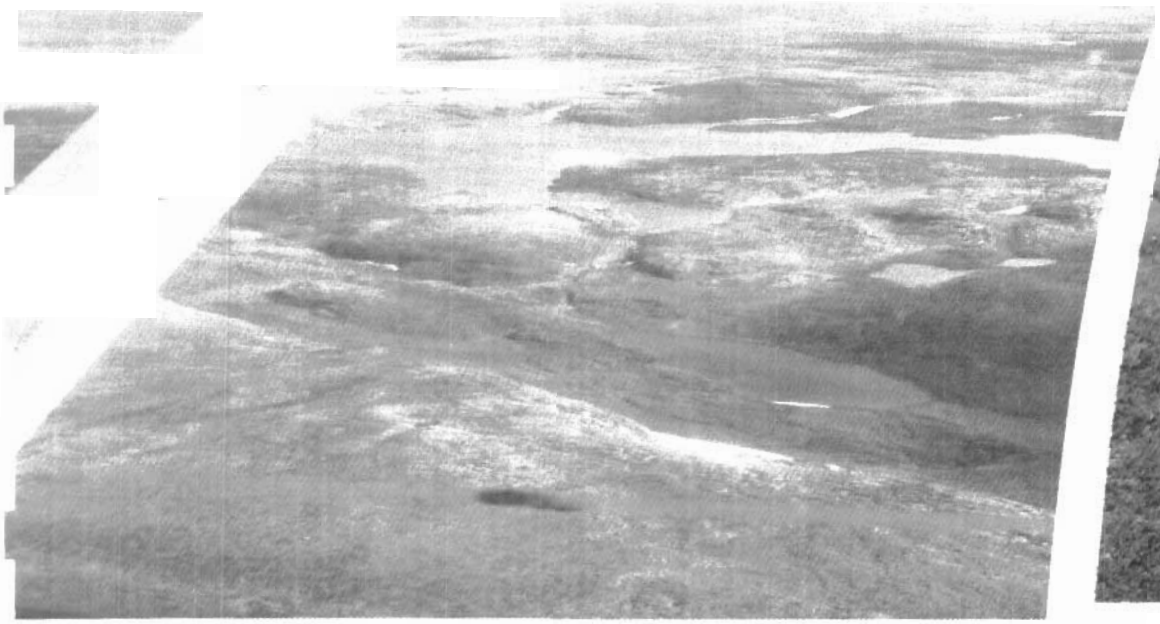

Human Health and Ecological Risk Assessment for CAM-F Dew Line Site

Sarcpa Lake

Submitted to:

Public Works and Government Services Canada

Western Region

February 4, 2005

Jacques Whitford

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REPORT TO:

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

ON BEHALF OF:

DEPARTMENT OF INDIAN AFFAIRS AND NORTHERN DEVELOPMENT

HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT FOR THE CAM-F (SARCPA LAKE) DISTANT EARLY WARNING (DEW) LINE SITE

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If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

EXECUTIVE SUMMARY

Jacques Whitford Limited (Jacques Whitford) performed a human health and ecological risk assessment (HHERA) on the CAM-F (Sarcpa Lake) Distant Early Warning (DEW) Line Site located at 68°33' N, 83°19' W on the Melville Peninsula between Foxe Basin and Committee Bay, Nunavut. The primary objective of this study was to evaluate whether known concentrations of chemicals in surface soil and water at the site would present a significant risk to human or ecological health based on future use of the property in its current condition and after remediation.

Study Background

The current study undertook a preliminary quantitative human and ecological risk assessment of the CAM-F site. It is supported by new contaminant data for the site, based on a Phase III Environmental Site Assessment (Earth Tech 2004) which included analysis for hydrocarbons, PAHs, PCBs, and inorganic substances in soils, as well as a limited number of analyses of ground water, lake and river sediments, lake water and fish. A restricted number of background soil samples were also collected. The ERA considered a broad range of ecological receptors and incorporated the new data, while retaining the previously collected data for CAM-F. The HHERA evaluates both Phase II and the newly generated Phase III data supplied and described by Earth Tech (2004).

