Human Health and Ecological Risk Assessment

RESOLUTE BAY AIRPORT LANDFILL SITES AND VEHICLE STORAGE AREA

FINAL REPORT

Prepared for:

Transport Canada
On behalf of
Public Works and Government Services Canada

Prepared by:
Franz Environmental Inc.
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Project No. 1747-0901
March 2010

The enclosed report entitled:

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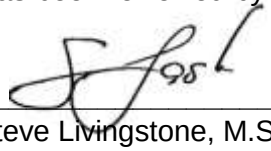
Has been reviewed by Steve Livingstone (Project Director) as to form and content:



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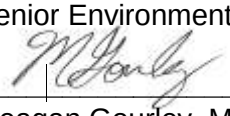

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March 2010

EXECUTIVE SUMMARY

Purpose and Objectives

The primary objective of this Human Health and Ecological Risk Assessment Report was to preliminarily assess risks to human health and the ecology from identified COPCs in soil, groundwater, surface water, and sediment at the Resolute Bay Airport Landfill and Vehicle Storage Area sites.

Site Setting

Resolute Bay lies within the centre of the high arctic, situated on Cornwallis Island, Nunavut. The Resolute Bay airport is owned by the Government of Nunavut (GN). The airport is approximately 5 km northeast from the Inuit hamlet Resolute (Qausuittuq – place with no dawn) on the southwest part of Cornwallis Island.

Two unlined landfills, the Solid Waste Landfill (AEC 1) and the Historic Landfill (AEC 2), are present near the airport facilities. A third site, a boneyard for metal debris, identified as the "Vehicle Storage Area" (AEC 3), is north of the Solid Waste Landfill. Land use at AECs 1 and 3 are expected to remain unchanged. A hotel is being "developed along the northeastern boundary of the historic landfill (AEC 2). COPCs investigated in AEC 1, 2 and 3 during the 2009 Phase II/III ESA conducted by FRANZ included PHCs, PAHs Volatile Organic Compounds (VOCs), Metals, PCBs, were identified as COPCs

PQRA and ERA Chemical Screening

Screening to identify Chemicals of Potential Concern (COPCs) for both the human health and ecological risk assessment components of this report was completed by primarily comparing maximum concentrations of contaminants in media with federal CCME guidelines and standards The following were identified as COPCs in environmental media onsite and used as inputs in the human health PQRA spreadsheets:

- Metals - boron, copper, lead, zinc
- PHCs – benzene, ethylbenzene, toluene, PHC Fraction 1, PHC Fraction 2
- PAHs – chrysene

COPCs in environmental media were subject to a further "qualitative screening assessment". COPC concentrations considered to potentially harm ecological receptors were:

- Soil – F2, F3, Cu, Zn, benzene, toluene, ethylbenzene
- Sediment - F2, benzene, xylenes, boron, acenaphthene, fluorene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene
- Groundwater- F1, F2, Cd, Cu, Fe, Pb, naphthalene
- Surface Water- Cadmium, copper, zinc, boron, and iron

PQRA Methodology

The human health risk assessment was conducted in accordance with Health Canada PQRA guidance documents (Health Canada, 2004, 2007, 2009 updates).

PQRA Potential Receptors

- Adult airport employees involved in operational and maintenance activities onsite. This would be considered a chronic exposure scenario.
- Remedial workers or adult construction workers involved in demolition, remediation and maintenance activities at the Site. These workers would be onsite for intense short term exposures during the summer season. Workers returning to the site would also be considered in a chronic exposure scenario.
- Potential adult hotel employees at the new hotel under construction on the edge of the Historic Landfill (AEC 2). Employees at the hotel could be exposed to contamination because of their presence at the site. Exposure would be incidental in nature.

PQRA Operable Pathways

- Accidental ingestion of soil particles, and inhalation of soil particles (fugitive dust)
- Dermal contact with soil
- Dermal contact with groundwater

PQRA Risk Characterization

The target hazard quotient of 0.2 has been exceeded in the site remediation worker receptor scenario, and unacceptable risks (HQ>0.2) were estimated for the site remediation worker with chronic oral/dermal exposure to petroleum hydrocarbons (PHCs) F1 and F2 in soil. Unacceptable risks (HQ>1.0) to the site remediation worker also exist from sub-chronic oral/dermal exposure to the COPC mixture PHC F2. The Health Canada recommended threshold for ILCR (1.0E-05) has not been exceeded by exposure to carcinogens (benzene and chrysene) for any onsite receptors.

ERA Methodology

A qualitative evaluation of COPCs, ecological receptors, and relevant exposure pathways was conducted in order to develop an Ecological Conceptual Site Model to support an ecological risk assessment (ERA).

ERA Potential Receptors

The ERA primarily considered species known or likely to be on Site, or in the immediate vicinity of the Site. The feeding guilds considered included terrestrial plants, soil invertebrates, burrowing small mammals, terrestrial birds, large carnivores/omnivores, and large herbivores. Aquatic receptors were not considered for evaluation in the qualitative assessment as the contaminant migration pathway is incomplete to marine or freshwaters where aquatic life is present (FRANZ, 2010).

ERA Operable Pathways

- Leaching of subsurface contamination into groundwater, and overall transport (e.g. surface water runoff, groundwater drainage) into surface waters onsite, followed by dermal contact with, and ingestion of contaminated surface waters by terrestrial receptors
- Ingestion of contaminated food items (vegetation, tissue) as well as incidental ingestion of contaminated soil or sediment by terrestrial receptors.
- Direct dermal contact with contaminated soil or sediment onsite by terrestrial receptors.

ERA Risk Characterization

Based on the results of the chemical screening, effects assessment, exposure assessment and qualitative risk characterization preliminary conclusions for the ERA are as follows:

- PHCs F2, F3, copper and zinc concentrations in soil represent high to medium risk to terrestrial plants through dermal contact with contaminated soil, and to soil invertebrates with the potential to ingest contaminated soil particles (high risk for F2 and copper specifically). These contaminants represent low-medium risks to large carnivores, omnivorous mammals and birds via the ingestion of contaminated food items and the potential for bioaccumulation of COCs in prey items and biomagnification in food chains;
- Boron, F2, Xylenes and PAHs (Benzene, Fluorene, 2-methylnaphthalene, , Acenaphthene, , 1-methylnaphthalene, Naphthalene) represent sediment contaminant concentrations of low concern to herbivores with the potential for dermal contact with, and accidental ingestion of sediment;

- Exposure to groundwater was considered an incomplete exposure pathway and was not considered as a potential risk to ecological receptors;
- Cadmium, copper, zinc, iron, and boron concentrations in surface water were considered to be low risks to terrestrial receptors exposed via dermal contact with, and ingestion of surface waters;

ERA and PQRA Recommendations

Action should be taken to manage the high concentrations of contamination at the site that drives the human health risk assessment results (unacceptable risks to the site remediation worker from oral/dermal exposure to PHCs in soils onsite). Management of potential oral/dermal exposure to PHCs in soils onsite, should include the remediation worker's adherence to a site specific health and safety plan.

If no action is taken to manage the high concentration of contamination at the site, then further refinement of the human health and ecological risk assessment is warranted. The most appropriate areas to further refine the risk assessment include:

1) Refine the human health and ecological exposure scenarios to better reflect actual patterns of exposure for onsite receptors.

2) Refine the statistical database/input parameters to determine the most appropriate statistic values (e.g. 95% upper confidence limits) for contaminant concentrations.

3) Carry out a site specific ERA in which site specific modelling of ecological receptors exposure to contaminants is applied, and risks to ecological receptors are quantitatively characterized.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 Objectives of Risk Assessment 1
1.2 Project Team 1
2.0 DESCRIPTION OF SITE 2
2.1 Site Owner 2
2.2 Site Features and Background 2
2.2.1 AEC 1 – Solid Waste Landfill 2
2.2.2 AEC 2 – Historic Landfill 3
2.2.3 AEC 3 – Vehicle Storage Area 3
2.3 Current Permit Information and Future Landuse 3
2.4 Climate Conditions 4
2.5 Natural Environment - Overview 4
3.0 PHYSICAL SITE CHARACTERISTICS 5
3.1 Regional and Local Topography 5
3.2 Regional and Local Drainage 5
3.3 Geology and Surficial Geology 5
3.4 Hydrogeology and Hydrology 6
4.0 REVIEW OF PREVIOUS INVESTIGATIONS 7
4.1 Identification of Areas of Environmental Concern (AECs) 9
5.0 SCREENING OF CONTAMINANTS OF POTENTIAL CONCERN 10
6.0 HUMAN HEALTH RISK ASSESSMENT 16
6.1 PQRA Objectives 16
6.2 Problem Formulation 16
6.3 Identification of Contaminants of Potential Concern 16
6.4 Identification of Potential Receptors 16
6.5 Identification of Operable Exposure Pathways 17
6.6 Conceptual Site Model 19
6.7 Problem Formulation Checklist 19
7.0 EXPOSURE ASSESSMENT 21
7.1 Characterization of Potential Receptors 21
7.1.1 Exposure Frequency and Duration 22
7.2 Exposure Equations and Models 23
7.3 Relative Absorption Factors 23

8.0 TOXICITY ASSESSMENT 24
8.1 Carcinogens and Non-Carcinogens 24
8.2 Toxicological Effects 25
8.3 Evaluation of Potential Toxic Interactions 27
9.0 PQRA RISK CHARACTERIZATION 28
9.1 Summary of Hazard Quotients 28
9.1.1 Evaluation of Sub-Chronic Risk 31
9.2 Summary of Carcinogenic Risks 32
9.2.1 Summary of Risk Characterization 33
9.2.2 Risk Management 33
9.3 PQRA Uncertainty Evaluation 33
9.4 PQRA Summary and Conclusions 35
10.0 ECOLOGICAL RISK ASSESSMENT (ERA) 37
10.1 ERA Objectives 37
10.2 Problem Formation 37
10.3 Contaminants of Potential Concern 37
10.4 Effects Assessment 39
10.5 Receptor Characterization and Exposure Assessment 45
10.5.1 Terrestrial Receptors 45
10.5.2 Ecological Conceptual Site Model 47
10.6 Risk Characterization 48
10.6.1 Discussion of Uncertainty 49
10.7 ERA Conclusions 51
11.0 OVERALL CONCLUSIONS 52
11.1 Conclusions 52
11.2 Human Health 52
11.3 Ecological 54
11.4 Recommendations 56
12.0 LIMITATIONS 57
13.0 REFERENCES 58

LIST OF TABLES

Table 3-1: AECs and COPCs
Table 6-1: Soil, Chemical Concentrations – Summary
Table 6-2: Sediment Chemical Concentrations- Summary
Table 6-3: Surface Water Chemical Concentrations – Summary
Table 6-4: Groundwater Chemical Concentrations-Summary
Table 9-1: PQRA Maximum Hazard Quotients – All Operative Pathways
Table 9-2: PQRA Estimate of Potential Carcinogenic Risks – All Operative Pathways

LIST OF FIGURES

Figure 6-1: PQRA Conceptual Site Model
Figure 10-1: ERA Conceptual Site Model

LIST OF APPENDICES

Appendix A Risk Assessment Summary Data Tables
Appendix B Human Health (PQRA) Input and Output Tables
Appendix C Human Health (PQRA) Risk Assessment Equations
Appendix D Excerpt Figures from Phase II/III ESA (FRANZ, 2010)

1.0 INTRODUCTION

Franz Environmental Inc. (FRANZ) was retained by Public Works and Government Services Canada (PWGSC) Pacific Region on behalf of Transport Canada (TC), Prairie and Northern Region and Environmental Affairs Division to complete a risk assessment for the Resolute Bay Airport Dump/Landfills and Vehicle Storage Area on Cornwallis Island, Nunavut. The risk assessment report consists of a preliminary quantitative human health risk assessment (PQRA) and a qualitative ecological risk assessment.

1.1 Objectives of Risk Assessment

This report presents the methodology and findings of a risk assessment that was conducted to determine if the environmental conditions that exist at the Resolute Bay Airport Landfill and Vehicle Storage Area sites present a potential risk to humans and ecological receptors. The specific objectives of this assessment were to:

- Complete a review of all previous environmental site assessments and other information pertaining to the environmental conditions and potential risks posed by contamination detected on the site;
- Document the environmental conditions that exist at the site based on historical data, including the Phase IIIA ESA, for use in the risk assessment;
- Undertake a risk assessment to determine the significance of the current environmental conditions on the Resolute Bay site with respect to human and ecological receptors, consistent with federal Canadian Council of Ministers of the Environment (CCME) and Health Canada risk assessment methodologies.

1.2 Project Team

A multi-disciplinary team was used for this project. The key individuals and their respective roles are summarized below:

- Steve Livingstone, M.Sc., P.Geol. – Project Director
- Michael Shum, Ph.D., P.Ag., R.P.Bio. – Senior Risk Assessor
- Meagan Gourley, M.E.T. – Environmental Scientist

2.0 DESCRIPTION OF SITE

2.1 Site Owner

The Resolute Bay airport is owned by the Government of Nunavut (GN). The airport is approximately 5 km northeast from the Inuit hamlet Resolute (Qausuittuq – place with no dawn) on the southwest part of Cornwallis Island in Nunavut, Canada (see Figure 1). The airport was originally built in 1949 by the Royal Canadian Air Force. From 1964 to July 1, 1995, Resolute Bay Airport was owned by the Government of Canada and operated by Transport Canada. In July 1995, ownership was transferred to the Government of Northwest Territories. From July 1, 1995 until April 1, 1999, the airport was operated by the Arctic Airport Division of the Department of Transportation. Since April 1, 1999, the airport has been owned by the GN and operated by the Nunavut Airports Division of the Nunavut Department of Community Government, Housing and Transportation.

2.2 Site Features and Background

Past activities for transportation, communications and administration in the Arctic have resulted in the generation of solid waste. Solid waste disposal both from military activities and the community itself have resulted in the creation of several landfill sites. Two landfills, the Solid Waste Landfill and the Historic Landfill, are present near the airport facilities. A third site, a boneyard for metal debris, identified as the "Vehicle Storage Area" (as identified in the 1993 TC/PWGSC Audit), is north of the Solid Waste Landfill. The two landfill sites are within the airport's property boundaries, and the Vehicle Storage Area is off the airport lands.

