 | 28 | 421 |
| 2292560 (Front yard) | 10-20 cm | 11200 | 0.4 | 29.3 | 150 | 0.6 | 3.07 | 12500 | 27 | 54 | 274 | 27400 | 428 | 4410 | 427 | 4.1 | 2610 | 1.60 | 100 | 24 | 429 |
| | 10-20 cm | 13800 | <0.4 | 18.1 | 139 | 0.8 | 1.81 | 15300 | 24 | 40 | 198 | 27900 | 193 | 5700 | 470 | 3.8 | 1970 | <0.3 | 100 | 27 | 348 |
| | 10-20 cm | 12300 | <0.4 | 15.4 | 125 | 0.7 | 1.51 | 15000 | 30 | 39 | 200 | 25400 | 146 | 4620 | 369 | 3.7 | 2060 | <0.3 | 102 | 26 | 438 |
| 2292560 (Front yard) | 0-5 cm | 8900 | <0.4 | 12.0 | 95 | 0.6 | 1.19 | 24800 | 20 | 36 | 159 | 28200 | 192 | 7430 | 505 | 4.7 | 1980 | <0.3 | 61 | 20 | 311 |
| | 5-10 cm | 9490 | 1.4 | 23.6 | 123 | 0.7 | 2.25 | 24900 | 29 | 71 | 333 | 48800 | 316 | 7610 | 753 | 4.8 | 4820 | 2.00 | 69 | 20 | 586 |
| | 10-20 cm | 7420 | <0.4 | 10.8 | 77 | 0.5 | 0.85 | 17700 | 15 | 25 | 153 | 21000 | 133 | 5320 | 377 | 3.2 | 1920 | <0.3 | 56 | 19 | 225 |
| 2292561 (Front yard) | 0-5 cm | 8090 | <0.4 | 9.2 | 96 | 0.5 | 1.80 | 23300 | 29 | 41 | 190 | 29700 | 225 | 9100 | 471 | 3.7 | 2150 | 0.50 | 51 | 22 | 410 |
| | 5-10 cm | 7200 | 1.1 | 17.5 | 103 | 0.6 | 2.06 | 25800 | 38 | 61 | 278 | 48000 | 256 | 8350 | 652 | 4.3 | 3350 | 1.40 | 60 | 20 | 647 |
| | 10-20 cm | 6850 | <0.4 | 17.9 | 93 | 0.6 | 1.82 | 24400 | 30 | 47 | 235 | 38300 | 212 | 7300 | 531 | 3.9 | 3130 | 0.80 | 54 | 17 | 466 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|------|------|-----|-----|------|------|-----|----|-----|
| 2292562 (Back yard) | 0-5 cm | 10400 | 1.3 | 18.5 | 164 | 0.8 | 2.39 | 18900 | 30 | 70 | 334 | 39600 | 364 | 6620 | 545 | 4.2 | 4020 | 2.30 | 64 | 22 | 710 |
| | 5-10 cm | 8670 | 1.2 | 22.0 | 157 | 0.7 | 2.26 | 20700 | 29 | 60 | 335 | 38900 | 319 | 6340 | 529 | 4.1 | 3240 | 2.50 | 62 | 18 | 691 |
| | 10-20 cm | 6620 | 0.8 | 20.3 | 135 | 0.6 | 1.76 | 21500 | 21 | 47 | 249 | 32800 | 290 | 5610 | 439 | 4.0 | 2920 | 1.80 | 64 | 14 | 551 |
| 2292563 (Front yard) | 0-5 cm | 22500 | <0.4 | 10.6 | 152 | 1.2 | 1.58 | 22400 | 45 | 50 | 210 | 25700 | 173 | 1040 | 433 | 5.1 | 1620 | <0.3 | 62 | 50 | 359 |
| | 5-10 cm | 23800 | <0.4 | 12.5 | 157 | 1.2 | 1.60 | 18600 | 48 | 63 | 277 | 29100 | 183 | 8290 | 490 | 4.7 | 2320 | 0.50 | 54 | 50 | 357 |
| | 10-20 cm | 23000 | 0.8 | 31.7 | 207 | 1.3 | 2.60 | 22500 | 45 | 112 | 598 | 41000 | 263 | 8400 | 540 | 4.9 | 7590 | 5.30 | 72 | 42 | 662 |
| 2292564 (Back yard) | 0-5 cm | 23200 | 1.4 | 19.1 | 203 | 1.3 | 2.30 | 17700 | 38 | 43 | 282 | 30200 | 274 | 6800 | 413 | 4.2 | 2030 | 0.50 | 85 | 47 | 578 |
| | 5-10 cm | 25200 | 3.3 | 29.3 | 323 | 1.6 | 2.27 | 19900 | 42 | 50 | 485 | 34600 | 446 | 6530 | 346 | 4.3 | 3210 | 0.70 | 119 | 47 | 635 |
| | 10-20 cm | 25500 | 1.3 | 28.6 | 266 | 1.6 | 2.06 | 21600 | 40 | 41 | 359 | 30200 | 258 | 6560 | 297 | 3.9 | 2780 | 0.70 | 133 | 46 | 512 |
| 2292565 (Front yard) | 0-5 cm | 23900 | <0.4 | 12.7 | 190 | 1.3 | 1.80 | 22800 | 35 | 42 | 437 | 26000 | 244 | 9410 | 392 | 4.2 | 1900 | <0.3 | 86 | 47 | 336 |
| | 5-10 cm | 26500 | <0.4 | 15.0 | 202 | 1.5 | 1.76 | 24700 | 36 | 43 | 244 | 28300 | 226 | 1030 | 410 | 4.1 | 2140 | 0.40 | 99 | 50 | 306 |
| | 10-20 cm | 26100 | <0.4 | 14.5 | 202 | 1.5 | 1.53 | 24300 | 35 | 35 | 215 | 27200 | 203 | 8660 | 372 | 5.0 | 1930 | <0.3 | 115 | 48 | 273 |
| 2292566 (Back yard) | 0-5 cm | 18800 | 7.6 | 19.2 | 405 | 1.5 | 2.17 | 34500 | 40 | 52 | 306 | 28000 | 717 | 1120 | 495 | 4.4 | 2290 | 1.10 | 347 | 41 | 727 |
| | 5-10 cm | 22100 | 13.5 | 25.2 | 470 | 1.7 | 2.17 | 32300 | 45 | 50 | 393 | 33600 | 925 | 9970 | 465 | 4.4 | 2880 | 0.50 | 180 | 41 | 779 |
| | 10-20 cm | 22300 | 13.6 | 27.2 | 530 | 1.6 | 2.44 | 27100 | 68 | 46 | 372 | 32000 | 1100 | 7930 | 440 | 4.9 | 2720 | 0.50 | 173 | 42 | 853 |
| 2292567 (Front yard) | 0-5 cm | 21800 | 1.5 | 7.9 | 155 | 1.2 | 1.03 | 18600 | 33 | 31 | 153 | 24700 | 221 | 8390 | 415 | 3.5 | 1260 | <0.3 | 63 | 44 | 280 |
| | 5-10 cm | 20500 | <0.4 | 7.2 | 146 | 1.1 | 0.99 | 19200 | 29 | 28 | 137 | 24300 | 126 | 8280 | 377 | 3.6 | 1190 | <0.3 | 69 | 40 | 292 |
| | 10-20 cm | 22400 | <0.4 | 8.9 | 158 | 1.2 | 1.04 | 18400 | 32 | 30 | 149 | 26800 | 128 | 8380 | 412 | 3.7 | 1270 | <0.3 | 66 | 43 | 275 |
| 2292568 (Back yard) | 0-5 cm | 23700 | <0.4 | 11.6 | 156 | 1.3 | 1.21 | 21400 | 33 | 40 | 199 | 29200 | 150 | 9600 | 450 | 3.7 | 1920 | <0.3 | 66 | 46 | 301 |
| | 5-10 cm | 20500 | <0.4 | 9.0 | 145 | 1.2 | 1.03 | 20800 | 32 | 31 | 167 | 31900 | 157 | 8390 | 408 | 3.7 | 1980 | <0.3 | 69 | 39 | 263 |
| | 10-20 cm | 21200 | <0.4 | 8.6 | 154 | 1.2 | 1.07 | 19900 | 32 | 34 | 175 | 32500 | 133 | 7870 | 391 | 3.5 | 2150 | <0.3 | 75 | 41 | 294 |
| 2292568 (Back yard) | 0-5 cm | 24100 | <0.4 | 12.9 | 163 | 1.4 | 1.19 | 20700 | 33 | 40 | 229 | 44200 | 138 | 8910 | 404 | 3.9 | 3060 | <0.3 | 74 | 44 | 264 |
| | 5-10 cm | 22000 | <0.4 | 8.6 | 148 | 1.2 | 0.91 | 25100 | 30 | 30 | 152 | 32800 | 103 | 9970 | 427 | 3.7 | 2340 | <0.3 | 80 | 40 | 227 |
| | 10-20 cm | 27600 | <0.4 | 8.2 | 174 | 1.4 | 1.01 | 21700 | 35 | 33 | 173 | 36100 | 121 | 9180 | 445 | 3.6 | 1960 | <0.3 | 68 | 48 | 229 |
| 2292568 (Back yard) | 0-5 cm | 20300 | <0.4 | 9.8 | 217 | 1.2 | 1.47 | 21200 | 35 | 33 | 166 | 25700 | 237 | 7980 | 473 | 4.0 | 1340 | <0.3 | 107 | 41 | 514 |
| | 5-10 cm | 19000 | <0.4 | 8.4 | 203 | 1.2 | 1.41 | 19700 | 34 | 32 | 158 | 25200 | 298 | 7840 | 408 | 3.8 | 1350 | <0.3 | 96 | 40 | 498 |
| | 10-20 cm | 20400 | <0.4 | 8.3 | 208 | 1.2 | 1.47 | 20600 | 35 | 32 | 157 | 25400 | 230 | 8060 | 409 | 3.7 | 1320 | <0.3 | 97 | 41 | 503 |
| 2292568 (Back yard) | 5-10 cm | 19500 | <0.4 | 9.2 | 195 | 1.2 | 1.44 | 22200 | 33 | 33 | 189 | 25100 | 229 | 8300 | 393 | 3.7 | 1440 | <0.3 | 102 | 40 | 489 |
| | 5-10 cm | 20400 | <0.4 | 9.3 | 219 | 1.4 | 1.43 | 20200 | 36 | 35 | 178 | 25700 | 252 | 8050 | 412 | 4.4 | 1410 | <0.3 | 114 | 45 | 551 |
| | 5-10 cm | 20900 | <0.4 | 8.5 | 199 | 1.1 | 1.48 | 21800 | 33 | 32 | 155 | 26800 | 242 | 8110 | 404 | 3.7 | 1420 | <0.3 | 95 | 39 | 463 |
| 2292568 (Back yard) | 10-20 cm | 19800 | 0.6 | 8.6 | 191 | 1.2 | 1.31 | 18300 | 33 | 32 | 165 | 25300 | 223 | 7030 | 370 | 3.6 | 1440 | <0.3 | 89 | 40 | 440 |
| | 10-20 cm | 20600 | 0.9 | 9.7 | 217 | 1.3 | 1.50 | 18100 | 35 | 35 | 178 | 26200 | 280 | 7320 | 391 | 3.7 | 1540 | <0.3 | 104 | 41 | 511 |
| | 10-20 cm | 21900 | <0.4 | 10.4 | 216 | 1.2 | 1.49 | 20900 | 34 | 34 | 182 | 27700 | 272 | 7810 | 391 | 3.7 | 1730 | <0.3 | 96 | 39 | 480 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|-----|------|------|-----|----|-----|
| 2292569 (Front yard) | 0-5 cm | 30700 | <0.4 | 8.4 | 159 | 1.4 | 1.08 | 15500 | 36 | 32 | 141 | 30900 | 173 | 8710 | 437 | 3.5 | 1370 | <0.3 | 71 | 49 | 259 |
| | 5-10 cm | 32700 | <0.4 | 7.5 | 166 | 1.5 | 1.01 | 20600 | 37 | 32 | 137 | 33900 | 152 | 1000 | 449 | 3.6 | 1380 | <0.3 | 82 | 50 | 232 |
| | 10-20 cm | 29600 | <0.4 | 11.0 | 168 | 1.4 | 1.15 | 28800 | 34 | 34 | 172 | 33400 | 172 | 1070 | 461 | 3.6 | 1870 | <0.3 | 98 | 45 | 244 |
| 2292570 (Back yard) | 0-5 cm | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| | 5-10 cm | 21100 | <0.4 | 7.8 | 136 | 1 | 0.91 | 27300 | 26 | 28 | 126 | 28600 | 159 | 9320 | 473 | 4.4 | 1200 | <0.3 | 70 | 36 | 245 |
| | 10-20 cm | 20300 | <0.4 | 9.9 | 145 | 1 | 0.98 | 33300 | 27 | 28 | 141 | 29000 | 168 | 9290 | 411 | 3.8 | 1490 | <0.3 | 79 | 34 | 245 |
| 2292571 (Front yard) | 0-5 cm | 19000 | 0.5 | 14.8 | 222 | 1 | 2.05 | 33400 | 31 | 50 | 242 | 29800 | 334 | 1380 | 449 | 4.1 | 2520 | 8.00 | 127 | 36 | 578 |
| | 5-10 cm | 18900 | 2.3 | 18.9 | 180 | 1 | 2.33 | 44300 | 29 | 55 | 286 | 33900 | 362 | 1750 | 473 | 4.4 | 3120 | 9.00 | 138 | 34 | 565 |
| | 10-20 cm | 25900 | <0.4 | 13.0 | 186 | 1.3 | 1.42 | 44500 | 31 | 31 | 176 | 32600 | 190 | 1530 | 585 | 4.1 | 1660 | <0.3 | 197 | 41 | 341 |
| 2292572 (Front yard) | 0-5 cm | 19900 | <0.4 | 12.6 | 223 | 1.2 | 1.90 | 24700 | 33 | 46 | 247 | 25900 | 342 | 1060 | 484 | 4.3 | 1910 | <0.3 | 70 | 41 | 542 |
| | 5-10 cm | 23600 | <0.4 | 19.6 | 274 | 1.4 | 2.10 | 26200 | 36 | 52 | 294 | 30700 | 341 | 1030 | 488 | 4.3 | 2880 | <0.3 | 125 | 45 | 522 |
| | 10-20 cm | 24200 | <0.4 | 11.5 | 206 | 1.4 | 1.21 | 35500 | 32 | 30 | 185 | 26700 | 222 | 1270 | 468 | 4.2 | 1450 | <0.3 | 87 | 44 | 334 |
| 2292573 (Back yard) | 0-5 cm | 18300 | 7.9 | 7.9 | 123 | 0.9 | 0.99 | 14100 | 27 | 21 | 124 | 20300 | 165 | 6670 | 476 | 3.5 | 563 | <0.3 | 62 | 36 | 246 |
| | 5-10 cm | 17200 | 34.5 | 14.1 | 176 | 1 | 1.80 | 24600 | 29 | 36 | 353 | 26000 | 554 | 9550 | 443 | 4.4 | 1400 | <0.3 | 89 | 36 | 471 |
| | 10-20 cm | 22600 | 91.1 | 27.1 | 326 | 1.4 | 2.59 | 24700 | 41 | 46 | 625 | 31900 | 782 | 9520 | 428 | 4.9 | 2370 | <0.3 | 124 | 43 | 822 |
| 2292574 (Front yard) | 0-5 cm | 26800 | <0.4 | 13.5 | 192 | 1.4 | 1.92 | 15300 | 37 | 49 | 221 | 31600 | 239 | 7950 | 821 | 4.1 | 2080 | <0.3 | 52 | 52 | 397 |
| | 5-10 cm | 30400 | <0.4 | 15.3 | 243 | 1.6 | 1.92 | 15600 | 41 | 51 | 248 | 36300 | 236 | 8160 | 731 | 3.9 | 2450 | <0.3 | 51 | 57 | 400 |
| | 10-20 cm | 25400 | <0.4 | 8.6 | 195 | 1.4 | 1.40 | 24400 | 31 | 26 | 198 | 28800 | 219 | 7540 | 588 | 4.0 | 1180 | <0.3 | 67 | 46 | 443 |
| 2292575 (Front yard) | 0-5 cm | 15600 | <0.4 | 15.3 | 187 | 0.9 | 1.41 | 22900 | 28 | 65 | 273 | 22200 | 505 | 8760 | 478 | 4.4 | 2770 | <0.3 | 53 | 36 | 565 |
| | 5-10 cm | 19400 | <0.4 | 23.8 | 206 | 1.1 | 1.72 | 18100 | 33 | 86 | 617 | 28000 | 428 | 8080 | 494 | 4.2 | 4550 | 1.20 | 49 | 41 | 607 |
| | 10-20 cm | 21800 | <0.4 | 15.7 | 183 | 1.3 | 1.09 | 24300 | 31 | 48 | 245 | 24500 | 302 | 8630 | 498 | 3.9 | 2860 | <0.3 | 62 | 41 | 362 |
| 2292576 (Back yard) | 0-5 cm | 14500 | <0.4 | 18.3 | 177 | 1 | 1.36 | 18000 | 24 | 40 | 220 | 20300 | 270 | 6080 | 382 | 3.8 | 1950 | 0.40 | 66 | 32 | 356 |
| | 5-10 cm | 13500 | <0.4 | 18.5 | 164 | 0.9 | 1.20 | 20700 | 22 | 34 | 192 | 20100 | 239 | 6230 | 355 | 3.8 | 1790 | <0.3 | 69 | 30 | 299 |
| | 10-20 cm | 13000 | <0.4 | 12.9 | 136 | 0.8 | 0.97 | 21600 | 18 | 20 | 116 | 15400 | 196 | 6590 | 293 | 3.7 | 883 | <0.3 | 74 | 28 | 216 |
| 2292577 (Front yard) | 0-5 cm | 20500 | <0.4 | 12.4 | 186 | 1.2 | 1.51 | 19800 | 30 | 54 | 278 | 25800 | 289 | 9100 | 445 | 4.2 | 2490 | <0.3 | 75 | 42 | 365 |
| | 0-5 cm | 18500 | <0.4 | 9.3 | 168 | 1.1 | 1.29 | 19200 | 27 | 48 | 233 | 23600 | 248 | 8840 | 397 | 4.3 | 2160 | <0.3 | 69 | 39 | 316 |
| | 0-5 cm | 20100 | | 12.1 | 194 | 1.2 | 1.50 | 20200 | 31 | 55 | 284 | 25600 | 283 | 9260 | 436 | 4.3 | 2530 | <0.3 | 72 | 43 | 377 |
| 2292578 (Back yard) | 5-10 cm | 20600 | <0.4 | 20.4 | 285 | 1.4 | 2.04 | 29500 | 40 | 74 | 504 | 30300 | 491 | 1100 | 472 | 4.7 | 4870 | 0.60 | 97 | 40 | 588 |
| | 5-10 cm | 19700 | <0.4 | 17.6 | 241 | 1.4 | 1.77 | 28200 | 30 | 63 | 381 | 28000 | 392 | 1070 | 489 | 4.4 | 3780 | <0.3 | 107 | 39 | 481 |
| | 5-10 cm | 21000 | <0.4 | 15.8 | 253 | 1.4 | 1.59 | 27200 | 30 | 56 | 332 | 26700 | 393 | 1010 | 448 | 4.2 | 3020 | <0.3 | 97 | 41 | 441 |
| 2292579 (Front yard) | 10-20 cm | 22600 | 0.6 | 19.0 | 283 | 1.4 | 1.81 | 30900 | 32 | 64 | 446 | 33800 | 456 | 1010 | 481 | 4.5 | 4770 | <0.3 | 102 | 41 | 465 |
| | 10-20 cm | 20800 | <0.4 | 28.0 | 323 | 1.5 | 2.26 | 30200 | 33 | 82 | 531 | 35200 | 485 | 9250 | 502 | 4.6 | 5990 | 1.20 | 114 | 38 | 684 |
| | 10-20 cm | 20600 | <0.4 | 27.4 | 327 | 1.3 | 2.51 | 39000 | 32 | 80 | 589 | 34300 | 570 | 1080 | 524 | 4.7 | 6060 | 1.10 | 117 | 37 | 901 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|----------------------|----------|-------|------|-----|-----|------|-------|-------|-----|-----|-------|-------|------|------|-----|-------|------|------|-----|------|
| 2292578 (Back yard) | 0-5 cm | 20500 | 0.6 | 12.9 | 344 | 1.2 | 1.84 | 19100 | 35 | 43 | 282 | 25900 | 493 | 6840 | 390 | 4.1 | 1910 | <0.3 | 92 | 42 | 683 |
| | 0-5 cm | 17300 | 0.7 | 11.3 | 285 | 1 | 1.69 | 17000 | 39 | 39 | 437 | 23700 | 519 | 6150 | 351 | 4.0 | 1740 | <0.3 | 81 | 37 | 596 |
| | 0-5 cm | 15600 | 0.7 | 12.2 | 244 | 1 | 2.09 | 17400 | 29 | 40 | 238 | 23200 | 384 | 6410 | 351 | 4.1 | 1830 | 0.30 | 73 | 35 | 514 |
| | 5-10 cm | 20000 | 1.7 | 16.5 | 547 | 1.3 | 2.31 | 24800 | 41 | 48 | 441 | 32200 | 1430 | 7750 | 431 | 4.4 | 2660 | <0.3 | 113 | 38 | 960 |
| | 5-10 cm | 18300 | 1.7 | 19.0 | 624 | 1.1 | 2.43 | 25000 | 44 | 50 | 567 | 30600 | 681 | 7370 | 443 | 4.5 | 2690 | <0.3 | 116 | 35 | 1100 |
| | 5-10 cm | 16600 | 1.1 | 16.4 | 532 | 1.1 | 2.15 | 25000 | 39 | 46 | 351 | 27200 | 634 | 8060 | 399 | 4.4 | 2580 | <0.3 | 103 | 33 | 864 |
| 2292579 (Front yard) | 10-20 cm | 15300 | 4.2 | 17.9 | 502 | 1.2 | 1.93 | 25300 | 35 | 36 | 350 | 26900 | 860 | 6150 | 317 | 4.3 | 2360 | <0.3 | 128 | 29 | 869 |
| | 10-20 cm | 14700 | 1.1 | 15.3 | 600 | 1 | 1.84 | 24500 | 33 | 35 | 327 | 25700 | 686 | 6240 | 345 | 4.1 | 2230 | <0.3 | 105 | 29 | 846 |
| | 10-20 cm | 12900 | 1.9 | 20.4 | 430 | 0.9 | 2.27 | 25600 | 37 | 40 | 513 | 25700 | 746 | 6440 | 335 | 4.3 | 2720 | 0.30 | 108 | 28 | 812 |
| | 0-5 cm | 12000 | <0.4 | 1.2 | 50 | 0.6 | 0.32 | 6090 | 19 | 12 | 37 | 17300 | 37 | 4330 | 580 | 2.7 | 139 | <0.3 | 20 | 25 | 69 |
| | 5-10 cm | 12100 | <0.4 | 1.9 | 42 | 0.6 | 0.21 | 5420 | 15 | 10 | 25 | 18100 | 20 | 4070 | 655 | 2.4 | 60 | <0.3 | 18 | 24 | 47 |
| | 10-20 cm | 11300 | <0.4 | 2.1 | 41 | 0.6 | 0.20 | 11800 | 15 | 9 | 27 | 32200 | 20 | 5550 | 1140 | 3.3 | 64 | <0.3 | 24 | 24 | 59 |
| 2292580 (Back yard) | 0-5 cm | 33500 | <0.4 | 15.9 | 254 | 1.1 | 2.48 | 24900 | 37 | 47 | 250 | 45800 | 338 | 7720 | 386 | 4.8 | 3300 | <0.3 | 90 | 37 | 494 |
| | 5-10 cm | 37000 | <0.4 | 20.5 | 287 | 1.2 | 2.20 | 46700 | 39 | 47 | 261 | 49500 | 565 | 7940 | 397 | 4.3 | 3610 | <0.3 | 114 | 39 | 521 |
| | 10-20 cm | 33600 | 0.8 | 21.6 | 289 | 1.1 | 2.12 | 55000 | 39 | 39 | 241 | 45700 | 707 | 8080 | 385 | 4.3 | 3110 | <0.3 | 125 | 34 | 463 |
| | 0-5 cm | 30900 | <0.4 | 21.4 | 130 | 0.8 | 1.32 | 11100 | 24 | 42 | 212 | 40400 | 149 | 5620 | 467 | 3.8 | 3220 | <0.3 | 39 | 33 | 282 |
| 2292582 (Back yard) | 5-10 cm | 32600 | <0.4 | 21.0 | 128 | 0.9 | 1.39 | 11800 | 23 | 40 | 186 | 42900 | 136 | 5820 | 894 | 3.5 | 3250 | <0.3 | 42 | 33 | 256 |
| | 10-20 cm | 38900 | <0.4 | 19.2 | 145 | 1.1 | 1.21 | 45300 | 27 | 38 | 196 | 50200 | 129 | 9790 | 1170 | 4.0 | 3000 | <0.3 | 62 | 38 | 235 |
| | 0-5 cm | 14500 | <0.4 | 13.9 | 90 | 0.6 | 1.09 | 5680 | 20 | 22 | 85 | 32800 | 83 | 2980 | 421 | 3.0 | 755 | <0.3 | 29 | 29 | 211 |
| | 5-10 cm | 14400 | <0.4 | 12.2 | 89 | 0.6 | 1.09 | 5660 | 20 | 21 | 84 | 33600 | 84 | 2970 | 434 | 3.1 | 722 | <0.3 | 29 | 29 | 212 |
| | 10-20 cm | 13900 | <0.4 | 18.9 | 157 | 0.8 | 1.44 | 10700 | 22 | 31 | 149 | 27000 | 151 | 4100 | 718 | 3.5 | 1480 | <0.3 | 54 | 29 | 427 |
| | 0-5 cm | 22500 | <0.4 | 4.5 | 107 | 1 | 0.91 | 9070 | 26 | 33 | 109 | 23200 | 68 | 5260 | 371 | 4.0 | 864 | <0.3 | 40 | 43 | 256 |
| 2292583 (Front yard) | 5-10 cm | 17200 | <0.4 | 4.9 | 98 | 0.9 | 0.78 | 7650 | 24 | 34 | 140 | 22100 | 66 | 4410 | 356 | 3.3 | 1140 | <0.3 | 42 | 39 | 197 |
| | 10-20 cm | 25200 | <0.4 | 7.0 | 130 | 1.1 | 0.88 | 16300 | 28 | 37 | 154 | 28900 | 65 | 8720 | 481 | 3.7 | 1600 | <0.3 | 54 | 46 | 218 |
| | 0-5 cm | 21000 | <0.4 | 7.8 | 154 | 1 | 1.51 | 25000 | 32 | 86 | 287 | 25600 | 120 | 1230 | 500 | 4.1 | 3000 | <0.3 | 61 | 41 | 217 |
| | 5-10 cm | 23600 | <0.4 | 7.9 | 165 | 1.1 | 2.19 | 26600 | 31 | 88 | 305 | 27500 | 107 | 1350 | 528 | 4.1 | 2770 | <0.3 | 53 | 44 | 214 |
| | 10-20 cm | 28000 | <0.4 | 30.5 | 213 | 1.4 | 1.80 | 28800 | 41 | 151 | 653 | 54500 | 150 | 1370 | 670 | 4.9 | 10400 | 1.50 | 60 | 49 | 415 |
| | 0-5 cm | 15700 | <0.4 | 5.7 | 111 | 0.8 | 1.00 | 22700 | 29 | 39 | 191 | 21000 | 100 | 8710 | 347 | 4.5 | 1820 | <0.3 | 81 | 30 | 214 |
| 2292584 (Front yard) | 5-10 cm | 18500 | <0.4 | 7.8 | 128 | 1 | 1.11 | 27200 | 25 | 49 | 236 | 24000 | 113 | 1150 | 400 | 4.2 | 2100 | <0.3 | 88 | 36 | 250 |
| | 10-20 cm | 20900 | <0.4 | 12.8 | 142 | 1 | 1.14 | 35500 | 28 | 64 | 489 | 29600 | 152 | 1750 | 494 | 4.4 | 4030 | <0.3 | 88 | 39 | 283 |
| | 0-5 cm | 38300 | <0.4 | 1.8 | 305 | 1.7 | 1.87 | 36000 | 54 | 47 | 153 | 35900 | 371 | 1470 | 661 | 4.3 | 1240 | <0.3 | 118 | 64 | 416 |
| | 5-10 cm | 40500 | <0.4 | 6.8 | 514 | 1.8 | 3.78 | 37900 | 53 | 109 | 809 | 40100 | 552 | 1630 | 681 | 4.9 | 3470 | <0.3 | 133 | 69 | 931 |
| | 10-20 cm | 41200 | <0.4 | 7.1 | 345 | 1.8 | 1.73 | 51800 | 49 | 82 | 415 | 41400 | 216 | 1980 | 646 | 4.7 | 2950 | <0.3 | 431 | 69 | 415 |
| | 2292587 (Front yard) | 10-20 cm | 41200 | <0.4 | 7.1 | 345 | 1.8 | 1.73 | 51800 | 49 | 82 | 415 | 41400 | 216 | 1980 | 646 | 4.7 | 2950 | <0.3 | 431 | 69 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|------|-------|-------|-----|-----|-------|-------|------|------|-----|------|-------|------|-----|-----|------|
| 2292588 (Back yard) | 0-5 cm | 34000 | <0.4 | 1.4 | 193 | 1.5 | 0.57 | 33900 | 38 | 30 | 103 | 31700 | 98 | 1640 | 576 | 4.3 | 873 | <0.3 | 101 | 57 | 160 |
| | 5-10 cm | 37300 | <0.4 | 2.5 | 205 | 1.6 | 0.54 | 34400 | 39 | 29 | 91 | 34900 | 118 | 1580 | 746 | 4.1 | 675 | <0.3 | 114 | 61 | 195 |
| | 10-20 cm | 45800 | <0.4 | 0.3 | 278 | 2 | 0.75 | 40800 | 67 | 27 | 60 | 40200 | 103 | 1730 | 788 | 4.5 | 373 | <0.3 | 120 | 73 | 146 |
| 2292589 (Front yard) | 0-5 cm | 30100 | <0.4 | 3.0 | 201 | 1.3 | 0.61 | 52500 | 34 | 35 | 96 | 29600 | 104 | 2160 | 574 | 4.5 | 910 | <0.3 | 144 | 52 | 175 |
| | 5-10 cm | 36700 | <0.4 | 0.6 | 202 | 1.6 | 0.43 | 53600 | 39 | 20 | 54 | 33800 | 49 | 2100 | 585 | 4.1 | 201 | <0.3 | 126 | 60 | 156 |
| 2292590 (Back yard) | 10-20 cm | 34200 | <0.4 | 1.3 | 228 | 1.5 | 0.65 | 37900 | 38 | 48 | 129 | 36600 | 97 | 1840 | 806 | 4.1 | 1540 | <0.3 | 102 | 57 | 161 |
| | 0-5 cm | 29800 | <0.4 | 2.0 | 176 | 1.3 | 0.46 | 45500 | 32 | 21 | 69 | 29500 | 55 | 2190 | 516 | 4.4 | 357 | <0.3 | 94 | 50 | 117 |
| | 5-10 cm | 34400 | <0.4 | 1.6 | 192 | 1.5 | 0.75 | 35600 | 38 | 22 | 108 | 31600 | 61 | 1920 | 452 | 4.1 | 380 | <0.3 | 84 | 56 | 111 |
| 2292591 (Front yard) | 10-20 cm | 31900 | <0.4 | 5.0 | 188 | 1.3 | 0.58 | 33000 | 37 | 32 | 134 | 29600 | 116 | 1860 | 487 | 4.1 | 1310 | <0.3 | 75 | 52 | 159 |
| | 0-5 cm | 16600 | <0.4 | 17.8 | 220 | 1 | 2.25 | 27600 | 37 | 222 | 646 | 34300 | 237 | 1340 | 598 | 4.9 | 9760 | 3.90 | 63 | 41 | 747 |
| | 5-10 cm | 29000 | <0.4 | 16.1 | 272 | 1.4 | 1.76 | 35100 | 41 | 136 | 504 | 41100 | 293 | 1520 | 618 | 4.7 | 6640 | 0.30 | 83 | 55 | 580 |
| 2292592 (Back yard) | 10-20 cm* | 19975 | 1.4 | 27.1 | 204 | 1 | 1.55 | 26300 | 35 | 144 | 558 | 47625 | 222 | 1082 | 559 | 2.2 | 11825 | 2.08 | 63 | 48 | 473 |
| | 0-5 cm | 33900 | <0.4 | 11.5 | 353 | 1.6 | 1.28 | 24700 | 44 | 85 | 339 | 44100 | 250 | 1300 | 773 | 4.7 | 4740 | <0.3 | 95 | 60 | 431 |
| | 5-10 cm | 38400 | <0.4 | 13.3 | 319 | 1.9 | 1.24 | 14900 | 47 | 80 | 329 | 43000 | 249 | 1070 | 461 | 4.4 | 5350 | <0.3 | 98 | 67 | 353 |
| 2292593 (Front yard) | 10-20 cm | 47300 | <0.4 | 8.3 | 294 | 2.1 | 0.58 | 17600 | 52 | 49 | 193 | 50800 | 94 | 1440 | 840 | 4.0 | 2610 | <0.3 | 85 | 75 | 194 |
| | 0-5 cm | 26400 | <0.4 | 15.3 | 340 | 1.3 | 2.02 | 18800 | 41 | 144 | 452 | 42400 | 238 | 9330 | 641 | 4.4 | 6430 | 0.80 | 65 | 54 | 539 |
| | 0-5 cm | 26700 | <0.4 | 12.9 | 284 | 1.3 | 1.66 | 23100 | 40 | 159 | 428 | 42600 | 274 | 9990 | 710 | 4.3 | 5860 | 1.00 | 74 | 51 | 514 |
| 2292594 (Back yard) | 0-5 cm | 29700 | <0.4 | 11 | 268 | 1 | 1.34 | 21000 | 41 | 129 | 325 | 40800 | 252 | 1020 | 636 | 4 | 4390 | <0.3 | 72 | 57 | 418 |
| | 5-10 cm | 26900 | <0.4 | 15.5 | 349 | 1.3 | 1.55 | 22600 | 41 | 87 | 393 | 40900 | 231 | 9960 | 603 | 4.8 | 5110 | <0.3 | 84 | 52 | 497 |
| | 5-10 cm | 24700 | <0.4 | 24.1 | 449 | 1.2 | 2.95 | 24800 | 50 | 146 | 722 | 55000 | 420 | 9700 | 716 | 5.3 | 9030 | 2.60 | 82 | 49 | 936 |
| 2292594 (Back yard) | 5-10 cm | 30500 | <0.4 | 14.6 | 370 | 1.4 | 2.34 | 22800 | 47 | 82 | 398 | 42600 | 326 | 1120 | 600 | 4.3 | 4340 | <0.3 | 71 | 57 | 648 |
| | 10-20 cm* | 23800 | 4.5 | 45.2 | 517 | 1.4 | 35.33 | 23313 | 50 | 159 | 890 | 56050 | 771 | 8583 | 712 | 3.0 | 12350 | 4.78 | 105 | 51 | 945 |
| | 10-20 cm | 26400 | <0.4 | 27.2 | 512 | 1.4 | 3.31 | 22700 | 52 | 121 | 553 | 48600 | 553 | 9040 | 624 | 5.3 | 8530 | 2.20 | 102 | 51 | 950 |
| 2292594 (Back yard) | 10-20 cm | 39600 | <0.4 | 5 | 290 | 2 | 1.17 | 29500 | 47 | 38 | 144 | 39500 | 170 | 1360 | 720 | 4 | 1420 | <0.3 | 87 | 66 | 300 |
| | 0-5 cm | 15000 | <0.4 | 23.8 | 452 | 1 | 2.62 | 21500 | 42 | 172 | 640 | 38600 | 603 | 7530 | 542 | 4.8 | 8470 | 6.40 | 93 | 37 | 1020 |
| | 0-5 cm | 15800 | <0.4 | 26.0 | 440 | 1.2 | 2.56 | 21300 | 43 | 163 | 645 | 39700 | 614 | 6790 | 539 | 5.1 | 7940 | 5.00 | 121 | 38 | 1050 |
| 2292594 (Back yard) | 0-5 cm* | 15025 | 1.6 | 30.5 | 323 | 1 | 1.54 | 20350 | 37 | 177 | 632 | 39575 | 427 | 6530 | 590 | 2.5 | 8473 | 5.13 | 98 | 39 | 769 |
| | 5-10 cm* | 15675 | 2.1 | 43.0 | 417 | 1 | 1.73 | 22350 | 40 | 144 | 776 | 47450 | 674 | 7795 | 545 | 2.7 | 10950 | 6.25 | 96 | 37 | 1230 |
| | 5-10 cm | 18000 | <0.4 | 35.6 | 464 | 1.3 | 3.33 | 21300 | 44 | 171 | 823 | 52100 | 750 | 6570 | 561 | 5.2 | 13400 | 5.80 | 127 | 37 | 1160 |
| 2292594 (Back yard) | 5-10 cm* | 18325 | 1.0 | 36.0 | 375 | 1.1 | 1.91 | 19900 | 41 | 139 | 772 | 48800 | 582 | 7550 | 622 | 3.4 | 10650 | 5.61 | 93 | 39 | 981 |
| | 10-20 cm* | 14675 | 1.5 | 29.7 | 329 | 1 | 1.94 | 22925 | 39 | 86 | 526 | 45975 | 549 | 6853 | 498 | 4.1 | 6855 | 3.78 | 107 | 34 | 1075 |
| | 10-20 cm* | 17775 | 1.1 | 26.6 | 342 | 1 | 1.61 | 21975 | 36 | 86 | 629 | 40450 | 512 | 6600 | 466 | 3.3 | 7448 | 3.76 | 112 | 38 | 849 |
| 10-20 cm* | 17950 | 0.9 | 32.9 | 348 | 1.1 | 1.60 | 22125 | 37 | 102 | 605 | 44075 | 546 | 7010 | 532 | 3.5 | 8540 | 4.00 | 115 | 37 | 866 | |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|------|-------|------|------|-----|-----|-------|------|-----|----|------|
| 2292595 (Front yard) | 0-5 cm* | 13200 | 0.4 | 6.3 | 85 | 0.6 | 0.47 | 7518 | 18 | 33 | 103 | 17975 | 78 | 4195 | 417 | 2.1 | 1213 | 0.66 | 31 | 31 | 150 |
| | 5-10 cm | 14900 | <0.4 | 10.4 | 174 | 0.9 | 0.86 | 13700 | 25 | 54 | 233 | 23300 | 199 | 5710 | 435 | 3.8 | 2730 | <0.3 | 64 | 34 | 300 |
| | 10-20 cm | 12500 | <0.4 | 12.0 | 143 | 0.8 | 0.71 | 23000 | 25 | 50 | 262 | 21500 | 167 | 6890 | 353 | 3.9 | 3170 | 0.60 | 72 | 29 | 283 |
| 2292596 (Back yard) | 0-5 cm | 14600 | <0.4 | 2.9 | 93 | 0.8 | 0.24 | 28800 | 18 | 52 | 66 | 16300 | 37 | 1050 | 373 | 3.8 | 550 | <0.3 | 75 | 33 | 135 |
| | 5-10 cm | 15400 | <0.4 | 2.3 | 94 | 0.9 | 0.23 | 30200 | 18 | 37 | 61 | 16700 | 37 | 1130 | 367 | 3.7 | 547 | <0.3 | 84 | 34 | 104 |
| | 10-20 cm | 14100 | <0.4 | 4 | 94 | 1 | 0.24 | 34000 | 19 | 60 | 68 | 16100 | 39 | 1200 | 406 | 4 | 675 | <0.3 | 96 | 34 | 100 |
| 2292597 (Front yard) | 0-5 cm | 19000 | <0.4 | 13.5 | 235 | 1.2 | 1.67 | 19900 | 40 | 63 | 301 | 33100 | 409 | 6720 | 508 | 4.6 | 3460 | 0.60 | 95 | 37 | 539 |
| | 5-10 cm | 19800 | 1.0 | 16.9 | 245 | 1.4 | 1.78 | 21500 | 40 | 64 | 328 | 33900 | 368 | 6860 | 540 | 4.5 | 3590 | 0.70 | 106 | 38 | 530 |
| | 10-20 cm | 16800 | <0.4 | 24.2 | 256 | 1.5 | 2.14 | 22200 | 39 | 85 | 428 | 42000 | 363 | 6220 | 566 | 5.3 | 5940 | 2.43 | 143 | 35 | 587 |
| 2292598 (Back yard) | 0-5 cm | 12300 | 0.8 | 9.7 | 138 | 0.7 | 1.72 | 14300 | 45 | 46 | 180 | 21500 | 210 | 4920 | 303 | 3.9 | 2190 | 0.40 | 60 | 26 | 323 |
| | 5-10 cm | 12900 | 1.7 | 13.6 | 158 | 0.8 | 1.86 | 17700 | 44 | 51 | 207 | 20600 | 364 | 5330 | 326 | 4.1 | 2440 | 0.64 | 67 | 27 | 336 |
| | 10-20 cm | 12500 | 0.7 | 16.3 | 213 | 1.2 | 1.79 | 18800 | 36 | 56 | 257 | 22300 | 289 | 5160 | 335 | 4.4 | 3000 | 0.70 | 145 | 28 | 400 |
| 2292599 (Front yard) | 0-5 cm | 13800 | <0.4 | 8.1 | 87 | 0.6 | 0.99 | 11800 | 21 | 43 | 156 | 22500 | 111 | 5730 | 406 | 3.6 | 2140 | <0.3 | 34 | 28 | 245 |
| | 5-10 cm* | 13850 | 0.4 | 10.6 | 79 | 0.5 | 0.78 | 9158 | 20 | 40 | 151 | 20825 | 93 | 4440 | 367 | 2.3 | 1963 | 0.60 | 28 | 29 | 214 |
| | 10-20 cm | 14600 | <0.4 | 10.9 | 77 | 0.7 | 1.04 | 8890 | 23 | 48 | 212 | 25400 | 98 | 4340 | 403 | 3.5 | 2990 | 0.30 | 29 | 27 | 235 |
| 2292600 (Back yard) | 0-5 cm | 13300 | <0.4 | 7.8 | 75 | 0.5 | 0.96 | 6900 | 25 | 41 | 138 | 17600 | 118 | 3250 | 258 | 3.1 | 1750 | <0.3 | 33 | 27 | 268 |
| | 5-10 cm | 13600 | <0.4 | 3.8 | 48 | 0.5 | 0.56 | 3970 | 16 | 21 | 67 | 15000 | 58 | 2400 | 200 | 2.6 | 837 | 0.30 | 24 | 26 | 129 |
| | 10-20 cm | 14100 | 6.4 | 6.7 | 71 | 0.6 | 1.10 | 4930 | 20 | 36 | 135 | 20800 | 101 | 2770 | 273 | 3.0 | 1540 | <0.3 | 24 | 26 | 205 |
| 2292601 (Front yard) | 0-5 cm | 4580 | <0.4 | 1.3 | 22 | 0.2 | 0.18 | 18000 | 8 | 5 | 8 | 8820 | 8 | 5380 | 240 | 3.2 | 48 | <0.3 | 34 | 16 | 30 |
| | 5-10 cm | 4880 | <0.4 | 2.7 | 19 | 0.3 | 0.18 | 19400 | 9 | 5 | 6 | 10100 | 6 | 5480 | 236 | 3.3 | 38 | <0.3 | 37 | 19 | 23 |
| | 10-20 cm | 32100 | 0.7 | | 134 | 1.2 | 0.18 | 6520 | 40 | 16 | 8 | 27100 | 35 | 8050 | 220 | 3.3 | 38 | <0.3 | 73 | 63 | 74 |
| 2292602 (Back yard) | 0-5 cm | 5970 | <0.4 | 4.1 | 61 | 0.3 | 0.71 | 19100 | 13 | 30 | 99 | 12400 | 74 | 5960 | 286 | 3.6 | 1040 | <0.3 | 60 | 20 | 195 |
| | 5-10 cm | 12900 | 0.7 | 22.5 | 304 | 0.8 | 2.82 | 19100 | 31 | 85 | 486 | 37100 | 334 | 6430 | 465 | 4.5 | 6240 | 4.90 | 81 | 30 | 990 |
| | 10-20 cm | 18600 | 0.7 | 28.3 | 230 | 1.1 | 2.81 | 32000 | 33 | 80 | 2720 | 41000 | 355 | 8820 | 474 | 5.1 | 7410 | 3.78 | 113 | 36 | 1210 |
| 2292603 (Front yard) | 0-5 cm | 24700 | <0.4 | 12.2 | 191 | 1.2 | 1.53 | 16100 | 32 | 58 | 264 | 27700 | 146 | 7860 | 430 | 4.5 | 2860 | 0.69 | 72 | 45 | 310 |
| | 5-10 cm | 26600 | <0.4 | 11.2 | 185 | 1.3 | 1.41 | 13900 | 33 | 50 | 236 | 27300 | 115 | 7570 | 405 | 4.3 | 2560 | <0.3 | 68 | 47 | 260 |
| | 10-20 cm | 18000 | <0.4 | 30.3 | 221 | 1.1 | 2.23 | 15700 | 38 | 101 | 612 | 48500 | 206 | 6740 | 682 | 5.0 | 7920 | 3.90 | 69 | 34 | 546 |
| 2292604 (Back yard) | 0-5 cm | 5630 | <0.4 | 4.1 | 39 | 0.3 | 0.43 | 20000 | 11 | 13 | 39 | 11500 | 43 | 6580 | 249 | 3.7 | 419 | <0.3 | 54 | 21 | 82 |
| | 5-10 cm | 6560 | 0.4 | 9.5 | 95 | 0.5 | 0.96 | 17800 | 14 | 30 | 136 | 14800 | 163 | 5230 | 280 | 4.0 | 1500 | 0.56 | 81 | 20 | 232 |
| | 10-20 cm | 17400 | 6.8 | 41.2 | 533 | 1.8 | 4.31 | 19700 | 49 | 153 | 791 | 60200 | 1800 | 5700 | 722 | 6.2 | 10300 | 5.75 | 190 | 38 | 1350 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|-----|-----|-------|-----|------|------|------|-------|------|-----|----|-----|
| 2292605 (Front yard) | 0-5 cm | 16700 | <0.4 | 20.2 | 232 | 1 | 2.53 | 35500 | 35 | 90 | 491 | 37200 | 389 | 1620 | 622 | 5.7 | 5700 | 2.80 | 124 | 34 | 667 |
| | 0-5 cm | 18100 | <0.4 | 18.1 | 254 | 1.1 | 2.71 | 28400 | 35 | 81 | 444 | 35700 | 327 | 1280 | 599 | 5.4 | 4890 | 2.66 | 114 | 36 | 620 |
| | 0-5 cm | 15500 | <0.4 | 20.9 | 206 | 0.9 | 2.83 | 26300 | 34 | 88 | 502 | 37400 | 351 | 1190 | 593 | 5.2 | 5780 | 3.11 | 95 | 32 | 662 |
| | 5-10 cm | 21500 | <0.4 | 34.1 | 235 | 1.2 | 3.33 | 22700 | 44 | 138 | 739 | 57400 | 372 | 1020 | 799 | 6.7 | 9570 | 4.01 | 89 | 40 | 766 |
| | 5-10 cm | 21200 | <0.4 | 25.5 | 240 | 1.3 | 2.58 | 24600 | 37 | 113 | 610 | 48100 | 313 | 1070 | 718 | 5.3 | 7820 | 2.90 | 91 | 40 | 740 |
| | 5-10 cm | 19300 | <0.4 | 33.2 | 218 | 1.2 | 3.22 | 20800 | 40 | 145 | 739 | 58000 | 376 | 9520 | 818 | 5.4 | 9520 | 4.98 | 85 | 36 | 844 |
| | 10-20 cm | 18000 | <0.4 | 40.8 | 265 | 1.2 | 3.37 | 24900 | 38 | 134 | 888 | 59400 | 392 | 9040 | 836 | 6.0 | 10800 | 5.03 | 90 | 32 | 794 |
| | 10-20 cm | 18000 | <0.4 | 31.9 | 216 | 1.2 | 2.74 | 24300 | 35 | 113 | 716 | 48000 | 306 | 9540 | 719 | 5.3 | 8160 | 3.47 | 89 | 36 | 758 |
| | 10-20 cm | 18100 | <0.4 | 28.0 | 212 | 1.1 | 3.04 | 22700 | 34 | 107 | 654 | 48200 | 333 | 9670 | 725 | 5.3 | 9230 | 3.81 | 94 | 35 | 686 |
| | 0-5 cm | 19000 | <0.4 | 16.7 | 250 | 1.1 | 1.92 | 25700 | 34 | 88 | 391 | 36500 | 284 | 1020 | 1280 | 5.8 | 4230 | 2.20 | 134 | 36 | 519 |
| 2292606 (Back yard) | 0-5 cm | 20000 | 0.5 | 18.8 | 194 | 1.2 | 1.84 | 13700 | 35 | 96 | 392 | 35400 | 196 | 6800 | 680 | 4.7 | 4710 | 2.76 | 91 | 43 | 433 |
| | 0-5 cm | 21400 | 0.8 | 22.3 | 241 | 1.3 | 3.01 | 14700 | 39 | 101 | 447 | 36800 | 269 | 6230 | 702 | 5.0 | 4910 | 3.42 | 114 | 43 | 537 |
| | 5-10 cm | 22300 | 3.1 | 22.0 | 307 | 1.2 | 2.54 | 13500 | 46 | 96 | 465 | 45200 | 408 | 6480 | 671 | 5.1 | 5700 | 2.79 | 82 | 42 | 666 |
| | 5-10 cm | 26500 | 0.5 | 24.5 | 224 | 1.4 | 1.97 | 14300 | 43 | 100 | 504 | 48900 | 220 | 7660 | 750 | 4.8 | 6450 | 1.98 | 78 | 45 | 548 |
| | 5-10 cm | 23100 | 1.2 | 24.8 | 253 | 1.4 | 2.33 | 13700 | 43 | 113 | 554 | 50200 | 241 | 6500 | 964 | 5.1 | 7110 | 2.51 | 103 | 42 | 604 |
| | 10-20 cm | 22400 | 1.9 | 29.0 | 252 | 1.3 | 2.38 | 16400 | 46 | 113 | 559 | 53900 | 320 | 7430 | 766 | 5.4 | 7830 | 3.72 | 87 | 41 | 689 |
| | 10-20 cm | 27700 | 0.6 | 33.4 | 267 | 1.5 | 2.17 | 19600 | 49 | 99 | 541 | 53700 | 252 | 9160 | 847 | 5.1 | 7690 | 3.00 | 99 | 47 | 583 |
| | 10-20 cm | 23300 | 0.4 | 32.1 | 271 | 1.5 | 2.24 | 17500 | 46 | 113 | 567 | 55500 | 309 | 7560 | 836 | 5.6 | 8190 | 3.76 | 120 | 42 | 599 |
| | 0-5 cm | 13500 | <0.4 | 19.0 | 131 | 0.8 | 1.88 | 15100 | 27 | 90 | 339 | 35100 | 185 | 5410 | 628 | 4.6 | 4140 | 2.66 | 60 | 27 | 450 |
| | 5-10 cm | 12600 | 0.6 | 24.7 | 119 | 0.7 | 1.93 | 16000 | 30 | 90 | 378 | 42900 | 88 | 5180 | 715 | 4.5 | 4780 | 2.11 | 56 | 25 | 442 |
| 2292609 (Back yard) | 10-20 cm | 12900 | 0.7 | 20.5 | 102 | 0.7 | 1.73 | 16800 | 25 | 73 | 338 | 35500 | 157 | 5370 | 591 | 4.6 | 4560 | 1.34 | 56 | 26 | 364 |
| | 0-5 cm | 22900 | <0.4 | 2.9 | 125 | 1 | 0.54 | 7170 | 30 | 23 | 68 | 22900 | 58 | 5840 | 415 | 3.4 | 670 | <0.3 | 66 | 41 | 140 |
| | 5-10 cm | 28800 | <0.4 | 1.1 | 143 | 1.2 | 0.43 | 5680 | 33 | 20 | 44 | 26600 | 47 | 6690 | 433 | 3.1 | 392 | <0.3 | 37 | 50 | 106 |
| | 10-20 cm | 36200 | <0.4 | 1.9 | 177 | 1.5 | 0.47 | 6640 | 42 | 23 | 47 | 33700 | 54 | 8330 | 500 | 3.7 | 390 | <0.3 | 52 | 61 | 124 |
| | 0-5 cm | 14800 | <0.4 | 6.0 | 100 | 0.5 | 0.51 | 6390 | 17 | 23 | 69 | 16300 | 73 | 3380 | 241 | 6.3 | 885 | <0.3 | 25 | 25 | 152 |
| | 5-10 cm | 14700 | <0.4 | 5.5 | 94 | 0.4 | 0.44 | 5250 | 17 | 22 | 62 | 14500 | 61 | 3050 | 237 | 6.2 | 708 | <0.3 | 21 | 25 | 123 |
| | 10-20 cm | 16600 | 0.4 | 11.0 | 135 | 0.6 | 0.76 | 8280 | 22 | 36 | 156 | 21800 | 122 | 4630 | 390 | 8.2 | 1490 | <0.3 | 30 | 30 | 217 |
| | 0-5 cm | 16400 | 0.5 | 9.9 | 146 | 0.6 | 0.90 | 8910 | 22 | 30 | 110 | 22700 | 123 | 4920 | 482 | 8.3 | 808 | <0.3 | 33 | 30 | 232 |
| | 5-10 cm | 17700 | <0.4 | 11.0 | 161 | 0.7 | 0.86 | 10100 | 24 | 32 | 109 | 23400 | 129 | 5500 | 491 | 8.8 | 820 | <0.3 | 36 | 32 | 246 |
| | 10-20 cm | 18600 | 1.2 | 13.2 | 180 | 0.8 | 1.29 | 14900 | 30 | 40 | 153 | 27700 | 190 | 6590 | 487 | 10.3 | 1190 | <0.3 | 51 | 35 | 341 |
| 2292612 (Front yard) | 0-5 cm | 17100 | 0.7 | 12.2 | 141 | 0.8 | 0.75 | 23400 | 26 | 47 | 144 | 27200 | 137 | 1210 | 547 | 10.6 | 1380 | <0.3 | 57 | 35 | 233 |
| | 5-10 cm | 19300 | 0.9 | 12.5 | 150 | 1 | 0.79 | 28600 | 29 | 48 | 150 | 29700 | 137 | 1580 | 626 | 11.8 | 1370 | <0.3 | 66 | 37 | 238 |
| | 10-20 cm | 19300 | 0.8 | 12.0 | 132 | 0.9 | 0.73 | 29100 | 29 | 47 | 144 | 31500 | 101 | 1520 | 678 | 11.7 | 1470 | <0.3 | 60 | 36 | 203 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|-----|------|------|------|----|----|-----|
| 2292613 (Back yard) | 0-5 cm | 20700 | 0.9 | 10.5 | 158 | 1 | 0.98 | 21100 | 30 | 40 | 123 | 27400 | 118 | 1140 | 556 | 11.0 | 1030 | <0.3 | 54 | 39 | 222 |
| | 5-10 cm | 21700 | 0.9 | 9.8 | 159 | 1 | 0.95 | 28600 | 29 | 40 | 115 | 28200 | 112 | 1520 | 593 | 11.6 | 936 | <0.3 | 61 | 40 | 210 |
| | 10-20 cm | 23500 | 0.5 | 9.6 | 150 | 1 | 0.78 | 33200 | 31 | 39 | 100 | 29800 | 79 | 1630 | 630 | 12.1 | 835 | <0.3 | 66 | 42 | 166 |
| 2292614 (Side yard) | 0-5 cm | 17500 | 1.4 | 17.4 | 131 | 0.9 | 0.87 | 19900 | 27 | 56 | 210 | 30600 | 116 | 8560 | 512 | 10.6 | 2270 | 1.00 | 59 | 34 | 218 |
| | 5-10 cm | 21700 | 1.1 | 17.8 | 151 | 1 | 0.77 | 24500 | 33 | 57 | 202 | 32600 | 108 | 1010 | 548 | 11.8 | 2080 | <0.3 | 64 | 41 | 211 |
| | 10-20 cm | 21300 | 1.5 | 17.8 | 154 | 1 | 0.96 | 20600 | 30 | 57 | 210 | 34000 | 121 | 8720 | 599 | 11.6 | 2190 | 0.80 | 67 | 39 | 216 |
| 2292615 (Front yard) | 0-5 cm | 13600 | <0.4 | 7.6 | 95 | 0.6 | 3.13 | 16900 | 25 | 25 | 58 | 18800 | 105 | 7920 | 488 | 8.1 | 430 | <0.3 | 51 | 31 | 140 |
| | 0-5 cm | 13500 | <0.4 | 5.8 | 95 | 0.5 | 0.94 | 19600 | 21 | 24 | 56 | 17200 | 83 | 8780 | 434 | 7.9 | 418 | <0.3 | 50 | 30 | 124 |
| | 0-5 cm | 16500 | 1.1 | 6.9 | 125 | 0.7 | 1.33 | 18300 | 26 | 29 | 67 | 21500 | 97 | 9370 | 501 | 9.2 | 503 | <0.3 | 62 | 35 | 159 |
| | 5-10 cm | 14000 | <0.4 | 5.6 | 98 | 0.6 | 0.78 | 20200 | 21 | 25 | 49 | 19300 | 73 | 8550 | 491 | 8.4 | 330 | <0.3 | 55 | 32 | 119 |
| | 5-10 cm | 10700 | <0.4 | 3.6 | 63 | 0.4 | 0.43 | 18900 | 17 | 19 | 37 | 14500 | 55 | 9010 | 316 | 7.0 | 277 | <0.3 | 45 | 28 | 85 |
| | 5-20 cm | 13500 | <0.4 | 6.3 | 98 | 0.6 | 0.84 | 17500 | 21 | 25 | 60 | 19200 | 83 | 8460 | 471 | 8.2 | 412 | <0.3 | 69 | 31 | 133 |
| | 10-20 cm | 19900 | 0.5 | 7.6 | 139 | 0.9 | 0.75 | 22700 | 28 | 31 | 60 | 25100 | 75 | 9160 | 621 | 10.3 | 406 | <0.3 | 79 | 40 | 136 |
| | 10-20 cm | 17500 | <0.4 | 7.1 | 123 | 0.8 | 0.61 | 22500 | 26 | 28 | 60 | 22200 | 93 | 1040 | 474 | 9.7 | 402 | <0.3 | 78 | 38 | 147 |
| | 10-20 cm | 22900 | 0.5 | 7.1 | 147 | 1 | 0.83 | 19400 | 31 | 33 | 60 | 27200 | 77 | 9950 | 679 | 10.8 | 412 | <0.3 | 64 | 45 | 133 |
| | 0-5 cm | 11000 | <0.4 | 6.5 | 76 | 0.4 | 1.26 | 13700 | 18 | 22 | 59 | 15800 | 103 | 6280 | 467 | 7.0 | 352 | <0.3 | 36 | 26 | 134 |
| 2292616 (Back yard) | 0-5 cm | 13300 | <0.4 | 7.7 | 96 | 0.5 | 0.77 | 12000 | 20 | 25 | 68 | 17900 | 119 | 6300 | 521 | 7.7 | 396 | <0.3 | 40 | 29 | 164 |
| | 0-5 cm | 12600 | 0.4 | 7.6 | 79 | 0.4 | 0.81 | 13400 | 18 | 24 | 67 | 16500 | 111 | 6530 | 481 | 7.2 | 418 | <0.3 | 37 | 27 | 162 |
| | 5-10 cm | 9880 | <0.4 | 6.9 | 78 | 0.4 | 0.88 | 20500 | 15 | 23 | 72 | 15500 | 116 | 7740 | 361 | 7.1 | 446 | <0.3 | 51 | 25 | 161 |
| | 5-10 cm | 11600 | <0.4 | 6.3 | 86 | 0.4 | 0.91 | 15200 | 16 | 22 | 61 | 16400 | 145 | 7250 | 460 | 7.2 | 351 | <0.3 | 41 | 26 | 175 |
| | 5-10 cm | 11100 | 0.4 | 6.6 | 74 | 0.4 | 1.26 | 15600 | 15 | 24 | 68 | 15600 | 123 | 7180 | 394 | 7.1 | 426 | <0.3 | 40 | 25 | 282 |
| | 10-20 cm | 11300 | 0.6 | 7.6 | 98 | 0.4 | 0.87 | 22700 | 18 | 27 | 88 | 18500 | 140 | 9150 | 379 | 8.0 | 582 | <0.3 | 66 | 29 | 192 |
| | 10-20 cm | 12600 | <0.4 | 6.9 | 113 | 0.5 | 1.03 | 19600 | 18 | 26 | 76 | 17400 | 131 | 8690 | 423 | 7.9 | 479 | <0.3 | 71 | 27 | 246 |
| | 10-20 cm | 8070 | <0.4 | 5.2 | 56 | 0.3 | 1.39 | 16800 | 13 | 21 | 54 | 13600 | 95 | 7390 | 271 | 6.5 | 364 | <0.3 | 38 | 23 | 408 |
| | 0-5 cm | 16900 | 1.4 | 16.4 | 177 | 0.9 | 1.43 | 24200 | 31 | 57 | 238 | 29700 | 316 | 1040 | 615 | 11.7 | 1920 | 0.60 | 84 | 34 | 361 |
| | 5-10 cm | 17900 | <0.4 | 15.3 | 158 | 1.1 | 1.72 | 19200 | 36 | 50 | 259 | 33700 | 251 | 8440 | 646 | 4.7 | 2630 | 1.40 | 70 | 36 | 401 |
| 2292618 (Front yard) | 10-20 cm | 19800 | <0.4 | 15.7 | 160 | 1.2 | 1.56 | 19200 | 32 | 46 | 251 | 32900 | 196 | 8930 | 638 | 4.6 | 2430 | 0.90 | 65 | 37 | 316 |
| | 0-5 cm | 13900 | <0.4 | 2.4 | 83 | 0.7 | 0.66 | 26700 | 24 | 13 | 43 | 19100 | 64 | 1010 | 487 | 4.4 | 107 | <0.3 | 60 | 28 | 131 |
| | 5-10 cm | 15700 | <0.4 | 2.3 | 94 | 0.8 | 0.56 | 29500 | 32 | 16 | 42 | 21500 | 67 | 1000 | 567 | 4.7 | 101 | <0.3 | 67 | 31 | 117 |
| 2292619 (Back yard) | 10-20 cm | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd | nd |
| | 0-5 cm | 13500 | <0.4 | 2.7 | 79 | 0.7 | 0.72 | 27200 | 23 | 14 | 47 | 18700 | 69 | 1030 | 519 | 4.3 | 196 | <0.3 | 56 | 27 | 132 |
| | 5-10 cm | 13900 | <0.4 | 4.1 | 82 | 0.7 | 0.69 | 30800 | 21 | 12 | 37 | 19000 | 51 | 1110 | 514 | 4.3 | 97 | <0.3 | 61 | 29 | 112 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|------|-------|-------|----|-----|-------|-------|------|------|------|------|-------|-------|-----|-----|------|
| 2292620 (Front yard) | 0-5 cm | 10100 | <0.4 | 5.8 | 149 | 0.6 | 1.16 | 18400 | 25 | 22 | 81 | 21300 | 254 | 7560 | 582 | 4.2 | 985 | <0.3 | 42 | 25 | 267 |
| | 5-10 cm | 10900 | 0.4 | 4.8 | 167 | 0.6 | 1.07 | 14400 | 26 | 18 | 64 | 21200 | 324 | 6590 | 605 | 3.8 | 591 | <0.3 | 33 | 25 | 233 |
| | 10-20 cm | 10900 | 3.6 | 15.9 | 389 | 0.9 | 2.36 | 24000 | 43 | 64 | 290 | 43100 | 769 | 9070 | 680 | 5.3 | 5940 | 0.80 | 82 | 24 | 591 |
| 2292621 (Back yard) | 0-5 cm | 15900 | <0.4 | 4.1 | 87 | 0.8 | 0.47 | 20000 | 22 | 14 | 45 | 18000 | 82 | 1010 | 362 | 3.9 | 298 | <0.3 | 35 | 32 | 135 |
| | 5-10 cm | 17700 | <0.4 | 2.4 | 96 | 0.8 | 0.44 | 24400 | 23 | 13 | 38 | 19000 | 77 | 1120 | 377 | 4.1 | 228 | <0.3 | 36 | 34 | 127 |
| | 10-20 cm | 20500 | <0.4 | 2.3 | 98 | 1 | 0.39 | 17900 | 25 | 12 | 31 | 21900 | 40 | 8760 | 440 | 3.7 | 184 | <0.3 | 31 | 39 | 100 |
| 2292622 (Front yard) | 0-5 cm | 18400 | 0.7 | 3.8 | 111 | 1 | 0.65 | 19500 | 26 | 19 | 77 | 21900 | 115 | 1060 | 443 | 4.3 | 450 | <0.3 | 42 | 34 | 173 |
| | 5-10 cm | 19400 | <0.4 | 4.3 | 117 | 1 | 0.58 | 21100 | 28 | 18 | 61 | 22200 | 92 | 1160 | 544 | 4.1 | 367 | <0.3 | 40 | 36 | 145 |
| | 0-5 cm | 15400 | <0.4 | 3.4 | 90 | 0.8 | 0.58 | 15400 | 22 | 16 | 53 | 18300 | 97 | 7800 | 349 | 3.8 | 341 | <0.3 | 33 | 31 | 163 |
| 2292623 (Back yard) | 5-10 cm | 15400 | <0.4 | 4.4 | 96 | 0.8 | 0.66 | 16700 | 22 | 16 | 55 | 18400 | 122 | 7960 | 348 | 3.8 | 381 | | 35 | 32 | 186 |
| | 10-20 cm | 9150 | <0.4 | 2.5 | 55 | 0.5 | 0.39 | 22900 | 14 | 10 | 31 | 12700 | 96 | 7340 | 266 | 3.8 | 199 | <0.3 | 35 | 22 | 119 |
| | 0-5 cm | 23000 | 6.1 | 22.0 | 208 | 1.3 | 2.13 | 27600 | 37 | 70 | 383 | 41400 | 332 | 9140 | 687 | 5.2 | 4100 | 2.40 | 85 | 40 | 427 |
| 2292624 (Front yard) | 5-10 cm | 25200 | 5.8 | 22.9 | 220 | 1.4 | 2.01 | 30000 | 34 | 61 | 347 | 41900 | 286 | 9260 | 680 | 4.8 | 4010 | 2.30 | 89 | 42 | 377 |
| | 10-20 cm | 21900 | 6.0 | 19.9 | 213 | 1.3 | 1.86 | 32800 | 28 | 53 | 334 | 37800 | 279 | 8220 | 651 | 4.9 | 3800 | 2.10 | 102 | 37 | 359 |
| | 0-5 cm | 29100 | 5.1 | 18.6 | 234 | 1.3 | 2.18 | 26400 | 38 | 41 | 190 | 34700 | 289 | 1230 | 626 | 4.8 | 1750 | <0.3 | 133 | 49 | 330 |
| 2292625 (Back yard) | 5-10 cm | 31000 | 5.6 | 17.1 | 230 | 1.3 | 1.35 | 29600 | 39 | 38 | 221 | 35900 | 302 | 1360 | 687 | 4.7 | 1580 | <0.3 | 146 | 51 | 287 |
| | 10-20 cm | 32700 | 6.2 | 12.0 | 249 | 1.5 | 1.48 | 29500 | 39 | 44 | 197 | 37000 | 212 | 1320 | 617 | 5.0 | 1730 | <0.3 | 160 | 53 | 299 |
| | 0-5 cm | 21600 | 5.2 | 12.9 | 174 | 1 | 1.16 | 17700 | 29 | 37 | 162 | 26400 | 197 | 8470 | 403 | 4.1 | 1610 | 0.40 | 77 | 38 | 222 |
| 2292626 (Side yard) | 5-10 cm | 27300 | 5.5 | 14.9 | 213 | 1.2 | 1.36 | 21400 | 35 | 47 | 203 | 33500 | 254 | 1020 | 488 | 4.7 | 2090 | 0.40 | 95 | 46 | 273 |
| | 10-20 cm | 24700 | 5.5 | 20.6 | 218 | 1.2 | 1.60 | 24200 | 34 | 48 | 218 | 31100 | 290 | 1000 | 440 | 4.5 | 2190 | 0.90 | 126 | 43 | 299 |
| | 0-5 cm | 21600 | 5.6 | 15.9 | 189 | 1 | 1.44 | 20500 | 33 | 76 | 296 | 32300 | 263 | 9080 | 470 | 4.8 | 2850 | 1.10 | 82 | 39 | 332 |
| 2292627 (Front yard) | 5-10 cm | 21900 | 5.5 | 20.5 | 172 | 1.1 | 1.51 | 19400 | 30 | 62 | 275 | 31200 | 179 | 7280 | 416 | 4.4 | 2890 | 2.40 | 84 | 39 | 262 |
| | 10-20 cm | 30400 | 5.9 | 18.9 | 205 | 1.4 | 1.60 | 21000 | 38 | 64 | 302 | 40100 | 160 | 8760 | 540 | 4.7 | 3480 | 1.60 | 92 | 52 | 278 |
| | 0-5 cm | 22100 | 4.7 | 13.2 | 178 | 1.1 | 1.30 | 25500 | 35 | 54 | 237 | 31200 | 198 | 1120 | 554 | 4.8 | 2400 | 0.90 | 108 | 42 | 325 |
| 2292628 (Back yard) | 5-10 cm | 31600 | 5.0 | 7.9 | 192 | 1.3 | 0.83 | 15100 | 39 | 36 | 144 | 31600 | 124 | 9300 | 561 | 4.4 | 1450 | <0.3 | 73 | 53 | 238 |
| | 10-20 cm | 22700 | 6.5 | 10.1 | 149 | 1 | 0.85 | 25800 | 36 | 35 | 180 | 29900 | 146 | 1020 | 954 | 5.1 | 1870 | 0.60 | 73 | 38 | 342 |
| | 0-5 cm | 17500 | 4.6 | 28.2 | 200 | 1.1 | 2.47 | 19000 | 35 | 193 | 676 | 43900 | 291 | 7370 | 766 | 5.1 | 7870 | 8.60 | 81 | 38 | 592 |
| 2292629 (Front yard) | 0-5 cm | 13300 | 5.4 | 36.1 | 204 | 0.9 | 2.91 | 16200 | 43 | 209 | 780 | 65800 | 373 | 5960 | 865 | 5.9 | 10600 | 10.00 | 64 | 32 | 794 |
| | 5-10 cm | 12000 | 6.2 | 30.8 | 195 | 0.9 | 2.73 | 16500 | 36 | 181 | 674 | 53300 | 407 | 5810 | 758 | 5.2 | 9460 | 9.90 | 65 | 30 | 733 |
| | 10-20 cm | 16500 | 5.7 | 42.6 | 197 | 1 | 3.03 | 14100 | 37 | 150 | 734 | 55800 | 345 | 5610 | 760 | 4.9 | 9860 | 8.50 | 57 | 31 | 721 |
| 2292629 (Front yard) | 5-10 cm | 17600 | 6.5 | 57.8 | 254 | 1.2 | 4.30 | 17300 | 53 | 262 | 1100 | 83300 | 459 | 6350 | 1050 | 6.4 | 16600 | 19.40 | 71 | 31 | 1150 |
| | 5-10 cm | 15700 | 6.1 | 44.6 | 253 | 1.1 | 3.57 | 15700 | 47 | 218 | 949 | 71000 | 421 | 5770 | 876 | 5.9 | 13100 | 14.20 | 66 | 32 | 934 |
| | 10-20 cm | 19300 | 5.5 | 29.4 | 172 | 1.1 | 2.03 | 15700 | 29 | 75 | 450 | 38300 | 211 | 5670 | 572 | 4.2 | 5720 | 4.30 | 60 | 40 | 399 |
| 10-20 cm | 13600 | 4.5 | 11.0 | 101 | 0.8 | 0.85 | 11200 | 22 | 34 | 182 | 29700 | 92 | 4930 | 353 | 3.4 | 2600 | 0.90 | 37 | 41 | 188 | |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Ca | Cd | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|----------------------|------------|-------|------|------|-----|-----|------|-------|----|----|-----|-------|-----|------|------|-----|------|------|-----|----|-----|
| 2292630 (Back yard) | 10-20 cm | 10700 | 4.3 | 18.2 | 109 | 0.7 | 1.52 | 12200 | 22 | 62 | 304 | 33900 | 185 | 4990 | 441 | 4.0 | 4330 | 3.80 | 39 | 31 | 348 |
| | 0-5 cm | 14800 | 4.5 | 10.1 | 141 | 0.8 | 1.33 | 20900 | 23 | 36 | 163 | 24800 | 156 | 6850 | 457 | 4.2 | 1650 | 0.80 | 63 | 29 | 349 |
| | 0-5 cm | 10300 | 4.5 | 8.2 | 121 | 0.6 | 1.16 | 22400 | 21 | 32 | 129 | 21500 | 188 | 7510 | 334 | 4.0 | 1410 | 0.80 | 59 | 24 | 322 |
| | 0-5 cm | 13300 | 6.0 | 10.9 | 164 | 0.8 | 1.66 | 22300 | 25 | 39 | 172 | 23200 | 244 | 7870 | 401 | 4.3 | 1580 | 1.00 | 75 | 27 | 447 |
| | 5-10 cm | 15900 | 6.0 | 17.1 | 264 | 1 | 1.92 | 24900 | 28 | 44 | 257 | 31900 | 351 | 7540 | 443 | 4.6 | 2750 | 2.70 | 87 | 30 | 615 |
| 2292631 (Front yard) | 5-10 cm | 15700 | 7.5 | 22.4 | 295 | 1.1 | 2.78 | 27700 | 33 | 61 | 402 | 38500 | 448 | 8190 | 533 | 4.8 | 3780 | 2.40 | 117 | 31 | 751 |
| | 5-10 cm | 13600 | 6.1 | 14.8 | 182 | 0.9 | 1.89 | 26200 | 27 | 51 | 246 | 32000 | 298 | 8220 | 435 | 4.0 | 2720 | 1.90 | 79 | 30 | 492 |
| | 10-20 cm | 19600 | 6.1 | 23.1 | 219 | 1.2 | 2.11 | 31200 | 31 | 44 | 274 | 35300 | 252 | 1010 | 526 | 4.7 | 2800 | 1.80 | 101 | 37 | 492 |
| | 10-20 cm | 17400 | 8.3 | 21.9 | 281 | 1.2 | 2.12 | 29400 | 32 | 55 | 337 | 39800 | 612 | 8150 | 545 | 4.8 | 3830 | 1.80 | 126 | 32 | 625 |
| | 10-20 cm | 19300 | 6.6 | 23.7 | 383 | 1.6 | 2.35 | 31800 | 34 | 48 | 358 | 37700 | 498 | 8320 | 548 | 4.8 | 3200 | 1.50 | 165 | 37 | 692 |
| 2292632 (Back yard) | 0-5 cm | 20800 | 4.0 | 5.4 | 88 | 0.7 | 0.52 | 4960 | 23 | 22 | 70 | 21100 | 63 | 3970 | 311 | 3.0 | 914 | <0.3 | 24 | 35 | 123 |
| | 5-10 cm | 20800 | 3.5 | 5.7 | 89 | 0.7 | 0.56 | 5840 | 23 | 22 | 75 | 22000 | 63 | 4280 | 329 | 3.3 | 927 | <0.3 | 23 | 36 | 125 |
| | 10-20 cm | 23100 | 4.4 | 13.0 | 137 | 1 | 0.96 | 12000 | 30 | 36 | 164 | 28800 | 113 | 6120 | 423 | 4.0 | 2120 | 1.10 | 38 | 40 | 197 |
| | 0-5 cm | 37700 | 4.6 | 2.9 | 171 | 1.3 | 0.64 | 8990 | 39 | 21 | 67 | 27200 | 84 | 6940 | 306 | 3.6 | 545 | <0.3 | 51 | 55 | 152 |
| | 5-10 cm | 27800 | <0.4 | 8.7 | 174 | 1.2 | 0.98 | 11900 | 37 | 32 | 118 | 28900 | 125 | 7080 | 379 | 3.8 | 1140 | <0.3 | 55 | 51 | 228 |
| 2292633 (Front yard) | 10-20 cm | 20000 | 5.3 | 17.7 | 164 | 0.9 | 1.47 | 15900 | 30 | 45 | 200 | 32100 | 200 | 6840 | 487 | 4.1 | 2290 | 0.60 | 59 | 37 | 295 |
| | 0-5 cm | 26300 | 4.4 | 8.5 | 187 | 1.2 | 1.12 | 14600 | 33 | 36 | 160 | 28600 | 190 | 6580 | 451 | 4.1 | 1710 | <0.3 | 59 | 45 | 272 |
| | 5-10 cm | 28200 | 5.0 | 10.4 | 225 | 1.3 | 1.26 | 15900 | 35 | 41 | 190 | 32300 | 226 | 7470 | 529 | 4.2 | 2170 | <0.3 | 63 | 47 | 307 |
| | 10-20 cm | 28800 | 5.7 | 11.7 | 220 | 1.3 | 1.23 | 31300 | 34 | 39 | 212 | 35400 | 202 | 1050 | 587 | 4.7 | 2450 | <0.3 | 85 | 47 | 305 |
| | 0-5 cm | 28000 | 4.6 | 8.3 | 182 | 1.2 | 1.24 | 12100 | 35 | 40 | 170 | 30900 | 276 | 6490 | 558 | 4.0 | 1740 | <0.3 | 45 | 48 | 304 |
| 2292634 (Back yard) | 5-10 cm | 27600 | 5.3 | 6.2 | 165 | 1.2 | 0.95 | 10400 | 32 | 33 | 139 | 28500 | 150 | 6570 | 539 | 3.7 | 1450 | <0.3 | 38 | 46 | 224 |
| | 10-20 cm | 30000 | 5.7 | 9.5 | 208 | 1.4 | 1.09 | 23100 | 41 | 40 | 208 | 34400 | 190 | 1050 | 5620 | 5.1 | 2040 | <0.3 | 60 | 53 | 288 |
| | 0-5 cm | 30000 | 5.5 | 8.0 | 180 | 1.3 | 1.14 | 14000 | 35 | 41 | 172 | 34200 | 132 | 7780 | 525 | 4.1 | 1990 | <0.3 | 53 | 50 | 240 |
| | 5-10 cm | 30900 | 5.1 | 8.9 | 187 | 1.3 | 1.06 | 13500 | 35 | 38 | 172 | 34300 | 134 | 7910 | 548 | 4.2 | 2030 | <0.3 | 52 | 51 | 221 |
| | 10-20 cm | 31200 | 5.6 | 11.1 | 212 | 1.4 | 1.12 | 22600 | 39 | 44 | 225 | 38900 | 160 | 9880 | 597 | 4.8 | 2790 | <0.3 | 65 | 51 | 260 |
| 2292635 (Front yard) | 0-5 cm | 19000 | 5.2 | 13.8 | 151 | 0.8 | 1.17 | 23800 | 27 | 45 | 225 | 31400 | 198 | 1080 | 490 | 4.6 | 3030 | 0.80 | 58 | 34 | 321 |
| | 5-10 cm | 17800 | 5.2 | 15.2 | 143 | 0.8 | 1.15 | 27300 | 26 | 46 | 229 | 32600 | 192 | 1160 | 540 | 4.6 | 3140 | 1.10 | 61 | 32 | 302 |
| | 10-20 cm | 17700 | 5 | 17 | 151 | 1 | 1.32 | 35600 | 27 | 51 | 259 | 35000 | 181 | 1410 | 604 | 5 | 3590 | 1 | 68 | 32 | 321 |
| | 0-5 cm | 21600 | 5.1 | 14.5 | 188 | 1 | 1.64 | 16700 | 35 | 63 | 267 | 39100 | 248 | 8270 | 607 | 4.5 | 3830 | 1.30 | 56 | 38 | 418 |
| | 5-10 cm | 20400 | 6.6 | 27.1 | 203 | 1 | 2.16 | 16300 | 37 | 85 | 385 | 49500 | 302 | 7780 | 688 | 4.7 | 6420 | 3.60 | 49 | 34 | 521 |
| 2292638 (Back yard) | 10-20 cm | 20300 | 6.1 | 19.4 | 186 | 1 | 1.58 | 14900 | 31 | 54 | 254 | 35900 | 223 | 7010 | 562 | 4.3 | 3650 | 1.40 | 47 | 37 | 341 |
| | 0-5 cm | 17500 | 5.4 | 12.3 | 175 | 0.9 | 1.14 | 19800 | 31 | 47 | 205 | 35700 | 263 | 8210 | 521 | 4.5 | 2850 | 0.80 | 66 | 36 | 352 |
| | 5-10 cm | 24100 | 8 | 15 | 232 | 1 | 1.22 | 21900 | 36 | 50 | 287 | 39500 | 428 | 9310 | 598 | 5 | 2810 | 0 | 81 | 44 | 374 |
| | 10-20 cm | 24300 | 6.8 | 13.0 | 272 | 1.2 | 1.14 | 21500 | 36 | 43 | 207 | 37600 | 406 | 8510 | 491 | 4.4 | 2630 | 0.40 | 89 | 43 | 404 |