Data Compilation

The soil and water sample data from the Phase II and Phase III sampling programs were screened for use in this risk assessment. For the purposes of the risk assessment for both human and ecological receptors, only soil samples that accurately reflect concentrations in the upper 10 to 30 cm from ground surface are relevant to potential exposures.

The Phase II and Phase III data were screened on the basis of depth and any sample that did not intersect the surface and/or extended to a depth of greater than 0.3 m below ground surface (mbgs) was excluded. This was done to ensure that the data used were representative of surface soil and not heavily influenced by subsurface soil characteristics.

Screening of Chemicals of Potential Concern (CoPCs)

CoPCs included for consideration were the chemicals identified by Earth Tech in their Phase III Reports as exceeding generic CCME soil quality guidelines (CCME 1999). Generic CCME guidelines may be based on either ecological or human health protection and provide a protective initial screening of the site data. For the human health risk assessment (HHRA), these chemicals were screened specifically against human health based generic guidelines and for the ecological risk assessment (ERA), they were screened specifically against ecologically based generic guidelines. In order of preference, these guidelines are taken from CCME (CCME 1999), Ontario Ministry of the

Environment (OMOE 1996a), or the United States Environmental Protection Agency (US EPA).

Based on the human health based criteria screening, the chemicals carried forward to the HHRA were antimony, barium, beryllium, cadmium, copper, lead, tin, total polychlorinated biphenyls (PCBs) and total petroleum hydrocarbons (TPH) F2, F3 and F4 fractions.

The chemicals carried forward in the ERA included antimony, barium, beryllium, boron, cadmium, chromium, copper, lead, tin, zinc, total PCBs, benzene, toluene, ethylbenzene, xylene (BTEX) and TPH F1, F2, F3 and F4 fractions.

Exposure Scenarios

The study area was defined as the area including and surrounding the investigated areas at CAM-F. The site consisted of a Main Station Area, two Dump Sites and a former Construction Camp.

Infrastructure at the site included a module building train; warehouse and garage; Inuit house (dormitory); petroleum, oil, lubricant (POL) pumphouse; quonset hut; collapsed communications antenna; POL tanks; drum storage pads, sewage outfall; vehicle pile. generator site, former construction camp, shop site and two dump sites.

Due to the northern location of the CAM-F and the probable use of the site by Inuit for traditional purposes, the conventional land use categories (residential, parkland, commercial, and industrial) were expanded to incorporate the Traditional Inuit Land Use. The parameters of this land use are discussed in detail in Gartner Lee and Cantox (1998), and were developed after consultation with residents of the Eastern Arctic, the Quikiqtaaluk Corporation and DIAND.

The current assessment adopted the Traditional Land Use for the CAM-F site, as set out by Gartner Lee and Cantox (1998). The Traditional Land Use designation consists of Inuit families residing on the land, in tents for periods up to 3 months. It was assumed that during this period the Inuit engaged in traditional hunting, fishing and gathering activities. It was also assumed that all time spent on site was in the non-snow covered months, which resulted in the most extensive exposure scenario for the human receptors. Detailed exposure values are discussed in Section 4.3, and in the Gartner Lee and Cantox report (1998).

Based on this land use, the following conceptual models were developed:

Human Health

The conceptual model that forms the basis for the derivation of the human health soil quality site-specific target levels was as follows:

Traditional Site Use Scenario:

- A toddler aged six months to four years is exposed to surface soil contaminated with non-carcinogenic antimony, barium, beryllium, cadmium, copper, lead, tin, total PCBs and TPH F2, F3 and F4 fractions by inadvertent ingestion / dermal contact / dust inhalation, ingestion of wild game (caribou

and arctic hare) and lake trout, and by ingestion and dermal contact with surface water.

- A person visits the site yearly from birth to 75 years of age and is exposed to carcinogenic beryllium and cadmium by inadvertent dust inhalation and total PCBs by inadvertent ingestion / dermal contact / dust inhalation, ingestion of wild game (caribou and arctic hare) and lake trout, and by ingestion and dermal contact with surface water, throughout their lifetime.