Although the disposal sites are identified as landfills in this and other reports, they are actually dump sites. These sites are unlined and disposal does not appear to have been controlled. Due to the historic nature and types of materials in these landfills, PAHs, PCBs and pesticides could be considered potential chemicals of concern.

2.2.1 AEC 1 – Solid Waste Landfill

The Solid Waste Landfill (AEC 1) is at the top of a ridge near the service road. It is approximately 40,000 m² and rises approximately 10 m above sea level. Various types of waste material including drums, plastic and scrap metal were also observed scattered across the tundra near the site. The area beyond the toe of the landfill is boggy, with pools of standing water, which drain 2 km along a small stream to Allen Bay. Evidence of leaching from the landfill includes discolored water at the toe of the landfill, hydrocarbon sheens, solvent odours during test pitting, and significant vegetation growth at the base of the landfill and along the stream leading to Allen Bay. Resolute Bay Airport's sewage disposal lagoons are immediately adjacent to the landfill and are contributing to the quality and quantity of water entering the bog area.

Waste material was dumped on the Solid Waste Landfill around the 1960s and the 1970s (Jacques Whitford, 2006). This landfill has not been officially used since 1995, when a new landfill was constructed southeast of the hamlet. However, as recently as the summer of 2005, there was evidence of recent dumping of wastes in the landfill (Jacques Whitford, 2006).

2.2.2 AEC 2 – Historic Landfill

The Historic Landfill (AEC 2) is approximately 5 km from the hamlet of Resolute Bay, and approximately 300 m southwest of the airport terminal building. The landfill covers an area of approximately 145,000 m². Most of the buried waste is covered by soil, however, various types of debris were observed at or near the site including drums, lumber, metal wire, plastic and an airplane fuselage. The area at the toe of the landfill is boggy and significant vegetative growth relative to the surrounding area was observed. There is a hotel development in the northeast corner of the landfill, along the service road. The ground surface in and around the historical landfill slopes gently to the west towards the ocean. The community water supply, Strip Lake, is located several kilometres to the south. Groundwater and surface water are not used for any purpose in this area.

The Historic Landfill was used from 1947 to 1996. The Canadian and American military forces used this landfill between 1947 and 1964. Transport Canada and various airport tenants used the landfill between 1964 and 1995. Although air photos recorded the end of activity in the early 1970s, it was in 1996 when the use of the Historic Landfill officially stopped (Jacques Whitford, 2006).

2.2.3 AEC 3 – Vehicle Storage Area

The Vehicle Storage Area (AEC 3) has not been investigated previously; however, it was identified in a 1993 audit. The area is on the south edge of the McMaster River valley, approximately 1 km northwest of the Solid Waste Landfill. There are two distinct disposal sites (approximately 3,750 m^2 and 900 m^2) with abandoned vehicles, as well as other equipment (drums, tanks, tires, fencing, glass, shingles, etc.).

2.3 Current Permit Information and Future Landuse

FRANZ understands that uses at AECs 1 and 3 remain unchanged and that there are no known proposed changes. The use at AEC 2 remains unchanged, however, a hotel is being developed along the northeastern boundary of the historic landfill. A request put in to INAC mining records department on August 20, 2009, to search for past and present mineral claims on the property, turned up no records. No land claims have been made on the subject property.

2.4 Climate Conditions

Resolute Bay is in the high arctic and the climatic is characteristic of the Arctic Circle. The average daily temperature ranges from –32.4 ºC to 4.3 ºC. The average monthly temperature is below 0°C for ten months of the year. Snowfall that accumulates over the winter generally melts over a relatively short period of time of about 1 – 2 weeks at the start of the summer in June. The active warm months are July and August, with daily average temperatures of 4.3 ºC and 1.5 ºC, respectively. The site is in the zone of continuous permafrost. Polar desert conditions limit vegetation to prostrate dwarf trees, grasses, lichens and mosses.

Most months receive less than 10 mm precipitation, with only summer months experiencing more. The majority of rainfall during the summer can be characterized as low rainfall events (0.2 - 5 mm). Many of the rainfall events likely only wet the ground surface and do not result in significant infiltration. The average annual precipitation is 150 mm, with 50.3 mm of annual rainfall and 110.3 mm of annual snowfall (www.climate.weatheroffice.ec.gc.ca).

2.5 Natural Environment - Overview

Resolute Bay lies within the centre of the high arctic, which is extremely frigid and dry, on Cornwallis Island. The area is underlain by continuous permafrost and is generally low gently undulating. Permafrost was encountered during intrusive investigation in the native at approximately 0.6 m depth. Elevations range from 0-100 m asl.

The soils in the area are considered polar desert soils. These soils are extremely coarse textured with poor soil and horizon development. The lack of soil development is poor due to the lack of leaching, extremely sparse vegetation, and intense cryoturbation. There is little organic matter accumulation.

Polar desert conditions limit vegetation to prostrate trees, grasses, lichens and mosses. The only woody plant in the Resolute Bay area, and likely the entire island, is the arctic willow (*Salix arctica*), a prostrate form (Lange, 1959). Vegetative cover is extremely low and typically less than 5%. Sedge meadows develop in most areas such as seepage sites.

Wildlife in this area is sparse, but includes, caribou, arctic foxes, and other small mammals. Polar bears have been sighted on occasion, although they do not frequent the area. Marine wildlife in the area includes seals, walruses, and whales, and in the late spring assorted waterfowl, including Ivory Gulls.

3.0 PHYSICAL SITE CHARACTERISTICS

3.1 Regional and Local Topography

Cornwallis Island, Nunavut, is relatively flat with low-lying terrain, and a maximum elevation of 312 metres above sea level in the eastern part of the island (http://atlas.nrcan.gc.ca). Cornwallis Island is characterized by extensive rolling upland plateau areas incised by river channels (Edlund, 1991).

The study areas are characterized, for the most part, by flat to gently sloping terrain. The Solid Waste Landfill (AEC 1) and Historic Landfill (AEC 2) are both characterized by gently sloping terrain, with elevations that range from approximately 35 to 60 m asl and 40 to 60 m asl, respectively. The Vehicle Storage Area (AEC 3) is on the top of the south slope of the McMaster River Valley at an elevation of approximately 30 to 35 m asl. Where present, plant cover is irregular and discontinuous.

3.2 Regional and Local Drainage

Drainage on Cornwallis Island appears to be topographically controlled. Rivers and creeks on the island discharge into the Arctic Ocean from upland areas in the central and eastern parts of the island.

Drainage from both the Solid Waste Landfill (AEC 1) and the Vehicle Storage Area (AEC 3) discharges towards the west into Allen Bay. The area beyond the toe of the Solid Waste Landfill (AEC 1) is drained by a small unnamed creek, and several small ponds. The localized boggy area/wetland, indicative of saturated conditions likely due to an abundant water supply and shallow permafrost, has developed along the creek downgradient from the Landfill. Surficial flows in the Vehicle Storage Area (AEC 3) drain into the McMaster River valley; however, surface water was not observed in the immediate vicinity of the AEC.

The Historical Landfill (AEC 2) is drained by a complex sequence of interconnected lakes and drainage channels that ultimately discharge towards the south into Resolute Bay. Three small lakes west of the landfill capture runoff and drainage from the landfill. These small lakes subsequently drain into Meretta Lake and Resolute Lake, and then discharge into Resolute Bay. A patchy, discontinuous wetland has developed at the toe of the Historic Landfill (AEC 2) along its southern extent.

3.3 Geology and Surficial Geology

Cornwallis Island is comprised predominantly of Ordovician to Devonian carbonates (limestone and dolomite), shales, siltstones and sandstones (Edlund, 1991 and Okulitch, 1991). The study

areas are underlain by carbonates of the Allen Bay Formation to the west, and dolomite of the Cape Storm Formation to the east and to the south (Okulitch, 1991). Surficial geology consists predominantly of weathered bedrock debris.

The area is generally covered with sedimentary rocks consisting mostly of limestone, argillaceous limestone, dolomite, and calcareous shale (Thorsteinsson and Kerr, 1968), which leads to the highly calcareous soils on the island. Soils in the study areas are generally poorly developed and granular, ranging from sand to gravel.

3.4 Hydrogeology and Hydrology

Based on the regional geology and the presence of permafrost, the groundwater flow is likely complex and controlled by topography, surface water bodies and bedrock structure. Groundwater in the continuous permafrost zone is confined to this shallow active layer. Vertical groundwater flow is limited by the shallow permafrost.

Groundwater at the study areas is both relatively limited in quantity and ephemeral, being confined to a shallow active soil layer which is frozen up to ten months of the year. Shallow groundwater was encountered at the toe of both landfills.

It is expected that the surface water bodies are expressions of the water table. Surface water flow is likely the principal mode of water transport in the study areas. Surface water runoff due to the annual snow melt is considered to play a significant role.

4.0 REVIEW OF PREVIOUS INVESTIGATIONS

The following is a brief description of the previous environmental investigations reviewed by FRANZ as well as information obtained from the historical environmental investigations.

Public Works Canada/Transport Canada, 1993

Architectural and Engineering Services of Public Works Canada (PWC) and Transport Canada (TC) conducted an environmental audit of the Resolute Bay Airport in order to substantiate compliance with environmental regulations. Several sites were inspected, including the Historic Landfill (formerly known as Garbage Dump) and the Vehicle Storage Area (APEC 3). Although the Fire Training Area was addressed in detail, the nearby Solid Landfill (APEC 1) was not mentioned on the audit.

Dillon Consulting, 1995

An Environmental Baseline Study (EBS) was conducted at the airport to define potential environmental liabilities prior to the transfer from TC to the Government of Northwest Territories in 1995.

Dillon Consulting, 1999 (Environmental Site Investigation)

Dillon Consulting conducted an Environmental Site Investigation of the Solid Waste Landfill (APEC 1) to determine the extent and nature of subsurface contamination and to assess landfill closure options. The study included a review of historical aerial photographs, a geophysical investigation to identify the lateral extent of the landfill, and soil and water sampling from shallow test holes.

Environmental concerns were not identified with the exception of blue water and staining on soil/bedrock in downgradient areas. The blue colour was attributed to the use of *Rhodamine* Blue which was used to mark the airport runway in the winter. Rhodamine dyes are generally considered toxic and soluble in water. At a community consultation meeting, residents expressed concern over the contamination downgradient of the landfill and near the ocean.

Dillon Consulting, 1999 (Baseline Study Reaudit)

Dillon carried out an audit to review the remedial actions undertaken by TC and the airport tenants to address the inefficiencies identified in the 1995 EBS. In general, the outstanding noncompliance issues were associated with bulk storage tanks. Additionally, practices at the Solid Waste Landfill (APEC/AEC 1) still did not appear to conform to accepted operating procedures. Numerous empty barrels were present with unknown contents, asbestos-containing

materials were not disposed of properly according to regulations, and soil cover materials were not regularly placed over the refuse.

Transport Canada, 2000

Transport Canada Prairie and Northern Region (TC-PNR) implemented an environmental monitoring program at the decommissioned Solid Waste Landfill (APEC 1) to follow up the 1999 Dillon study. The program included sampling soil, water and sediments at and downgradient of the landfill.

Laboratory results indicated that all contaminants in the samples were lower than the federal and territorial guidelines/standards. Microtox tests, TEH, metal concentrations, pesticides, PCBs, phenols, and glycols in soil, sediment, freshwater and saltwater samples were all below the CCME criteria.

Jacques Whitford, 2006

Jacques Whitford conducted an Environmental Site Investigation at the Resolute Bay Airport. The work consisted of a review of previous environmental reports, a spills database search, and intrusive investigations at several sites at the airport, including the Solid Waste Landfill (APEC/AEC 1) and the Historic Landfill (APEC/AEC 2).

The objective of the intrusive investigations was to delineate soil and melt water impacts at the investigated sites. Samples were collected:

- near the toe of the Solid Waste Landfill (APEC 1), 100-150 m downgradient of the landfill, and
- at the north end and near the toe of the Historic Landfill (APEC 2).

Samples from both sites were analysed for PHC's, metals, PCB, PAH, VOC, and glycol.

Site observations and the analytical results indicate some leaching of PHC's and metals from the Solid Waste Landfill (APEC/AEC 1), and some leaching of PHC's from the Historic Landfill (APEC/AEC 2). Both sites were reported as containing wastes from unknown historic sources, having no leachate collection or monitoring plans, and being unlined and lacking sufficient soil cover. Recommendations were made to develop and implement a plan to continue monitoring leachate at both landfill sites, remove scattered waste, and capping the exposed waste material with additional soil cover.

4.1 Identification of Areas of Environmental Concern (AECs)

Based on previous environmental work and the historical review, the site was divided into three distinct AECs. The locations of the AECs, sampling locations within the AECs and analytical results for sampling locations are shown in Figures 1 to 9, excerpt from the Phase II/III ESA (FRANZ, 2010) and included in Appendix D of this report.

Based on the previous environmental assessment activities completed to date and the historical records review, the following AECs and PCOCs formed the basis for the Phase II/III ESA sampling plan.

Table 3-1: Summary of AECs and PCOCs

AEC	PCOCs
AEC 1- Solid Waste Landfill	PHCs, PAHs, Volatile Organic Compounds (VOCs), Metals, PCBs, and Pesticides
AEC 2 – Historic Landfill	PHCs, PAHs, Volatile Organic Compounds (VOCs), Metals, PCBs, and Pesticides
AEC 3 – Vehicle Storage Area	PHCs, PAHs, Volatile Organic Compounds (VOCs), Metals, PCBs, and Pesticides

5.0 SCREENING OF CONTAMINANTS OF POTENTIAL CONCERN

Overview

This section presents the methodology used to screen the environmental quality data for the Resolute Bay Airport Landfill and Vehicle Storage sites and from which to identify contaminants of potential concern (COPCs) for the PQRA and ERA. Data retained for this risk assessment report was sourced from FRANZ (2010) and Jacques Whitford (2006). The areas of investigation completed by FRANZ were based on the historical sampling, observations and chemicals results. Further details regarding the FRANZ Phase II/III Environmental Site Assessment are included in FRANZ (2010).

COPCs were identified by comparing the maximum concentrations of chemicals detected in soil, groundwater, surface water, and sediment with guidelines/standards/criteria protective of human health and the environment. Commercial land use has been applied and is considered conservative given the remote nature of the sites and lack of routine activity in the area.