Table A1: Chemical analysis of soils collected in the fall of 2000

| Site / Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|---------------------|------------|-------|------|-----|----|-----|------|------|----|----|----|-------|----|------|-----|-----|-----|------|----|----|-----|
| 2292640 (Back yard) | 0-5 cm | 15300 | <0.4 | 1.7 | 65 | 0.6 | 0.72 | 4990 | 17 | 17 | 51 | 14700 | 53 | 3120 | 226 | 2.7 | 420 | <0.3 | 19 | 30 | 113 |
| | 5-10 cm | 15700 | <0.4 | 3.0 | 63 | 0.6 | 0.55 | 4380 | 16 | 17 | 47 | 14600 | 48 | 3050 | 224 | 2.6 | 429 | <0.3 | 18 | 30 | 99 |
| | 10-20 cm | 17800 | <0.4 | 5.2 | 89 | 0.8 | 0.69 | 7890 | 22 | 25 | 85 | 17900 | 79 | 4710 | 341 | 3.3 | 779 | <0.3 | 28 | 35 | 139 |

Table A2: Results of Chemical Analysis of Trench Soil Samples, Port Colborne, Fall 2000

| Site/Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|--|--------------|-------|-----|------|------|------|-------|--------|------|------|------|--------|-----|-------|------|------|------|------|------|------|------|
| 2292641 Baseball Park, SE corner of Davis & Rodney Sts., near 2 nd base | 30 - 35 cm | 25500 | 1.6 | 8.5 | 222 | 1.26 | 0.025 | 53100 | 31.5 | 29.3 | 182 | 27900 | 76 | 20400 | 455 | 2.3 | 1500 | <0.3 | 246 | 48.9 | 156 |
| | 30 - 35 cm | 19700 | 1.3 | 9.3 | 160 | 0.98 | 0.025 | 55700 | 24.5 | 28.7 | 191 | 24400 | 77 | 22900 | 499 | 2.2 | 1430 | <0.3 | 282 | 40.5 | 154 |
| | 60 - 65 cm | 24600 | 1.3 | 8.7 | 240 | 1.38 | 0.025 | 74000 | 26.6 | 29.3 | 188 | 27000 | 82 | 23900 | 668 | 2.3 | 1740 | <0.3 | 292 | 45.4 | 132 |
| | 60 - 65 cm | 24300 | 2 | 9 | 205 | 1.31 | 0.05 | 67700 | 33.5 | 28.6 | 158 | 29400 | 77 | 22800 | 568 | 2.6 | 1540 | <0.3 | 215 | 48.8 | 137 |
| | 100 - 105 cm | 12100 | 2.5 | 33.1 | 84.7 | 0.4 | 0.025 | 16100 | 24.3 | 88.8 | 524 | 38400 | 127 | 4660 | 377 | 2.5 | 6880 | 2.5 | 68.1 | 30.9 | 341 |
| | 100 - 105 cm | 24100 | 1.6 | 12.5 | 179 | 1.23 | 0.025 | 48100 | 29.9 | 50.5 | 440 | 29600 | 86 | 18300 | 517 | 2.4 | 3020 | <0.3 | 190 | 48.5 | 166 |
| 2292642 Baseball Park, SE corner of Davis and Rodney Sts., centre of outfield | 30 - 35 cm | 22400 | 1.4 | 9.9 | 207 | 1.25 | 0.025 | 70200 | 27.5 | 26.6 | 148 | 26600 | 67 | 29700 | 408 | 2.5 | 1500 | <0.3 | 336 | 48.1 | 128 |
| | 30 - 35 cm | 22500 | 1.1 | 8.2 | 320 | 1.4 | 0.12 | 84500 | 31.8 | 22.8 | 123 | 24200 | 63 | 31200 | 519 | 2.5 | 1290 | <0.3 | 460 | 44 | 107 |
| | 60 - 65 cm | 22700 | 2.1 | 11.2 | 224 | 1.35 | 0.08 | 66200 | 28.2 | 26.8 | 135 | 29800 | 71 | 24600 | 601 | 2.6 | 1430 | <0.3 | 263 | 46.5 | 119 |
| | 60 - 65 cm | 18500 | 0.8 | 4.2 | 94.8 | 0.51 | 0.09 | 6320 | 24.5 | 10.8 | 37.1 | 16200 | 24 | 4440 | 198 | 1.1 | 304 | <0.3 | 52.8 | 39.7 | 63 |
| | 100 - 105 cm | 20500 | 1.6 | 15.8 | 224 | 1.41 | 0.025 | 62600 | 25 | 32 | 207 | 29600 | 99 | 23800 | 574 | 2.6 | 2100 | <0.3 | 226 | 42.5 | 166 |
| | 100 - 105 cm | 10700 | 0.5 | 13.6 | 72.8 | 0.28 | 0.025 | 11100 | 15.7 | 21.8 | 266 | 21400 | 29 | 4700 | 246 | 1.4 | 2210 | <0.3 | 54 | 30.5 | 127 |
| 2292643 North shoulder of Rodney St., between Mitchell & Davis Sts. | 30 - 35 cm | 12000 | 3.8 | 37.4 | 118 | 0.97 | 0.025 | 97600 | 38 | 177 | 749 | 53700 | 183 | 39100 | 690 | 3.5 | 9730 | 4.6 | 171 | 41.2 | 436 |
| | 30 - 35 cm | 9020 | 2.9 | 30.7 | 149 | 0.77 | 0.025 | 106000 | 30 | 176 | 699 | 46900 | 148 | 49200 | 597 | 3.2 | 8900 | 4.8 | 130 | 36.2 | 334 |
| | 60 - 65 cm | 12900 | 7.2 | 43.1 | 309 | 2.1 | 3.34 | 18900 | 30.9 | 24.7 | 80.6 | 16800 | 247 | 4050 | 1920 | 4.6 | 204 | <0.3 | 124 | 75.7 | 3190 |
| | 60 - 65 cm | 27000 | 6.5 | 19 | 525 | 4.21 | 2.3 | 84600 | 21.3 | 23.3 | 51.9 | 137000 | 150 | 10700 | 1400 | 2.7 | 384 | <0.3 | 323 | 73 | 3710 |
| | 100 - 105 cm | 20700 | 1.1 | 6.4 | 116 | 0.61 | 0.3 | 14600 | 25.1 | 10.5 | 48.4 | 17500 | 34 | 4840 | 191 | 1.6 | 374 | <0.3 | 82.2 | 35.8 | 113 |
| | 100 - 105 cm | 23900 | 0.8 | 2.5 | 121 | 0.67 | 0.13 | 5420 | 28.1 | 10.8 | 4.8 | 17100 | 28 | 5500 | 189 | 1 | 66.4 | <0.3 | 39.5 | 42.1 | 81 |
| 2292644 NW corner of vacant lot south of Rodney St. between Welland & Fares Sts. | 30 - 35 cm | 2520 | 0.2 | 6.9 | 18.7 | 0.05 | 0.24 | 27800 | 5.86 | 8.68 | 34.9 | 12500 | 25 | 7180 | 163 | 1.3 | 364 | <0.3 | 41.7 | 14.1 | 81 |
| | 30 - 35 cm | 3170 | 1.3 | 16.2 | 38 | 0.19 | 0.32 | 29800 | 15.6 | 29.8 | 158 | 33700 | 69 | 7340 | 316 | 2.2 | 1650 | 0.5 | 51.5 | 15.6 | 293 |
| | 60 - 65 cm | 2700 | 0.2 | 2.6 | 23.9 | 0.06 | 0.21 | 30600 | 5.14 | 3.77 | 11.7 | 7780 | 18 | 7870 | 156 | 1.2 | 102 | <0.3 | 62.6 | 12.5 | 34 |
| | 60 - 65 cm | 3440 | 1.2 | 12.6 | 32.1 | 0.13 | 0.33 | 30400 | 17 | 24.4 | 115 | 31200 | 58 | 7940 | 333 | 2.4 | 1310 | <0.3 | 46.6 | 22.6 | 218 |
| | 100 - 105 cm | 2720 | 0.2 | 3.2 | 33.9 | 0.19 | 0.4 | 21600 | 6.13 | 4.2 | 9.6 | 6460 | 5 | 1260 | 233 | 3 | 96.9 | <0.3 | 117 | 23.3 | 9 |
| | 100 - 105 cm | 2870 | 0.2 | 4.3 | 47.2 | 0.16 | 0.29 | 25700 | 6.51 | 5.96 | 20.9 | 6930 | 5 | 1430 | 279 | 5.2 | 210 | 2.5 | 145 | 21.6 | 28 |
| 2292645 NE corner of vacant lot south of Rodney St. between Welland & Fares Sts. | 30 - 35 cm | 3340 | 0.2 | 7.5 | 28.8 | 0.28 | 0.36 | 30700 | 6.88 | 6.08 | 47.6 | 14300 | 21 | 7030 | 222 | 5.3 | 289 | <0.3 | 53.2 | 16.2 | 89 |
| | 30 - 35 cm | 3780 | 0.2 | 27.3 | 68.1 | 0.39 | 1.94 | 29100 | 11.7 | 49 | 275 | 41300 | 123 | 6660 | 725 | 6.4 | 3320 | 0.9 | 55.6 | 9.1 | 409 |
| | 60 - 65 cm | 2720 | 0.2 | 3.7 | 16.2 | 0.19 | 0.16 | 30100 | 6.64 | 3.83 | 16.2 | 8740 | 8 | 7590 | 161 | 5.4 | 91.7 | <0.3 | 47.7 | 17.3 | 32 |
| | 60 - 65 cm | 2480 | 0.2 | 2.3 | 12.4 | 0.15 | 0.1 | 14900 | 5.13 | 2.86 | 1.2 | 6100 | 5 | 6250 | 112 | 4.6 | 14.8 | <0.3 | 28.1 | 13.1 | 13 |
| | 100 - 105 cm | 1420 | 0.2 | 5 | 25.7 | 0.15 | 0.26 | 21800 | 4.04 | 5.51 | 17.9 | 6490 | 7 | 2090 | 152 | 4.1 | 185 | <0.3 | 87 | 5.6 | 35 |
| | 100 - 105 cm | 1440 | 0.2 | 3.9 | 23.7 | 0.14 | 0.2 | 22700 | 3.57 | 3.69 | 12.3 | 5710 | 3 | 2100 | 133 | 4 | 123 | 0.5 | 97.8 | 6.27 | 24 |
| 2292647 West trench in park E of Welland St & N of Nickel St. | 30 - 35 cm | 20400 | 0.2 | 7.9 | 153 | 1.15 | 0.99 | 24900 | 39.8 | 24.6 | 107 | 37300 | 138 | 9100 | 623 | 7 | 516 | <0.3 | 75.2 | 38.3 | 289 |
| | 30 - 35 cm | 7960 | 0.2 | 13.6 | 117 | 0.82 | 1.46 | 40900 | 54.1 | 29.7 | 167 | 56300 | 124 | 8780 | 1290 | 9.3 | 975 | <0.3 | 96.9 | 13 | 499 |
| | 60 - 65 cm | 12600 | 9.4 | 17.1 | 307 | 2.49 | 5.88 | 40300 | 122 | 51.9 | 141 | | 479 | 3770 | 4050 | 12.8 | 558 | 1.4 | 157 | 1.28 | 3410 |
| | 60 - 65 cm | 10300 | 8 | 12.5 | 282 | 2.11 | 6.17 | 30500 | 94.2 | 52.8 | 151 | | 520 | 3200 | 3990 | 10.6 | 640 | 0.8 | 126 | 0.74 | 3680 |
| | 100 - 105 cm | 7070 | 0.2 | 14.6 | 121 | 0.86 | 1.18 | 37100 | 12.5 | 13.4 | 124 | 20900 | 97 | 2500 | 343 | 7.2 | 739 | <0.3 | 469 | 21.7 | 173 |
| | 100 - 105 cm | 4980 | 0.2 | 13.1 | 100 | 0.58 | 0.97 | 26100 | 9 | 12.2 | 85.8 | 14500 | 104 | 1780 | 247 | 6.4 | 727 | <0.3 | 302 | 18.3 | 120 |

Table A2: Results of Chemical Analysis of Trench Soil Samples, Port Colborne, Fall 2000

| Site/Location | Soil Depth | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn |
|--|--------------|-------|------|-------------|------|-------------|------|--------|------|------|------|--------|------------|-------|------|------|------------|------|------|------|-------------|
| 2292647 East trench in park west of Welland St. & N of Nickel St. | 30 - 35 cm | 8740 | 10.5 | <u>32</u> | 168 | 1.08 | 3.49 | 53400 | 110 | 47.2 | 134 | 15100 | <u>335</u> | 11500 | 3300 | 10.7 | <u>613</u> | <0.3 | 224 | 34.4 | <u>1870</u> |
| | 30 - 35 cm | 13100 | 0.8 | 9.7 | 48.7 | 0.74 | 0.47 | 122000 | 27.8 | 15.3 | 58.5 | 18100 | 34 | 70400 | 227 | 3.3 | <u>301</u> | <0.3 | 72.8 | 33.3 | 59 |
| | 60 - 65 cm | 10400 | 9.3 | <u>27.6</u> | 198 | <u>1.35</u> | 4.41 | 54100 | 101 | 47.3 | 132 | 147000 | 344 | 12800 | 3610 | 9.3 | <u>578</u> | <0.3 | 199 | 33.7 | <u>1860</u> |
| | 60 - 65 cm | 10400 | 6.7 | 21.3 | 195 | <u>1.38</u> | 2.35 | 50100 | 55.9 | 46.2 | 128 | 129000 | <u>234</u> | 11000 | 2750 | 5.2 | <u>852</u> | <0.3 | 189 | 34.2 | <u>1380</u> |
| 2292648 West berm in park west of Welland St. & N of Nickel St. | 100 - 105 cm | 16600 | 0.7 | 3.6 | 68.5 | 0.49 | 0.28 | 10600 | 18.8 | 10.3 | 16.7 | 17200 | 34 | 5600 | 226 | 1.5 | 97.3 | <0.3 | 26.3 | 33.1 | 76 |
| | 100 - 105 cm | 15400 | 0.4 | 3.5 | 70.1 | 0.46 | 0.27 | 11600 | 18.7 | 10.5 | 16.9 | 17400 | 42 | 6020 | 242 | 1.5 | 107 | <0.3 | 26.7 | 32.9 | 82 |
| | 0-5 cm | 16600 | 0.8 | 3.2 | 72.1 | 0.51 | 0.3 | 14500 | 19 | 10.2 | 16.2 | 18200 | 38 | 6860 | 254 | 1.6 | 89.2 | <0.3 | 30.7 | 33.7 | 77 |
| | 0-5 cm | 15900 | 0.6 | 4 | 75.4 | 0.49 | 0.28 | 15500 | 18.2 | 10.1 | 16 | 17700 | 43 | 7020 | 312 | 1.5 | 90.4 | <0.3 | 30.6 | 32.9 | 74 |
| 2292649 East berm in park west of Welland St. & N of Nickel St. | 5-10 cm | 17200 | 1.4 | 4.4 | 84.4 | 0.59 | 0.26 | 27000 | 21 | 11.3 | 15.7 | 20900 | 39 | 12000 | 367 | 1.7 | 92 | <0.3 | 44.5 | 34.8 | 79 |
| | 5-10 cm | 20300 | 1.1 | 4.6 | 109 | 0.74 | 0.28 | 33200 | 23.2 | 12.8 | 16.4 | 23200 | 37 | 14100 | 479 | 1.7 | 89.2 | <0.3 | 53.7 | 39.5 | 85 |
| | 10-15 cm | 24100 | 1.4 | 5.3 | 126 | 0.92 | 0.36 | 30800 | 28.9 | 14.4 | 18.5 | 29000 | 41 | 13300 | 482 | 1.8 | 105 | <0.3 | 65.2 | 45.9 | 130 |
| | 10-15 cm | 16400 | 1 | 3.8 | 92.8 | 0.61 | 0.3 | 32700 | 21.7 | 12.2 | 17.3 | 21100 | 44 | 11900 | 374 | 1.8 | 107 | <0.3 | 54.4 | 33.8 | 100 |
| 2292649 East berm in park west of Welland St. & N of Nickel St. | 0-5 cm | 14400 | 0.2 | 1.7 | 71.4 | 0.63 | 0.41 | 11600 | 19.2 | 10.8 | 21.6 | 17300 | 55 | 5630 | 257 | 4.9 | 108 | <0.3 | 27.6 | 30.2 | 96 |
| | 0-5 cm | 14100 | 0.2 | 2.7 | 66.6 | 0.58 | 0.41 | 11200 | 17.4 | 10.9 | 21.3 | 16300 | 53 | 5550 | 248 | 4.9 | 115 | <0.3 | 24.4 | 29.6 | 87 |
| | 5-10 cm | 16200 | 0.2 | 3.1 | 79.3 | 0.71 | 0.39 | 14700 | 20 | 11.4 | 18.3 | 19100 | 45 | 7130 | 304 | 5.5 | 102 | <0.3 | 31.5 | 32.3 | 87 |
| | 5-10 cm | 14100 | 0.2 | 3.7 | 80.9 | 0.65 | 0.45 | 18100 | 19.5 | 11.1 | 21.1 | 18200 | 60 | 7590 | 307 | 5.5 | 117 | <0.3 | 34.3 | 27.4 | 105 |
| 2292649 East berm in park west of Welland St. & N of Nickel St. | 10-15 cm | 26800 | 0.2 | 2.4 | 173 | <u>1.29</u> | 0.44 | 30800 | 33.2 | 16.4 | 23.4 | 29200 | 106 | 15200 | 514 | 6.3 | 98.4 | <0.3 | 62.9 | 48.7 | 118 |
| | 10-15 cm | 18400 | 0.2 | 4.7 | 124 | 0.92 | 0.49 | 35800 | 25.4 | 14.4 | 30.3 | 23700 | 110 | 14000 | 496 | 6.4 | 135 | <0.3 | 63 | 35.7 | 133 |
| | 15-20 cm | 19000 | 0.2 | 2.8 | 124 | 0.94 | 0.45 | 33200 | 26.4 | 15.1 | 29.9 | 24600 | 87 | 13500 | 447 | 6.3 | 143 | <0.3 | 65.9 | 37.8 | 131 |
| | 15-20 cm | 25100 | 0.2 | 2.9 | 157 | 1.21 | 0.41 | 33200 | 31.6 | 16.6 | 22 | 30100 | 61 | 15100 | 585 | 6.4 | 95.2 | <0.3 | 68.7 | 46.2 | 105 |

Bold face and underlined values exceed corresponding MOE Table A generic guideline for residential/parkland land use- medium/fine textured soil.

| Table A3: Samples from Port Colborne submitted for pH in distilled water | | | | | |
|--|-----------------|-----------------|----------------|-----------------|-----------------|
| Sample ID | Soil pH (Run 1) | Soil pH (Run 2) | Soil pH (Mean) | Soil depth (cm) | Site / Location |
| 800 | 7.18 | 7.18 | 7.18 | 0-5 | 2292547 |
| 805 | 7.11 | 7.09 | 7.10 | 10-20 | 2292548 |
| 824 | 7.11 | 7.05 | 7.08 | 0-5 | 2292555 |
| 854 | 7.22 | 7.27 | 7.24 | 0-5 | 2292561 |
| 858 | 7.42 | 7.37 | 7.39 | 5-10 | 2292562 |
| 946 | 7.48 | 7.52 | 7.50 | 10-20 | 2292583 |
| 947 | 7.03 | 6.99 | 7.01 | 0-5 | 2292640 |
| 952 | 7.14 | 7.19 | 7.16 | 0-5 | 2292484 |
| 956 | 7.19 | 7.21 | 7.20 | 5-10 | 2292485 |
| 1019 | 7.42 | 7.37 | 7.39 | 10-20 | 2292502 |
| 1020 | 7.13 | 7.13 | 7.13 | 0-5 | 2292503 |
| 1059 | 7.01 | 7.03 | 7.02 | 0-5 | 2292516 |
| 1134 | 7.26 | 7.26 | 7.26 | 0-5 | 2292537 |
| 1139 | 7.29 | 7.32 | 7.30 | 10-20 | 2292538 |
| 1330 | 7.36 | 7.37 | 7.36 | 0-5 | 2292584 |
| 1334 | 7.25 | 7.35 | 7.30 | 5-10 | 2292585 |
| 1373 | 7.56 | 7.61 | 7.58 | 5-10 | 2292595 |
| 1375 | 7.51 | 7.51 | 7.51 | 0-5 | 2292596 |
| 1379 | 7.29 | 7.21 | 7.25 | 5-10 | 2292597 |
| 1381 | 7.09 | 7.10 | 7.09 | 0-5 | 2292598 |
| 3341 | 7.38 | 7.37 | 7.37 | 0-5 | 2292410 |
| 3346 | 7.61 | 7.70 | 7.65 | 10-20 | 2292411 |
| 3814 | 7.22 | 7.30 | 7.26 | 5-10 | 2292376 |
| 3816 | 6.89 | 6.88 | 6.88 | 0-5 | 2292377 |
| 3834 | 7.66 | 7.65 | 7.65 | 10-20 | Rodney/Fares St |
| 3892 | 7.11 | 7.09 | 7.10 | 0-5 | 2292473 |
| 5182 | 7.25 | 7.28 | 7.26 | 0-5 | 2292327 |
| 5187 | 7.76 | 7.75 | 7.75 | 10-20 | 2292328 |
| 5252 | 6.98 | 6.99 | 6.98 | 5-10 | 2292445 |
| 5313 | 7.58 | 7.63 | 7.60 | 10-20 | 2292449 |
| 5315 | 6.95 | 6.85 | 6.90 | 5-10 | 2292450 |
| 5361 | 7.23 | 7.24 | 7.23 | 5-10 | 2292321 |
| 5363 | 7.21 | 7.26 | 7.23 | 0-5 | 2292322 |
| 5390 | 7.28 | 7.31 | 7.29 | 0-5 | 2292470 |
| 5404 | 7.52 | 7.61 | 7.56 | 10-20 | 2292471 |
| 5407 | 7.36 | 7.38 | 7.37 | 10-20 | 2292471 |

Appendix A-4: Simulated Stomach Acid Leach Test Results

| Aluminum (Al) | | | | |
|---------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 5,500 | 101 | 1.84 |
| C77340 - 2 | 2022013 | 5,800 | 105 | 1.81 |
| C77349 - 1 | 2023301 | 10,000 | 126 | 1.26 |
| C77349 - 2 | 2023301 | 10,000 | 109 | 1.09 |
| C77351 - 1 | 2023501 | 11,000 | 117 | 1.06 |
| C77351 - 2 | 2023501 | 12,000 | 129 | 1.08 |
| C77351 - 3 | 2023501 | 12,000 | 107 | 0.89 |
| C77351 - 4 | 2023501 | 9,500 | 122 | 1.28 |
| C77353 - 1 | 2023701 | 6,100 | 83 | 1.36 |
| C77353 - 2 | 2023701 | 5,900 | 80 | 1.35 |
| Average | | 8,780 | 108 | 1.3 |
| Low Value | | 5,500 | 80 | 0.89 |
| High Value | | 12,000 | 122 | 1.84 |

| Antimony (Sb) | | | | |
|---------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 2.45 | 0.0040 | 0.16 |
| C77340 - 2 | 2022013 | 1.82 | 0.0035 | 0.19 |
| C77349 - 1 | 2023301 | 2.10 | 0.0033 | 0.16 |
| C77349 - 2 | 2023301 | 2.33 | 0.0033 | 0.14 |
| C77351 - 1 | 2023501 | 2.83 | 0.0036 | 0.13 |
| C77351 - 2 | 2023501 | 2.52 | 0.0030 | 0.12 |
| C77351 - 3 | 2023501 | 2.24 | 0.0033 | 0.15 |
| C77351 - 4 | 2023501 | 2.01 | 0.0026 | 0.13 |
| C77353 - 1 | 2023701 | 2.42 | 0.0025 | 0.10 |
| C77353 - 2 | 2023701 | 2.05 | 0.0023 | 0.11 |
| Average | | 2.28 | 0.0031 | 0.14 |
| Low Value | | 1.82 | 0.0023 | 0.10 |
| High Value | | 2.83 | 0.0040 | 0.19 |

| Arsenic (As) | | | | |
|--------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C79545 - 1 | 2022013 | 52 | 0.70 | 1.35 |
| C79545 - 2 | 2022013 | 39 | 0.56 | 1.44 |
| C79546 - 1 | 2023301 | 45 | 0.58 | 1.29 |
| C79546 - 2 | 2023301 | 50 | 0.69 | 1.38 |
| C79547 - 1 | 2023501 | 63 | 0.40 | 0.63 |
| C79547 - 2 | 2023501 | 45 | 0.39 | 0.87 |
| C79547 - 3 | 2023501 | 43 | 0.43 | 1.0 |
| C79547 - 4 | 2023501 | 42 | 0.53 | 1.26 |
| C79548 - 1 | 2023701 | 62 | 0.54 | 0.87 |
| C79548 - 2 | 2023701 | 38 | 0.51 | 1.34 |
| Average | | 48 | 0.53 | 1.10 |
| Low Value | | 38 | 0.39 | 0.63 |
| High Value | | 63 | 0.70 | 1.44 |

| Barium (Ba) | | | | |
|-------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 130 | 4.5 | 3.5 |
| C77340 - 2 | 2022013 | 140 | 4.6 | 3.3 |
| C77349 - 1 | 2023301 | 160 | 5.4 | 3.4 |
| C77349 - 2 | 2023301 | 150 | 4.8 | 3.2 |
| C77351 - 1 | 2023501 | 210 | 5.5 | 2.6 |
| C77351 - 2 | 2023501 | 200 | 5.7 | 2.9 |
| C77351 - 3 | 2023501 | 200 | 4.6 | 2.3 |
| C77351 - 4 | 2023501 | 190 | 5.2 | 2.8 |
| C77353 - 1 | 2023701 | 120 | 3.7 | 3.1 |
| C77353 - 2 | 2023701 | 94 | 4.5 | 4.8 |
| Average | | 159 | 4.8 | 3.2 |
| Low Value | | 94 | 3.7 | 2.3 |
| High Value | | 200 | 5.5 | 4.8 |

| Beryllium (Be) | | | | |
|----------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 0.6<T | 0.02<T | nc |
| C77340 - 2 | 2022013 | 0.5<W | 0.02<T | nc |
| C77349 - 1 | 2023301 | 0.5<W | 0.02<T | nc |
| C77349 - 2 | 2023301 | 0.5<W | 0.02<T | nc |
| C77351 - 1 | 2023501 | 0.5<W | 0.03<T | nc |
| C77351 - 2 | 2023501 | 0.5<W | 0.03<T | nc |
| C77351 - 3 | 2023501 | 0.5<W | 0.02<T | nc |
| C77351 - 4 | 2023501 | 0.5<W | 0.03<T | nc |
| C77353 - 1 | 2023701 | 0.5<W | 0.03<T | nc |
| C77353 - 2 | 2023701 | 0.5<W | 0.02<T | nc |
| Average | | 0.5<W | 0.024<T | nc |
| Low Value | | 0.5<W | 0.02<T | nc |
| High Value | | 0.5<W | 0.03<T | nc |

| Cadmium (Cd) | | | | |
|--------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 0.2<W | 0.04 | nc |
| C77340 - 2 | 2022013 | 0.3<T | 0.04 | nc |
| C77349 - 1 | 2023301 | 0.2<W | 0.08 | nc |
| C77349 - 2 | 2023301 | 0.2<W | 0.09 | nc |
| C77351 - 1 | 2023501 | 0.2<W | 0.06 | nc |
| C77351 - 2 | 2023501 | 0.2<W | 0.05 | nc |
| C77351 - 3 | 2023501 | 0.2<W | 0.05 | nc |
| C77351 - 4 | 2023501 | 0.2<W | 0.06 | nc |
| C77353 - 1 | 2023701 | 0.2<W | 0.04 | nc |
| C77353 - 2 | 2023701 | 0.2<W | 0.05 | nc |
| Average | | 0.2<W | 0.06 | nc |
| Low Value | | 0.2<W | 0.04 | nc |
| High Value | | 0.3<T | 0.09 | nc |

| Calcium (Ca) | | | | |
|--------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 9,900 | 491 | 4.96 |
| C77340 - 2 | 2022013 | 11,000 | 541 | 4.92 |
| C77349 - 1 | 2023301 | 22,000 | 1,010 | 4.59 |
| C77349 - 2 | 2023301 | 23,000 | 1,040 | 4.52 |
| C77351 - 1 | 2023501 | 30,000 | 1,360 | 4.53 |
| C77351 - 2 | 2023501 | 29,000 | 1,390 | 4.79 |
| C77351 - 3 | 2023501 | 33,000 | 1,470 | 4.45 |
| C77351 - 4 | 2023501 | 29,000 | 1,280 | 4.41 |
| C77353 - 1 | 2023701 | 14,000 | 645 | 4.61 |
| C77353 - 2 | 2023701 | 16,000 | 689 | 4.31 |
| Average | | 21,700 | 992 | 4.61 |
| Low Value | | 9,900 | 491 | 4.31 |
| High Value | | 33,000 | 1,360 | 4.96 |

| Chromium (Cr) | | | | |
|---------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 49 | 0.3 | 0.61 |
| C77340 - 2 | 2022013 | 44 | 0.32 | 0.73 |
| C77349 - 1 | 2023301 | 42 | 0.23 | 0.55 |
| C77349 - 2 | 2023301 | 29 | 0.15 | 0.52 |
| C77351 - 1 | 2023501 | 57 | 0.24 | 0.42 |
| C77351 - 2 | 2023501 | 45 | 0.19 | 0.42 |
| C77351 - 3 | 2023501 | 36 | 0.16 | 0.44 |
| C77351 - 4 | 2023501 | 27 | 0.13 | 0.48 |
| C77353 - 1 | 2023701 | 46 | 0.19 | 0.41 |
| C77353 - 2 | 2023701 | 32 | 0.18 | 0.56 |
| Average | | 41 | 0.21 | 0.51 |
| Low Value | | 27 | 0.13 | 0.41 |
| High Value | | 49 | 0.32 | 0.73 |

| Cobalt (Co) | | | | |
|--------------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 200 | .96 | 0.98 |
| C77340 - 2 | 2022013 | 180 | 1.66 | 0.92 |
| C77349 - 1 | 2023301 | 130 | 1.17 | 0.90 |
| C77349 - 2 | 2023301 | 140 | 1.23 | 0.88 |
| C77351 - 1 | 2023501 | 210 | 2.35 | 1.12 |
| C77351 - 2 | 2023501 | 160 | 1.71 | 1.07 |
| C77351 - 3 | 2023501 | 220 | 1.69 | 0.77 |
| C77351 - 4 | 2023501 | 150 | .85 | 1.23 |
| C77353 - 1 | 2023701 | 230 | 1.44 | 0.63 |
| C77353 - 2 | 2023701 | 120 | 1.29 | 1.08 |
| Average | | 174 | 1.64 | 0.96 |
| Low Value | | 120 | 0.85 | 0.63 |
| High Value | | 220 | 2.35 | 1.23 |

| Copper (Cu) | | | | |
|--------------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 990 | 17.2 | 1.74 |
| C77340 - 2 | 2022013 | 770 | 17.1 | 2.22 |
| C77349 - 1 | 2023301 | 1000 | 19.1 | 1.91 |
| C77349 - 2 | 2023301 | 780 | 14.2 | 1.82 |
| C77351 - 1 | 2023501 | 1000 | 15.9 | 1.59 |
| C77351 - 2 | 2023501 | 840 | 14.7 | 1.75 |
| C77351 - 3 | 2023501 | 1000 | 20.5 | 2.05 |
| C77351 - 4 | 2023501 | 980 | 20.7 | 2.11 |
| C77353 - 1 | 2023701 | 970 | 16.1 | 1.66 |
| C77353 - 2 | 2023701 | 640 | 14.0 | 2.19 |
| Average | | 897 | 17 | 1.90 |
| Low Value | | 640 | 14.0 | 1.59 |
| High Value | | 1000 | 20.7 | 2.22 |

| IRON (Fe) | | | | |
|-------------|--------------|---|--|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 130,000 | 254 | 0.20 |
| C77340 - 2 | 2022013 | 90,000 | 252 | 0.28 |
| C77349 - 1 | 2023301 | 77,000 | 261 | 0.34 |
| C77349 - 2 | 2023301 | 48,000 | 162 | 0.34 |
| C77351 - 1 | 2023501 | 90,000 | 251 | 0.28 |
| C77351 - 2 | 2023501 | 93,000 | 195 | 0.21 |
| C77351 - 3 | 2023501 | 60,000 | 142 | 0.24 |
| C77351 - 4 | 2023501 | 62,000 | 131 | 0.21 |
| C77353 - 1 | 2023701 | 130,000 | 245 | 0.19 |
| C77353 - 2 | 2023701 | 66,000 | 201 | 0.30 |
| Average | | 84,600 | 209 | 0.26 |
| Low Value | | 48,000 | 142 | 0.19 |
| High Value | | 130,000 | 261 | 0.34 |

| Lead (Pb) | | | | |
|-------------|--------------|---|--|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 400 | 15.6 | 3.9 |
| C77340 - 2 | 2022013 | 480 | 21.1 | 4.4 |
| C77349 - 1 | 2023301 | 350 | 12.8 | 3.7 |
| C77349 - 2 | 2023301 | 310 | 11.1 | 3.6 |
| C77351 - 1 | 2023501 | 400 | 13.3 | 3.3 |
| C77351 - 2 | 2023501 | 370 | 14.4 | 3.9 |
| C77351 - 3 | 2023501 | 300 | 9.17 | 3.1 |
| C77351 - 4 | 2023501 | 350 | 11.4 | 3.3 |
| C77353 - 1 | 2023701 | 360 | 15.4 | 4.3 |
| C77353 - 2 | 2023701 | 290 | 13.1 | 4.5 |
| Average | | 361 | 13.74 | 3.8 |
| Low Value | | 290 | 9.17 | 3.1 |
| High Value | | 480 | 21.1 | 4.5 |

| Magnesium (Mg) | | | | |
|----------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 3,200 | 102 | 3.19 |
| C77340 - 2 | 2022013 | 3,300 | 111 | 3.36 |
| C77349 - 1 | 2023301 | 6,600 | 238 | 3.61 |
| C77349 - 2 | 2023301 | 6,500 | 228 | 3.51 |
| C77351 - 1 | 2023501 | 10,000 | 374 | 3.74 |
| C77351 - 2 | 2023501 | 10,000 | 382 | 3.82 |
| C77351 - 3 | 2023501 | 10,000 | 371 | 3.71 |
| C77351 - 4 | 2023501 | 8,400 | 307 | 3.65 |
| C77353 - 1 | 2023701 | 5,500 | 194 | 3.53 |
| C77353 - 2 | 2023701 | 5,900 | 207 | 3.51 |
| Average | | 6,940 | 251 | 3.56 |
| Low Value | | 3,200 | 102 | 3.19 |
| High Value | | 10,000 | 382 | 3.82 |

| Manganese (Mn) | | | | |
|----------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 1200 | 35.3 | 2.94 |
| C77340 - 2 | 2022013 | 1100 | 35.9 | 3.26 |
| C77349 - 1 | 2023301 | 980 | 33.4 | 3.41 |
| C77349 - 2 | 2023301 | 720 | 25.6 | 3.56 |
| C77351 - 1 | 2023501 | 1200 | 36.5 | 3.04 |
| C77351 - 2 | 2023501 | 1000 | 32.6 | 3.26 |
| C77351 - 3 | 2023501 | 960 | 30.8 | 3.21 |
| C77351 - 4 | 2023501 | 1100 | 33.2 | 3.02 |
| C77353 - 1 | 2023701 | 1100 | 33.0 | 3.00 |
| C77353 - 2 | 2023701 | 800 | 29.0 | 3.62 |
| Average | | 1016 | 32.5 | 3.23 |
| Low Value | | 720 | 25.6 | 2.92 |
| High Value | | 1200 | 35.9 | 3.62 |

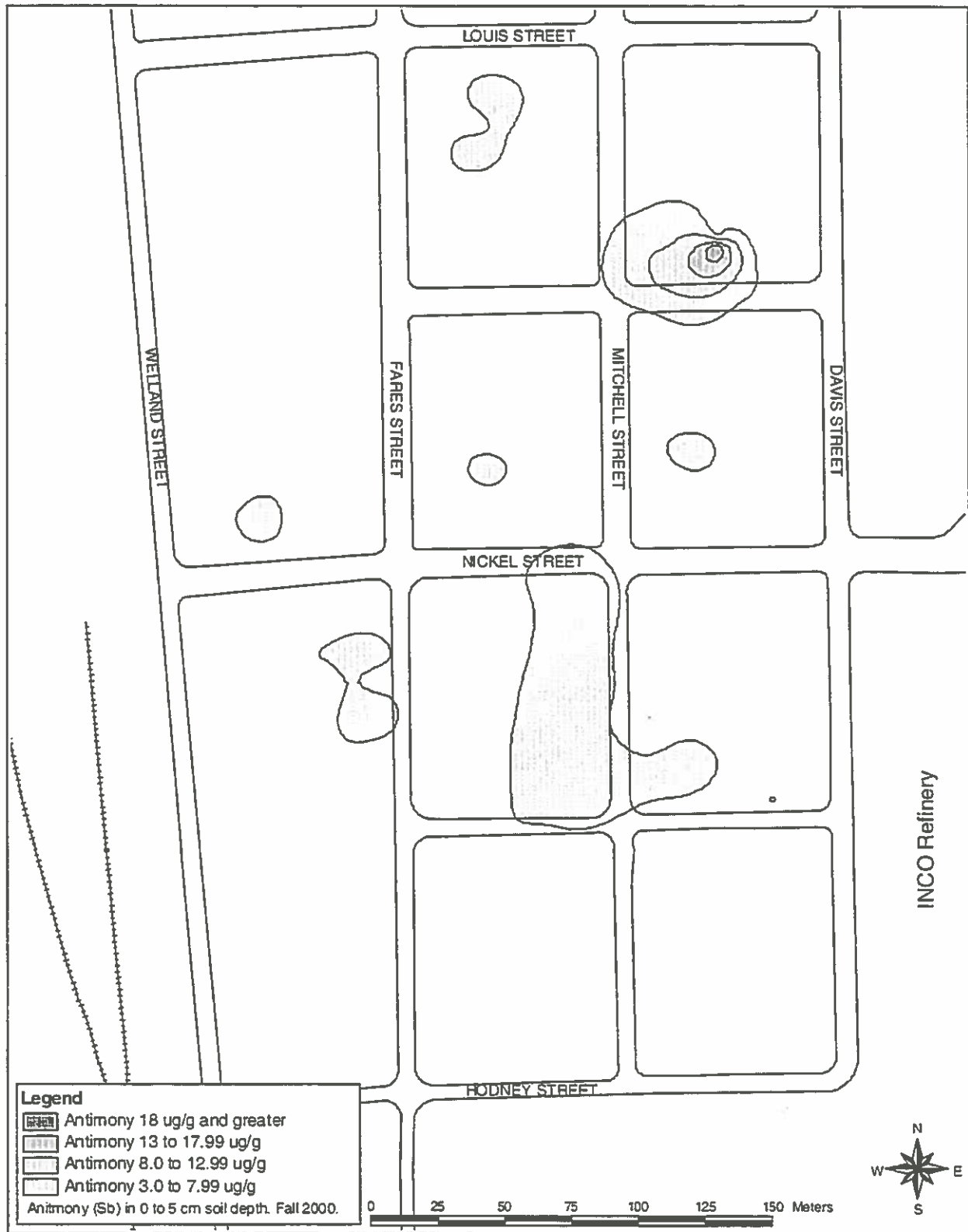
| Nickel (Ni) | | | | |
|-------------|--------------|---|--|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 16,000 | 104 | 0.65 |
| C77340 - 2 | 2022013 | 9,200 | 107 | 1.16 |
| C77349 - 1 | 2023301 | 14,000 | 127 | 0.91 |
| C77349 - 2 | 2023301 | 11,000 | 93 | 0.85 |
| C77351 - 1 | 2023501 | 14,000 | 115 | 0.82 |
| C77351 - 2 | 2023501 | 13,000 | 97 | 0.75 |
| C77351 - 3 | 2023501 | 12,000 | 89 | 0.74 |
| C77351 - 4 | 2023501 | 11,000 | 88 | 0.8 |
| C77353 - 1 | 2023701 | 17,000 | 100 | 0.59 |
| C77353 - 2 | 2023701 | 8,000 | 86 | 0.98 |
| Average | | 12,600 | 101 | 0.82 |
| Low Value | | 8,000 | 86 | 0.59 |
| High Value | | 17,000 | 107 | 1.16 |

| Selenium (Se) | | | | |
|---------------|--------------|---|--|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 7.0 | 0.001 <T | nc |
| C77340 - 2 | 2022013 | 7.0 | 0.001 <T | nc |
| C77349 - 1 | 2023301 | 8.4 | 0.001 <T | nc |
| C77349 - 2 | 2023301 | 8.3 | 0.001 <T | nc |
| C77351 - 1 | 2023501 | 12.3 | 0.0008 <T | nc |
| C77351 - 2 | 2023501 | 10.0 | 0.0006 <T | nc |
| C77351 - 3 | 2023501 | 7.6 | 0.0005 <W | nc |
| C77351 - 4 | 2023501 | 6.4 | 0.0005 <W | nc |
| C77353 - 1 | 2023701 | 11.1 | 0.0009 <T | nc |
| C77353 - 2 | 2023701 | 7.8 | 0.0009 <T | nc |
| Average | | 8.6 | - | nc |
| Low Value | | 6.4 | 0.0005 <W | nc |
| High Value | | 12.3 | 0.001 <T | nc |

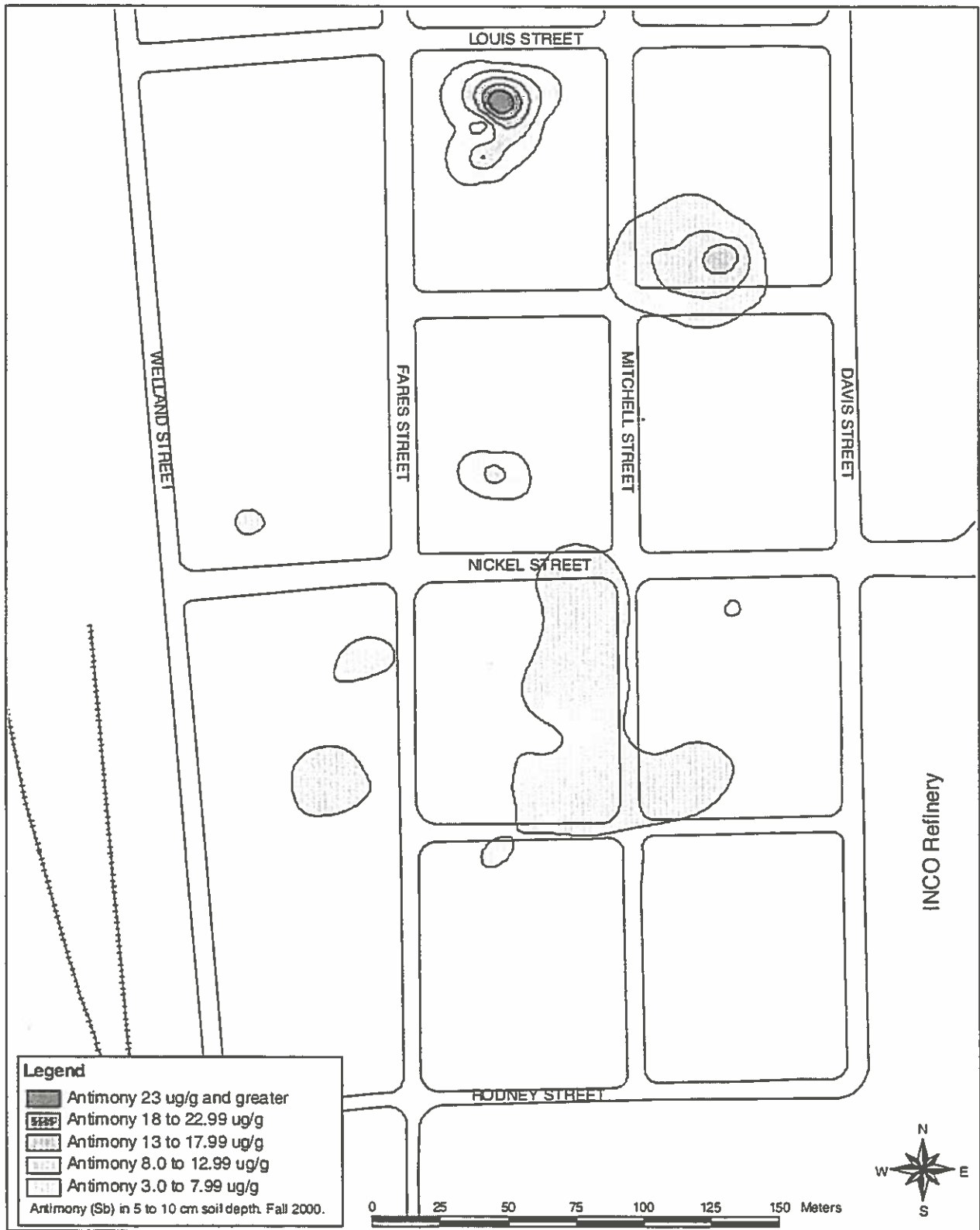
| Strontium (Sr) | | | | |
|----------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 37 | 1.52 | 4.11 |
| C77340 - 2 | 2022013 | 41 | 1.59 | 3.88 |
| C77349 - 1 | 2023301 | 68 | 2.92 | 4.29 |
| C77349 - 2 | 2023301 | 81 | 3.23 | 3.99 |
| C77351 - 1 | 2023501 | 95 | 3.54 | 3.73 |
| C77351 - 2 | 2023501 | 100 | 4.18 | 4.18 |
| C77351 - 3 | 2023501 | 100 | 4.46 | 4.46 |
| C77351 - 4 | 2023501 | 110 | 4.24 | 3.85 |
| C77353 - 1 | 2023701 | 37 | 1.44 | 3.89 |
| C77353 - 2 | 2023701 | 37 | 1.46 | 3.95 |
| Average | | 70.6 | 2.86 | 4.03 |
| Low Value | | 37 | 1.44 | 3.73 |
| High Value | | 110 | 4.46 | 4.46 |

| Vanadium (V) | | | | |
|--------------|--------------|--|---|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 34 | 0.40 | 1.18 |
| C77340 - 2 | 2022013 | 29 | 0.41 | 1.41 |
| C77349 - 1 | 2023301 | 34 | 0.44 | 1.29 |
| C77349 - 2 | 2023301 | 31 | 0.40 | 1.29 |
| C77351 - 1 | 2023501 | 39 | 0.35 | 0.90 |
| C77351 - 2 | 2023501 | 41 | 0.44 | 1.07 |
| C77351 - 3 | 2023501 | 36 | 0.28 | 0.78 |
| C77351 - 4 | 2023501 | 32 | 0.26 | 0.81 |
| C77353 - 1 | 2023701 | 30 | 0.30 | 1.00 |
| C77353 - 2 | 2023701 | 24 | 0.31 | 1.29 |
| Average | | 33 | 0.36 | 1.10 |
| Low Value | | 24 | 0.28 | 0.78 |
| High Value | | 41 | 0.44 | 1.41 |

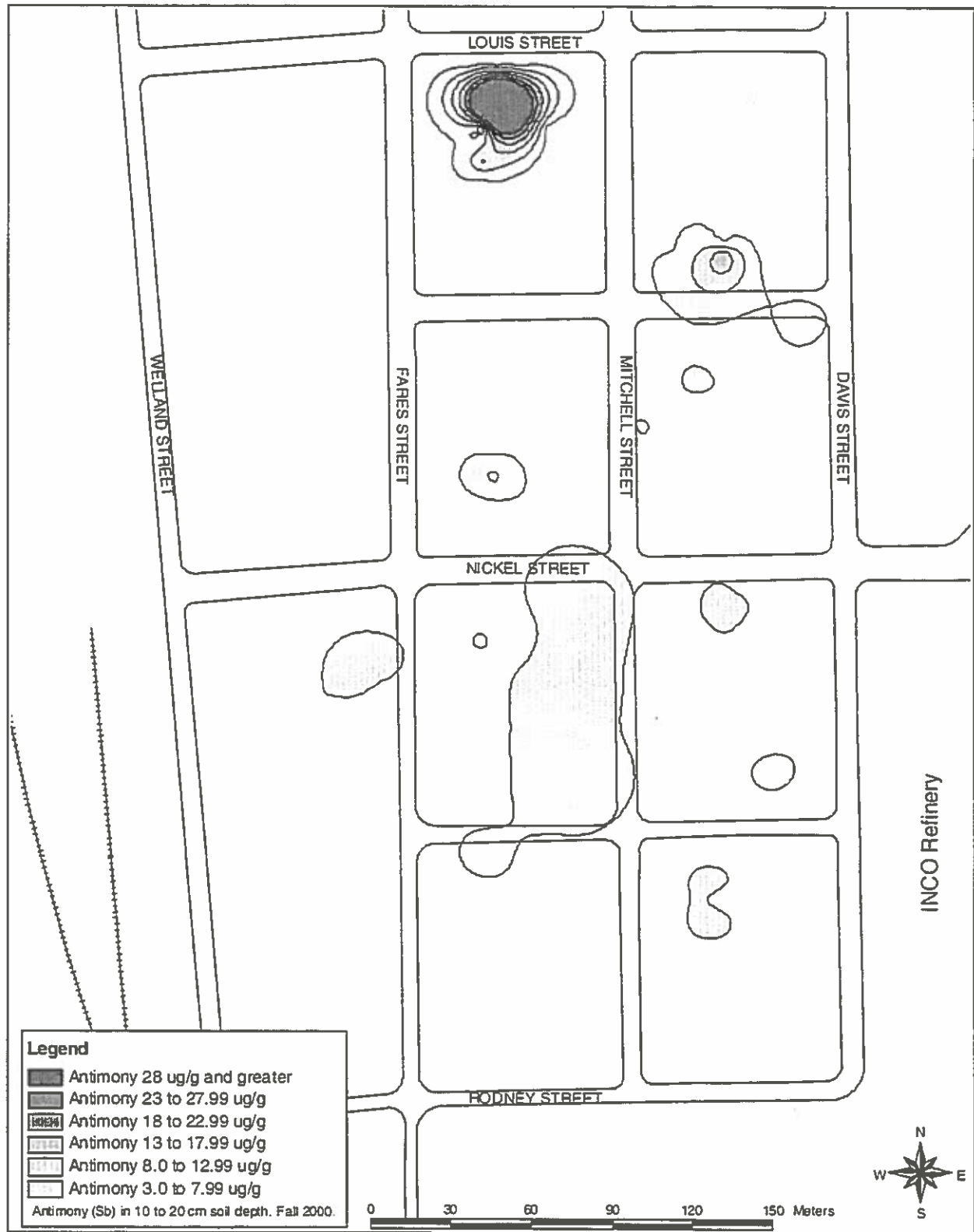
| Zinc (Zn) | | | | |
|-------------|--------------|---|--|---------|
| Sample I.D. | Station I.D. | Soil Concentration ($\mu\text{g/g}$) | Leach Concentration ($\mu\text{g/g}$) | % Leach |
| C77340 - 1 | 2022013 | 1100 | 23.6 | 2.5 |
| C77340 - 2 | 2022013 | 990 | 24.0 | 2.42 |
| C77349 - 1 | 2023301 | 930 | 20.5 | 2.2 |
| C77349 - 2 | 2023301 | 690 | 15.2 | 2.2 |
| C77351 - 1 | 2023501 | 1100 | 24.3 | 2.21 |
| C77351 - 2 | 2023501 | 1000 | 21.2 | 2.12 |
| C77351 - 3 | 2023501 | 830 | 17.7 | 2.13 |
| C77351 - 4 | 2023501 | 840 | 18.3 | 2.18 |
| C77353 - 1 | 2023701 | 1000 | 20.4 | 2.04 |
| C77353 - 2 | 2023701 | 700 | 17.1 | 2.44 |
| Average | | 918 | 20.2 | 2.21 |
| Low Value | | 690 | 15.2 | 2.04 |
| High Value | | 1100 | 24.3 | 2.44 |



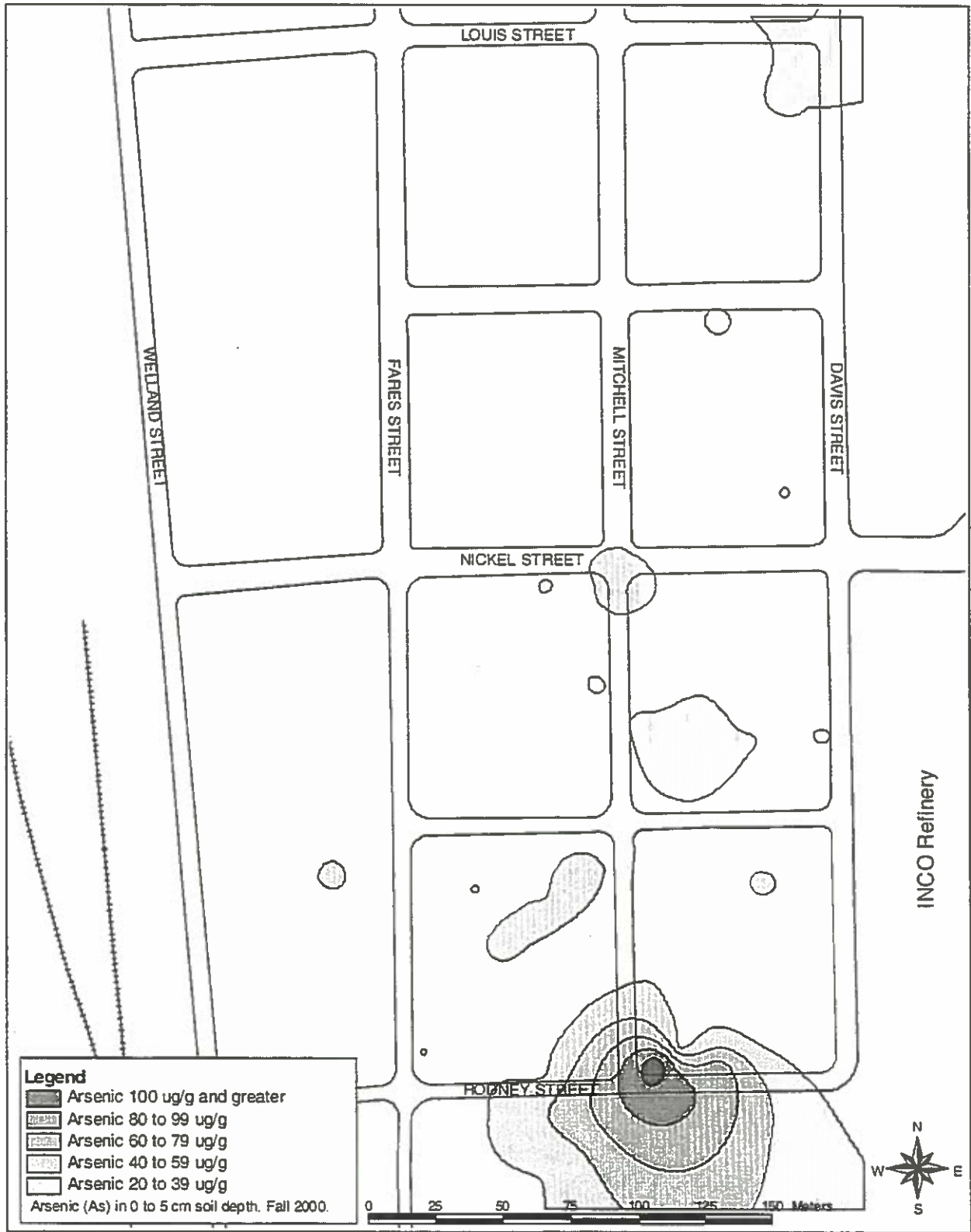
Map B1: Antimony in 0 to 5 cm soil depth.



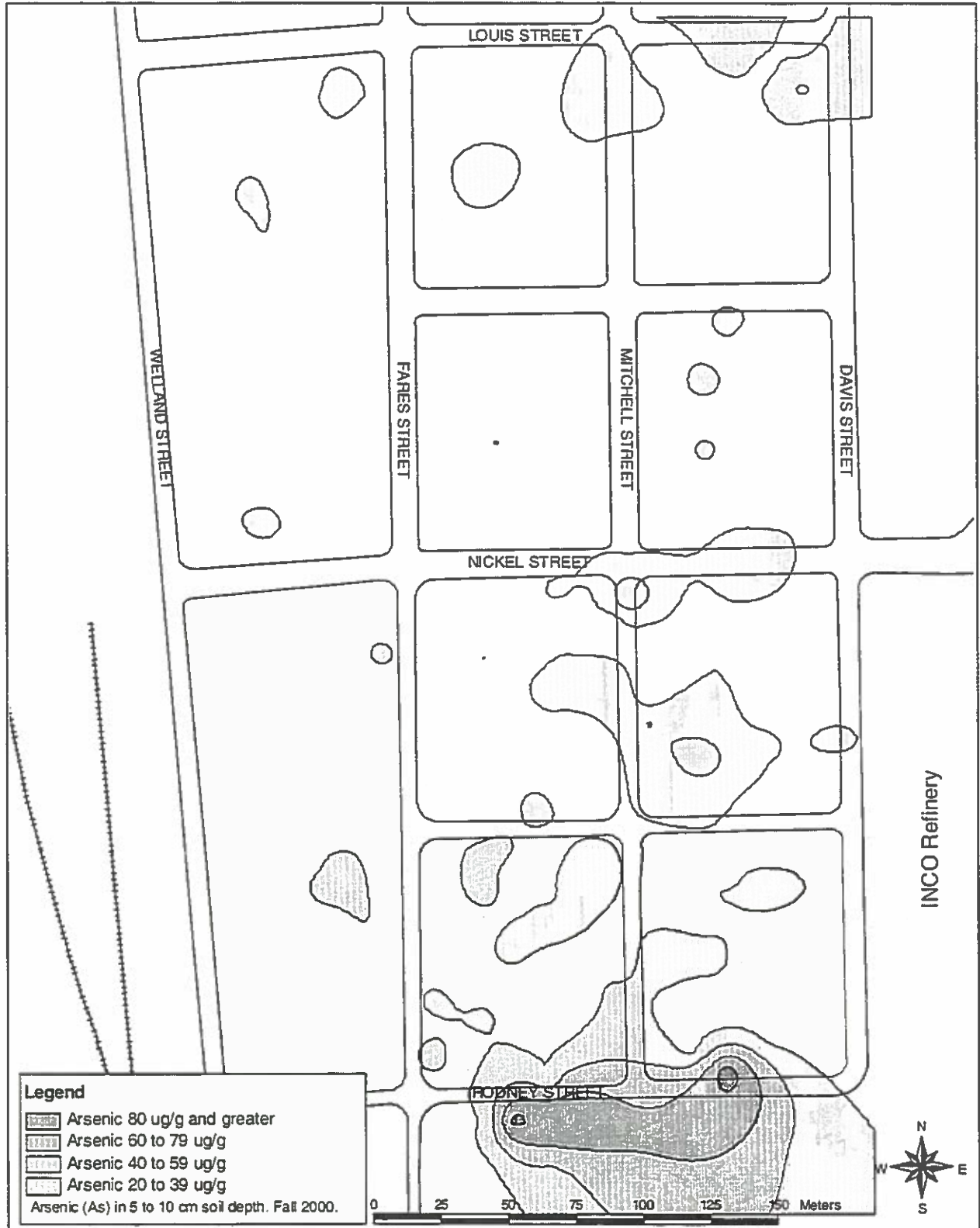
Map B2: Antimony in 5 to 10 cm soil depth.



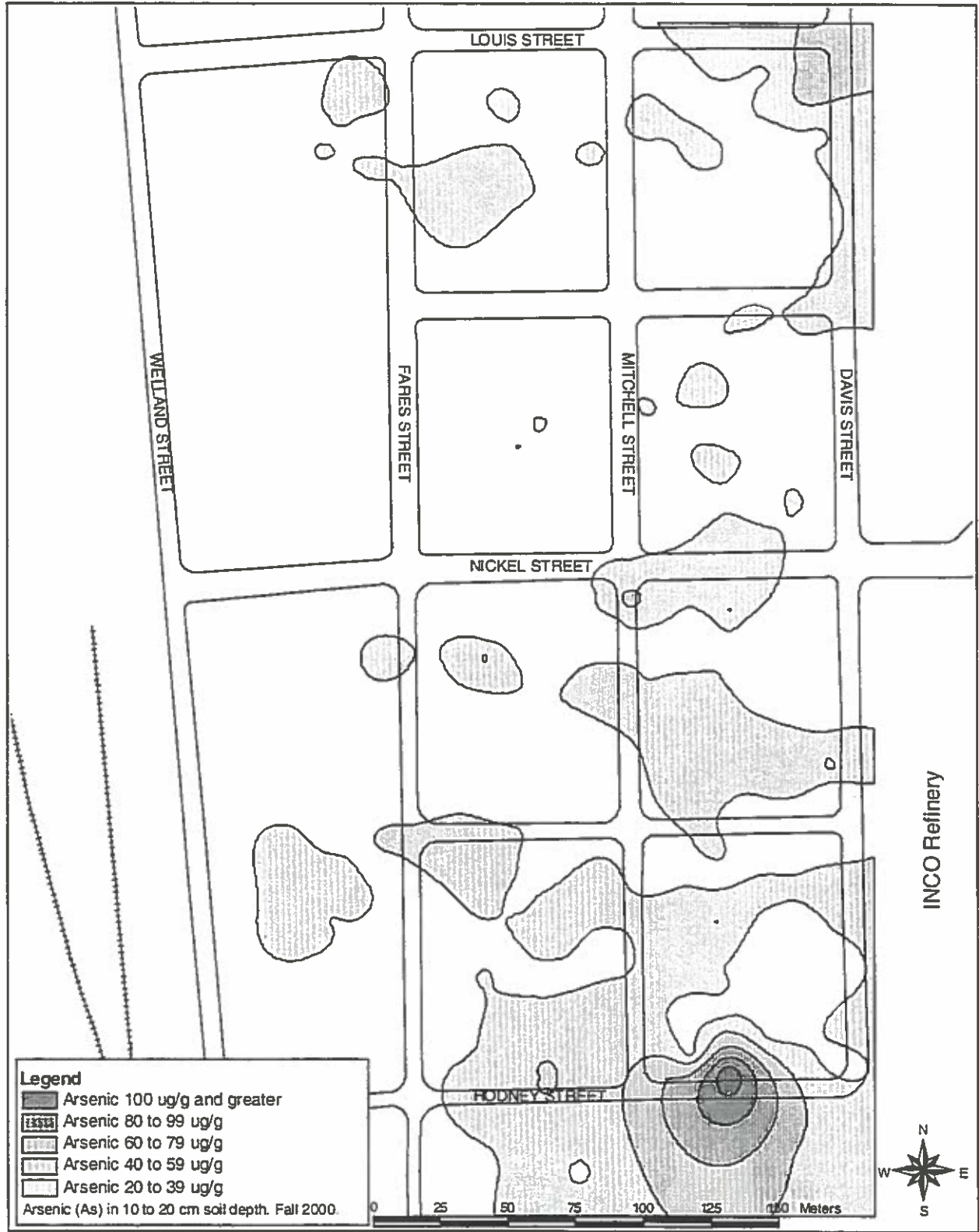
Map B3: Antimony in 10 to 20 cm soil depth.



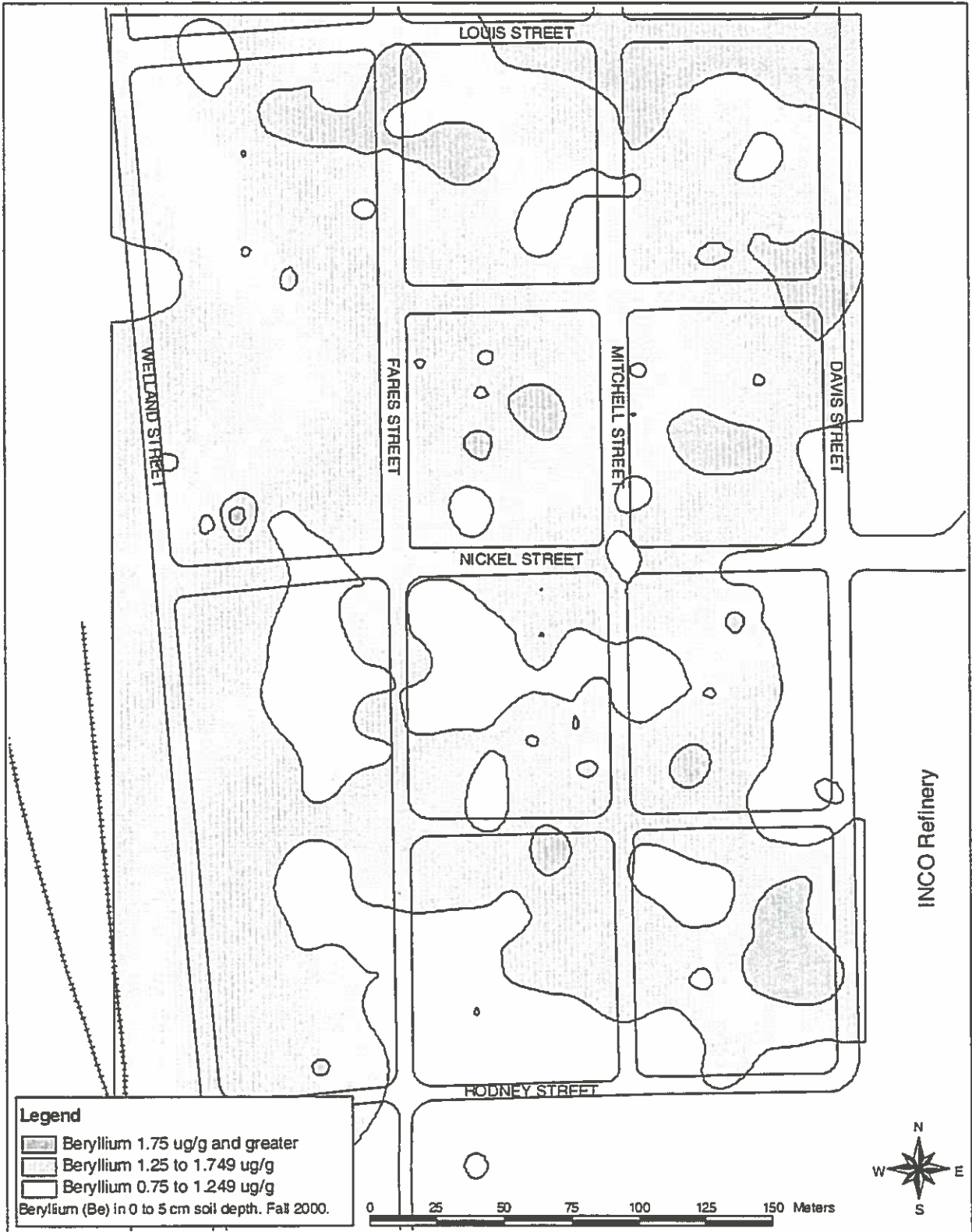
Map B4: Arsenic in 0 to 5 cm soil depth.