Ecological Health

The risks of exposure to contaminated soils were the focus of the ecological risk assessment (ERA). The potential exposure media for intake of metals included direct ingestion of soils, as well as metal uptake from eating terrestrial plant material, drinking water, ingesting terrestrial invertebrates, and terrestrial mammals. The major exposure pathway considered was ingestion. Inhalation and dermal absorption were also possible exposure pathways, but these were considered to be relatively minor by comparison to ingestion, and were not included as direct pathways in the ERA. Soil that adheres to fur or feathers is, for the most part, ingested by preening/licking activity and was included in the estimate of direct soil ingestion.

The receptors selected in the ERA were the Ermine, Arctic Hare, Ptarmigan, Lemming, Snowy Owl, Arctic Fox, and Caribou. These receptors are considered to be representative of indigenous wildlife at the CAM-F site. Other valued ecosystem components (VECs) were considered for the sites (discussed in Section 5.2.4) but these receptors were chosen to be protective of all VECs potentially on site.

Risk Characterization

The above-noted exposure scenarios were evaluated to identify the potential for adverse effects to human or ecological receptors, with the following outcomes:

- Maximum concentrations of lead, TPH F2 and F4 Fractions resulted in a HQ greater than 0.2 and the maximum total PCB concentration resulted in an Incremental Excess Lifetime Cancer Risk (IELCR) greater than $1x10^{-5}$, indicating that exposure to the site could result in potential to produce adverse effects in human receptors under the exposure scenarios included in the risk assessment.

- Surface soil exposure point concentrations (EPCs) of the identified chemicals are not anticipated to produce adverse effects in ecological receptors under the exposure scenarios included in the risk assessment.

Site specific target levels (SSTLs) were calculated for each of the chemicals identified as a potential risk in the HHRA. The SSTLs were calculated by setting the HQ at 0.2 and the IELCR at $1x10^{-5}$, and determining the corresponding surface soil EPC for that target value, using a backward calculation.

Remediation

Specific localized areas have been identified as "hot spots" where concentrations of selected CoPCs were elevated. Even though, these areas do not pose a significant human or ecological risk, they were selected to be removed for aesthetic reasons as well as to remove any remaining and obvious soil stained/contaminated areas. These areas will be excavated and removed from contact of all receptors. The consequential removal of these selected areas resulted in drops of EPCs for human health of 14% (antimony), 52% (barium), 20% (beryllium), 86% (cadmium), 93% (copper), 19% (lead), 87% (tin), 95% (total polychlorinated biphenyls (PCBs)), 94% (total petroleum hydrocarbon (TPH) F2 fraction) and 40% (TPH F4 fraction). The EPC for human health represents a drop in the maximum concentrations found on site. This resulted in a subsequent drop in the calculated total hazard quotients associated with the site of 36% (barium), 16% (beryllium), 69% (cadmium), 39% (copper), 78% (lead), 2% (tin), 48% (PCBs), 94% (TPH F2 fraction) and 64% (TPH F4 fraction).

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GLOSSARY

Acceptable risk: A risk level that is considered by society or regulatory agencies as tolerable.

Background level: The normal ambient environmental concentration levels of a substance.

BTEX: benzene, toluene, ethylbenzene, xylenes - substances typically found in petroleum products such as gasoline, heating oil, automotive oil, etc.

Cancer: a disease characterized by malignant, uncontrolled invasive growth of body tissue cells.

Carcinogen: A chemical or substance capable or suspected to be capable of producing cancer in living organisms.

CCME: Canadian Council of Ministers of the Environment. CCME publishes Canadian Environmental Quality Guidelines for soil and other environmental media. CCME also publishes a process for assessing and clean-up of contaminated sites.

Chronic exposure: The long-term, low-level exposure to substances, i.e., the repeated exposure or doses to a substance over a long period of time. It may cause latent damage that does not appear until a later period in time.

Chronic toxicity: The occurrence of symptoms, diseases, or other adverse health effects that develop and persist over time, after exposure to a substance delivered over a relatively long period of time.

Chronic daily intake: The intake of a substance, expressed in mg/kg-day, averaged over a long period of time.