The federal CCME guidelines and standards were used to screen the data. This is appropriate since the Government of Nunavut has adopted the CCME approach. Groundwater on Site and surface water in the Site vicinity is non-potable and not used as a community water supply. However, as a measure of conservatism in the PQRA, groundwater and surface water were primarily screened against Health Canada drinking water standards when available. Substances for which there are no CCME environmental quality guidelines, were screened against those established by provincial authorities. In cases where applicable provincial guidelines were unavailable, chemical concentrations in soil, sediment, surface water, and groundwater were compared to USEPA Region IX Soil (Residential Land Use) and Tapwater Regional Screening Level Guidelines (2009) for the protection of human health, and Environment Canada Compendium of Environmental Quality Benchmarks (1999) for the protection of human health and environmental health.

Federal Guidelines

- CCME 1999 “Canadian Environmental Quality Guidelines” and recent updates (2007) for commercial (CL) use for coarse grained soil;
- CCME 2008 “Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil” Human Health and Environmental Health Guidelines, commercial (CL) use;
- CCME guidelines for the protection of freshwater aquatic life (FWAL; 2007 Update – used for surface waters and groundwater);
- Health Canada 2008 "Guidelines for Canadian Drinking Water Quality" Summary Table (used for surface water and groundwater); and

- CCME guidelines for the protection of ecosystems (Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL); 2002 Update).

Substances screened into the PQRA and ERA, and their respective maximum measured concentrations in environmental media are identified in Tables 5-1 and 5-2. Use of the maximum values is a conservative approach and provides a protective estimate of potential risks to human health and the environment.

All parameters recorded as non-detect (ND) in all samples and for which detection limits were below the applicable screening criteria are not considered COPCs and have been omitted from further evaluation.

For the PQRA, if a contaminant exceeded the relevant guidelines/standards in one environmental medium, its corresponding maximum concentration in other media (soil, sediment, surface water, or groundwater) was also screened in, as appropriate, for input into the PQRA spreadsheets for detailed exposure calculations. Since the ERA did not involve a quantitative approach, COPCs in each media were identified, but their respective concentrations in other media were not screened into exposure models.

Tables 6-1 (soil), 6-2 (sediment), 6-3 (surface water), 6-4 (groundwater) provide the summary statistics (number of samples, average, standard deviation, minimum, maximum), screening criteria, and sample associated with the maximum concentration for sampled media.

Table 5-1: COPCs screened into the Human Health Risk Assessment

COPCs in Soil (ug/g)	COPCs in Sediment (ug/g)	COPCs in Groundwater (ug/L)
F1 (120)	*F1 (250)*	**F1 (2280)**
F2 (6100)	**F2 (570)**	**F2 (9600)**
Benzene (0.69)	**Benzene (0.097)**	*Benzene (5)*
Toluene (1.4)	*Toluene (0.28)*	*Toluene (79.1)*
Ethylbenzene (0.7)	*Ethylbenzene (0.12)*	**Ethylbenzene (37.1)**
Boron (1.8)	**Boron (4.7)**	*Boron (NA)*
Copper (870)	*Copper (9.9)*	*Copper (200)*
Lead (170)	*Lead (13)*	**Lead (23.6)**
Zinc (385)	*Zinc (57)*	*Zinc (27)*

Chrysene (2.8)	*Chrysene (0.04)*	*Chrysene (0.1)*

- *Bold lettering indicates the substance concentration exceeded guidelines in that specific media*.

Surface water samples were collected from shallow pond areas and flowing waters in AECs 1, 2, and 3. No COPCs to human health were identified from screening surface water data.

Table 5-2: COPCs screened into the Ecological Qualitative Risk Assessment

COPCs in Soil (ug/g)	**COPCs in Sediment (ug/g)**	**COPCs in Groundwater (ug/L)**	**COPCs in Surface Water (ug/L)**
F2 (C10-C16) (6100)	Benzene (0.097)	F1 (C6-C10) (2280)	Boron (250)
F3 (C16-C34) (11 000)	Xylenes (total) (0.6)	F2 (C10-C16) (9600)	Cadmium (0.4)
Copper (870)	F2 (C10-C16) (570)	Cadmium (0.11)	Copper (10.9)
Zinc (385)	Boron (4.7)	Copper (200)	Iron (590)
Benzene (0.69)	Acenaphthene (0.02)	Iron (1100)	Zinc (110)
Ethylbenzene (0.7)	Fluorene (0.028)	Lead (23.6)	
Toluene (1.4)	1-Methylnaphthalene (0.4)	Naphthalene (39.0)	
	2-Methylnaphthalene (0.39)		
	Naphthalene (0.11)		

Substances that were screened out of the PQRA or ERA, and the rationale for screening them out as COPCs for human and ecological receptors are included in Table 5-3.

Table 5-3: COPCs screened out of the PQRA and/or ERA

COPC	Rationale for exclusion from the PQRA and/or ERA
Sodium *(Excluded from PQRA and ERA)*	• Sodium concentrations observed at the site are not from anthropogenic sources (ie are naturally occurring). Sodium in a natural alkali element present in the earth's crust and can be produced by the weathering of salt deposits and contact of water with igneous rock. Most soils range in content from 0.1 to 1% (Health Canada Technical Document Updated December 1992). Mean sodium concentration in site soils is 326 mg/kg (Jacques Whitford, 2006) indicating that the sodium content of soils onsite is approximately 0.0326%, below the average content of Canadian soils. • Sodium content in surface water (32.8-49.1 mg/L) and groundwater (6-130 mg/L) samples collected by Jacques Whitford (2006) onsite and in the Site vicinity are within the background ranges for Canadian surface waters and groundwater (Health Canada Technical Document Updated December 1992). • Sodium content of vegetation collected onsite was variable (61-920 ppm) and exceeded the OMOE vegetation upper limits of normal (50ppm). However, studies undertaken in Nunavut, investigating the elemental composition of vegetation (lichen, mosses, vascular plant leaves) indicated mean Na concentrations of 783.1 ppm, 1475.3 ppm, and 50.4 ppm for sampled lichen, mosses, and vascular plant leaves respectively (Chiarenzelli et al. 2001). The sodium concentration in vegetation collected onsite falls within this range of concentrations. Additionally, vegetation observed onsite was abundant in wetland areas and appeared unstressed. It is expected that some vegetation in the Canadian high arctic is capable of tolerating high sodium contents without causing visible signs of phytotoxicity.
Aroclor 1262 and 1268 *(Excluded from PQRA)*	•There are no available soil or sediment criteria for the protection of human health for Aroclor 1262 and Aroclor 1268. However the concentrations of these contaminants in soil and sediment are non-detect (ND) in all samples analyzed.
Octachloro-styrene *(Excluded from PQRA)*	•There are no available soil criteria for the protection of human health for Octachlorostyrene. However the concentrations of this contaminant in soil are non-detect (ND) in all samples analyzed.
Total Glycol *(Excluded from PQRA)*	•There are no available surface water or groundwater criteria for the protection of human health for total Glycol. However the concentrations of this contaminant in surface water and groundwater are non-detect (ND) in all samples analyzed.
Zirconium *(Excluded*	•There are no available water criteria for the protection of human health for Zirconium. However the concentration of this contaminant in groundwater is ND in 10 of 11 groundwater samples collected. The sample (1-MW-14) with a detectable concentration of zirconium (1 µg/L) is at the lower end of the method

from PQRA)	detection limit range (1-5 µg//L) for analysis of this parameter.
Acenaphthylene *(Excluded from PQRA and ERA)*	•Acenaphthylene concentrations are non-detect in 22 of 24 soil samples collected onsite (2-TP-8 (0.2 µg/g) and FL-TP6-SA1 (0.07 µg/g) only one of which exceeds the OMOE guideline. •Acenaphthylene has a toxic/potency equivalence factor (TEF) of 0.001 relative to benzo[a]pyrene (Law et al. 2002), which indicates that acenaphthylene is approximately 1000x less toxicity than benzo[a]pyrene. The CCME soil guideline considered protective of human health for benzo[a]pyrene is 0.37 µg/g (CCME 2008). Based on the benzo[a]pyrene concentration and the TEF, acenaphthylene concentrations in soil on site are below the CCME benzo[a]pyrene guideline of 0.37 µg/g guidelines and the TEF-modified benzo[a]pyrene value of 370ug/g. •As a comparative measure between guidelines both soil samples with detectable acenapthylene concentrations are below the Alberta Environment (ANEV) Tier I Soil Remediation Guidelines for coarse soils, commercial land use value of 6.0 µg/g. ANEV guidelines are applicable to the specific characteristics of the Site, and like the OMOE guidelines have been developed to be protective of human health as well as environmental health.
Calcium *(Excluded from PQRA)*	•Calcium is the fifth most abundant element, and its presence in freshwater systems can be attributed to the weathering of rocks (e.g. limestone) and soil seepage, leaching and runoff. Calcium concentrations in water are dependant of the residence time of water in calcium rich geological formations (Health Canada- Technical Document 1987). As mentioned previously this particular Site is characterized by mostly sedimentary rocks consisting of limestone, argillaceous limestone, dolomite, and calcareous shale (Thorsteinsson and Kerr, 1968), which leads to the highly calcareous soils on the island. •Calcium concentrations in surface waters are variable, drinking water in Canada can contain between 1100 and 112 800 µg/L calcium (Health Canada- Technical Document 1987). The maximum cacium concentration (100 000 µg/L) detected in surface waters in the Site vicinity are within this range. •Calcium absorption in the body is primarily regulated by the lining of the small intestine, its intracellular and extracellular concentrations are highly regulated by cellular mechanisms and hormones in the bloodstream, and excretion is via urine and feces. High dietary levels of calcium can result in the reduced absorption of other inorganic minerals, constipation, and the risk or kidney stones. However dietary calcium intake is also correlated to the prevention of osteoporosis and the prevention of colon cancer among other benefits (Health Canada- Technical Document 1987). •Efforts to reduce calcium in drinking water are mainly due to aesthetic reasons (e.g. reducing water hardness) and there is no evidence of adverse health effects that can specifically be attributed to calcium in drinking waters (Health Canada- Technical Document 1987).
Iron *(Excluded from PQRA)*	•Iron is the fourth most abundant element in the earth's crust and its presence in waters can be attributed to the weathering of rocks and minerals. Iron is generally found in surface waters as salts containing Fe(III) when the pH >7. Most of the salts are insoluble in water and settle out or are adsorbed into surfaces (Health Canada Supporting Documentation 1978). •Concentrations of iron in Canadian surface waters are generally below 10 000 µg/L, but based on data collected from National Water Quality Database (NAQUADA) stations range between 1.0 – 90 000 µg/L in

	lakes and rivers across Canada (Health Canada Supporting Documentation 1978). The maximum concentration detected in surface water (590 µg/L) and groundwater (1100 µg/L) samples from the sites are within this range. •Iron is an essential element for human health, integral to the functioning of cytochromes, porphyrins, and metalloenzymes. Its absorption occurs mainly through the intestines upon dietary intake. Iron toxicity is mainly due to underlying disease etiologies, and dietary over-ingestion. Total daily intake of iron from food, air, and water for an average adult is approximately 18 000 µg /day (Health Canada Supporting Documentation 1978). •The Health Canada 2008 Drinking Water Quality Guideline for iron (300 µg/L) is currently not health based but an aesthetic objective based on the evidence that concentrations over 300 ug/L tend to cause rust coloured silt in water supplies, which is unpalatable, stains clothing, and above this concentration can promote the growth of iron bacteria in water systems (Health Canada Supporting Documentation 1978). •Groundwater and surface waters in the site vicinity are not potable and the application of drinking water standards to waters onsite is a measure of conservatism in this human health assessment.

6.0 HUMAN HEALTH RISK ASSESSMENT

6.1 PQRA Objectives

The PQRA was conducted in accordance with the Health Canada guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) guidance documents *Federal (Contaminated Site Risk Assessment in Canada - Parts I, II, III and IV,* September 2004, June 2007, and 2009 drafts). These documents were specifically developed for PQRA, and are useful in developing this PQRA as this is the first evaluation of overall risk to human health that has been completed on this site.

6.2 Problem Formulation

The problem formulation is the first and most critical step of a risk assessment process. The purpose of this step is to identify substances that potentially have adverse effects to human receptors. The result of the problem formulation step is a Conceptual Site Model (CSM) which represents the current understanding of the sources of contamination, release and transport within and among environmental media, and exposure and pathways by which contaminants may contact receptors. This phase involves:

1. Screening and identification of contaminants of potential concern (COPCs);
2. Identification and description of potential receptors based on the current and future use of the site; and
3. Identification of operable exposure pathways.

Consistent with the recommendations of Health Canada (Health Canada, 2007), this human health risk assessment assumes that the current land use will remain unchanged.

6.3 Identification of Contaminants of Potential Concern

Please refer to Section 5.0 of this report for contaminants of potential concern identified in soil, sediment, groundwater and surface water, and their respective concentrations screened into Health Canada PQRA models for further evaluation of exposure and risk to onsite receptors.

6.4 Identification of Potential Receptors

Characterization of potential human receptors should consider present and future land uses. Potential human receptors at the site include:

- Adult airport employees involved in operational and maintenance activities onsite. Personal communication with onsite airport employees indicates that employees are not likely to conduct activities on the landfill or vehicle storage areas. However, to be conservative, it was assumed that airport employees would be present in these areas for short periods of

time (1 day/wk) during routine activities (e.g. wildlife sighting, airport grounds inspections) on airport land. This would be considered a chronic exposure scenario.

- Remedial workers or adult construction workers involved in demolition, remediation and maintenance activities at the Site. These workers would be onsite for intense short term exposures (acute) during the summer season. Workers returning to the site would be considered in a chronic exposure scenario as well.
- Potential adult hotel employees at the new hotel under construction on the edge of the Historic Landfill (AEC 2). Employees at the hotel could be exposed to contamination because of their presence at the site. However, there are no known activities where there would be routine exposure. Exposure would be incidental in nature.
- Hotel patrons would be at the Site for short durations during the summer season, however, there are no reasonable scenarios where hotel patrons would be exposed to significant contamination in soil or water.