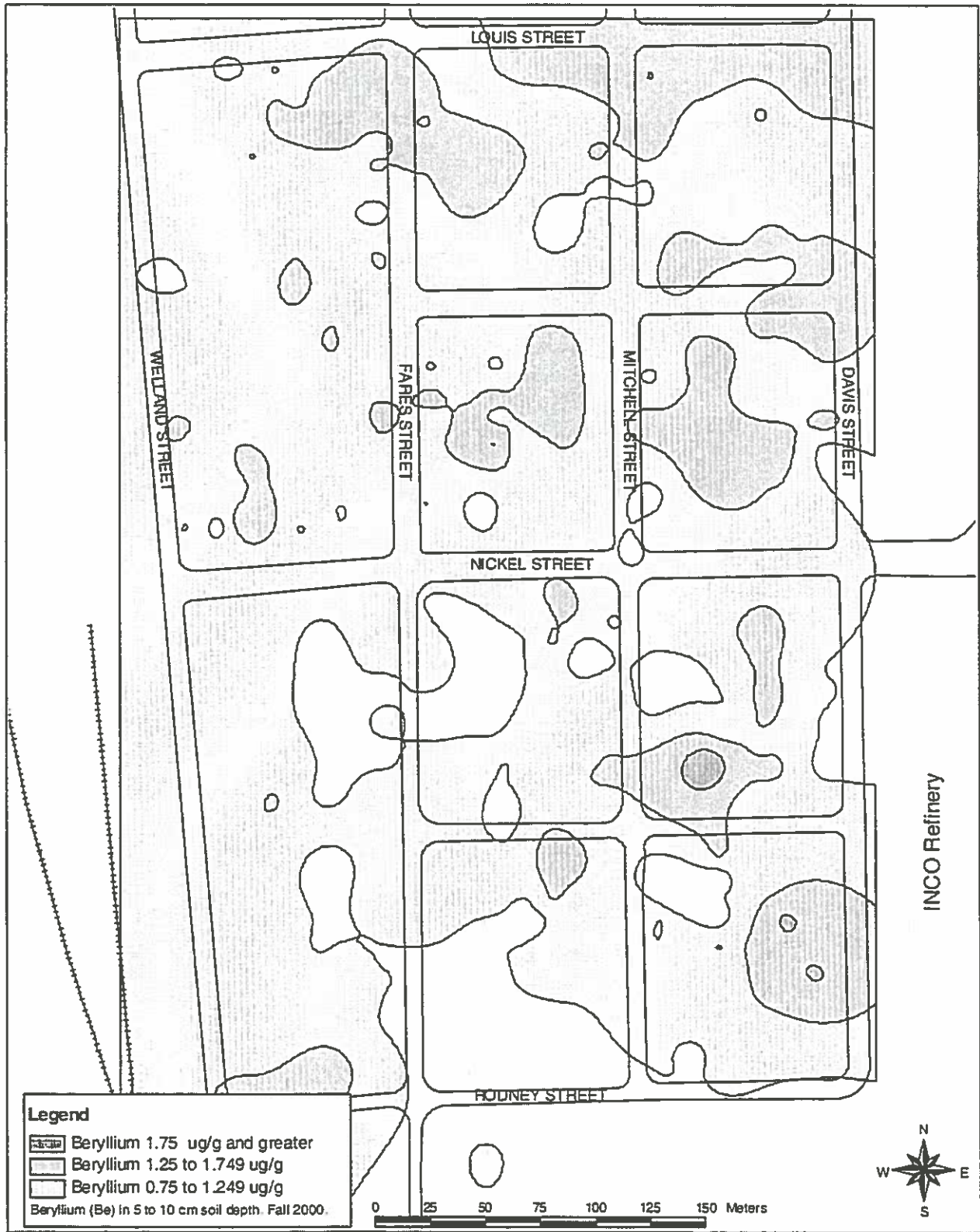
Map B5: Arsenic in 5 to 10 cm soil depth.



Map B6: Arsenic in 10 to 20 cm soil depth.



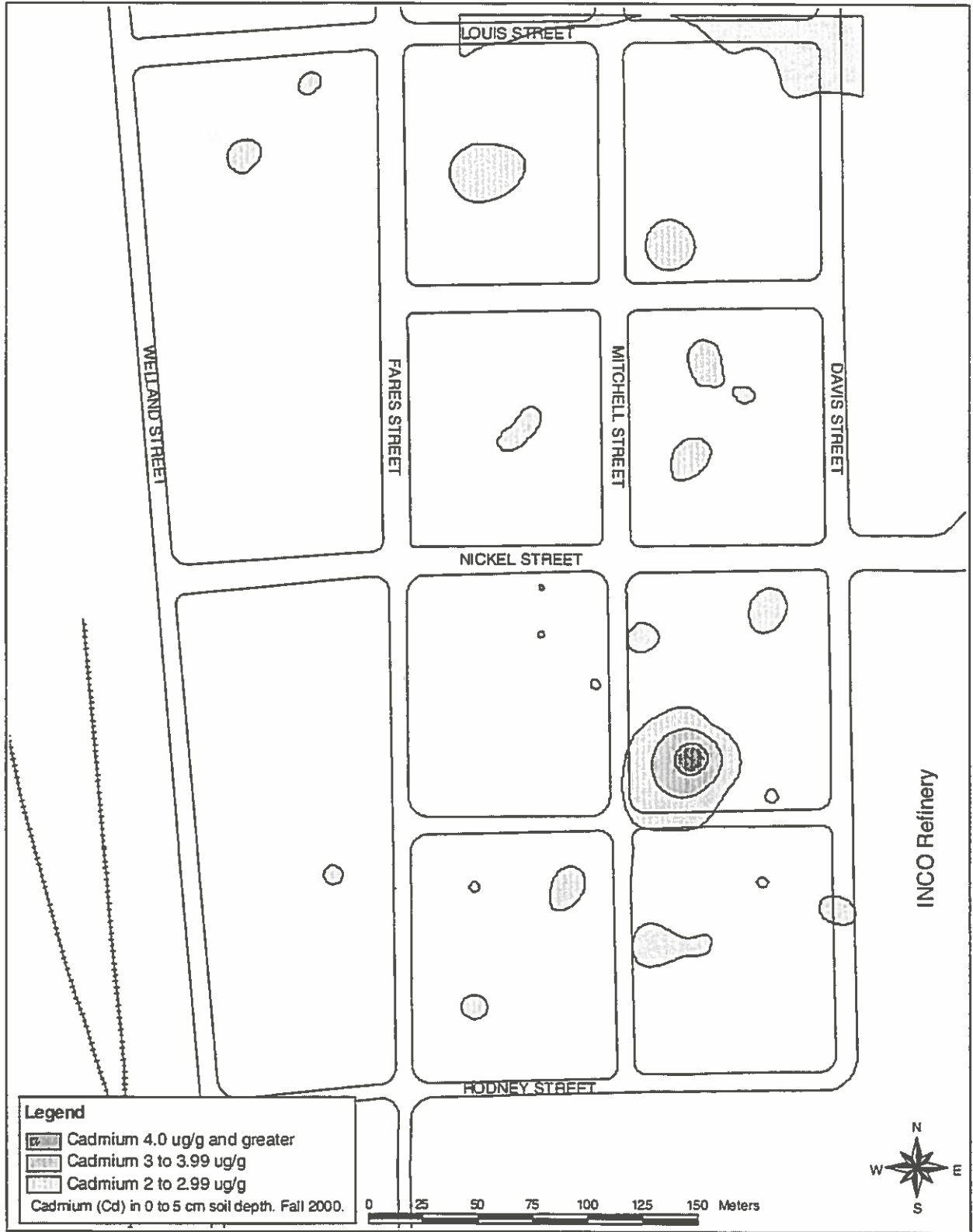
Map B7: Beryllium in 0 to 5 cm soil depth.

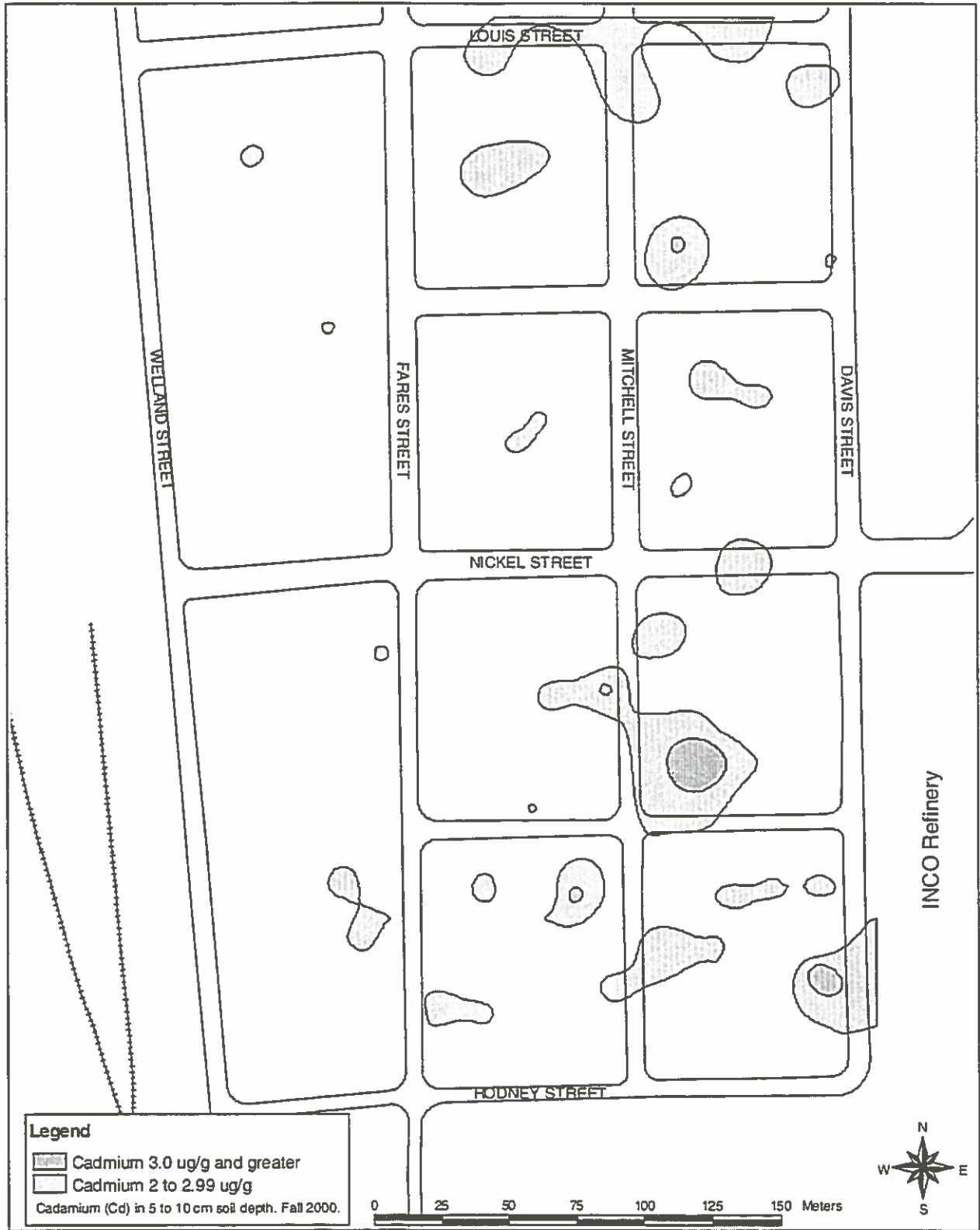


Map B8: Beryllium in 5 to 10 cm depth.

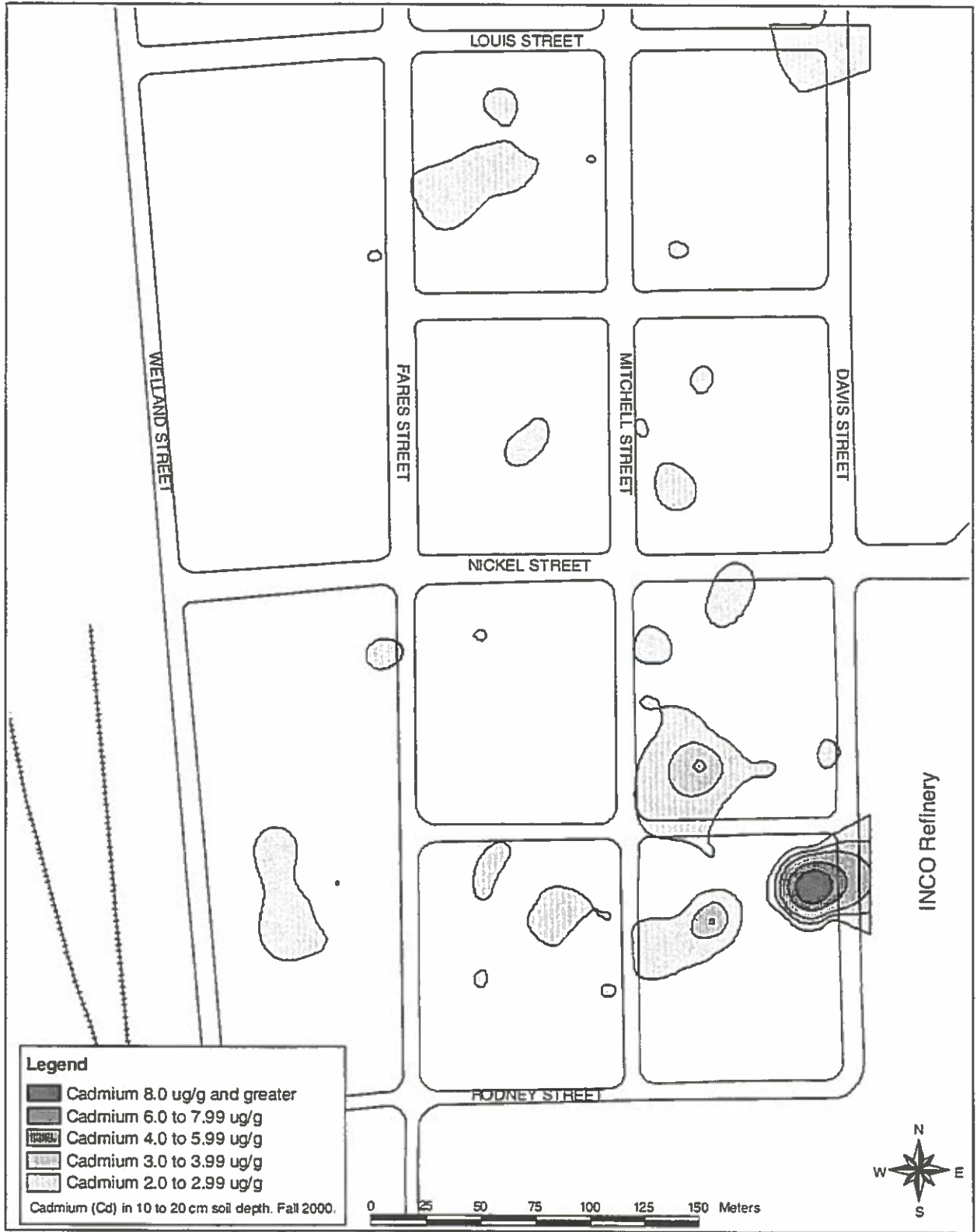


Map B9: Beryllium in 10 to 20 soil depth.

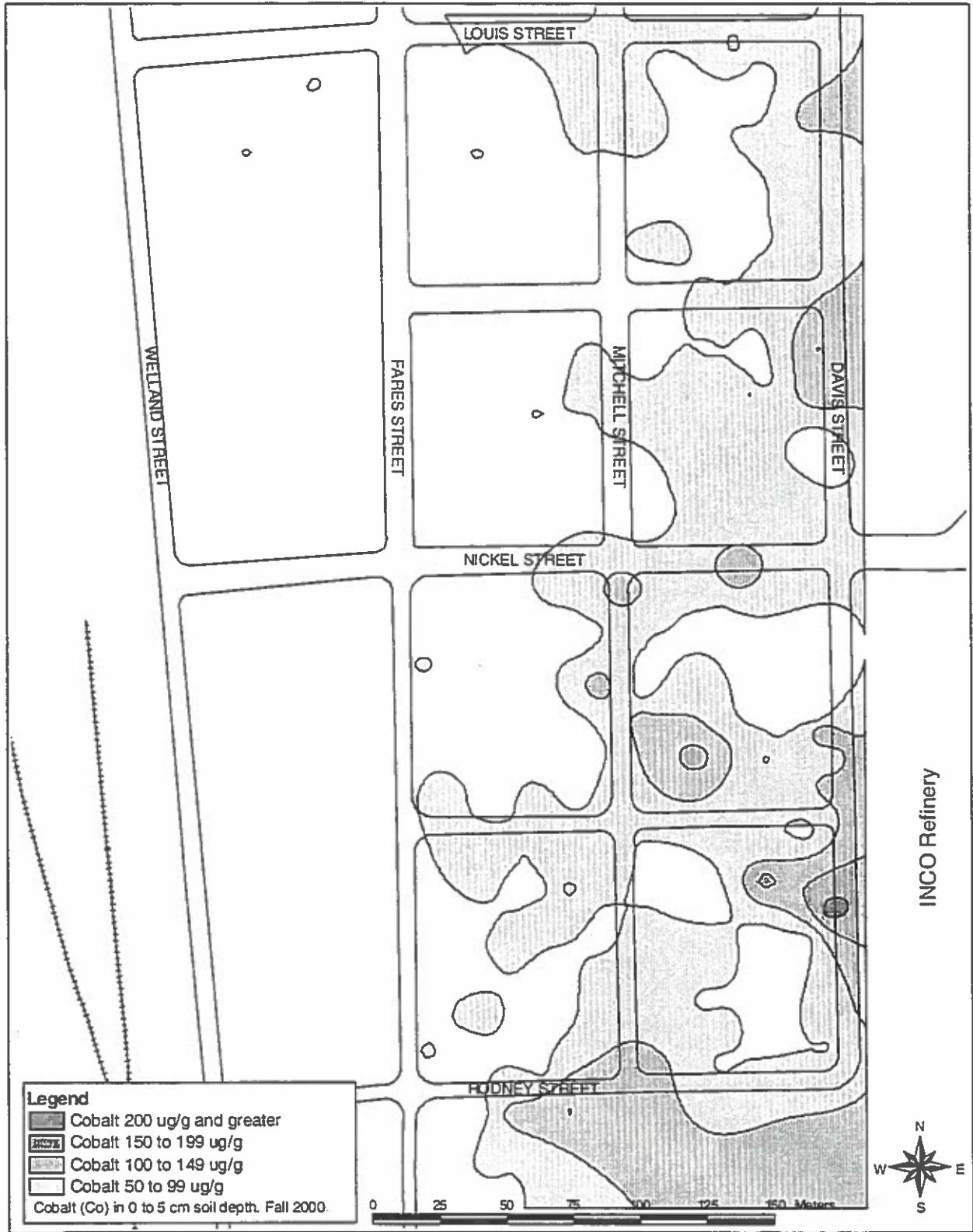




Map B11: Cadmium in 5 to 10 cm soil depth.

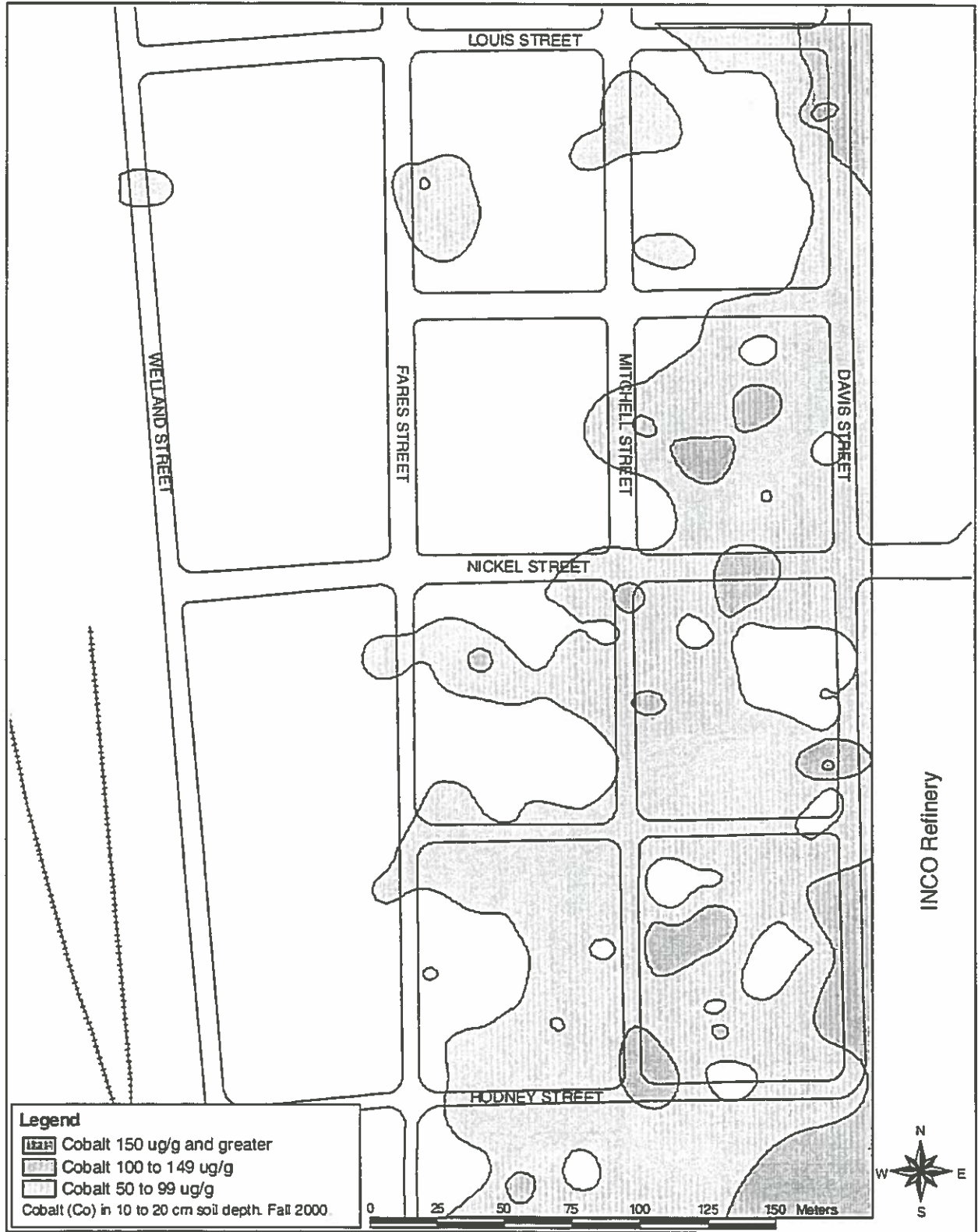


Map B12: Cadmium in 10 to 20 cm soil depth.

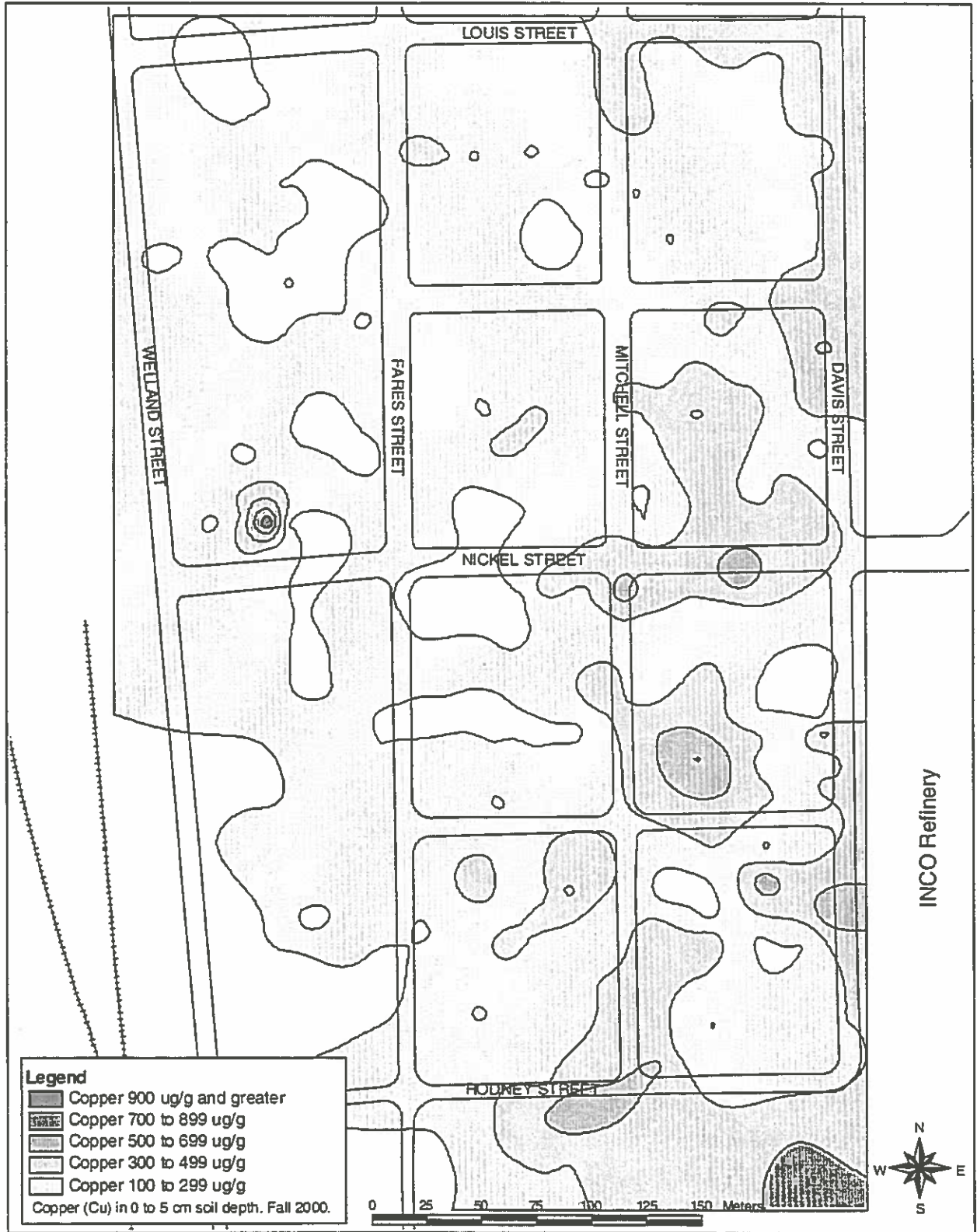




Map B14: Cobalt in 5 to 10 cm soil depth.



Map B15: Cobalt in 10 to 20 cm soil depth.

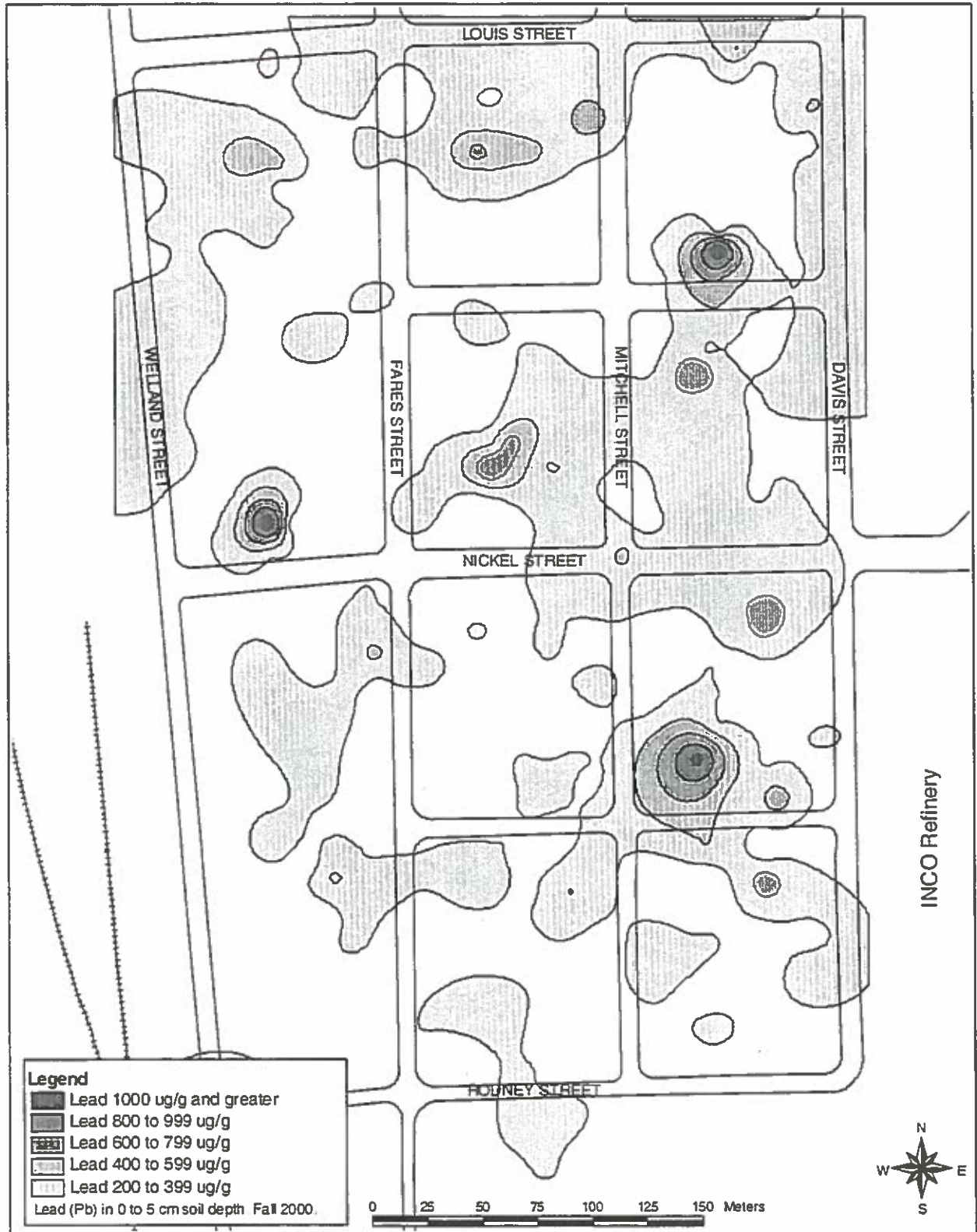


Map B16: Copper in 0 to 5 cm soil depth.

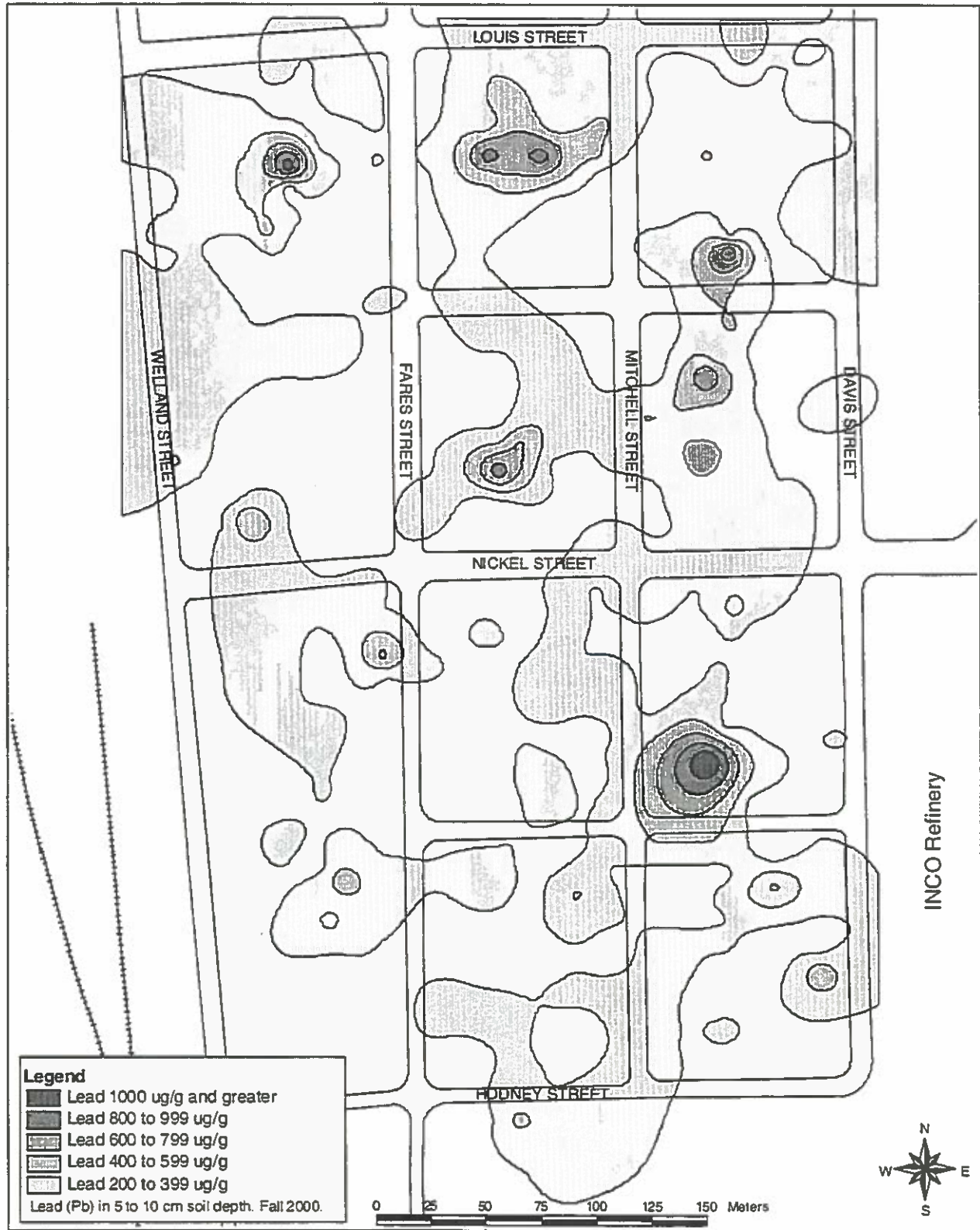




Map B18: Copper in 10 to 20 cm soil depth.



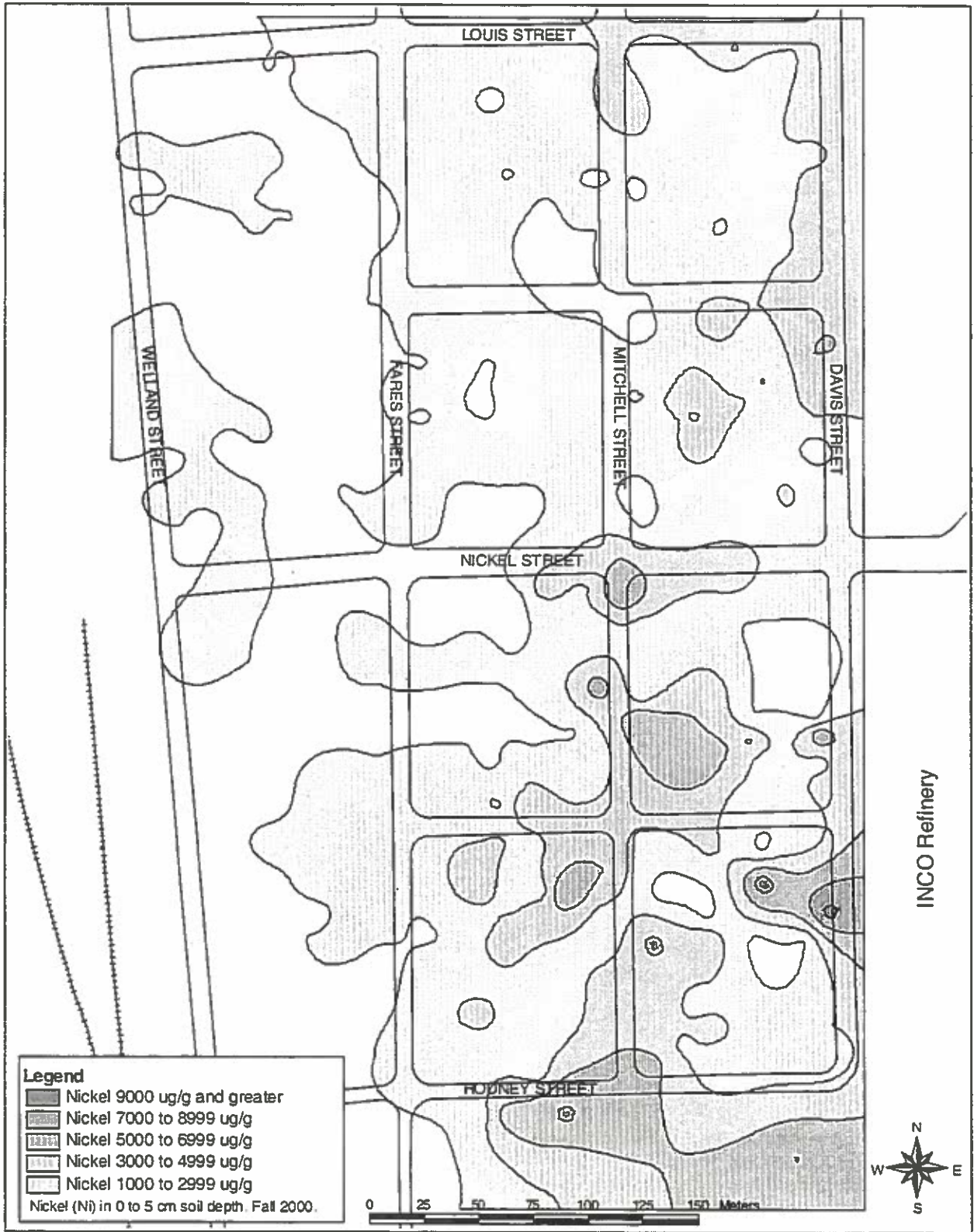
Map B19: Lead in 0 to 5 cm depth soil.



Map B20: Lead in 5 to 10 cm soil depth.



Map B21: Lead in 10 to 20 cm soil depth.



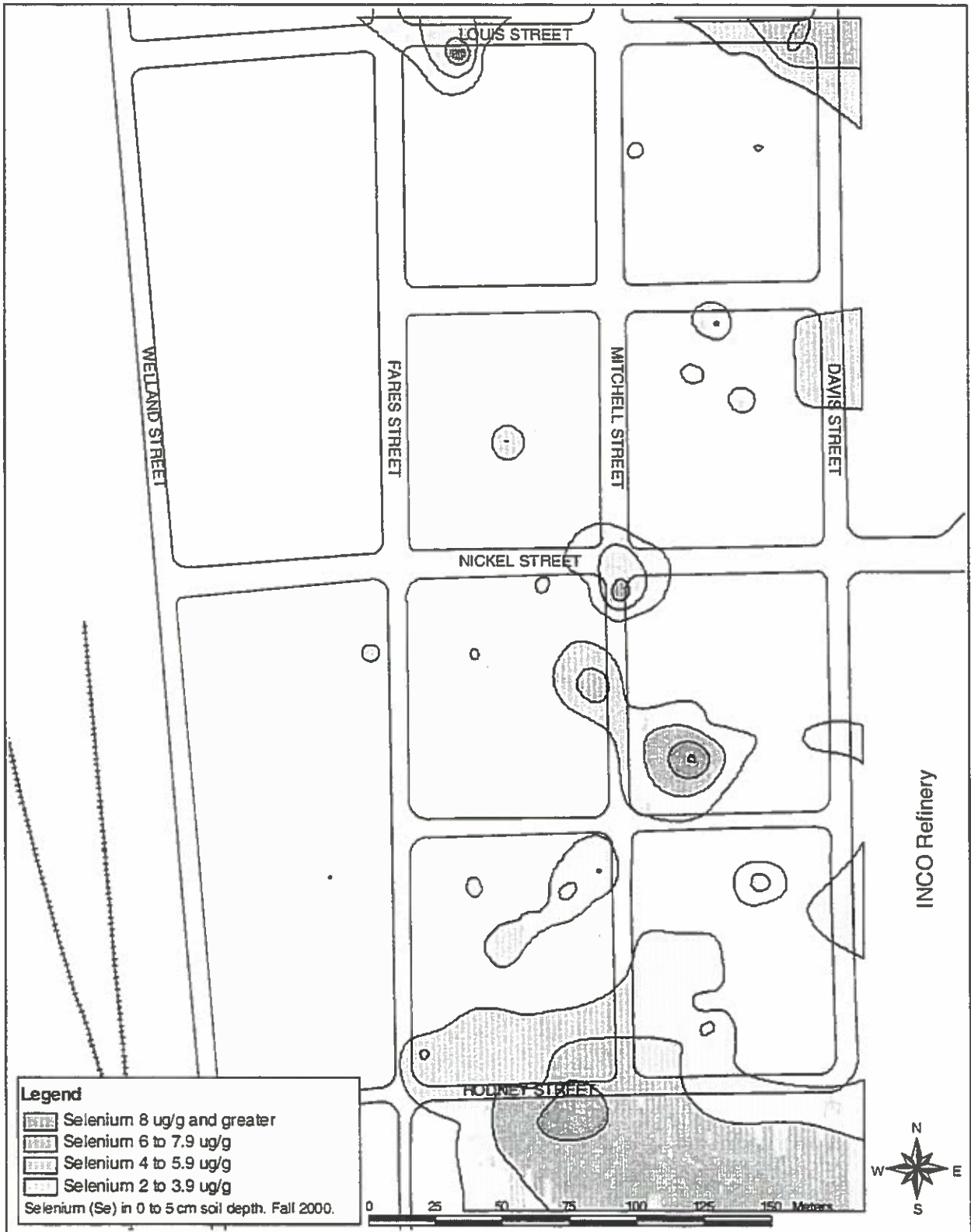
Map B22: Nickel in 0 to 5 cm soil depth.



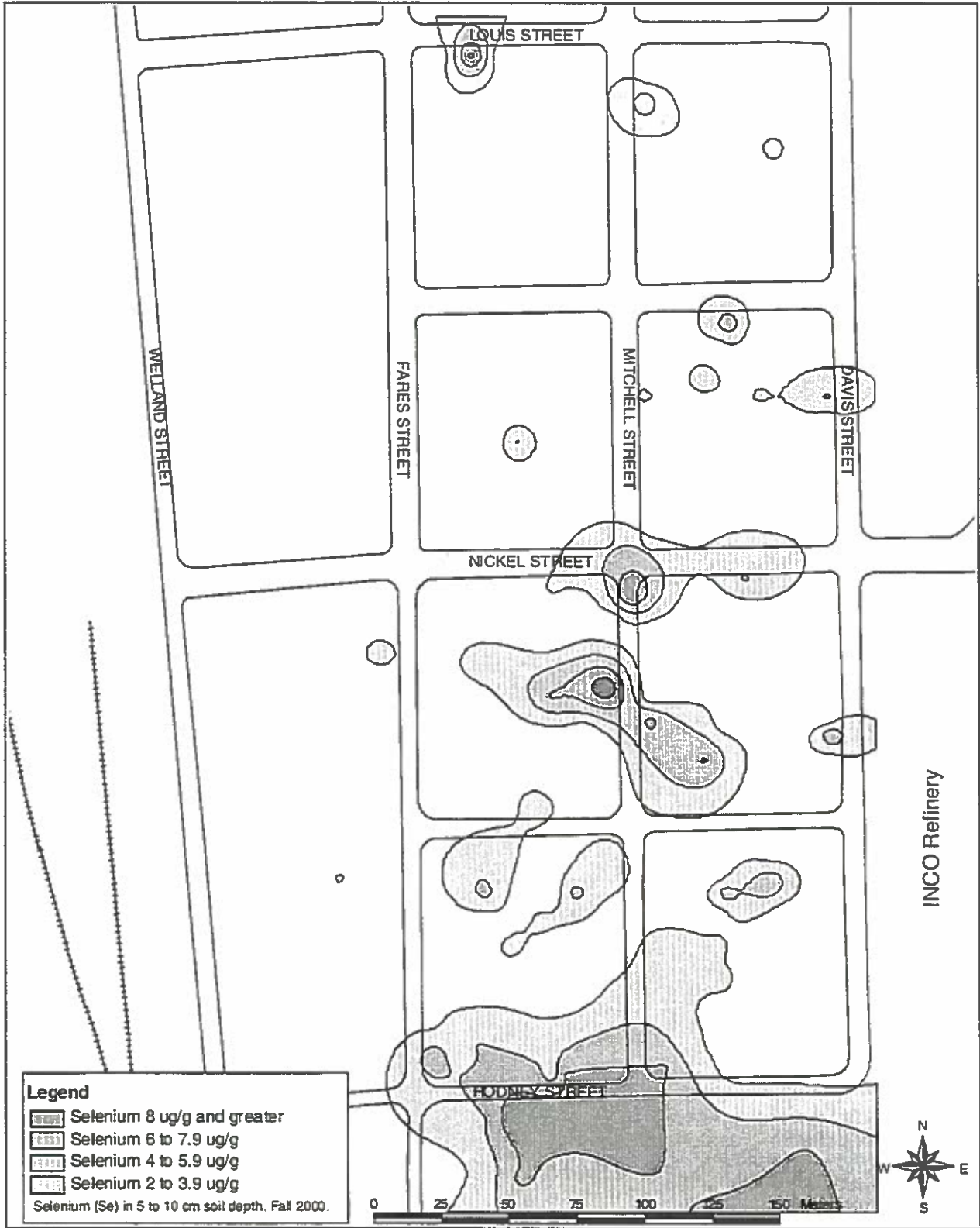
Map B23: Nickel in 5 to 10 cm soil depth.



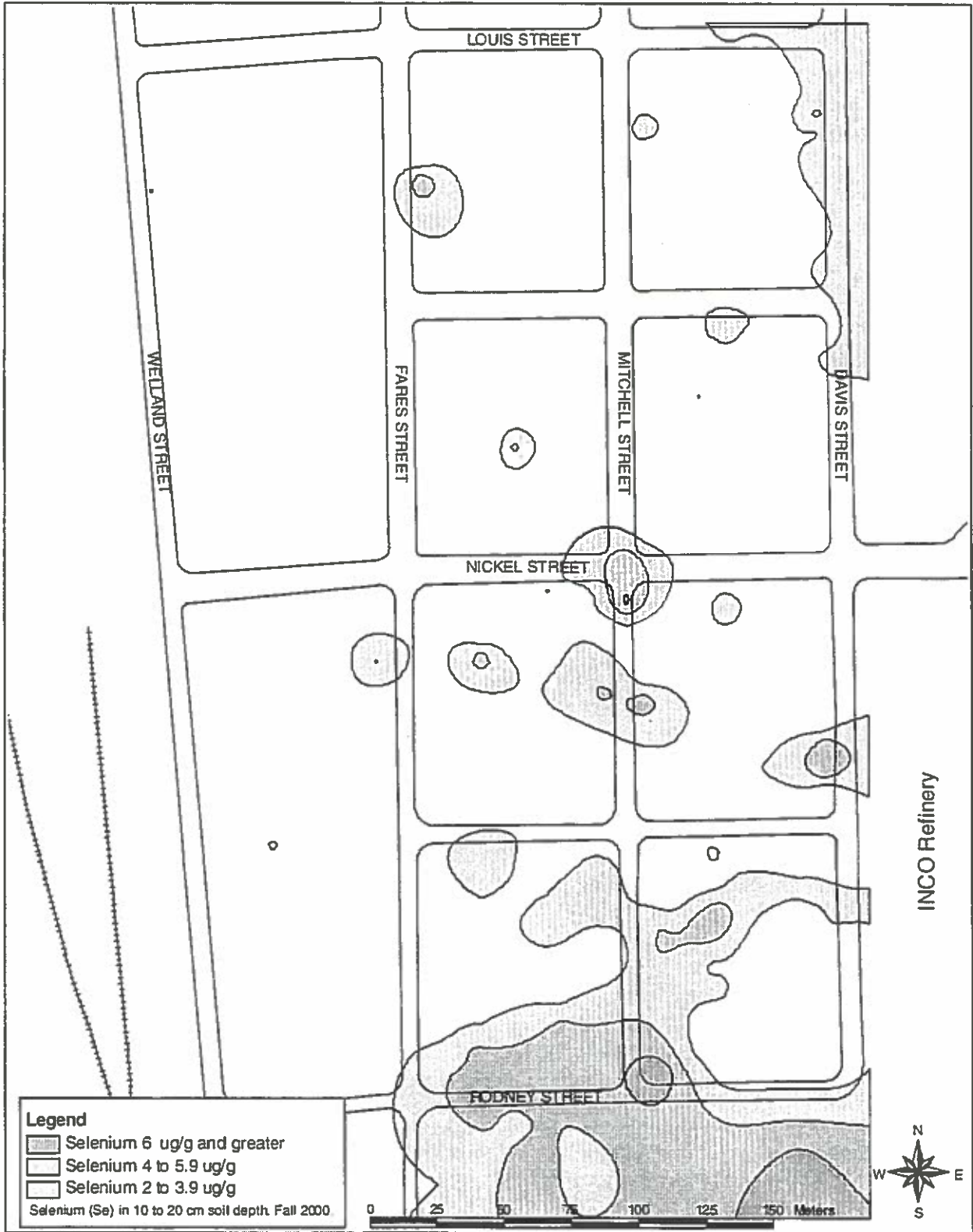
Map B24: Nickel in 10 to 20 cm soil depth.



Map B25: Selenium in 0 to 5 cm soil depth.



Map B26: Selenum in 5 to 10 cm soil depth.



Map B27: Selenium in 10 to 20 cm soil depth.

Methodology for Producing Surfer/ArcView Soil Contamination Maps

Software Utilized

Two software packages were used to generate the maps. The data analysis and creation of the concentration contours was done using Surfer Version 7.00 for Windows by Golden Software Inc. The output from Surfer was imported into ArcView GIS Version 3.1 by Environmental Systems Research Institute, Inc., and combined with base maps, roads and properties, to produce the final maps. The base map data was obtained from the City of Port Colborne, Public Works Department.

Data Used

For the contour maps produced in this report, all sampling stations collected south of Louis St in the fall of 2000 as part of the large survey or as individual complaint investigations, were used to generate the contours.

Mapping Process

The process involved in creating the maps was to analyze the data and create the desired contours using the Surfer program. The individual contours were exported from Surfer as ESRI Shape files. The polygon portion of the Shape files were imported into ArcView GIS and modified to remove polygon holes created by the export process. The resulting polygons were combined with the street base maps, and the station locations were imported from the Phytotoxicology Information Management System (PIMS). Layouts were then created to include a legend, labels, scale and compass and printed for the report.

Surfer

For all data sets, a Krigging gridding method was used and the search option was set to use all data. For all contours, smoothing was set at high. All co-ordinates were in Universal Trans Mercator (UTM) Easting and Northing. Where duplicate or triplicate samples existed for a sampling location the program was set to use the average of the results.

Surfer Settings

| Grid Line Geometry | | | | |
|-------------------------|-----------|-----------|---------|------------|
| | Minimum | Maximum | Spacing | # of Lines |
| X Axis (Easting) | 643185 m | 643527 m | 3 m | 115 |
| Y Axis (Northing) | 4748834 m | 4749383 m | 3 m | 184 |
| Duplicates - averaged | | | | |
| Matrix Smoothing - none | | | | |

Arc View

Station Map

A base map was created by importing the Autocad DXF files provided by the City of Port Colborne, Works Department and converting to Arcview Shape files. Only the road, rail lines, property boundaries and building foot prints layers were turned on. To this was added all of the stations sampled in the fall of 2000 by importing the station co-ordinates and related information from the PIMS database.

Contour Maps

The street layer of the station map was used as the underlying map for all contour maps. Property boundaries, building foot prints and street numbers were not included. The polygon for each contour interval were imported into Arcview as individual shape files from Surfer, any polygon holes removed and combined with the other contour intervals. Grey scales were used to differentiate contours for printing purposes.

Final Maps

A separate ArcView layout was produced for each of the maps and consisted of a base map, contour polygons, scale, compass and legend. Sampling stations were included on the contour polygons maps. These layouts were imported into the report.

Appendix C: Analysis of Chemical Relationships

Table C1: Results of Pearson Correlation Test on soil data from all depths.

| Parameter | Al | Sb | As | Ba | Be | Cd | Ca | Cr | Co | Cu | Fe | Pb | Mg | Mn | Mo | Ni | Se | Sr | V | Zn | |
|-----------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|----|--|
| Aluminum (Al) | 1 | | | | | | | | | | | | | | | | | | | | |
| Antimony (Sb) | 0 | 1 | | | | | | | | | | | | | | | | | | | |
| Arsenic (As) | -0.2 | 0.16 | 1.00 | | | | | | | | | | | | | | | | | | |
| Barium (Ba) | 0.35 | 0.22 | 0.20 | 1.00 | | | | | | | | | | | | | | | | | |
| Beryllium (Be) | 0.79 | 0.1 | 0 | 0.60 | 1.00 | | | | | | | | | | | | | | | | |
| Cadmium (Cd) | 0.16 | 0.14 | 0.12 | 0.44 | 0.28 | 1.00 | | | | | | | | | | | | | | | |
| Calcium (Ca) | 0.11 | 0.1 | 0 | 0.34 | 0.28 | 0.13 | 1.00 | | | | | | | | | | | | | | |
| Chromium (Cr) | 0.45 | 0.11 | 0.34 | 0.47 | 0.52 | 0.26 | 0.14 | 1.00 | | | | | | | | | | | | | |
| Cobalt (Co) | 0 | 0.1 | 0.56 | 0.31 | 0.11 | 0.27 | 0.1 | 0.36 | 1 | | | | | | | | | | | | |
| Copper (Cu) | 0 | 0.16 | 0.56 | 0.46 | 0.16 | 0.33 | 0.14 | 0.37 | 0.84 | 1.00 | | | | | | | | | | | |
| Iron (Fe) | 0 | 0.15 | 0.59 | 0.34 | 0.17 | 0.2 | 0.14 | 0.41 | 0.75 | 0.71 | 1.00 | | | | | | | | | | |
| Lead (Pb) | 0 | 0.38 | 0.28 | 0.74 | 0.29 | 0.41 | 0.27 | 0.30 | 0.36 | 0.50 | 0.37 | 1 | | | | | | | | | |
| Magnesium (Mg) | 0.44 | 0 | -0.2 | 0.21 | 0.4 | 0.1 | 0.69 | 0.23 | 0 | 0 | 0 | 0.1 | 1.00 | | | | | | | | |
| Manganese (Mn) | 0.1 | 0.1 | 0.25 | 0.23 | 0.21 | 0.11 | 0.25 | 0.23 | 0.34 | 0.31 | 0.49 | 0.18 | 0.15 | 1.00 | | | | | | | |
| Molybdenum (Mo) | 0.25 | 0 | -0.2 | 0.2 | 0.32 | 0.19 | 0.17 | 0.16 | 0 | 0 | 0 | 0.12 | 0.25 | 0.14 | 1.00 | | | | | | |
| Nickel (Ni) | -0.1 | 0.1 | 0.6 | 0.33 | 0.1 | 0.29 | 0.08 | 0.33 | 0.93 | 0.87 | 0.82 | 0.41 | 0 | 0.35 | -0.1 | 1.00 | | | | | |
| Selenium (Se) | -0.4 | 0.11 | 0.56 | 0.1 | -0.2 | 0.1 | 0 | 0.13 | 0.73 | 0.66 | 0.68 | 0.26 | -0.2 | 0.27 | -0.3 | 0.77 | 1.00 | | | | |
| Strontium (Sr) | 0.1 | 0.14 | 0.1 | 0.44 | 0.33 | 0.18 | 0.67 | 0.2 | 0.1 | 0.19 | 0.16 | 0.36 | 0.30 | 0.12 | 0.1 | 0.11 | 0.1 | 1.00 | | | |
| Vanadium (V) | 0.89 | 0 | 0 | 0.37 | 0.75 | 0.13 | 0.1 | 0.49 | 0.1 | 0 | 0.13 | 0 | 0.44 | 0.11 | 0.15 | 0 | -0.3 | 0.1 | 1.00 | | |
| Zinc (Zn) | -0.1 | 0.23 | 0.5 | 0.67 | 0.23 | 0.42 | 0.21 | 0.42 | 0.66 | 0.77 | 0.65 | 0.75 | 0 | 0.3 | 0 | 0.71 | 0.57 | 0.34 | 0 | 1 | |

All values > 0.08 are significantly correlated to the 95% level

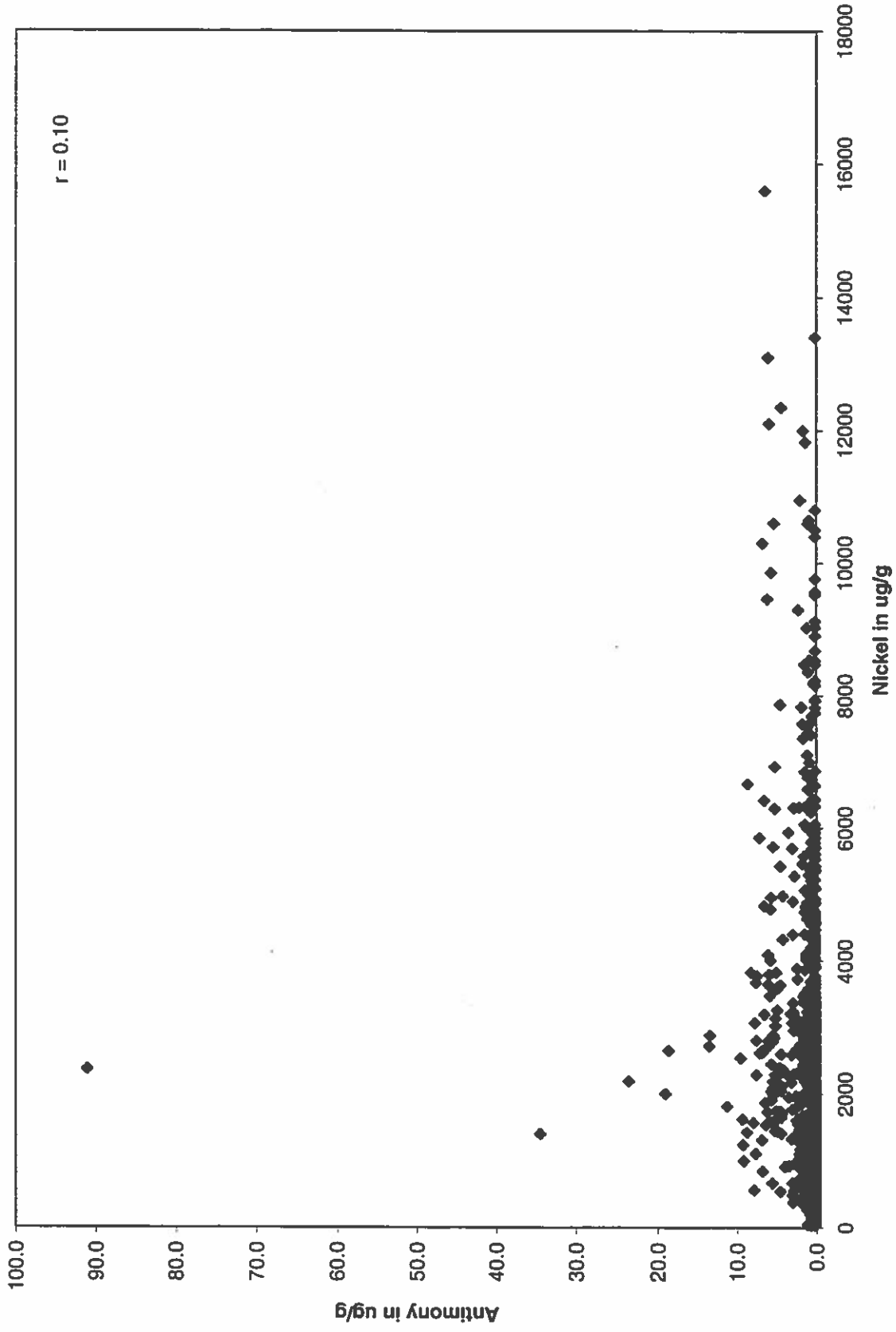


Figure C1: Relationship between antimony and nickel in soil for all depths.

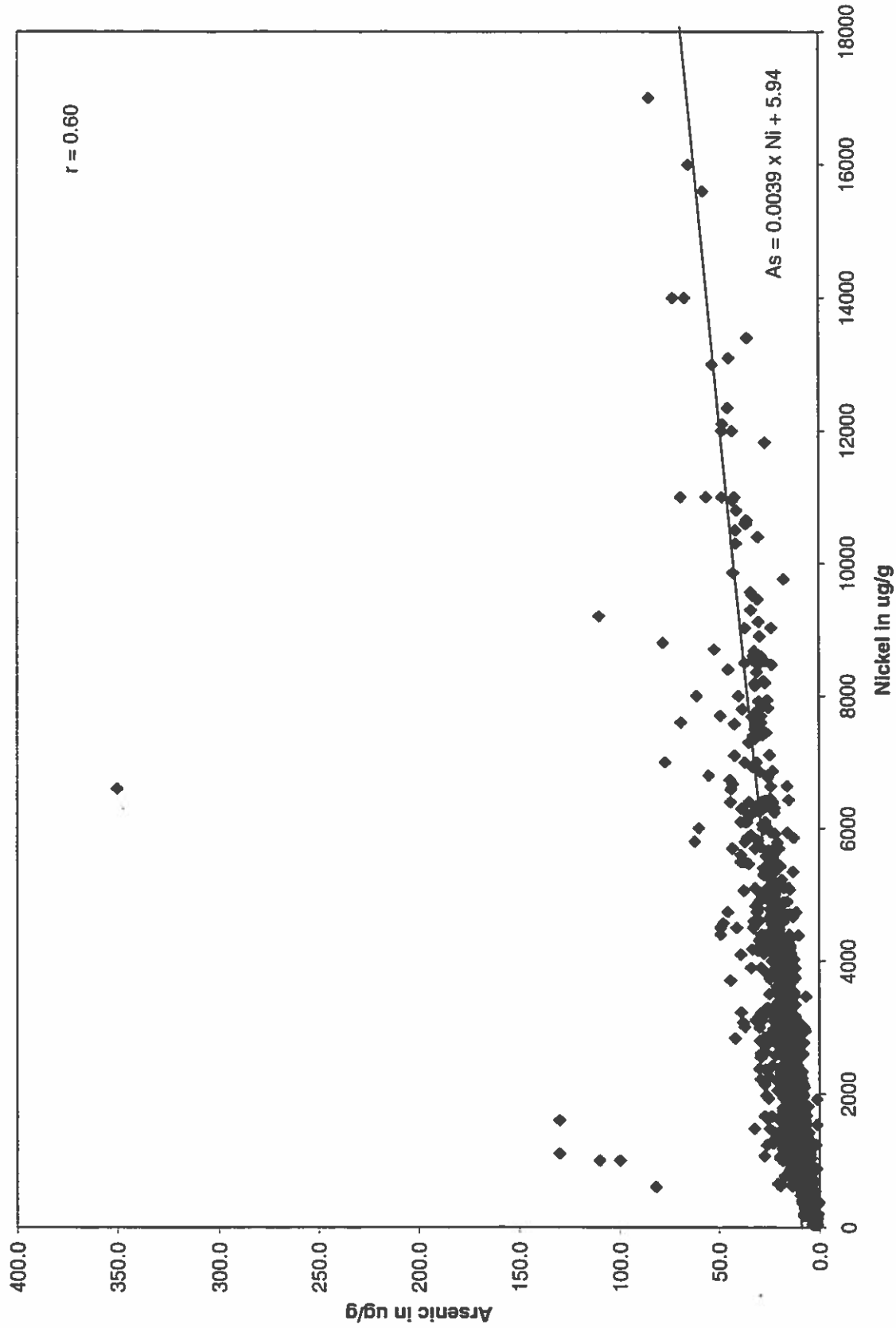


Figure C2: Relationship between arsenic and nickel in soil for all depths.

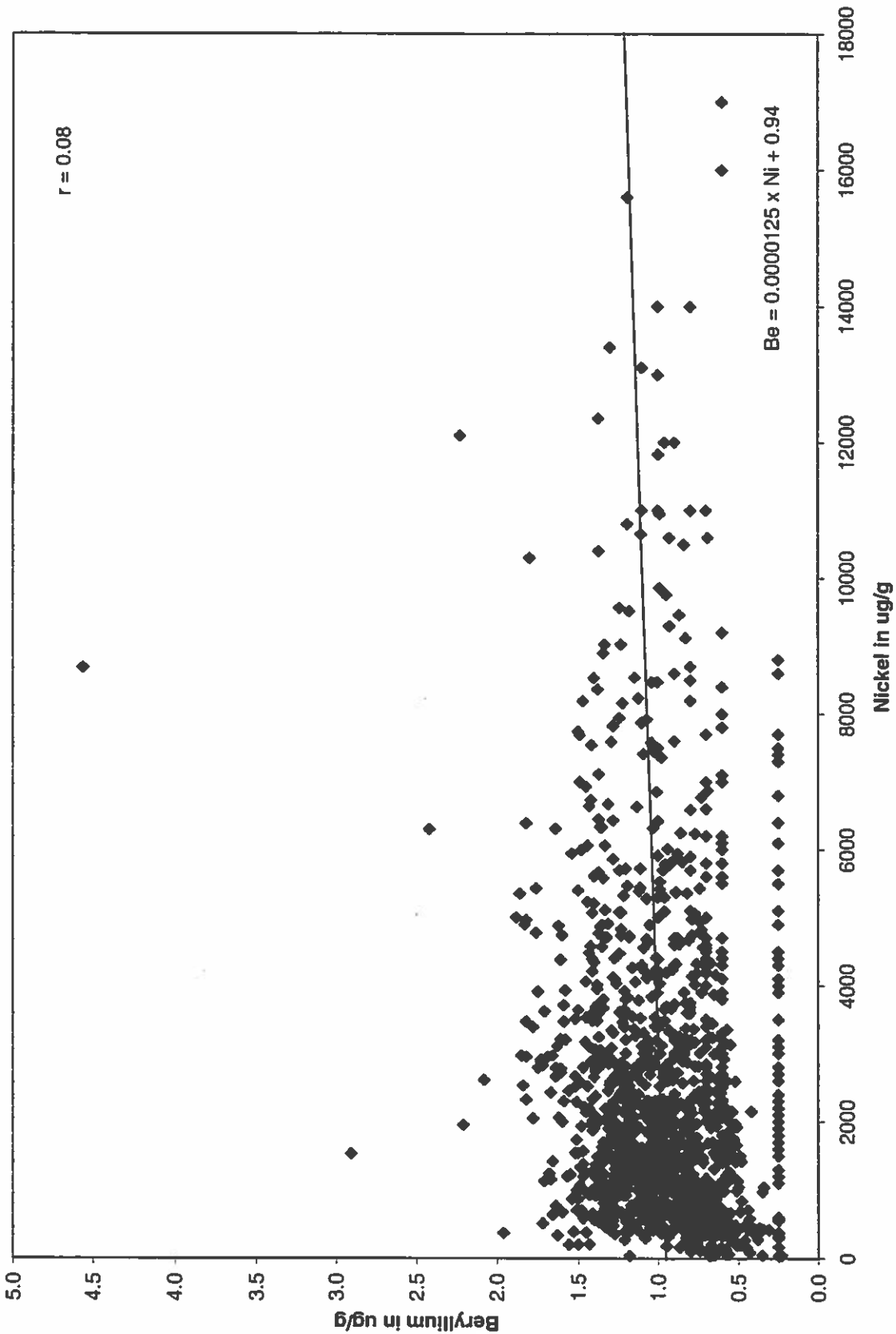


Figure C3: Relationship between beryllium and nickel in soil for all depths.

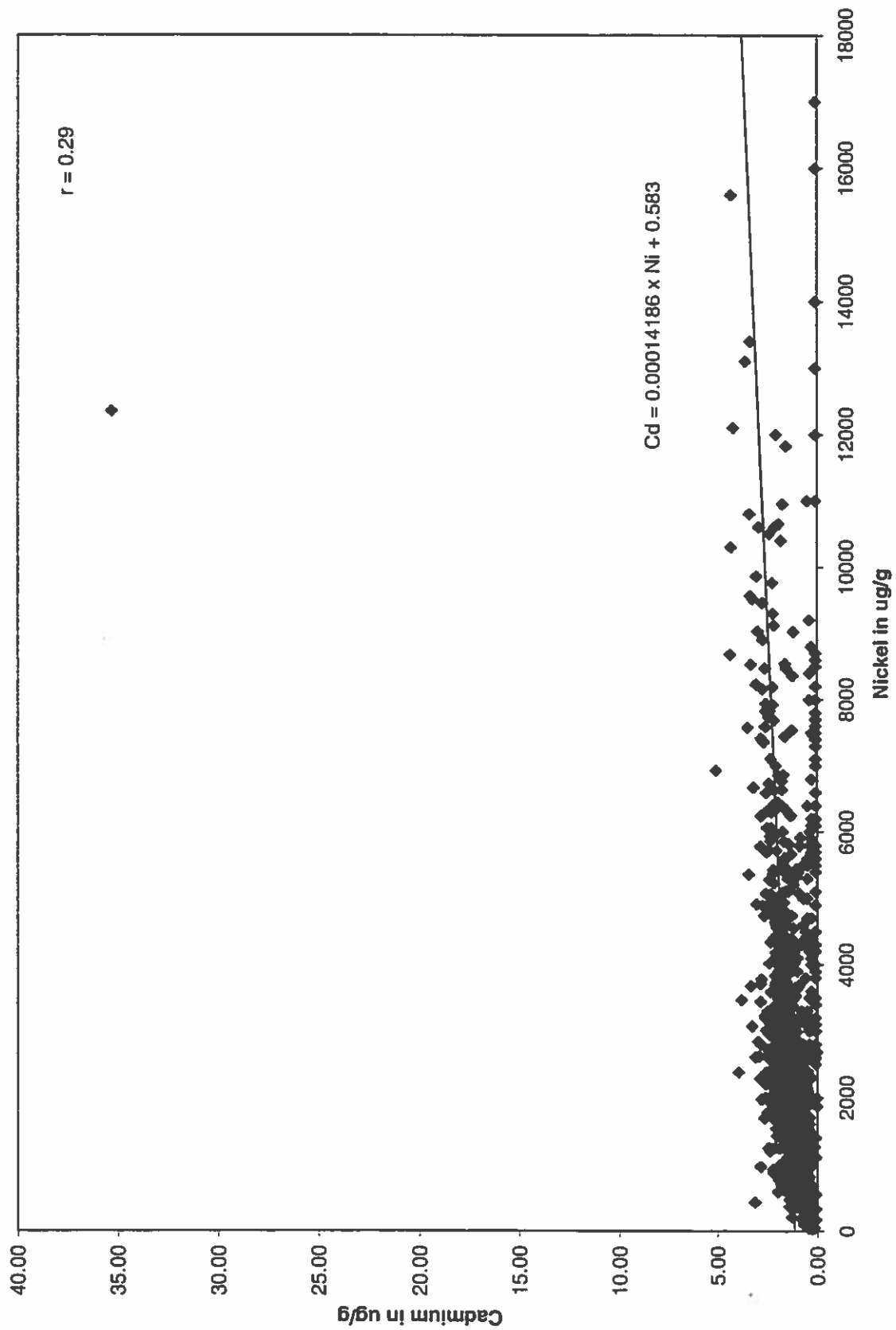


Figure C4: Relationship between cadmium and nickel in soil for all depths.

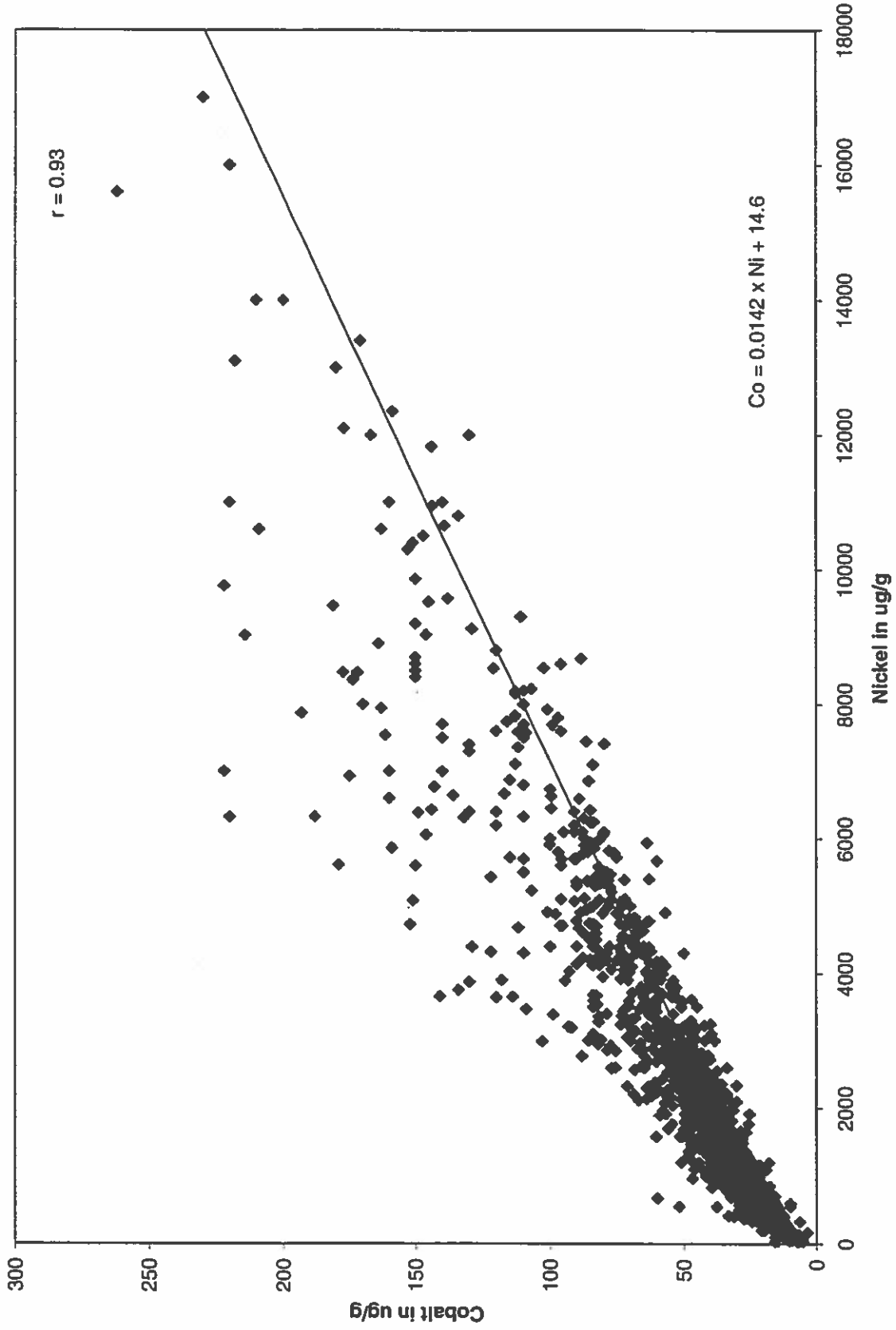


Figure C5: Relationship between cobalt and nickel in soil for all depths.