Concentration: A quantitative measure of the amount of a substance present in a sample. Typically defined in milligrams per kilogram (mg/kg) for soil samples or milligrams per litre (mg/L) for water samples. mg/kg and mg/L are also equivalently expressed as parts per million (ppm)

Conservatism: The tendency towards caution or protection. Conservative assumptions made in a risk assessment are designed so as to over-predict the actual risks.

CoPC: Chemical of Potential Concern: A chemical that is carried forward into a risk assessment.

Dermal exposure: Exposure to a substance through skin absorption.

Dose: That amount of a substance taken in by a receptor on exposure; it is a measure of the amount of the substance received by the receptor, as a result of exposure expressed as an amount of exposure (in mg) per unit body weight of the receptor (in kg).

Dose-response: The quantitative relationship between the dose of a substance and observed health effect caused by exposure to such substance.

Dose-response evaluation: The process of quantitatively evaluating toxicity information and characterizing the relationship between the

dose of a substance and the expected incidence of adverse health effects in the exposed population.

Effect: The response observed in the body due to exposure to a substance (e.g., decreased body weight).

Endpoint: The specific effect (e.g., liver damage) upon which a toxicity value is determined.

Exposure: Receiving a dose of a substance; or coming in contact with a hazard.

Exposure assessment: The exposure assessment includes the identification of the receptors of interest, the identification of the relevant exposure pathways, and the quantification of the exposures from each pathway.

Exposure pathway: The mechanism by which a receptor can be exposed to a chemical hazard, such as ingestion of contaminated soil or inhalation of contaminated air.

Exposure Point Concentration (EPC): The calculated concentration of a substance that is representative of the concentration at the point of exposure (i.e., the concentration of a substance in soil, water or air that is carried forward in the risk assessment calculations for a particular exposure pathway).

Exposure Scenario: Combination of a hazard, pathway and a receptor.

Groundwater: The water contained in interconnected pores located below the water table.

Guidelines: Guidelines for environmental quality are defined by regulators for many substances to quickly and easily identify the concentration of a substance where no further investigation or study is required. If the concentration of a sample exceeds an established guideline, then further investigation is carried out to determine if action might be required.

Hazard: The inherent toxic potency of a substance independent of level of exposure.

Hazard identification: This is the first step in a risk assessment and is used to identify environmental hazards (e.g., CoPC) that may pose a health risk. The chemical hazards at a site are identified based on the results of data reviewed and field investigations, as well as an understanding of the toxicology of the substances of concern.

Hazard index (HI): Sum of the CoPC – specific hazard quotients for an exposure scenario.

Hazard quotient (HQ): The ratio between the calculated potential dose of a substance and the toxicity value for that substance. Values below 1.0 suggest the potential dose is below the toxicity value and no adverse health effects would be expected

Human health risk: The likelihood (or probability) that a given exposure or series of exposures to a hazardous substance will cause adverse health impacts on individual receptors experiencing the exposures.

Hydrocarbons: Organic chemicals associated with fossil fuels such as petroleum products.

Incremental excess lifetime cancer risk (IELCR): An upper-bound estimate of the excess potential cancer risk, expressed as a probability of cancer incidence for an exposed individual over a lifetime.

Ingestion: Exposure to a substance through the mouth and into the gastrointestinal system.

Inhalation: Exposure to a substance through the respiratory tract system.

Intake: The amount of material inhaled, ingested, or dermally absorbed during a specified time period. It is a measure of exposure, expressed in mg CoPC /kg BW - day.

Lifetime average daily dose (LADD): The average dose of a substance over a lifetime, expressed as a mass of a substance per unit body weight per unit time.

Modeling: Use of mathematical algorithms t simulate and predict real events and processes.

Petroleum Hydrocarbons: A class of organic chemicals associated with petroleum products such as gasoline. lubricating oil and home heating oil.

Polycyclic Aromatic Hydrocarbons (PAHs): A class of organic chemicals often associated with the burning of wood, coal, heating oil, and many industrial processes.