Other receptors such as the general public and local residents have been considered, but are not considered potential receptors. The airport is approximately 5km from the hamlet and the AECs do not have any significant features which would lead to its routine use by the general public or local residents. The presence of a community landfill near the hamlet reduces the need for residents to use the landfills.

6.5 Identification of Operable Exposure Pathways

An exposure pathway is a mechanism by which a human receptor is exposed to chemicals from a source. The following four elements constitute a complete exposure pathway.

- A source and mechanism of chemical release;
- A retention or transport medium;
- A point of potential receptor contact with the affected medium, and
- A means of entry into the body (e.g. ingestion) at the contact point.

Complete pathways therefore, represent situations where there is a potential for receptors to be exposed to the contaminants. Incomplete pathways represent situations where exposure or contact with the contaminant is unlikely to occur and there is therefore no risk to the receptor. Several possible contaminant exposure pathways may exist at a site.

Groundwater Ingestion

The site is a non-potable land use environment. Ingestion of groundwater is therefore not considered an operable exposure pathway.

Groundwater- Dermal Contact with Water

Exposure to COPCs in groundwater has been considered to occur through dermal contact. Based on field data the groundwater table onsite is inferred to be shallow. Receptors at risk of exposure to contaminants in groundwater are remediation/construction workers. It is assumed that remediation/construction workers would be wearing coveralls and boots, and that exposed skin surface area would be limited to hands and arms.

Surface water - Dermal Contact with Water

There are no surface water features on the AECs which would lead to recreational exposure. The potential for dermal contact by human receptors (hotel employees, airport employees) with surface waters is considered unlikely and an incomplete exposure pathway. Contact to groundwater by remediation workers is considered a more conservative expression of exposure since COPC concentrations are typically higher in groundwater than surface water.

Sediment – Dermal Contact

The site is in the zone of continuous permafrost. As stated previously, the average monthly temperature is below 0°C for ten months of the year. The active warm months are July and August, which daily average temperatures are 4.3 ºC and 1.5 ºC, respectively. The potential for dermal contact of receptors with surface water sediment onsite is considered negligible.

Food Sources - Ingestion

There are no known gardens or significant food sources in this area, particularly not in the areas associated with contaminated media (landfill areas and vehicle dump areas). As such, the ingestion of contaminated food or traditional country foods has not been considered as a complete exposure pathway for this human health risk assessment.

Soil – Dermal Contact, Ingestion, and Inhalation of Vapours

Exposure to COPCs in contaminated soil is possible through incidental ingestion of soil particulates, dermal contact with soil, and particulate inhalation (inhalation of fugitive dust). Dermal contact is assumed for hands, arms, lower legs, and feet.

Exposure to volatile COPCs present in soil through outdoor inhalation of soil vapours is not considered an operable exposure pathway. The presence of a continuous permafrost layer prevents the use of subsurface utility conduits and subsurface building foundations where construction and utility workers may typically be exposed to high concentrations of volatile COPCs in the confined spaces of utility trenches and excavations.

Vapour intrusion into buildings on site is also not considered an operable exposure pathway. Buildings present onsite (in the vicinity of the AECs) are not erected slab on grade due to the

shifting of land during the annual freeze-thaw cycle in the permafrost layer. The airspace beneath buildings would decouple the vapour migration pathway from the soil into the building, thus the force driving vapour intrusion into buildings is negligible from the soil.

6.6 Conceptual Site Model

The Conceptual Site Model (CSM) represents the current understanding of the sources of contaminants, release and transport within and among environmental media onsite, and exposure and pathways by which they may contact receptors. The COPCs for the operable exposure pathways are petroleum hydrocarbon fraction (F1) and (F2), benzene, toluene, ethylbenzene, chrysene, boron, copper, lead, and zinc. The CSM is represented in Figure 6-1. As shown, the operable pathways are:

- Incidental ingestion of soil;
- Inhalation of soil particulates;
- Dermal contact with soil
- Dermal contact with groundwater

6.7 Problem Formulation Checklist

The land use, receptors and identified complete exposure pathways in establishing the problem formulation step is summarized as follows.

Problem Formulation Checklist

	Land Uses (check as appropriate)		**Receptor Group(s) (check as appropriate)**		**Critical Receptors (check as appropriate)**		**Exposure Pathways (check as appropriate)**
	Agricultural		General Public		Infant	√	Soil Ingestion
	Residential/urban parkland	√	Employees		Toddler	√	Soil Dermal Absorption
	Commercial with daycare	√	Construction Workers		Child	√	Particulate Inhalation
√	Commercial without daycare		Native Communities		Teen		Vapour Inhalation
	Industrial			√	Adult- Hotel Employee	√	Dermal Contact with water
	Consumption of Traditional Country foods			√	Adult- Site Remediation Worker		Country Food Ingestion
	Recreational			√	Adult- Airport Employee		

7.0 EXPOSURE ASSESSMENT

An exposure assessment estimates the dose of each COPC for each potential receptor (e.g. hotel employee and remedial worker). The following sections present the key parameters that are used to estimate exposure. Most of the assumptions are taken from Health Canada's Federal Contaminated Site Risk Assessment in Canada. Part 1-Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA), Version 2 (June 2007).

A toxicity assessment for an acute exposure scenario was also considered in the PQRA for the remediation worker receptor. To assess potential risks from short-term contaminant exposure (5 days/week for 14, weeks) under this scenario, doses (mg/kg/day) of threshold response chemicals (non-carcinogens) were compared to chronic toxicity reference values (TRVs) without additionally amortizing the exposure over a yearly period. Derived sub-chronic hazard quotients were then used to quantitatively assess the acute risks from contaminant exposure.

7.1 Characterization of Potential Receptors

The characteristics for the potential receptors used in this PQRA were mainly obtained from Health Canada (June 2007).

Parameters	Airport Employee	Hotel Employee	Remedial Worker
Age	≥ 20 y	≥ 20 y	≥ 20 y
Body Weight (kg)	70.7	70.7	70.7
Soil Ingestion Rate (g/d)	0.02	0.02	0.1 [b]
Inhalation rate (m^3/d)	15.8	15.8	15.8
Total skin surface area (cm^2)	9110 [a]	9110 [a]	3390
Soil loading to exposed skin (g/cm^2/event)	$1X10^{-4}$	$1x10^{-4}$	$1x10^{-4}$

[a] Surface area per Richardson, G.M. (1997)
[b] (Health Canada, PQRA guidance Part I, 2004)

The exposed skin surface area applied to the airport employee and hotel employee scenarios was the sum of the adult skin surface area for hands, arms, and legs as determined from Richardson, G.M. (1997). These are conservative estimates of exposed skin surface area for receptors given that the site is located within an arctic climate and potential receptors onsite would be expected to have legs and feet covered year-round.

The skin surface area applied for the site remediation worker scenario was obtained from the "Human Health Risk Assessment Supplemental Guidance, Exposure Assessment for the Construction and Utility Worker" prepared for Health Canada by Dillon Consulting Ltd. (March 2005). This exposed skin surface (3390 cm^2) area is the adult skin surface area for the hands and upper and lower arms as derived by Richardson, G.M. (1997). Given the arctic climate of the site and workplace safety regulations this exposed skin surface estimate is considered reasonable.

7.1.1 Exposure Frequency and Duration

Assumptions concerning exposure frequency and duration are mainly derived from Health Canada (2004 and 2007 updates) for commercial land use and construction/remediation workers, as well as site-specific exposure assumptions for remedial workers. The assumptions for all receptors are considered to be conservative because there are no known or reasonably foreseeable routine activities at these AECs, and remedial work is not yet routinely conducted at the site.

Exposure Frequency and Duration – All Operative Pathways

Scenario	Airport Employee (chronic)	Remedial Worker (acute)	Remedial Worker (chronic)	Hotel Employee (chronic)
Hours per day (indoors)	0	0	0	8.0
Hours per day (outdoors)	4	10	10	1.5 [a]
Days per week	1	6	6	5
Weeks per year	14	14	14	50
Dermal exposure events per day	1	1	1	1
Water contact events per day	0	1	1	0
Duration of water contact event (h)	0	1	1	0
Days/year of contaminated food ingestion	0	0	0	0
Exposure Duration (years)	60	0.27 (98 days)	5	60
Years for carcinogen amortization	60	5	5	60

[a] Time outdoors (adult) - Richardson, G.M. (1997)

These assumptions are considered to be conservative because:

- Hotel employee - It was assumed that the hotel employee would be a resident of the Resolute hamlet and work full time (40 hours/week) at the hotel being built onsite. In this scenario it was assumed that time not spent indoors, or outdoors (1.5 hr/day) onsite would be spent offsite.

- Remedial Workers - It was assumed that long term remediation work would be conducted annually during summer months (6 days/week, 14 weeks/year). Albeit, remedial work is not routinely conducted at the site there is the potential for some remedial work in the next 3 to 5 years.
- Remedial Workers - The potential for dermal contact with groundwater is realistic as the groundwater table is shallow onsite. However given the arctic climate of the Site, it is deemed unlikely that remedial workers would be in dermal contact with groundwater for up to 9 hours/day ("Human Health Risk Assessment Supplemental Guidance, Exposure Assessment for the Construction and Utility Worker" prepared for Health Canada by Dillon Consulting Ltd. (March 2005)). Daily one hour dermal exposures to groundwater are considered a conservative estimate of exposure duration for remedial workers under these site specific conditions;
- Ground cover - It is likely that exposure pathways related to incidental contact with soil, or inhalation of fugitive dust particles would be **inoperable** during months when snow is present. Though Resolute Bay is characterized by a dry arctic climate, precipitation usually in the form of snowfall tends to occur from August to September. The average annual precipitation is 150 mm, with 50.3 mm of annual rainfall and 110.3 mm of annual snowfall, therefore the ground surface at the site is covered or frozen for much of the year.

7.2 Exposure Equations and Models

For this PQRA, the estimates of exposure were based on standard risk assessment equations used by Health Canada (2004 and 2007 update), and the Health Canada PQRA spreadsheet model: *Federal Contaminated Site Risk Assessment in Canada Part IV* was used to estimate exposures through dermal contact, soil ingestion and particulate inhalation. Equations used in the model are provided in Appendix C.

7.3 Relative Absorption Factors

Bioavailability is the degree to which a chemical or other substance is absorbed or becomes physiologically available to cause an adverse effect. Bioavailability is generally less than 100% of the amount of contaminant to which there is exposure. The amount of absorption will depend on the contaminant's chemical form, the exposure pathway, biological and individual susceptibility, and absorption characteristics. The default Relative Absorption Factors (RAF) from the Health Canada PQRA spreadsheet model: *Federal Contaminated Site Risk Assessment in Canada Part IV* (2009) were applied in this preliminary risk assessment. Bioavailability is assumed to be 100% for the ingestion and inhalation pathways as per Health Canada guidance (2004 and 2007).

8.0 TOXICITY ASSESSMENT

The toxicity assessment identifies toxicity reference values (TRV) with which to compare estimated exposure at a site in order to estimate risk. For this PQRA default TRVs from the spreadsheet tool *Federal Contaminated Site Risk Assessment in Canada: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) Part IV, 2009*) were applied.

8.1 Carcinogens and Non-Carcinogens

Of the COPCs, benzene and chrysene are considered carcinogenic. Exposures to these carcinogenic substance was estimated for all potential receptors using the default exposure duration in the spreadsheet tool (Health Canada PQRA Guidance Part IV, 2009) as a measure of conservatism for all receptors.

The non-carcinogens for this PQRA were boron, copper, lead, zinc, toluene, ethylbenzene, and PHC F1 and F2.

8.2 Toxicological Effects

A description of the toxicological effects or health concerns of the contaminants of potential concern are summarized as follows:

				Health Concern or Target Organ [1,4,5]											
COPC	***Toxicity Reference Values (mg/kg-d) and Slope factors ((mg/kg-d)-1)***	***Non Carcinogen***	***Carcinogen***	Brain & Nervous System (neurotoxicity)	Liver (hepatic changed)	Blood circulation/pressure (haematological changes)	Decrease in body weight	Kidney (nephrotoxicity)	Lung/Respiratory system	Bladder	Skin (exterior and orifice)	Digestive system	Reproductive system	Eyes	Immune System
PHC-Fraction 1	*See footnote 6*	x		X	X	X	X								
PHC-Fraction 2	*See footnote 6*	x			X	X	X								
benzene	Oral SF(0.226) Inhal. Unit Risk (0.0033) [2]		x	X		X									X
toluene	0.22	x		X	X	X		X	X			X	X	X	
ethylbenzene	0.1	x		X	X			X	X		X				
chrysene	Oral SF(0.023) Inhal. Unit Risk (0.00031) [2]		x		x						x				x
boron	0.0175	x		X							X	X	X		
copper	0.141	x			X			X				X			
lead	0.0036	x		X		X		X				X	X		X
zinc	0.566	x				X					X	X			

[1] Denotes main health concerns or target organs, others may exist

[2] Oral and Inhalation slope factors (mg/kg-d)-1 or inhalation unit risk (mg/m3)-1 used to derive an estimate of potential incremental lifetime cancer risk (ILCR) for carcinogenic substances

[3] All TRVs were sourced from Health Canada PQRA Guidance Part IV , 2009.

[4] Concerns are related to oral, dermal and/or inhalation pathways

[5] Toxicological effects of contaminant exposure are sourced from the USEPA RAIS (Risk Assessment Information System) Toxicological Profiles, ATSDR (Agency for Toxic Substances or Disease) Toxicological Profiles, CCME, and Health Canada Technical Documents.

[6] PHC F1 mixture TRVs (mg/kg-d): Aliphatics (C6-C8)=5 , Aliphatics (C8-C10)=0.1, Aromatics (C8-C10)=0.04
PHC F2 mixture TRVs (mg/kg-d): Aliphatics (C10-C12)=0.1, Aliphatics (C12-C16)=0.1, Aromatics (C10-C12)=0.04, Aromatics (C12-C16)=0.04 (TRVs were sourced from Health Canada PQRA Guidance Part IV , 2009).