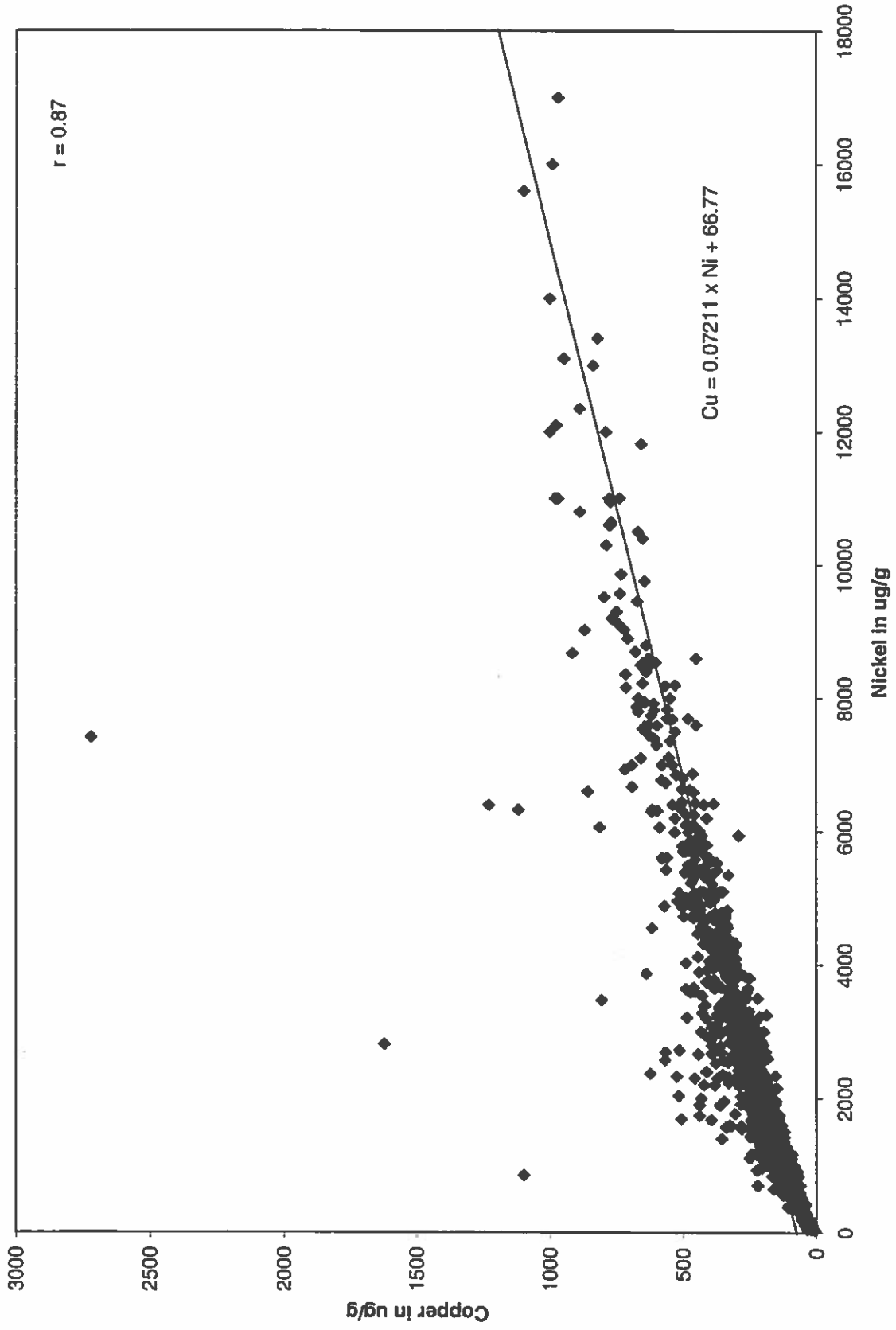


Figure C6: Relationship between copper and nickel in soil for all depths.

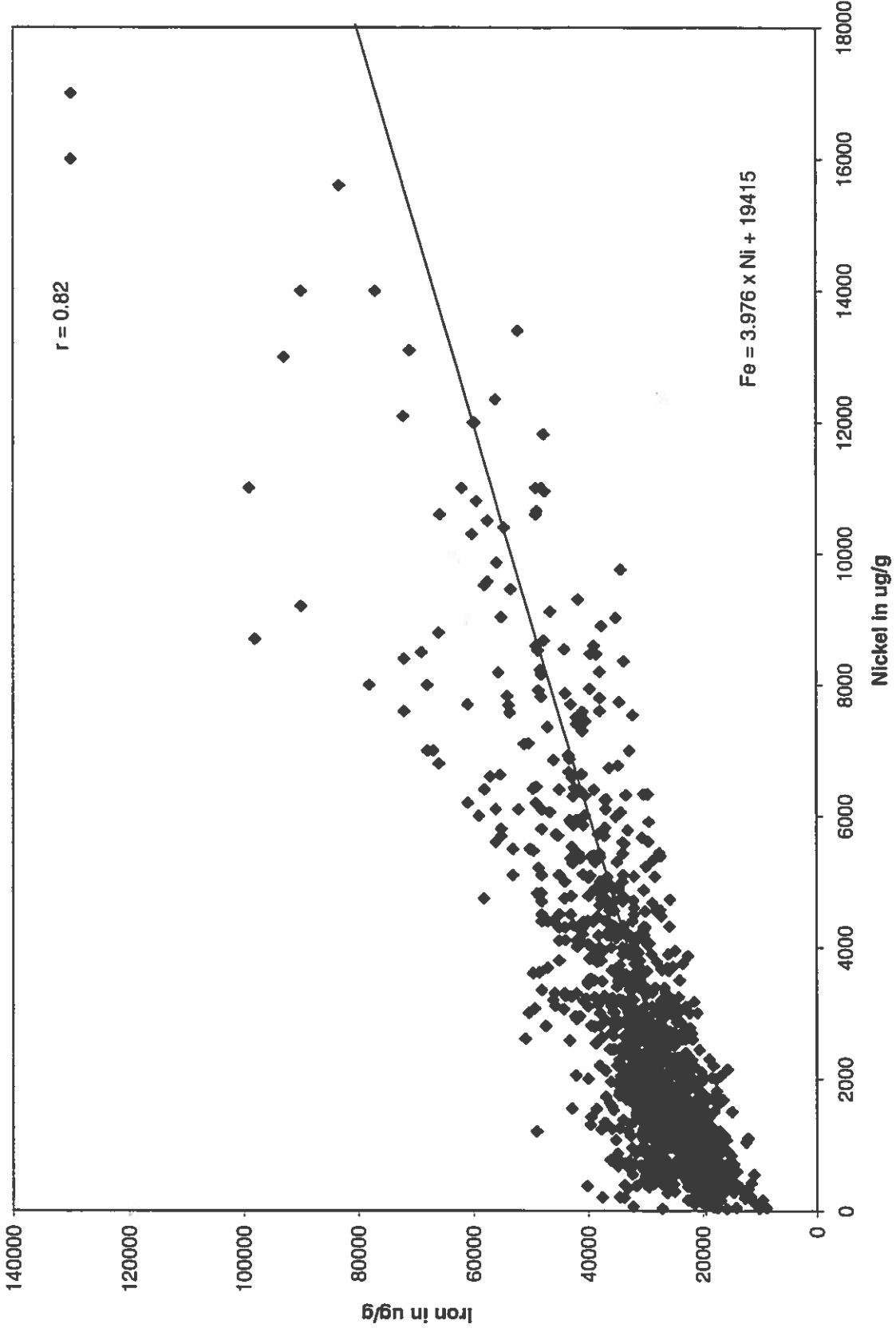


Figure C7: Relationship between iron and nickel in soil for all depths.

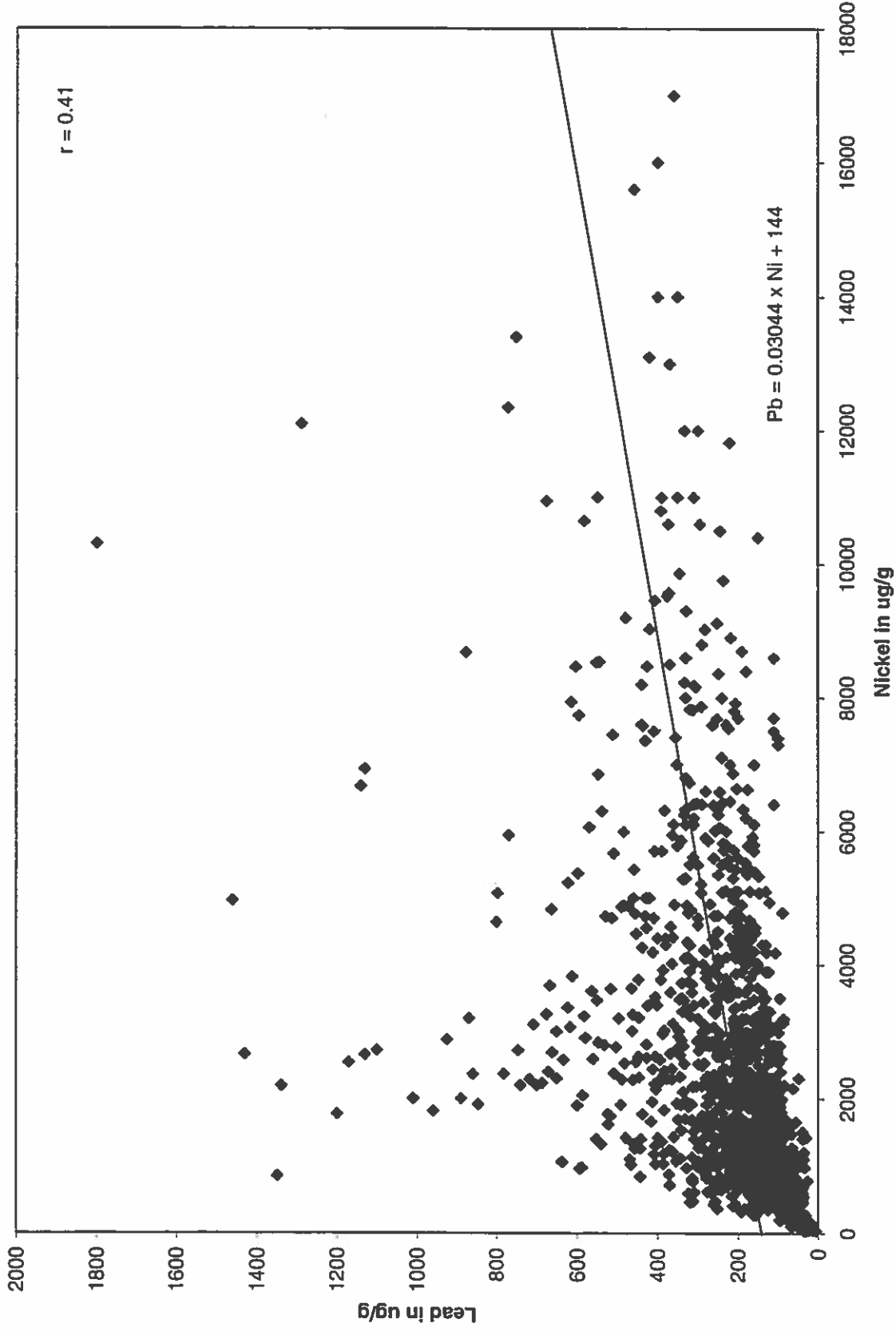


Figure C8: Relationship between lead and nickel in soil for all depths.

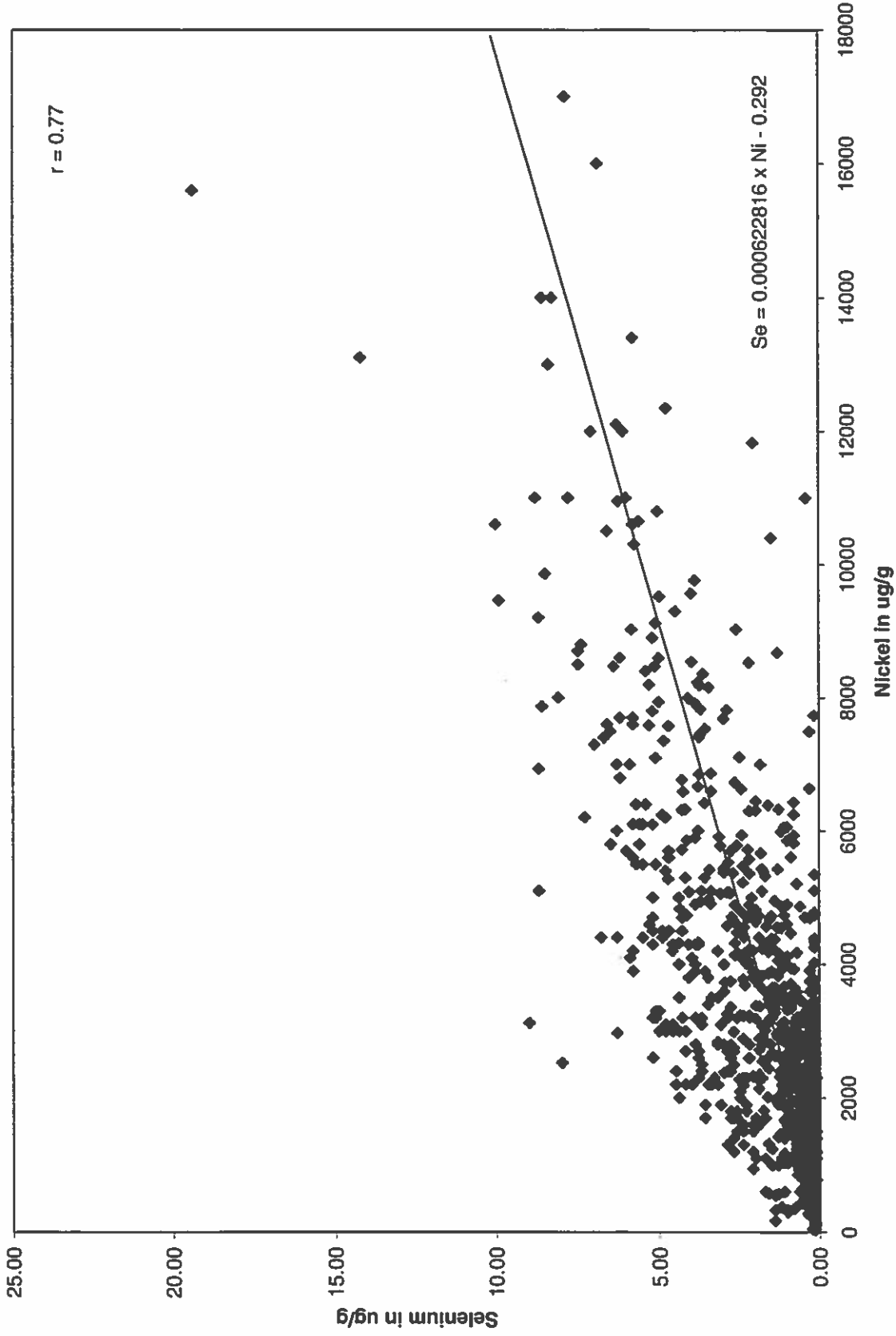


Figure C9: Relationship between selenium and nickel in soil for all depths.

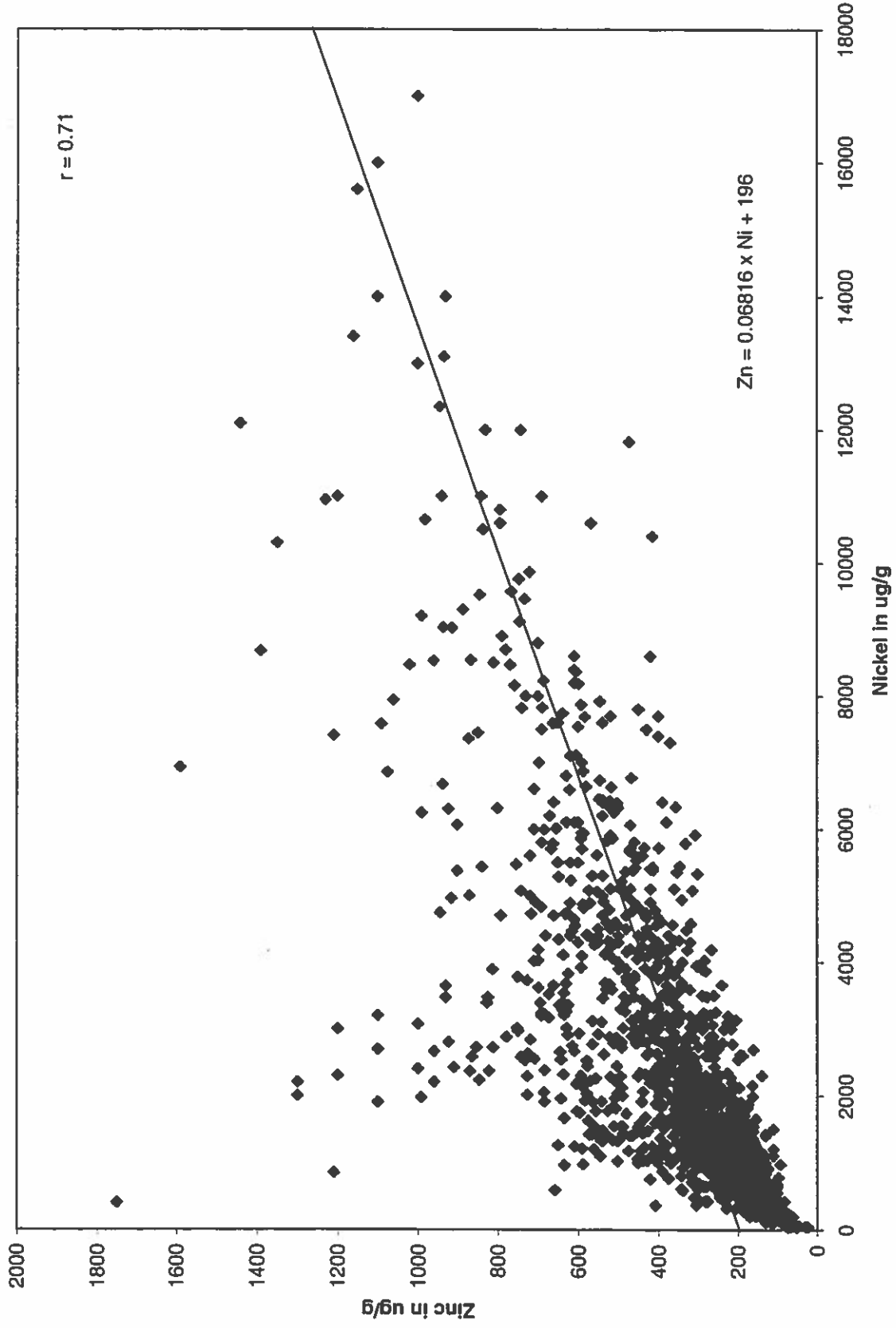


Figure C10: Relationship between zinc and nickel in soil for all depths.

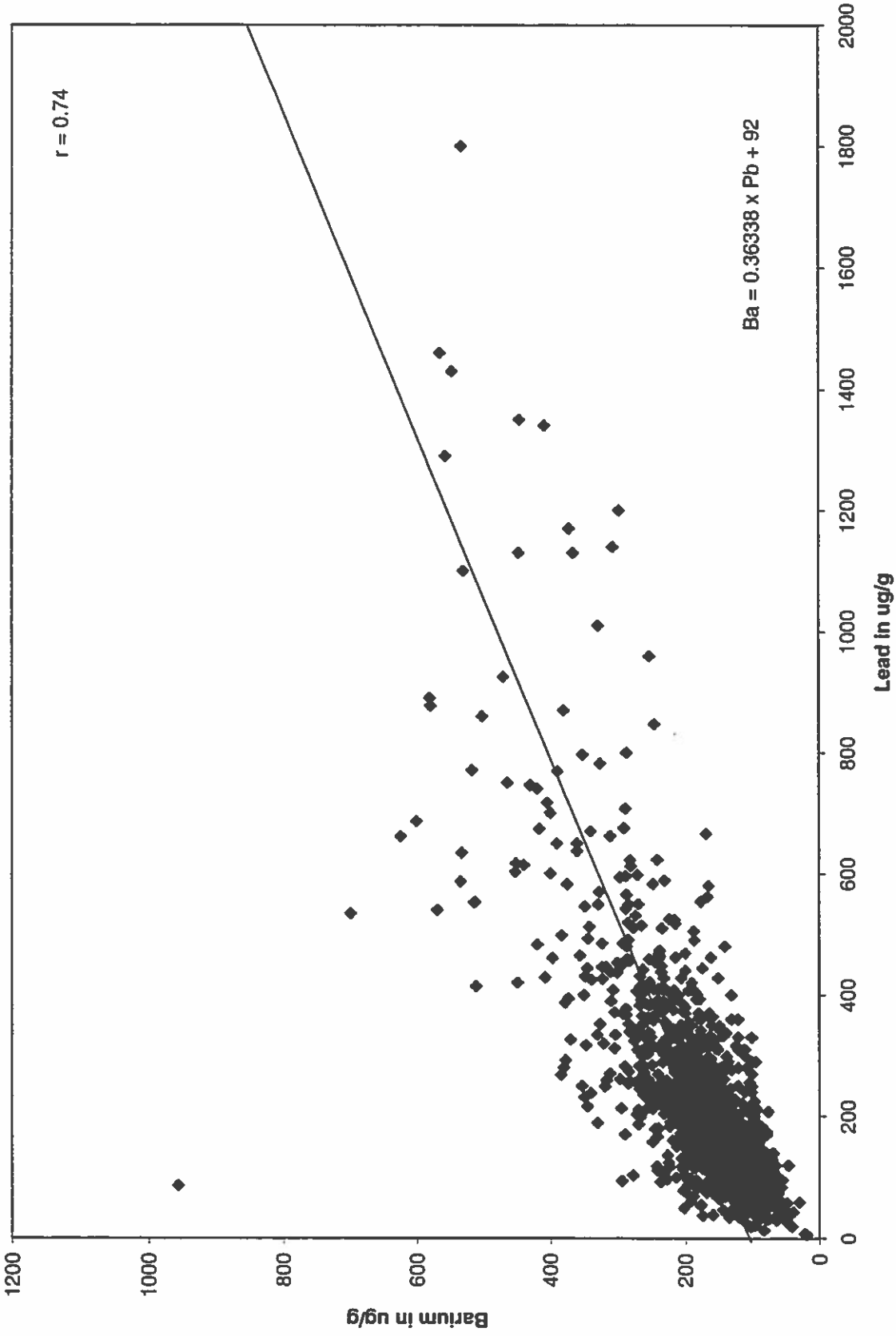


Figure C11: Relationship between barium and lead in soil for all depths.

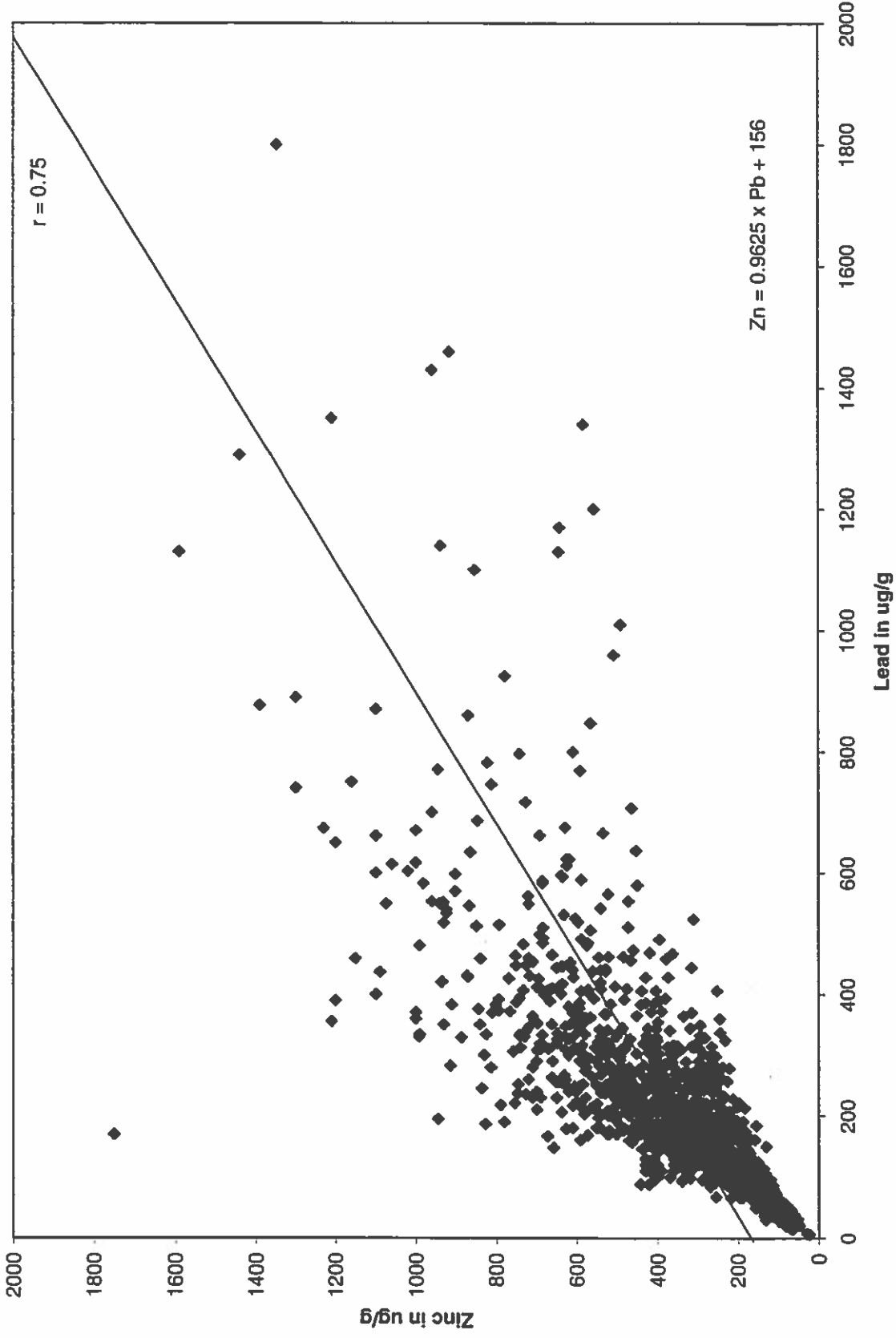


Figure C12: Relationship between zinc and lead in soil for all depths.

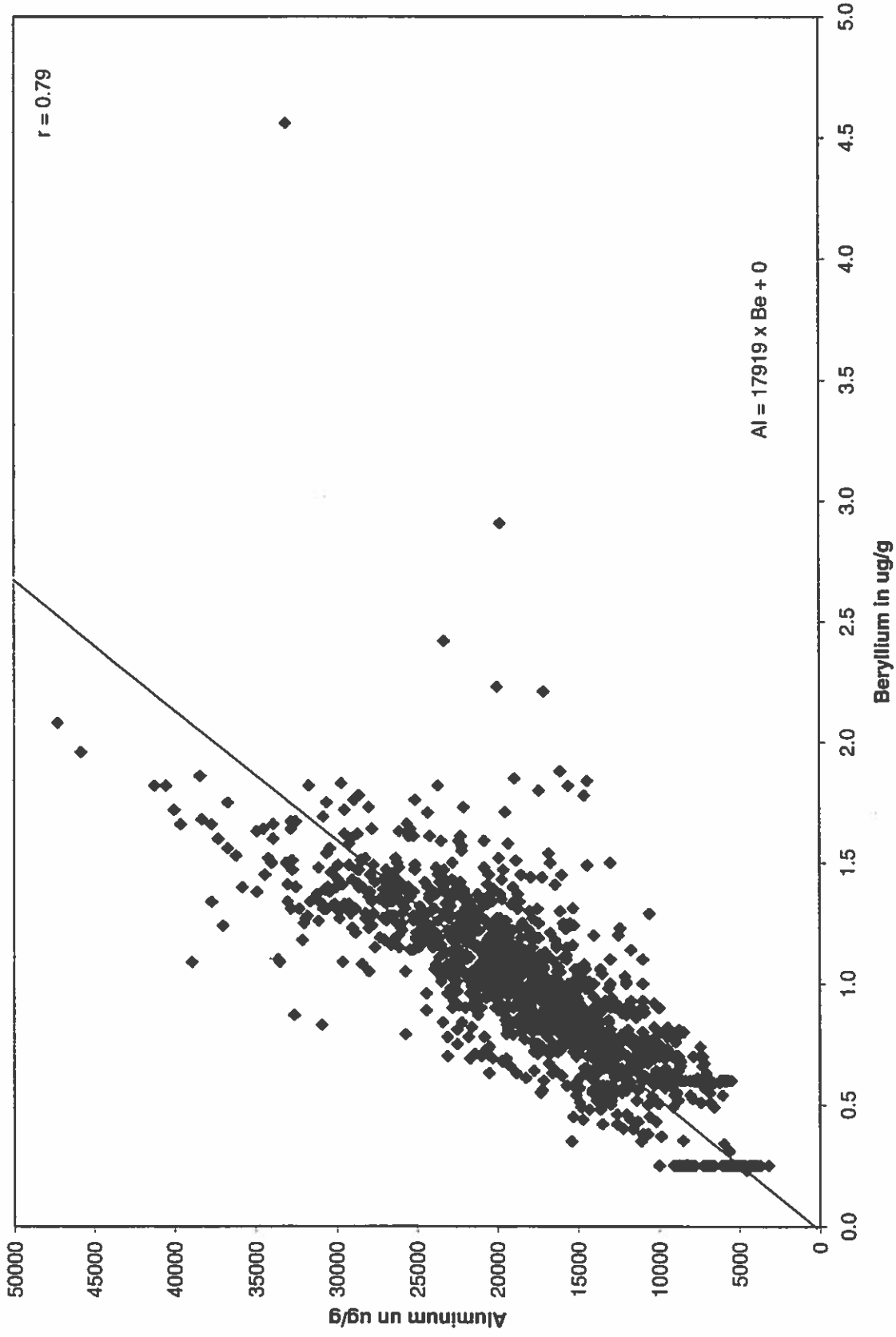


Figure C13: Relationship between aluminum and beryllium in soil for all depths.

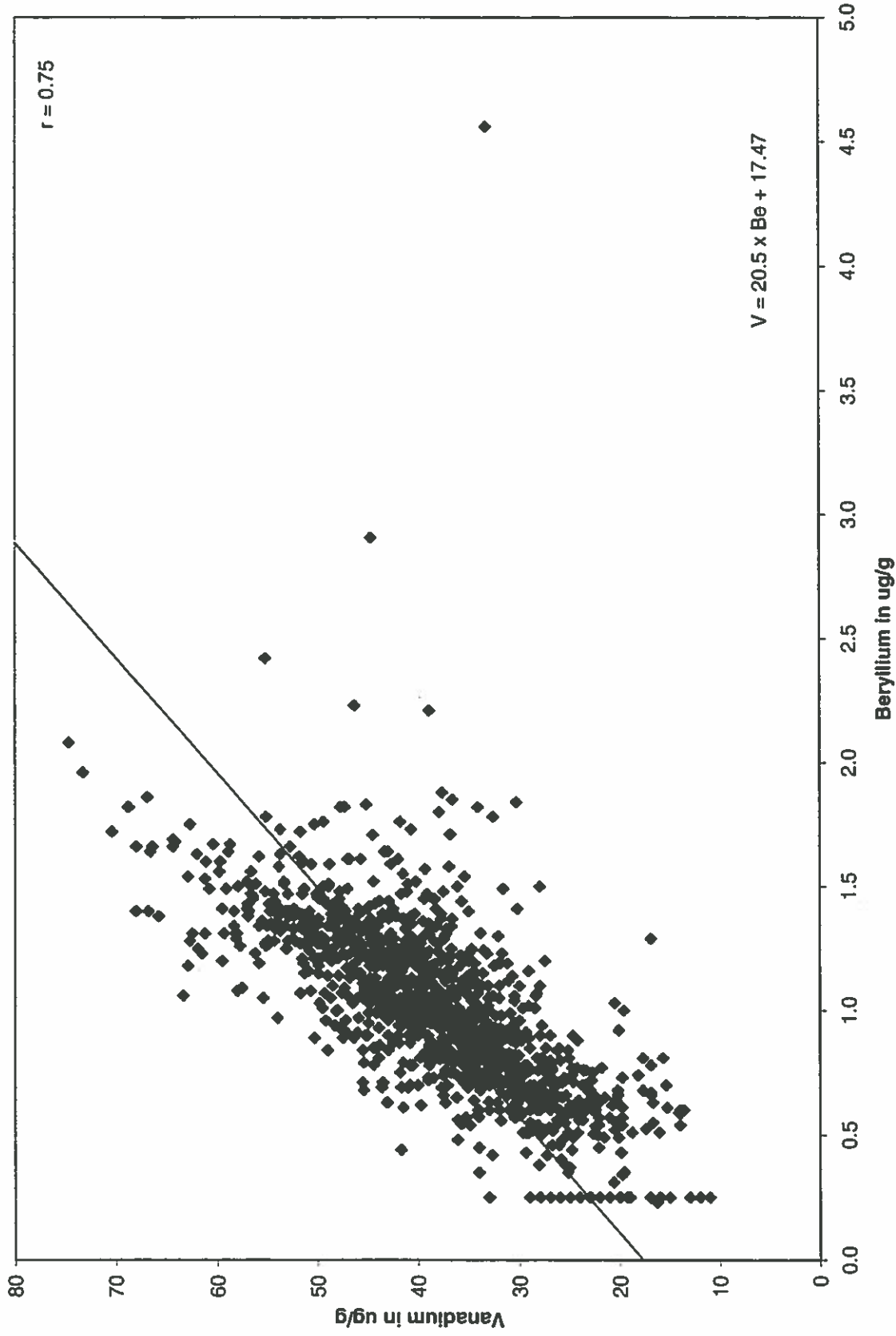


Figure C14: Relationship between vanadium and beryllium in soil for all depths.

Appendix D

Derivation and Significance of the MOE Soil Remediation Criteria (Clean-up Guidelines)

The MOE soil clean-up *Guidelines* have been developed to provide guidance for cleaning up contaminated soil. The *Guidelines* are not legislated Regulations. Also, the *Guidelines* are not action levels, in that an exceedence does not automatically mean that a clean-up must be conducted. The *Guidelines* were prepared to help industrial property owners decide how to clean-up contaminated soil when property is sold and/or the land-use changes. Most municipalities insist that contaminated soil is cleaned up according to the MOE *Guidelines* before they will approve a zoning change for redevelopment, therefore, even though the *Guideline* is voluntary most industrial property owners and developers are obliged to use it. For example, the owner of an industrial property who plans to sell the land to a developer who intends to build residential housing can use the *Guideline* to clean up the soil to meet the residential land-use criteria. In this way previously-contaminated industrial land can be re-used for residential housing without concern for adverse environmental effects.

The *Guideline* contains a series of Tables (A through F), each having criteria for soil texture, soil depth, and ground water use for various land-use categories (eg, agricultural, residential, industrial). Table F *criteria* reflect the upper range of background concentrations for soil in Ontario. An exceedence of Table F indicates the likely presence of a contaminant source. Tables A through E *criteria* are effects-based and are set to protect against the potential for adverse effects to human health, ecological health, and the natural environment, whichever is the most sensitive. By protecting the most sensitive parameter the rest of the environment is protected by default. The *Guideline criteria* take into consideration the potential for adverse effects through direct contact, and through contaminant transfer from soil to indoor air, from ground water or surface water through release of volatile gases, from leaching of contaminants in soil to ground water, or from ground water discharge to surface water. However, the *Guideline criteria may not* ensure that corrosive, explosive, or unstable soil conditions will be eliminated.

If the decision is made that remedial action is needed, the *criteria* in Tables A to F of the *Guideline* can be used as clean-up targets. In some cases, because of economic or practical reasons, it may not be possible to clean up a site using the generic *criteria* in Tables A to F. The *Guideline* provides a process, called a *site specific risk assessment*, which is used to evaluate the soil contamination with respect to conditions that are unique to the contaminated site. In a *site specific risk assessment* the proponent examines all the potential pathways through which the contamination may impact the environment and must demonstrate that because of conditions unique to that site the environment and human health will not be adversely effected if contamination above the generic *criteria* in Table A to E is left in place.

When contamination is present and a change in land-use is not planned, for example residential properties and public green spaces near a pollution source, the *Guideline* may be used in making decisions about the need for remediation. This is different from the previously described situation where a company that caused contamination on their own property decides to clean up the soil, usually at the insistence of the municipality who will not approve a zoning change unless remediation is conducted. Decisions on the need to undertake remedial action when the *Guideline criteria* are exceeded *and* where

the land-use is not changing are made on a site by site basis using *site specific risk assessment* principals and are usually contingent on the contaminants having caused an adverse environmental effect or there is a demonstrated likelihood that the contamination may cause an adverse effect. Because of the long history of industrial operation and our practice of living close to our work place the soil in many communities in Ontario is contaminated above the effects-based *criteria* in the MOE *Guidelines*. In practice, remediation of contaminated soil on privately-owned residential property and public green spaces has only been conducted in communities when the potential for adverse health effects has been demonstrated.

The soil clean-up *Guidelines* were developed from published U.S. EPA and Ontario environmental data bases. Currently there are criteria for about 25 inorganic elements and about 90 organic compounds. Criteria were developed only if there were sufficient, defensible, effects-based data on the potential to cause an adverse effect. All of the criteria address human health and aquatic toxicity, but terrestrial ecological toxicity information was not available for all elements or compounds. The development of these clean-up *Guidelines* is a continuous program, and criteria for more elements and compounds will be developed as additional environmental data become available. Similarly, new information could result in future modifications to the existing *Guidelines*.

For more information on the MOE's soil clean-up *Guidelines* please refer to the *Guideline for Use at Contaminated Sites in Ontario. Revised February 1997*, Ontario Ministry of Environment and Energy, PIBs 3161E01, ISBN 0-7778-6114-3, or go to the MOE web site at www.ene.gov.on.ca.

Part B: Human Health Risk Assessment

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1.0 Introduction

This document is part of a combined Standards Development Branch soil investigation (Part A) and health-based risk assessment report (Part B). The health-based risk assessment part of this report is designed to answer community health concerns raised by the discovery of elevated levels of nickel and other metals below the normal surface soil sampling depth (0-5 cm) on a Rodney Street property in June 2000. The soil metal concentrations were higher than previously measured (Part A).

While this study is health-based, it is not a community health study. This health-based risk assessment is directed at assessing exposure to selected metals in Rodney Street properties to evaluate whether health-based exposure limits are exceeded and whether there is an exposure level (or soil concentration) that warrants further actions (including soil remediation) to reduce exposure to identified soil metal concentrations. This approach takes a snapshot of current soil levels based on the most recent soil monitoring information as shown in the accompanying soil investigation (Part A).

For historical reasons and the proximity of the INCO metal refinery, the primary focus of the investigation was directed at the widespread and elevated levels of nickel in the community. Initially this study was targeted at performing a detailed human health risk assessment (HHRA) for this metal. However, as information on other metals became available, a need to assess the potential for health risks due to these other metals was indicated. A detailed HHRA for each of these other metals was performed. The other metals were initially selected for further study on the basis that their soil concentrations exceeded the residential soil quality criteria (*Table A*) of the Ministry's Guideline for Use at Contaminated Sites in Ontario (MOE, 1997). Exceedance of the *Table A* guidelines does not necessarily imply that exposure constitutes an undue risk to health. Several of the *Table A* guidelines are based on ecotoxicological effects. Health based *Table A* guidelines incorporate an adequate margin of safety and are set well below any concentration where health effects might occur.

Because of the extensive knowledge of risks related to arsenic and lead in soil, particularly through similar and more detailed risk assessments in other Ontario towns and cities, a careful analysis comparing levels, conditions and risk in these other situations to levels and conditions in the Rodney Street community allowed meaningful insight into the question of possible increased risk. Additionally, in the case of lead, a weight of evidence approach with consideration of various factors from the most recent scientific and regulatory literature, are used to support derivation of appropriate intervention levels.

1.1 Background

As described in Part A of this report, over 60 years of emissions (1918-1984) from the INCO nickel refinery have caused elevated surface soil concentrations of nickel, copper, and cobalt in a large area of the town of Port Colborne. The refinery ceased processing nickel concentrate in 1984. Based on extensive sampling conducted by the Phytotoxicology Section of the Standards Development Branch, MOE in 1998 and 1999 (Part A), soil nickel levels exceed the MOE background-based

guideline ($43 \mu\text{g/g}^1$) up to 28 km downwind of the refinery over an area of 345 km^2 . The MOE effects-based soil nickel guideline is exceeded up to 3 km downwind over an area of 29 km^2 .

The guideline criteria for Ni, Cu and Co are all based on phytotoxicity (vegetation effects). MOE and OMAFRA studies have documented metal toxicity to agricultural crops in the Port Colborne area. MOE toxicologists in conjunction with epidemiologists at the Regional Niagara Public Health Unit conducted a health risk assessment of soil nickel, copper, and cobalt levels in 1997. The conclusion of the health risk assessment was "*based on a multimedia 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 area. Furthermore, the review of population health data did not indicate any adverse health effects which may have resulted from environmental exposures.*" The maximum nickel concentration utilized in the multimedia exposure assessment was $9,750 \mu\text{g/g}$.

The Rodney Street community, which is located due west of INCO, lies in a neighbourhood that has been directly impacted by historical stack emissions. Also, because of its close proximity to the refinery, the Rodney Street community was also subject to extensive fugitive emissions from the refinery during the early years prior to the construction of a stack (e.g. the period between 1918 and 1929). Previous MOE surface soil sampling found that soil Ni concentrations averaged less than $5,000 \mu\text{g/g}$ in this area; however, very little depth sampling (greater than 5 cm depth) was conducted in the Rodney St. area. Previously, the highest soil Ni concentration found at depth (5-10 cm depth) was $2,750 \mu\text{g/g}$.

Further sampling and analysis of soil samples from the Rodney Street community in June of 2000 showed that soil Ni concentrations at depth (10-15 cm depth) were very high ($17,000 \mu\text{g/g}$). In addition, Cu, Co, As, Pb and Zn at depth, also exceeded corresponding MOE soil remediation guideline criteria.

As a result of the findings for the Rodney St. property, the Niagara District Medical Officer of Health requested that the remaining residential properties on Rodney St. be sampled as well. This additional sampling of front and back yards was completed in October, 2000. The results of the October 2000 soil sampling are discussed in Part A.

1.2 Purpose and Scope

A human health risk assessment of the elevated metals concentrations found in the soil in the Rodney Street area of Pt. Colborne, Ontario was conducted by Standards Development Branch, MOE. The health risk assessment was peer reviewed by an international panel of peer reviewers prior to public release. There is considerable public and media interest in the assessment and a peer review has assisted in improving the credibility and acceptability of the study.

MOE adopted a risk assessment framework to evaluate the environmental and human health risks of metals in Rodney Street community soils. The risk assessment paradigm which has dominated

¹

Because the assessment of potential risks requires that intakes be estimated in $\mu\text{g/day}$, all soil concentration units used in the main report are expressed on a $\mu\text{g/g}$ basis. This measure is equivalent to 0.000001 g/g , 1 mg/kg and 1 ppm

the regulatory decision making processes for the past two decades is the one promulgated in the 1983 U.S. NRC document "Risk assessment in the federal government: Managing the process" (NRC, 1983). This risk assessment paradigm and local variations on its theme has been adopted worldwide. As well as U.S. agencies, it is used by Canada and the Provinces, WHO and jurisdictions in most countries. Detailed methodologies for interpreting toxicological information and the various exposure pathways are extensive and are constantly being updated.

The human health risk assessment makes use of environmental monitoring data and recent toxicological information to estimate exposures and potential health effects. It examines current toxicological information to determine the types of health effects which have been reported following exposure to each of these metals (*hazard identification*), and to identify the levels of exposure at which the reported effects were manifested (*dose-response assessment*). It also makes use of multi-pathway modelling to estimate the total exposure to each of these metals which are likely to occur (*exposure assessment*). It then combines the toxicological and exposure information to estimate the potential health effects which may occur (*risk characterization*). Each of these components, hazard identification, exposure assessment, dose-response assessment and risk characterization has been described in detail in previous health risk assessment reports which have evaluated potential health risks associated with exposures to various metals in the soils in Port Colborne (MOE, 1997) and other locations in Ontario (MOE, 1991; MOEE, 1994, MOE, 1998).

The human health risk assessment includes the following components:

- *A multimedia approach*, which considers total exposure from all environmental media, was chosen to characterize the risk and to develop site-specific intervention levels for nickel and other metals in Rodney Street community soils. The approach recognizes that contaminants are present simultaneously in food, air, water, consumer products, soil or dust.
- *The exposure pathways of concern*, which include inhalation and incidental ingestion of soil particles derived from backyard soils, dermal contact with this soil and ingestion of backyard produce. In addition, exposures to supermarket food, ambient air and drinking water are estimated. The exposure model estimates daily intakes from all exposure pathways for different age classes (infant, toddler, child, teen and adult). Food basket data included recent Canadian Market Basket Survey information and backyard vegetable data collected from the Rodney Street area.
- *Important receptors*, which include, infants, toddlers, children, teens and adults. Toddlers (aged 7 months to 4 years) represent the most important receptor due to their increased exposures to soil and hand-to-mouth behaviour compared with other receptor age groups.
- *Assessment of the bioavailability of nickel (and other metals) from soil*. The bioaccessibility of nickel (and other metals) in soil was investigated using a simulated stomach acid leach test data.
- *Dermal exposure to nickel (and other metals)*. The dermal exposure pathway was examined as an intake pathway, however, even though contact dermatitis (for nickel) is a relatively common occurrence in the general population (i.e., due to contact with coinage, jewelry and

stainless steel objects), oral and dermal exposure limits for this endpoint have not been developed by other regulatory agencies.

- *Toxicological assessment of nickel (and other metals).* The dose-response assessment assessed cancer and non-cancer exposure limits based on nickel species characterization (other metals were not speciated).
- *Development of health-based site-specific intervention levels.* An important output of the risk assessment process are intervention levels. These are tools for evaluating and cleaning up contaminated soils.

1.3 Organization of the Report

The risk assessment for antimony, beryllium, cadmium, cobalt, copper and nickel (Hazard identification (identifying metals of concern), Toxicity assessment, Exposure Assessment, Risk Characterization), identification of soil intervention levels, discussion of uncertainties, and, recommendations and conclusions for nickel (and other metals) form the main body of the report. Information on Environmental Monitoring of Metals in the Rodney Street community and Port Colborne; Toxicity Assessment (toxicity profiles); Detailed Estimates of Daily Intakes of Metals; Estimating Daily Intakes of Metals from Supermarket Food; Simulated Stomach Acid Leach Test Results; Estimating Backyard Vegetable Consumption for the Rodney Street community; and Dermal Uptake Coefficients for Metals are found in appendices 1 to 7.

2.0 Identifying Metals of Concern

An extensive sampling program has been carried out for the homes in the Rodney Street community in Port Colborne (Part A). The monitoring program identified ten metals that are present in the soil at levels that exceed the current Ministry of the Environment guidelines for medium fine textured soil in a residential community (MOE, 1997). The range of reported concentrations for each of the ten metals is listed in Table 2-1. The respective MOE *Table A* criteria are also listed. Because this assessment focuses on human health, metal levels were also compared to the human health specific criteria originally developed for the MOE *Table A* which are listed in the *Rationale Document* which is one of three supporting documents for the MOE *Guideline* (MOE, 1996). The data in Table 2-1 shows that for seven of the ten metals including; antimony, arsenic, beryllium, cadmium, copper, lead and nickel, the highest reported concentrations exceed both the MOE *Table A* criteria and their respective human health criteria. For the remaining three metals, cobalt, selenium and zinc, the maximum levels reported in Rodney Street community soil are below their respective human health based criteria. Based on this, cobalt, selenium and zinc would not be expected to be human health concerns for the residents of the Rodney Street community. However, the previous risk assessment undertaken by the MOE included cobalt as a metal of concern. Therefore cobalt has been carried through the current assessment of exposure and risk. Selenium and zinc have not been carried through to the detailed risk assessment because the screening assessment has shown that these metals are not present in soil in sufficient quantity to represent a potential human health concern. Based on the screening of metals shown in Table 2-1, eight metals have identified for inclusion in the detailed assessment of exposure and risk for the Rodney Street community.

Table 2-1: Summary of Soil Data for the Rodney Street Area

| Metal | Concentration in Soil ($\mu\text{g/g}$) ¹ | | | | MOE Cleanup Criteria ² ($\mu\text{g/g}$) | |
|-----------|--|--------|---------|---------|---|------------------------|
| | Minimum | Median | Average | Maximum | Guideline Criterion | Human Health Criterion |
| Antimony | 0.28 | 0.20 | 1.20 | 91.1 | 13 | 13 |
| Arsenic | 0.60 | 12.70 | 15.90 | 350 | 25 | - |
| Beryllium | 0.23 | 0.97 | 0.97 | 4.56 | 1.2 | 0.37 |
| Cadmium | 0.14 | 1.09 | 1.20 | 35.33 | 12 | 14 |
| Cobalt | 3.50 | 39.80 | 50.7 | 262 | 50 | 2,700 |
| Copper | 4.40 | 200 | 250 | 2,720 | 300 | 1,100 |
| Lead | 5.90 | 179 | 223 | 1,800 | 200 | 200 |
| Nickel | 34.60 | 1,800 | 2,544 | 17,000 | 200 | 710 |
| Selenium | 0.23 | 0.29 | 1.29 | 19.40 | 10 | 320 |
| Zinc | 23.00 | 314 | 370 | 1,750 | 800 | 16,000 |

1: (0-30 cm; based on 1378 sample points)

2: Table A/B criteria for metals in residential/parkland soil for medium/fine textured soil

For two of the eight metals; arsenic and lead, the MOE has undertaken detailed assessments of exposure and risk in communities similar to the Rodney Street community (MOE, 1991, MOE, 1995). The results of these previous assessments have been used to develop management strategies

for arsenic and lead in the Rodney Street area of Port Colborne. These strategies are presented in the *Conclusions and Recommendations* section of the report (Section 7.0). Therefore, the human health risk assessment has focused on the remaining 6 metals. The detailed exposure assessment used the highest reported concentration of each metal in the soil from the Rodney Street area. The metals carried through to the risk assessment, and the soil concentrations used in the assessment are summarized in Table 2-2.

Table 2-2: Metals Considered in the Exposure Assessment

| Metal | Concentration ($\mu\text{g/g}$) |
|--------------|---|
| Antimony | 91.1 |
| Beryllium | 4.56 |
| Cadmium | 35.33 |
| Cobalt | 262 |
| Copper | 2,720 |
| Nickel | 17,000 |

3.0 Toxicity Assessment

The screening of chemicals in the soil in the Rodney Street area identified eight metals of potential concern (Section 2.0). A detailed toxicity assessment for each metal is provided in Appendix 2. This toxicity assessment briefly outlines the toxicological effects that have been reported to be associated with inhalation, ingestion and dermal contact exposures to antimony, arsenic, beryllium, cadmium, cobalt, copper, lead and nickel, and identifies whether each metal should be considered as a carcinogen or a non-carcinogen. The type of exposure limit selected is dependent upon whether a compound is considered to be non-carcinogenic or carcinogenic.

The toxicological profiles were not used to develop exposure limits for exposure routes where no exposure limits are available, nor were they used to critically review and/or modify currently existing exposure limits.

A summary of the information contained in Appendix 2 is provided in Table 3-1 and Table 3-2. For each metal, the selected reference dose, toxicological end-point and reference to the appropriate section of Appendix 2 is provided. These exposure limits have been used in conjunction with the exposure estimates (Section 4.0) to characterize potential risks (Section 5.0) associated with exposures to each of the metals in residential soil in the Rodney Street community.

Table 3-1: Exposure Limits and Toxicological Endpoints for Non-Carcinogenic Effects

| Compound | Route | Non-Cancer Endpoints | | Appendix Reference |
|-----------|------------|--------------------------------|---|--------------------|
| | | R _D /R _C | Endpoint | |
| Antimony | Oral | 0.4 µg/kg-day | decreased longevity and altered blood chemistry in rats | A2-1 |
| | Inhalation | 0.2 µg/m ³ | pulmonary toxicity in rats | |
| Beryllium | Oral | 2 µg/kg-day | intestinal lesions in dogs | A2-3 |
| | Inhalation | 0.02 µg/m ³ | beryllium sensitization in human populations | |
| Cadmium | Oral | 1 µg/kg-day | kidney damage in humans | A2-4 |
| | Inhalation | -1 | | |
| Cobalt | Oral | 60 µg/kg-day | kidney effects in renally compromised patients | A2-5 |
| | Inhalation | 0.03 µg/m ³ | squamous metaplasia in rodent larynx | |
| Copper | Oral | 140 µg/kg-day | liver damage | A2-6 |
| | Inhalation | 2.4 µg/m ³ | inhalation chronic reference exposure limit | |
| Nickel | Oral | 20 µg/kg-day | decreased body and organ weights in rats | A2-8 |
| | Inhalation | - | | |

- no value available

Table 3-2: Cancer Potency Values for Contaminants of Concern

| Compound | Route | Cancer Endpoints | | | Appendix Reference |
|-----------|------------|--|-----------------|--|--------------------|
| | | UR ¹ | SF ² | Endpoint | |
| Beryllium | Oral | - ³ | | | A2-3 |
| | Inhalation | 0.0024 ($\mu\text{g}/\text{m}^3$) ⁻¹ | | lung cancer in humans | |
| Cadmium | Oral | - | | | A2-4 |
| | Inhalation | 0.0018 ($\mu\text{g}/\text{m}^3$) ⁻¹ | | lung cancer in cadmium workers | |
| Nickel | Oral | - | | | A2-8 |
| | Inhalation | 0.00024 ($\mu\text{g}/\text{m}^3$) ⁻¹ | | lung cancer in nickel refinery workers | |

1. UR = Unit Risk = risk per ($\mu\text{g}/\text{L}$) oral or ($\mu\text{g}/\text{m}^3$) in air.

2. SF = Cancer slope factor = risk per dose body weight ie per ($\mu\text{g}/\text{kg}\text{-day}$)

3. - no value available

4.0 Exposure Assessment

The presence of elevated levels of several metals in the soil of residential properties in the Rodney Street community in Port Colborne has raised concerns regarding exposures experienced by residents and the potential human health effects associated with these exposures. The current assessment has been undertaken to provide interested/concerned parties with estimates of the metal exposures that could be experienced by residents of the Rodney Street community. People living in the Rodney Street community, like all residents of Ontario, are exposed to metals from a number of sources including, processed food, drinking water and air. In addition to these general exposures that are common to the population of Ontario, the residents of the Rodney Street community can be exposed to metals in the soil and in home grown produce. A detailed assessment was undertaken for people living in the Rodney Street community to develop estimates of the total daily exposure experienced by people of all ages. Specific details of exposure assessment methodologies are found in Appendices 3 to 7.

4.1 Receptor Identification

4.1.1 Identification of Potential Receptors

The Rodney Street community in Port Colborne is a residential neighbourhood with single family detached homes. The properties are municipally serviced with domestic water that is not derived from groundwater in the area. People living in the homes in the Rodney Street community will be exposed to the metals present in the soil, but not to any metals that may be present in the groundwater in the area. Because this is a residential community, anybody living in the area can be expected to come into contact with metals present in the soil in the neighbourhood. A list of all of people who can be expected to be exposed to metals in the soil is provided in Table 4-1.

Table 4-1: Potential Human Receptors In The Rodney Street Community

| Potential Receptor | Activity Assumptions |
|------------------------------|---|
| Infant (0 - 6 months of age) | Assumed to be present on residential property for 24 hour per day every day over each phase of a 70 year life-time. |
| Toddler (7 months - 4 years) | All ingested soil is assumed to contain the highest reported level of each metal in soil in the Rodney Street community. |
| Child (5 - 11 years) | All soil assumed to adhere to skin every day of the year. All backyard produce consumed assumed to contain highest level found. |
| Teen (12 - 19 years) | All drinking water assumed to contain highest concentration found in distribution system. |
| Adult (20+ years) | All inhaled air is assumed to contain the highest reported annual average level of each metal measured in Port Colborne or nine other sites in Ontario. |

4.1.2 Identifying Exposure Pathways

People living in the homes in the Rodney Street community can be exposed to the metals in the soil by one of three different routes including; inhalation, ingestion and dermal contact. There are several things that can contribute to the exposures experienced by each of these routes. For example, the ingestion of soil and the consumption of backyard produce would contribute to ingestion exposures, while skin contact with soil would contribute to dermal contact exposures. Each of these possibilities, known as *exposure pathways*, contribute to the total daily exposures experienced by people living in these homes. The potential exposure pathways that could contribute to these exposures are listed in Table 4-2, along with the rationale for their inclusion in the assessment. Table 4-2 also identifies exposure pathways that have not been considered and provides rationale for their exclusion from the process. In order to estimate any potential risks associated with exposure to the metals in the soil, the contribution that each included pathway makes to the total daily exposure must be assessed.

Table 4-2: Possible Human Exposure Pathways In The Rodney Street Community

| Media | Exposure Route | Pathway | Retained | Rationale |
|-------------|----------------|--|----------|--|
| Air | Inhalation | Inhalation of metals on re-entrained soil and dust in indoor air and outdoor air | Yes | The exposure assessment has not distinguished between indoor and outdoor air. The current assessment assumes that a person will be exposed to the same level of nickel and other metals in indoor and outdoor air and that the highest annual average from air monitoring data will be representative. |
| Soil | Ingestion | Ingestion of soil | Yes | The ingestion of metals in soil represents a potential exposure pathways for people living in the homes in the in Rodney Street community |
| | | Uptake into plants and consumption of plants | Yes | Fruits and vegetables grown in backyard gardens in the Rodney Street community properties may contain metals taken up from the soil. The consumption of this produce represents a potential exposure pathway for residents in the Rodney Street community. |
| | | Uptake into animals through plants and consumption of animal products | No | The homes in the Rodney Street community are not used for the production of livestock. Therefore exposure to metals through the consumption of livestock raised in the Rodney Street community will not occur. |
| | Dermal Uptake | Dermal contact with soil | Yes | Exposure to metals through skin contact with metal bearing soil is a potential exposure pathway for residents in the Rodney Street community. |
| Groundwater | Ingestion | Ingestion of metals in water derived from groundwater | No | Groundwater is not used as a source of domestic supply. |
| | Dermal Uptake | Dermal Contact with metals in the groundwater. | No | The groundwater will not be used for any purpose on-site. |

4.1.3 Identifying Receptor Parameters

In addition to knowing who will be exposed to the metals in the soil and what routes contribute to the total exposure, it is necessary to have an understanding of amount of exposure that could be expected to people in each of the age groups identified in Table 4-1. For example, the amount of soil ingested will determine the level of direct exposure to metals in the soil, and the amount of air inhaled in a day will govern the inhalation exposures experienced. These factors, and others, known as *receptor parameters* will govern the exposures experienced by the residents of the Rodney Street community. A list of the receptor parameters including; body weight, inhalation rate, drinking water intake, soil ingestion, soil adhesion to skin, and consumption rates for backyard garden vegetables, used to assess exposures for the residents of the Rodney Street community are presented in Table 4-3. A detailed discussion of the selection and derivation of the values listed in Table 4-3 is provided in Appendix 3 of the report.

Table 4-3: Receptor Parameters Used to Estimate Daily Exposures

| Parameter | Units | Infant | Toddler | Child | Teen | Adult | Source |
|-----------------------|---------------------|----------|----------|-----------|------------|-------|------------------------|
| | | 0 - 0.5y | 0.5 - 4y | 5 - 11yrs | 12 - 19yrs | 20+ | |
| Years in Age Group | years | 0.5 | 4.5 | 7 | 8 | 50 | CEPA, 1994c |
| Body Weight | kg | 8.2 | 16.5 | 32.9 | 59.7 | 70.7 | O'Connor, 1997 |
| Inhalation Rate | m ³ /day | 3.2 | 14.6 | 20.3 | 23.1 | 22.9 | O'Connor, 1997 |
| Drinking Water Intake | L/day | 0.3 | 0.6 | 0.8 | 1 | 1.5 | O'Connor, 1997 |
| Soil Ingestion | g/day | 0.035 | 0.08 | 0.08 | 0.02 | 0.02 | MOE, 1991 ¹ |
| Soil Adhesion to Skin | g/day | 2.2 | 3.5 | 5.8 | 9.1 | 8.7 | Health Canada, 1995 |
| Backyard .Root Veg | g/day | 8.18 | 10.3 | 15.9 | 22.4 | 19.3 | MOE, 1995 |
| Backyard .Other Veg | g/day | 7.09 | 6.6 | 9.65 | 11.8 | 14.1 | MOE, 1995 |
| Supermarket Food | g/day | 822 | 1478 | 1798 | 1945 | 1598 | CEPA, 1994c |

¹ Soil ingestion rates typically used by MOE is assessing risks associated with chemicals in soil

4.1.4 Exposure Assessment Assumptions

The objective of the assessment is to provide exposure estimates that are representative of the maximum exposures that could be experienced by the residents of the Rodney Street community. A list of the assumptions used in this assessment and the effect that each will have on exposure estimates is provided in Table 4-4.

4.2 Metal Concentrations in Environmental Media

As noted above, the risk assessment is intended to provide reasonable maximum estimates of exposure for residents in the Rodney Street community. Therefore the maximum level of each metal reported in drinking water, soil, and backyard garden vegetables have been used to assess potential exposures from these sources. Metal levels in ambient air are not based on the maximum reported levels, but rather on the maximum reported annual average value. The rationale for this is provided in Appendix 3. The concentrations of metals the various media are summarized in Table 4-5.

Table 4-4: Summary of Exposure Assessment Assumptions

| Parameter | Assumption | Effect on Assessment |
|--------------------------------|--|--|
| Residency Time | A person has been assumed to live in a residence every day for a full 70-year life-time (a total of 25550 days). | This approach over estimates all potential exposures because it does not allow for changes in exposure during the time when people would be away from the home. |
| Soil Ingestion | The rate of soil ingestion has been assumed to remain constant throughout the year. For each metal it was further assumed that all of the soil ingested in a day comes from the area of where the highest level of each individual metal was found. This assessment also assumed that surface soils are the only contributors to daily soil ingestion | This approach will over estimate soil ingestion exposures to metals because it assumes that people will have access to the soil 365 days per year. It does not allow for periods when access to the soil will not be possible due to snow cover or ground freezing. It also does not account for people moving about between areas of varying metal concentrations in the soil. However, year round soil ingestion should address the issue of indoor dust exposure. |
| Backyard Vegetable Consumption | Backyard vegetable consumption has been assumed to occur every day throughout the year. The amount of vegetables produced and consumed has been estimated based on previous studies conducted by the MOE in other communities in Ontario. | This assumption may over estimate potential exposures for people in the area who do not grow or consume home produce, or produce less than has been assumed in this assessment. |
| Skin Contact with Soil | The total amount of skin contact with soil was assumed to take place in the area of highest reported concentration for each metal. It was also assumed that dermal contact would occur every day 365 days per year, every year over a 70 year life-time. It was also assumed that once on the skin, soil would remain in place for a full 24 hours before it was removed by washing. | This approach will over estimate exposures that occur through skin contact. It does not account for periods during the year when access to the soil would be limited either through snow cover and/or ground freezing. It also does not account for soil being washed off the skin before the end of a 24 hour period. |
| Drinking Water Intakes | People living in the Rodney Street community were assumed to get all domestic water from the municipal supply. Exposures were also assumed to occur every day over a 70 year life-time. The highest level of each metal reported in the drinking water was assumed to be present in the drinking water over the entire 70 year exposure period. | Using maximum values will over estimate the drinking water exposures to metals for residents of the Rodney Street community. The maximum reported values for the 1996 to 1999 monitoring period range between 1.5 and 2-fold greater than the average levels reported over the same period (see Appendix 1). |

Continued.....

Table 4-4: Summary of Exposure Assessment Assumptions (continued)

| Parameter | Assumption | Effect on Assessment |
|--------------------|---|--|
| Supermarket Food | <p>Daily food consumption estimates developed by Health Canada for the general population were assumed to be representative of the food consumption rates and patterns for residents of the Rodney Street community. For Rodney Street community residents, it was further assumed that any backyard garden produce consumed would be in addition to the daily intakes of supermarket food. That is; the Health Canada daily consumption estimates for root and other vegetable were not lowered to account for decreases in the intakes of supermarket produce when home produce was being used.</p> | <p>This approach will over estimate the daily intakes of metals from produce purchased at the supermarket. The estimated daily dietary intakes of metals from supermarket foods will be marginally over estimated using this approach.</p> |
| Inhalation in Air | <p>Inhalation exposure to metals in the air of Port Colborne have been assumed to occur over a 24 hour period. It has been assumed that the levels of metals in indoor air are the same as those found in ambient outdoor air. It was further assumed that a person would be exposed to the highest reported annual average level of each metal every day over a 70 year life-time.</p> <p>This approach also assumes that the levels of metals reported in the air are present as free metal and are not bound to particulate matter.</p> | <p>This assumption will over estimate inhalation exposures to metals. It does not account for differences in exposure that could be expected to occur in indoor air, where metal and particulate levels could reasonably be expected to be lower than those measured in outdoor air. Further, assuming a 70 year life-time residency does not allow for decreases in exposures that may occur when a person would be away from the Rodney Street community.</p> <p>This assumption also does not account for the bioavailability of the metal on the particulate. By assuming that the monitored levels represent free metal, and further assuming that all of this metal is available for absorption in the lung, the assessment over estimates actual doses.</p> |
| Inhalation of Dust | <p>This assessment has not directly considered the inhalation of metals on re-entrained dust particles. The assessment has used ambient air monitoring data for the metals of concern. In ambient air, metals are generally bound to particulate matter. Therefore ambient air monitoring results reflect the levels of metals bound to particulates in the air and provide a truer estimate of the levels of metals present in the air than measurement of particulate matter would.</p> | <p>Not directly considering the inhalation of metals on particulates does not compromise the assessment of exposure or risk because direct inhalation exposures to metals are being considered.</p> |

Metal levels in individual supermarket food items are not considered directly in the current assessment. Rather the exposure assessment has relied on estimates of the total daily dietary intake of each metal provided by regulatory agencies such as Health Canada. A detailed discussion of the derivation of the daily dietary intakes of metals for all age groups is provided in Appendix 4. These values have been used directly in the estimation of total daily intake for receptors in each age group.

The values listed in Table 4-5 have been used in conjunction with the daily dietary intake estimates for each metal to develop estimates of total daily exposure for all residents in the Rodney Street community.

Table 4-5: Metal Concentrations Used to Assess Residential Exposures

| Medium | Units | Metal Concentrations | | | | | |
|---------------------------|-------------------|----------------------|-----------|---------|--------|--------|--------|
| | | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Drinking Water | µg/L | 0.97 | 0.2 | 0.083 | 0.04 | 44 | 1.3 |
| Ambient Air | µg/m ³ | 0.0011 | 0.0001 | 0.0007 | 0.002 | 0.112 | 0.033 |
| Soil | µg/g | 91.1 | 4.56 | 35.3 | 262 | 2720 | 17000 |
| Backyard Root Vegetables | µg/g | 0.0008 | 0* | 0.049 | 0.048 | 1.92 | 1.82 |
| Backyard Other Vegetables | µg/g | 0.021 | 0.007 | 0.063 | 0.083 | 1.06 | 1.58 |

* beryllium was not detected in root vegetables taken from gardens from Rodney Street community

4.3 Metal Exposures in Individual Media

In assessing the total daily intakes of each metal of concern in the Rodney Street community, it is necessary to determine the contribution that each individual exposure pathway makes to the daily total. Each of the potential exposure pathways has been assessed individually for the residents of the Rodney Street community. These individual contributions of each pathway are then combined to provide estimates of the total daily intake of each metal from all sources for each receptor age group (Section 4.4). Exposures from the individual pathways identified in Section 4.1 are summarized in the following sections. Detailed discussions of all pathways are provided in Appendix 3 of the report.

4.3.1 Intake of Metals from Supermarket Foods

Estimates of the daily dietary intakes of metals from supermarket foods are generally limited and the amount of information available varies widely between metals. The metals of concern in Port Colborne include, antimony, beryllium, cadmium, cobalt, copper, and nickel. Information regarding daily dietary intakes of these metals has been taken from regulatory agencies in Canada and internationally. Additional information has been taken from the available literature. For the purposes of assessing likely daily dietary metal intakes for the residents of the Rodney Street community, preference has been given to data generated from the Canadian population. It was felt that information from Canadian sources would provide the best reflection of likely dietary habits and metal

intakes for Rodney Street community residents. The daily dietary intake of metals is discussed in detail in Appendix 4. A summary of the daily dietary intake of metals for all age groups is summarized in Table 4-6. These estimates have been used in conjunction with those from the other media to develop total daily intake values for each metal (Section 4.4).

Table 4-6: Estimated Daily Intakes of Metals from Supermarket Food

| Receptor | Daily Intakes of Metals from Supermarket Food ($\mu\text{g}/\text{day}$) | | | | | |
|----------|--|-----------|---------|--------|--------|--------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 1.3 | 4.8 | 5.08 | 4.18 | 518 | 180 |
| Toddler | 2.3 | 8.6 | 10.6 | 7 | 822 | 264 |
| Child | 3.5 | 13.2 | 16.8 | 10 | 1230 | 329 |
| Teen | 4 | 15 | 17.3 | 12 | 1520 | 340 |
| Adult | 3.4 | 12.7 | 14.8 | 10.5 | 1430 | 311 |

4.3.2 Intake of Metals from Drinking Water

The intake of metals from drinking water depends upon the level of metal in the water and the amount of water consumed by the average person in a day. Residents in the Rodney Street community are supplied with municipal water that is not derived from groundwater, but rather, from Lake Erie. Therefore, water quality monitoring data for the town of Port Colborne was used to estimate the exposures to metals in drinking water for residents of the Rodney Street community. The concentration of each metal in the municipal supply is listed in Table 4-5. These values have been used to estimate the daily intake of antimony, beryllium, cadmium, cobalt, copper and nickel, for each receptor age group considered. The daily intake estimates for each metal for each age group are summarized in Table 4-7. A detailed discussion of the calculations used to estimate the daily intakes is provided in Appendix 3 of the report. The data in Table 4-7 shows that the daily intakes of most metals are generally below $1 \mu\text{g}/\text{day}$ for most metals. The notable exception is copper, where daily intakes for all age groups are greater than $1 \mu\text{g}/\text{day}$ and range between 13.2 and $66 \mu\text{g}/\text{day}$. The contribution that drinking water makes to total daily exposure is discussed in Section 4.4.

Table 4-7: Estimated Daily Intakes of Metals from Drinking Water

| Receptor | Daily Intakes of Metals from Drinking Water ($\mu\text{g}/\text{day}$) | | | | | |
|----------|--|-----------|---------|--------|--------|--------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 0.29 | 0.06 | 0.025 | 0.012 | 13 | 0.39 |
| Toddler | 0.58 | 0.12 | 0.056 | 0.024 | 26 | 0.78 |
| Child | 0.78 | 0.16 | 0.066 | 0.032 | 35 | 1.0 |
| Teen | 0.97 | 0.2 | 0.083 | 0.040 | 44 | 1.3 |
| Adult | 1.5 | 0.3 | 0.12 | 0.060 | 66 | 2.0 |

4.3.3 Intake of Metals from Ambient Air

The risks associated with inhalation exposures to metals in the Rodney Street community have been assessed in two ways in this report.

- Firstly; the potential ingestion exposures associated with inhalation exposures to metal bearing particles is considered. This type of exposure is considered in this section of the report.
- Secondly; the potential human health risks directly associated with inhaled metals were assessed by comparing the highest annual average air concentrations in the MOE Port Colborne or Environment Canada air monitoring data for Ontario (Table A3-7, Appendix 3) with the appropriate inhalation exposure limit. This latter exposure has been directly assessed in the *Risk Characterization* section of the report (Section 5.0).

In Port Colborne, inhaled metals will be associated with particulate matter and will not be present as free metal. Therefore, there is a potential for the inhaled particulate matter to be cleared from the lungs, through mucocilliary transport, and swallowed. Material cleared from the lungs in this fashion will add to the total daily ingestion of metal. The amount of particulate delivered to the stomach by this process is difficult to predict with any accuracy. Therefore, to provide conservative estimates of the amount of metal ingested as a result of the clearance of inhaled particles, it has been assumed that all inhaled metal is cleared from the lung and passed to the stomach. This approach will over estimate the contribution that inhalation exposures make to the total daily intakes of metals. The highest reported annual average level of each metal (Table 4-5) has been used to estimate the daily ingestion intake of metals following inhalation for people living in the Rodney Street community. The rationale for using annual average ambient air quality monitoring information, and the calculations used to estimate daily intakes of each metal for each age group are discussed in detail in Appendix 3. The data in Table 4-8 shows that inhalation exposures make a very small contribution to ingestion exposures for the metals in soil in the Rodney Street community, even when it has been assumed that all inhaled material is passed to the stomach. Thus, it can be concluded that inhalation exposure to metals does not make a significant contribution to ingestion exposures to metals for the residents of the Rodney Street community. However, these intake estimates have been used in conjunction with the other values to develop total ingestion intake estimates for each metal (Section 4.4).

Table 4-8: Estimated Daily Intakes of Metals from Ambient Air

| Receptor | Daily Intakes of Metals from Ambient Air ($\mu\text{g}/\text{day}$) | | | | | |
|----------|---|-----------|---------|--------|--------|--------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 0.0035 | 0.00038 | 0.0022 | 0.0064 | 0.36 | 0.11 |
| Toddler | 0.016 | 0.0018 | 0.01 | 0.029 | 1.6 | 0.48 |
| Child | 0.022 | 0.0024 | 0.014 | 0.041 | 2.6 | 0.67 |
| Teen | 0.025 | 0.0028 | 0.016 | 0.046 | 2.6 | 0.76 |
| Adult | 0.25 | 0.0027 | 0.016 | 0.046 | 2.6 | 0.76 |

4.3.4 Intake of Metals from Backyard Vegetables

Eating vegetables grown in backyards where metal levels are above typical levels, represents a potential exposure pathway if the metals present in the soil are taken up into the vegetables. The exposures received by people eating such produce depends upon the concentration of the metals in the vegetables and the amount of vegetables consumed from backyard gardens on an annual basis. The current assessment has assumed that backyard garden produce is consumed on a daily basis throughout the year. The amount of backyard garden vegetables consumed on an annually averaged daily basis is discussed in detail in Appendix 6.