Potency: A measure of the relative toxicity of a substance.

ppb (parts per billion): An amount of substance in a billion parts of another material; also expressed by µg/kg or µg /L.

ppm (parts per million): An amount of substance in a million parts of another material; also expressed by mg/kg or mg/L.

Receptor: Refers to members of a potentially exposed population, e.g., persons or organisms that are potentially exposed to a particular substance. Receptors do not represent real people, but rather are used hypothetically, to represent an individual who might be expected to have a maximum potential exposure.

Receptor identification: Identification of the receptors that may be exposed to the CoPC.

Reference dose (RfD): The maximum theoretical chronic dose of substance that the human body can absorb without experiencing chronic health effect; it is expressed in mg of substance per kg body weight per day. It is the estimate of lifetime daily exposure of a non-carcinogenic substance for the general human population which appears to be without an appreciable risk of deleterious effect; used interchangeably with Tolerable Daily Intake (TDI).

Risk: The probability or likelihood of an adverse consequence from a hazardous situation or hazard, or the potential for the realization of undesirable adverse consequences from impending events.

Risk assessment: The determination of the potential adverse health effects due to exposure to substances that may cause harm.

Risk characterization: The assessment of the predicted health risk from exposure to each substance by each receptor. The quantification of health risks is calculated for the identified pathways using generally accepted methods and appropriate assumptions about exposure. The risk characterization can determine if adverse health effects are expected from exposure to the substance at the exposure point.

Risk management: The steps and processes taken to reduce, abate, or eliminate any unacceptable risks that have been identified by a risk assessment.

Slope factor (SF): A plausible upper-bound probability estimate of a response per unit intake of a substance over a lifetime. It is used to estimate an upper bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

Surface Soil: Includes all samples taken at shallow depths (less than 20 cm) in an outdoor location and any soil type material that might have been collected inside a building.

Surface Water: Water from lakes, rivers and streams.

Threshold: The lowest dose or exposure of a substance at which a specified measurable effect is observed and below which such effect is not observed.

Tolerable Daily Intake (TDI): The maximum amount of a substance that the human body can absorb without experiencing chronic health effects; it is expressed in mg of substance per kg body weight per day. It is the estimate of lifetime daily exposure of a non-carcinogenic substance for the general human population that appears to be without an appreciable risk of deleterious effects; used interchangeably with Reference Dose (RfD).

Toxicity: The harmful effects produced by a substance. It is the quality or degree of being poisonous or harmful to human or ecological receptors.

Toxicity assessment: Toxicity reference values are obtained for the CoPC. The reference dose (RfD) is the estimate of lifetime daily exposure to a non-carcinogenic substance for the general human population that appears to be without appreciable risk of deleterious effects. It is expressed as mg substance/kg body weight/day. The slope factor (SF) is a plausible upper-bound estimate of the probability of a response per unit intake of a substance over a lifetime, expressed as $(mg/kg\ bw/day)^{-1}$. It is used to estimate an upper bound probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen.

Uncertainty: The degree of confidence in the estimate of a variable's magnitude or probability of occurrence.

Uncertainty assessment: A qualitative or quantitative assessment of the uncertainty associated with the risk estimation. Uncertainty may be associated with a number of components of the HHRA, including the exposure estimate, the toxicity reference value, and the assumed bioavailability of the CoPC from the exposure matrix.

Uncertainty factor (UF): Refers to a factor that is used to provide a margin of error when extrapolating from experimental animals to estimate human health risks.

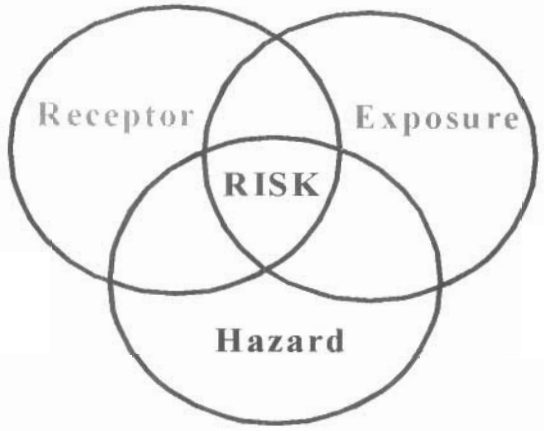
1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) was commissioned by Public Works and Government Services Canada (PWGSC) on behalf of the Department of Indian and Northern Development (DIAND) to complete a Human Health and Ecological Risk Assessment (HHERA) to evaluate the current risk associated with chemical concentrations found on-site, develop Site Specific Target Levels (SSTLs) and evaluate the effects of proposed remedial actions on the risk associated with the CAM-F (Sarcpa) Distant Early Warning (DEW) site (Figure 1.1). The study addresses concerns regarding exposure to potentially hazardous metals and organic chemicals in surface soil and water.