8.3 Evaluation of Potential Toxic Interactions

Typically, criteria, guidelines, and standards developed by provincial and federal regulatory agencies are unable to account for potential interactions between contaminants within mixtures (e.g. landfill leachaete). Currently, chemical interactions (additive, synergistic, and/or antagonistic) in environmental mixtures are not well characterized. The approach of summing the HQ values is a conservative measure of dealing with potential toxic interactions, and may be overly protective in its assumption that mixture contaminants will interact at the same cellular targets and via the same mechanisms of action in the body.

Carcinogenic PAHs have been detected at levels exceeding EQGs onsite, and as such the Overall Estimate of Incremental Lifetime Cancer Risk (ILCR) for onsite receptors entailed summing the estimated ILCRs for these substances.

9.0 PQRA RISK CHARACTERIZATION

The risk characterization stage brings together all the previous components of the risk assessment into an overall quantitative assessment of the potential health effects to each human receptor.

For substances presenting risks other than cancer, a Hazard Quotient (HQ) is derived as the ratio of the estimated exposure to an appropriate toxicity reference value (TRV) according to the following equation:

$$\text{Hazard Quotient} = \frac{\text{Estimated Exposure}}{\text{Toxicity Reference Value}}$$

Toxicity risks are evaluated separately for each contaminant and pathway. For purposes of this risk assessment, exposures associated with HQ ≤ 0.2 will be deemed negligible (Health Canada, 2007, 2009).

For simultaneous exposure to multiple COPCs, the HQ is assumed to be additive and the sum of the hazard quotients for each COPC and pathway with the same target organ should not exceed 0.2 to be considered acceptable (Health Canada, 2007).

For substances deemed to be carcinogenic, the estimated exposure should be multiplied by the appropriate slope factor or unit risk to derive a conservative estimate of the potential incremental lifetime cancer risk (ILCR). Cancer risks are considered negligible if the estimated ILCR is less than or equal to 1-in-100,000 or 1.00E-05 (Health Canada, 2007).

9.1 Summary of Hazard Quotients

Hazard Quotient (HQ) calculations using the Health Canada spreadsheet model are shown in Appendix B. Maximum calculated HQs are shown in Table 9-1.

Table 9 –1: Maximum Hazard Quotients - All Operative Pathways

COPC	Pathways	Adult- Airport Employee	Adult- Remediation Worker	Adult- Hotel Employee
METALS				
boron	oral/dermal	1.21E-06	3.40E-05	2.17E-05
	inhalation	1.12E-10	1.68E-09	7.50E-10
	Total	1.22E-06	3.40E-05	2.17E-05
copper	oral/dermal	1.02E-04	2.17E-03	1.81E-03
	inhalation	6.72E-09	1.01E-07	4.50E-08
	Total	1.02E-04	2.17E-03	1.81E-03
lead	oral/dermal	5.40E-04	1.55E-02	9.65E-03
	inhalation	5.14E-08	7.71E-07	3.44E-07
	Total	5.40E-04	1.55E-02	9.65E-03
zinc	oral/dermal	1.37E-05	2.48E-04	2.45E-04
	inhalation	7.41E-10	1.11E-08	4.96E-09
	Total	1.37E-05	2.48E-04	2.45E-04
PHC				
benzene	oral/dermal	NA	NA	NA
	inhalation	NA	NA	NA
	Total	NA	NA	NA
toluene	oral/dermal	8.70E-08	2.00E-04	1.55E-06
	inhalation	1.57E-12	2.35E-11	1.05E-11
	Total	8.70E-08	2.00E-04	1.55E-06

ethylbenzene	oral/dermal	9.57E-08	3.74E-04	1.71E-06
	inhalation	3.15E-12	4.73E-11	2.11E-11
	Total	9.57E-08	3.74E-04	1.71E-06
Fraction 1	oral/dermal	2.11E-05	***2.83E-01***	3.77E-04
	inhalation	4.68E-10	7.02E-09	3.13E-09
	Total	2.11E-05	***2.83E-01***	3.77E-04
Fraction 2	oral/dermal	2.34E-03	***4.41E+00***	4.18E-02
	inhalation	5.32E-08	7.97E-07	3.56E-07
	Total	2.34E-03	***4.41E+00***	4.18E-02
PAH				
chrysene	oral/dermal	NA	NA	NA
	inhalation	NA	NA	NA
	Total	NA	NA	NA

NA-Health Canada did not provide a TDI for this pathway
Bold and Underlined values exceed the acceptable HQ of 0.2

The target HQ of 0.2 has been exceeded for:

- One receptor and multiple COPCs
    - PHC Fraction 1 & 2 (oral/dermal); site remediation worker
- The sum of the HQ's for the site remediation worker receptor
- The sum of the HQs for COPCs with similar target organs for toxic mechanisms of action

The results indicate that the unacceptable risk is primarily a function of oral/dermal exposures. The modeling suggests that the highest potential risk is from the oral/dermal exposure for the following listed in order of descending HQ: PHC F2, and PHC F1. Note that the PQRA calculations are estimates only and do not represent actual risks.

9.1.1 Evaluation of Sub-Chronic Risk

The Health Canada PQRA spreadsheet model is primarily developed to evaluate chronic health risks from contaminant exposures. As such, the equations built into the PQRA model averages short term exposures over a yearly period.

In the case of receptors (e.g. site remediation worker) which are likely subject to an intense short term exposure to contaminated media, amortizing a short term exposure duration over a yearly period does not account for acutely toxic effects that may result from short term exposure episodes.

Short term exposures (mg/kg-d) through oral, dermal and inhalation of soil particulate pathways were calculated for the exposure episode (6 days/week for 14 weeks, without amortizing the exposure over a yearly period). A sub-chronic hazard quotient was derived for each COPC by comparing total short term exposures (mg/kg-d) to chronic toxicity reference values (mg/kg-d) (Health Canada, 2009) for each COPC. Derivation of these sub-chronic hazard quotients for the site remediation worker is included in Appendix C. Non-carcinogenic COPCs with sub-chronic HQ ≤ 1.0 were deemed to be of negligible risk (Wilson Scientific Consulting Inc., 2007).

Derived Sub-chronic Hazard Quotients for Non-Carcinogens

COPC	HQ	COPC	HQ	COPC	HQ
Boron	1.27E-04	**Ethylbenzene**	1.39E-03	**PHC F2 (Aromatics C10-C12)**	1.68E+00
Copper	8.07E-03	**PHC F1 (Aliphatics C6-C8)**	1.77E-02	**PHC F2 (Aliphatics C12-C16)**	5.87E+00
Lead	5.78E-02	**PHC F1 (Aliphatics C8-C10)**	4.36E-01	**PHC F2 (Aromatics C12-C16)**	5.85E+00
Zinc	9.25E-04	**PHC F1 (Aromatics C8-C10)**	6.03E-01		
Toluene	7.44E-04	**PHC F2 (Aliphatics C10-C12)**	3.02E+00		

The results of this modeling suggest that the target HQ of 1.0 has been exceeded by COPC mixture PHC F2, for the site remediation worker over a short term exposure duration, and that unacceptable risk is mainly a function of oral/dermal exposure (see Appendix C). Note that the sub-chronic HQ calculations are estimates only and do not represent actual risks.

9.2 Summary of Carcinogenic Risks

Estimates of Incremental Lifetime Cancer Risk (ILCR) were made using the Health Canada spreadsheet tool and are shown in Appendix B. The maximum calculated ILCRs are shown in Table 9-2.

Table 9-2: Estimate of Potential Carcinogenic Risks - All Operative Pathways

	ILCR Risk Estimate- Benzene	ILCR Risk Estimate- Chrysene	ILCR Risk Estimate- Total
Airport Employee - Adult			
Cancer Risk from Oral/Dermal Exposure	2.13E-09	1.48-09	
Cancer Risk from Inhalation Exposure	8.83E-15	4.23E-15	
Cancer Risk - Total	2.13E-09	1.48E-09	3.61E-09
Remediation Worker- Adult			
Cancer Risk from Oral/Dermal Exposure	3.44E-07	6.53E-08	
Cancer Risk from Inhalation Exposure	1.32E-13	6.34E-14	
Cancer Risk - Total	3.44E-07	6.53E-08	4.09E-07
Hotel Employee- Adult			
Cancer Risk from Oral/Dermal Exposure	3.81E-08	2.64E-08	
Cancer Risk from Inhalation Exposure	5.91E-14	2.83E-14	
Cancer Risk - Total	3.81E-08	2.64E-08	6.44E-08

Bold and Underlined values exceed the maximum acceptable ILCR of 1.0E-05.

The Health Canada recommended threshold for ILCR (1.0E-05) has not been exceeded by benzene and chrysene exposures to any of the site receptors. The modelling suggests that benzene and chrysene exposures to identified potential receptors does not significantly increase

their incremental lifetime cancer risk (ILCR). Note that the PQRA calculations are estimates only and do not represent actual risks.

9.2.1 Summary of Risk Characterization

The risk characterization has shown there are unacceptable risks for onsite remediation workers from exposure to two of the COPCs.

For threshold response chemicals (non-carcinogens), the unacceptable chronic risks (HQ > 0.2) to site remediation workers are due to oral/dermal exposure to petroleum hydrocarbons (Fraction 1 and Fraction 2) via accidental ingestion of contaminated soil particles, inhalation of contaminated soil particles (fugitive dust), and dermal contact with contaminated soils and groundwater.

Derivation of sub-chronic hazard quotients to assess acute risks to site remediation workers from short-term exposure to non-carcinogens suggest that the target HQ of 1.0 has been exceeded by the COPC mixture PHC F2, and that unacceptable sub-chronic risk is mainly a function of oral/dermal exposure.

For non-threshold chemicals (carcinogens) such as benzene and chrysene, the ILCR (1.0E-05) has not been exceeded by benzene and chrysene exposures to any of the site receptors. Note that the PQRA calculations are estimates only and do not represent actual risks.

9.2.2 Risk Management

The outcomes of the PQRA indicate that remediation or risk management measures are required to reduce the risks to human health (for site remediation workers) at the site. The main risks to human receptors are associated with PHCs in soils.

To manage the potential risks from onsite exposure, all workers involved in remediation work should follow a site specific health and safety plan; and adhere to general PPE guidance (e.g. wear appropriate personal protective equipment (gloves, long-sleeved clothes, pants) and practice prudent hygiene (e.g. wash hands prior to eating and when exiting the site)).

9.3 PQRA Uncertainty Evaluation

Sources of uncertainty associated with modeling in risk assessment can include variability in input parameters due to spatial and temporal variation in the parameters, lack of data for key parameters, and the structure of the model due to simplification and assumptions within the model.

The table below describes some of the uncertainties associated with this preliminary quantitative human health risk assessment.

Uncertainty Analysis

Factor	Uncertainty	Effect on Risk Assessment
Model Assumptions Regarding Patterns of Exposure	<u>User Defined Exposure Scenario</u> The user-defined exposure scenarios were based on assumed patterns of access to the site for specific receptors. These assumptions are believed to reasonably over-estimate exposures at the site. The actual pattern of exposure at the site for these specific receptors is not known, however, there are no known routine activities or planned activities at the AECs.	Overestimation. Estimated pattern of exposure believed to be overestimation. This overestimation of exposure will result in an overestimation of risk.
Model Assumptions Regarding Receptor Characteristics	The risk assessment was based on assumed generic receptor characteristics provided in the Health Canada guidance and as determined based on site specific information, while actual receptor characteristics may differ from these standard assumptions. Any variance in actual receptor characteristics (e.g. weight, soil and water ingestion, inhalation rates, etc.) to the standard values of the model will be a source of uncertainty.	Possible over-estimation of risks to user defined receptors
Model Assumptions Regarding Contaminant Concentrations and Distributions	<u>Concentration of Contaminants</u> There is always uncertainty associated with the collection and analysis of environmental sampling data. Sources of uncertainty typically include: • Which samples are collected and assumed to represent actual site conditions; and • Inherent variance in procedures for sample collection, shipment/storage and laboratory analysis.	Unknown. However many of the known and highly toxic chemicals have been accounted for in the PQRA. Additionally, the sampling program was targeted at potential "hotspots" (AECs), and it is reasonable to assume that the data collected may be representative of the highest concentrations at the site (especially considering that for a number of COCs, concentrations were non-detect (ND) in many samples). The contaminant concentrations across much of the site are likely much lower than those used in the calculations, thus the risk estimates are conservatively high.

Factor	Uncertainty	Effect on Risk Assessment
Model Assumptions Regarding Toxicological Mechanisms and Effects	Toxicity reference values used in this assessment are published by regulatory agencies based on animal studies. Toxicity reference values are derived by the extrapolation of the animal study data. Since humans and animals differ in their response to the absorption and distribution of chemicals, the extrapolated toxicity reference values are typically numerically adjusted to add margins of conservatism (safety factors) that are built into the final toxicity reference values.	Unknown. Generally an overestimation of risk will result. Additionally, bioavailability of most COPCs in media (e.g. soil, sediment) was assumed to be 1 (e.g. the contaminant is assumed to be 100% bioavailable). This assumption would result in a highly conservative calculated dose as not all COPCs in soil and sediment are 100% bioavailable.

9.4 PQRA Summary and Conclusions

Purpose and Methodology

A human health RA was conducted using the Human Health Preliminary Quantitative Risk Assessment (PQRA) guidance documents (Health Canada, 2004, 2007, 2009 updates). The PQRA consists of a Site Characterization, Problem Formulation, Exposure Assessment, Toxicity/Hazard Assessment and Risk Characterization. To quantify risks due to the presence of on-site contaminants, the updated version of the Health Canada PQRA spreadsheet model (March 2009) was used.

Chemical Screening

An initial chemical screening process identified the following as Chemicals of Potential Concern (COPCs) based on their concentrations in environmental media. This information was further used as inputs in the PQRA spreadsheets:

boron	**benzene**	**chrysene**
copper	**ethylbenzene**	
lead	**toluene**	
zinc	**PHC Fraction 1**	
	PHC Fraction 2	

Potential Receptors and Operable Pathways

Potential human receptors at the site include:

- Adult airport employees involved in operational and maintenance activities onsite. This would be considered a chronic exposure scenario.

- Remedial workers or adult construction workers involved in demolition, remediation and maintenance activities at the Site. This would be considered as both acute and chronic exposure scenarios
- Potential adult hotel employees at the new hotel under construction on the edge of the Historic Landfill (AEC 2). Exposure would be incidental in nature.