As part of the on-going work in Port Colborne, samples of backyard produce have been collected by the MOE and Jacques Whitford Environmental Limited (JWEL) from Rodney and Mitchell Streets. The levels of individual metals in the various types of produce tested are provided in Appendix 1 of this report. For the purposes of this assessment, backyard garden produce has been divided into two general categories;

- root vegetables* includes; beet root and radish samples from Rodney and Mitchell Street gardens and the Wainfleet bog
- other vegetables.* includes; beet tops, celery, lettuce, peppers and tomatoes from Rodney and Mitchell Street gardens and the Wainfleet bog

An examination of metal levels in vegetables and the soils in which they were grown showed that a relationship does exist between the levels of metals in vegetables and corresponding soils (Appendix 3). Therefore, metal levels in soil were not used to predict the uptake of metals into vegetable as a means of estimating potential human exposure. Rather, the highest level of each metal reported in both of these categories were used to estimate daily intakes of metals from backyard garden produce. The calculation of daily intakes of metals from backyard produce is discussed in detail in Appendix 3. Summaries of the daily intake estimates for each metal from root and other vegetables, for each age group are shown in Table 4-9 and Table 4-10 respectively.

The intake estimates for root and other vegetables for each metal and each receptor age group, were used in conjunction with intake estimates from the other sources to develop total daily intake estimates for each metal and age group (Section 4.4).

Table 4-9: Estimated Daily Intakes of Metals from Backyard Root Vegetables

| Receptor | Daily Intakes of Metals from Backyard Root Vegetables ($\mu\text{g}/\text{day}$) | | | | | |
|----------|--|------------------------|---------|--------|--------|--------|
| | Antimony | Beryllium ¹ | Cadmium | Cobalt | Copper | Nickel |
| Infant | 0.065 | 0 | 0.4 | 0.39 | 16 | 15 |
| Toddler | 0.082 | 0 | 0.5 | 0.49 | 20 | 19 |
| Child | 0.13 | 0 | 0.78 | 0.76 | 31 | 29 |
| Teen | 0.18 | 0 | 1.1 | 1.1 | 43 | 41 |
| Adult | 0.15 | 0 | 0.95 | 0.93 | 37 | 35 |

1: beryllium was not detected in root crops from the Port Colborne area

Table 4-10: Estimated Daily Intakes of Metals from Other Backyard Vegetables

| Receptor | Daily Intakes of Metals from Other Backyard Vegetables ($\mu\text{g/day}$) | | | | | |
|----------|--|-----------|---------|--------|--------|--------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 0.15 | 0.047 | 0.45 | 0.59 | 7.5 | 11 |
| Toddler | 0.14 | 0.044 | 0.42 | 0.55 | 7 | 10 |
| Child | 0.2 | 0.064 | 0.61 | 0.8 | 10 | 15 |
| Teen | 0.25 | 0.078 | 0.74 | 0.98 | 13 | 19 |
| Adult | 0.3 | 0.093 | 0.89 | 1.2 | 15 | 22 |

4.3.5 Intake of Metals from Soil

The ingestion of soil that contains metal represents a potential exposure pathway for people who live in the homes in the Rodney Street community. The daily intake of metal from soil depends upon the amount of soil ingested and the level of metal bound to soil particles. The soil monitoring program conducted by the MOE in the Rodney Street community showed that metal levels in the soil varied across the community. It also showed that metal levels in soil varied across the sampling horizon of 30 cm. The results of the sampling program are discussed in detail in Part A. A summary of the soil monitoring results is presented in Appendix 1 of this report. Because elevated levels of metals appear to be confined to the top 30 cm of soil, it is possible that typical gardening activities could bring materials to the surface and thereby be available for exposure. Therefore, the highest level of each metal reported in the top 30 cm of soil was used to assess exposure for residents of the Rodney Street community. This approach will provide estimates of reasonable maximum exposures for all receptor age groups.

In addition to the amount of metal ingested with soil, the effective intake of metal is also dependent upon the amount of metal released from the soil during digestion. Only metal that is released from soil into the stomach or intestines during digestion can be considered to be accessible to the body and available for uptake. Any metal not released from soil is excreted in the faeces and does not have the opportunity to cause adverse health effects. Therefore, in assessing exposure and potential human health risks, it is necessary to consider the amount of metal actually released from the soil into the gut and not the amount of metal ingested with the soil, when assessing exposures and the potential for human health effects to occur.

The metals in the soil in the Rodney Street community are generally insoluble in water and tend to remain bound to soil particles under neutral conditions (pH 6 - pH 8). However, the solubility of the metals increases under acidic conditions. Therefore, under the acidic conditions of the stomach, it is reasonable to expect that some metal will be released and be accessible to the body and available for uptake. The amount of metal released from soil from the Rodney Street community has been examined by subjecting the soil to a simulated stomach acid digestion and measuring the amount of each metal released from the soil into the acid solution. These results, expressed as a percentage of the total metal level in the original soil sample have been used to correct the estimates of metal intake from soil ingestion. The stomach acid leach test used to determine the adjustment factors for each metal is discussed in detail in Appendix 5. The equations used to estimate the adjusted metal intake from ingested soil are provided in Appendix 3. The results of this assessment are summarized in Table

4-11. The estimates of daily metal intakes from ingested soil for each receptor age group have been used in conjunction with the intake estimates from other sources to provide total daily intake estimates for each metal (Section 4.4).

4.3.6 Dermal Contact with Metals in Soil

Daily contact with metals through soil present on the skin represent a potential route of exposure. However, the insoluble nature of most metals in soil limits their bio-accessability for uptake into and through the skin. Where data is available, it shows that dermal uptake of metals is low (Paustenbach, 2000). In determining the amount of metal that could be delivered to the skin from soil, a number of conservative assumptions have been used to provide maximum estimates of potential exposure. It was assumed that soil on the skin would remain in place for a full 24 hour period and that bathing would only remove soil from the skin once every 24 hours. In addition, conservative or default assumptions were made regarding the amount of metal that would be released from the soil to the skin. Detailed discussions of the derivation of the dermal uptake coefficient for each metal and the calculation of the dermal contact exposures are presented in Appendix 7. The dermal contact/uptake values calculated in Appendix 7 were assumed to represent intake values for each metal in order to facilitate their comparison with intakes from the other exposure routes. Estimates of dermal contact/intake are summarized in Table 4-12.

Table 4-11: Estimated Daily Intakes of Metals from Soil Ingestion

| Receptor | Daily Intakes of Metals from Soil Ingestion ($\mu\text{g}/\text{day}$) | | | | | |
|----------|--|-----------|---------|--------|--------|--------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 0.0062 | 0.0003 | 0.0023 | 0.11 | 2.1 | 6.9 |
| Toddler | 0.0141 | 0.00069 | 0.0054 | 0.26 | 4.8 | 16 |
| Child | 0.0141 | 0.00069 | 0.0054 | 0.26 | 4.8 | 16 |
| Teen | 0.0035 | 0.00017 | 0.0013 | 0.064 | 1.2 | 3.9 |
| Adult | 0.0035 | 0.00017 | 0.0013 | 0.064 | 1.2 | 3.9 |

Table 4-12: Estimated Daily Intakes of Metals from Dermal Contact

| Receptor | Daily Intakes of Metals from Dermal Contact ($\mu\text{g}/\text{day}$) | | | | | |
|----------|--|-----------|---------|--------|--------|--------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 0.38 | 0.016 | 0.15 | 0.23 | 132 | 14 |
| Toddler | 0.61 | 0.03 | 0.23 | 0.37 | 209 | 23 |
| Child | 1 | 0.05 | 0.39 | 0.61 | 347 | 37 |
| Teen | 1.6 | 0.079 | 0.61 | 0.95 | 545 | 59 |
| Adult | 1.5 | 0.075 | 0.58 | 0.91 | 521 | 56 |

4.4 Estimating Total Daily Intakes Of Metals

In order to estimate the potential health effects associated with exposure to metals for the residents of the Rodney Street community, it is necessary to know the total daily intakes of metals from all sources. In the Rodney Street community, two types of exposures can be considered to occur;

| | |
|---|--|
| General Exposures: | these can be defined as; <i>exposures that are common across the Rodney Street community, Port Colborne and the Ontario Population.</i> These include metal intakes from supermarket food, drinking water and ambient air. |
| Rodney Street Community Specific Exposures: | these can be defined as; <i>exposures that are directly affected by the metals present in the soil on the properties in the Rodney Street community.</i> These include metal intakes from backyard garden produce, ingestion of soil and dermal contact with soil. |

Total metal intakes from General and Rodney Street community specific exposures have been assessed separately to provide an indication of any additional exposure burdens that may be experienced by the residents of the Rodney Street community as a result of elevated levels of metals in the community. General and Rodney Street community specific exposures for each metal for all receptor age groups are provided in the following sections. In addition to providing estimates of total daily intakes on a $\mu\text{g}/\text{day}$ basis, each of the following sections provided *Estimated Daily Intake* (EDI) values for each receptor group on a per body weight basis, expressed as $\mu\text{g}/\text{kg}\text{-day}$. These can be considered as dose estimates and are necessary in the estimation of *chronic daily intakes* (CDI) which are used to estimate life-time averaged daily doses (LADD). The LADD and its use in estimating potential human health risks is discussed in detail in Appendix 2, and is calculated in Section 5 (Risk Characterization).

4.4.1 Total Daily Intakes of Antimony

The contributions that general and Rodney Street community specific exposures make to the total daily intake of antimony are summarized in Table 4-13 and 4-14 respectively. The data shows that supermarket food makes the largest contribution to the total daily intake of antimony for all age groups. It also suggests that dermal contact with antimony will make a significant contribution to daily intakes for all receptors. It should be noted however that the estimates of dermal exposure are based on a very conservative assumption the amount of antimony released from the soil during a 24 hour digest of soil in strong acid would also be released from the soil and be accessible to the skin. As noted in Appendix 7, information relating to the uptake of metals into the skin from soil is extremely limited. Of the six metals considered in this assessment, dermal uptake factors are available for two; cobalt and nickel. For these two metals, the factors used to assess potential dermal exposures were 0.0004 and 0.00038 respectively (Appendix 7). These values are 10-fold lower than the default

factor used to estimate dermal exposures to antimony in soil. If the dermal absorption factor for antimony is similar to that for cobalt and nickel, the contribution that dermal contact makes to the total exposure to antimony would be reduced 10-fold and the dermal contribution to total daily exposure would be comparable to the contribution made by the ingestion of backyard root vegetables (Table 4-14). While it is unlikely that dermal exposure to antimony is a significant contributor to total daily exposure, the absence of antimony specific data on dermal uptake dictates that a conservative approach be used to estimate exposures. The implications of these exposures and the potential for health effects to develop as a result of these exposures is discussed in Section 5.0.

Table 4-13: Total Daily Intakes of Antimony: General Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\text{-day}$) |
|----------|--|----------------|-------------|------------------------------------|------------------|---|
| | Supermarket | Drinking Water | Ambient Air | | | |
| Infant | 1.3 | 0.29 | 0.0035 | 1.59 | 8.2 | 0.19 |
| Toddler | 2.3 | 0.58 | 0.016 | 2.90 | 16.5 | 0.18 |
| Child | 3.5 | 0.78 | 0.022 | 4.30 | 32.9 | 0.13 |
| Teen | 4 | 0.97 | 0.025 | 5.00 | 59.7 | 0.084 |
| Adult | 3.4 | 1.5 | 0.25 | 5.11 | 70.7 | 0.072 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\text{-day}$

Table 4-14: Total Daily Intakes of Antimony: Rodney Street Community Specific Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\text{-day}$) |
|----------|--|-----------|----------------|--------|------------------------------------|------------------|---|
| | Root Veg | Other Veg | Soil Ingestion | Dermal | | | |
| Infant | 0.065 | 0.15 | 0.0062 | 0.38 | 0.60 | 8.2 | 0.07 |
| Toddler | 0.082 | 0.14 | 0.014 | 0.61 | 0.85 | 16.5 | 0.05 |
| Child | 0.13 | 0.2 | 0.014 | 1 | 1.34 | 32.9 | 0.04 |
| Teen | 0.18 | 0.25 | 0.0035 | 1.6 | 2.03 | 59.7 | 0.034 |
| Adult | 0.15 | 0.3 | 0.0035 | 1.5 | 1.95 | 70.7 | 0.028 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\text{-day}$

4.4.2 Total Daily Intakes of Beryllium

The contributions that general and Rodney Street community specific exposures make to the total daily intake of beryllium are summarized in Table 4-15 and 4-16 respectively. The data shows that supermarket food and drinking water make the largest contributions to the total daily intakes of beryllium accounting for more than 99.8% of the total daily intake for infants and toddlers. As the consumption of backyard garden vegetables increases across the age groups, the contribution the general exposures make to the total daily intakes falls from 96.8% in children to 95.5% in adults. This suggests that the daily exposures to beryllium experienced by residents in the Rodney Street community of Port Colborne do not differ from those experienced by the general Ontario population. The implications of these exposures and the potential for health effects to develop as a result of these exposures is discussed in Section 5.0.

Table 4-15: Total Daily Intakes of Beryllium: General Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\text{-day}$) |
|----------|--|----------------|-------------|------------------------------------|------------------|---|
| | Supermarket | Drinking Water | Ambient Air | | | |
| Infant | 4.8 | 0.06 | 0.00038 | 4.86 | 8.2 | 0.59 |
| Toddler | 8.6 | 0.12 | 0.0018 | 8.72 | 16.5 | 0.53 |
| Child | 13.2 | 0.16 | 0.0024 | 13.36 | 32.9 | 0.41 |
| Teen | 15 | 0.2 | 0.0028 | 15.20 | 59.7 | 0.25 |
| Adult | 12.7 | 0.3 | 0.0027 | 13.00 | 70.7 | 0.18 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\text{-day}$ **Table 4-16: Total Daily Intakes of Beryllium: Rodney Street Community Specific Exposures**

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\text{-day}$) |
|----------|--|-----------|----------------|--------|------------------------------------|------------------|---|
| | Root Veg | Other Veg | Soil Ingestion | Dermal | | | |
| Infant | 0 | 0.047 | 0.0003 | 0.019 | 0.07 | 8.2 | 0.0081 |
| Toddler | | 0.044 | 0.00069 | 0.03 | 0.07 | 16.5 | 0.0045 |
| Child | 0 | 0.064 | 0.00069 | 0.05 | 0.11 | 32.9 | 0.0035 |
| Teen | 0 | 0.078 | 0.00017 | 0.079 | 0.16 | 59.7 | 0.0026 |
| Adult | 0 | 0.093 | 0.00017 | 0.075 | 0.17 | 70.7 | 0.0024 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\text{-day}$

4.4.3 Total Daily Intakes of Cadmium

The contributions that general and Rodney Street community specific exposures make to the total daily intake of cadmium are summarized in Table 4-17 and 4-18 respectively. The data shows that supermarket food and backyard produce make the largest contributions to total daily intakes for all age groups. The contribution to total daily intakes made by general exposures ranges between 78.5% in infants to 86.8% in children. In teens and adults, general exposures account for 83.2 and 81.7% respectively. This indicates that Rodney Street community specific exposures make a measurable contribution to the total daily exposures to cadmium for residents of the Rodney Street community. The implications of these exposures and the potential for health effects to develop as a result of these exposures is discussed in Section 5.0

Table 4-17: Total Daily Intakes of Cadmium: General Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\text{-day}$) |
|----------|--|----------------|-------------|------------------------------------|------------------|---|
| | Supermarket | Drinking Water | Ambient Air | | | |
| Infant | 5.08 | 0.025 | 0.0022 | 5.11 | 8.2 | 0.62 |
| Toddler | 10.6 | 0.05 | 0.01 | 10.66 | 16.5 | 0.65 |
| Child | 16.8 | 0.066 | 0.014 | 16.88 | 32.9 | 0.51 |
| Teen | 17.3 | 0.083 | 0.016 | 17.40 | 59.7 | 0.29 |
| Adult | 14.8 | 0.12 | 0.016 | 14.94 | 70.7 | 0.21 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\text{-day}$

Table 4-18: Total Daily Intakes of Cadmium: Rodney Street Community Specific Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\cdot\text{day}$) |
|----------|--|-----------|----------------|--------|------------------------------------|------------------|---|
| | Root Veg | Other Veg | Soil Ingestion | Dermal | | | |
| Infant | 0.4 | 0.45 | 0.0023 | 0.15 | 1.00 | 8.2 | 0.12 |
| Toddler | 0.5 | 0.42 | 0.0054 | 0.23 | 1.16 | 16.5 | 0.070 |
| Child | 0.78 | 0.61 | 0.0054 | 0.39 | 1.79 | 32.9 | 0.054 |
| Teen | 1.1 | 0.74 | 0.0013 | 0.61 | 2.45 | 59.7 | 0.041 |
| Adult | 0.95 | 0.89 | 0.0013 | 0.58 | 2.42 | 70.7 | 0.034 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\cdot\text{day}$

4.4.4 Total Daily Intakes of Cobalt

The contributions that general and Rodney Street community specific exposures make to the total daily intake of cobalt are summarized in Table 4-19 and 4-20 respectively. The data shows that supermarket food and backyard produce make the largest contributions to total daily intakes for all age groups. The contribution to total daily intakes made by general exposures ranges between 71.0% in infants to 76.5% in toddlers. In teens and adults, general exposures account for 74.4 and 72.6% respectively. The data also shows that exposures to cobalt in drinking water and ambient air are significantly lower than exposures through the other pathways. This indicates that Rodney Street community specific exposures make a measurable contribution to the total daily exposures to cobalt for residents of the Rodney Street community. The implications of these exposures and the potential for health effects to develop as a result of these exposures is discussed in Section 5.0.

Table 4-19: Total Daily Intakes of Cobalt: General Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\cdot\text{day}$) |
|----------|--|----------------|-------------|------------------------------------|------------------|---|
| | Supermarket | Drinking Water | Ambient Air | | | |
| Infant | 4.18 | 0.012 | 0.0064 | 4.20 | 8.2 | 0.51 |
| Toddler | 7 | 0.024 | 0.029 | 7.05 | 16.5 | 0.43 |
| Child | 10 | 0.032 | 0.041 | 10.07 | 32.9 | 0.31 |
| Teen | 12 | 0.04 | 0.046 | 12.09 | 59.7 | 0.20 |
| Adult | 10.5 | 0.06 | 0.046 | 10.61 | 70.7 | 0.15 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\cdot\text{day}$ **Table 4-20: Total Daily Intakes of Cobalt: Rodney Street Community Specific Exposures**

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\cdot\text{day}$) |
|----------|--|-----------|----------------|--------|------------------------------------|------------------|---|
| | Root Veg | Other Veg | Soil Ingestion | Dermal | | | |
| Infant | 0.39 | 0.59 | 0.11 | 0.23 | 1.32 | 8.2 | 0.16 |
| Toddler | 0.49 | 0.55 | 0.26 | 0.37 | 1.67 | 16.5 | 0.10 |
| Child | 0.76 | 0.8 | 0.26 | 0.61 | 2.43 | 32.9 | 0.07 |
| Teen | 1.1 | 0.98 | 0.064 | 0.95 | 3.09 | 59.7 | 0.052 |
| Adult | 0.93 | 1.2 | 0.064 | 0.91 | 3.10 | 70.7 | 0.044 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\cdot\text{day}$

4.4.5 Total Daily Intakes of Copper

The contributions that general and Rodney Street community specific exposures make to the total daily intake of copper are summarized in Table 4-21 and 4-22 respectively. The data shows that supermarket food and dermal contact make the largest contributions to total daily intakes for all age groups. The contribution to total daily intakes made by general exposures ranges between 70.8% in teens to 76.6% in toddlers. As noted for antimony (Section 4.4.1), the contribution attributed to dermal exposure is likely to be a substantial over estimate of actual exposures through the skin. However, in the absence of copper-specific dermal uptake coefficient data the factor used in this assessment will provide conservative estimates of exposure for all receptor age groups. The data presented in Tables 4-21 and 4-22 show that Rodney Street community specific exposures make a measurable contribution to the total daily exposures to copper for residents of the Rodney Street community. The implications of these exposures and the potential for health effects to develop as a result of these exposures is discussed in Section 5.0

Table 4-21: Total Daily Intakes of Copper: General Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\cdot\text{day}$) |
|----------|--|----------------|-------------|------------------------------------|------------------|---|
| | Supermarket | Drinking Water | Ambient Air | | | |
| Infant | 518 | 13 | 0.36 | 531.36 | 8.2 | 65 |
| Toddler | 822 | 26 | 1.6 | 849.60 | 16.5 | 51 |
| Child | 1230 | 35 | 2.3 | 1267.30 | 32.9 | 39 |
| Teen | 1520 | 44 | 2.6 | 1566.60 | 59.7 | 26 |
| Adult | 1430 | 66 | 2.6 | 1498.60 | 70.7 | 21 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\cdot\text{day}$

Table 4-22: Total Daily Intakes of Copper: Rodney Street Community Specific Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\cdot\text{day}$) |
|----------|--|-----------|----------------|--------|------------------------------------|------------------|---|
| | Root Veg | Other Veg | Soil Ingestion | Dermal | | | |
| Infant | 16 | 7.5 | 2.1 | 132 | 157.60 | 8.2 | 19 |
| Toddler | 20 | 7 | 4.8 | 209 | 240.80 | 16.5 | 15 |
| Child | 31 | 10 | 4.8 | 347 | 392.80 | 32.9 | 12 |
| Teen | 43 | 13 | 1.2 | 545 | 602.20 | 59.7 | 10 |
| Adult | 37 | 15 | 1.2 | 521 | 574.20 | 70.7 | 8.1 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\cdot\text{day}$

4.4.6 Total Daily Intakes of Nickel

The contributions that general and Rodney Street community specific exposures make to the total daily intake of nickel are summarized in Table 4-23 and 4-24 respectively. The data shows that while supermarket food makes the largest single contribution to total daily nickel intakes for all receptor age groups, Rodney Street community specific exposures also make a significant contribution. Unlike the other metals considered in the current assessment where intakes from soil ingestion were relatively small, for nickel, soil ingestion makes a measurable contribution to the total

daily exposure. In comparison to the predicted exposures to nickel from supermarket food, backyard produce, soil ingestion and dermal contact, nickel exposures from drinking water and ambient air are relatively small, accounting for less than 1% of the total daily intakes for all age groups. The data presented in Tables 4-23 and 4-24 show that Rodney Street community specific exposures make a measurable contribution to the total daily exposures to nickel for residents of the Rodney Street community. The implications of these exposures and the potential for health effects to develop as a result of these exposures is discussed in Section 5.0.

Table 4-23: Total Daily Intakes of Nickel: General Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\text{-day}$) |
|----------|--|----------------|-------------|------------------------------------|------------------|---|
| | Supermarket | Drinking Water | Ambient Air | | | |
| Infant | 180 | 0.39 | 0.11 | 180.50 | 8.2 | 22 |
| Toddler | 264 | 0.78 | 0.48 | 265.26 | 16.5 | 16 |
| Child | 329 | 1 | 0.67 | 330.67 | 32.9 | 10 |
| Teen | 240 | 1.3 | 0.76 | 242.06 | 59.7 | 4.1 |
| Adult | 311 | 2 | 0.76 | 313.76 | 70.7 | 4.4 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\text{-day}$

Table 4-24: Total Daily Intakes of Nickel: Rodney Street Community Specific Exposures

| Receptor | Intake for Individual Media ($\mu\text{g}/\text{day}$) | | | | Total ($\mu\text{g}/\text{day}$) | Body Weight (kg) | EDI ¹ ($\mu\text{g}/\text{kg}\text{-day}$) |
|----------|--|-----------|----------------|--------|------------------------------------|------------------|---|
| | Root Veg | Other Veg | Soil Ingestion | Dermal | | | |
| Infant | 15 | 11 | 6.9 | 14 | 46.90 | 8.2 | 5.7 |
| Toddler | 19 | 10 | 16 | 23 | 68.00 | 16.5 | 4.1 |
| Child | 29 | 15 | 16 | 37 | 97.00 | 32.9 | 2.9 |
| Teen | 41 | 19 | 3.9 | 59 | 122.90 | 59.7 | 2.1 |
| Adult | 35 | 22 | 3.9 | 56 | 116.90 | 70.7 | 1.7 |

1: EDI = Estimated Daily Intake expressed in $\mu\text{g}/\text{kg}\text{-day}$

5.0 Risk Characterization

The potential health risks for residents of the Rodney Street community were characterized using two procedures:

One, the general and Rodney Street community specific exposures were combined into the total metal intake from all exposure pathways and were compared with the oral exposure limit (RfD, etc.) (Table 3-1) selected for that metal;

Two, potential health risks from inhaling airborne metals were assessed by comparing the highest annual average air concentration in the MOE air monitoring data for Port Colborne or Environment Canada air monitoring data for Ontario (Table A3-7) with the selected inhalation exposure limit (RfC, unit cancer risk, etc.) (Table 3-1 and Table 3-2).

In order to compare the estimated daily exposures to each metal calculated for each of the receptor age groups, it is necessary to convert the individual exposures into a life-time averaged daily dose (LADD). The rationale for using life-time averaged daily doses for estimating the risks associated with life-time exposures is provided in Appendix 2. The LADD is calculated as shown in equation 5-1.

Eq 5-1:

$$LADD = \sum_1^n \left(\frac{EDI_{1..n} * Time_{1..n}}{70 \text{ years}} \right)$$

| | | | |
|--------|----------------------|---|-----------|
| Where: | LADD | = Life-Time Averaged Daily Dose | µg/kg-day |
| | EDI _{1..n} | = Estimated Daily Intake of age group n | µg/kg-day |
| | Time _{1..n} | = Time spent in each age group | years |

From equation 5-1 it can be seen that the total LADD is a sum of the fractional LADD contributions made by exposures that occur during each life stage (receptor age groups). For the purposes of this assessment, the fractional LADDs for general and Rodney Street community specific exposures have been calculated for each receptor age group (identified as LADD_f in the tables). The total LADDs for the general and Rodney Street community specific exposures are also listed to provide an indication of what factors make the greatest contributions to the final LADD. The final LADDs are compared to their respective oral RfD values in making the final estimates of potential risk. LADDs that are lower than their respective RfD values indicate that exposures are below the identified exposure limit and that human health effects would not be expected to occur.

Graphical representations of the EDIs for the individual receptor age groups as well as the LADD compared to the RfD are also provided for the six metals carried through the detailed risk assessment. In comparing the individual EDI values to the RfD values, it should be remembered that the US EPA recommends that this serve only as a screening tool to indicate potential risk but that they are not to be considered as predictive of potential human health effects. Predictive estimates of

potential risk should only be based on a comparison between the LADD and the RfD (US EPA, 1992).

5.1 Antimony

5.1.1 Ingestion Exposure to Antimony

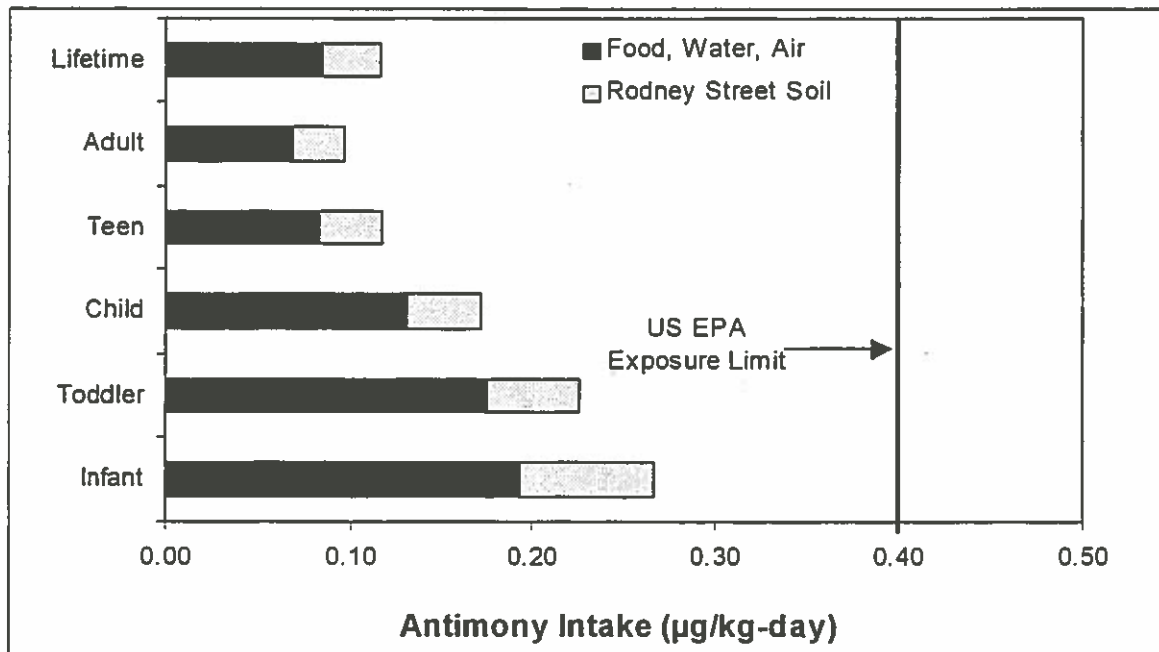
To characterize the potential health risks for residents of the Rodney Street community, the total antimony intake from all exposure pathways (Table 5.1) was compared with the 0.4 µg/kg/day oral exposure limit (US EPA and WHO)(Table 3.1).

Table 5-1: Life-Time Averaged Daily Antimony Intakes for the Rodney Street Community

| Metal | Receptor | Years | General Exposures | | | Rodney St Specific Exposures | | | Total CDI ⁴ |
|----------|---------------|-------|-------------------|------------------|--------------------|------------------------------|------------------|--------------------|------------------------|
| | | | EDI ¹ | CDI ² | Σ CDI ³ | EDI ¹ | CDI ² | Σ CDI ³ | |
| Antimony | 0- 6 months | 0.5 | 0.19 | 0.001 | 0.087 | 0.070 | 0.0005 | 0.032 | 0.12 |
| | 7 months - | 4.5 | 0.18 | 0.011 | | 0.050 | 0.0032 | | |
| | 5 - 11 years | 7 | 0.13 | 0.013 | | 0.040 | 0.0040 | | |
| | 12 - 19 years | 8 | 0.08 | 0.009 | | 0.034 | 0.0039 | | |
| | 20 + years | 50 | 0.07 | 0.051 | | 0.028 | 0.020 | | |

- 1: estimated daily intake (µg/kg-day)
- 2: Chronic Daily Intake Fraction (µg/kg-day)
- 3: ΣCDI = sum of CDI_i for General or Rodney Street community specific Exposures (µg/kg-day)
- 4: Total CDI = Chronic Daily Intake for a life-time exposure to metal in the Rodney Street community (µg/kg-day)

Figure 5-1: General and Rodney Street Community Specific Exposures to Antimony



Inspection of Table 5.1 and Figure 5.1 show that the presence of up to 91.1 $\mu\text{g/g}$ antimony in soil in the Rodney Street community is unlikely to be associated with any adverse health effects. Dietary intake is the predominant contributor to the total daily intake of antimony accounting for between 86% and 96.7% of the total daily intake for residents of the Rodney Street community. Surface soil, through ingestion and dermal absorption accounts for approximately 3% of the total daily intake of antimony. The highest level of antimony reported in subsurface soil in the Rodney Street community was approximately 3.8-fold higher than that reported in surface soil (91.1 $\mu\text{g/g}$). If subsurface soil was assumed to contribute to daily exposures to antimony in soil, soil would account for about 11% of the total daily exposure (3.8-fold greater than the 3% contribution made by surface soil). Even at these levels the total daily intake for the infant, (receptor with the estimated highest exposure) is approximately 0.25 $\mu\text{g/kg-day}$ which lies well below the RfD of 0.4 $\mu\text{g/kg-day}$.

5.1.2 Inhalation Exposure for Antimony

Potential health risks from inhaling airborne antimony were assessed by comparing the highest maximum and annual average air concentrations in the Environment Canada air monitoring data for Ontario (Table A3-7, Appendix 3) with the US EPA RfC of 0.2 $\mu\text{g}/\text{m}^3$ (Table 3.1). In this case, both the maximum antimony concentration (0.012 $\mu\text{g}/\text{m}^3$) and the highest annual average concentration (0.0011 $\mu\text{g}/\text{m}^3$) were well below the RfC. Consequently, there appears to be no potential for health related effects from inhalation of antimony.

5.2 Beryllium

5.2.1 Ingestion Exposure to Beryllium

To characterize the potential health risks for residents of the Rodney Street community, the total beryllium intake from all exposure pathways (Table 5-2) was compared with the 2 $\mu\text{g/kg/day}$ oral exposure limit (US EPA)(Table 3.1).

Table 5-2: Life-Time Averaged Daily Beryllium Intakes for the Rodney Street Community

| Metal | Receptor | Years | General Exposures | | | Rodney St Specific Exposures | | | Total CDI ⁴ |
|-----------|---------------|-------|-------------------|------------------|---------------------------|------------------------------|------------------|---------------------------|------------------------|
| | | | EDI ¹ | CDI ² | Σ CDI ³ | EDI ¹ | CDI ² | Σ CDI ³ | |
| Beryllium | 0- 6 months | 0.5 | 0.59 | 0.004 | 0.24 | 0.0081 | 0.0001 | 0.0027 | 0.24 |
| | 7 months - | 4.5 | 0.53 | 0.034 | | 0.0045 | 0.0003 | | |
| | 5 - 11 years | 7 | 0.41 | 0.041 | | 0.0035 | 0.0004 | | |
| | 12 - 19 years | 8 | 0.25 | 0.028 | | 0.0026 | 0.0003 | | |
| | 20 + years | 50 | 0.18 | 0.131 | | 0.0024 | 0.0017 | | |

1: estimated daily intake ($\mu\text{g/kg-day}$)

2: Chronic Daily Intake Fraction ($\mu\text{g/kg-day}$)

3: Σ CDI = sum of CDI² for General or Rodney Street community specific Exposures ($\mu\text{g/kg-day}$)

4: Total CDI = Chronic Daily Intake for a life-time exposure to metal in the Rodney Street community ($\mu\text{g/kg-day}$)

Inspection of Table 5-2 and Figure 5-2 show that the presence of up to 4.56 $\mu\text{g/g}$ beryllium in soil in the Rodney Street community is unlikely to be associated with any adverse health effects since these conservatively estimated total intakes did not exceed the US EPA RfD for any age class. Figure 5-3 shows the estimated daily intakes of beryllium on an expanded scale, to make it easier to see the relative contributions made by general exposures and those received from Rodney Street soil. From Figure 5-3 it can be seen that Rodney Street community specific exposures to beryllium in soil do not make an appreciable contribution to the total daily intakes of beryllium.

Figure 5-2: General and Rodney Street Community Specific Exposures to Beryllium

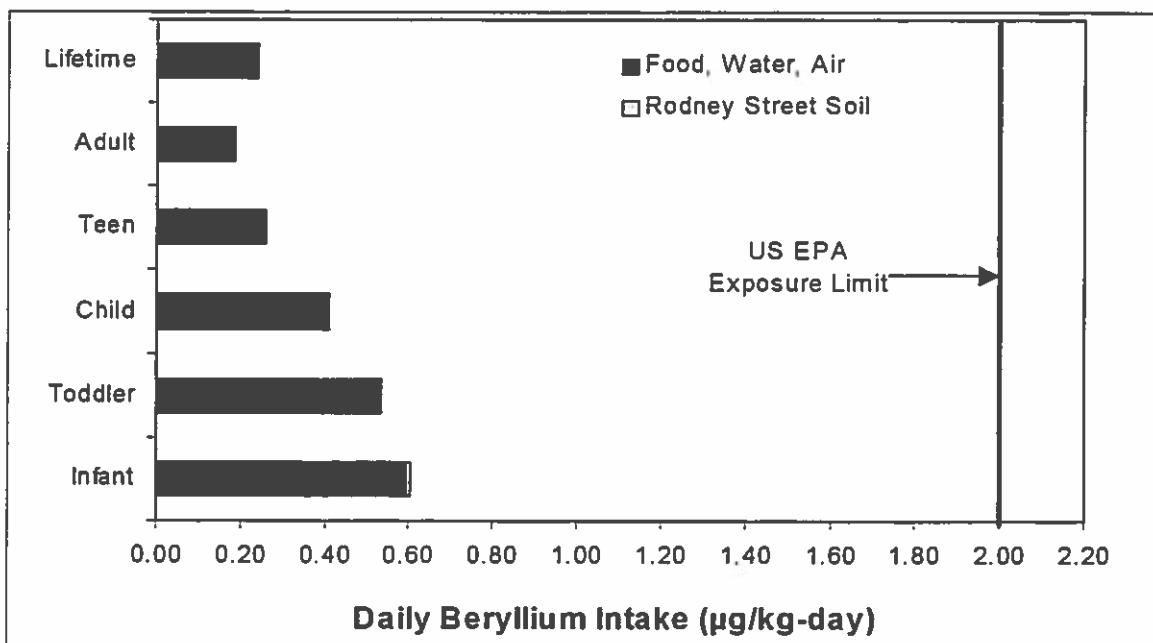
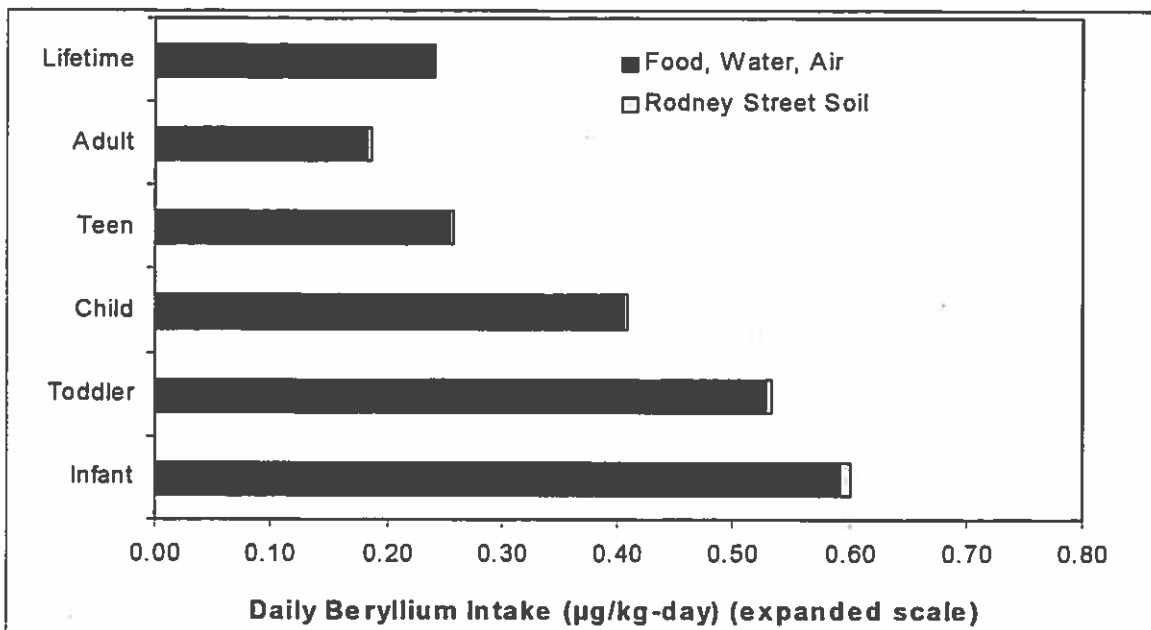


Figure 5-3: Exposures to Beryllium (expanded scale)



5.2.2 Inhalation Exposure to Beryllium

Potential health risks from inhaling airborne beryllium were assessed by comparing the estimated airborne concentration of beryllium in TSP with both the RfC of $0.002 \mu\text{g}/\text{m}^3$ for non-cancer effects (Table 3.1) and with the US EPA inhalation unit risk of $0.0024 (\mu\text{g}/\text{m}^3)^{-1}$ (Table 3.2). In both cases, the estimated airborne beryllium concentration ($0.00012 \mu\text{g}/\text{m}^3$) in the Rodney Street community (see Appendix 3) is less than the RfC and the air concentration at the 10^{-6} lifetime cancer risk level. Consequently, there appears to be no potential for health related effects from inhalation of beryllium.

5.3 Cadmium

5.3.1 Ingestion Exposure to Cadmium

To characterize the potential health risks for residents of the Rodney Street community, the total cadmium intake from all exposure pathways (Table 5-3) was compared with the $1 \mu\text{g}/\text{kg}/\text{day}$ oral exposure limit proposed by the US EPA and WHO (Table 3.1). This higher intake limit was used because intakes were estimated for all exposures not just drinking water or diet.

Table 5-3: Life-Time Averaged Daily Cadmium Intakes for the Rodney Street Community

| Metal | Receptor | Years | General Exposures | | | Rodney St Specific Exposures | | | Total CDI ⁴ |
|---------|---------------|-------|-------------------|------------------|---------------------------|------------------------------|------------------|---------------------------|------------------------|
| | | | EDI ¹ | CDI ² | Σ CDI ³ | EDI ¹ | CDI ² | Σ CDI ³ | |
| Cadmium | 0- 6 months | 0.5 | 0.62 | 0.004 | 0.28 | 0.12 | 0.0009 | 0.040 | 0.32 |
| | 7 months - | 4.5 | 0.65 | 0.041 | | 0.070 | 0.0045 | | |
| | 5 - 11 years | 7 | 0.51 | 0.051 | | 0.054 | 0.0054 | | |
| | 12 - 19 years | 8 | 0.29 | 0.033 | | 0.041 | 0.0047 | | |
| | 20 + years | 50 | 0.21 | 0.15 | | 0.034 | 0.0243 | | |

1: estimated daily intake ($\mu\text{g}/\text{kg}/\text{day}$)

2: Chronic Daily Intake Fraction ($\mu\text{g}/\text{kg}/\text{day}$)

3: Σ CDI = sum of CDI² for General or Rodney Street community specific Exposures ($\mu\text{g}/\text{kg}/\text{day}$)

4: Total CDI = Chronic Daily Intake for a life-time exposure to metal in the Rodney Street community ($\mu\text{g}/\text{kg}/\text{day}$)

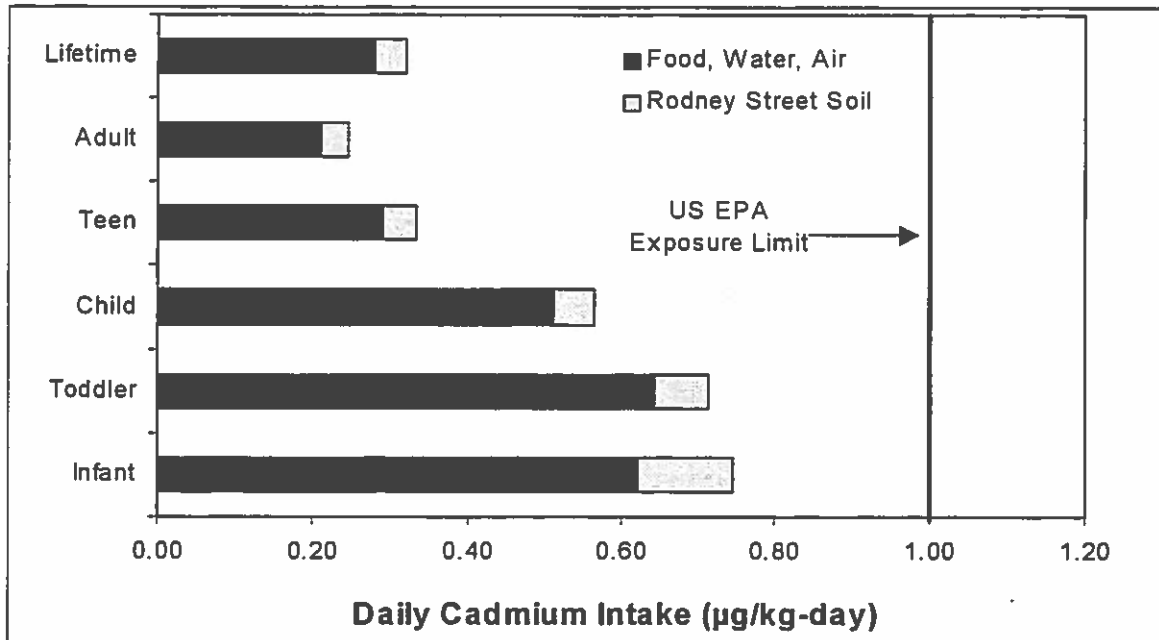
Inspection of Table 5-3 and Figure 5-4 show that the presence of up to $35.3 \mu\text{g}/\text{g}$ cadmium in soil in the Rodney Street community is unlikely to be associated with any adverse health effects since these conservatively estimated total intakes did not exceed the US EPA RfD for any age class.

5.3.2 Inhalation Exposure to Cadmium

Potential cancer risks from inhaling airborne cadmium were assessed by comparing the highest annual average air concentration in the Environment Canada air monitoring data for Ontario (Table A3-7) with the US EPA inhalation unit risk ($0.0018 (\mu\text{g}/\text{m}^3)^{-1}$) (Table 3.2). In this case, the maximum cadmium concentration found in the 1995-1999 Environment Canada monitoring of nine sites spread across Ontario was $0.0067 \mu\text{g}/\text{m}^3$, or about 1.1×10^{-5} lifetime risk. Since this is the estimated risk

at the maximum air concentration found and the average air concentration is $0.0007 \mu\text{g}/\text{m}^3$, or about ten times lower, the overall lifetime cancer from inhalation of cadmium is more likely to be in the 10^{-6} (1-in-a million) to 10^{-5} risk range, a risk range considered negligible by the federal government.

Figure 5-4: General and Rodney Street Community Specific Exposures to Cadmium



5.4 Cobalt

5.4.1 Ingestion Exposure to Cobalt

To characterize the potential health risks for residents of the Rodney Street community, the total cobalt intake from all exposure pathways (Table 5-4) was compared with the $60 \mu\text{g}/\text{kg}\text{-day}$ oral exposure limit proposed by the US EPA Region III (Table 3.1).

Table 5-4: Life-Time Averaged Daily Cobalt Intakes for the Rodney Street Community

| Metal | Receptor | Years | General Exposures | | | Rodney St Specific Exposures | | | Total CDI ⁴ |
|--------|---------------|-------|-------------------|------------------|--------------------|------------------------------|------------------|--------------------|------------------------|
| | | | EDI ¹ | CDI ² | Σ CDI ³ | EDI ¹ | CDI ² | Σ CDI ³ | |
| Cobalt | 0- 6 months | 0.5 | 0.51 | 0.003 | 0.19 | 0.16 | 0.0011 | 0.24 | |
| | 7 months - | 4.5 | 0.43 | 0.027 | | 0.10 | 0.0064 | | |
| | 5 - 11 years | 7 | 0.31 | 0.031 | | 0.070 | 0.0070 | | |
| | 12 - 19 years | 8 | 0.20 | 0.023 | | 0.052 | 0.0059 | | |
| | 20 + years | 50 | 0.15 | 0.11 | | 0.044 | 0.031 | | |

1: estimated daily intake ($\mu\text{g}/\text{kg}\text{-day}$)

2: Chronic Daily Intake Fraction ($\mu\text{g}/\text{kg}\text{-day}$)

3: ΣCDI = sum of CDI_f for General or Rodney Street community specific Exposures ($\mu\text{g}/\text{kg}\text{-day}$)

4: Total CDI = Chronic Daily Intake for a life-time exposure to metal in the Rodney Street community ($\mu\text{g}/\text{kg}\text{-day}$)

Inspection of Table 5-4 and Figure 5-5 show that the presence of up to 262 µg/g cobalt in soil in the Rodney Street community is unlikely to be associated with any adverse health effects since these conservatively estimated total intakes did not exceed the US EPA RfD for any age class. Figure 5-6 shows the contributions to total daily intakes of cadmium made by general and Rodney Street community specific exposures.

Figure 5-5: General and Rodney Street Community Specific Exposures to Cobalt

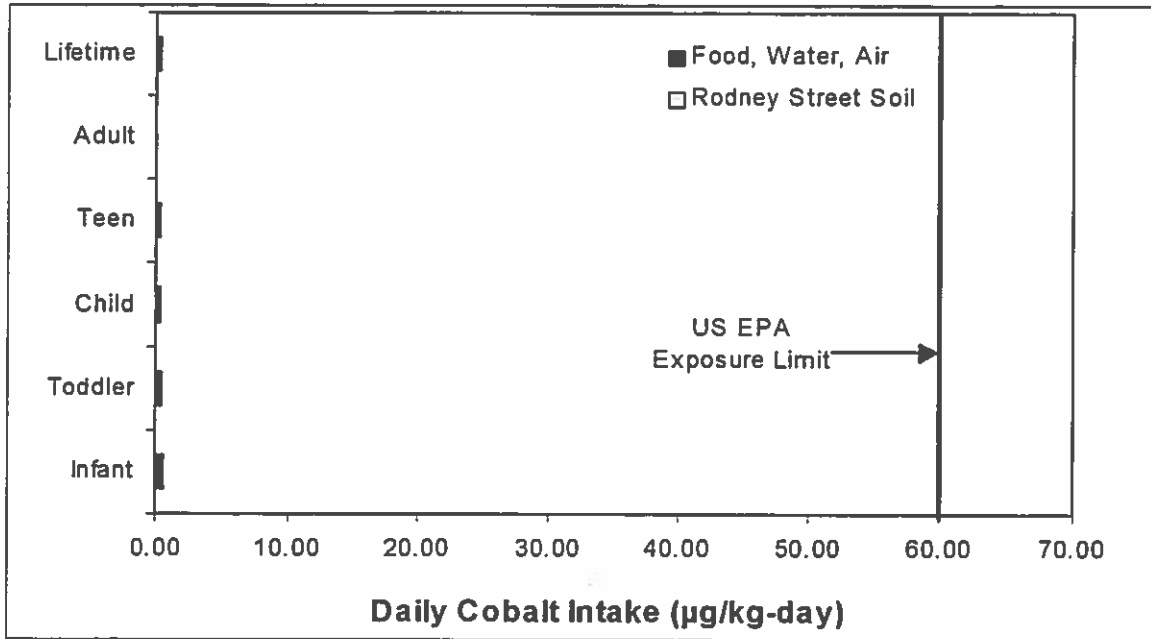
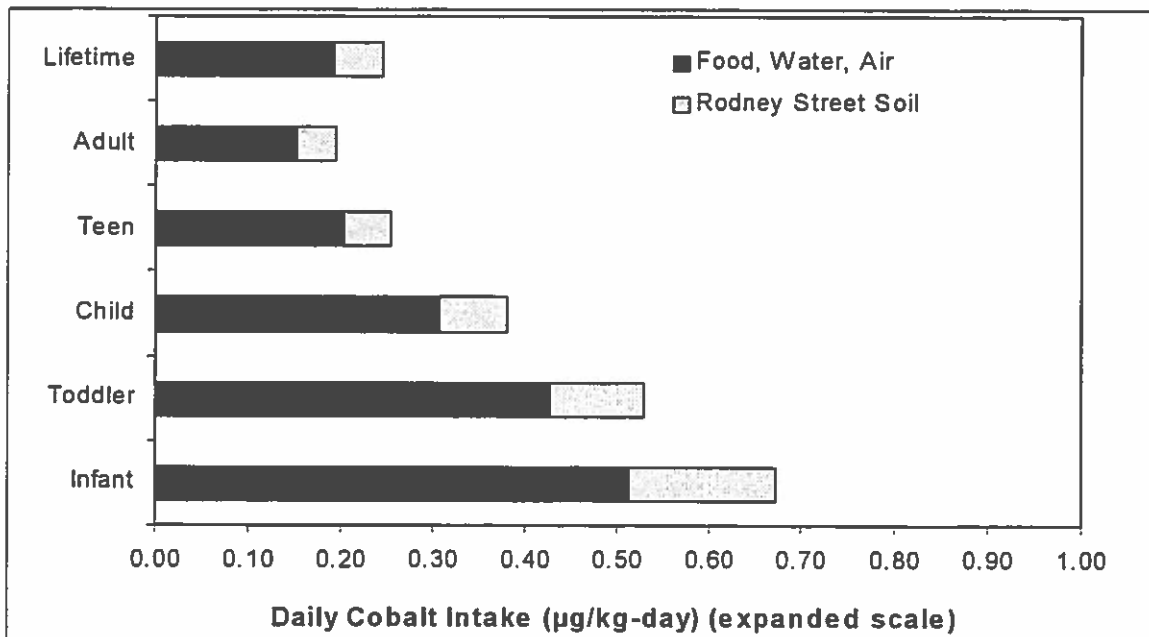


Figure 5-6: Exposures to Cobalt (expanded scale)



5.4.2 Inhalation Exposure to Cobalt

Potential health risks from inhaling airborne cobalt were assessed by comparing the highest annual average air concentration in the Environment Canada air monitoring data for Ontario (Table A3-7) with the US ATSDR inhalation MRL ($0.03 \mu\text{g}/\text{m}^3$) (Table 3.1). In this case, the maximum cobalt concentration found in the 1995-1999 Environment Canada monitoring of nine sites spread across Ontario ($0.017 \mu\text{g}/\text{m}^3$) and the highest annual average concentration ($0.002 \mu\text{g}/\text{m}^3$), are well below this inhalation MRL. Consequently, there appears to be no potential for health related effects from inhalation of cobalt.

5.5 Copper

5.5.1 Ingestion Exposure to Copper

To characterize the potential health risks for residents of the Rodney Street community, the total copper intake from all exposure pathways (Table 5-5) was compared with the Recommended Daily Allowances (RDA) for adults ($30 \mu\text{g}/\text{kg}\text{-day}$) or children ($50 \mu\text{g}/\text{kg}\text{-day}$) and the tolerable upper intake limit of $140 \mu\text{g}/\text{kg}\text{-day}$ proposed by the WHO, 1998 and IOM, 2001 (Table 3.1).

Table 5-5: Life-Time Averaged Daily Copper Intakes for the Rodney Street Community

| Metal | Receptor | Years | General Exposures | | | Rodney St Specific Exposures | | | Total CDI ⁴ |
|--------|---------------|-------|-------------------|------------------|---------------------------|------------------------------|------------------|---------------------------|------------------------|
| | | | EDI ¹ | CDI ² | Σ CDI ³ | EDI ¹ | CDI ² | Σ CDI ³ | |
| Copper | 0- 6 months | 0.5 | 65 | 0.46 | 26 | 19 | 0.14 | 9.2 | 35 |
| | 7 months - | 4.5 | 52 | 3.3 | | 15 | 0.96 | | |
| | 5 - 11 years | 7 | 39 | 3.9 | | 12 | 1.2 | | |
| | 12 - 19 years | 8 | 26 | 3.0 | | 10 | 1.1 | | |
| | 20 + years | 50 | 21 | 15 | | 8.1 | 5.8 | | |

- 1: estimated daily intake ($\mu\text{g}/\text{kg}\text{-day}$)
- 2: Chronic Daily Intake Fraction ($\mu\text{g}/\text{kg}\text{-day}$)
- 3: Σ CDI = sum of CDI^f for General or Rodney Street community specific Exposures ($\mu\text{g}/\text{kg}\text{-day}$)
- 4: Total CDI = Chronic Daily Intake for a life-time exposure to metal in the Rodney Street community ($\mu\text{g}/\text{kg}\text{-day}$)

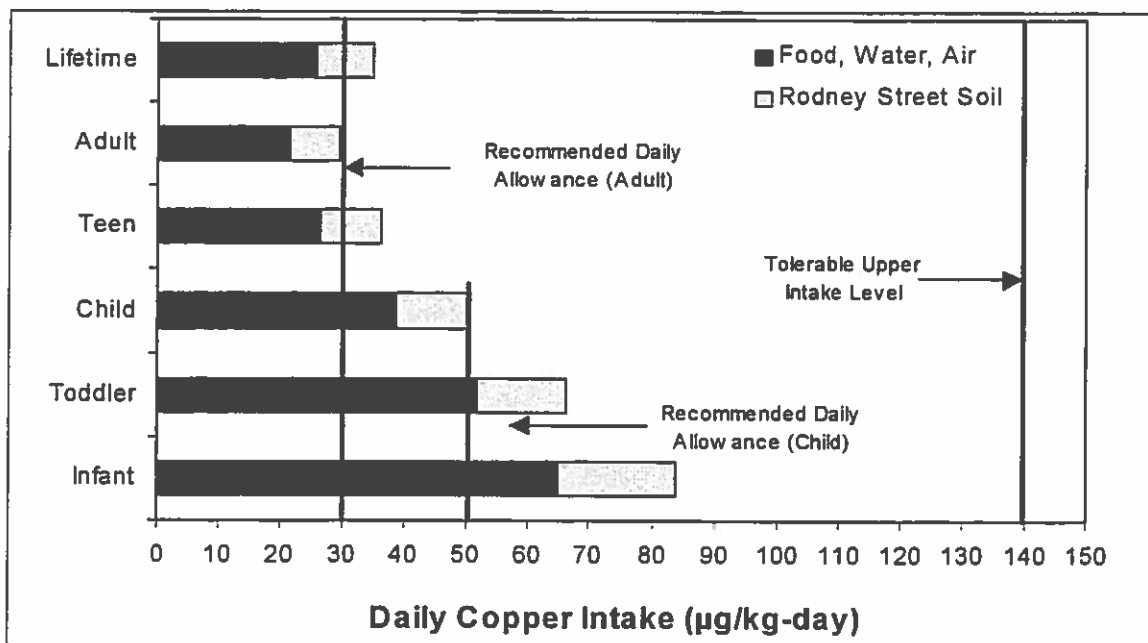
Inspection of Table 5-5 and Figure 5-5 show that the presence of up to $2720 \mu\text{g}/\text{g}$ copper in soil in the Rodney Street community is unlikely to be associated with any adverse health effects since these conservatively estimated total intakes did not exceed the tolerable upper intake limit for any age class.

5.5.2 Inhalation Exposure to Copper

Potential health risks from inhaling airborne copper were assessed by comparing the highest annual average air concentration in the MOE air monitoring data for Port Colborne (Table A3-7) with the chronic air quality criteria for copper used by California (Table 3.1). In this case, the maximum copper concentration found ($0.56 \mu\text{g}/\text{m}^3$) and the highest annual average concentration ($0.112 \mu\text{g}/\text{m}^3$), are well below California's chronic inhalation reference exposure limit (REL) ($2.4 \mu\text{g}/\text{m}^3$) (Table 3.1). Consequently, there appears to be no potential for health related effects from

inhalation of copper.

Figure 5-7: General and Rodney Street Community Specific Exposures to Copper



5.6 Nickel

5.6.1 Ingestion Exposure to Nickel

To characterize the potential health risks for residents of the Rodney Street community, the total nickel intake from all exposure pathways (Table 5-6), was compared with the US EPA RfD of 20 µg/kg/d (Table 3.1). Table 5-6 shows that total nickel intakes are below the RfD for age groups over the age of 5 years. This situation is also true for people in the Rodney Street community even when soil nickel levels are as high as 17,000 µg/g.

Table 5-6: Life-Time Averaged Daily Nickel Intakes for the Rodney Street Community

| Metal | Receptor | Years | General Exposures | | | Rodney St Specific Exposures | | | Total CDI ⁴ |
|--------|---------------|-------|-------------------|------------------|--------------------|------------------------------|------------------|--------------------|------------------------|
| | | | EDI ¹ | CDI ² | Σ CDI ³ | EDI ¹ | CDI ² | Σ CDI ³ | |
| Nickel | 0- 6 months | 0.5 | 22 | 0.16 | 5.8 | 5.7 | 0.041 | 2.0 | 7.9 |
| | 7 months - | 4.5 | 16 | 1.0 | | 4.1 | 0.26 | | |
| | 5 - 11 years | 7 | 10 | 1.0 | | 2.9 | 0.29 | | |
| | 12 - 19 years | 8 | 4.1 | 0.46 | | 2.1 | 0.24 | | |
| | 20 + years | 50 | 4.4 | 3.2 | | 1.7 | 1.2 | | |

- 1: estimated daily intake (µg/kg-day)
- 2: Chronic Daily Intake Fraction (µg/kg-day)
- 3: ΣCDI = sum of CDI² for General or Rodney Street community specific Exposures (µg/kg-day)
- 4: Total CDI = Chronic Daily Intake for a life-time exposure to metal in the Rodney Street community (µg/kg-day)

For adults exposed to soil containing 17,000 $\mu\text{g/g}$ nickel, their estimated lifetime intake averages 8 $\mu\text{g/kg/d}$ (40% of the US EPA RfD). For the infant age class, total nickel intakes exceed the US EPA RfD by about 25% even in the general population. This is due to a combination of the nickel levels in baby food and the low body weight of infants. This situation exists whatever the soil nickel concentration. For the toddler exposure scenario, the estimated daily intake is 18.5 $\mu\text{g/kg/d}$ at 5000 $\mu\text{g/g}$ and 19.2 $\mu\text{g/kg/d}$ at 10,000 $\mu\text{g/g}$. A large and fixed percentage of these intake estimates is due to exposures not influenced by soil nickel concentrations (supermarket food, drinking water and ambient air) which form 79% to 82% of the total intake. Even at soil nickel levels of 200 $\mu\text{g/g}$, the total daily intake is 17.9 $\mu\text{g/kg/day}$. The relationships of total daily intake, age class and the US EPA RfD are shown in Figure 5-6.

5.6.2 Inhalation Exposure to Nickel

Potential cancer risks from inhaling airborne nickel were assessed by comparing the highest annual average air concentration in the MOE air monitoring data for Port Colborne (Table A3-7, Appendix 3) with the US EPA inhalation unit risk ($0.00024 (\mu\text{g}/\text{m}^3)^{-1}$) (Table 3.2). In this case, the highest annual average nickel concentration found was 0.033 $\mu\text{g}/\text{m}^3$, or about 7.8×10^{-6} lifetime risk. The US EPA inhalation unit risk was developed for nickel refinery dust which contains a small percentage of nickel oxide (less than 10 %). The airborne nickel inhaled in the Rodney Street community is mainly nickel oxide and does not contain nickel subsulphide, the major carcinogenic component of nickel refinery dusts. While nickel oxide has been classified as a human carcinogen, there are no published or other reliable ways of assessing its carcinogenic potency. There is no evidence to suggest that nickel oxide has a greater carcinogenic potency than nickel refinery dust. Consequently the actual cancer risk for inhaling ambient air in the Rodney Street community is more likely to be below 10^{-6} lifetime risk. This risk range is considered negligible by the federal government.

Figure 5-8: General and Rodney Street Community Specific Exposures to Nickel (17,000 $\mu\text{g/g}$)

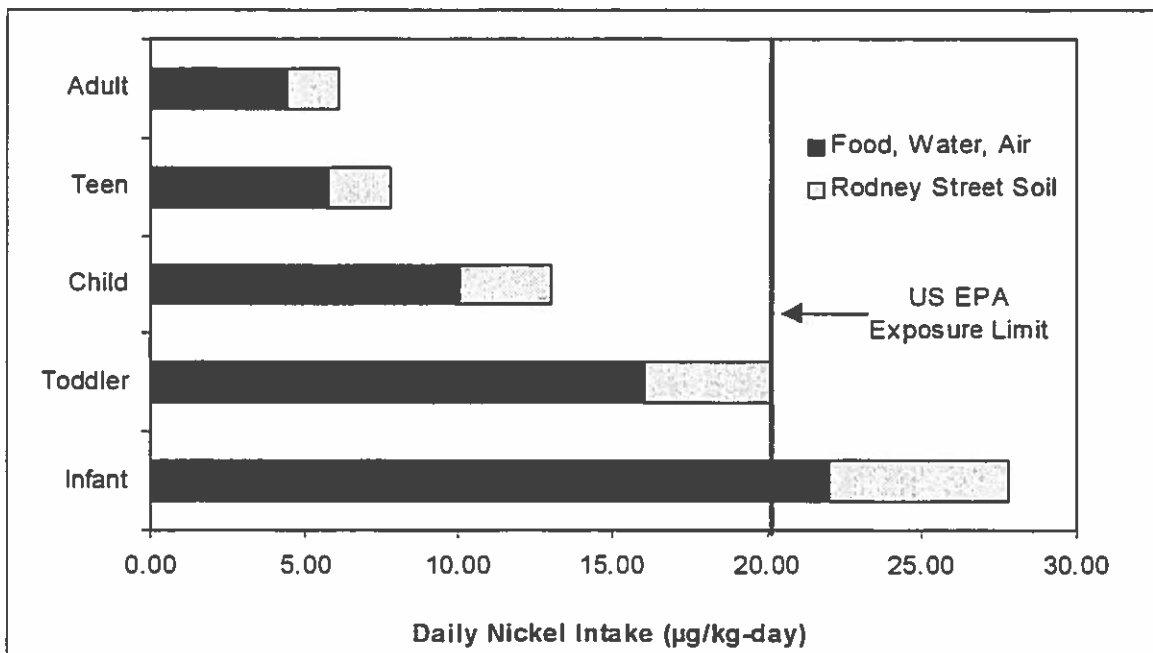
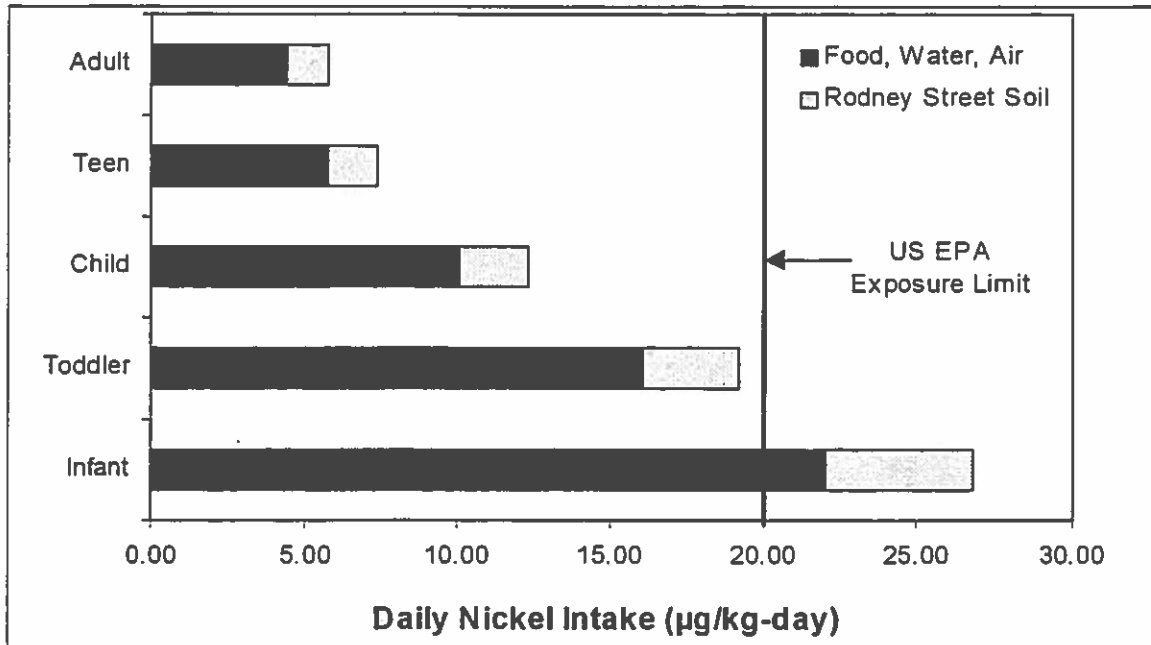


Figure 5-9: General and Rodney Street Community Specific Exposures to Nickel (10,000 µg/g)



5.7 Arsenic

Human Health Significance of Measured Soil Arsenic Levels

Arsenic is a known human carcinogen. Long term chronic ingestion of arsenic has been associated with skin changes including skin cancer and is reported to increase the risk of cancer of the liver, bladder, kidney and lung (ATSDR, 2000). Major public health agencies base their quantitative assessment on skin cancer as the most critical effect. Unlike lead, exposures over the entire lifetime are more important than exposures during childhood only. Because of the extensive experience with risk evaluation of arsenic in soil in other Ontario studies, it is considered that replication of similar calculations would not shed any light of additional value on arsenic levels in this situation. Rather, Port Colborne is compared to these other Ontario communities to determine whether the levels here are out of the ordinary and whether it is plausible that increased health risk could occur.

An important consideration regarding potential exposure to arsenic in these soils is that arsenic ions form insoluble salts with a number of cations in soils and are adsorbed by soil constituents, such as organic colloids and iron and aluminum oxides. Arsenic is held quite strongly by soils, especially fine-textured ones, and is leached very slowly. As such, relatively high levels of arsenic in soil may pose little risk if there are indeed highly insoluble and therefore not available for absorption if swallowed. In fact the measured solubility of arsenic in these soil samples using a simulated stomach acid leach test is very low with a maximum of 1.42 %. This suggests that the arsenic in the Rodney Street community is very tightly bound to soil and has very little potential to cause health effects, even at the highest measured levels in this neighbourhood i.e. 350 µg/g. Consistent with this are the very low and non-detectable levels measured in backyard vegetables

which show that plants are unable to take up the tightly bound arsenic. This also implies that levels many multiples of the MOE arsenic in soil guideline of 20 $\mu\text{g/g}$ (which is based on plant effects, not human health) would not pose undue health risk to residents.

People everywhere, including Ontario, are chronically exposed to low levels of arsenic in the environment and as such everyone has a certain amount of risk. These exposures can occur by a number of different pathways including the normal diet and drinking water. To understand the potential relevance of the measured soil levels in Port Colborne it is useful to compare the levels found with levels elsewhere in the province and in particular with the findings of health studies around arsenic conducted in the province.

The average level of arsenic in the Rodney Street community is approximately 16 $\mu\text{g/g}$, with the majority of samples lower than 18 $\mu\text{g/g}$ which is the 98th percentile of typical urban parklands in Ontario. Out of all properties sampled there were two which had unusually high arsenic levels (i.e. greater than 100 $\mu\text{g/g}$ As in soil). Background soil arsenic levels in North America range from 1 to 40 $\mu\text{g/g}$. Measured arsenic levels in Port Hope, Ontario average 20 $\mu\text{g/g}$, with a maximum of around 250 $\mu\text{g/g}$ (MOE, 1990). Most typical urban communities show this type of distribution with a few elevated properties within a given area. These higher levels are sometimes attributable to past herbicide use for weed control. As such there is nothing unusual regarding the soil arsenic levels measured in this community. It is therefore expected that exposure, based on levels alone, would be comparable or perhaps less than other Ontario communities.

In the Port Hope risk assessment study (MOE, 1991)- where average soil levels are roughly double what they are in this case, and had several properties in excess of 100 $\mu\text{g/g}$ - incremental cancer risk levels for soil arsenic exposure were calculated to be less than one-tenth of the calculated cancer risk from arsenic in the normal diet and to be non-significant. As well, the assumed availability of arsenic in soil was 45% for the Port Hope study, whereas in this situation it is maximally 1.4%. Even if availability is somewhat higher than measured, by corollary, it can be concluded that exposures to the arsenic in soil in Port Colborne would not produce significant cancer risk. Also, it is not anticipated that these levels would lead to increases arsenic levels in people as measured in urine. A study of exposure in a mining village with much higher levels of arsenic in the soil than in Port Colborne showed no relationship between elevated soil arsenic and urinary arsenic in people in all age groups (MOE, 1999)

Although findings in other studies cannot be directly applied to Port Colborne, they do provide a reasonable context for the levels measured in Port Colborne and do suggest that contact with these soils across the range of values measured, is unlikely to result in increased exposures. At the same time, for those few properties where arsenic levels are quite elevated, even though health impacts are not expected, it is desirable to reduce exposure, simply as a matter of precaution as these are unusually elevated above those generally found in the community.

With respect to dermal exposure, dermal absorption of dissolved arsenic compounds may occur, but is considered minimal, and therefore this route of environmental exposure would be considered inconsequential, as skin is rather impermeable to water and dissolved ions (Scheupler and Blackwell, 1971)

The very low levels of arsenic in backyard vegetables suggest no undue exposures would occur through this route. However because arsenic is a carcinogen it is prudent to minimize exposure and as such vegetables should be washed thoroughly before cooking and consumption because soil particles may adhere to leafy vegetables in particular.

5.8 Lead

Human Health Significance of Measured Soil Lead Levels

Lead in soil has long been recognized as posing potential risk, particularly to younger children ages one to four years, who may play in these areas. Because of their higher contact rates with soil and higher rates of intestinal absorption for lead as compared with adults, young children will generally have greater exposures by this pathway. Although exposures of women of child-bearing age due to fetal exposure issues merit consideration, such exposures will generally be much smaller and result in smaller absorbed intakes than for children. Therefore, young children may be considered the most susceptible receptor for exposures for direct soil/dust ingestion, and therefore characterization of risk should focus on this subgroup. Exposure to lead in soil occurs predominantly through the eating of soil or dust. Breathing of dust and skin absorption are considered trivial.

It is useful to compare the reported levels of lead in soil in this neighbourhood with those in other Ontario urban areas in order to postulate whether exposures to lead here could be greater. Bearing in mind that there is no "typical" urban residential site, one may examine other Ontario residential sites in built-up areas that are not obviously associated with any lead-related industry (although the areas may have been influenced to some degree by other industry, vehicle exhaust deposition, etc.). Linzon (1976) reports in a survey of an Ontario downtown area, serving as control for samples collected near a lead industry, lead levels in surface soils (0-5 cm), averaging 482 $\mu\text{g/g}$ with a range of 18 to 1,450 $\mu\text{g/g}$. Similar ranges of levels are reported in the scientific rationale for the MOE's lead in soil guideline (MOE, 1995). Also, lead levels near roadways and major intersections can easily exceed 500 $\mu\text{g/g}$ (Rinne, 1986). It can thus be suggested that reported on average soil lead levels in the Port Colborne area (mean and median of 222 and 179 $\mu\text{g/g}$ respectively in surface samples) are essentially no greater than, and in many cases less than, those expected for other urban residential sites in Ontario. As well, the pattern of lead levels on these residences is consistent with very localized spots of higher (i.e. > 1,000 $\mu\text{g/g}$) contamination related to leaded paint or fuel use. By corollary, estimated exposures (and hence blood lead levels) would be predicted to be on average similar to those for other urban Ontario populations.