CAM-F was an intermediate DEW line site that is listed as one of the high priority sites for mitigation and remediation of environmental impacts as part of the Federal Contaminated Sites Accelerated Action Plan (FCSAAP).

1.1 SCOPE AND OBJECTIVES

The purpose of this study was to determine concentrations of chemicals of potential concern (CoPCs) in surface soil below which no adverse health effects would be expected. These site-specific target levels (SSTLs) are to be used in preparation for reclamation work at the CAM-F DEW line site. To meet this objective, a widely accepted risk assessment framework was adopted in which potential hazards, exposure pathways, and receptors are evaluated to determine if a risk is present, as illustrated in the diagram below:



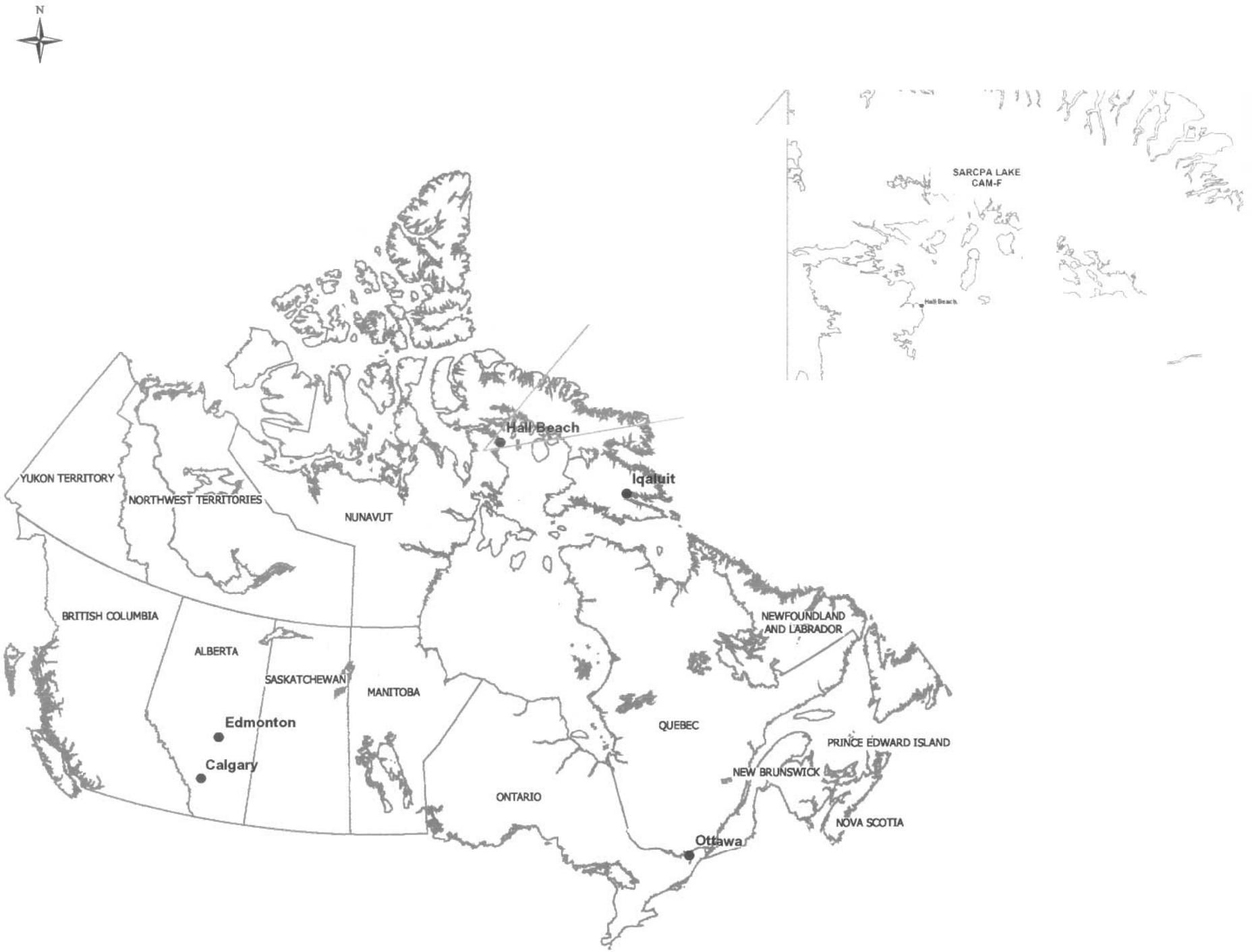
The human health and ecological risk assessment framework comprises the following major components:

Hazard Identification: Identification of the environmental hazards that may pose a health risk (e.g. chemicals).

Receptor Identification: Identification of the human receptors and biota that may be exposed to the above hazard(s).

Toxicity Assessment: Identification of published, scientifically reviewed toxicity values against which exposures can be compared.

Exposure Assessment: Qualitative or quantitative evaluation of the likelihood or degree to which the receptors will be exposed to the hazard.


N
SARCPA LAKE
CAM-F
Hall Beach
Hall Beach
Iqaluit
YUKON TERRITORY
NORTHWEST TERRITORIES
NUNAVUT
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
NEWFOUNDLAND
AND LABRADOR
PRINCE EDWARD ISLAND
NEW BRUNSWICK
NOVA SCOTIA
Edmonton
Calgary
Ottawa

Risk Characterization: Qualitative or quantitative assessment of the actual health risk of each hazard to each receptor, based on the degree of exposure

Uncertainty Assessment: Review of the uncertainty associated with the risk estimation.

SSTL Determination: The determination of concentrations at the site below which no adverse effects would be expected.

The derivation of SSTLs presented in this report follows the general methodology as outlined above. Specific tasks included:

- Review and compilation of existing data and a summary of past results;
- Qualitative risk screening to identify scenarios which are likely to present the greatest risk; and
- Quantitative risk analysis to develop SSTLs for those scenarios which are most likely to present risk.

It is important to note that this report does not evaluate potential health issues that may have occurred in the past, rather it is designed only to evaluate current and potential future exposures to chemicals in soil, based on present day conditions and assumed future post-reclamation conditions.

1.2 RATIONALE FOR SITE-SPECIFIC RISK ASSESSMENT

Generic or Tier I surface soil guidelines have been developed by the Canadian Council of Ministers of the Environment (CCME 1999). These guidelines are conservative benchmarks developed for screening purposes. If soil concentrations are less than these guidelines, then the potential for human health and ecological effects is negligible. Conversely, if soil concentrations exceed these guidelines it does not necessarily mean that unacceptable risks exist. The generic guidelines are intentionally conservative, do not take into account regional or site-specific information (e.g., background soil conditions) and are not appropriate for every site or region of the country.

With this in mind, in 1996 the CCME published two documents (CCME 1996a, b), thereby acknowledging that these guidelines are not set in stone but may be modified in some instances if supported by sound reasoning and/or by the provision of site-specific data. In fact, to proceed with remediation without developing site-specific criteria could result in disruptive remedial action that brings little or no health benefit. Deriving SSTLs specifically for Sarcpa Lake is a more accurate way of assessing the significance of soil concentrations to human and ecological health in the area.

Soil chemical concentrations were initially evaluated using the Canadian Environmental Quality Guidelines published by the CCME in 1999.

The specific methods employed to develop the SSTLs are consistent with CCME and Health Canada protocols as referenced above, and with standard human health and ecological risk assessment methodologies.