The operable pathways considered for the PQRA were:

- Accidental ingestion of soil particles, and inhalation of soil particles (fugitive dust)
- Dermal contact with soil and groundwater;

Risk Characterization

The target HQ of 0.2 has been exceeded in the site remediation worker receptor chronic scenario, for multiple COPCs. The results indicate that there are unacceptable risks primarily with oral/dermal exposures. The modeling suggests that the highest potential risk is from the oral/dermal exposure for the following listed in order of descending HQ: PHC F2, and PHC F1.

Derivation of sub-chronic hazard quotients to assess acute risks to site remediation workers from short-term exposure to non-carcinogens suggest that the target HQ of 1.0 has been exceeded by the COPC mixture PHC F2, and that unacceptable sub-chronic risk is mainly a function of oral/dermal exposure.

The Health Canada recommended threshold for ILCR (1.0E-05) has been not been exceeded by exposure to carcinogens (benzene and chrysene) for onsite receptors. Note that the PQRA calculations are estimates only and do not represent actual risks.

Conclusions and Risk Management

Based on the high risk estimate (HQ) for the site remediation worker, this PQRA has likely overestimated the risk. This overestimation is consistent with the intent of a PQRA: to provide a protective estimate of potential risks.

To manage the potential oral/dermal exposure to PHCs in soils onsite, workers involved in remediation work should follow a site specific health and safety plan.

10.0 ECOLOGICAL RISK ASSESSMENT (ERA)

This section presents the assumptions, methodologies and results of a qualitative Ecological Qualitative Risk Assessment (ERA) that was conducted to provide an understanding of potential risks to potential ecological receptors based on the environmental conditions at the Resolute Bay Airport Landfills and Vehicle Storage Area Site.

The qualitative screening method used in this ERA is intended to provide a record of the assumptions made in performing this qualitative estimation of risk and to identify the limitations of the data used in this risk estimation process. The results of the qualitative ERA can then be used towards the next stages of a quantitative risk assessment (if needed).

10.1 ERA Objectives

The primary objective of the ERA was to qualitatively assess ecological risks to determine if previously identified COPCs in soil, groundwater, surface water and sediment represent a potential risk to ecological receptors. Unlike the human health risk assessment, the goal of the ERA was not to protect each individual ecological receptor from toxic effects, but rather to protect the viability of populations and the overall community of organisms within the ecosystem.

10.2 Problem Formation

The objective of problem formulation is to identify which chemicals can potentially pose risks to ecological receptors. In the following sections an evaluation of COPCs identified from present and historical activities onsite, ecological receptors, and relevant pathways of exposure was conducted in order to identify which substances had the potential to cause adverse effects to ecological receptors. This information was used to develop an Ecological Conceptual Site Model (ECSM) that represents the current understanding of contaminant sources, release and transport mechanisms within and among environmental media, and exposure pathways by which ecological receptors may be exposed to contaminants.

10.3 Contaminants of Potential Concern

Please refer to Section 5.0 of this report for contaminants of potential concern (and respective maximum concentrations) identified in soil, sediment, groundwater and surface water and screened into the ERA for further evaluation of exposure and risk to onsite receptors.

Information level for COPCs

Information Level	Definition
High	Greater than 20 samples have been analyzed for the COPC in this environmental media.

Low	Greater than 20 samples have been analyzed for the COPC in this environmental media.

- Based on the information level expected for this sample number (Health Canada PQRA Guidance Part I (2007))

Hazard Data for Chemicals of Potential Concern in Environmental Media

Hazard	Max. Conc.	# Exceedences (# samples)	Threshold Limit	Inferred Extent of Contamination	Info. Level
COPCs in soil (µg/g)	F2 (C10-C16)(6100)	6 (39)	260 µg/g [1]	Non-localized (AEC 1 and 2)	High
	F3 (C16-C34) (11 000)	3 (39)	1700 µg/g [1]	Non-localized (AEC 1 and 3)	High
	Copper (870)	4 (39)	91 µg/g [2]	Non-localized (AEC 1,2, and 3)	High
	Zinc (385)	1 (39)	360 µg/g [2]	Localized (AEC 2)	High
	Benzene (0.69)	6 (23)	0.03 µg/g [2]	Non-localized (AEC 1 and 2)	High
	Ethylbenzene (0.7)	4 (23)	0.082 µg/g [2]	Localized (AEC 2)	High
	Toluene (1.4)	1 (23)	0.37 µg/g [2]	Localized (AEC 2)	High
COPCs in GW (µg/L)	F1 (C6-C10)(2280)	1(6)	750 µg/L [3]	Localized (AEC 2)	Low
	F2 (C10-C16)(9600)	3 (14)	150 µg/L [3]	Non –localized (AEC 1 and 2)	Low
	Cadmium(0.11)	10 (11)	0.017 µg/L [4]	Non-localized (AEC 1 and 2)	Low
	Copper (200)	3 (11)	4 µg/L [4]	Non-localized (EC 1 and 2)	Low
	Iron(1100)	3 (11)	300 µg/L [4]	Localized (AEC 1)	Low
	Lead(23.6)	1 (11)	7 µg/L([4]	Localized (AEC 1)	Low
	Naphthalene (39)	2 (7)	1.1 µg/L [4]	Non-Localized (AEC 1 and 2)	Low
COPCs in sedi-ment (µg/g)	Benzene (0.097)	5 (12)	0.03 µg/g [2]	Non-Localized (AEC 1 and 2)	Low
	Xylenes (total) (0.6)	5 (12)	0.025 µg/g [5]	Non-Localized (AEC 1 and 2)	Low
	F2 (C10-C16) (570)	1 (22)	260 µg/g [1]	Localized (AEC 1)	High
	Boron (4.7)	2 (24)	2 µg/g [6]	Non-Localized (AEC 1 and 3)	High
	Acenaphthene (0.02)	18 (18)	0.00671 µg/g[5]	Non-Localized (AEC 1, 2, 3)	Low
	Fluorene (0.028)	1 (18)	0.0212 µg/g [5]	Localized (AEC 1)	Low
	1-Methylnaphthalene (0.4)	1 (18)	0.0202 µg/g [5]	Localized (AEC 1)	Low
	2-Methylnaphthalene (0.39)	1 (18)	0.0202 µg/g [5]	Localized (AEC 1)	Low
	Naphthalene (0.11)	1 (18)	0.0346 µg/g [5]	Localized (AEC 1)	Low
COPCs in surface water (µg/L)	Boron (250)	2 (23)	200 µg/L [7]	Localized (AEC 1)	High
	Cadmium (0.4)	23 (24)	0.017 µg/L [4]	Non-localized (AEC 1,2, and 3)	High
	Copper (10.9)	2 (24)	4 µg/L [4]	Localized (AEC 1)	High
	Iron (590)	3 (23)	300 µg/L [4]	Localized (AEC 1)	High
	Zinc (110)	2 (23)	30 µg/L [4]	Localized (AEC 1)	High

1) CL CWS, CCME 2008 (coarse grained, surface)
2) CL EQG, CCME 2007
3) Table 3, OMOE 2009
4) FWAL, CCME 2007
5) CCME ISQG 2002
6) AL EQG, CCME 2007
7) PWQO, OMOE 1994)

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10.4 Effects Assessment

A secondary chemical screening approach, referred to as a "qualitative screening assessment", was conducted. This assessment employed toxicological benchmark values protective of ecological receptors for each environmental medium.

The effects assessment qualitatively ranked chemicals according to their potential to cause harmful effects to ecological receptors. The ranking is based on the chemicals inherent toxicity to receptor populations, as well as potential for exposure. Evaluation criteria for potential effects on receptors populations and the results of the qualitative screening assessment against toxicological benchmark values are discussed below.

Potential Effects on Receptors

Severity of Effect	Definition
Severe	Expected to affect a population of species in sufficient magnitude to cause a decline in abundance beyond which natural recruitment would not return for that population, or any population or species depending upon it, to its former level within several generations. Expect a major change in ecosystem structure and function. Maximum and/or mean concentration exceeds the toxicity threshold value by greater than 10-fold.
Moderate	Expected to affect a portion of a population that results in a measurable change in abundance and/ or distribution over one or more generations of that population or any population dependant on it., but does not change the integrity of the population as a whole. It may be localized and recovery would be expected over many generations if exposure to COPC was stopped. Maximum and/or mean concentration exceeds the toxicity threshold value by 5 to 10-fold.
Minor	Expected to affect a portion of a population at a localized area and over a short period of time (one generation or less), but not affecting other trophic levels, and having little impact on the size or dynamics of the population itself. Rapid recovery of the population would be expected if exposure to COPC was stopped. Maximum and/or mean concentration exceeds the toxicity threshold value by less than 5-fold.
Minimal	Expected to affect a population or specific group at a localized area and over a short period of time in such a way as to be similar in effect to natural variation the population due to environmental irregularities, but having an undetectable effect on the population as a whole. Expected that maximum and/or mean concentration does not exceed toxicity threshold value.

Note ecological definitions are modeled after Fletcher (2005)

Hazard Data for Chemicals of Potential Concern in Soil

COPCs in soil (µg/g)	Hazard Measure (Toxicological Benchmark)	Severity of Effect	Basis for Assessment
F2 (C10-C16) (6100)	260 µg/g (50th percentile of EC20 for soil invertebrates and plants mortality and reproduction endpoints) (1)	severe	-Max concentration is above toxicity benchmark, (mean=396ug/g, 46% non-detect) -Contaminant mixture and sorption to organics -high bioconcentration potential from soil exposure (Kow >6.0 for aliphatics and aromatics), and high potential for bioaccumulation in food webs
F3 (C16-C34) (11 000)	390-1100 µg/g (50th percentile of EC20 for soil invertebrates and plants mortality and reproduction endpoints) (2)	moderate	-Max concentration is above toxicity benchmark (mean=417ug/g, 31% non-detect) -Contaminant mixture
Copper (870)	28 µg/g (Avian Eco-SSL, Lowest Eco-SSL for plants, invertebrates, avian and mammals) (3)	severe	-Max concentration is above toxicity benchmark (mean=56ug/g, 13% non-detect) Essential element in plants and animals Potential for bioconcentration and multiple target organs
Zinc (385)	46 µg/g (Avian Eco-SSL, Lowest Eco-SSL for plants, invertebrates, avian and mammals)(4)	moderate	-Max concentration is above toxicity benchmark (mean=62ug/g, 3% non-detect) -Essential element in plants and animals Multiple target organs, and potential for bioconcentration
Benzene (0.69)	25 µg/g (CCME Soil Quality Check Guideline for the ingestion of soil and food (based on ingestion toxicity data for mammalian and avian species) (5)	minimal	Max concentration is below toxicity benchmark (mean=0.09 ug/g, 35% non-detect) -low bioconcentration potential (Kow<4.0)
Ethylbenzene (0.7)	16 µg/g (NOEC for adverse effects in earthworms in coarse soil) (6)	minimal	-Max concentration is below toxicity benchmark (mean=0.1ug/g, 35% non-detect). -Multiple target organs, low bioconcentration potential (Kow<4.0), volatile
Toluene (1.4)	200 µg/g (phytotoxicity) (7)	minimal	Max concentration is below toxicity benchmark (mean=0.2ug/g, 35% non-detect).. low bioconcentration potential (Kow<4.0), volatile Multiple target organs

(1) CCME CWS for PHC in Soil Scientific Rationale, Supporting Technical Document, January 2008

(2) CCME CWS for PHC in Soil Scientific Rationale, Supporting Technical Document, January 2008, Appendix F, Table 17. Summary of Revised F3 Guidelines.

(3) USEPA Ecological Soil Screening Levels for Copper (Revised Feb 2007)

(4) USEPA Ecological Soil Screening Levels for Zinc (Revised June 2007)

(5) CCME Soil Quality Guidelines for the Protection of Environmental and Human Health, Benzene 2004 Fact Sheet

(6) CCME Soil Quality Guidelines for the Protection of Environmental and Human Health, Ethylbenzene 2004 Fact Sheet

(7) Oak Ridge National Laboratory - Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (ORNL, 1997). Table1 1. Screening benchmark concentrations for the phytotoxicity of chemicals in soil and soil solution.

Hazard Data for Chemicals of Potential Concern in Sediment

COPCs in sediment (µg/g)	Hazard Measure (Toxicological Benchmark)	Severity of Effect	Basis for Assessment
Benzene (0.097)	25 µg/g (CCME Soil Quality Check Guideline for the ingestion of soil and food (based on ingestion toxicity data for mammalian and avian species) (1)	minimal	-Max concentration is below toxicity benchmark (mean=0.03ug/g, 0% non-detect) -low bioconcentration potential from sediment exposure (Kow=2.1), and low potential for bioaccumulation in food webs -low potential to bioconcentrate in organisms exposed through the overlying water column
Xylenes (total) (0.6)	78 µg/g (LOEC for adverse effects in earthworms in coarse soil) (2)	minimal	-Max concentration is below toxicity benchmark (mean=0.11ug/g, 0% non-detect) -multiple endpoint effects in aquatic organisms (reproduction, mortality, growth) -low bioconcentration potential from sediment exposure (Kow=3.2), and low potential for bioaccumulation in food webs
F2 (C10-C16) (570)	260 µg/g* (50th percentile of EC20 for soil invertebrates and plants mortality and reproduction endpoints) (3)	minimal	-Max concentration is above toxicity benchmark (mean=37ug/g, 91% non-detect) -Contaminant mixture, sorption to organics -high bioconcentration potential from sediment exposure (Kow >6.0 for aliphatics and aromatics), and high potential for bioaccumulation in food webs
Boron (4.7)	0.5 µg/g* (phytotoxicity) (4)	minor	-Max concentration is above toxicity benchmark (mean=1.0ug/g, 0% non-detect) - not expected to bioaccumulate in organism or biomagnify in food webs -can bioaccumulate in plants -Potential for reproductive effects in organisms
Acenaphthene (0.02)	100 µg/g (Eco-SSL for Mammals) (5)	minimal	-Max concentration is below toxicity benchmark (mean=0.02ug/g, 94% non-detect) - sorption to organics, multiple endpoint effects in aquatic organisms (reproduction, mortality, growth) -low bioconcentration potential from sediment exposure (Kow<4.0), and low potential for bioaccumulation in food webs -Can bioconcentrate in organisms exposed through the overlying water column
Fluorene (0.028)	100 µg/g (Eco-SSL for Mammals) (5)	minimal	-Max concentration is above toxicity benchmark(mean=0.01ug/g, 94% non-detect) -relatively low bioconcentration potential from sediment exposure (Kow=4.2), and low potential for bioaccumulation in food webs -greatest risk aquatic organisms ingesting sediment and exposed to contaminant in overlying water and sorbed to sediment, sorption to organics affects bioavailability -Can bioconcentrate in organisms exposed through the overlying water column
1-Methylnaphthalene (0.4)	100 µg/g (Eco-SSL for Mammals) (5)	minimal	-Max concentration is below toxicity benchmark (mean=0.03ug/g, 94% non-detect) -greatest risk aquatic organisms ingesting sediment and exposed to contaminant in overlying water and sorbed to sediment -Can bioconcentrate in organisms exposed through the overlying water column