Another consideration in this situation is the measurement of lead solubility in the Port Colborne soils. Results of tests conducted by the MOE laboratories on several samples indicated a maximum solubility of approximately 5%. In other words, only 5% of the lead in the soil will leach from the soil particles under acidic stomach conditions and be available for absorption into the body and the rest would pass through in stool. Furthermore, in the derivation of the current MOE guideline of 200 $\mu\text{g/g}$ for residential sites (a level to clean up to), relationships between lead intake in water and baby formula were utilized. Lead in drinking water and formula will be essentially entirely soluble and hence, largely bioavailable. Therefore in assessing the potential impact of intake from soils, adjustment must be made for the vast difference in solubility of lead adsorbed to soils versus lead in

drinking water. Even if the solubility of lead in Port Colborne soils were twice the measured maximum (i.e 10%) levels as high as 5X the MOE guideline or more could be without concern as actual uptake of the lead into the body would be very limited..

It is also relevant to discuss briefly the current scientific information relating to lead in soil and blood lead level in young children (for review see MOE, 1995; Davies, 1998; Stern, 1994). This question has been examined to some extent in a number of epidemiological investigations. Some studies have found positive correlations between soil lead and blood lead levels in children, particularly where soil lead levels exceed 1,000 ppm. Blood lead appears to vary directly with soil lead concentrations in some cases. The range of reported average slope factors (which attempt to describe this relationship numerically) is 0.6-8.0 $\mu\text{g}/\text{dL}$ per 1,000 $\mu\text{g}/\text{g}$ soil lead (MOE, 1995; Davies, 1998) based on roughly 20 studies using a range of data analysis methods. For example, the study of Baltrop et al. (1975) in Derbyshire, England, concluded that soil lead contributed 0.6 ($\mu\text{g}/\text{dL}$)/(mg Pb/g) soil in a rural area where industrial point sources of lead no longer operate. Another study has demonstrated no apparent elevation in mean blood lead concentrations (compared to low exposure groups) for children in two English villages with mean soil lead levels of greater than 1,000 $\mu\text{g}/\text{g}$ (Baltrop and Strehlow, 1988). In a more recent review of blood lead studies in mining areas (Steele et al., 1990) with mine waste but no recent or current history of smelting, it is noted that blood leads appear in general not to be elevated despite some very high soil lead concentrations. Average blood lead levels were lower than expected when compared with studies of urban communities or communities with operational smelters.

It is important to realize that environmental conditions greatly influence this relationship, and generally those that exhibit slope factors at the upper end of the range typically involve settings which are arid and lacking grass cover, where the soil lead will be virtually present as lead dust. These sites generally involve operating lead-based industry emissions (lead smelters, mining and battery plants). In contrast, those with the lowest slopes tend to not involve lead dusts or arid conditions. For example, in Baltrop's (1975) study in Derbyshire, almost all soil was grass-covered and there appeared to be little influence of the soil lead upon children's blood lead levels. Although one can not rely on this pattern entirely, it would suggest that in the Rodney Street community where there is not a great deal of bare soil in sampled areas nor a lead-based industry, that a large influence on blood lead by soil lead would not be expected to be at work. For illustrative purposes only, assuming that a very high slope factor operated in this situation, say a 7- 8 $\mu\text{g}/\text{dL}$ increase per 1,000 $\mu\text{g}/\text{g}$ lead in soil, and knowing that background blood lead levels in Ontario children are on average 2 $\mu\text{g}/\text{dL}$, it would require soil lead levels of 1,000 $\mu\text{g}/\text{g}$ or greater to cause blood lead levels to increase to the level of concern of 10 $\mu\text{g}/\text{dL}$ recommended by the US Centre for Disease Control (1990), Health Canada (1996) and the National Academy of Science. From this perspective it can be concluded that based on a highly conservative assumption, soil levels below 1,000 $\mu\text{g}/\text{g}$ should not pose an appreciable risk, whereas those at 1,000 $\mu\text{g}/\text{g}$ and greater, allowing for some individual variability between different children, may pose a significant risk.

Lead may be taken up into edible plants from the soil; therefore home gardening may also contribute to exposure if the produce is grown in soil containing high lead concentrations. Simple measures such as thorough washing of vegetables prior to preparation and consumption can minimize this type of exposure. Other measures to reduce personal lead exposure are contained in the MOE's Lead in the Environment Fact sheet.

In general based upon consideration of; a) typical urban lead levels in Ontario; b) the very low solubility of lead in these soils; and, c) consideration of findings regarding the observed relationship between soil lead and blood lead in other communities, it can be concluded that exposure to lead in these soils should not result in undue health effects in this community. It cannot be concluded that the reported values on average would lead to undue elevation of blood lead levels overall in this community. At the same time, based upon findings in the literature it is prudent to conclude that in the few residences with reported levels above 1,000 $\mu\text{g/g}$ in soil, there may be some possibility for exposures that result in some elevation in blood lead levels in children who routinely play in these areas.

Consideration of Exposure Reduction and Intervention Levels of Lead in Soil

Individuals can very greatly reduce their exposure to lead in soil in many ways. Regular hand and face washing to remove lead dust from young children, especially before meals, can lower the possibility of accidentally swallowing lead in dust while eating. Regularly cleaning the home of tracked in soil and removal of shoes after having been in soil areas will also reduce exposure. Planting of grass, or other coverings, over bare areas of a yard can lower contact that children and pets may have with soil and the tracking of soil into homes.

With respect to identifying a specific soil lead level which requires intervention through soil removal or other form of remediation, it must be remembered that a large variety of risk factors influence lead exposure in any given situation and as such there is not one universal lead in soil standard that can be applied to all cases. Determining the specific contribution of any particular environmental variable like soil/dust to blood lead level is extremely difficult. This difficulty is also confounded by significant other factors such as socioeconomic status and dietary exposure. For instance, the numerous variables studied in Ontario blood lead studies (MOH, 1984; MOH/MOE, 1990) were unable to account for more than 30% of the variations seen in blood levels in children. The range of observations on the relationship between soil lead and blood lead seen in various studies is a further reflection of the difficulties of determining such associations. As such selection of a single value for this situation involves considerable judgement.

An intervention level or other exposure reduction controls should have some reasonably clear potential for elevating blood lead levels in children to medical levels of concern (10 $\mu\text{g/dL}$ blood lead). The range of slope factors relating soil lead to blood lead is quite wide but consideration of the upper end of the range suggests that levels of 1,000 $\mu\text{g/g}$ could result in elevation of blood lead, possibly to levels of concern. Although the low lead solubility of the soils in this community suggest that levels as high as 1,000 $\mu\text{g/g}$ or more are likely to be of no concern from a health point of view, it would seem prudent to err on the side of caution and select 1,000 $\mu\text{g/g}$ as an intervention level for remediation/control at a residence in the absence of individual blood lead testing data for the 9 residences which fall into this category. This would be applied to both bare and grass-covered soils.

Another approach to development of a soil lead level of concern is to utilize multi-pathway exposure modelling. One such tool is the US EPA Integrated Uptake Biokinetic (IUBK) Model for Lead. In simple terms, this model converts estimates of lead exposure from different routes and predicts a blood lead level in children. Utilizing dietary, air, and drinking water intakes and exposure factors for Ontario populations of young children (0.5-4years)(MOE, 1994a) and assuming

conservative soil lead bioavailability of 30%, the model predicted a soil lead concentration of 1700 $\mu\text{g/g}$ associated with a blood lead level of 10 $\mu\text{g/dL}$. Predicted blood lead levels ranged from 5.5 - 7.7 $\mu\text{g/dL}$ over the soil lead range of 400 - 1,000 $\mu\text{g/g}$. This is consistent with the analysis above that suggests an intervention level of 1,000 $\mu\text{g/g}$ as sufficiently protective under typical exposure conditions.

Also very relevant to the choice of an appropriate intervention level are existing regulatory standards or guidelines from other jurisdictions. Most recently US EPA (2001) has developed a new lead in soil hazard standard under section 403 of the Toxic Substances Control Act. After initial consideration of a 2,000 $\mu\text{g/g}$ standard and extensive public comment, the following standards were established: a soil lead hazard standard of 400 $\mu\text{g/g}$ for bare soil in play areas and an average of 1200 $\mu\text{g/g}$ for bare soil in non-play areas of the yard. The EPA view is that this is a pragmatic approach which focuses exposure reduction actions on those areas where exposures may be highest for children. This approach would appear reasonable and adoption of a similar stratified approach for this situation seems sensible. Use of a 400 $\mu\text{g/g}$ soil lead level in bare soil of children's play area is prudent given the possibility of higher exposures in these areas for some children.

One other important consideration is that soil removal cannot be guaranteed to reduce actual exposure. In a comprehensive study of the effect of soil replacement on blood lead in children in the South Riverdale community of Toronto, findings could not support a beneficial effect of replacement on children living in homes that had received abatement or partial abatement (Langlois et al., 1996). In fact, 25 children who had soil replaced had a geometric mean blood lead 2.57 $\mu\text{g/dL}$ higher than children that had not had soil replaced. The no abatement group also had blood lead declines over time significantly faster than the abated group. Although abatement activities may have contributed to the worse result in individuals in the abatement group, selection bias and re-contamination are likely more significant factors. Also of note is that in other studies, e.g the Boston lead abatement project (US EPA, 1986), it is often observed that a notably elevated starting soil lead concentration (i.e. in excess of 1,000 to 2,000 $\mu\text{g/g}$ lead in soil) is possibly necessary to see a measurable, significant decline in blood lead. Therefore, those considering soil removal and replacement should bear in mind that the exposure reduction is unlikely to be demonstrable in sites with less than 1,000 $\mu\text{g/g}$ lead in soil, but rather only theoretically reduced. And, in certain cases, blood lead level may be increased following soil removal.

6.0 Discussion of Uncertainties

6.1 General Discussion of Uncertainty

The risk assessment process requires that many assumptions be made, either because of gaps in available monitoring data, or because of an improper or incomplete understanding of how people are likely to be exposed to the contaminants of concern. For example; when estimating daily exposures to a chemical, it is necessary to assume specific body weights in order to determine daily doses on a per body-weight basis, which is necessary in order to make predictive estimates of potential health effects. However, large variations in body weights are normal between people in any of the age groups considered. The use of such assumptions results in a degree of uncertainty in the overall estimates of exposure and risk and in the final conclusions of the risk assessment. As regulators, conservative or precautionary assumptions are made to err on the side of caution and to ensure that the risk assessment does not under estimate the potential for adverse effects.

Another way of approaching uncertainty is to say "how reliable" are the conclusions of the risk assessment, or, what is the "confidence rating" in the process? It is useful to distinguish between at least two types of uncertainty;

Variability In the Data:

This is the most common type of uncertainty. The extent of this type of uncertainty can be quantified statistically. For example, the analytical results for the testing of air, water, soil, and backyard produce from Port Colborne and the Rodney Street community have some degree of sampling and analytical error.

Scientific Judgement:

This type of uncertainty is introduced into the process when scientific judgement must be used to bridge gaps in analytical, toxicological or receptor characteristic data. For example, in estimating dermal exposure to metals it is necessary to use scientific judgement in selecting reasonable dermal uptake factors for metals where direct information is not available. In this type of situation, uncertainty in the parameter may be mitigated either by obtaining more data or by the use of conservative estimates that are applied in a consistent manner throughout the risk assessment.

Several areas of uncertainty exist within the current risk assessment. These are discussed in the following sections. In addition, a discussion of the implications that each has on the overall conclusions of the risk assessment is provided as a summary.

6.2 Uncertainties in Environmental Media Concentrations

There are several areas in the estimates of metal concentrations in environmental media (air, water, soil, backyard vegetables, diet) where uncertainties could have been introduced into the risk assessment including;

Estimates of Dietary Intakes of Metals:

Information on the levels of metals in typical foods and the daily intake of metals from the diet is limited. Reasonable data is available for nickel and several of the other metals considered in this report. However, even within these data sets there are discrepancies in the estimates of daily dietary intakes between the populations examined. For instance, estimates of daily dietary intakes of nickel by the Canadian population are two to three times the levels estimated for the US population (Appendix 4).

The Canadian data was used in this assessment because it was felt that this provided the best reflection of likely dietary intakes for the residents of the Rodney Street community. This approach avoids under estimates of the likely dietary intake of nickel for the residents of the Rodney Street community, which in turn, ensures that maximal estimates of total daily intakes are calculated. Similar approaches are used for the other metals considered in the detailed assessment of risk.

Metal Levels in Backyard Garden Vegetables:

The current assessment has had the benefit of more metal in backyard garden produce information than the previous assessment carried out for Port Colborne (MOE, 1998). However, even the current data only provides limited information on metal levels in a limited selection of crops. To address any uncertainties that may be introduced due to the limited nature of the present data, the metal levels in the examined crops were assumed to be representative of the levels of the levels found in all crops of an equivalent type. In addition, the highest reported level found in the root and other vegetable categories were used to estimate exposures. This approach will over estimate likely intakes of metals.

Metal Levels in Ambient Air:

Ambient air monitoring specific to Port Colborne was available for copper, lead and nickel. The remainder of the metal levels relied on Environment Canada data for southern Ontario. While there is no reason to believe that southern Ontario data for these other metals is not representative of ambient air levels in Port Colborne, the lack of direct data introduces a limited level of uncertainty into the assessment. However, the detailed exposure assessment clearly showed that inhalation exposures to metals in ambient air make a very minor contribution to the total daily exposure and do not, in themselves, represent a risk.

Metal Levels in Soil:

An extensive sampling program was undertaken in the Rodney Street community. Metal levels were assessed in over 1300 samples. However, even with a large data set there is a potential for an error of up to 20% in the reported metal level for any one sample. To address this, the highest level of each metal was used to assess exposures for all residents of the Rodney Street community regardless of where they resided.

Metal Levels in Indoor Dust:

Metal levels were not determined in indoor dust. It was assumed that the daily intake

of soil and dust would occur from the soil with the highest reported level of each metal. It was further assumed that this would occur every day of the year even when winter conditions prevent direct exposure to residential soils. In most cases metal levels in household dust are lower than those reported in soil from the yard. By assuming that all soil and dust ingested comes from the area of highest metal levels yearly exposures to metals through soil and dust ingestion will have been over estimated.

Estimates of Metal Bio-accessibility from Soil:

The metals in the soil, particularly nickel, are largely present in insoluble forms that are tightly bound to the soil matrix. Therefore their accessibility to the body, either in the gut, or through the skin, will depend upon their release from the soil. While the metals are insoluble in water at neutral pH (6.0 - 8.0), their solubility increases under acidic conditions. To address the potential for metal release from the soil during digestion, soils were subjected to a simulated stomach acid leach test (Appendix 5). The digests were conducted over a 24 hour period which is longer than the time material spends in the stomach. The amount of each metal released under these conditions was used to adjust the soil intake estimates to provide an indication of the level of material available for uptake. This approach provides maximum estimates of the amount of each metal available for uptake and consequently will provide maximal estimates of exposure and risk.

6.3 Uncertainties in Receptor Characteristics

There are several areas related to the characteristics and activity patterns of the residents where uncertainties can be introduced into the assessment of exposure and risk.

Receptor Characteristics:

As noted above, the use of single point values to characterize the population does not account for the wide variation that exists within any community. The receptor parameters used in this assessment have been taken from Canadian sources and are based on statistical surveys of the Canadian population. As such they can be considered to be reasonable representative of the residents of the Rodney Street community.

Statistical methods exist to address these variations and provide ranges of exposures and risk for a community. However, these techniques are really only beneficial when an initial worst case assessment demonstrates that potential risks exist. The current assessment made use of conservative assumptions to provide reasonable worst case estimates of exposure and risk. These showed that even at the highest predicted exposures for antimony, beryllium, cadmium, cobalt and cooper, risks do not exist within the community. Therefore a refinement of exposure estimates to account for variation within the population was not deemed necessary.

Activity Patterns:

The current assessment assumed that a person would be living in the Rodney Street community every day of a full 70 year life-time. All exposures were assumed to occur within this community. No correction was made for time spent away for this area. This approach will over estimate all potential exposures.

Dermal Contact with Soil:

Dermal contact for metals is generally considered to be a very minimal pathway of exposure. However, in the current assessment, dermal exposure was estimated to make a reasonable contribution to the total daily exposure for many of the metals examined. This is due to the use of a series of very conservative assumptions regarding the amount of material that may adhere to the skin and the amount of metal that could be released from the soil during contact with the skin. The current assessment used the acid leach test data to represent the amount of metal that would be available for uptake through the skin. This assumption will have over estimated exposure because the level of metal likely to be released from soil under neutral pH condition will be significantly lower. However, in the absence of data to indicate the levels of metals that could reasonably be expected to be released, the acid leach test numbers were used as a worst case.

Consumption of Home Grown Produce:

There is some uncertainty associated with the actual amount of home grown produce a family could consume. For the current assessment, it was conservatively assumed that a family of four would consume 100% of the total garden yield. In addition to this assumption, annual backyard garden yields were based on an assumed garden size and an estimated average crop yield. Depending on the actual family size, garden size, and crop yield, this may be an over- or underestimate of individual exposure. However, given that there was no reduction of exposures to home garden produce due to crop loss (*e.g.*, browsing by wildlife and birds or spoilage), it is concluded that the estimates employed in this assessment would be conservative.

6.4 Uncertainties in Toxicity Information

Each of the toxicologically based exposure limits used to estimate potential health risks have uncertainty factors associated with them. These factors account for the strength of the toxicological data and incorporate uncertainty factors to account for intraspecies and interspecies extrapolations of toxicological data. These uncertainty factors reflect the adequacy of the toxicological data available for each compound. Where toxicological data is poor or limited to one or two studies, large uncertainty factors are applied to insure adequate protection of sensitive members of the population. The result is a general overestimation of potential risks from exposure. Thus, exposures which exceed the exposure limits may not always result in adverse health effects. The uncertainty factor attached to each exposure estimate gives a measure of this potential. The lower the uncertainty factor, the more certain the data and the more predictive of adverse health effects an exposure limit is. In these cases, the probability that exceedances of exposure limits will result in adverse health effects is higher. For exposure limits with higher uncertainty factors, the probability of adverse effects occurring as a result of limited exceedance of exposure limits is thought to decline.

The toxicity and exposure limits selected in this study also have conservative assumptions incorporated into them. However, since these parts of the risk assessment were taken from the reviewed literature and from recognized regulatory agencies, discussion of their uncertainty is beyond the scope of this report. However, it should be noted that the toxicological basis of exposure limits is updated as new information becomes available so every effort was made to ensure that recent information was used.

6.5 Uncertainties in the Risk characterization

Using an Exposure Limit for Nickel Soluble Salts:

In estimating potential risks associated with ingestion and dermal exposures to nickel, the report made use of the non-cancer oral exposure limit for nickel soluble salts put forward by the US EPA. The nickel in soil in the Rodney Street community and Port Colborne has been identified as nickel oxide which is insoluble in water. Therefore there are some potential uncertainties associated with using an oral exposure limit set for a soluble form of the metal. However, the risk assessment made use of a stomach acid leach test to determine the amount of nickel that could be released from the soil matrix during digestion. This digestion would, in fact convert nickel oxide to soluble forms. Once released from the soil matrix, the nickel would be in the form of a soluble salt. Thus, the comparison of this to a exposure limit set for a soluble form of nickel is appropriate.

Use of Life-Time Averaged Daily Doses:

The current assessment developed life-time average daily dose estimates from all age groups (life stages) to estimate the life-time exposure. These values were compared to the reference dose limits set by the US EPA. While not standard practice in risk assessment, it is the approach recommended by the US EPA. The use of a life-time average daily dose is appropriate for the current assessment because exposures have been considered to occur every day over a 70 year life-time, a truly life-time exposure. This approach limits the uncertainty in the assessment to the uncertainties inherent in the reference dose itself.

Estimates of exposure for individual age groups have also been compared to the reference dose, but this serves only as a tool for comparison to determine if potential risks exist. If exposures for individual age groups do not exceed the reference dose then the likelihood that life-time exposures will result in adverse effects is limited. It should be noted that this does not apply to one-time exposures to metals at levels that could result in acutely toxic effects.

6.6 Implications of Uncertainties

Systemic Health Effects:

There are a number of areas where uncertainties may have been introduced into the current assessment of exposure and risk. Throughout, conservative assumptions have been used in an effort to provide estimates of the maximum likely exposures. The objective was to determine if these exposures had the potential to cause adverse health effects in the residents of the Rodney Street community. The risk characterization has shown that even under the conservative conditions that have been assumed to exist in the Rodney Street community, exposures to metals in the soil in the community would not be expected to result in adverse health effects. In most cases, the estimated exposures were significantly lower than the exposure limits identified for each metal.

Contact Dermatitis:

The current assessment for nickel shows that the risks of systemic effects occurring as a result of exposure to nickel in the soil are limited. However, the potential for contact dermatitis to occur in response to skin contact with soil, or through the ingestion of nickel bearing soil in individuals who have already been sensitized to nickel has not been addressed. In the absence of exposure limits set to protect against this effect, the risk assessment process employed here cannot effectively address this issue.

7.0 Recommendations and Conclusions

A plausible worst case exposure estimate was modeled using the maximum reported metal levels in surface soil (0-30 cm) within the Rodney Street community, in municipal drinking water, in backyard produce from the Rodney Street community, in supermarket food and in air monitoring data for Port Colborne or for nine other sites in Ontario. The exposure assessment looked at receptors for each age class (infant, toddler, child, teen and adult) and modeled exposures for inhalation, ingestion and dermal contact using standard exposure assessment methodologies. Adjustments were made for the fact that the predominant form of nickel in the Rodney Street community is insoluble nickel oxide. Acid leachate tests were used to adjust for the amount of each metal that would be bio-accessible in the digestive tract and at the surface of the skin. In other cases, accepted dermal exposure factors were taken from the scientific literature.

Metal exposures for residents of the Rodney Street community were divided into two main components, those related either to dermal contact with metals in the soil or the ingestion of soil and/or backyard garden produce from the Rodney Street community and, general exposures to metals such as those experienced by people elsewhere in Ontario. These general exposures include supermarket food, municipal drinking water and ambient air. The major contributor, in all cases, to total daily intakes of metals is supermarket food which is independent of any local soil metal exposures experienced in the Rodney Street community.

When total metal exposures are broken down by age group, the highest exposures are for the infant and toddler age classes (up to 5 years old). Worst case exposures for these age classes only exceeded the US EPA RfD for nickel.

Potential health risks from inhaling airborne metals were assessed by comparing the highest annual average air concentration in the MOE air monitoring data for Port Colborne or Environment Canada air monitoring data for Ontario (Table A3-7) with the selected inhalation exposure limit (RfC, unit cancer risk, etc.). In all cases except nickel, there appears to be no potential for health related effects from inhalation of these metals in ambient air in the Rodney Street community.

Exposures to lead and arsenic were assessed by comparison with health studies of other Ontario communities with elevated soil concentrations of these metals that were generally higher than those in the Rodney Street community. Conclusions and recommendations for arsenic and lead are described in separate sections below.

7.1 Nickel

For infants, the total nickel intake is mainly due to supermarket food exposure (mainly baby foods). At the maximum soil nickel concentration in the Rodney Street community (17,000 $\mu\text{g/g}$), the toddler receptor is at the RfD level of exposure. The general exposure component of the toddler's exposure is below the RfD, consequently, reducing its soil exposure by reducing the soil nickel level to 10,000 $\mu\text{g/g}$ reduces the Rodney Street community specific exposure component of the toddler's exposure and reduces its total intake to below the RfD. This adds a small margin of safety. The effect of adjusting the soil nickel level on the size of the Rodney Street community specific exposure

component was calculated using the spreadsheet developed for the exposure assessment. Skin contact with soil is an important contributor to the exposures experienced by toddlers in the Rodney Street community. This estimate is based on conservative assumptions about dermal exposure to nickel sulphate which is more soluble than nickel oxide. Unfortunately, there is no information on dermal exposure to nickel oxide.

In the case of inhaled nickel, the estimated lifetime cancer risk was greater than 1-in-1,000,000. However, this risk estimate was based on an unit inhalation risk factor developed for nickel refinery dusts which contain less than 10 % of nickel oxide (the main form of nickel in soil in the Rodney Street community). While nickel oxide has been classified as a human carcinogen, there are no published or other reliable ways of assessing its carcinogenic potency. There is no evidence to suggest that nickel oxide has a greater carcinogenic potency than nickel refinery dust. Consequently the actual cancer risk for inhaling ambient air in the Rodney Street community is more likely to be below 10^{-6} lifetime risk. This risk range is considered negligible by the federal government.

A site-specific soil intervention level of 10,000 μg nickel/g soil was developed specifically for the Rodney Street community based on toddler exposure. While conservatively estimated, there are several reasons to support the use of this site-specific soil intervention level of 10,000 μg nickel/g. These reasons include:

- uncertainty in the sampling and analytical measurement of nickel in soil
- uncertainty in the estimates of the actual amounts of nickel that would be absorbed into the toddler due to ingestion of, and, dermal contact with soil containing nickel at this concentration
- there may be some uncertainty as to whether the current US EPA RfD of 20 μg nickel / kg - day completely protects against the contact dermatitis experienced by a percentage of the population, mainly female, who are already sensitized to nickel through wearing jewellery, dental or surgical prostheses or other contact with metallic nickel and stainless steel.

7.1.1 Recommendations for Nickel

1. The site-specific soil intervention level of 10,000 μg nickel/g for noncancer effects based on toddler exposure developed specifically for the Rodney Street community, be used to facilitate remediation of affected properties in the Rodney Street community.

7.2 Arsenic

It is concluded that the measured levels of arsenic in these soils do not pose an undue health risk to residents of this community based upon consideration of:

- 1.) comparison to typical levels elsewhere;
- 2.) knowledge of outcomes of health studies involving arsenic in soil exposure in other Ontario communities and;
- 3.) the very low measured availability of the arsenic in these soils.

Measured levels of arsenic in the Rodney Street community are not anticipated to pose an undue health risk to community residents.

7.2.1 Recommendations for Arsenic

1. Residents living on properties with arsenic levels above the MOE guideline should be provided with the MOE Greenfact Sheet entitled "Arsenic in the Environment" which outlines simple measures related to reducing exposure.

7.3 Lead

The weight-of evidence would support an intervention level for exposure reduction of 1,000 $\mu\text{g/g}$ in soils based on:

- empirical findings regarding the potential contribution of soil lead levels to blood lead in children and a blood lead level of concern of 10 $\mu\text{g/dL}$;
- use of the U.S. EPA Biokinetic model suggest that 1,000 $\mu\text{g/g}$ would provide adequate protection with a margin of safety;
- the new EPA lead in soil standard of 1,200 $\mu\text{g/g}$ suggests that an intervention level of 1,000 $\mu\text{g/g}$ lead in soil would be protective of persons in this community and;
- abatement observations that suggest that only remediation of soils in excess of 1,000 $\mu\text{g/g}$ have a measurable impact on exposure reduction.

In addition, adoption of the U.S. EPA stratified approach to a soil standard seems desirable to focus resources and efforts on those areas which have the highest exposure potential for children. Therefore, an intervention level of 400 $\mu\text{g/g}$ for lead in bare soil play areas is reasonable to apply. Bare soil allows for greater contact of soil particles with children and therefore a more stringent value than 1,000 $\mu\text{g/g}$ is warranted for these specific areas on a property.

7.3.1 Recommendations for Lead

1. An intervention level be established for this community at a soil lead level of 400 $\mu\text{g/g}$ for children's play areas with bare soil on residential properties or in public areas, and at a level of 1,000 $\mu\text{g/g}$ for all other areas of these properties to which children have access.
2. Soil removal, where conducted, should occur to a depth of up to 40 cm. Wet methods of dust control should be employed.
3. Residents living at properties exceeding these intervention levels for lead in soil should

minimize/avoid contact with these soils and not consume vegetables from backyard gardens.

4. All households with measured lead levels above the Ministry screening guideline (200 µg/g) receive the MOE fact sheet on "Lead in Soil" to provide a better understanding of lead exposure and simple measures that can reduce potential exposure.

7.4: Antimony, Beryllium, Cadmium, Cobalt and Copper

For the metals, antimony, beryllium, cadmium, cobalt and copper, estimated total daily intakes for all age classes were well below stringent oral or inhalation exposure limits from major recognized jurisdictions, such as, the US EPA, WHO and Health Canada.

No soil intervention levels for the metals, antimony, beryllium, cadmium, cobalt and copper, in soil in the Rodney Street community are recommended.

8.0 References

The references listed here pertain to the citations contained in this, the main document. Lists of the references used in each of the appendices are provided at the end of each appendix.

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APPENDIX 1

**Environmental Monitoring of Metals
in Rodney Street and Port Colborne**

Drinking Water Monitoring Data

Table A1-1: Summary of Pt. Colborne Municipal Drinking Water Data - 1996 -1999
(Number of Samples = 8)

| Element | Range of Drinking Water Concentrations (µg/L) | Average Drinking Water Concentration (µg/L) | MOE Drinking Water Standard (µg/L) | World Health Organization Drinking Water Guidelines (µg/L) | EPA Maximum Contaminant Levels (µg/L) |
|--|---|---|------------------------------------|--|---------------------------------------|
| <i>Treated Drinking Water</i> | | | | | |
| Antimony | 0.306 - 0.96 | 0.5965 | none | 5 (provisional) | 6 |
| Arsenic | 0.2 - 0.6 | 0.3394 | 25 | 10 (provisional) | 5 |
| Beryllium | 0.11 - 0.2 | 0.155 | none | none | 4 |
| Cadmium | 0.0041 - 0.051 | 0.0224 | 5 | 3 | 5 |
| Cobalt | 0.025 - 0.0538 | 0.0348 | none | none | none |
| Copper | 0.333 - 1 | 0.6534 | none | 2,000 (provisional) | 1,300 (aesthetics) |
| Lead | 0.05 - 1.9 | 0.3705 | 10 | 10 | 15 |
| Nickel | 0.4 - 1.1 | 0.7686 | none | 20 (provisional) | none |
| <i>Distributed Water at Charlotte Street</i> | | | | | |
| Antimony | 0.45 - 0.97 | 0.6445 | none | 5 (provisional) | 6 |
| Arsenic | 0.143 - 0.401 | 0.2767 | 25 | 10 (provisional) | 5 |
| Beryllium | 0.0306 - 0.2 | 0.1125 | none | none | 4 |
| Cadmium | 0.022 - 0.083 | 0.0558 | 5 | 3 | 5 |
| Cobalt | 0.026 - 0.04 | 0.0341 | none | none | none |
| Copper | 5 - 44.1 | 14.5 | none | 2,000 (provisional) | 1,300 (aesthetics) |
| Lead | 0.067 - 0.71 | 0.3834 | 10 | 10 | 15 |
| Nickel | 0.6 - 1.3 | 0.9432 | none | 20 (provisional) | none |

* EPA Region III Risk Based Concentrations are not standards or guidelines and were used for comparison purpose only when the MOE or EPA did not have a standard/guideline for a particular substance.

Table A1-2: Summary of Well and Cistern Data - JWEL - Pt.Colborne - Samples Taken at External Tap

| Element | Range of Drinking Water Concentrations (µg/L) | Number of Samples | MOE Drinking Water Standard (µg/L) | World Health Organization Drinking Water Guidelines (µg/L) | EPA Maximum Contaminant Levels (µg/L) |
|-------------------|---|-------------------|------------------------------------|--|---------------------------------------|
| Antimony | <0.5 - <0.6 | 14 | none | 5 (provisional) | 6 |
| Arsenic | <2 - 3 | 14 | 25 | 10 (provisional) | 5 |
| Beryllium | <1 | 14 | none | none | 4 |
| Cadmium | <0.1 - 0.2 | 14 | 5 | 3 | 5 |
| Cobalt | <0.1 - 2.4 | 14 | none | none | none |
| Copper | 2 - 558 | 14 | none | 2,000 (provisional) | 1,300 (aesthetics) |
| Lead ¹ | 0.5 - 3.6 | 14 | 10 | 10 | 15 |
| Nickel | <1 - 24 | 14 | none | 20 (provisional) | none |

* EPA Region III Risk Based Concentrations are not standards or guidelines and were used for comparison purpose only when the MOE or EPA did not have a standard/guideline for a particular substance.

¹ One lead sample was measured at 0.0921 mg/L, subsequent confirmatory sampling of the site by JWEL, MOE, and Niagara Regional Health Department resulted in lead levels below the MOE Drinking Water Standard.

Air Monitoring Data

Table A1-3: MOE Air monitoring data (1992-1996) from monitoring station 27047 at Davis & Fraser (ng/ m³)

| Year (# of Samples) | Percentiles | | | | | | Max. | Mean | Geom. Mean |
|------------------------|-------------|-----|-----|-----|-----|-----|------|------|---------------|
| | 10% | 30% | 50% | 70% | 90% | 99% | | | |
| 1992 (54) | 5 | 5 | 20 | 38 | 130 | 496 | 690 | 53 | 20 |
| 1993 (49) | 2 | 6 | 10 | 20 | 90 | 302 | 390 | 34 | 13 |
| 1994 (48) | 4 | 7 | 11 | 21 | 67 | 141 | 160 | 25 | 14 |
| 1995 (55) | 3 | 8 | 11 | 19 | 49 | 135 | 140 | 23 | 11 |
| 1996 (12) | 2 | 6 | 10 | 17 | 34 | 62 | 66 | INS | INS |

INS = insufficient data

Table A1-4: Summary of Air Monitoring Data for Pt. Colborne

| Metal | Minimum Air Concentration (µg/m ³) | Maximum Air Concentration (µg/m ³) | Average Concentration (µg/m ³) | OMOE Air Standard (24- hour) |
|--|--|--|--|------------------------------------|
| <i>Ontario Ministry of the Environment - Pt. Colborne Air Monitoring Data - 1992 - 1996</i> | | | | |
| Nickel | 0.002 | 0.69 | 0.0327 | 2 |
| Copper | 0.058 | 0.56 | 0.112 | 50 |
| Lead | 0.01 | 0.06 | 0.02 | 2 |
| Total Suspended Particulate | 9 | 222 | 51.66 | 120 |
| <i>Jacques Whitford Environmental - Air Monitoring Data for Pt. Colborne Schools - Summer 2000</i> | | | | |
| Arsenic | 0.001 | 0.005 | 0.002 | 0.3 |
| Cobalt | 0.004 | 0.01 | 0.0075 | 0.1 |
| Copper | 0.01 | 0.08 | 0.0345 | 50 |
| Nickel | 0.01 | 0.11 | 0.05 | 2 |
| Total Suspended Particulate | 24 | 63 | 48.67 | |
| PM ₁₀ | 21 | 44 | 34 | |
| <i>Environment Canada - Typical Ontario Air Concentrations - 1995 - 1999 (24-hr or annual numbers)</i> | | | | |
| Antimony | 0.0001 | 0.0115 | 0.001056 | 25 |
| Arsenic | 0.003 | 0.0158 | 0.001644 | 0.3 |
| Beryllium | No data available | | | 0.01 |
| Cadmium | 0.0001 | 0.0067 | 0.000711 | 2 |
| Cobalt | 0.001 | 0.017 | 0.001967 | 0.1 |
| Copper | 0.001 | 0.1009 | 0.018022 | 50 |
| Lead | 0.0005 | 0.1337 | 0.0077 | 2 |
| Nickel | 0.0007 | 0.0351 | 0.003011 | 2 |

Soil Monitoring Data

**Table A1-5: Summary of Soil Data for the Rodney Street Area
(0-30 cm; based on 1378 sample points)**

| Chemical | Concentration Range | Median Concentration | Average Concentration | MOE Cleanup Guideline |
|------------|---------------------|----------------------|-----------------------|-----------------------|
| Aluminum | 3,200 - 47,300 | 17,800.00 | 17,851.30 | None |
| Antimony | 0.275 - 91.1 | 0.20 | 1.20 | 13.00 |
| Arsenic | 0.6 - 350 | 12.70 | 15.90 | 20 (25) |
| Barium | 18.5 - 956 | 157.00 | 173.10 | 750 (1000) |
| Beryllium | 0.23 - 4.36 | 0.97 | 0.97 | 1.20 |
| Cadmium | 0.14 - 35.325 | 1.09 | 1.20 | 12.00 |
| Calcium | 1,920 - 93,400 | 18,700.00 | 20,118.00 | None |
| Chromium | 6 - 245 | 29.40 | 30.20 | 750 (1000) |
| Cobalt | 3.5 - 262 | 39.80 | 50.70 | 40 (50) |
| Copper | 4.4 - 2,720 | 200.00 | 250.20 | 225 (300) |
| Iron | 8,820 - 130,000 | 27,300.00 | 29,529.40 | None |
| Lead | 5.9 - 1,800 | 179.00 | 221.70 | 200.00 |
| Magnesium | 990 - 31,900 | 7,220.00 | 7,780.50 | None |
| Manganese | 131 - 5620 | 480.00 | 506.10 | None |
| Molybdenum | 0.2 - 12.1 | 4.00 | 3.81 | 40.00 |
| Nickel | 34.6 - 17,000 | 1,800.00 | 2,543.80 | 150 (200) |
| Selenium | 0.225 - 19.4 | 0.29 | 1.29 | 10.00 |
| Strontium | 14.3 - 690 | 69.10 | 79.20 | None |
| Vanadium | 11 - 74.7 | 37.10 | 37.40 | 200 (250) |
| Zinc | 23 - 1,750 | 314.00 | 369.50 | 600 (800) |

Dark shading indicates chemicals considered for evaluation in this risk assessment.

Light shading indicates chemicals which exceed ecological based component of the Cleanup guidelines, but not the human health component and are, therefore, not considered in this risk assessment.

Backyard Garden Vegetable Monitoring Data

Table A1-6: Summary JWEL Vegetable Data - Pt. Colborne - Not Including Rodney Street

| Element | Type of Vegetation | Range (Dry Weight ($\mu\text{g}/\text{kg}$)) | Number of Samples | Control Range* |
|-----------|------------------------------------|--|-------------------|----------------------------------|
| Antimony | Orchard Tree Leaves | <0.05 - <0.15 | 5 | No Control |
| | Orchard Fruit | <0.04 - 0.26 | 14 | Food Store - Apples (<0.08) |
| | Garden Produce -Roots | <0.05 - <0.1 | 6 | <0.05 |
| | Garden Produce - Vegetable (Fruit) | <0.05 - 0.68 | 13 | <0.1 - 0.1 |
| | Garden Produce - Vegetable (Leafy) | <0.05 - 0.21 | 8 | <0.1 - <0.15 |
| Arsenic | Orchard Tree Leaves | <0.2 - <0.8 | 5 | No Control |
| | Orchard Fruit | <0.2 | 14 | Food Store - Apples (<0.2) |
| | Garden Produce -Roots | <0.2 | 6 | <0.2 |
| | Garden Produce - Vegetable (Fruit) | <0.2 - <0.6 | 13 | <0.4 |
| | Garden Produce - Vegetable (Leafy) | <0.2 - <0.6 | 8 | < 0.4 - <0.6 |
| Beryllium | Orchard Tree Leaves | <0.1 - <0.4 | 5 | No Control |
| | Orchard Fruit | <0.1 | 14 | Food Store - Apples (<0.1) |
| | Garden Produce -Roots | <0.1 | 6 | <0.1 |
| | Garden Produce - Vegetable (Fruit) | <0.1 - <0.3 | 13 | <0.2 |
| | Garden Produce - Vegetable (Leafy) | <0.1 - <0.3 | 8 | <0.2 - <0.3 |
| Cadmium | Orchard Tree Leaves | <0.01 - 0.22 | 5 | No Control |
| | Orchard Fruit | <0.01 - 0.13 | 14 | Food Store - Apples <0.01 |
| | Garden Produce -Roots | 0.01 - 0.13 | 6 | 0.21 - 0.31 |
| | Garden Produce - Vegetable (Fruit) | 0.07 - 0.32 | 13 | 0.17 - 0.89 |
| | Garden Produce - Vegetable (Leafy) | 0.11 - 0.86 | 8 | 0.69 - 1.06 |
| Cobalt | Orchard Tree Leaves | <0.01 - 0.22 | 5 | No Control |
| | Orchard Fruit | <0.01 - 0.14 | 14 | Food Store - Apples (<0.01) |
| | Garden Produce -Roots | 0.02 - 0.09 | 6 | 0.02-0.11 |
| | Garden Produce - Vegetable (Fruit) | 0.03 - 0.13 | 13 | 0.05 - 0.56 |
| | Garden Produce - Vegetable (Leafy) | <0.02 - 0.78 | 8 | 0.22 - 0.28 |
| Copper | Orchard Tree Leaves | 0.44 - 9.23 | 5 | No Control |
| | Orchard Fruit | 1.57 - 13 | 14 | Food Store only - Apples (2.21) |
| | Garden Produce -Roots | 2.63 - 9.8 | 6 | 7.78 -7.93 |
| | Garden Produce - Vegetable (Fruit) | 4.56 - 15.6 | 13 | 14.9 - 18.7 |
| | Garden Produce- Vegetable (Leafy) | 2.78 - 10.6 | 8 | 6.54 - 7.21 |
| Lead | Orchard Tree Leaves | 0.13 -1.26 | 5 | No Control |
| | Orchard Fruit | <0.05 - 0.78 | 14 | Food Store only - Apples (<0.05) |
| | Garden Produce -Roots | 0.09 - 0.42 | 6 | 0.1 - 0.17 |
| | Garden Produce - Vegetable (Fruit) | <0.1 - 0.68 | 13 | 0.13 - 0.15 |
| | Garden Produce - Vegetable (Leafy) | 0.1 - 3.92 | 8 | 0.23 - 0.35 |
| Nickel | Orchard Tree Leaves | 0.4 - 23 | 5 | No Control |
| | Orchard Fruit | <0.1 | 14 | Food Store only - Apples (<0.1) |
| | Garden Produce -Roots | 0.3 - 1.9 | 6 | 0.1 - 0.3 |
| | Garden Produce - Vegetable (Fruit) | 0.3 - 12.2 | 13 | 0.2 - 4.8 |
| | Garden Produce - Vegetable (Leafy) | 1.2 - 12.9 | 8 | 0.6 |

* Control consists of two samples; one purchased at a food store and the other taken from the background control, Wainfleet Bog

**Table A1-7: Levels of Antimony in Vegetables from Rodney Street Residences
(JWEL,2000)**

| Location | Antimony Soil Concentration ($\mu\text{g/g}$) | Vegetable | Dry Weight Antimony Concentration in Vegetable ($\mu\text{g/g}$) | Conversion Factor (Dry to Fresh weight) | Fresh Weight Antimony Concentration in Vegetable ($\mu\text{g/g}$) |
|------------------------------------|---|--------------|--|---|--|
| 3 | <0.5 | Beet Root | 0.06 | 0.13 | 0.0078 |
| | | Celery | <0.05 | 0.059 | - |
| | | Tomato | <0.1 | 0.065 | - |
| 9 | Not analyzed | Tomato | <0.1 | 0.065 | - |
| 25 | 1.1 | Pepper | <0.1 | 0.066 | - |
| | | Lettuce | 0.46 | 0.045 | 0.021 |
| | | Beet Root | <0.1 | 0.13 | - |
| 33 | Not analyzed | Lettuce | <0.1 | 0.045 | - |
| | | Pepper | <0.05 | 0.066 | - |
| 34 | Not analyzed | Radish | <0.05 | 0.055 | - |
| | | Pepper | 0.27 | 0.066 | 0.018 |
| 41 | Not analyzed | Tomato | <0.1 | 0.065 | - |
| MOE Samples | | | | | |
| Sample #1 | | Tomato | | 0.065 | |
| | | Green Pepper | | 0.066 | |
| Sample #2 | | Pepper | | 0.066 | |
| | | Tomato | | 0.065 | |
| Control Samples | | | | | |
| Food Store Control | | Beet | <0.05 | 0.13 | - |
| | | Pepper | <0.1 | 0.066 | - |
| | | Lettuce | <0.15 | 0.045 | - |
| Wainfleet Bog (Background Control) | | Beet Root | <0.05 | 0.13 | - |
| | | Pepper | <0.1 | 0.066 | 0.0066 |
| | | Beet Top | <0.1 | 0.091 | - |

**Table A1-8: Levels of Beryllium in Vegetables from Rodney Street Residences
(JWEL, 2000)**

| Location | Beryllium Soil Concentration (µg/g) | Vegetable | Dry Weight Beryllium Concentration in Vegetable (µg/g) | Conversion Factor (Dry Weight to Fresh Weight) | Fresh Weight Beryllium Concentration in Vegetable (µg/g) |
|------------------------------------|-------------------------------------|--------------|--|--|--|
| 3 | 0.7 | Beet Root | <0.1 | 0.13 | - |
| | | Celery | <0.1 | 0.059 | - |
| | | Tomato | <0.1 | 0.065 | - |
| 9 | Not Analyzed | Tomato | <0.2 | 0.065 | - |
| 25 | 0.5 | Pepper | <0.2 | 0.066 | - |
| | | Lettuce | <0.2 | 0.045 | - |
| | | Beet Root | <0.1 | 0.13 | - |
| 33 | Not Analyzed | Lettuce | <0.2 | 0.045 | - |
| | | Pepper | <0.1 | 0.066 | - |
| 34 | Not Analyzed | Radish | <0.1 | 0.055 | - |
| | | Pepper | <0.3 | 0.066 | - |
| 41 | Not Analyzed | Tomato | <0.2 | 0.065 | - |
| MOE Samples | | | | | |
| Sample #1 | 0.75 | Tomato | 0.1 | 0.065 | 0.0065 |
| | | Green Pepper | 0.1 | 0.066 | 0.0066 |
| Sample #2 | 0.425 | Pepper | 0.1 | 0.066 | 0.0066 |
| | | Tomato | 0.1 | 0.065 | 0.0065 |
| Control Samples | | | | | |
| Food Store Control | n/a | Beet | <0.1 | 0.13 | - |
| | | Pepper | <0.2 | 0.066 | - |
| | | Lettuce | <0.3 | 0.045 | - |
| Wainfleet Bog (Background Control) | 0.5 | Beet Root | <0.1 | 0.13 | - |
| | | Pepper | <0.2 | 0.066 | - |
| | | Beet Top | <0.2 | 0.091 | - |

**Table A1-9: Levels of Cadmium in Vegetables from Rodney Street Residences
(JWEL, 2000)**

| Location | Cadmium Soil Concentration (µg/g) | Vegetable | Dry Weight Cadmium Concentration in Vegetable (µg/g) | Conversion Factor (Dry Weight to Fresh Weight) | Fresh Weight Cadmium Concentration in Vegetable (µg/g) |
|------------------------------------|-----------------------------------|--------------|--|--|--|
| 3 | <0.5 | Beet Root | 0.38 | 0.13 | 0.049 |
| | | Celery | 0.85 | 0.059 | 0.050 |
| | | Tomato | 0.23 | 0.065 | 0.015 |
| 9 | Not Analyzed | Tomato | 0.13 | 0.065 | 0.0085 |
| 25 | 1.1 | Pepper | 0.15 | 0.066 | 0.0099 |
| | | Lettuce | 0.34 | 0.045 | 0.013 |
| | | Beet Root | 0.24 | 0.13 | 0.031 |
| 33 | Not Analyzed | Lettuce | 0.45 | 0.045 | 0.020 |
| | | Pepper | 0.22 | 0.066 | 0.015 |
| 34 | Not Analyzed | Radish | 0.16 | 0.055 | 0.0088 |
| | | Pepper | 0.28 | 0.066 | 0.018 |
| 41 | Not Analyzed | Tomato | 0.13 | 0.065 | 0.0085 |
| MOE Samples | | | | | |
| Sample #1 | 0.8 | Tomato | 0.2 | 0.065 | 0.013 |
| | | Green Pepper | 0.05 | 0.066 | 0.0033 |
| Sample #2 | 0.1 | Pepper | 0.2 | 0.066 | 0.013 |
| | | Tomato | 0.2 | 0.065 | 0.013 |
| Control Samples | | | | | |
| Food Store Control | n/a | Beet | 0.21 | 0.13 | 0.027 |
| | | Pepper | 0.17 | 0.066 | 0.011 |
| | | Lettuce | 1.06 | 0.045 | 0.048 |
| Wainfleet Bog (Background Control) | 15.4-15.8 | Beet Root | 0.31 | 0.13 | 0.040 |
| | | Pepper | 0.89 | 0.066 | 0.059 |
| | | Beet Top | 0.69 | 0.091 | 0.063 |

**Table A1-10: Levels of Cobalt in Vegetables from Rodney Street Residences
(JWEL,2000)**

| Location | Cobalt Soil Concentration (µg/g) | Vegetable | Dry Weight Cobalt Concentration in Vegetable (µg/g) | Conversion Factor (Dry Weight to Fresh Weight) | Fresh Weight Cobalt Concentration in Vegetable (µg/g) |
|---------------------------------------|----------------------------------|--------------|---|--|---|
| 3 | 20.1 | Beet Root | 0.37 | 0.13 | 0.048 |
| | | Celery | 0.14 | 0.059 | 0.083 |
| | | Tomato | 0.09 | 0.065 | 0.0059 |
| 9 | Not Analyzed | Tomato | 0.06 | 0.065 | 0.0039 |
| 25 | 28.6 | Pepper | 0.05 | 0.066 | 0.0033 |
| | | Lettuce | 0.1 | 0.045 | 0.0045 |
| | | Beet Root | 0.11 | 0.13 | 0.014 |
| 33 | Not Analyzed | Lettuce | 0.33 | 0.045 | 0.015 |
| | | Pepper | 0.04 | 0.066 | 0.0026 |
| 34 | Not Analyzed | Radish | 0.13 | 0.055 | 0.0072 |
| | | Pepper | <0.03 | 0.066 | - |
| 41 | Not Analyzed | Tomato | 0.04 | 0.065 | 0.0026 |
| MOE Samples | | | | | |
| Sample #1 | 44.5 | Tomato | 0.1 | 0.065 | 0.0065 |
| | | Green Pepper | 0.1 | 0.066 | 0.0066 |
| Sample #2 | 58 | Pepper | 0.1 | 0.066 | 0.0066 |
| | | Tomato | 0.1 | 0.065 | 0.0065 |
| Control Samples | | | | | |
| Food Store | Control | Beet | 0.02 | 0.13 | 0.0026 |
| | | Pepper | 0.05 | 0.066 | 0.0033 |
| | | Lettuce | 0.28 | 0.045 | 0.013 |
| Wainfleet Bog (Background Control) | 4.5 | Beet Root | 0.11 | 0.13 | 0.014 |
| | | Pepper | 0.56 | 0.066 | 0.037 |
| | | Beet Top | 0.22 | 0.091 | 0.020 |

**Table A1-11: Levels of Arsenic in Vegetables from Rodney Street Residences
(JWEL, 2000)**

| Location | Arsenic Soil Concentration (µg/g) | Vegetable | Dry Weight Arsenic Concentration in Vegetable (µg/g) | Conversion Factor (Dry Weight to Fresh Weight) | Fresh Weight Arsenic Concentration in Vegetable (µg/g) |
|------------------------------------|-----------------------------------|--------------|--|--|--|
| 3 | <0.2 | Beet Root | <0.2 | 0.13 | - |
| | | Celery | <0.2 | 0.059 | - |
| | | Tomato | <0.4 | 0.065 | - |
| 9 | Not Analyzed | Tomato | <0.4 | 0.065 | - |
| 25 | 18.6 | Pepper | <0.4 | 0.066 | - |
| | | Lettuce | <0.4 | 0.045 | - |
| | | Beet Root | <0.4 | 0.13 | - |
| 33 | Not Analyzed | Lettuce | <0.4 | 0.045 | - |
| | | Pepper | <0.2 | 0.066 | - |
| 34 | Not Analyzed | Radish | 0.2 | 0.055 | 0.011 |
| | | Pepper | <0.6 | 0.066 | - |
| 41 | Not Analyzed | Tomato | <0.4 | 0.065 | - |
| MOE Samples | | | | | |
| Sample #1 | 13 | Tomato | 0.1 | 0.065 | 0.0065 |
| | | Green Pepper | 0.1 | 0.066 | 0.0066 |
| Sample #2 | 17.5 | Pepper | 0.1 | 0.066 | 0.0066 |
| | | Tomato | 0.1 | 0.065 | 0.0065 |
| Control Samples | | | | | |
| Food Store (Control) | | Beet | <0.2 | 0.13 | - |
| | | Pepper | <0.4 | 0.066 | - |
| | | Lettuce | <0.6 | 0.045 | - |
| Wainfleet Bog (Background Control) | 1.3 - 1.4 | Beet Root | <0.2 | 0.13 | - |
| | | Pepper | <0.4 | 0.066 | - |
| | | Beet Top | <0.4 | 0.091 | - |

**Table A1-12: Levels of Copper in Vegetables from Rodney Street Residences
(JWEL, 2000)**

| Location | Copper Soil Concentration (µg/g) | Vegetable | Dry Weight Copper Concentration in Vegetable (µg/g) | Conversion Factor (Dry Weight to Fresh Weight) | Fresh Weight Copper Concentration in Vegetable (µg/g) |
|------------------------------------|----------------------------------|--------------|---|--|---|
| 3 | 134 | Beet Root | 14.8 | 0.13 | 1.92 |
| | | Celery | 5.14 | 0.059 | 0.30 |
| | | Tomato | 10.1 | 0.065 | 0.66 |
| 9 | Not Analyzed | Tomato | 11.3 | 0.065 | 0.73 |
| 25 | 194 | Pepper | 10.4 | 0.066 | 0.67 |
| | | Lettuce | 11.8 | 0.045 | 0.53 |
| | | Beet Root | 9.71 | 0.13 | 1.26 |
| 33 | Not Analyzed | Lettuce | 8.81 | 0.045 | 0.40 |
| | | Pepper | 7.09 | 0.066 | 0.47 |
| 34 | Not Analyzed | Radish | 5.2 | 0.055 | 0.29 |
| | | Pepper | 1.6 | 0.066 | 1.06 |
| 41 | Not Analyzed | Tomato | 7.93 | 0.065 | 0.52 |
| MOE Samples | | | | | |
| Sample #1 | 220 | Tomato | 4.9 | 0.065 | 0.32 |
| | | Green Pepper | 5.9 | 0.066 | 0.39 |
| Sample #2 | 325 | Pepper | 9.4 | 0.066 | 0.62 |
| | | Tomato | 4.6 | 0.065 | 0.30 |
| Control Samples | | | | | |
| Food Store (Control) | | Beet | 7.78 | 0.13 | 1.01 |
| | | Pepper | 18.7 | 0.066 | 1.23 |
| | | Lettuce | 6.54 | 0.045 | 0.29 |
| Wainfleet Bog (Background Control) | 14.9-22.2 | Beet Root | 7.93 | 0.13 | 1.03 |
| | | Pepper | 14.9 | 0.066 | 0.98 |
| | | Beet Top | 7.21 | 0.091 | 0.66 |

**Table A1-13: Levels of Lead in Vegetables from Rodney Street Residences
(JWEL, 2000)**

| Location | Lead Soil Concentration (µg/g) | Vegetable | Dry Weight Lead Concentration in Vegetable (µg/g) | Conversion Factor (Dry Weight to Fresh Weight) | Fresh Weight Lead Concentration in Vegetable (µg/g) |
|------------------------------------|--------------------------------|--------------|---|--|---|
| 3 | 379 | Beet Root | 6.26 | 0.13 | 0.81 |
| | | Celery | 4.16 | 0.059 | 0.25 |
| | | Tomato | 0.1 | 0.065 | 0.0065 |
| 9 | Not Analyzed | Tomato | 0.12 | 0.065 | 0.0078 |
| 25 | 371 | Pepper | 0.15 | 0.066 | 0.0099 |
| | | Lettuce | 0.93 | 0.045 | 0.042 |
| | | Beet Root | 8.11 | 0.13 | 1.05 |
| 33 | Not Analyzed | Lettuce | 2.43 | 0.045 | 0.11 |
| | | Pepper | 2.55 | 0.066 | 0.17 |
| 34 | Not Analyzed | Radish | 2.55 | 0.055 | 0.14 |
| | | Pepper | 0.58 | 0.066 | 0.038 |
| 41 | Not Analyzed | Tomato | <0.1 | 0.065 | - |
| MOE Samples | | | | | |
| Sample #1 | 91.5 | Tomato | 0.25 | 0.065 | 0.016 |
| | | Green Pepper | 0.25 | 0.066 | 0.017 |
| Sample #2 | 88 | Pepper | 0.6 | 0.066 | 0.040 |
| | | Tomato | 1.9 | 0.065 | 0.12 |
| Control Samples | | | | | |
| Food Store Control | n/a | Beet | 0.17 | 0.13 | 0.022 |
| | | Pepper | 0.13 | 0.066 | 0.0086 |
| | | Lettuce | 0.23 | 0.045 | 0.010 |
| Wainfleet Bog (Background Control) | 10.9 - 11 | Beet Root | 0.1 | 0.13 | 0.013 |
| | | Pepper | 0.15 | 0.066 | 0.0099 |
| | | Beet Top | 0.35 | 0.091 | 0.032 |

APPENDIX 2

Toxicity Assessment

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Toxicity Assessment

A2-1 Introduction

The chemical screening section of the main report identified eight metals as being potential human health concerns in the Rodney Street area of Port Colborne. The objectives of the toxicity assessment are;

- to provide the reader with a brief understanding of the toxicological effects that have been reported to be associated with exposure to the chemicals of concern;
- to identify whether each metal of concern should be considered as being carcinogenic or non-carcinogenic and;
- to identify suitable exposure limits against which exposures can be compared to provide estimates of potential health risks.

The toxicological profiles are **not** intended to;

- be exhaustive examinations of all the toxicological information available for each metal;
- be used to develop exposure limits for exposure routes where no exposure limits are available, or;
- critically review and/or modify currently existing exposure limits.

This toxicity assessment outlines the toxicological effects that have been reported to be associated with inhalation, ingestion and dermal contact exposures to antimony, arsenic, beryllium, cadmium, cobalt, copper, lead and nickel, and identify whether each metal should be considered as a carcinogen or a non-carcinogen. The type of exposure limit selected is dependent upon whether a compound is considered to be non-carcinogenic or carcinogenic. The types of exposure limits associated with both types of compounds are discussed below.

The toxicological profiles also examine the effect that the route of exposure has on the toxicological activity of each compound. For some compounds, the route by which the compound enters the body can have a marked effect on the toxicological effects that occur. In cases where the toxicological effects of a chemical differ between the routes of exposure, it is necessary to assess inhalation and ingestion exposures independently. For example, arsenic, beryllium, cadmium and nickel inhalation exposures may be carcinogenic, but are not carcinogenic by ingestion exposure. Therefore, where route-specific exposure limits are available, the toxicological profiles will provide both. In cases where exposure limits are available for a single route of exposure, the toxicological profiles will not develop exposure limits by route-to-route extrapolation. Although route-to-route extrapolation is undertaken in some situations, it is discouraged by the US EPA and similar regulatory agencies because it requires detailed knowledge of pharmacokinetic and pharmacodynamic factors and extensive modelling. All of which are beyond the scope of the current assessment.

The references used in the development of each toxicological profile are provided at the end of each profile.

A2-1.1 Exposure Limits for Non-Carcinogenic Compounds.

Non-carcinogenic compounds are generally considered to act on the body through threshold mechanisms. This means that at low doses the body is able to remove the compounds from the body without the compounds causing adverse or toxic effects. As the dose or exposure to a compound increases, the body's ability to clear the compound is reduced. When exposure exceeds the body's ability to process and excrete the compound, it can cause adverse or toxic effects. The point at which this occurs is called the threshold. The threshold is different for every compound. The exposure limits developed for each compound reflect the threshold for each chemical.

The US EPA is a reliable source of exposure limits or *Reference Doses* RfDs for ingestion exposures and *Reference Concentration* (RfCs) for inhalation exposures, that are developed from toxicological studies of human or animal populations. These are set to ensure that chronic exposures to a chemical at concentrations that are at or below the exposure limit will not result in adverse effects. The US EPA defines the RfD/RfC as;

A quantitative estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of non-carcinogenic, deleterious effects during a life-time.

The US EPA RfD/RfC values are based on life-time averaged exposures. This means that limited exposures to a compound that exceed an exposure limit will not result in adverse effects, provided that over a life-time, the averaged daily dose does not exceed the exposure limit. The exposure limit is set to prevent the accumulation of the compound in the body at levels that exceed the threshold and therefore limit the possibility of adverse health effects occurring.

The RfD/RfC values are intended to be used as life-time average daily exposures and therefore, in assessing potential risks for an exposed individual or population, life-time averaged daily doses should be used if the exposures are expected to occur over a life-time. The US EPA *Risk Assessment Guidance for Superfund (RAGS)* recommends that in the assessment of risks associated with exposures to non-carcinogenic compounds that life-time averaged exposures be used to assess risks when exposures occur over a life-time (RAGS, 1989¹). The RAGS further notes that the comparison of short-term or non-life-time exposures to RfD/RfC values should only be used as a screening exercise to determine if a potential human health risk would be predicted based on estimated exposures. Short-term exposures that are below the chronic exposure limit, concern for adverse human health effects is low (RAGS, 1989). Life-time averaged daily doses (LADD) are calculated as shown in equation A2-1.

$$\text{Eq A2-1} \quad LADD = \sum_1^n \frac{(Intake_{(1..n)} \times Time_{(1..n)})}{(B.W._{(1..n)} \times 70 \text{ years})}$$

¹

US EPA, 1989. Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A), US EPA, EPA/540/1-89/002

A2-1.2 Exposure Limits for Carcinogenic Compounds

Carcinogenic compounds are generally considered to work through a non-threshold mechanism which means that there is no dose below which an adverse effect will not occur. Any exposure to a carcinogen is considered to be associated with some level of risk. At very low doses, the probability that an adverse effect (cancer) will occur is extremely small. The probability of developing cancer increases as the dose increases. Incremental increases in life-time cancer risk (ILCR) are estimated by comparing the established potency for each compound with the calculated LADD for that compound.

The US EPA is a reliable source of estimates of carcinogenic potency for numerous chemicals. The US EPA expresses carcinogenic potencies as cancer slope factors (*Risk per ($\mu\text{g}/\text{kg body weight-day}$)*) or as a *Unit Risk (UR ($\mu\text{g}/\text{m}^3$)⁻¹)* for inhalation exposures or (*UR ($\mu\text{g}/\text{L}$)⁻¹*) for exposures to chemicals in drinking water. The slope factor is defined by the US EPA as;

An upper-bound on a maximum likelihood estimate developed from dose-response data using one of several models incorporating low-dose linearity.

The *Unit Risk* is defined as;

The upper-level increased likelihood that an individual will develop cancer when exposed to a chemical over a life-time at a concentration of 1 $\mu\text{g}/\text{L}$ in drinking water or 1 $\mu\text{g}/\text{m}^3$ in air for a continuous inhalation exposure.

Health Canada provides cancer potency estimates as Tumorigenic Doses (TD_{05}). These values represent life-time exposure levels that would result cancers in 5% of the population.

In this document, the term *$\mu\text{g}/\text{kg body weight-day}$* will be abbreviated as $\mu\text{g}/\text{kg-day}$.

A2-2 Toxicological Profile for Antimony

The health risk of antimony (Sb) exposure in Ontario soils has been assessed for Port Hope (MOE, 1991). This appendix updates MOE (1991).

Antimony is a naturally occurring metal that is used in various manufacturing processes. It is generally found as a sulphide or oxides. The natural sulfide of antimony was known and used in Biblical times as medicine and as a cosmetic. The most important use of antimony metal is as a hardener in lead for storage batteries. The metal also finds applications in solders and other alloys. Antimony trioxide is the most important of the antimony compounds and is primarily used in flame-retardant formulations. These flame-retardant applications include such markets as children's clothing, toys, aircraft and automobile seat covers.

A2-2.1 Pharmacokinetics

Exposure to antimony may be via inhalation, oral and dermal routes (ATSDR, 1990). Antimony is sparingly absorbed following ingestion or inhalation (Felicetti et al., 1974; Gerber et al., 1982; US EPA, 1998). Both gastrointestinal and pulmonary absorption are a function of compound solubility. Trivalent antimony is more readily absorbed than pentavalent forms. Antimony is transported in the blood. Antimony is not metabolized but may bind to macromolecules and react covalently with sulfhydryl and phosphate groups (ATSDR, 1990). Excretion of antimony is primarily via the urine and feces (Cooper et al., 1968; Ludersdorf et al., 1987; ATSDR, 1990).

A2-2.2 Toxicology

A2-2.2.1 Non-Cancer Effects

Acute oral exposure of humans and animals to high doses of antimony or antimony-containing compounds (antimonials) may cause gastrointestinal disorders (vomiting, diarrhea), respiratory difficulties, and death at extremely high doses (Bradley and Frederick, 1941; Beliles, 1979; ATSDR, 1990). Subchronic and chronic oral exposure may affect hematologic parameters (ATSDR, 1990). Long-term exposure to high doses of antimony or antimonials has been shown to adversely affect longevity in animals (Schroeder et al., 1970). Limited data suggest that prenatal and postnatal exposure of rats to antimony interferes with vasomotor responses (Marmo et al., 1987; Rossi et al., 1987).

Acute occupational exposure may cause gastrointestinal disorders (probably due to ingestion of airborne antimony) (ATSDR, 1990). Exposure of animals to high concentrations of antimony and antimonials (especially stibine gas) may result in pulmonary edema and death (Price et al., 1979). Long-term occupational exposure of humans has resulted in electrocardiac disorders, respiratory disorders, and possibly increased mortality (Renes, 1953; Breiger et al., 1954). Antimony levels for these occupational exposure evaluations ranged from 2,200 to 11,980 $\mu\text{g Sb/m}^3$. Based on limited data, occupational exposure of women to metallic antimony and several antimonials has reportedly caused alterations in the menstrual cycle and an increased incidence of spontaneous abortions

(Belyaeva, 1967). Reproductive dysfunction has been demonstrated in rats exposed to antimony trioxide (Belyaeva, 1967).

No data were available indicating that dermal exposure of humans to antimony or its compounds results in adverse effects. Eye irritation due to exposure to stibine gas and several antimony oxides has been reported for humans (Stevenson, 1965; Potkonjak and Pavlovich, 1983).

A2-2.2.2 Cancer Effects

The U.S. EPA has not evaluated antimony or antimonials for carcinogenicity.

A2-2.2.3 Susceptible Populations

No studies were located regarding unusual susceptibility of any human subpopulation to antimony. A susceptible population will exhibit a different or enhanced response to antimony than will most persons exposed to the same level of antimony in the environment. Reasons include genetic make-up, developmental stage, health and nutritional status, and chemical exposure history. These parameters result in decreased function of the detoxification and excretory processes (mainly hepatic and renal) or the pre-existing compromised function of target organs. For these reasons the elderly with declining organ function and the youngest of the population with immature and developing organs are expected to be generally be more vulnerable to toxic substances than healthy adults (ATSDR, 1993).

A2-2.3 Current Exposure Limits

A2-2.3.1 Oral Exposure Limits

The U. S. EPA (U.S. EPA, 1991) has calculated subchronic and chronic oral reference doses (RfDs) of 0.4 $\mu\text{g}/\text{kg}\text{-day}$ based on decreased longevity and alteration of blood chemistry in rats chronically exposed to potassium antimony tartrate in the drinking water (5 ppm equivalent to 350 $\mu\text{g Sb}/\text{kg}\text{-day}$) (Schroeder et al, 1970). More recently, the NRC has proposed an oral RfD for antimony trioxide of 200 $\mu\text{g}/\text{kg}\text{-day}$ based on increases in serum enzymes and liver weight in female rats in the study of Hext et al (1999)(NRC, 2000)

A2-2.3.2 Inhalation Exposure Limits

The U. S. EPA (IRIS, 1998) has calculated a reference concentration for chronic inhalation exposure (RfC) of 0.2 $\mu\text{g} / \text{m}^3$ based on pulmonary toxicity and chronic interstitial inflammation in a one year inhalation toxicity study in rats exposed to antimony trioxide (Newton et al., 1994). This RfC was also proposed by the NRC (NRC, 2000).

A2-2.3.3 Selection of Exposure Limits

The exposure limits used to assess the potential risks associated with ingestion and inhalation exposures to antimony are summarized in Table A2-1

Table A2-1: Selected Exposure Limits for Antimony

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|---------------------------|------------------------|---|---------------|
| Non-Cancer Effects | | | |
| Ingestion | 0.4 µg/kg-day | decreased longevity and altered blood chemistry in rats | EPA, 1998 |
| Inhalation | 0.2 µg /m ³ | pulmonary toxicity in rats | EPA, 1998 |
| Dermal Contact | | | |
| Cancer Effects | | | |
| Ingestion | N.A. ¹ | | |
| Inhalation | N.A. | | |
| Dermal Contact | N.A. | | |

1. Not Applicable

A2-2.4 Antimony References

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A2-3 Toxicological Profile for Arsenic

Arsenic (As) is a brittle, gray metal that tarnishes in air. It is a natural component of the earth's crust and occurs in small amounts in rock, soil, water and underwater sediments. It is commonly found in combination with sulfur and iron in minerals such as arseno-pyrite. Arsenic is used mainly to preserve wood and to control insects and weeds.

Elemental arsenic is not soluble in water; calcium arsenate, and calcium arsenites are sparingly soluble in water; the remaining arsenicals are soluble in water. Arsenic, arsenic pentoxide, arsenic trioxide, the calcium arsenites, lead arsenate, and potassium arsenate are soluble in various acids (ATSDR, 1993).

A2-3.1 Pharmacokinetics

The oral bioavailability of arsenic compounds is dependent on the chemical species and on the matrix (e.g. soil or dust) in which it is administered. Based on published literature, the absorption of water-soluble inorganic arsenic compounds in an aqueous solution is about 95 percent. For soil and house dust containing arsenic the absorption is about 14 and 19 percent respectively. The bioavailability of inorganic arsenic for exposure via inhalation would be in the range of 30 – 34 percent. The dermal absorption in humans range from 0.8 to 1.9 percent (ATSDR, 1993).

Distribution of arsenic within the body is affected by the route through which exposure occurs. Given sufficient time for equilibration, arsenic generally tends to be evenly distributed amongst tissues within the body. The interaction of arsenic with various tissues is dependent on the chemical form of the arsenic. The primary pathway of elimination of inorganic arsenic is excretion via the urine. Because of the importance of urinary excretion as the primary route of elimination of arsenic, concentrations of arsenic compounds in the urine is considered to be a reliable index of recent exposure to arsenic (ATSDR, 1993).

A2-3.2 Toxicology

A2-3.2.1 Non-Cancer Effects

There are numerous studies that have looked at human exposures to inorganic arsenic in the air, but there are no reports of fatalities associated with short-term occupational exposures to arsenic levels as high as 100 mg As/m³ (ATSDR, 1993).

Inhalation exposures to inorganic arsenic dusts in the workplace have been reported to cause irritation of the nose and throat, laryngitis, bronchitis and cases of very high exposures have been reported to result in perforation of the nasal septum (ATSDR, 1993). However, respiratory effects have not been noted at exposure levels that range between 0.1 and 1.0 mg/m³ (ATSDR, 1993). There is some limited evidence of respiratory tract effects following oral exposure to inorganic arsenic, but this is thought to be a secondary effect that is due to the vascular damage which results from the ingestion of arsenic (ATSDR, 1993).

There is limited and equivocal epidemiological evidence that suggests that inhalation exposures to arsenic trioxide dust may result in cardiovascular effects. However, there are a number of studies that indicate that oral exposures to inorganic arsenic can lead to serious damage of the cardiovascular system (ATSDR, 1993). Both acute and long-term exposures can result in myocardial depolarization and cardiac arrhythmias. Long-term exposures to low levels of arsenic can also result in damage to the vascular system, characterized by a progressive loss of circulation in the hands and feet (ATSDR, 1993). In areas of Taiwan, with elevated levels of arsenic in the drinking water, evidence of circulatory effects related to arsenic exposures begin to occur at a dose of approximately 0.014 mg As/kg-day (ATSDR, 1993).

There are several studies that have indicated that inhalation exposures to inorganic arsenic can lead to a number of neurological effects in humans, including; peripheral neuropathy of sensory and motor neurons that are manifested as numbness, loss of reflexes and muscle weakness. In extreme cases, frank encephalopathy including, hallucinations and memory loss have been reported (ATSDR, 1993). These effects generally cease once exposures have ended (ATSDR, 1993).

Acute effects of oral arsenic exposure include vomiting, nausea, diarrhea, gastrointestinal haemorrhage, and death. There are a large number of cases of human fatalities following the ingestion of inorganic arsenicals. In most cases, the doses resulting in death have been difficult to quantify. However, two reports, indicate that doses ranging between 1 and 22 mg As per kg body weight per day (mg/kg-day) have resulted in death. Although similar effects are often seen with long-term exposures to lower doses of arsenic, effects are not generally reported at doses lower than 0.01 mg As/kg-day (ATSDR, 1993).

There are a large number of studies that indicate that the acute ingestion of large amounts of inorganic arsenic can cause a number of injuries to the nervous system including; headache, lethargy, mental confusion, hallucination, seizures and in extreme cases, coma (ATSDR, 1993). Chronic exposures to lower levels of arsenic, ranging between 0.019 and 0.5 mg/kg-day, are typically characterized by a peripheral neuropathy similar to that seen with inhalation exposures. Neurological effects have not been detected in populations chronically exposed to arsenic levels of less than 0.01 mg/kg-day (ATSDR, 1993).

A number of hematological effects including anemia and leukopenia have been reported in humans as a result of acute, intermediate and chronic oral exposures to arsenic (ATSDR, 1993). These effects are usually not seen in persons exposed to levels of arsenic lower than 0.07 mg/kg-day (ATSDR, 1993).

Oral exposures to inorganic arsenic have been reported to cause several toxic effects in the liver including, elevated levels of hepatic enzymes in the blood, portal tract fibrosis and swelling of the liver (ATSDR, 1993). These effects are generally seen in cases where chronic exposures range between 0.019 to 0.1 mg/kg-day (ATSDR, 1993). It has been suggested by several researchers that these effects are secondary to the damage of hepatic blood vessels resulting from the damaging effects that inorganic arsenic has on the circulatory system. However, there is insufficient clinical information available to confirm this (ATSDR, 1993).

There is little clinical evidence of renal damage following oral exposures to inorganic arsenic

compounds (ATSDR, 1993). A few cases of renal failure have been reported in cases of arsenic poisoning, but this is felt to be due to fluid imbalances of vascular damage caused by arsenic, and not directly attributable to arsenic (ATSDR, 1993).

The most common dermal effect associated with the ingestion of inorganic arsenic is the development of a pattern of skin changes which include; hyperkeratosis, the development of hyperkeratotic warts, areas of hyperpigmentation and hypopigmentation (ATSDR, 1993). Numerous studies have shown that dermal effects are common in humans exposed to inorganic arsenic levels that range between 0.01 and 0.1 mg As/kg-day. These studies have also demonstrated that, below a dose level of 0.01 mg As/kg-day, dermal effects are not reported (ATSDR, 1993).

A2-3.2.2 Cancer Effects

There is sufficient convincing epidemiological evidence to show that inhalation exposure to inorganic arsenic can increase the risk of developing lung cancer. Many studies provide only qualitative evidence of an association between the duration of and/or level of exposure to arsenic and the increase in the rate of lung cancer. There is sufficient epidemiological information available from occupational studies for the US EPA to develop cancer potency estimates for inhalation exposures to inorganic arsenic (USEPA, 1995).

There are a large number of epidemiological studies that provide convincing evidence that the ingestion of inorganic arsenic increases the risk of developing skin cancer. The most common effect is the development of squamous cell carcinomas. Basal cell carcinomas also occur. In the majority of cases, skin cancer only develops after prolonged exposure (ATSDR, 1993). There is sufficient human epidemiological data available for the US EPA to develop estimates of cancer risk associated with oral exposure to inorganic arsenic (USEPA, 1995).

A2-3.2.3 Susceptible Populations

No studies were located regarding unusual susceptibility of any human subpopulation to arsenic. A susceptible population will exhibit a different or enhanced response to arsenic than will most persons exposed to the same level of arsenic in the environment. Reasons include genetic make-up, developmental stage, health and nutritional status, and chemical exposure history. These parameters result in decreased function of the detoxification and excretory processes (mainly hepatic and renal) or the pre-existing compromised function of target organs. For these reasons the elderly with declining organ function and the youngest of the population with immature and developing organs are expected to be generally be more vulnerable to toxic substances than healthy adults (ATSDR, 1993).

A2-3.3 Current Exposure Limits

A2-3.3.1 Oral Exposure Limits

The USEPA (1998) calculated an oral RfD of 0.3 $\mu\text{g As/kg-day}$ based on epidemiological

studies of chronic exposure to arsenic through drinking water. This limit was selected for non-carcinogenic effects.

Arsenic exposure via the oral route was considered to be carcinogenic to humans, based on the incidence of skin cancers in epidemiological studies examining human exposure through drinking water. The cancer slope factor of $0.0015 (\mu\text{g As/kg-day})^{-1}$ and corresponding risk specific dose (RSD) of $0.00067 \mu\text{g As/kg-day}$ are based on an acceptable risk level of one-in-one million.

A2-3.3.2 Inhalation Exposure Limits

The USEPA (1998) calculated an inhalation unit risk for arsenic of $0.0043 (\mu\text{g}/\text{m}^3)^{-1}$ based on epidemiological studies of lung cancer in workers at arsenic smelters (EPA, 1999).

A2-3.3.3 Selection of Exposure Limits

The estimates of the carcinogenic potencies of inhaled and ingested inorganic arsenic, developed by the US EPA can be used to assess potential human health risks associated with exposure to inorganic arsenic at this site. The potency estimates established by the US EPA and the health effects upon which they are based are summarized below.

Table A2-2: Selected Exposure Limits for Arsenic

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|--------------------|--|---------------------|---------------|
| Non-Cancer Effects | | | |
| Ingestion | 0.30 $\mu\text{g}/\text{kg-day}$ | | US EPA, 1998 |
| Inhalation | N.A. ¹ | | |
| Cancer Effects | | | |
| Ingestion | N.A. ¹ | | |
| Inhalation | $4.3 \times 10^{-3} (\mu\text{g}/\text{m}^3)^{-1}$ | Lung Cancer | USEPA, 1998 |

1. Not Applicable

A2-3.4 Arsenic References

ATSDR, (1993) Agency for Toxic Substances and Disease Registry, Toxicological Profile for Arsenic. U.S. Department of Health and Human Services, Atlanta, Georgia, USA.

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MOE. 2001. Survey of Arsenic Exposure for Residents of Wawa. Prepared by Goss Gilroy, Inc., Ottawa, for the Wawa Environmental Steering Committee, January, 2001.

USEPA (1995) United States Environmental Protection Agency: Integrated Risk Information System (IRIS). Substance File for Inorganic Arsenic.

A2-4 Toxicological Profile for Beryllium

Beryllium (Be) is a hard, grayish, odourless metal. The element occurs naturally as a chemical component of certain rocks, coal and oil, volcanic dust, and soil. Two kinds of mineral rocks, bertrandite and beryl, are mined commercially for the recovery of beryllium. (ATSDR, 1993). Beryllium is used in beryllium-copper alloys, in microelectronics, in aerospace technology, as a solid-propellant in rocket fuels (Lewis, 1993), in aircraft brakes, in X-ray windows, and in neutron reflectors (Ashford, 1994).

A2-4.1 Pharmacokinetics

Inhaled beryllium is absorbed through the lungs, however insufficient data are available to determine the rate and extent of absorption. The biological half-life of beryllium in serum is estimated to be between 2 to 8 weeks.

Toxicity through oral exposure is not very likely since animal studies show that beryllium is not efficiently absorbed through the gastrointestinal tract. Soluble salts are precipitated by reaction with proteins in the alimentary tract (Browning, 1969). No human data are available regarding the absorption of beryllium after oral exposure.

Beryllium does not appear to be absorbed through intact skin as exposed workers only demonstrated skin rashes and ulcerations when the skin was cut accidentally.

A2-4.2 Toxicology

A2-4.2.1 Non-Cancer Effects

The effects of exposure to beryllium via inhalation depends on how much you are exposed to and for how long. Inhalation of high concentrations of soluble beryllium compounds has caused pneumonia in occupationally exposed workers. Chronic inhalation exposure to somewhat lower concentrations can lead to an obstructive lung disease known as chronic beryllium disease (CBD). Chronic beryllium disease is caused by genetically regulated cell-mediated immune responses (US EPA, 1998; Chang, 1996).

Swallowing beryllium has not been reported to cause effects in humans because very little beryllium can move from the stomach and intestines into the bloodstream. No human data are available regarding ingestion of beryllium, however animal studies show lesions on the stomach as well as the small and large intestines as the result of ingestion of beryllium sulphate in the diet.

Skin lesions have been reported in a few individuals occupationally exposed to beryllium. Skin ulceration occurred only if the skin had been accidentally cut.

A2-4.2.2 Cancer Effects

Several epidemiological studies show an increase incidence of lung cancer deaths amongst workers employed at beryllium factories (ATSDR, 2000). However, historical exposure levels were not reported so no correlation could be drawn between the incidence of lung cancer deaths and beryllium exposure.

The United States Environmental Protection Agency classifies *inhaled* beryllium and beryllium compounds as a probable human carcinogen (Group B1) based on limited evidence for humans and sufficient data for animals (US EPA, 1998). The United States Environmental Protection Agency also indicates that there are no studies on the potential carcinogenicity of ingested beryllium for humans and that the available animal studies do not indicate that adverse effects (US EPA, 1998). The United States National Toxicology Program classifies beryllium and compounds as reasonably anticipated carcinogens (NTP, 2001).

The International Agency for Research on Cancer has classified beryllium and beryllium compounds as carcinogenic to humans (Group 1) based on sufficient animal and human data.

A2-4.2.3 Susceptible Populations

A genetic predisposition for a human leukocyte antigen (HLA) class II may make some individuals more susceptible to chronic beryllium disease. Other factors which may increase susceptibility to beryllium are lowered adrenal gland or liver function.

A2-4.3 Current Exposure Limits

A2-4.3.1 Oral Exposure Limits

The United States Environmental Protection Agency has developed an oral reference dose of 2.0 $\mu\text{g}/\text{kg}\text{-day}$ for beryllium (US EPA, 1998). The reference dose is based on a benchmark dose derived from dose response modelling of data for a study of lesions on the small intestines of dogs (Morgareidge et al, 1976). A benchmark dose is the dose at the 95% confidence interval of a dose-response model and corresponds to a 10% increase in effects (stomach lesions) in comparison to the control population. An uncertainty factor of 300 (10 for interspecies differences, 10 for differences in human populations and 3 for database deficiencies) was applied to the benchmark dose to determine the reference dose.

ATSDR has developed an minimal risk level for beryllium based on the same dog study (Morgareidge et al, 1976) of 1.0 μg beryllium/kg-day. The MRL was determined by applying an uncertainty factor of 100 to the no-observed-adverse-effect (NOAEL) at 100 μg beryllium/kg-day.

A2-4.3.2 Inhalation Exposure Limits

The US EPA (US EPA, 1998) has developed an inhalation RfC of 0.02 $\mu\text{g}/\text{m}^3$ based on

beryllium sensitization and progression to chronic beryllium disease in beryllium workers (Kreiss et al., 1996) and the Eisenbud et al. (1949) study of community residents living near a beryllium plant..

The US EPA (US EPA, 1998) has developed an inhalation unit risk of $0.0024 (\mu\text{g}/\text{m}^3)^{-1}$ based on lung cancer mortality in male beryllium manufacturing workers (Wagoner et al., 1980). The air concentration at the 10^{-5} and 10^{-6} lifetime cancer risk levels are $0.004 \mu\text{g}/\text{m}^3$ and $0.0004 \mu\text{g}/\text{m}^3$, respectively.

Health Canada (1996) has determined a tumorigenic dose (TD_{05}) of $5.1 \mu\text{g}/\text{m}^3$ for inorganic beryllium compounds. This TD_{05} can be divided by 5000 to obtain a 10^{-5} lifetime cancer risk air concentration of $0.001 \mu\text{g}/\text{m}^3$.

A2-4.3.3 Selection of Exposure Limits

The estimates of the carcinogenic potencies of inhaled and ingested beryllium, developed by the US EPA will be used to assess potential human health risks associated with exposure to beryllium at this site. The potency estimates established by the US EPA and the health effects upon which they are based are summarized below.

Table A2-3: Selected Exposure Limits for Beryllium

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|--------------------|--|--|---------------|
| Non-Cancer Effects | | | |
| Ingestion | $2 \mu\text{g}/\text{kg}\text{-day}$ | intestinal lesions in dogs | EPA, 1998 |
| Inhalation | $0.02 \mu\text{g}/\text{m}^3$ | beryllium sensitization in human populations | EPA, 1998 |
| Cancer Effects | | | |
| Ingestion | N/A ¹ | | |
| Inhalation | $0.0024 (\mu\text{g}/\text{m}^3)^{-1}$ | lung cancer in humans | EPA, 1998 |

1. Not Applicable

A2-4.4 Beryllium References

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ATSDR, 1993. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Beryllium. U.S. Department of Health and Human Services - Public Health Service (CDROM version, 2000).

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Chang, L.W. (ed.), 1996. Toxicology of Metals. Boca Raton, FL: Lewis Publishers, p.929-30. (as cited in HSDB, 2001)

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Morgareidge, K., G.E. Cox and D.E. Bailey. 1975. Chronic feeding studies with beryllium sulfate in rats. Food and Drug Research Laboratories, Inc. Final report to the Aluminum Company of America, Pittsburg, Pa. (Cited in EPA, 1987).

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US EPA, 1998. Integrated Risk Information System (IRIS). Beryllium and Compounds. United States Environmental Protection Agency. [<http://www.epa.gov/iris/>]

US EPA, 1987. Health assessment document for beryllium. Prepared by Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, U.S. Environmental Protection Agency, Research Triangle Park, NC for Office of Health and Environmental Assessment, Office of Research and Development, U.S. Environmental Protection Agency,

Washington, DC. EPA/600/8-84/026F. (as cited in ATSDR, 1993)

Wagoner, J.K., P.F. Infante and D.L. Bayliss. 1980. Beryllium: an etiologic agent in the induction of lung cancer, nonneoplastic respiratory disease, and heart disease among industrially exposed workers. Environ. Res. 21: 15-34.

A2-5 Toxicological Profile for Cadmium

The health risk of cadmium (Cd) exposure in Ontario soils has been assessed for Port Hope (MOE, 1991). This appendix updates MOE (1999).

Cadmium is a natural element that is usually found as a mineral combined with other elements such as oxygen, chloride, and sulphur. Cadmium forms both organic and inorganic compounds. It is extracted mostly during the production of other metals, and is used in batteries, pigments, metal coatings, and plastics.

A2-5.1 Pharmacokinetics

Following inhalation, the major site of cadmium absorption in humans is the alveoli of the lung. Human data are not available for absorption in the lung. A kinetic respiratory tree model has been developed to predict cadmium particle deposition in the lung (Nordberg et al, 1985). This model suggests that only 5% of the particles that are greater than 10 μm in diameter will be deposited and that about 50% of the particles less than 0.1 μm will be deposited. The respiratory tree model also predicts that 50 to 100% of the cadmium deposited in the alveoli will be absorbed.

The majority of ingested cadmium tends to pass through the gastrointestinal tract without being absorbed and is excreted in the feces. Almost all of the cadmium found in the feces represents cadmium which was not absorbed from the gastrointestinal tract. Absorption of ingested cadmium is influenced by nutritional status, with absorption increased by low intake of calcium, iron, zinc and copper (Nordberg et al., 1985). Absorbed (from the lungs and gastrointestinal tract) cadmium tends to be excreted very slowly and is found equal proportions in the urine and feces. The main target organ for cadmium following ingestion is the kidney. The half-life of cadmium in the human body is very long. An estimated half-life for cadmium in the kidney ranges from 6 to 38 years and the liver from 4 and 19 years (ATSDR, 1998). The placenta may act as a partial barrier to fetal cadmium exposure.

Cadmium is not metabolized, rather it binds to proteins and other molecules. In particular it binds to the protein, albumin in the bloodstream which transports cadmium to the liver. Once cadmium enters the liver it becomes bound to another protein called metallothionein and is released to the bloodstream. The metallothionein bound cadmium is then filtered by the kidney glomerulus and is then reabsorbed by the proximal tubule cells. Lysozymes (strong enzymes) degrade the cadmium-metallothionein complex and cause free cadmium to be released in the kidney. The free cadmium initiates the synthesis of metallothionein in the proximal tubule cells and can also cause damage to the kidneys in excessive amounts.

There is currently not enough information to determine the potential absorption of cadmium via the dermal route of exposure (ATSDR, 1998). Based on the limited information it appears that very little cadmium is absorbed through the skin

A2-5.2 Toxicology

Cadmium and cadmium compounds possess moderately acute toxicity via both ingestion and inhalation. Cadmium is slowly excreted by the body, and therefore bioaccumulates in humans. Chronic cadmium poisoning can be associated with both inhalation and ingestion.

A2-5.2.1 Non-Cancer Effects

Based on studies of cadmium production workers, the route of entry for cadmium with the most immediate health effects is inhalation of fumes or dust. Localized health effects caused by cadmium exposure include irritation to the respiratory tract and to the mucous membrane lining of the inner surface of the eyelid. This is often accompanied by dyspnea (severe difficulty in breathing) and general weakness. Troubled breathing may become more pronounced as pulmonary edema and tracheobronchitis develop. The most common result of acute systemic cadmium exposure is emphysema, but in some instances, mortality may occur. Prolonged exposure may also result in anosmia (loss of sense of smell) and discolouration of the teeth.

Ingestion of high acute doses of cadmium may cause gastrointestinal effects such as nausea, vomiting, and abdominal pain (Nordberg et al, 1973). Cadmium causes kidney damage, particularly to the proximal renal tubules in the early stages and, as the disease progresses, or the dose increases, glomerular damage is also observed. Renal dysfunction has been demonstrated to be a consequence of chronic low level exposure to cadmium (Bernard et al., 1994).

Chronic cadmium exposure coupled with poor nutrition can lead to changes in the way which the kidney metabolizes vitamin D. This can result in painful bone diseases such as osteomalacia and osteoporosis, mainly in women. There is limited data to suggest that cadmium exposures in pregnant women may result in decreased birth weight in their babies.

Cadmium appears to have a relatively low dermal toxicity based on studies that showed that workers who were occupationally exposed to high levels of cadmium dust, did not report any dermal effects. Cadmium does not appear to cause sensitization by repeated dermal contact.

A2-5.2.2 Cancer Effects

Epidemiological studies demonstrate increased incidence of lung cancer in workers exposed to cadmium via the inhalation route, however, the studies did not control for factors such as smoking and simultaneous exposures to other metals so the causal relationship is somewhat controversial. Oral exposure to cadmium has not been associated with cancer in humans or animals.

The United States Environmental Protection Agency has classified cadmium as a probable human carcinogen (Group B2) when inhaled, based on limited human and sufficient animal data (US EPA, 1992). Health Canada has classified cadmium as a Group II carcinogen.

A2-5.2.3 Susceptible Populations

Populations which may be unusually susceptible to cadmium exposure are those with a genetic predisposition to lower inducibility of metallothionein, the enzyme which sequesters cadmium. Dietary deficiencies which lead to depleted levels of calcium or iron in individuals may result in increased absorption of cadmium from the gastrointestinal tract. Infants and children may have increased uptake of cadmium via the gastrointestinal tract and higher concentrations of cadmium in the bone.

A2-5.3 Current Exposure Limits

A2-5.3.1 Oral Exposure Limits

ATSDR (1998) has developed a chronic oral minimum risk level of 0.2 $\mu\text{g}/\text{kg}\text{-day}$ for cadmium. The chronic MRL is derived from a NOAEL of 2.1 $\mu\text{g}/\text{kg}\text{-day}$ from a study of cadmium accumulation in the kidneys of Japanese farmers living in an area of Japan with highly elevated cadmium levels. An uncertainty factor of 10 was used to account for variability in the human population.

The United States Environmental Protection Agency has developed oral reference doses for cadmium for food and water. The oral reference dose for food is 1.0 $\mu\text{g}/\text{kg}\text{-day}$ and for water is 0.5 $\mu\text{g}/\text{kg}\text{-day}$ (US EPA, 1994). The highest cadmium level in the human kidney which does not produce proteinuria (excretion of low weight molecular proteins into the urine) has been determined to be 200 μg cadmium/g of wet kidney cortex. A toxicokinetic model was used to determine the level of chronic oral exposure that would result in a cadmium kidney concentration of 200 μg cadmium/g of wet kidney cortex. The toxicokinetic model assumes that 0.01% of the body cadmium kidney burden is eliminated daily and that absorption of cadmium from food and water are 2.5% and 5% respectively. A No-Observed-Adverse-Effect Level (NOAEL) for chronic cadmium exposure was determined to be 5.0 and 10 $\mu\text{g}/\text{kg}\text{-day}$. An uncertainty factor of 10 to account for human variability was applied to the NOAELs to develop the reference doses for food and water.

JECFA (WHO, 1993) proposed that the total daily intake of cadmium should not exceed 1 $\mu\text{g}/\text{kg}$ body weight/ day. This intake was designed to keep the cadmium levels in the renal cortex below 50 $\mu\text{g}/\text{g}$, and assumed an absorption rate for dietary cadmium of 5% and a daily excretion rate of 0.005% of body burden (WHO, 1996).

Health Canada has not determined a tolerable daily intake for cadmium (HC, 1996).

A2-5.3.2 Inhalation Exposure Limits

The US EPA (US EPA, 1998) has developed an inhalation unit risk of $1.8 \times 10^{-3} (\mu\text{g}/\text{m}^3)^{-1}$. This unit risk is based on lung and upper respiratory tract cancers in cadmium production workers (Thun et al., 1985). The air concentration at the 10^{-5} lifetime cancer risk level (1-in-100,000) is 0.006 $\mu\text{g}/\text{m}^3$.

The WHO has an annual guideline value (noncancer) of $0.005 \mu\text{g}/\text{m}^3$ (WHO, 2000)

Health Canada has calculated a TC_{05} of $5.1 \mu\text{g}/\text{m}^3$. This TC_{05} can be divided by 5000 to obtain a 10^{-5} lifetime cancer risk air concentration of $0.001 \mu\text{g}/\text{m}^3$.

A2-5.3.3 Selection of Exposure Limits

The estimates of the carcinogenic potencies of inhaled and ingested cadmium, developed by the US EPA will be used to assess potential human health risks associated with exposure to cadmium at this site. The potency estimates established by the US EPA and the health effects upon which they are based are summarized below.

Table A2-4: Selected Exposure Limits for Cadmium

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|--------------------|--|--------------------------------|------------------------------|
| Non-Cancer Effects | | | |
| Ingestion | $1 \mu\text{g}/\text{kg}\text{-day}$ | kidney damage in humans | EPA, 1998, WHO (JECFA), 1993 |
| Inhalation | | | |
| Cancer Effects | | | |
| Ingestion | N/A ¹ | | |
| Inhalation | $0.0018 (\mu\text{g}/\text{m}^3)^{-1}$ | lung cancer in cadmium workers | EPA, 1998 |

1. Not Applicable

A2-5.4 Cadmium References

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A2-6 Toxicological Profile for Cobalt

The health risk of cobalt (Co) exposure in Ontario soils has been assessed for Port Hope (MOE, 1991) and Port Colborne (MOE, 1998). This appendix updates MOE (1998).

Cobalt exists in nature as a brittle hard metal, closely resembling iron and nickel in appearance. It has two valence states (Co(II) and Co(III)), which form numerous organic and inorganic salts. It is alloyed with iron and nickel to make Alnico. Cobalt is used in Stellite alloys, and stainless steel alloys used in jet and gas turbines. Cobalt salts have been used for centuries for the production of brilliant and permanent blue colours in porcelain, glass, pottery and enamel.

Cobalt is an essential nutrient for humans as it is needed to make vitamin B₁₂. Vitamin B₁₂ is a coenzyme in many biological reactions including the production of red blood cells. Cobalt has, therefore, also been used to treat anemia. As cobalt is an essential element, it is found in most body tissues with the highest concentrations occurring in the liver, kidney and bones.

A2-6.1 Pharmacokinetics

Inhaled cobalt particles accumulate in the respiratory tract depending on particle size. From the lungs, cobalt particles either dissolve into the bloodstream or are transferred to the gastrointestinal tract by mucocilliary action and swallowing. Approximately 50% of the cobalt transferred to the gastrointestinal tract is actually absorbed and the rest is eliminated in the feces. About 50 % of the portion of the initial lung burden can remain up to 6 months after exposure (Foster et al, 1989 as cited in ATSDR, 1992).

Cobalt consumed by the oral route of exposure is absorbed by the gastrointestinal tract. The amount of cobalt absorbed ranges from 18 to 97% in humans and is dependent upon the dose and type (form) of cobalt as well as the nutritional status of the individuals involved. Cobalt absorption tends to increase in subjects which have iron deficiencies in their diet. Elimination in the feces is the primary excretion method for oral cobalt exposures.

Absorption of cobalt through intact, or unbroken skin does not generally occur (ATSDR, 1992). However, cobalt may be absorbed through broken or injured skin.

A2-6.2 Toxicology

A2-6.2.1 Non-Cancer Effects

Acute effects of exposure to cobalt-containing dust occupationally are typically inflammation of the nasopharynx. Inhalation of cobalt can affect the respiratory system and if sufficient quantities are inhaled (3 µg cobalt/m³), irritation, wheezing, asthma and pneumonia can result. The occupational exposure levels noted here are approximately 10,000 to 100,000 times the typical outdoor air concentration. Individuals can also develop a sensitivity to cobalt if exposed continually in an occupational setting to concentrations of about 7 µg cobalt/m³ and subsequent exposures can result

in skin rashes or asthma attacks (ATSDR, 1992).

Oral exposure to cobalt has occurred in humans who consumed beer containing cobalt salts. In the 1960s, cobalt salts were added to beer to improve its foaming qualities. This practise has been discontinued as it led to several deaths amongst heavy beer drinkers (8 to 30 pints per day) who consumed doses ranging from 3 to 10 mg cobalt/per day ("beer drinkers cardiomyopathy"). Less serious effects associated with the consumption of beer containing cobalt compounds included nausea, vomiting and diarrhea. Increased production of red blood cells also occurs in humans after oral exposure to cobalt. Decreased uptake of iodine by the thyroid gland has been observed in humans exposed to short term doses of 1000 µg cobalt/kg-day or longer term doses of 540 µg cobalt/kg-day (ATSDR, 1992).

Developmental effects were not observed in babies born to mothers who were taking medication containing cobalt to regulate anemia while pregnant (Holly, 1955 as cited in ATSDR, 1992). Reproductive effects were not observed in the people who died after exposure to high cobalt levels in beer. Some effects have been observed in animals (adverse effects on the testes and increased length of the estrous cycle), however, the significance of these effects for humans is not clear as the cobalt doses used in these studies were much higher than those to which humans are usually exposed.

Contact dermatitis has also been consistently reported upon acute dermal exposure occupationally to cobalt compounds.

A2-6.2.2 Cancer Effects

There is insufficient evidence to implicate cobalt or cobalt compounds as human carcinogens. Cobalt has not been shown to cause cancer in humans.

Hamsters exposed cobalt oxide dust did not develop an increased incidence of lung tumours in comparison to the control population. Intramuscular injection of cobalt oxide resulted in the production of tumours in rats but not in mice (Gilman 1962 as cited in ATSDR, 1992). Based on animal data, the International Agency for Research on Cancer has classified cobalt as 2B; possibly carcinogenic for humans.

A2-6.2.3 Susceptible Populations

People who are already sensitized to cobalt may be unusually susceptible because subsequent cobalt exposure may trigger an asthma attack. Cobalt sensitization can be determined by cobalt-specific changes to serum antibodies (IgE and IgA)

A2-6.3 Current Exposure Limits

A2-6.3.1 Oral Exposure Limits

The recommended daily intake of cobalt as vitamin B₁₂ is 2 µg / day for adults and 0.3 µg/day for children less than two years old (Food and Drugs Act and Regulations (Canada)).

The USEPA Region III derived an oral RfD of 60 µg/kg-day for cobalt based on cobalt intake levels in food (USEPA, 2000). This RfD was based on the upper range of average intake for children, that is below the levels of cobalt needed to induce polycythemia in both renally compromised patients. However, the current USEPA IRIS list of chemicals does not include cobalt (USEPA, 1998).

A2-6.3.2 Inhalation Exposure Limits

An intermediate minimal risk level (MRL) of 0.03 µg cobalt/m³ is proposed by the Agency for Toxic Substances and Disease Registry (ATSDR, 1997). This inhalation RfD is based on a LOAEL of 110 µg /m³ (as cobalt sulfate) for squamous metaplasia of the larynx in rats and mice exposed for 13 weeks in the NTP (1991) and Bucher *et al.* (1990) studies. A safety factor of 1000 was applied.

No regulatory dermal exposure limits for cobalt were identified in the literature reviewed for the current assessment.

A2-6.3.3 Selection of Exposure Limits

The estimates of the carcinogenic potencies of inhaled and ingested cobalt, developed by the US EPA will be used to assess potential human health risks associated with exposure to cobalt at this site. The potency estimates established by the US EPA and the health effects upon which they are based are summarized below.

Table A2-5: Selected Exposure Limits for Cobalt

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|--------------------|------------------------|---|-----------------------|
| Non-Cancer Effects | | | |
| Ingestion | 60 µg/kg-day | effects in renally compromised patients | EPA, Region III, 2000 |
| Inhalation | | | |
| Cancer Effects | | | |
| Ingestion | N/A ¹ | | |
| Inhalation | 0.03 µg/m ³ | squamous metaplasia in rodent larvnx | ATSDR, 1997 |

1. Not Applicable

A2-6.4 Cobalt References

ATSDR (Agency for Toxic Substances and Disease Registry). 1992. Toxicological Profile for Cobalt. U.S. Department of Health and Human Services - Public Health Service (CDROM version, 2000).

Dabeka, R.W., and A.D. McKensie. 1995. Survey of lead, cadmium, fluoride, nickel, and cobalt in food composites and estimation of dietary intakes of these elements by Canadians in 1986-1988. J.AOAC. Intl. 78(4): 897-909.

MOE. 1998. Assessment of Potential Health Risk of Reported Soil Levels of Nickel, Copper and Cobalt in Port Colborne and Vicinity - May 1997. PIBS 3685e.

MOE & MOL. 1991. Assessment of Human Health Risk of Reported Soil Levels of Metals and Radionuclides in Port Hope. PIBS 1727.

US EPA. 2000. Risk-Based Concentration Table. US Environmental Protection Agency, Region III, Philadelphia, Penn. Available online at <http://www.epa.gov/reg3hwmd/risk/riskmenu.htm>.

A2-7 Toxicological Profile for Copper

The health risk of copper (Cu) exposure in Ontario soils has been assessed for Port Hope (MOE, 1991) and Port Colborne (MOE, 1998). This appendix updates MOE (1998).

Copper is a natural element that is also an essential nutrient for the human body. It is used as a conductive agent in electrical equipment, reducing agent, catalyst, and as wire material, and can be found in some pesticides.

Copper can be ingested from drinking water or eating certain foods. Another possible route of exposure includes the inhalation of roadway dust containing copper from the use of car brakes. It could also be ingested from foods that have absorbed it from copper cookware. Copper sulphate is used as a pesticide, fungicide and nutritional supplement in animal feed and fertilizer.

Copper is an essential element for humans and is found widely throughout the body. Adverse health effects can be linked to both copper deficiency as well as excessive copper levels. Copper deficiency is demonstrated by anemia, neutropenia and bone abnormalities, but is rarely observed in clinical situations. Copper is considered essential for the development of structural and enzymatic proteins. Enzymes regulating cellular respiration, free radical detoxification, iron metabolism, neurotransmitter function and synthesis of connective tissue contain copper. Regulation (activation and repression) of gene transcription also requires copper. Copper concentrations are regulated in the body by a process called homeostasis (ATSDR, 1990).

Copper regulates the mechanism which controls its intracellular homeostasis. Copper enters the liver where it is reduced and then complexes with glutathione. Metallothionein is the primary protein to which copper binds and these proteins are involved in the detoxification and binding of excess copper. Copper binds to the transcription factor which causes the production of metallothionein. When cellular copper levels are high then copper will bind to the metallothionein transcription factor causing metallothionein production, thereby detoxifying excess copper concentrations. If cellular copper levels are low, it is unlikely that there will be enough copper to bind to the metallothionein transcription factor, thereby limiting the production of metallothionein so that the copper can be used for metabolism (Gollan, 1996 as cited in WHO, 1998).

A2-7.1 Pharmacokinetics

No studies were found which document absorption, distribution or elimination of copper following inhalation exposure.

Absorption of copper occurs primarily through the gastrointestinal tract. Copper absorption is related to the amount of copper in the diet. For example, when adults were administered a low copper diet (780 µg copper per day) 55.6% of the administered copper was absorbed by the gastrointestinal tract as determined by the use of isotopes. For adults who were administered an adequate dose of copper in their diet (1,680 µg copper per day), 36.3% absorption was observed and for adults with a high daily copper intake (7,530 µg copper per day) only 12.4 % absorption was

found. Copper absorption in adults is saturable and the percentage of copper absorbed, decreases as the daily intake of copper increases. Total retention of copper increased with dietary intake and appropriate balance was maintained even at the lowest concentration studied (780 µg copper per day). Copper absorption and metabolism decreases as a result of competition with high levels of other metals such as iron and zinc for binding sites on metallothionein. Molybdenum inhibits copper retention.

Recent studies with an isotopic tracer indicate that infants absorb sufficient copper to meet their growth needs (Eherenkranz, 1989 as cited in WHO, 1998). Infants appear to reduce copper intake at high dietary concentrations by increasing fecal elimination and decreasing absorption.

The liver is the major organ involved in the distribution of copper throughout the body; distribution of copper to other tissues throughout the body occurs through the blood stream. The highest concentrations of copper are found in the brain, kidney, heart, liver and pancreas. Ceruloplasmin (a protein which can bind 6 to 8 Cu(II) atoms) and serum albumin appear to be the major carriers of copper through the bloodstream.

Bile is the major elimination pathway for liver copper as it accounts for approximately 80% of the copper leaving the liver. Pregnancy is associated with increased copper retention likely due to decreased biliary excretion resulting from the hormonal changes which typically occur. Urinary excretion and sweating are minor contributors to copper removal.

The use of topical medications containing copper compounds can increase dermal absorption of copper (Eldad, 1995 as cited in WHO, 1998). Components of topical medication such as salicylic acid or phenylbutazone facilitate the transport of copper through the skin.

A2-7.2 Toxicology
A2-7.2.1 Non-Cancer Effects

Inhalation exposure information is limited to studies on factory workers who have been exposed to significantly higher copper air concentrations than the general public. Copper dust is considered a respiratory irritant as factory workers experienced irritation of the mucosal membranes of the mouth, nose and eyes. Metal fume fever has also been observed in workers exposed to high concentrations of fine copper dust in air. Gastrointestinal effects such as nausea, anorexia and occasionally diarrhea were also experienced by factory workers and it is thought that the gastrointestinal effects are primarily due to swallowing a portion of the airborne copper (i.e., would be classified as an oral exposure).

Copper is rarely toxic unless very large amounts are ingested. The available toxicity data associated with oral consumption of copper are limited to ingestion of water with very high copper concentrations or suicide attempts involving copper sulphate. Chronic exposure to drinking water containing (dose approximately 60 µg copper/kg-day - 4,200 µg copper/day for a 70-kg adult) resulted in nausea, vomiting and abdominal pain shortly after consumption of the water. The gastrointestinal difficulties stopped after an alternate water supply was found for the affected persons.

Chronic copper poisoning is very rare, since the capacity for healthy human livers to excrete copper is considerable. Any reports of chronic copper poisoning that do exist involve patients with liver disease.

Developmental effects have not been observed in children of mothers with Wilson's Disease (a metabolic disorder which causes accumulation of copper in the liver) or healthy humans. Developmental toxicity has been found in mice, mink and hamsters who were fed a high copper diet or injected with copper. Reproductive effects have not been observed in human populations exposed to high copper levels. Copper containing intrauterine devices are used as a method of birth control and animal studies have shown that the copper wires contained within these devices are the contraceptive agent.

Dermal exposure to copper can result in allergic contact dermatitis.

A2-7.2.2 Cancer Effects

The United States Environmental Protection Agency has classified copper and copper compounds in Group D which indicates that they are substances for which inadequate data are available to make a carcinogenicity assessment. Specifically, for copper and copper compounds there are no human carcinogenicity data, animal bioassay data is inadequate and mutagenicity tests are equivocal (US EPA, 2000)

A2-7.2.3 Susceptible Populations

Infants and children under 1 year old are unusually susceptible copper toxicity because they have not developed the homeostatic mechanism to remove copper from the body. Wilson's Disease is a genetic disorder associated with impaired transport of copper from the liver to the bile, thereby resulting in increased copper concentrations in the liver as they are not able to maintain homeostasis. Another genetic condition which increases the susceptibility to copper toxicity is a deficiency in the enzyme glucose-6-phosphate dehydrogenase. Individuals with liver disease are also susceptible to copper toxicity because of the critical role the liver plays in eliminating copper from the body.

A2-7.3 Current Exposure Limits

A2-7.3.1 Oral Exposure Limits

As copper is considered an essential element for humans there are two types of exposure limits that are considered (a) the minimal daily intake so that a person will not suffer from copper deficiency and (b) the maximal permissible daily intakes so that a person will not suffer from copper toxicity.

The World Health Organization (WHO, 1998) has determined the minimal daily copper intake for adults to be 20 µg copper/kg-day which is equivalent to 1,400 µg copper per day for the average 70 kg adult. For children, the World Health Organization concluded that the minimal daily copper

intake should be 50 µg copper/kg-day (equivalent to 750 µg copper per day for a 15 kg child). The minimal daily copper intake was determined as the amount of copper needed for a child or adult to function properly while accounting for variables such as differences in copper absorption, retention and storage.

The Recommended Dietary Allowance (RDA) for US adults is 900 µg copper/day or about 13 µg/kg-day (IOM, 2001). This RDA is a combination of indicators, including plasma copper and ceruloplasmin concentrations, erythrocyte superoxide dismutase activity and platelet copper concentration in controlled human depletion/repletion studies.

The US Reference Daily Intake (a term which replaces "US RDA") for copper is 2000 µg/day or about 30 µg/ kg/day for adults (US FDA Consumer online magazine).

The tolerable upper intake level for US adults is 10,000 µg/day or about 140 µg / kg /day, and is based on protection from liver damage (IOM, 2001).

A2-7.3.2 Inhalation Exposure Limits

A chronic non-cancer Reference Exposure Level (REL) of 2.4 µg/m³ is listed for copper compounds in the California Air Pollution Control Officers Association Air Toxics "Hot Spots" Program, Revised 1992 Risk Assessment Guidelines. This REL are based on respiratory effects (CAPCOA, 1993). The United States Environmental Protection Agency (U.S. EPA) has not established a Reference Concentration (RfC) for copper compounds (U.S. EPA, 1994a).

A2-7.3.3 Selection of Exposure Limits

The estimates of the carcinogenic potencies of inhaled and ingested copper, developed by the US EPA will be used to assess potential human health risks associated with exposure to copper at this site. The potency estimates established by the US EPA and the health effects upon which they are based are summarized below.

Table A2-6: Selected Exposure Limits for Copper

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|--------------------|-----------------------|--|-------------------|
| Non-Cancer Effects | | | |
| Ingestion | 140 µg/kg-day | liver damage | IOM, 2001 |
| Inhalation | | | |
| Cancer Effects | | | |
| Ingestion | N/A ¹ | | |
| Inhalation | 2.4 µg/m ³ | chronic reference exposure limit - respiratory | California, 1998; |

I. Not Applicable

A2-7.4 Copper References

ATSDR (Agency for Toxic Substances and Disease Registry). 1990. Toxicological Profile for Copper. U.S. Department of Health and Human Services - Public Health Service (CDROM version, 2000).

MOE. 1998. Assessment of Potential Health Risk of Reported Soil Levels of Nickel, Copper and Cobalt in Port Colborne and Vicinity - May 1997. PIBS 3685e.

California Air Resources Board. 1998. List of Toxic Air Contaminants - Compound Summary Table. On-line at <http://www.arb.ca.gov/toxics/tac/tac.htm>

Canadian Council of Ministers of the Environment (CCME). 1997. Canadian Soil Quality Guidelines for Copper. CCME Subcommittee on Environmental Quality Criteria for Contaminated Sites. ISBN 0-662-25520-8.

MOE & MOL. 1991. Assessment of Human Health Risk of Reported Soil Levels of Metals and Radionuclides in Port Hope. PIBS 1727.

Institute of Medicine (Food and Nutrition Board) (IOM). 2001. Dietary Reference Intakes for Vitamins A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. National Academy Press, Washington, D.C.

US EPA. 2000. Integrated Risk Information System (IRIS). Copper. US Environmental Protection Agency. Online at <http://www.epa.gov/iris/index.html>.

World Health Organization (WHO). 1998. Copper. Guidelines for drinking-water quality, 2nd ed. Addendum to Vol. 2 Health criteria and other supporting information. WHO, Geneva. Pp. 31-46.

A2-8 Toxicological Profile for Lead

The health risks of lead have been assessed in detail for several Ontario communities (MOE, 1991; MOEE, 1994). This appendix offers supplemental information to section 5.8 of the main report (Part B).

Lead is a bluish-white lustrous metal. It is very soft, highly malleable, ductile, and a relatively poor conductor of electricity. It is very resistant to corrosion but tarnishes upon exposure to air. Lead pipes bearing the insignia of Roman emperors, used as drains from the baths, are still in service. Alloys include pewter and solder. Tetraethyl lead was used in some grades of petrol (gasoline).

A2-8.1 Pharmacokinetics

The absorption, distribution, metabolism, and elimination of lead has been extensively studied in both animals and humans. Available data can be used to quantify the uptake and disposition of lead in the human body for various populations of children and adults. Lead absorption is influenced by the route of exposure, chemical speciation, the physicochemical characteristics of the lead and exposure medium, and the age and physiological states of the exposed individual (e.g., fasting, nutritional calcium and iron status).

The primary sites for inorganic lead absorption are the gastrointestinal and respiratory tracts. The bioavailability of ingested soluble lead in adults may vary from less than 10% when ingested with a meal to 60–80% when ingested after a fast. Immediately following absorption, lead is widely distributed to blood plasma and soft tissues, then it redistributes and accumulates in bone (ATSDR, 1993).

Bone lead accounts for approximately 73% of the total body burden in children, increasing to 94% in adults due to changes in bone turnover rates with age. Transplacental transfer of lead has been demonstrated based on measurements of lead in umbilical cord blood in humans, as well as tissue concentrations in offspring of mice.

Lead that is not retained in the body is excreted principally by the kidney as salts or through biliary clearance into the gastrointestinal tract in the form of organometallic conjugates. Excretion rates measured in infants, children, and adults are highly variable, although available data suggest that the fraction of absorbed lead that is retained in humans decreases with age (ATSDR, 1993)

Dermal absorption of lead compounds is less significant than either oral or inhalation routes of exposure (ATSDR, 1993). Information on the dermal absorption of lead containing compounds is limited to a single study which applied a lotion containing lead acetate to the forearms of male volunteers, reported a dermal absorption rate of approximately 0.06% over a 12 hour period (ATSDR, 1993).

A2-8.2 Toxicology
A2-8.2.1 Non-Cancer Effects

The potential for lead to impair neurobehavioural development in children is the subject of much concern. Acute inhalation and oral exposures to lead often results in central nervous system effects including; dullness, restlessness, irritability, poor attention span, headaches, muscle tremors, hallucination and loss of memory (Health Canada 1992). Encephalopathy has been reported at very high lead exposure levels (100 μg lead/deciliter of blood in adults and 80 $\mu\text{g}/\text{dL}$ in children) (Health Canada 1992).

Chronic exposure to elevated levels of lead can result in a number of nervous system effects. Tiredness, sleeplessness, irritability, headaches, joint pain and gastrointestinal symptoms have all been reported (Health Canada, 1992). In adults, these effects are seen at blood lead levels of 50 - 80 $\mu\text{g}/\text{dL}$. Occupationally exposed persons have been found to suffer from muscle weakness, mood disruptions, and peripheral neuropathy when blood lead levels reached 40 - 60 $\mu\text{g}/\text{dL}$. At levels of 30 - 50 $\mu\text{g}/\text{dL}$, significant reductions in nerve conductive velocities were also reported (Health Canada, 1992). Renal disease has also been reported, but nephropathy has not been detected in adults of children whose blood lead levels were below 40 $\mu\text{g}/\text{dL}$ (Health Canada, 1992).

There is substantial human evidence in both adults and children which demonstrates that both the central and peripheral nervous system are the primary targets of lead toxicity. Sub-Encephalopathy, neurological and behavioral effects in adults and electrophysiological evidence of nervous system damage in children have been reported at blood lead levels as low as 30 $\mu\text{g}/\text{dL}$ (Health Canada, 1992). A number of epidemiological studies have examined the effects of lead exposure in young children. The studies were able to demonstrate no clear threshold below which the detrimental effects of lead on child neurological development does not occur (Health Canada, 1992).

Epidemiological studies of occupationally exposed adults were not able to demonstrate an increase in cancers among an exposed cohort compared to control. The International Agency for Research on Cancer (IARC), considers the overall evidence of lead carcinogenicity in humans to be inadequate. Animal studies have reported renal tumors in rats exposed to 1000 ppm lead salts in the diet. While exposures to lead acetate, subacetate and phosphate salts produced renal tumors in rats, equivalent exposures to other lead salts did not result in the production of renal tumors (Health Canada, 1992). Health Canada has classified lead as a Group IIIB (possibly carcinogenic to humans) compound based on a lack of adequate human data and limited evidence of carcinogenicity in animals.

Epidemiological studies have indicated that non-cancer neurological effects may occur at very low exposure levels. Therefore, an exposure level based on these effects will provide against the possible carcinogenic effects of lead. Health Canada (1996) recommended a provisional tolerable daily intake (PTDI) for lead of 3.57 $\text{g}/\text{kg}\text{-day}$. This value was based on technical reports from annual meetings of the Joint FAO/WHO Expert Committee on Food Additives (JEFCA), and epidemiological studies associating lead exposure with neurological effects in infants and children. The WHO value was established to prevent increases in blood lead levels in children. Studies with young children have shown that daily exposures to lead in the 3 -4 $\mu\text{g}/\text{kg}\text{-day}$ range do not alter the blood lead level in the study children. Intakes at or above 5 $\mu\text{g}/\text{kg}\text{-day}$ resulted in significant increases in blood lead levels.

A2-8.2.2 Cancer Effects

The USEPA (US EPA, 1998) has classified lead as a probable human carcinogen based on sufficient animal evidence. However, the Carcinogen Assessment Group (USEPA, 1998) did not recommend derivation of a quantitative estimate of oral carcinogenic risk, due to a lack of understanding pertaining to the toxicological and pharmacokinetic characteristics of lead. In addition, the neurobehavioural effects of lead in children were considered to be the most relevant endpoint in determining an exposure limit.

A2-8.2.3 Susceptible Populations

There is a very large database which documents the effects of acute and chronic lead exposure in adults and children. Extensive summaries of the human health effects of lead are available from a number of sources including Health Canada, the US EPA IRIS database and the ATSDR. These reviews show that infants, young children up to the age of 6 and pregnant women (developing foetuses) are the most susceptible (Health Canada 1992).

A2-8.3 Current Exposure Limits

A2-8.3.1 Oral and Inhalation Exposure Limits

Health Canada (1996) recommended a provisional tolerable daily intake (PTDI) for lead of 3.57 g/kg-day. This value was based on technical reports from annual meetings of the Joint FAO/WHO Expert Committee on Food Additives (JEFCA), and epidemiological studies associating lead exposure with neurological effects in infants and children.

The Ontario Ministry of the Environment and Energy recommended an IOC_{pop} (intake of concern for populations) of 1.85 $\mu\text{g}/\text{kg}\cdot\text{day}$ which incorporated the population-based significance of the health effects and attempted to minimize the predicted number of children with individual blood lead levels of concern (MOE, 1994). Subclinical neurobehavioural and developmental effects were the critical effects appearing at the lowest levels of exposure (MOE, 1994). The IOC_{pop} was based on an LOAEL in infants and young children of 10 $\mu\text{g}/\text{dL}$, converted to an intake, with an applied uncertainty factor of 2 for the use of an LOAEL (MOE, 1994). Because the IOC_{pop} was intended for the entire population and independent of route of exposure, 1.85 $\mu\text{g}/\text{kg}\cdot\text{day}$ was adopted for both oral and inhalation exposure limits for the current assessment.

A2-8.3.3 Selection of Exposure Limits

The exposure limits used to assess the potential risks associated with ingestion and inhalation exposures to nickel are summarized in Table A2-7.

Table A2-7: Selected Exposure Limits for Lead

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|--------------------|------------------|------------------------------------|---------------|
| Non-Cancer Effects | | | |
| Ingestion | 1.85 µg/kg-day | blood lead level in young children | MOE, 1994 |
| Inhalation | 1.85 µg/kg-day | blood lead level in young children | MOE, 1994 |
| Cancer Effects | | | |
| Ingestion | N/A ¹ | | |
| Inhalation | N/A ¹ | | |

1. Not Applicable

A2-8.4 Lead References

ATSDR, (1993). Agency for Toxic Substances and Disease Registry, Toxicological Profile for Lead

Baltrop, D., et al. (1975) Absorption of lead from dust and soils. Graduate Medical Journal 51:801-804

CDC (1991) Preventing Lead Poisoning In Young Children: A Statement by the Centers for Disease Control

Davies (1988) Lead in Soil: Issues and Guidelines Environmental Geochemistry and Health Monograph Series 4.

Health Canada (1992). Guidelines for Canadian Drinking Water Quality - Supporting Document for Lead

Health Canada (1996) Health-based tolerable daily intakes/ concentrations and tumorigenic doses/ concentrations for priority substances. ISBN 0-662-24858-9.

Integrated Risk Information System (IRIS). (1998) U.S. Environmental Protection Agency. On-line toxicological database at <http://www.epa.gov/iris/index.html>

Langlois, P, Fleming, S et al. (1996) Blood lead Levels in Toronto Children and Abatement of Lead-contaminated Soil and House Dust. Archives of Environmental Health 51:59-67.

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MOE (1987) Review and Recommendations on a lead in Soil Guideline.

MOE (1991) Assessment of Human Health Risk of Reported Soil Levels of Metals and Radionuclides in Port Hope, S. Fleming et al., 117pp.

MOE (1994a) Scientific Criteria Document for the Development of Multimedia Environmental Standards: Lead, S. Fleming, 332pp.

MOE (1994b) Rationale Document for the Development of Soil, Water and Air Quality Criteria for Lead.

Ontario Ministry of Health (1984) Blood Lead Concentrations and Associated Risk Factors in Ontario children.

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Rinne, R. (1986) Soil lead levels in urban areas of Ontario. Ministry of the Environment , Air Resources Branch.

Scheupler, R.J. and I.H. Blackwell (1971). Permeability of the skin. *Physiol. Rev.* 51:702-747.

Steele, MJ, Beck , BD et al. (1990) Assessing the contribution from lead in mining wastes to blood lead. *Reg. Tox. Pharmacol.* 11:156-190.

Stern, A. (1994) Derivation of a Target Level of Lead in Soil at Residential Sites Corresponding to a De Minimis Contribution to Blood Lead Concentration

US EPA (1986) Air Quality Criteria for Lead. EPA/600/80-83 Vols I-IV

US EPA (1996) Urban Soil Lead Abatement Demonstration Project Volume 1: 600/p93/001aF

US EPA (2001) Identification of Dangerous Levels of Lead: Final Rule. *Federal Register* 66:1205-1240.

A2-9 Toxicological Profile for Nickel

The health risk of nickel (Ni) exposure in Ontario soils has been assessed for Port Hope (MOE, 1991) and Port Colborne (MOE, 1998). This appendix updates MOE (1998).

Pure nickel is a hard, silvery-white metal, which has properties that make it very desirable for combining with other metals to form mixtures called alloys. Some of the metals that nickel can be alloyed with are iron, copper, chromium, and zinc. These alloys are used in making metal coins and jewelry and in industry formaking items such as valves and heat exchangers. Most nickel is used to make stainless steel. Compounds of nickel combined with many other elements, including chlorine, sulfur, and oxygen, exist. Many of these compounds dissolve fairly easily in water and have a characteristic green color. Nickel and its compounds have no characteristic odor or taste. Nickel compounds are used for nickelplating, to color ceramics, to make some batteries, and as substances known as catalysts that increase the rate of chemical reactions (ATSDR, 1997).

The physiological role of nickel in animals and humans has not yet been determined. It is believed, based on plants and microorganisms, that nickel is involved as a cofactor in metalloenzymes/proteins or as a cofactor which facilitates iron absorption in the intestine (Nielsen, 1985). Nickel may also affect endocrine function regulating prolactin levels. Nickel deficiency has not been observed in humans, but has been induced in animals, indicating that nickel is an essential element for animals (Schneegg and Kirchgessner, 1975).

An important issue relating to nickel toxicity is its speciation. Its form (metallic, salt, oxide, etc.) and solubility strongly influence its toxicology. The solubility (in water) of different nickel compounds ranges from the highly soluble nickel salts (nickel chloride - 642 g/L; nickel sulphate - 293 g/L) down to the insoluble nickel oxide (1.1 mg/L) and the sparingly soluble nickel subsulphide (517 mg/L)(ATSDR, 1997). The predominant nickel species in Rodney Street soils is the relatively insoluble nickel oxide (Results section of Part A).

The toxicity of nickel can be classified into four separate categories: (1) noncancer respiratory and other disorders , due to the inhalation or ingestion of nickel compounds; (2) cancer, due to inhalation of nickel compounds; (3) allergy, a hypersensitivity to nickel manifested by contact dermatitis; and (4) iatrogenic poisoning which may have occurred in the past in patients undergoing hemodialysis, corrosion of stainless steel prostheses, and nickel-contaminated medication or medication such as disulfiram that caused increased nickel concentration in the blood(not discussed).

A2-9.1 Pharmacokinetics

A2-9.1.1 Inhalation Exposure

Following inhalation exposure, nickel may accumulate in the lungs depending on the size of the particle inhaled. Larger particles (5-30 μm) tend to accumulate in the upper respiratory tract while smaller particles are deposited in the lower respiratory system. Absorption of nickel compounds deposited in the lung into the blood stream depends upon their form and solubility. Soluble nickel compounds such as nickel chloride and nickel sulphate are absorbed readily (up to

100%) from the respiratory tract while almost none of the less soluble nickel compounds such as nickel oxide and nickel subsulphide (as demonstrated by urinary nickel levels in exposed workers). Inhaled nickel that is absorbed is excreted through the urine. Studies conducted on nickel workers show that nickel urinary excretion increased towards the end of the shift and also towards the end of the work week, indicating that one fraction is removed quickly, but that there was also a fraction which was removed more slowly (Ghezzi *et al.*, 1989, Tola *et al.*, 1979; as cited in TERA, 1999). No reliable estimates are, however, found in the literature for retention and uptake of nickel from nickel oxide inhalation exposure in humans.

Occupational exposure to nickel results in higher nickel lung burdens than the general population. Workers exposed to insoluble forms of nickel (such as nickel oxide and nickel sulphide) have higher nickel levels in the nasal mucosa than those workers exposed to more soluble forms of nickel (this may be related to larger inhalable dust particles being trapped in the upper respiratory tract). Less soluble nickel compounds, therefore, appear to remain in the nasal passage following inhalation exposure. Serum nickel levels are higher in workers exposed to soluble nickel compounds in comparison to those exposed to insoluble nickel compounds (Torjussen and Andersen, 1979, as cited in ATSDR, 1997). Nickel sensitized individuals had similar nickel levels in blood, urine and hair relative to nonsensitive individuals (Spruit and Bongaarts, 1977, as cited in ATSDR, 1997).

Pulmonary exposure to green nickel oxide in rats resulted in nickel excretion in the feces, but not in the urine, indicating that the primary removal mechanism of nickel oxide involved clearance from the lungs rather than by dissolution-absorption processes (Benson *et al.*, 1994 as cited in ATSDR, 1997). The observed excretion could also reflect mucociliary clearance (being brought up in mucus and then being swallowed), in addition to macrophage clearance. Benson *et al.* (1994) also found that nickel subsulfide is cleared relatively rapidly (half-life of 4 days) from the lungs of rats. They concluded that nickel subsulfide is relatively insoluble in water, but dissolves rapidly in lung fluid.

A2-9.1.2 Oral Exposure

Studies examining the absorption of nickel by humans found that nickel sulphate was 40 times more bioavailable if administered in water than in food (Sunderman, 1989). The bioavailability of nickel also increased when administered in a soft drink, but not when given in milk, coffee, tea or orange juice. (Solomons *et al.*, 1982) Serum nickel levels were found to be elevated in subjects who had fasted prior to the administration of nickel in drinking water, but this was not the case for those who were administered nickel in food. Food tends to decrease the bioavailability of nickel. Some nickel sensitive individuals were found to have decreasing nickel serum concentrations and increasing nickel urinary concentrations with increased administered nickel concentrations (Santucci, 1994). This may be an indication that some nickel sensitive individuals can decrease nickel absorption in response to increased nickel intake. In non-occupationally exposed people, nickel concentrations tend to be highest in lungs, thyroid and adrenal glands, kidney, heart and liver (Rezuke *et al.*, 1987, as cited in ATSDR, 1997). The total amount of nickel estimated to be present in the human body is about 6 mg for a 70-kg adult (Sumino *et al.*, 1975, as cited in ATSDR, 1997).

Quantitative absorption data for unspecified forms of soluble nickel are as follows: 1-27% of

ingested nickel is absorbed (depending on whether food is consumed); approximately 1-6% of nickel administered with food or during a meal is absorbed; 12-27% of nickel absorbed after a fast (data from Diamond et al., 1998, as cited in *TERA*, 1999).

Nickel metabolism occurs via a series of nickel exchange reactions (Sarkar, 1984, as cited in ATSDR, 1997). In human blood, nickel binds to a blood protein called albumin. Nickel competes with copper for a binding site on the albumin (Hendel and Sunderman, 1972, as cited in ATSDR, 1997). Nickel is then transferred from the albumin to L-histidine, an amino acid. The nickel-histidine complex has a low molecular weight and can easily cross biological membranes (Sarker, 1984, as cited in ATSDR, 1997). Nickel is also tightly bound to a nickeloplasmin in human blood which is not available for exchange and hence not transported across biological membranes (Sunderman, 1986, as cited in ATSDR, 1997).

Most ingested nickel is excreted via feces, although the nickel absorbed by the gastrointestinal tract is excreted in the urine. In comparison studies of nickel doses administered with food or water, 26% of the dose given in water was eliminated in the urine and 76% in the feces by the fourth day following administration (Sunderman et al, 1989). In contrast, 2% of the nickel dose administered in food was eliminated in the urine and 102% was eliminated in the feces during the same time period. Nickel can also be eliminated through hair, sweat, milk and skin.

No reliable estimates are, however, found in the literature for retention and uptake of nickel from nickel oxide ingestion exposure.

A2-9.1.3 Dermal Exposure

Studies of the dermal uptake of nickel in humans have been summarized in Appendix 7.

A2-9.2 Toxicology

A2-9.2.1 Inhalation Exposure

The only data available for chronic nickel inhalation exposure for humans is limited to occupational data. One of the limitations associated with the epidemiological data available is that the workers were exposed to several different forms of nickel as well as other metals and irritant gases at the same time, so frequently the observed effects can not be attributed to a particular type of nickel. Other lifestyle factors, such as smoking, which affect disease outcomes are also not always available, thereby limiting the conclusions that can be drawn.

One death has been reported as the result of exposure to very high metallic nickel concentrations (382 mg/m^3) of a small particle size (Sunderman, 1993, as cited in ATSDR, 1997). Workers who were chronically exposed to nickel oxide or metallic nickel at concentrations greater than 0.04 mg/m^3 had a greater incidence of death from respiratory disease (Cornell and Landis, 1984, Polednak, 1981; as cited in ATSDR, 1997). Other respiratory effects found included chronic bronchitis, emphysema, and reduced vital capacity. These workers were also exposed to other metals, so it can not be concluded that nickel is the sole causative agent of the effects observed.

Asthma from primary irritation and as the result of dermal sensitization has also been documented amongst nickel workers (Dolovich et al., 1984, Novey et al., 1983, Shirakawa et al., 1990; as cited in ATSDR, 1997). Increased incidence of cardiovascular-related deaths has not been found in nickel workers.

Nickel refinery workers with elevated urinary nickel concentrations also showed a significant increase in urinary β_2 -microglobulin levels, which is indicative of tubular dysfunction in the kidneys (ATSDR, 1997). However, marked differences are seen between the results using single urine samples ("spot samples"), and sampling conducted over a 24-hour period (TERA, 1999). Although, male and female workers were exposed to the same average nickel (nickel chloride and nickel sulphide) air concentrations, the women had twice the nickel urinary concentrations of the men (Sunderman and Horak, 1981, as cited in ATSDR, 1997). A study of nickel production workers has found significant increases in levels of immunoglobulin G (IgG), IgA, and IgM as well as a significant decrease in IgE. Serum proteins involved in cell-mediated immunity also increased, suggesting stimulation of the immune system by nickel (Bencko et al., 1983, 1986; as cited in ATSDR, 1997). The TERA (1999) report concluded that "the overall epidemiological database regarding potential kidney effects of inhalation exposure to soluble nickel is weak. However, the available data do provide suggestive evidence that the kidney can be affected under exposure conditions below those causing acute toxicity."

Studies show that pregnant female workers at a nickel refining plant in the Kola region in Russia had a 15.9% increase in spontaneous abortions in comparison with a control population of pregnant female construction workers (who were not occupationally exposed to nickel) who had a spontaneous abortion rate of 8.5% (Chashschin et al, 1994). The Russian metal refinery workers were exposed to nickel sulphate concentrations of approximately 0.08 to 0.196 mg nickel/m³ and corresponding urinary nickel concentrations were 3.2 to 22.6 $\mu\text{g/L}$. Nickel urinary concentrations in persons not occupationally exposed range from <0.1 to 13.3 $\mu\text{g/L}$. Heavy lifting and heat stress are also associated with nickel refining. A preliminary study of pregnant Russian nickel refinery workers also indicated that babies born to these women had a 16.9% increase in development effects (primarily cardiovascular and musculoskeletal defects) relative to the children of construction workers who had a 5.8% increase in developmental effects. It is not clear whether the fact that the Russian workers also were exposed to heavy lifting and heat stress, could also be factors contributing to the observed abortions. No indications of fetal toxicity (birth weight of first child) in the general population in nickel smelter cities in the Kola region in Russia (Nikel and Zapoljarnij) were found in a large comparative study of pollution and health in the Norwegian-Russian border area, but further studies are in progress (Smith-Sivertsen et al, 1997; Odland, 1999).

A significant increase of gaps in the chromosomes was found in white blood cells of nickel workers who were exposed to nickel monosulfide and nickel subsulfide. Breakage or exchange of the chromosomes was not observed. The study did not find any correlation between the incidence of the chromosome gaps, blood nickel concentration, duration of nickel exposure or age of workers (Waksvik and Boysen, 1982, as cited in ATSDR, 1997).

A2-9.2.2 Oral Exposure

One death has been reported due to the accidental consumption of an extremely high nickel sulphate concentration (570 mg nickel/kg) (Daldrup et al., 1983, as cited in ATSDR, 1997). Gastrointestinal effects were reported in a incident where workers drank water from a fountain containing nickel sulphate and nickel chloride (Sunderman, 1988). Exposure doses ranged from 7.1 to 35.7 mg nickel/kg. Symptoms included nausea, abdominal pain, vomiting and diarrhea. Neurological effects were also observed in the affected workers.

Oral lethality tests of rats indicated that soluble nickel compounds were more toxic than insoluble nickel compounds. An oral lethal dose for 50% of the population (LD_{50}) for nickel sulphate in female rats was reported to be 39 mg/kg while oral LD_{50} values for insoluble nickel compounds were >3,930 and >3,665 mg/kg for nickel oxide and nickel subsulfide, respectively (Mastromatteo, 1986).

Decreased body weight has been observed in rats and mice given nickel chloride and nickel sulphate in drinking water (Schroeder et al., 1974). Ambrose *et al.* (1976) reported data on rats and dogs exposed for 2 years to nickel sulphate in the diet at 100, 1,000, and 2,500 ppm. Noncancer effects included decreased growth in dogs (mid and high doses) and rats (high dose), alterations in blood and urinary chemistry in high-dose dogs, and changes in relative organ weights for mid and high dose female rats (heart and liver) and high dose dogs (kidney and liver). The NOAEL was estimated to be 5,000 $\mu\text{g Ni/kg-day}$, based on the noncancer changes in the rat.

A 3-generation study, carried out by Ambrose *et al.* (1976), noted a higher incidence of stillborns in the first generation of albino rats fed 250, 500, or 1,000 ppm nickel in their diet (nickel sulphate) and depressed body weights of weanlings on the 1,000 ppm diet in all generations. A higher incidence of stillborns was not observed in subsequent generations (Ambrose *et al.*, 1976).

A2-9.2.3 Cancer Effects

Extensive reviews of the toxicology of nickel and nickel compounds, including animal carcinogenicity and human epidemiological data, have been published (IARC, 1990, Doll *et al.*, 1990). The studies reviewed included human exposures associated with nickel mining, smelting, refining and high nickel alloy manufacture. The reviews also indicated that different classes of nickel compounds have different carcinogenic potencies. More recently, the human and animal toxicology of soluble nickel salts is under review (TERA, 1999).

The epidemiological studies reviewed by IARC (1990) and Doll *et al.* (1990) have several limitations. The principal limitation was the lack of data related to concentrations of nickel in air within the facilities that were studied. Consequently, it was not possible to establish dose-response relationships for specific nickel species. Doll *et al.* (1990) noted that the conclusions of many of the epidemiological studies (with respect to lung tumours) were confounded by a lack of information about the smoking habits of the workers. It should be noted that several epidemiology studies (including updates of those in the Doll report) have been published since the completion of the Doll report (TERA, 1999).

Four studies were used in the U.S. EPA determination of the inhalation unit risk associated

with nickel refinery dust (US EPA, 2001). A cohort of employees of a nickel refinery in West Virginia who experienced a minimum 1 year exposure to nickel refinery dusts (containing nickel subsulphide, sulphate and oxide or only nickel oxide) did not show an increased incidence of lung cancer above expected rates (Enterline and Marsh, 1982). Chovil *et al.* (1981) studied a cohort of nickel refinery workers in Ontario, and observed a dose-related trend for the relationship between weighted exposure in years to the incidence of lung cancer. Similarly, a cohort of Welsh nickel refinery workers had elevated risks of cancer compared to the national average. Increased rates of nasal cancer were observed in men employed prior to 1920, while this rate was less than the national average for those starting work between 1920 and 1925, and equaled the expected value for those employed after 1925 (Doll *et al.*, 1977). A significantly increased lung cancer-related mortality was observed in employees starting prior to 1925 but not in those starting between the years 1930 to 1944. Magnus *et al.* (1982) conducted a study of men employed at a nickel refinery in Norway, and reported an elevated occurrence of respiratory cancer for nickel-exposed workers compared to expected values, and for workers involved in nickel processing steps compared to non-processing employees.

Numerous carcinogenicity experiments have been conducted with nickel compounds, administered *via* injection, inhalation or ingestion. Recent chronic inhalation studies have clearly indicated that different nickel compounds have different carcinogenic potentials and different animal species show different carcinogenic responses to various nickel compounds (NTP, 1996a,b,c).

Inhalation studies of the effects of nickel oxide concentrations of up to 42mg/m³ on hamsters for a lifetime did not show nickel-induced carcinogenicity (Wehner *et al.*, 1975 as cited in CEPA, 1994). However, rats exposed to 5 or 15 mg of nickel oxide via intratracheal instillation, demonstrated an increase in lung tumours (Pott *et al.*, 1987 as cited in CEPA, 1994). Nickel oxide compounds also caused an increased incidence of tumours at the site of injection in various experimental animals (IARC, 1990).

A number of inhalation studies of nickel carcinogenesis in rats and mice have yielded positive results. Ottolenghi *et al.* (1974) exposed Fischer 344 rats to 0.97 mg nickel sulphide/m³ for 78 weeks. An increased incidence of lung tumours was observed during treatment and during a 30-week observation period. Sunderman *et al.* (1957, 1959) also observed increased incidences of lung tumours in rats exposed to nickel carbonyl for up to 52 weeks.

The most recent chronic inhalation studies included up to 2-year inhalation exposures to nickel subsulphide, nickel sulphate hexahydrate and nickel oxide (NTP, 1996a,b,c).

In the nickel subsulphide inhalation study, rats were treated with 0, 0.11, or 0.73 mg Ni/m³ and mice with 0, 0.44 or 0.88 mg Ni/m³, 6 hours/day, 5 days/week for 104 weeks. NTP concluded that there was an increased incidence of alveolar/bronchiolar adenoma or carcinoma or squamous cell carcinoma in male and female rats, benign or malignant pheochromocytoma in males and benign pheochromocytoma in female rats. NTP concluded that there was no evidence of carcinogenic activity in mice and clear evidence of carcinogenic activity in male and female rats (NTP, 1996a).

In the nickel sulphate hexahydrate study, rats were exposed by inhalation to 0, 0.03, 0.06 or 0.11 mg Ni/m³ for 104 weeks, in the form of a nickel sulphate hexahydrate aerosol. NTP concluded that there was no evidence of carcinogenic activity (NTP, 1996b).

In the same nickel sulphate hexahydrate study, mice were treated with 0, 0.06, 0.11 or 0.22 mg Ni/m³ according to the same protocol used for the rats. NTP concluded that there was no evidence of carcinogenic activity (NTP, 1996b).

In the nickel oxide inhalation study, rats were treated with 0, 0.5, 1.0, or 2.0 mg Ni/m³ and mice with 0, 1.0, 2.0, or 3.9 mg Ni/m³ for 104 weeks. NTP concluded that there was some evidence of an increased incidence of alveolar/bronchiolar adenoma or carcinoma or squamous cell carcinoma, and benign or malignant pheochromocytoma in rats. NTP concluded that there was no evidence of carcinogenic activity in male mice but equivocal evidence of alveolar/bronchiolar adenoma or carcinoma in female mice (NTP, 1996c).

Increased tumourigenesis in mice, rats and dogs has not been associated with nickel compounds ingested in the diet or in drinking water (Schroeder *et al.*, 1964, Schroeder and Mitchener, 1975, Ambrose *et al.*, 1976).

Intrarenal injection of nickel subsulphide was reported to result in an increased incidence of renal tumours in male Fischer 344/NC rats (Higinbotham *et al.*, 1992). Intrarenal administration of nickel subsulphide to male Fischer 344 rats was associated with an increase in kidney tumours (Sunderman *et al.*, 1990). Nickel acetate was reported to induce a significant increase in lung tumours in rats following a series of intraperitoneal injections (Stoner *et al.*, 1976).

A2-9.2.4 Contact Dermatitis

Nickel dermatitis is the most prevalent effect of nickel and occurs in nickel-sensitized individuals. Nickel sensitization results from extensive contact with nickel-containing material such as jewelry, coins, dental braces, stainless steel etc. Contact dermatitis may also result from occupational exposure (Liden, 1994). Once an individual has been sensitized to nickel, subsequent exposure (inhalation, ingestion, or dermal contact) to low levels of nickel may cause a reaction (Keczkes *et al.*, 1982). Asthma may occur in a small number of sensitized individuals (Dolovich *et al.*, 1984, Novey *et al.*, 1983, Shirakawa *et al.*, 1990; as cited in ATSDR, 1997). However, continued oral exposure to nickel has also been shown to desensitize some individuals and prevent sensitization in other cases.

The issue of contact dermatitis following ingestion of nickel-containing food items has been reviewed (US FDA, 1993). In studies where nickel (mainly in a soluble form such as the sulphate) was administered to human subjects with chronic nickel dermatitis or eczema, single doses of 2,500 µg to 5,600 µg nickel produced aggravated reactions (Cronin *et al.*, 1980; Kaaber *et al.*, 1978; Gawkröder *et al.*, 1986; Veien *et al.*, 1983). One double-blind study showed that a single 2,500 g dose of orally administered nickel was sufficient to aggravate the chronic nickel dermatitis in 17 of the 28 patients tested (Veien *et al.*, 1983). Other, less reliable studies suggest that as little as 600 g or 1,250 g of ingested nickel may exacerbate the skin conditions in patients with long-standing (10-17 years) nickel hypersensitivity. In one double-blind study (Jordan and King, 1979), one of the 10 nickel hypersensitive patients tested consistently reacted to a 500 g oral nickel challenge. Thus, oral nickel exposure of as little as 500 µg /day may produce adverse reactions in some nickel hypersensitive persons. US FDA (1993) suggested that a tolerable intake for nickel of 50 g/day can be derived by

applying an uncertainty factor of 10 to the lowest observed effect level for dermatitis in hypersensitive individuals, however, a daily intake of 1200 µg nickel / day was used to develop consumption levels of concern for the general population consuming shellfish.

ATSDR (1997) also discusses the same studies of contact dermatitis following oral exposure and indicates that setting of oral exposure limits for nickel is complicated by the presence of sensitized individuals in the general population.

Contact dermatitis following dermal contact with nickel was reviewed by Hostynek et al. (1993). In the context of metallic nickel in jewellery or metal utensils, where nickel can be dissolved by sweat during skin contact, reference is made to a proposed occupational limit to limit release of nickel from metal items into sweat to less than 0.5 µg/cm²/week (or less than 0.07 µg/cm²/day) (Hostynek et al. (1993). This nickel release to sweat exposure limit is based on work by Menne et al. (1987). The European Union has issued a directive forbidding the use of nickel in products placed in direct contact with the skin and to restrict release of nickel to less than 0.5 µg/cm²/week during normal use for up to 2 years (ATSDR, 1997).

A2-9.2.5 Susceptible Populations

Populations which are unusually susceptible to nickel are those people already sensitive to nickel due to prolonged contact with nickel. Subsequent exposures may result in an allergic reaction. A greater number of women tend to be sensitized to nickel than men and this is believed to be related to the fact that woman tend to wear more metal jewelry than men. Further study is required to determine whether there is indeed a gender difference in nickel sensitivity. Persons with kidney dysfunction are also likely to be more susceptible to nickel as the primary route of nickel elimination is via the urine. Increased nickel serum concentrations have been observed in dialysis patients (Sudbury - Connecticut study)(ATSDR, 1997).

A2-9.3 Current Exposure Limits

It should be noted that the Health Canada (1996) exposure limits for nickel compounds cited below are based on toxicological literature reviewed up to 1993. Several major studies have been published since 1993.

A2-9.3.1 Nickel Refinery Dusts and Nickel Sub sulfide

Nickel refinery dusts and nickel subsulfide are both classified by the U.S. EPA as group A: human carcinogens. Only inhalation unit risk values for these substances are available; recent noncancer values for these forms of nickel are not available. For nickel refinery dusts, the inhalation unit risk is $2.4 \times 10^{-4} (\mu\text{g}/\text{m}^3)^{-1}$. For nickel subsulfide, the inhalation unit risk is $4.8 \times 10^{-4} (\mu\text{g}/\text{m}^3)^{-1}$ (US EPA, 2001).

Health Canada (1996) reports a non-cancer tolerable inhalation concentration of 0.02 µg/m³

for nickel subsulfide.

A2-9.3.2 Nickel Soluble Salts

The U.S. EPA (US EPA, 1998) recommended an oral RfD of 20 $\mu\text{g}/\text{kg}\text{-day}$ for soluble salts of nickel based on decreased body and organ weight data in two year dietary study in rats (Ambrose *et al.*, 1976). This RfD may not necessarily protect the already sensitized individual.

For nickel sulphate, Health Canada (1996) derived a TDI of 50 $\mu\text{g}/\text{kg}\text{-day}$, based on the NOAEL from the Ambrose *et al.* (1976) two year dietary study in rats.

Toxicological Excellence for Risk Assessment (TERA, 1999) has conducted a review of the oral RfD for soluble nickel and has proposed a value of 7.6 $\mu\text{g}/\text{kg}\text{-day}$ which does not account for nickel in the animal diet. As noted for the US EPA RfD, the TERA number may not necessarily protect the already sensitized individual.

For the inhalation route, Health Canada (1996) recommends a tolerable inhalation concentration (non-cancer effects) of 0.0035 $\mu\text{g}/\text{m}^3$ for nickel sulphate. The TC was based on lung and nasal lesions in rats and mice observed by Dunnick *et al.* (1989). This is based on a subchronic study, TERA (1999) have developed an inhalation RfC of 0.2 $\mu\text{g}/\text{m}^3$ based on a LOAEL (increased pup death) of 1.3 mg Ni / kg /day for chronic nickel chloride exposure in rats (Smith et al, 1993).

Health Canada has developed a tumorigenic dose (TD₀₅) of 0.07 mg/m³ for soluble nickel salts.