2-Methylnaphthalene (0.39)	100 µg/g (Eco-SSL for Mammals) (5)	minimal	-Max concentration is above toxicity benchmark(mean=0.03ug/g, 89% non-detect) - low bioconcentration potential (Kow=1.9) from sediment exposure, and low potential for bioaccumulation in food webs -greatest risk aquatic organisms ingesting sediment and exposed to contaminant in overlying water and sorbed to sediment -Can bioconcentrate in organisms exposed through the overlying water column
Naphthalene (0.11)	100 µg/g (Eco-SSL for Mammals) (5)	minimal	-Max concentration is below toxicity benchmark (mean=0.01ug/g, 94% non-detect) - low bioconcentration potential from sediment exposure (Kow=3.6), and low potential for bioaccumulation in food webs -greatest risk aquatic organisms ingesting sediment and exposed to contaminant in overlying water and sorbed to sediment , Can bioconcentrate in organisms exposed through the overlying water column

* In the absence of sediment quality standards , soil quality guidelines were applied

(1) CCME Soil Quality Guidelines for the Protection of Environmental and Human Health, Benzene 2004 Fact Sheet

(2) CCME Soil Quality Guidelines for the Protection of Environmental and Human Health, Xylenes 2004 Fact Sheet

(3) CCME CWS for PHC in Soil Scientific Rationale, Supporting Technical Document, January 2008

(4) Oak Ridge National Laboratory - Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision (ORNL, 1997). Table1 1. Screening benchmark concentrations for the phytotoxicity of chemicals in soil and soil solution

(5) USEPA Ecological Soil Screening Levels for PAHs (June 2007)

Toxicological benchmarks for COPCs in sediment were chosen for terrestrial receptors and did not consider aquatic receptors. Analytical results of samples collected in the receiving environment (marine waters) and at the upland point of discharge were compliant (FRANZ, 2010). Thus indicating the contaminant migration path was incomplete to marine or large freshwaters where aquatic receptors are present.

Hazard Data for Chemicals of Potential Concern in Surface Water

COPCs in surface water (µg/L)	Hazard Measure (Toxicological Benchmark)	Severity of Effect	Basis for Assessment
Boron (250)	401 000 µg/L (Lowest LOEL Based Benchmark) (1)	minimal	-Max concentration is below toxicity benchmark (mean=7ug/g, 4% non-detect) -Below CWQG for protection of FWAL -Can accumulate in aquatic plants and algae, does not appear to biomagnify in food webs
Cadmium (0.4)	3.16 µg /L (Lowest LOEL Based Benchmark) (1)	minimal	-Max concentration is above toxicity benchmark (mean=0.11ug/g, 83% non-detect) -Potential for biomagnification in food web (piscivorous species) -Known to partition to organics and bioconcentrate in tissues
Copper (10.9)	280 µg/L (Lowest LOEL Based Benchmark) (1)	minimal	-Max concentration is above toxicity benchmark (mean=2.3ug/g, 50% non-detect) - Essential element in plants and animals, known to partition to organics and bioconcentrate in tissues
Iron (590)	1000 µg/L (Standard, upper value (USEPA 1988d)) (2)	minimal	-Max concentration is above toxicity benchmark (mean=160ug/g, 74% non-detect) -Essential element in plants and animals, not known to bioaccumulate or biomagnify in aquatic food webs
Zinc (110)	268 µg/L (Lowest LOEL Based Benchmark) (1)	minimal	-Max concentration is above toxicity benchmark (mean=14ug/g, 61% non-detect) -Essential element in plants and animals, toxicity affected by water hardness (> hardness, >bioavailable Zn) -Known to partition to organics and bioconcentrate in tissues, affects multiple target organs and toxicological endpoints -Potential for biomagnification in food web (piscivorous species)

(1) Suter II GW and Tsao CL. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects in WIldlife: 1996 Revision. Oak Ridge National Laboratory. Appendix D: Table 12

(2) A Compendium of Environmental Quality Benchmarks (Environment Canada, 1999) Appendix 2-8 A Summary of Available Water Quality Criteria and Guidelines for the Protection of Wildlife (Water Consumption)

Toxicological benchmarks for COPCs in surface waters were chosen for terrestrial receptors and did not consider aquatic receptors. Analytical results of samples collected in the receiving environment (marine waters) and at the upland point of discharge were compliant (FRANZ, 2010). Thus indicating the contaminant migration path was incomplete to marine or freshwaters where aquatic receptors are present.

COPCs in Groundwater:

Groundwater was not considered a key exposure pathway for ecological receptors in the vicinity of the Resolute Bay Airport Landfills and Vehicle Storage Area site. Exposure of terrestrial wildlife receptors to contaminated groundwater is considered negligible for the site. Exposure of deep-rooted plants and trees in low-lying areas to groundwater is considered unlikely due to the stunted growth in the continuous permafrost layer, and that the majority of plant root colonization typically occurs in the upper meter of soil. Contact with groundwater was therefore deemed an incomplete exposure pathway for ecological receptors and was not considered further in the ERA.

10.5 Receptor Characterization and Exposure Assessment

Data from available resources on regional species, and personal communication with onsite employees form the basis for developing a list of species that use or could potentially use or inhabit the Site. This list focused on species designated as protected under the federal Species at Risk Act (SARA).

Under SARA, the federal government species-at-risk public registry includes a database of species at risk across Canada and the extent of their habitats. The database was searched for information on species at risk that may occupy the Resolute Bay Airport Site and the risk status for each species (endangered, threatened and special concern). Identified Species at Risk were included as representative onsite receptors. The following at-risk species were identified in the database as having habitat located within the Resolute Bay Airport Site. Identified at-risk species were considered representative species for their feeding guild.

- Ivory Gull *(Pagophila eburnea)* subspecies – Endangered, Schedule 1

Feeding guilds were selected to represent species with a potential for exposure to onsite contamination, including primary producers, primary consumers (e.g., herbivorous invertebrates), secondary consumers (e.g., omnivorous birds and mammals) and tertiary consumers (e.g., carnivorous mammals). Multiple ecological receptors were selected to capture exposure from drinking water and consumption of soil, plants and lichens, soil invertebrates, and small animals.

Aquatic receptors were not considered for evaluation in the qualitative assessment. Surface waters onsite consist of small ephemeral ponds and drainage streams adjacent to landfills (where aquatic life is not present), and are activated by melt waters from thawed permafrost that drain into larger marine or freshwater water bodies. Analytical results for water and sediment samples collected in the receiving environment and along the flow path to the receiving environment were compliant (FRANZ, 2010). Thus indicating the contaminant migration path was incomplete to marine or freshwaters where aquatic life is present.

Further references to surface water in this report are limited to the ephemeral surface waters onsite and not in reference to larger receiving waters where aquatic life may be present.

10.5.1 Terrestrial Receptors

The following terrestrial receptors were selected for evaluation in the qualitative assessment.

Primary Producers – Terrestrial Plants and Lichens:

Plants are a primary feature of terrestrial habitats and provide an important food source for herbivores. Exposure to COPCs can be through dermal absorption from contaminated soils, and may result in a loss of net ecosystem productivity by directly impacting the ability of plant species to photosynthesize and produce biomass and/or reproduce. Disruption of ecosystem function may also occur indirectly through negative health impacts for organisms that consume plant tissues contaminated by COPCs. Terrestrial plants can be grazed upon by large herbivorous mammals (eg. musk ox) and are foraged by herbivorous birds (eg. migrating snow geese) (Aiken et al. 1999).

Soil Invertebrates:

Soil-dwelling invertebrates play an important role in the degradation of organic materials and constitute a significant food source for animals at higher trophic levels. Negative impacts to soil invertebrates could occur via exposure to contaminants through ingestion of contaminated soil or via direct dermal contact of COPCs in soil, and could impair nutrient cycling and adversely impact the health and population dynamics of animals that feed on them.

Terrestrial Birds:

A number of terrestrial (herbivorous and omnivorous) birds have populations that are found seasonally and year-round on Cornwallis Island and islands within the Canadian High Arctic. The Ivory Gull was selected as a representative species of terrestrial birds onsite based on its designation as “endangered” under SARA and its identified presence in colonies on Cornwallis Island (Lange, 1959). These birds feed upon small marine fish, small mammals, zooplankton, and mammalian feces. Their predators include the arctic fox, polar bear, lemming, and ravens (COSEWIC Update Report 2006). Birds may be exposed to bioaccumulated COPCs via ingestion of prey animals, contaminated drinking waters (surface water), as well as ingestion of and dermal contact with contaminated soil.

Small Burrowing Mammals:

Small mammals (herbivourous and omnivorous) play important roles in insect and vegetation control, seed dispersal and as prey for higher trophic level predators. Small mammals may be exposed to COPCs by consuming contaminated vegetation or soil invertebrates, inhaling soil vapours or ingesting soil particulates, or by coming into direct dermal contact with contaminated soil when digging or burrowing. Burrowing mammals mainly forage for willows, berries, sedges, mosses, bird’s eggs and young chicks in both dry and wetland areas (Canadian Wildlife Service 2003).

Carnivorous Mammals:

Carnivorous mammals in the high Arctic include: the Arctic fox, polar bears, and the Arctic wolf. Large carnivores may be exposed to bioaccumulated COPCs through ingestion of other animals (caribou, muskox), contaminated drinking waters, and direct dermal contact with contaminated soil. Carnivores tend to have large home ranges and are present throughout the Canadian high arctic. There are no known permanent populations of this wildlife on Cornwallis Island. Their irregular presence likely occurs when ice bridges connect several islands together.

Large Herbivores:

Large herbivores in the high arctic include musk-oxen and caribou. Large herbivores can be exposed to COPCs through drinking contaminated surface waters, ingestion of bioaccumulated COPCs in vegetation, and ingestion and dermal contact with contaminated soils as they graze on vegetation. Large herbivores can be an important food source for top predators (e.g. wolves). Their irregular presence likely occurs when ice bridges connect several islands together.

Summary of Exposure Pathways

The three components in an operable exposure pathway are a source chemical, transport pathway and exposure mechanism. The following exposure pathways are identified as most significant:

1) Leaching of subsurface contamination into groundwater, and overall transport (e.g. surface water runoff, groundwater drainage) into surface waters on site, followed by dermal contact with and ingestion of contaminated surface waters (terrestrial).

2) Ingestion of contaminated food items (vegetation, tissue) as well as incidental ingestion of contaminated soil or sediment.

3) Direct dermal contact with contaminated soil or sediment (terrestrial).

10.5.2 Ecological Conceptual Site Model

The Ecological Conceptual Site Model (ECSM) is a description of how ecological receptors may be exposed to contaminants present on the site, and identifies ecological receptors and exposure routes.

The ERA was conducted for species known or likely to be on site, or in the immediate vicinity of the Resolute Bay site. The ECSM developed and relied upon for this assessment is shown in Figure 10.1. This model was prepared based on current use of the Resolute Bay Airport Landfills and Vehicle Storage Area Site and incorporates the information on site characteristics and environmental conditions.

10.6 Risk Characterization

In order to characterize risk based on exposure to contaminants in environmental media a qualitative estimate of the likelihood of exposure for each pathway was made based on the definitions presented in the table below.

Likelihood	Definition
Very Unlikely	Exposure levels not expected to have adverse effects
Unlikely	Exposure Level that could result in adverse effects would probably not occur
Possible	Level of exposure that could result in adverse effects might be expected
Likely	Level of exposure that could have adverse effects is expected. Exceedance of this exposure level might be expected

The potential risks associated with each potential hazard- exposure-receptor scenario are estimated by comparing the severity of the hazard with the likelihood of exposure (e.g. consideration of home range, receptor characteristics) according to the matrix seen below.

Risk Characterization		Exposure Assessment			
		Very Unlikely	**Unlikely**	**Possible**	**Likely**
Hazard Assessment	**Minimal**	Low	Low	Low	Low
	Minor	Low	Low	Medium	Medium
	Moderate	Low	Medium	Medium	High
	Severe	Low	Medium	High	High

Table: Risk Estimate for Qualitative Risk Assessment

Hazard Description	Hazard Severity	Exposure Pathway Description	Likelihood of exposure	Critical Receptor	Potential Risk	COC Info. Level
COCs in surface soil	Severe(F2, Cu) Moderate (Zn, F3) Minimal (Benzene, Ethylbenzene, Toluene)	Dermal contact with soil	Likely	Terrestrial plants	**High (F2,Cu, Zn, F3)**	High
	Severe(F2,Cu) Moderate(Zn, F3) Minimal (Benzene, Ethylbenzene, Toluene)	Ingestion of contaminated food items (e.g. tissue and/or vegetation)	Very Unlikely	Large Carnivores	**Low-Medium (F2,Cu, Zn, F3)**	High
	Minimal (Benzene, Ethylbenzene, Toluene)	Inhalation of soil vapours	Very Unlikely	Small burrowing mammals	Not evaluated	High
	Severe (F2,Cu) Moderate(Zn, F3)	Ingestion of soil particles	Possible	Soil invertebrates	**High (F2, Cu)**	High

	Minimal (Benzene, Ethylbenzene, Toluene)				**Medium (Zn,F3)**	
COCs in GW	Not Evaluated	Dermal contact with GW	Not considered as an operable pathway	Terrestrial plants	Not evaluated	Low
COCs in sediment	Minor (B) Minimal (Benzene , F2, Fluorene,2-methylnaphthalene, Xylenes, Acenaphthene, , 1-methylnaphthalene, Naphthalene)	Ingestion of sediment	Very unlikely	Large Herbivores	**Low (B, Benzene, F2, Fluorene, 2-methyl-naphthalene)**	Low
	Minor (B) Minimal (Benzene , F2, Fluorene,2-methylnaphthalene, Xylenes, Acenaphthene, , 1-methylnaphthalene, Naphthalene)	Dermal Contact with Sediment	Unlikely	Large Herbivores	**Low (B, Benzene , F2, Fluorene,2-methylnaphthalene)**	Low
COCs in surface water	Minimal (Cd, Cu, Zn, Fe, B)	Dermal Contact with Water	Possible	Terrestrial Birds	**Low (Cd, Cu, Zn, Fe, B)**	High
	Minimal (Cd, Cu, Zn, Fe, B)	Ingestion of contaminated water	Possible	Terrestrial Birds	**Low (Cd, Cu, Zn, Fe, B)**	High

10.6.1 Discussion of Uncertainty

The major sources of uncertainty associated with this qualitative ecological risk assessment includes factors such as representative chemical concentrations, the behaviour of chemicals in mixtures and under variable environmental conditions, assumed receptor characteristics for species within feeding guilds, and species sensitivities to COPCs in environmental media.