ATSDR (1998) has developed a chronic MRL for inhalation exposure of 2×10^{-4} mg/m³ (0.2 $\mu\text{g}/\text{m}^3$) based on a rat study of nickel sulfate hexahydrate. ATSDR did not determine oral MRLs for nickel because the protection of sensitized individuals and application of uncertainty factors to the LOAEL for contact dermatitis (0.009 mg/kg-day) would result in an MRL which would bring the dose below normal dietary intake (about 0.002 mg/kg-day in the U.S.).

A2-9.3.3 Nickel Oxide

Health Canada has not derived a chronic oral exposure limit for nickel oxide, but a tolerable inhalation concentration (non-cancer effects) of 0.02 $\mu\text{g}/\text{m}^3$ has been developed. (Health Canada, 1996).

Health Canada (1996) has classified oxidic nickel (including nickel oxide, nickel copper oxide, nickel silicate oxides and complex oxides as Group I (Carcinogenic to Humans). This classification is based on the studies of Doll et al. (1990) and the International Agency for Research in Cancer (IARC) evaluation (IARC, 1990).

It should be clarified that all toxicological information regarding the carcinogenicity of nickel

oxide, either as a component of nickel refinery dusts or as a pure compound administered to rats and mice is only by the inhalation route. There is no information regarding its carcinogenicity via the ingestion route in humans or animals. In addition, while nickel oxide has carcinogenic potential when inhaled (based on human and animal studies), there are no published inhalation unit cancer risks by which to assess its potency.

A2-9.3.4 Metallic Nickel

Health Canada (1996) reports a provisional non-cancer tolerable concentration (inhalation) of $0.018 \mu\text{g}/\text{m}^3$.

No appropriate exposure limit (oral or dermal) for contact dermatitis was found in the literature.

For the purposes of this risk assessment, the US EPA RfD for soluble nickel was selected to assess potential noncancer effects from estimated nickel intakes from all exposure routes. Other oral exposure limits were generally below normal dietary intake estimates.

To assess the potential for cancer effects related to inhalation of nickel oxide, the annual average ambient air concentration from MOE monitoring station 27047 (at Davis and Fraser) data was compared to the US EPA inhalation unit risk of $2.4 \times 10^{-4} (\mu\text{g}/\text{m}^3)^{-1}$ for nickel refinery dusts. The air concentration of nickel at the 10^{-5} lifetime cancer risk (one-in-100,000) level is $0.04 \mu\text{g}/\text{m}^3$.

Nickel refinery flue dust from INCO, Port Colborne used in animal carcinogenicity testing contained 20% nickel sulphate, 59% nickel subsulphide, and 6.3% nickel oxide (Gilman and Ruckerbauer, 1962). This flue dust has a similar composition to the nickel refinery dust mixtures that the US EPA inhalation unit risk is based on. However, INCO refinery dusts analysed for MOE and MOL in 1978 indicated that the prevalent nickel compound in INCO emissions was nickel oxide. In addition, the nickel speciation of Rodney Street soils (Results section of Part A) also indicates that nickel exposures are mainly due to nickel oxide. Consequently, since the main carcinogenic component of nickel refinery dust, namely nickel subsulphide is not present in airborne particulates inhaled by Rodney Street residents, the actual carcinogenic risk of inhaling Rodney Street air due to nickel is likely lower than inhaling real nickel refinery dusts. In this case, the inhalation risk from inhaling nickel in Rodney Street air is likely over estimated by at least ten-fold.

A2-9.3.5 Selection of Exposure Limits

Table A2-8: Selected Exposure Limits for Nickel Compounds

| Route of Exposure | Exposure Limit | Toxicological Basis | Source Agency |
|---------------------------|---|---|---------------|
| Non-Cancer Effects | | | |
| Ingestion | 20 µg/kg-day | decreased body and organ weight in rats | EPA, 1998 |
| Inhalation | | | |
| Dermal Contact | | | |
| Cancer Effects | | | |
| Ingestion | N.A. ¹ | | |
| Inhalation | 2.4×10^{-4} (µg/m ³) ⁻¹ | lung cancer in nickel refinery workers | EPA, 1998 |
| Dermal Contact | N.A. | | |

1. Not Applicable

A2-9.4 References

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APPENDIX 3

Detailed Estimates of Daily Intakes of Metals

Detailed Estimates of Daily Intakes of Metals

The presence of elevated levels of several metals in the soil of residential properties on Rodney Street in Port Colborne has raised concerns regarding exposures experienced by residents and the potential human health effects associated with these exposures. The current assessment has been undertaken to provide interested/concerned parties with estimates of the metal exposures that could be experienced by residents of the Rodney Street community. People living in the Rodney Street community, like all residents of Ontario, are exposed to metals from a number of sources including, processed food, drinking water and air. In addition to these general exposures that are common to the population of Ontario, the residents of the Rodney Street community can be exposed to metals in the soil and in home grown produce. A detailed assessment was undertaken for people living in the Rodney Street community to develop estimates of the total daily exposure experienced by people of all ages.

A3-1 Assessing Exposures to Metals

Each of the exposure pathways identified in Section 4.1 of the main report, that can contribute to the total daily metal exposures experienced by the residents of the Rodney Street community, is discussed below. The method of calculation is presented, identifying all of the receptors and site-specific parameters that are considered for each pathway. Exposures are assessed for all of the receptors identified in Section 4.1 of the main report, and were estimated using the receptor parameters listed in Table 4-3 of the main report.

A3-1.1 Intake of Metals from Supermarket Food

Estimates of the daily dietary intakes of metals from supermarket foods are generally limited and the amount of information available varies widely between metals. The metals of concern in the Rodney Street community, addressed in this exposure assessment include, antimony, beryllium, cadmium, cobalt, copper and nickel. Information regarding daily dietary intakes of these metals has been taken from regulatory agencies in Canada and internationally. Additional information has been taken from available literature. For the purposes of assessing likely daily dietary metal intakes for the residents of the Rodney Street community, preference has been given to data generated from the Canadian population. It was felt that information from Canadian sources would provide the best reflection of likely dietary habits and metal intakes for residents of the Rodney Street community. The daily dietary intake of metals is discussed in detail in Appendix 4. A summary of the daily dietary intake of metals for all age groups is summarized in Table A3-1.

A3-1.2 Intake of Metals from Drinking Water

Daily intakes of metals from drinking water are dependent on the amount of drinking water consumed on a daily basis and the level of metals present in the drinking water. The estimated intakes of metals from drinking water for the Rodney Street community has been calculated as shown in equation A3-1. Estimates of the intake of antimony, beryllium, cadmium, cobalt, copper

and nickel from the consumption of drinking water for all age groups are shown in Table A3-2.

Table A3-1: Estimated Daily Intakes of Metals from Supermarket Food

| Receptor | Daily Intakes of Metals from Supermarket Food ($\mu\text{g}/\text{day}$) | | | | | |
|-----------|--|------------------------|------------|-------------------------|------------|------------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 1.3 | 4.8 | 5.08 | 4.18 | 518 | 180 |
| Toddler | 2.3 | 8.6 | 10.6 | 7.0 | 822 | 264 |
| Child | 3.5 | 13.2 | 16.8 | 10.0 | 1230 | 329 |
| Teen | 4.0 | 15 | 17.3 | 12.0 | 1520 | 340 |
| Adult | 3.4 | 12.7 | 14.8 | 10.5 | 1430 | 311 |
| Reference | FSA, 1997 | Vaessen & Szteke, 2000 | CEPA, 1994 | Dabeka & McKensie, 1995 | CCME, 1997 | CEPA, 1994 |

EQ A3-1:

$$Intake_{dw} = IR_{dw} * C_{dw}$$

Where:

| | | |
|---------------|---|--------------------------|
| $Intake_{dw}$ | = Intake from drinking water | $\mu\text{g}/\text{day}$ |
| IR_{dw} | = Ingestion rate of drinking water | L/day |
| C_{dw} | = Metal concentration in drinking water | $\mu\text{g}/\text{L}$ |

The intake estimates are based on the highest level of each metal reported by the monitoring of drinking water taken from the municipal system at Charlotte Street. Although water quality was also measured at the treatment plant, the data from within the distribution system was felt to be more representative of the water quality in the Rodney Street community. The data in Table A3-2 shows that for most metals, daily intakes from drinking water are generally less than 1 $\mu\text{g}/\text{day}$. The most notable exception to this is copper, where intakes from drinking water range between 13.2 $\mu\text{g}/\text{day}$ for infants and 66 $\mu\text{g}/\text{day}$ for adults. For infants and toddlers intakes of nickel from drinking water are below 1 $\mu\text{g}/\text{day}$, but intakes for children, teens and adults are greater than 1 $\mu\text{g}/\text{L}$. These values will be used in conjunction with intakes from other sources to provide estimates of total daily exposure for people in all age groups.

A3-1.3 Intake of Metals from Ambient Air

Unlike other environmental media, such as soil or water, air quality may fluctuate from day to day or hour to hour and exposure levels are also influenced by changes in meteorological conditions. To protect the general population against contaminants in outdoor air, on a continuous

basis, time periods such as 24-hours or annual are used. These prescribed time periods are referred to as “averaging times” and are an important aspect of controlling air quality. This also has significance from a toxicological perspective since the dose of a chemical, which is time dependent, is a major determinant of toxicological effects. One consideration in establishing averaging time is to limit exposure peaks for airborne chemicals, which could occur within a long averaging period, such as a year.

Table A3-2: Estimated Metal Intakes from Drinking Water

| Metal | Receptor | C_{dw} ($\mu\text{g/L}$) | IR_{dw} (L/day) | Intake_{dw} ($\mu\text{g/day}$) |
|-----------|-------------------|------------------------------|-------------------|--|
| Antimony | 0- 6 months | 0.97 | 0.3 | 0.29 |
| | 7 months - 4years | 0.97 | 0.6 | 0.58 |
| | 5 - 11 years | 0.97 | 0.8 | 0.78 |
| | 12 - 19 years | 0.97 | 1 | 0.97 |
| | 20 + years | 0.97 | 1.5 | 1.5 |
| Beryllium | 0- 6 months | 0.20 | 0.3 | 0.06 |
| | 7 months - 4years | 0.20 | 0.6 | 0.12 |
| | 5 - 11 years | 0.20 | 0.8 | 0.16 |
| | 12 - 19 years | 0.20 | 1 | 0.20 |
| | 20 + years | 0.20 | 1.5 | 0.30 |
| Cadmium | 0- 6 months | 0.083 | 0.3 | 0.025 |
| | 7 months - 4years | 0.083 | 0.6 | 0.050 |
| | 5 - 11 years | 0.083 | 0.8 | 0.066 |
| | 12 - 19 years | 0.083 | 1 | 0.083 |
| | 20 + years | 0.083 | 1.5 | 0.12 |
| Cobalt | 0- 6 months | 0.040 | 0.3 | 0.012 |
| | 7 months - 4years | 0.040 | 0.6 | 0.024 |
| | 5 - 11 years | 0.040 | 0.8 | 0.032 |
| | 12 - 19 years | 0.040 | 1 | 0.040 |
| | 20 + years | 0.040 | 1.5 | 0.060 |
| Copper | 0- 6 months | 44 | 0.3 | 13 |
| | 7 months - 4years | 44 | 0.6 | 26 |
| | 5 - 11 years | 44 | 0.8 | 35 |
| | 12 - 19 years | 44 | 1 | 44 |
| | 20 + years | 44 | 1.5 | 66 |
| Nickel | 0- 6 months | 1.3 | 0.3 | 0.39 |
| | 7 months - 4years | 1.3 | 0.6 | 0.78 |
| | 5 - 11 years | 1.3 | 0.8 | 1.0 |
| | 12 - 19 years | 1.3 | 1 | 1.3 |
| | 20 + years | 1.3 | 1.5 | 2.0 |

Averaging time can be used to ensure protection against the different effects of airborne chemicals by ensuring that exposure limits for specific effects, acute or chronic, are not exceeded. Short term acute effects are normally based on a 1-hour (or less) exposure period while longer term chronic effects are based on a 24-hour or annual averaging time. Averaging times also provide useful benchmarks to monitor ambient air quality

The time taken for chemical exposure to cause adverse health effects varies among chemicals and even a single chemical can cause different effects at different doses. Chemicals such as sulphur dioxide, may trigger an effect within 15 minutes, or less, of exposure. Others, such as the carcinogenic chemicals, may have a longer-term cumulative effect, which may not clinically manifest for several years. The times over which concentrations should be averaged to reflect the timeframe during which their effects become apparent varies, and averaging times are often set to reflect this.

Air monitoring data is usually collected on air samplers over relatively short time periods, e.g., one to two days, and the results integrate the chemical concentration over the volume of air filtered and the time period the sampler was running. A single air sample would result in the air concentration over a daily time period. In the course of a year, if sufficient "daily" samples are taken, an annual average air concentration can be calculated. This way a picture of the peak levels and the overall average concentration in the air over the year can be constructed.

In the case of the risk assessment for the Rodney Street community, air monitoring data comes from several sources and locations. Local air sampling for nickel, lead, copper and total suspended particulates was obtained from the Ministry's sampling station at Davis St & Fraser St which operated from 1992 to 1996, and air sampling done during the summer of 2000 near schoolyards in Port Colborne by Jacques Whitford Environmental Limited (JWEL, 2000). The Ministry's sampling station is about 600 m north of Rodney Street. Prevailing winds in the general Port Colborne area are from the west and southwest. Those sectors account for about 45-50% of winds. The other sectors occur less and fairly evenly, about 5-15% each (Frank Dobroff, MOE, personal communication). While the Davis & Fraser location may be deemed slightly upwind of the Rodney Street community, inspection of the nickel concentration in soil maps in the Ministry's Phytotoxicology Soil Investigation reports (MOE, 1999; MOE, 2000) indicate that it is located in an area where nickel levels in surface soils range up to 1000 µg/g, and depending on wind direction would sample air particulates representative of the area just north of Rodney Street. The air monitoring performed at Port Colborne schools in the summer of 2000 (JWEL 2000) was only collected for the portion of the year that dust levels would normally be higher and may not be representative of long term average levels in the community. In all cases where air monitoring data exists for arsenic, cobalt, copper, nickel, and TSP, the maximum and average air concentrations for each metal from the JWEL (2000) air monitoring are less than or comparable with either the MOE or Environment Canada information.

Air concentrations of other metals not sampled extensively in Port Colborne (antimony, arsenic, , cadmium, cobalt, lead) were taken from Environment Canada's National Air Pollution Surveillance (NAPS) air monitoring program for Ontario for 1995-1999 (Tom Dann, Environment Canada, personal communication). Environment Canada air monitoring data comes from nine sites spread across Ontario, six of which are in Hamilton, Toronto and Windsor. In general, the Environment Canada air monitoring data for the same chemicals sampled by MOE at Davis and Fraser (the maximum and annual average air concentrations) was lower. In the absence of more suitable air quality data for chemicals not sampled extensively in Port Colborne, Environment Canada air monitoring data was used.

Air monitoring data for beryllium is not available either from Environment Canada or MOE air monitoring programs. In order to estimate potential health effects from inhaling airborne beryllium in the Rodney Street community, it was assumed that the total suspended particulates

(TSP) data from MOE monitoring at Davis & Fraser for 1992-1996 would have the same beryllium concentration as soil in the Rodney Street community.

As a check on the possible relationship between soil metal concentrations and metal levels in resuspended dust, the same calculation using the highest average TSP concentration from MOE monitoring at Davis & Fraser for 1992-1996 and the highest surface soil metal concentration in soil in the Rodney Street community is shown in Table A3-3. In general, these artificial resuspended soil as TSP calculations fall into a range overlapping the other air monitoring data since the artificial numbers range from near the highest annual average (antimony, cadmium, copper) to near the maximum air concentrations (arsenic, cobalt, lead and nickel) found in the MOE or Environment Canada air monitoring data. A summary of the metal levels in air, used in the current assessment is provided in Table A3-3

Table A3-3: Levels of Metals in Ambient Air in Port Colborne

| | Metal Concentration in Air in Port Colborne ($\mu\text{g}/\text{m}^3$) | | | | | |
|------------------------------|--|-----------|---------|--------|--------|--------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Short term maximum | 0.0115 | n/a | 0.0067 | 0.017 | 0.56 | 0.69 |
| Annual average (highest) | 0.0011 | 0.00012 | 0.0007 | 0.002 | 0.11 | 0.033 |
| Resuspended soil calculation | 0.0012 | 0.00012 | 0.00026 | 0.012 | 0.057 | 0.55 |

To assess the potential health risks related to inhalation, the highest annual average air concentration from the MOE or Environment Canada air monitoring data was used. This is more appropriate to estimate long term inhalation exposure, and, inhalation RfC and unit risks are developed for lifetime exposure not short term maximum air concentrations. Characterization of potential health risks from inhalation is discussed in Section 5.0 of the Human Health Risk Assessment main report (Part B)(Risk Characterization).

In the Rodney Street community, inhaled metals will be associated with particulate matter and will not be present as free metal. Therefore, there is a potential for the inhaled particulate matter to be cleared from the lungs, through mucocilliary transport, and swallowed. Material cleared from the lungs in this fashion will add to the total daily ingestion of metal. The amount of particulate delivered to the stomach by this process is difficult to predict with any accuracy. Therefore, to provide conservative estimates of the amount of metal ingested as a result of the clearance of inhaled particles, it has been assumed that all inhaled metal is cleared from the lung and passed to the stomach. This approach will over estimate the contribution that inhalation exposures make to the total daily intakes of metals. The estimated inhalation intake of each metal for each receptor based on the highest annual average level (Table A3-3) is shown in Table A3-4. These values are calculated as shown in equation A3-2.

Eq A3-2:

$$Intake_{air} = IR_{air} * C_{air}$$

Where: $Intake_{air}$ = Intake from air $\mu\text{g/day}$
 IR_{air} = Inhalation rate m^3/day
 C_{air} = Metal concentration air $\mu\text{g}/\text{m}^3$

Table A3-4: Estimated Metal Intakes from Air

| Metal | Receptor | C_{air} ($\mu\text{g}/\text{m}^3$) | IR_{air} (m^3/day) | Intake... ($\mu\text{g}/\text{day}$) |
|-----------|-------------------|--|--|--|
| Antimony | 0- 6 months | 0.0011 | 3.2 | 0.0035 |
| | 7 months - 4years | 0.0011 | 14.6 | 0.016 |
| | 5 - 11 years | 0.0011 | 20.3 | 0.022 |
| | 12 - 19 years | 0.0011 | 23.1 | 0.025 |
| | 20 + years | 0.0011 | 22.9 | 0.025 |
| Beryllium | 0- 6 months | 0.00012 | 3.2 | 0.00038 |
| | 7 months - 4years | 0.00012 | 14.6 | 0.0018 |
| | 5 - 11 years | 0.00012 | 20.3 | 0.0024 |
| | 12 - 19 years | 0.00012 | 23.1 | 0.0028 |
| | 20 + years | 0.00012 | 22.9 | 0.0027 |
| Cadmium | 0- 6 months | 0.0007 | 3.2 | 0.0022 |
| | 7 months - 4years | 0.0007 | 14.6 | 0.010 |
| | 5 - 11 years | 0.0007 | 20.3 | 0.014 |
| | 12 - 19 years | 0.0007 | 23.1 | 0.016 |
| | 20 + years | 0.0007 | 22.9 | 0.016 |
| Cobalt | 0- 6 months | 0.002 | 3.2 | 0.0064 |
| | 7 months - 4years | 0.002 | 14.6 | 0.029 |
| | 5 - 11 years | 0.002 | 20.3 | 0.041 |
| | 12 - 19 years | 0.002 | 23.1 | 0.046 |
| | 20 + years | 0.002 | 22.9 | 0.046 |
| Copper | 0- 6 months | 0.112 | 3.2 | 0.36 |
| | 7 months - 4years | 0.112 | 14.6 | 1.6 |
| | 5 - 11 years | 0.112 | 20.3 | 2.3 |
| | 12 - 19 years | 0.112 | 23.1 | 2.6 |
| | 20 + years | 0.112 | 22.9 | 2.6 |
| Nickel | 0- 6 months | 0.033 | 3.2 | 0.11 |
| | 7 months - 4years | 0.033 | 14.6 | 0.48 |
| | 5 - 11 years | 0.033 | 20.3 | 0.67 |
| | 12 - 19 years | 0.033 | 23.1 | 0.76 |
| | 20 + years | 0.033 | 22.9 | 0.76 |

A3-1.4 Intake of Metals from Backyard Garden Produce

Eating vegetables grown in backyards where metal levels are above typical levels, represents

a potential exposure pathway if the metals present in the soil are taken up into the vegetables. The exposures received by people eating such produce depends upon the concentration of the metals in the vegetables and the amount of vegetables consumed from backyard gardens. The current assessment has assumed that backyard garden produce is consumed on a daily basis throughout the year. The amount of backyard garden vegetables consumed on an annually averaged daily basis is discussed in detail in Appendix 6.

As part of the on-going work in Port Colborne, samples of backyard produce have been collected by the MOE and JWEL from Rodney and Mitchell Streets. The levels of individual metals in the various types of produce tested are provided in Appendix 1 of this report. For the purposes of this assessment, backyard garden produce has been divided into two general categories;

- root vegetables* includes; beet root and radish samples from Rodney and Mitchell Street gardens and the Wainfleet bog
- other vegetables.* includes; beet tops, celery, lettuce, peppers and tomatoes from Rodney and Mitchell Street gardens and the Wainfleet bog

A review of the vegetable data in Appendix 1 clearly shows that the concentrations of metals in vegetables is not strongly affected by the levels of metals present in the soil (see Table A3-5). The data in Table A3-5 provides a comparison of metal levels in soil and vegetables between various locations in the Port Colborne vicinity. For comparisons to be possible, metal levels must have been reported in the same crop from differing locations and metal levels in soil must also have been available. With the available data it was possible to develop comparisons for four of the six metals of concern including cadmium, cobalt, copper and nickel. Similar comparisons were not possible for antimony or beryllium.

Table A3-5: Comparison of Metal Levels in Soil and Vegetables

| Vegetable | Location | Metal Levels in Soil and Vegetables ($\mu\text{g/g}$) | | | | | | | |
|-----------|----------------|---|--------|--------|--------|------------|------|--------|-------|
| | | Cadmium | | Cobalt | | Copper | | Nickel | |
| | | Soil | Veg | Soil | Veg | Soil | Veg | Soil | Veg |
| Beet Root | Rodney Loc #3 | <0.5 | 0.049 | 20.1 | 0.048 | 134 | 1.92 | 764 | 1.82 |
| | Rodney Loc #25 | 1.1 | 0.031 | 28.6 | 0.014 | 194 | 1.26 | 1570 | 1.37 |
| | Wainfleet Bog | 15.6 | 0.04 | 4.5 | 0.014 | 14.9 -22.2 | 1.03 | 15.6 | 0.027 |
| Tomato | Rodney Loc 3 | <0.5 | 0.015 | 20.1 | 0.0059 | 134 | 0.66 | 764 | 0.21 |
| | MOE Sample # 1 | 0.8 | 0.013 | 44.5 | 0.0065 | 220 | 0.32 | 2750 | 0.35 |
| | MOE Sample # 2 | 0.1 | 0.013 | 58 | 0.0065 | 325 | 0.3 | 4400 | 0.31 |
| Pepper | Rodney Loc #25 | 1.1 | 0.0099 | 28.6 | 0.0033 | 194 | 0.67 | 1570 | 0.52 |
| | MOE Sample # 1 | 0.8 | 0.0033 | 44.5 | 0.0066 | 220 | 0.39 | 2750 | 0.92 |
| | MOE Sample # 2 | 0.1 | 0.013 | 58 | 0.0066 | 325 | 0.62 | 4400 | 1.58 |
| | Wainfleet Bog | 15.6 | 0.059 | 4.5 | 0.037 | 14.9 -22.2 | 0.98 | 15.6 | 0.039 |

1: metal levels in vegetables are reported on a fresh weight basis

In soil in the Rodney Street community where cadmium levels were less than $0.5 \mu\text{g/g}$, cadmium levels in beets was $0.049 \mu\text{g/g}$ on a fresh weight basis. These levels are marginally higher than the level of $0.040 \mu\text{g/g}$ reported in beets from the Wainfleet Bog where cadmium levels ranged

between 15.4 and 15.8 $\mu\text{g/g}$ (average 15.6 $\mu\text{g/g}$). Similar trends can be seen for all the metals listed in Table A3-5 and for all of the vegetables examined. This lack of a relationship between metal concentrations in soil and vegetables is most likely due to the relative insolubility of the metals of concern. The metals present in the soil will be bound to, or associated with, soil particles and will not be easily solubilized. As a result, they are not readily available for uptake into plants. Because there does not appear to be a relationship between metal levels in the soil and the levels in vegetable grown in the soil, metal levels in vegetables cannot be predicted on the basis of metal concentrations in soil. Therefore the highest levels reported in root and other vegetables from gardens in the Rodney Street community, the MOE samples and those taken from Wainfleet bog were used to assess potential intakes of metals from backyard produce in Port Colborne. To ensure that the data from the Rodney Street community would match the same categories used by Health Canada, the vegetables analyzed from the Rodney Street community were placed into two groups; *Root vegetables* and *Other Vegetables*. The metal levels used in this assessment are summarized in Table A3-6.

Table A3-6: Metal Levels in Backyard Produce in Port Colborne

| Vegetable | Metal Concentrations in Vegetables ($\mu\text{g/g}$) (Fresh Weight) | | | | | | | |
|------------------|---|---------|-----------|---------|--------|--------|------|--------|
| | Antimony | Arsenic | Beryllium | Cadmium | Cobalt | Copper | Lead | Nickel |
| Root Vegetables | 0.008 | 0.011 | - | 0.049 | 0.048 | 1.92 | 1.05 | 1.82 |
| Other Vegetables | 0.021 | 0.007 | 0.007 | 0.063 | 0.083 | 1.06 | 0.25 | 1.58 |

The highest level of each metal reported in both of these categories were used to estimate daily intakes of metals from backyard garden produce. Daily intakes of metal from backyard produce are calculated as shown in equation A3-3. Estimates of daily metals intakes from backyard garden vegetables for all age groups are shown in Table A3-7

A3-1.5 Intake of Metals from Soil

The metals of concern in the Rodney Street community area of Port Colborne are generally tightly bound to soil particles and are present in forms that either have limited solubility in water or are largely insoluble. However, the solubility of these metals increases under acidic conditions. When ingested, metals that are insoluble in water at neutral pH (6.0 - 8.0) can be solubilized and removed from soil particles in the acidic environment of the stomach. The metals released from the soil in the stomach become accessible for uptake by the gut. Ingested metals that remain bound to soil particles in the gut are not available for absorption and are excreted in the feces. The daily intake of metal from ingested soil is a function of the amount of soil ingested, the level of metal contained in the soil and the amount of metal released from the soil particles under the acidic conditions of the stomach. The estimated daily intake of metal from the ingestion of soil is calculated as shown in equation A3-4.

EQ A3-3:
$$Intake_{veg} = (IR_{root} * C_{root}) + (IR_{other} * C_{other})$$

Where: $Intake_{vegl}$ = Intake from backyard garden produce $\mu\text{g/day}$
 IR_x = Yearly averaged daily intake of backyard root or other vegetables (see Appendix 6) g/day
 C_x = Metal concentration in root/other vegetables $\mu\text{g/g}$

Table A3-7: Estimated Metal Intakes from Backyard Vegetables

| Metal | Receptor | Root Vegetables | | | Other Vegetables | | | Total ($\mu\text{g/day}$) |
|-----------|---------------|------------------------|-------------------------|---|------------------------|-------------------------|---|-----------------------------|
| | | Cx ($\mu\text{g/g}$) | IR _x (g/day) | Intake _{air} ($\mu\text{g/day}$) | Cx ($\mu\text{g/g}$) | IR _x (g/day) | Intake _{air} ($\mu\text{g/day}$) | |
| Antimony | 0- 6 months | 0.008 | 8.18 | 0.065 | 0.021 | 7.09 | 0.15 | 0.21 |
| | 7 months - | 0.008 | 10.3 | 0.082 | 0.021 | 6.60 | 0.14 | 0.22 |
| | 5 - 11 years | 0.008 | 15.9 | 0.13 | 0.021 | 9.65 | 0.20 | 0.33 |
| | 12 - 19 years | 0.008 | 22.4 | 0.18 | 0.021 | 11.8 | 0.25 | 0.43 |
| | 20 + years | 0.008 | 19.3 | 0.15 | 0.021 | 14.1 | 0.30 | 0.45 |
| Beryllium | 0- 6 months | 0 | 8.18 | 0.00 | 0.0066 | 7.09 | 0.047 | 0.05 |
| | 7 months - | 0 | 10.3 | 0.00 | 0.0066 | 6.60 | 0.044 | 0.04 |
| | 5 - 11 years | 0 | 15.9 | 0.00 | 0.0066 | 9.65 | 0.064 | 0.06 |
| | 12 - 19 years | 0 | 22.4 | 0.00 | 0.0066 | 11.8 | 0.078 | 0.08 |
| | 20 + years | 0 | 19.3 | 0.00 | 0.0066 | 14.1 | 0.093 | 0.09 |
| Cadmium | 0- 6 months | 0.049 | 8.18 | 0.40 | 0.063 | 7.09 | 0.45 | 0.85 |
| | 7 months - | 0.049 | 10.3 | 0.50 | 0.063 | 6.60 | 0.42 | 0.92 |
| | 5 - 11 years | 0.049 | 15.9 | 0.78 | 0.063 | 9.65 | 0.61 | 1.4 |
| | 12 - 19 years | 0.049 | 22.4 | 1.1 | 0.063 | 11.8 | 0.74 | 1.8 |
| | 20 + years | 0.049 | 19.3 | 0.95 | 0.063 | 14.1 | 0.89 | 1.8 |
| Cobalt | 0- 6 months | 0.048 | 8.18 | 0.39 | 0.083 | 7.09 | 0.59 | 0.98 |
| | 7 months - | 0.048 | 10.3 | 0.49 | 0.083 | 6.60 | 0.55 | 1.0 |
| | 5 - 11 years | 0.048 | 15.9 | 0.76 | 0.083 | 9.65 | 0.80 | 1.6 |
| | 12 - 19 years | 0.048 | 22.4 | 1.1 | 0.083 | 11.8 | 0.98 | 2.1 |
| | 20 + years | 0.048 | 19.3 | 0.93 | 0.083 | 14.1 | 1.2 | 2.1 |
| Copper | 0- 6 months | 1.92 | 8.18 | 16 | 1.06 | 7.09 | 7.5 | 23 |
| | 7 months - | 1.92 | 10.3 | 20 | 1.06 | 6.60 | 7.0 | 27 |
| | 5 - 11 years | 1.92 | 15.9 | 31 | 1.06 | 9.65 | 10 | 41 |
| | 12 - 19 years | 1.92 | 22.4 | 43 | 1.06 | 11.8 | 13 | 56 |
| | 20 + years | 1.92 | 19.3 | 37 | 1.06 | 14.1 | 15 | 52 |
| Nickel | 0- 6 months | 1.82 | 8.18 | 15 | 1.58 | 7.09 | 11 | 26 |
| | 7 months - | 1.82 | 10.3 | 19 | 1.58 | 6.60 | 10 | 29 |
| | 5 - 11 years | 1.82 | 15.9 | 29 | 1.58 | 9.65 | 15 | 44 |
| | 12 - 19 years | 1.82 | 22.4 | 41 | 1.58 | 11.8 | 19 | 59 |
| | 20 + years | 1.82 | 19.3 | 35 | 1.58 | 14.1 | 22 | 57 |

Eq A3-4:
$$Intake_{soil} = IR_{soil} * C_{soil} * Bio_{soil}$$

| | | | |
|--------|-----------------|---|-------------------|
| Where: | $Intake_{soil}$ | = Intake from soil | $\mu\text{g/day}$ |
| | IR_{soil} | = Soil ingestion rate | g/day |
| | C_{soil} | = Metal concentration in soil | $\mu\text{g/g}$ |
| | Bio_{soil} | = % of metal release from soil in stomach | unitless |

The soil ingestion rates for each of the receptor age groups are listed in Table 4-3 of the main report. The highest reported level of each metal in the soil from the Rodney Street community was used to estimate the daily ingestion of metal from soil. The Bio_{soil} parameter is a measure of the amount of metal that is released from the soil under the acidic conditions of the stomach. This represents the amount of metal that is considered to be bio-accessible, or available to the gut for uptake, from the soil. The amount of each metal released from the soil in the stomach has been estimated using a simulated stomach acid leach test. The test methodology is discussed in detail in Appendix 5. The results of the stomach acid leach test for each metal are also provided in Appendix 5. For each metal, the maximum reported result was used to estimate the amount of metal that would be bio-accessible. This was used to estimate the effective daily intake for each metal from soil. The estimated daily intake of each metal from the soil is shown in Table A3-8.

A3-1.6 Intake of Metals Through Dermal Contact with Soil

Daily contact with metals through soil present on the skin represents a potential route of exposure. However, the insoluble nature of most metals in soil limits their bio-accessability for uptake into and through the skin. Where data is available, it shows that dermal uptake of metals is low (Paustenbach, 2000). The rate at which a metal is taken up into the outer layers of the skin is referred to as the *dermal uptake coefficient* (DUC). For the purposes of the current exposure assessment, the dermal uptake coefficients have been used to represent the amount of metal delivered to the skin surface from the soil that would be accessible for uptake. This is considered to be the *delivered dose* and is has been considered to be equivalent to the dermal intake. A detailed discussion of the derivation of the DUC values for each of the metals in provided in Appendix 7. The delivered dose, is calculated as shown in equation A3-6. These values have been used in conjunction with the estimates of intake from other sources to provide an estimate of the total daily dose for each age group for each metal (Table A3-9).

Eq A3-6:
$$Intake_{derm} = A_{soil} * C_{soil} * DUC_{soil}$$

Where: $\text{Intake}_{\text{derm}}$ = Dermal Intake from soil $\mu\text{g/day}$
 A_{soil} = Soil adhesion to skin g/day
 C_{soil} = Metal concentration soil $\mu\text{g/g}$
 DUC_{soil} = Dermal uptake coefficient unitless

Table A3-8: Estimated Metal Intakes from Soil

| Metal | Receptor | C_{soil} ($\mu\text{g/g}$) | IR_{soil} (g/day) | Bio_{soil} | Total ($\mu\text{g/day}$) |
|-----------|-------------------|---------------------------------------|--|----------------------------|-----------------------------|
| Antimony | 0- 6 months | 91.1 | 0.035 | 0.0019 | 0.0062 |
| | 7 months - 4years | 91.1 | 0.080 | 0.0019 | 0.014 |
| | 5 - 11 years | 91.1 | 0.080 | 0.0019 | 0.014 |
| | 12 - 19 years | 91.1 | 0.020 | 0.0019 | 0.0035 |
| | 20 + years | 91.1 | 0.020 | 0.0019 | 0.0035 |
| Beryllium | 0- 6 months | 4.56 | 0.035 | 0.0019 | 0.00030 |
| | 7 months - 4years | 4.56 | 0.080 | 0.0019 | 0.00069 |
| | 5 - 11 years | 4.56 | 0.080 | 0.0019 | 0.00069 |
| | 12 - 19 years | 4.56 | 0.020 | 0.0019 | 0.00017 |
| | 20 + years | 4.56 | 0.020 | 0.0019 | 0.00017 |
| Cadmium | 0- 6 months | 35.3 | 0.035 | 0.0019 | 0.0023 |
| | 7 months - 4years | 35.3 | 0.080 | 0.0019 | 0.0054 |
| | 5 - 11 years | 35.3 | 0.080 | 0.0019 | 0.0054 |
| | 12 - 19 years | 35.3 | 0.020 | 0.0019 | 0.0013 |
| | 20 + years | 35.3 | 0.020 | 0.0019 | 0.0013 |
| Cobalt | 0- 6 months | 262 | 0.035 | 0.0123 | 0.11 |
| | 7 months - 4years | 262 | 0.080 | 0.0123 | 0.26 |
| | 5 - 11 years | 262 | 0.080 | 0.0123 | 0.26 |
| | 12 - 19 years | 262 | 0.020 | 0.0123 | 0.064 |
| | 20 + years | 262 | 0.020 | 0.0123 | 0.064 |
| Copper | 0- 6 months | 2720 | 0.035 | 0.0222 | 2.1 |
| | 7 months - 4years | 2720 | 0.080 | 0.0222 | 4.8 |
| | 5 - 11 years | 2720 | 0.080 | 0.0222 | 4.8 |
| | 12 - 19 years | 2720 | 0.020 | 0.0222 | 1.2 |
| | 20 + years | 2720 | 0.020 | 0.0222 | 1.2 |
| Nickel | 0- 6 months | 17000 | 0.035 | 0.0116 | 6.9 |
| | 7 months - 4years | 17000 | 0.080 | 0.0116 | 16 |
| | 5 - 11 years | 17000 | 0.080 | 0.0116 | 16 |
| | 12 - 19 years | 17000 | 0.020 | 0.0116 | 3.9 |
| | 20 + years | 17000 | 0.020 | 0.0116 | 3.9 |

Table A3-9: Estimated Metal Intakes from Dermal Contact with Soil

| Metal | Receptor | C_{soil} ($\mu\text{g/g}$) | A_{soil} (g/day) | DUC_{soil} | $Intake_{derm}$ ($\mu\text{g/day}$) |
|-----------|-------------------|--------------------------------|--------------------|--------------|---------------------------------------|
| Antimony | 0- 6 months | 91.1 | 2.2 | 0.00190 | 0.38 |
| | 7 months - 4years | 91.1 | 3.5 | 0.00190 | 0.61 |
| | 5 - 11 years | 91.1 | 5.8 | 0.00190 | 1.0 |
| | 12 - 19 years | 91.1 | 9.1 | 0.00190 | 1.6 |
| | 20 + years | 91.1 | 8.7 | 0.00190 | 1.5 |
| Beryllium | 0- 6 months | 4.56 | 2.2 | 0.00190 | 0.019 |
| | 7 months - 4years | 4.56 | 3.5 | 0.00190 | 0.030 |
| | 5 - 11 years | 4.56 | 5.8 | 0.00190 | 0.050 |
| | 12 - 19 years | 4.56 | 9.1 | 0.00190 | 0.079 |
| | 20 + years | 4.56 | 8.7 | 0.00190 | 0.075 |
| Cadmium | 0- 6 months | 35.3 | 2.2 | 0.00190 | 0.15 |
| | 7 months - 4years | 35.3 | 3.5 | 0.00190 | 0.23 |
| | 5 - 11 years | 35.3 | 5.8 | 0.00190 | 0.39 |
| | 12 - 19 years | 35.3 | 9.1 | 0.00190 | 0.61 |
| | 20 + years | 35.3 | 8.7 | 0.00190 | 0.58 |
| Cobalt | 0- 6 months | 262 | 2.2 | 0.0004 | 0.23 |
| | 7 months - 4years | 262 | 3.5 | 0.0004 | 0.37 |
| | 5 - 11 years | 262 | 5.8 | 0.0004 | 0.61 |
| | 12 - 19 years | 262 | 9.1 | 0.0004 | 0.95 |
| | 20 + years | 262 | 8.7 | 0.0004 | 0.91 |
| Copper | 0- 6 months | 2720 | 2.2 | 0.02200 | 132 |
| | 7 months - 4years | 2720 | 3.5 | 0.02200 | 209 |
| | 5 - 11 years | 2720 | 5.8 | 0.02200 | 347 |
| | 12 - 19 years | 2720 | 9.1 | 0.02200 | 545 |
| | 20 + years | 2720 | 8.7 | 0.02200 | 521 |
| Nickel | 0- 6 months | 17000 | 2.2 | 0.000380 | 14 |
| | 7 months - 4years | 17000 | 3.5 | 0.000380 | 23 |
| | 5 - 11 years | 17000 | 5.8 | 0.000380 | 37 |
| | 12 - 19 years | 17000 | 9.1 | 0.000380 | 59 |
| | 20 + years | 17000 | 8.7 | 0.000380 | 56 |

A3-2 Summary

For each receptor age group daily metal intakes have been estimated for each of the pathways of concern. For each metal, intakes from all exposure pathways must be combined for each receptor in order to estimate the total daily dose received by each receptor age group. This summation of exposures is presented in Section 4.4 of the Human Health Risk Assessment main report (Part B).

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APPENDIX 4

**Estimating Daily Intakes of Metals from
Supermarket Food**

Estimating Metal Intakes from Supermarket Food

Estimates of the dietary intakes of metals from supermarket food by the general Canadian population are limited. Daily dietary intake estimates for arsenic, cadmium, copper and nickel have been published by CEPA (Health Canada and Environment Canada) and CCME (see Table A4-1). Sources of similar estimates for cobalt and lead are listed in Table A4-1. Information on dietary intakes for all age groups is not available for all metals. For example, information on dietary intakes of antimony and beryllium are limited to single estimates of daily intake by the general population (FSA, 1997, Vaessen and Szteke, 2000).

A4-1 Estimating Dietary Intakes of Metals for All Age Groups

The lack of dietary intakes for all age groups used in this assessment required that intake estimates be derived from available information. The shaded areas in Table A4-1 indicate where such derivations have been necessary.

Table A4-1: Estimated Daily Intakes of Metals from Supermarket Food

| Receptor | Daily Intakes of Metals from Supermarket Food ($\mu\text{g}/\text{day}$) | | | | | |
|-----------|--|------------------------|-------------|-------------------------|------------|-------------|
| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
| Infant | 1.3 | 4.8 | 5.08 | 4.18 | 518 | 180 |
| Toddler | 2.3 | 8.6 | 10.6 | 7.0 | 822 | 264 |
| Child | 3.5 | 13.2 | 16.8 | 10.0 | 1230 | 329 |
| Teen | 4.0 | 15 | 17.3 | 12.0 | 1520 | 340 |
| Adult | 3.4 | 12.7 | 14.8 | 10.5 | 1430 | 311 |
| Reference | FSA, 1997 | Vaessen & Szteke, 2000 | CEPA, 1994a | Dabeka & McKensie, 1995 | CCME, 1997 | CEPA, 1994b |

Shaded cells represent calculated values (see text for explanations)

CEPA and CCME provide daily dietary intake estimates for arsenic, cadmium, copper and nickel for all age groups. The age groups examined by Dabeka and McKensie (1995) differ slightly from those used by CEPA and CCME. Dabeka and McKensie (1995) do not report intakes for children age 0 - 1 year, and their toddler age group includes children aged 1 - 4 years rather than the 7 months to 4 years used by Health Canada and CCME. Dabeka and McKensie (1995), Health Canada and CCME use the same age groupings for children (5 - 11 years), teens (12 - 19 years) and adults (20+ years). For the purposes of this assessment the intake estimates provided by Dabeka and McKensie (1995) for cobalt for toddlers, have been applied to the toddler (7 months - 4 years) used in this assessment. The cobalt intakes for infants, shown in Table A4-1 have been estimated based on the intakes reported for toddlers. The ratios were determined by averaging the ratios of infant and toddler intakes for arsenic, cadmium, copper and nickel as shown in equation A4-1. The estimated intakes for cobalt were derived by correcting the toddler intakes for cobalt (Table A4-1).

Eq A4-1:
$$C_I = \left[\frac{\left(\frac{I_{As}}{T_{As}} \right) + \left(\frac{I_{Cd}}{T_{Cd}} \right) + \left(\frac{I_{Cu}}{T_{Cu}} \right) + \left(\frac{I_{Ni}}{T_{Ni}} \right)}{4} \right] = 0.598$$

Where: C_I = Correction factor for infant intake
 I_x = Infant intake for arsenic, cadmium, copper, and nickel
 T_x = Toddler intake for arsenic, cadmium, copper, and nickel

A4-2 Additional Information on Dietary Intakes for Antimony, Beryllium and Nickel

Dietary intake information for antimony and beryllium is limited to a single, general population estimate for each (FSA, 1997; Vaessen and Szteke, 2000). In order to develop likely total daily intakes from supermarket foods for all age groups of concern in this assessment, the single values have been used as a basis for estimating intakes in all age groups. A ratio process similar to the one outlined in Equation A4-1 was used. The estimated daily intakes of antimony and beryllium are 4 µg/day (FSA, 1997) and 15 µg/day (Vaessen and Szteke, 2000), respectively. A review of intake data for the other metals shows that the highest daily intakes of metals occurs in the “teen” age group for all metals considered (See Table A4-1). Therefore, the values reported for antimony and beryllium were assigned to this age group. Ratios for metal intakes between the teen age group and the other age groups were developed for arsenic, cadmium, cobalt and lead. The average of these values for each of the age groups was used to generate the intake estimates for antimony and beryllium for each of the age groups. The derivation of the ratios is shown in Table A4-2.

Table A4-2: Dietary Intake Ratios for different Age groups for Arsenic, Cadmium, Cobalt and Lead.

| Receptor | Daily Intakes of Metals from Supermarket Food (µg/day) | | | | | | | | Averaging Ratio |
|----------|--|-------|---------|-------|--------|-------|--------|-------|-----------------|
| | Arsenic | | Cadmium | | Cobalt | | Lead | | |
| | Intake | Ratio | Intake | Ratio | Intake | Ratio | Intake | Ratio | |
| Infant | 19.70 | 0.28 | 5.08 | 0.29 | 4.18 | 0.35 | 8.97 | 0.37 | 0.32 |
| Toddler | 33.00 | 0.46 | 10.60 | 0.61 | 7.00 | 0.58 | 15.00 | 0.63 | 0.57 |
| Child | 62.50 | 0.87 | 16.80 | 0.97 | 10.00 | 0.83 | 20.00 | 0.83 | 0.88 |
| Teen | 71.60 | 1.00 | 17.30 | 1.00 | 12.00 | 1.00 | 24.00 | 1.00 | 1.00 |
| Adult | 42.40 | 0.59 | 14.80 | 0.86 | 10.50 | 0.88 | 25.70 | 1.07 | 0.85 |

Because nickel and copper can be added during food processing operations, it was felt that the levels of these metals would not provide a true reflection of trace metal levels in foods. Therefore nickel and copper were not considered in the development of the ratios used to estimate the daily intakes of the trace metals antimony and beryllium.

A4-2.1 Antimony

There is very limited data on dietary intakes of antimony in general/supermarket food. ATSDR (1990) estimated that the antimony concentration in the diet of a typical adult male was 9.3 $\mu\text{g}/\text{kg}$ dry weight. The WHO used the information cited by the ATSDR to develop an estimate of the daily intake of antimony from food of 18 $\mu\text{g}/\text{day}$ (WHO, 1996). Two studies that post-date the work cited by ATSDR and the WHO have also examined dietary intakes of antimony (FSA, 1997 and Miahara *et al.*, 1998). Miahara *et al.* examined antimony intakes in preschool children and the elderly in Brazil. Estimates of dietary intake ranged between 1.1 $\mu\text{g}/\text{day}$ and 2.3 $\mu\text{g}/\text{day}$. The Food Standards Agency in Great Britain estimated dietary intakes of antimony in the British population. The study found a mean daily intake of 3 $\mu\text{g}/\text{day}$ with a 97.5 percentile estimate of 4 $\mu\text{g}/\text{day}$. The study further noted that these values are approximately 10-fold lower than the previous estimate of 29 $\mu\text{g}/\text{day}$ that was based on a 1976 survey. The difference was attributed to a significant lowering of analytical detection limits between the time of the two studies (FSA, 1997). Although the WHO suggested a daily intake of 18 $\mu\text{g}/\text{day}$ in 1996, this value was based on estimates developed before changes in analytical techniques allowed for better estimates of antimony levels in foods. As a result, the WHO value is likely to over estimate daily dietary intakes of antimony. For the purposes of this assessment, the upper estimate of 4 $\mu\text{g}/\text{day}$ suggested by the FSA has been used to estimate dietary intakes of antimony for the residents of Rodney Street in Port Colborne. The upper FSA estimate (4 $\mu\text{g}/\text{day}$) was assumed to be a lifetime daily intake for a typical Rodney Street teen and was prorated to average estimates of supermarket food intake for other age classes as shown in Table A4-3.

A4-2.2 Beryllium

Information on the dietary exposure to beryllium is limited. Recently, a review of the worldwide literature on the occurrence of beryllium in food and drinking water and estimates of daily dietary exposure was sponsored by the Food Chemistry Commission of the International Union for Pure and Applied Chemistry (IUPAC)(Vaessen and Szeke, 2000). Beryllium levels in food were found to range from <1 to approximately 20 $\mu\text{g}/\text{kg}$ fresh weight. In the US, the average beryllium concentration in drinking water is 0.2 $\mu\text{g}/\text{L}$. Estimates of beryllium intake from food consumption for the UK and the US ranged from 12 to 15 $\mu\text{g}/\text{day}$, however, these food intakes were considered to be rough estimates. The 15 $\mu\text{g}/\text{day}$ estimate was assumed to be a lifetime daily intake for a typical Rodney Street teen and was prorated to average estimates of supermarket food intake for other age classes as shown in Table A4-3.

Table A4-3: Sample Calculation of Estimated Dietary Intakes for Each Age Class using Averaging Ratios.

| Receptor | Averaging Ratio | Daily Intakes of Metals from Supermarket Food ($\mu\text{g}/\text{day}$) | | | |
|----------|-----------------|--|------------|-----------|------------|
| | | Antimony | | Beryllium | |
| | | Reported | Calculated | Reported | Calculated |
| Infant | 0.3227 | | 1.3 | | 4.8 |
| Toddler | 0.5705 | | 2.3 | | 8.6 |
| Child | 0.8777 | | 3.5 | | 13.2 |
| Teen | 1.0000 | 4.0 | 4.0 | 15.0 | 15.0 |
| Adult | 0.8484 | | 3.4 | | 12.7 |

A4-2.3 Nickel

Interpreting information from dietary intake studies requires assessing a whole range of information from levels of nickel in specific food items to how this information is integrated into overall population intakes by age class and averages and percentiles for each age class. Some agencies report just average intakes for the adult population, others indicate upper ranges of intake, as well, and sometimes just a range of intakes is reported. Consequently, the full range of intakes reported by various agencies is tabulated in Table A4-4.

Several studies have attempted to estimate the daily intake of nickel from supermarket or processed food in the Canadian and North American populations. Based on the US Food and Drug Administration's Total Diet Study of 1984, the mean nickel consumption of infants and young children was 69 to 90 $\mu\text{g}/\text{day}$ (Pennington and Jones, 1987). Average daily dietary intake of nickel in the US has been reported as 168 $\mu\text{g}/\text{day}$ (Myron et al., 1978; cited in ATSDR, 1997). A more recent review of dietary intake has included nickel intakes from dietary supplements and estimates that adults consume 76 to 105 $\mu\text{g}/\text{day}$ of nickel from diet and supplements (IOM, 2001). The US dietary intake data formatted to match the Canadian age class groups is shown in Table A4-4.

A 1984 market basket survey of dietary nickel intake in England determined an intake of 154-166 $\mu\text{g}/\text{day}$ (Smart and Sherlock, 1987). More recently, the results of the 1997 UK Total Diet Study were published (Ysart et al., 2000). The average dietary exposure for UK adults was 120 $\mu\text{g}/\text{day}$ and the 97.5th percentile was 210 $\mu\text{g}/\text{day}$, similar to their 1994 survey. This information was prorated to Canadian age class intervals using the averaging ratios in Table A4-3 is shown in Table A4-4.

CEPA, provides estimates of daily nickel intakes from food for the general Canadian population (CEPA, 1994b). These estimates are based on a survey of nickel concentrations in various foods conducted by National Health and Welfare, 1992 and estimates of age-specific food intakes derived from a Nutrition Canada, Environmental Health Directorate survey (CEPA, 1994c). More detailed information on dietary intakes of nickel by Canadians was reported in Dabeka and McKensie (1995). The Canadian dietary intake of nickel for all ages, male and female, is 286 $\mu\text{g}/\text{day}$

(Dabeka and McKensie (1995). It is not indicated whether the Canadian dietary intakes are averages or some upper range, however, inspection of the tables of nickel levels in various food categories indicates that the reported Canadian dietary intakes are average values.

Inspection of Table A4-4 shows that Canadian dietary nickel intakes are higher than US and UK estimates. Dabeka and McKensie (1995) comment on this situation and indicate that the highest nickel intakes were for meat and poultry (about 40%), bakery goods and cereals (about 19%), soups (about 15%) and vegetables (about 11%). These data are felt to provide the best representation of likely nickel intakes from food for the Canadian population as a whole. Therefore these values have been used to represent the intake of nickel from non-home grown food sources for the residents of Rodney Street (Table A4-1).

Table A4-4: Estimated Daily Dietary Intake of Nickel for Various Countries

| Medium | Daily Intake 0 - 6 mon (µg/day) | Daily Intake 1 - 4 yr (µg/day) | Daily Intake 5-11yr (µg/day) | Daily Intake 12-19 yr (µg/day) | Daily Intake Adult (µg/day) |
|--|---------------------------------------|--------------------------------------|------------------------------------|--------------------------------------|-----------------------------------|
| CEPA, 1994b | 154 | 208 | 270 | 325 | 308 |
| Dabeka and McKensie, 1995 | (80) | 190 | 251 | 313 | 304 |
| US FDA Total Dietary Study (95 th %ile) (IOM, 2001) | 9(37) | 81(153) | 107(199) | 125(250) | 119(233) |
| UK Total Dietary Study 1997 (97.5 th %ile) (Ysart et al, 2000) | 39(68) | 68(120) | 105(184) | 120(210) | 102(178) |

A4 References:

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APPENDIX 5

Simulated Stomach Acid Leach Tests

Simulated Stomach Acid Leach Tests

The metals of concern in the Rodney Street area of Port Colborne are generally tightly bound to soil particles and are present in forms that either have limited solubility in water or are largely insoluble. However, the solubility of these metals increases under acidic conditions. When ingested, metals that are insoluble in water at neutral pH (6.0 - 8.0) can be solubilized and removed from soil particles in the acidic environment of the stomach. The metals released from the soil in the stomach become available for uptake by the gut. Ingested metals that remain bound to soil particles in the gut are not available for absorption and are excreted in the feces. Elimination in the feces is the primary route of excretion following ingestion for each of the metals of concern. The elimination of ingested metals is discussed in the toxicological profile for each metal (Appendix 2).

The oral exposure limits identified for all of the metals of concern, except lead, are based on experimental animal data where metals were administered in soluble forms. Thus, the reported doses are based on free or soluble metal levels administered. Under the conditions that exist in the Rodney Street area of Port Colborne, metals ingested with soil will largely be present as insoluble forms, are not available in the gut, and do not form a component of the administered dose that is available for uptake. Thus, this component of the dose should not be considered in the estimation of exposure. The metals that are released from the soil particles during acid digestion in the stomach can be considered to be equivalent to the soluble forms of metals administered during toxicological testing. The inclusion of all ingested metal in the assessment of exposure will over represent the amount of metal actually available in the gut. The current assessment has attempted to account for this discrepancy by determining the amount of metal that could be released from soil particles in the acidic environment of the stomach, by subjecting the soil to a simulated stomach acid digest. The amount of each metal released from the soil particles (leached) was used to represent the amount of metal that was bio-accessible (the effective amount of metal ingested). These values were used to determine metal ingestion levels from soil as part of the exposure assessment.

Ten soil samples from the Rodney Street area, containing very high levels of nickel were selected for simulated stomach acid leach testing. For each soil sample, 20 g of dried, sieved material was added to 400 ml of 0.17 N HCl (pH 1.0). The samples were agitated for 24 hours on a rotary extractor. The mixture was then filtered through a 4.5 micron filter and the filtrate was analyzed for metals and hydrides. For each sample, the percentage leached was calculated by dividing the concentration of the metal in the leachate by the concentration in the original soil sample and the multiplying the ration by 100. The results of the analyses are shown in Tables A5-1 through A5-8. The maximum reported leached value was used to represent the amount of each metal that would be released from the soil in the stomach and would be available to contribute to actual exposures.

It is recognized that the use of a 24 hour digestion period, which is longer than the typical residency times for food in the stomach, will overestimate the amount of metal that will be released and available. However, it was believed that as a precautionary measure, the potential overestimation of exposures was justified.

Table A5-1: Simulated Stomach Acid Leachate Test: Antimony

| Level in Soil (ppm) ¹ | Amount Leached (ppm) | % Leached |
|----------------------------------|----------------------|-----------|
| 2.454 | 0.004 | 0.16 |
| 1.818 | 0.0035 | 0.19 |
| 2.096 | 0.0033 | 0.16 |
| 2.334 | 0.0033 | 0.14 |
| 2.826 | 0.0036 | 0.13 |
| 2.524 | 0.003 | 0.12 |
| 2.2111 | 0.0033 | 0.15 |
| 2.011 | 0.0026 | 0.13 |
| 2.416 | 0.0025 | 0.10 |
| 2.052 | 0.0023 | 0.11 |
| Averaged Values | | |
| 2.2772 | 0.00314 | 0.14 |
| Minimum % Leached | | 0.10 |
| Maximum % Leached | | 0.19 |

1: ppm is equivalent to $\mu\text{g/g}$ in soil and $\mu\text{g/ml}$ in leachate

Table A5-2: Simulated Stomach Acid Leachate Test: Arsenic

| Level in Soil (ppm) ¹ | Amount Leached (ppm) | % Leached |
|----------------------------------|----------------------|-----------|
| 52.0 | 0.704 | 1.35 |
| 39.1 | 0.556 | 1.42 |
| 45.0 | 0.576 | 1.28 |
| 50.2 | 0.689 | 1.37 |
| 63.1 | 0.396 | 0.628 |
| 44.8 | 0.386 | 0.860 |
| 43.1 | 0.430 | 0.998 |
| 42.2 | 0.526 | 1.24 |
| 62.3 | 0.544 | 0.872 |
| 37.6 | 0.514 | 1.36 |
| Averaged Values | | |
| 48.0 | 0.532 | 1.14 |
| Minimum % Leached | | 0.623 |
| Maximum % Leached | | 1.42 |

1: ppm is equivalent to $\mu\text{g/g}$ in soil and $\mu\text{g/ml}$ in leachate

Table A5-3: Simulated Stomach Acid Leachate Test: Beryllium

| Level in Soil (ppm) ¹ | Amount Leached (ppm) | % Leached |
|----------------------------------|------------------------|-------------------|
| | Below Detection Limits | |
| Averaged Values | | |
| | | |
| Minimum % Leached | | |
| Maximum % Leached | | 0.19 ² |

1: ppm is equivalent to µg/g in soil and µg/ml in leachate
 2: substitute value, see text

Table A5-4: Simulated Stomach Acid Leachate Test: Cadmium

| Level in Soil (ppm) ¹ | Amount Leached (ppm) | % Leached |
|----------------------------------|------------------------|-------------------|
| | Below Detection Limits | |
| Averaged Values | | |
| | | |
| Minimum % Leached | | |
| Maximum % Leached | | 0.19 ² |

1: ppm is equivalent to µg/g in soil and µg/ml in leachate
 2: substitute value, see text

Beryllium and cadmium levels in leachate were below detection limits. Therefore the lowest soil leaching value (0.19%) reported for antimony was used to provide estimates of the amount of beryllium and cadmium leached for soil by stomach acid. This approach will provide conservative estimates of the amount of beryllium and cadmium that are bio-accessible.

Table A5-5: Simulated Stomach Acid Leachate Test: Cobalt

| Level in Soil (ppm) ¹ | Amount Leached (ppm) | % Leached |
|----------------------------------|----------------------|-----------|
| 200 | 1.96 | 0.98 |
| 180 | 1.66 | 0.92 |
| 130 | 1.17 | 0.90 |
| 140 | 1.23 | 0.88 |
| 210 | 2.35 | 1.1 |
| 160 | 1.71 | 1.1 |
| 220 | 1.69 | 0.77 |
| 150 | 1.85 | 1.2 |
| 230 | 1.44 | 0.63 |
| 120 | 1.29 | 1.1 |
| Averaged Values | | |
| 174 | 1.64 | 0.96 |
| Minimum % Leached | | 0.63 |
| Maximum % Leached | | 1.2 |

1: ppm is equivalent to µg/g in soil and µg/ml in leachate

Table A5-6: Simulated Stomach Acid Leachate Test: Copper

| Level in Soil (ppm) ¹ | Amount Leached (ppm) | % Leached |
|----------------------------------|----------------------|-----------|
| 990 | 17.2 | 1.7 |
| 770 | 17.1 | 2.2 |
| 1000 | 19.1 | 1.9 |
| 780 | 14.2 | 1.8 |
| 1000 | 15.9 | 1.6 |
| 840 | 14.7 | 1.8 |
| 1000 | 20.5 | 2.1 |
| 980 | 20.7 | 2.1 |
| 970 | 16.1 | 1.7 |
| 640 | 14.0 | 2.2 |
| Averaged Values | | |
| 897 | 16.9 | 1.9 |
| Minimum % Leached | | 1.6 |
| Maximum % Leached | | 2.2 |

1: ppm is equivalent to µg/g in soil and µg/ml in leachate

Table A5-7: Simulated Stomach Acid Leachate Test: Lead

| Level in Soil (ppm) ¹ | Amount Leached (ppm) | % Leached |
|----------------------------------|----------------------|-----------|
| 400 | 15.6 | 3.9 |
| 480 | 21.1 | 4.4 |
| 350 | 12.8 | 3.7 |
| 310 | 11.1 | 3.6 |
| 400 | 13.3 | 3.3 |
| 370 | 14.4 | 3.9 |
| 300 | 9.17 | 3.1 |
| 350 | 11.4 | 3.3 |
| 360 | 15.4 | 4.3 |
| 290 | 13.1 | 4.5 |
| Averaged Values | | |
| 361 | 13.7 | 3.8 |
| Minimum % Leached | | 3.1 |
| Maximum % Leached | | 4.5 |

1: ppm is equivalent to µg/g in soil and µg/ml in leachate

Table A5-8: Simulated Stomach Acid Leachate Test: Nickel

| Level in Soil (ppm)¹ | Amount Leached (ppm) | % Leached |
|--|-----------------------------|------------------|
| 8800 | 86.2 | 0.98 |
| 9200 | 107 | 1.16 |
| 11000 | 93 | 0.85 |
| 11000 | 87.9 | 0.8 |
| 12000 | 88.5 | 0.74 |
| 13000 | 96.9 | 0.75 |
| 14000 | 127 | 0.91 |
| 14000 | 115 | 0.82 |
| 16000 | 104 | 0.65 |
| 17000 | 99.9 | 0.59 |
| Average | | |
| 12600 | 100.54 | 0.82 |
| Minimum % Leached | | 0.59 |
| Maximum % Leached | | 1.16 |

1: ppm is equivalent to $\mu\text{g/g}$ in soil and $\mu\text{g/ml}$ in leachate

APPENDIX 6

**Estimating Backyard Vegetable Consumption
for the
Rodney Street Community**

Estimating Backyard Garden Vegetable Consumption for Rodney Street

The assessment of potential health risks for people living in the homes on Rodney Street, Port Colborne considers exposures to the metals of concern from all relevant pathways. Eating vegetables grown in backyards where metal levels are above typical levels, represents a potential exposure pathway if the metals present in the soil are taken up into the vegetables. The exposures received by people eating such produce depends upon the concentration of the metals in the vegetables and the amount of vegetables consumed from backyard gardens on an annual basis. Specific data on backyard garden vegetable consumption patterns for the homes on Rodney Street are not available. Therefore it was necessary to estimate likely consumption rates based on studies conducted in other communities in Ontario (MOE, 1995). As part of the on-going work in Port Colborne, samples of backyard produce have been collected by the MOE and Jacques Whitford Environmental Limited (JWEL) from Rodney and Mitchell Streets. The levels of individual metals in the various types of produce tested are provided in Appendix 1 of this report.

The amounts and types of produce that people might consume from a backyard garden are affected by the size of the garden, the preferences of individuals for the types of crops grown and the yields achieved. In previous risk assessments in other communities, the MOE developed an estimate of backyard garden crop yield of 1.4 kg/m² for mixed produce (MOE, 1995). An assumed garden size of 30 m² was used to provide an estimated total annual yield of 42 kg of produce. These assumptions have been used to estimate backyard garden produce consumption for people living on Rodney Street.

Estimates of the daily vegetable consumption, based on Nutrition Canada surveys of the Canadian population (O'Connor, 1997) have been used to estimate the total daily and annual levels of vegetable consumption for people living on Rodney Street. Backyard fruit production does not appear to be significant at Rodney Street homes. Further, the collection of produce from these homes did not include fruit. Although data was collected from tomatoes and green peppers, these are generally considered to be vegetables and were considered as such by the Nutrition Canada survey studies. Further, fruit consumption surveys in the Canadian population include many items, such as citrus fruit and bananas that would not grow in Port Colborne. Therefore, it was believed that using a fruit category would not be representative of backyard garden produce consumption for the homes on Rodney Street. Daily consumption rates of root and other vegetables for all age groups are shown in Table A6-1.

In assessing exposures from the consumption of backyard garden produce, it has been assumed that backyard garden vegetables constitute a portion of the daily intake of vegetables every day of the year. In determining the contribution that the consumption of backyard garden vegetables makes to the annual total, it has been necessary to estimate the total annual consumption of vegetables in a typical household on Rodney Street. This assessment has assumed that a typical family consists of two adults and two children. The children were further assumed to be between 5 and 11 years of age. Based on these assumptions the total annual intake of vegetables and the contribution from backyard garden produce can be calculated as shown in Table A6-2.

To estimate daily consumption rates for backyard garden vegetables, the vegetable consumption rates listed in Table A6-1 are adjusted by the fraction that is attributable to backyard gardens. Estimates of daily backyard garden vegetable consumption are shown in Table A6-3. These values have been used to estimate metal intakes from backyard produce for the people living on Rodney Street.

Table A6-1: Daily Vegetable Consumption Rates for the Canadian Population¹

| | Vegetable Consumption Rates (g/day) | | | | |
|---|-------------------------------------|------------------------|-----------------------|----------------------|--------------------|
| | Infant (0 - 6 mo.) | Toddler (7 mo-4 yr) | Child (5 - 11 yr.) | Teen (12 - 19 yr) | Adult (20+ yr.) |
| Root Vegetables | 83 | 105 | 161 | 227 | 188 |
| Other Vegetables | 72 | 67 | 98 | 120 | 137 |
| Total Daily Consumption | 155 | 172 | 259 | 347 | 325 |
| Root as a % of Total Daily Consumption | 54% | 61% | 62% | 65% | 58% |
| Other as a % of Total Daily Consumption | 46% | 39% | 38% | 35% | 42% |

1. from O'Connor, 1997.

Table A6-2: Estimation of Backyard Vegetable Contribution to Total Vegetable Consumption

| Receptor | Daily Consumption (g/day) | Number | Total Daily Consumption (g/day) | Days/year | Total Annual Consumption | |
|--|------------------------------|--------|------------------------------------|-----------|--------------------------|---------|
| | | | | | g/year | kg/year |
| Adult | 325 | 2 | 650 | 365 | 237,250 | 237 |
| Child | 259 | 2 | 518 | 365 | 189,070 | 189 |
| Annual Family Consumption of Vegetables | | | | | 426,320 | 426 |
| Annual Vegetable Yield from Backyard Garden ¹ | | | | | 42,000 | 42 |
| % of Annual Vegetable Consumption that comes from Backyard Gardens | | | | | 9.85% | 9.85% |

1. from MOE, 1995.

Table A6-3: Estimated Daily Consumption of Backyard Garden Produce for all Age Groups

| | Vegetable Consumption Rates (g/day) | | | | |
|--|-------------------------------------|------------------------|-----------------------|----------------------|--------------------|
| | Infant (0 - 6 mo.) | Toddler (7 mo-4 yr) | Child (5 - 11 yr.) | Teen (12 - 19 yr) | Adult (20+ yr.) |
| Total Daily Consumption of Root Vegetables | 83 | 105 | 161 | 227 | 188 |
| Total Daily Consumption of Other Vegetables | 72 | 67 | 98 | 120 | 137 |
| % Consumed as Backyard Garden Produce | 9.9% | 9.9% | 9.9% | 9.9% | 9.9% |
| Daily Consumption of Backyard Root Vegetables | 8.18 | 10.34 | 15.86 | 22.36 | 18.52 |
| Daily Consumption of Other Backyard Vegetables | 7.09 | 6.60 | 9.65 | 11.82 | 13.49 |

A6 References:

Jacques Whitford Environmental Limited (JWEL). 2000. Document in preparation.

MOE. 1995. Health risk assessment of mercury contamination in the vicinity of ICI Forest Products Cornwall, Ontario. Ontario Ministry of Environment and Energy. May 1995. PIBS 3352.

O'Connor. 1997. Compendium of Canadian Human Exposure Factors for Risk Assessment. O'Connor Associates Environmental Inc. and G.M. Richardson. Ottawa, Ontario, Canada.

APPENDIX 7

Dermal Uptake Coefficients for Metals

dose in occluded skin over a 93 hour testing period. The study further showed that the level of absorption was dependent on the carrier vehicle used, and that the dermal absorption of dissolved nickel was greater than that of undissolved or crystalline nickel (Fullerton *et al.*, 1992). Analysis of nickel levels in the stratum corneum, epidermal and dermal layers of skin also showed that the outer stratum corneum layer held the highest levels of nickel. The study also found that little nickel was able to penetrate through all layers of the skin to the underlying tissue (Fullerton *et al.*, 1992). The authors suggest that this layer of the skin may act as a reservoir for nickel that could allow nickel to move into other tissue and that as the level of nickel increases in this layer, subsequent exposures would allow greater amounts of nickel to move through the skin (Fullerton *et al.*, 1992).

It should be stressed that the work of Fullerton *et al.*, in 1992 was conducted with occluded skin. This is not representative of dermal contact with soil where exposures would not be expected to last for more than 24 hours. Further, Hostynek *et al.* note that occlusion increases skin penetration ten-fold over unoccluded conditions. The authors further note that sweat contains significantly higher levels of nickel than normal blood serum and that it is a significant excretory pathway for the metal (Hostynek *et al.* 1993). Thus, it would appear that dermal absorption of nickel from soil is likely to be very limited and that much of what is absorbed into the outer layers of the skin is likely to be lost from the skin due either to removal in sweat or through the normal loss of outer skin cells from the stratum corneum.

The study using unoccluded skin most closely resembles the dermal exposures to nickel in soil that could be expected in the Rodney Street community. Therefore, the absorption factor of 0.23%, reported by Fullerton, *et al.*, 1986 was used to develop a dermal uptake coefficient for nickel in Port Colborne.

As noted above, Fullerton *et al.*, 1986 reported that 0.23% (0.0023) of an applied dose of nickel chloride was absorbed over a period of 144 hours. However, bathing activities can be expected to limit skin contact with nickel bearing soil to a maximum of 24 hours. Therefore, it is necessary to correct the uptake coefficient reported by Fullerton *et al.*, 1986, to account for the difference in the expected exposure duration of 24 hours and the 144 hours used in the Fullerton study. In developing a corrected dermal uptake coefficient for nickel oxide, it has been assumed that soil would remain in contact with the skin for a period of 24 hours before being removed by bathing activities. The derivation of dermal uptake coefficient for nickel is shown in equation A7-1.

$$\text{Eq A7-1:} \quad DUC_{Ni} = 0.0023 * \left(\frac{24 \text{ hours}}{144 \text{ hours}} \right) = 0.00038 = 3.8 \times 10^{-4}$$

Where: DUC_{Ni} = Dermal Uptake Coefficient for nickel
 24 hours = Expected exposure duration
 144 hours = Duration of experimental exposure
 0.0023 = Reported dermal absorption of Nickel Chloride

It should be noted that this approach assumes a linear relationship between the length of exposure and the amount of nickel available to the skin for absorption. It should also be noted that there is a marked difference in water solubilities between the nickel chloride used by Fullerton *et al*, 1986 and nickel oxide which is the predominant form of nickel found in the soil on Rodney Street and elsewhere in Port Colborne. Reported solubilities are 642 g/L and 0.0011 g/L for nickel chloride and nickel oxide respectively (ATSDR, 1997). Further, the nickel chloride used by Fullerton *et al*, was applied in solution and was freely available for absorption by the skin. In Port Colborne, the nickel oxide is associated with soil particles and must dissociate (dissolve) from the soil particles before it is available for absorption by the skin. Therefore, using a dermal dose factor derived for dissolved nickel chloride to estimate the dermal dose of undissolved nickel oxide, will significantly over estimate the amount of nickel oxide available for absorption by the skin. Thus, the *DUC* factor selected for use at Rodney Street in Port Colborne will provide conservative estimates of dermal exposure for all age groups considered in the assessment.

A7-2 Dermal Uptake Coefficient for Cobalt

Paustenbach cites a dermal uptake coefficient of 0.0004 for cobalt chloride (Paustenbach, 2000). Information on the cobalt species present in Rodney Street soil is not available. Therefore, it has been assumed that the dermal uptake coefficient for cobalt chloride is representative of the dermal uptake coefficient for cobalt in soil in the Rodney Street area.

A7-3 Dermal Uptake Coefficients for Antimony, Beryllium, Cadmium and Copper

Dermal uptake coefficients for the remaining metals are not available. In the absence of such values, a default value of 0.01 is recommended by the US EPA for assessing dermal exposure to inorganic compounds such as metals (US EPA, 1992). However, this recommendation is based on the conservative assumption that all metal delivered to the skin is available for uptake into the skin. The metals in Port Colborne soils appear to be tightly bound to the soil matrix and therefore would not be fully available for uptake through the skin. As noted in elsewhere in this report, the amount of each metal that could be released for the soils from Rodney Street, under acidic conditions has been assessed (Appendix 5). The maximum levels of metals released under these conditions ranged between 0.19% (0.0019) for antimony to 2.2 % (0.02) for copper. These values represent the maximum amount of each metal that could be expected to be released from the soil while in contact with skin. Therefore, these values have been used as the dermal uptake coefficients for estimating dermal exposure to these metals. By assuming that the amount of metal released under acidic conditions will be equivalent to the amount of metal released under neutral pH conditions will over estimate the amount of metal released and subsequent exposures. The dermal uptake coefficients used in this report are summarized in Table A7-1.

Table A7-1: Dermal Uptake Coefficients

| | Antimony | Beryllium | Cadmium | Cobalt | Copper | Nickel |
|-------------|----------|-----------|---------|--------|--------|---------|
| Coefficient | 0.0019 | 0.0019 | 0.0019 | 0.0004 | 0.022 | 0.00038 |

A7 References:

ASTDR (Agency for Toxic Substances and Disease Registry), 1997. U.S. Department of Health and Human Services. Toxicological Profile for Nickel. Atlanta, Georgia, USA.

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