Representative Chemical Concentrations:

Perhaps the greatest source of uncertainty is the use of maximum COPC concentrations recorded for various media to assess potential impacts to ecological receptors. This approach overestimates the potential for negative effects for several reasons. First, many ecological receptors are mobile to varying degrees within and outside of the study area, and therefore will not be continuously exposed to the highest COPC concentrations recorded. This is true even for plants, which have some limited capacity for movement as roots extend progressively in colonized soil. Secondly, environmental conditions that influence exposure to COPCs can be

extremely variable, both temporally and spatially, and this variability can have a direct influence on the toxic response of receptors.

Representative Receptors for Feeding Guilds:

Feeding guilds considered in the ERA were chosen based on the likelihood of species within the guild being present onsite, and their classification as an endangered or at risk species (e.g. Ivory gull). That not all receptor species were considered in this ERA represents a source of uncertainty in the assessment and potential overestimation of risk for all species belonging to each feeding guild.

Toxicological Benchmarks:

Another major source of uncertainty is the applicability of the toxicological benchmarks chosen in the effects assessment to the various exposure pathways and ecological receptors identified in this report. The benchmarks chosen were considered to be protective of the most sensitive receptor guild given the exposure pathways for each environmental media. However these toxicological benchmarks are for general receptor guilds, not specific to site-specific species and are considered to be protective of all receptor guild populations that may be present in a given location. As such, they are likely to overestimate potential risk as they are designed to ensure comprehensive protection to even the most sensitive species of each receptor guild. The lack of toxicological benchmarks for specific COPCs in each environmental media, and for combinations of COPCs in media represents an important source of uncertainty. Toxicological benchmarks for potentially less sensitive, higher level receptors on site were not considered in the effects assessment and as such represents a source of uncertainty in the assessment. Finally, the use of established benchmark values for comparison with contaminant concentrations in environmental media may lead to an overestimation of the actual risks. In general, these values have been developed using highly conservative assumptions regarding chemical fate and transport characteristics, physicochemical properties, ecotoxicological endpoints and exposure calculations.

Chemical Interactions:

Finally, there is uncertainty regarding the potential chemical interaction of the various COPCs identified at the Site. It is accepted that chemical interactions can cause antagonistic, additive or synergistic toxic effects. Although interactions have been described in the literature for specific endpoints of specific receptors for simple combinations of some of the COPCs identified in this report, the nature and effect of the vast majority of possible interactions is unknown.

10.7 ERA Conclusions

An ERA was conducted to **qualitatively** identify potential risks to ecological receptors at the Resolute Bay Airport Landfills and Vehicle Storage Area Site. Potential impacts were evaluated using the maximum chemical concentrations in environmental media.

Based on the results of the chemical screening, effects assessment, exposure assessment and **qualitative** risk characterization preliminary conclusions are as follows:

- Petroleum hydrocarbon fraction 2 (F2) and, copper concentrations in soil contaminants are of greatest concern to terrestrial receptors;
- PHCs F2, F3, copper and zinc concentrations in soil represent high to meduim risk to terrestrial plants through dermal contact with contaminated soil, and to soil invertebrates with the potential to ingest contaminated soil particles (high risk for F2 and copper specifically);
- PHCs F2 and F3, copper and zinc in soil represent low-medium risks to large carnivorous and omnivorous mammals and birds through the ingestion of contaminated food items (e.g. primary consumers) and the potential for these COCs to bioaccumulate in prey items and biomagnify in food chains;
- Boron, F2, benzene, xylenes and PAHs (fluorene, 2-methylnaphthalene, acenaphthene, , 1-methylnaphthalene, naphthalene) represent sediment contaminant concentrations of low concern to large herbivores with the potential for dermal contact with sediment, and accidental ingestion of sediment while foraging for vegetation surrounding surface waters;
- Exposure to groundwater by ecological receptors was considered an incomplete exposure pathway and, was not considered as a potential risk to ecological receptors;
- Cadmium, copper, zinc, iron, and boron represent surface water contaminants of low concern to terrestrial receptors ;
- Cadmium, copper, zinc, iron, and boron concentrations in surface waters were considered to be low risks to terrestrial bird species with the potential for dermal contact with contaminated surface water and ingestion of contaminated surface waters;

11.0 OVERALL CONCLUSIONS

11.1 Conclusions

The primary objective of this Human Health and Ecological Risk Assessment Report was to preliminarily assess risks to human health and the ecology from previously identified COPCs in soil, groundwater, surface water, and sediment.

11.2 Human Health

A human health risk assessment was conducted in accordance Health Canada PQRA guidance documents (Health Canada, 2004, 2007, 2009 updates).

A screening to identify Chemicals of Potential Concern (COPCs) was completed by comparing maximum concentrations of contaminants with generic CCME Environmental Quality Criteria, relevant Soil Quality Guidelines (human health-SQG_{HH}), or provincial guidelines, USEPA Region IX regional screening levels, or criteria from the Compendium of Environmental Quality Benchmarks 1999, as required. The following were identified as COPCs in environmental media onsite and used as inputs in the PQRA spreadsheets:

- Metals - boron, copper, lead, zinc
- PHCs – benzene, ethylbenzene, toluene, PHC Fraction 1, PHC Fraction 2
- PAHs - chrysene

Potential Receptors

Potential human receptors at the site include:

- Adult airport employees involved in operational and maintenance activities onsite. This would be considered a chronic exposure scenario.
- Remedial workers or adult construction workers involved in demolition, remediation and maintenance activities at the Site. These workers would be onsite for intense short term exposures (acute) during the summer season. Workers returning to the site would be considered in a chronic exposure scenario as well.
- Potential adult hotel employees at the new hotel under construction on the edge of the Historic Landfill (AEC 2 Exposure would be incidental in nature.
- Hotel patrons would be at the Site for short durations during the summer season, however, there are no reasonable scenarios where hotel patrons would be exposed to significant contamination in soil or water.

Operable Pathways

The operable pathways considered for the PQRA were

- Accidental ingestion of soil particles, and inhalation of soil particles (fugitive dust)
- Dermal contact with soil
- Dermal contact with groundwater

Risk Characterization

Summary of Hazard Quotients

The target HQ of 0.2 has been exceeded in the site remediation worker receptor scenario, for multiple COPCs. The results indicate that there are unacceptable risks primarily with oral/dermal exposures. The modeling suggests that the highest potential chronic risk is from the oral/dermal exposure for the following listed in order of descending HQ: PHC F2, and PHC F1.

Sub-chronic risks to site remediation workers from exposure to non-carcinogens were evaluated by deriving a sub-chronic hazard quotient for each COPC by comparing total short term exposures (mg/kg-d, without amortization over a yearly period) to chronic toxicity reference values (mg/kg-d) (Health Canada, 2009) for each COPC. The results of this modeling suggest that the target HQ of 1.0 has been exceeded by the COPC mixture PHC F2, for the site remediation worker over a short term exposure duration, and that unacceptable sub-chronic risk is mainly a function of oral/dermal exposure.

Summary of Carcinogenic Risks

The Health Canada recommended threshold for ILCR (1.0E-05) has been not been exceeded by exposure to carcinogens (benzene and chrysene) for onsite receptors.

Note that the PQRA calculations are estimates only and do not represent actual risks. Based on the high risk estimate (HQ) for the site remediation worker, this PQRA has likely overestimated the risk. This overestimation is consistent with the intent of a PQRA: to provide a protective estimate of potential risks.

Major uncertainty factors in the human health risk assessment include:

- Unknown actual exposure patterns for site users (time on site, etc.);
- Assumed generic receptor characteristics provided in the Health Canada guidance and as determined based on site specific information, while actual receptor characteristics may differ from these standard assumptions;
- The assumption that most of the COPCs are 100% bioavailable from the ingestion and inhalation exposure routes;
- Use of toxicity reference values derived from animal studies.

Risk Management

To manage the potential oral/dermal exposure to PHCs in soils onsite, workers involved in remediation work follow a site specific health and safety plan.

11.3 Ecological

An evaluation of COPCs, ecological receptors, and relevant exposure pathways was conducted in order to develop an Ecological Conceptual Site Model to support an ERA. The ERA primarily considered species known or likely to be on Site, or in the immediate vicinity of the Site. The feeding guilds considered included terrestrial plants, soil invertebrates, burrowing small mammals, terrestrial birds, large carnivores/omnivores, and large herbivores.

Aquatic receptors were not considered for evaluation in the qualitative assessment. Surface waters onsite consist of small ephemeral ponds and drainage streams adjacent to landfills and are activated by melt waters from thawed permafrost that drain into larger marine or freshwater water bodies. Analytical results for water and sediment samples collected in the receiving environment and along the flow path to the receiving environment were compliant (FRANZ, 2010). Thus indicating that the contaminant migration pathway is incomplete to marine or freshwaters where aquatic life is present.

Further references to surface water in this report are limited to the ephemeral surface waters onsite and not in reference to larger receiving waters where aquatic life may be present.

COPCs in environmental media were subject to a "qualitative screening assessment". This involved a comparison of the COPC concentrations to toxicological benchmark values protective of ecological receptor guilds. The outcome was a qualitative ranking of the COPCs according to their potential to cause harmful effects to ecological receptors. The COPCs considered were:

- Soil – F2, F3, Cu, Zn, benzene, toluene, ethylbenzene
- Sediment - F2, benzene, xylenes, boron, acenaphthene, fluorene, 1-methylnaphthalene, 2-methylnaphthalene, naphthalene
- Groundwater- F1, F2, Cd, Cu, Fe, Pb, naphthalene
- Surface Water- Cadmium, copper, zinc, boron, and iron

Operable Pathways

The following exposure pathways are identified as most significant to ecological receptors onsite and in the site vicinity:

- Leaching of subsurface contamination into groundwater, and overall transport (e.g. surface water runoff, groundwater drainage) into surface waters onsite, followed by dermal contact with and ingestion of contaminated surface waters by terrestrial receptors
- Ingestion of contaminated food items (vegetation, tissue) as well as incidental ingestion of contaminated soil or sediment by terrestrial receptors.
- Direct dermal contact with contaminated soil or sediment onsite by terrestrial receptors.

Risk Characterization

Based on the results of the chemical screening, effects assessment, exposure assessment and qualitative risk characterization preliminary conclusions are as follows:

- Petroleum hydrocarbon fraction 2 (F2) and, copper concentrations in soil contaminants are of greatest concern to terrestrial receptors;
- PHCs F2, F3, copper and zinc concentrations in soil represent high to medium risk to terrestrial plants through dermal contact with contaminated soil, and to soil invertebrates with the potential to ingest contaminated soil particles (high risk for F2 and copper specifically);
- PHCs F2 and F3, copper and zinc in soil represent low-medium risks to large carnivorous and omnivorous mammals and birds through the ingestion of contaminated food items (e.g. primary consumers) and the potential for these COCs to bioaccumulate in prey items and biomagnify in food chains;
- Boron, F2, Xylenes and PAHs (Benzene, Fluorene, 2-methylnaphthalene, , Acenaphthene, , 1-methylnaphthalene, Naphthalene) represent sediment contaminant concentrations of low concern to large herbivores with the potential for dermal contact with sediment, and accidental ingestion of sediment while foraging for vegetation surrounding surface waters;
- Exposure to groundwater by ecological receptors was considered an incomplete exposure pathway and, was not considered as a potential risk to ecological receptors;
- Cadmium, copper, zinc, iron, and boron represent surface water contaminants of low concern to terrestrial receptors ;
- Cadmium, copper, zinc, iron, and boron concentrations in surface waters were considered to be low risks to terrestrial bird species with the potential for dermal contact with contaminated surface water and ingestion of contaminated surface waters;

The major sources of uncertainty associated with this qualitative ERA includes factors such as representative chemical concentrations, the behaviour of chemicals in mixtures and under

variable environmental conditions, assumed receptor characteristics for species within feeding guilds, and species sensitivities to COCs in environmental media, as outlined below.

- Use of maximum COPC concentrations recorded for various media to assess potential impacts to ecological receptors
- The use of toxicological benchmarks designed for general receptor feeding guilds to further qualify risks to specific species from COPCs in environmental media
- The uncertainty regarding the potential chemical interactions of the multiple COPCs identified in environmental media at the Site, and uncertainty surrounding the nature and toxic effects of chemical mixtures on ecological receptors;

11.4 Recommendations

Action should be taken to manage the high concentrations of contamination at the site that drives the human health risk assessment results.

If no action is taken to manage the high concentration of contamination at the site, then further refinement of the human health and ecological risk assessment is warranted. The most appropriate areas to further refine the risk assessment include:

1) Refine the human health and ecological exposure scenarios to better reflect actual patterns of exposure on site.

2) Refine the statistical database/input parameters to determine the most appropriate statistic values (e.g. 95% upper confidence limits) for contamination concentrations.

3) Carry out a site specific ERA in which site specific modelling of ecological receptors exposure to contaminants is applied, and risks to ecological receptors are quantitatively characterized.

12.0 LIMITATIONS

Franz Environmental Inc. prepared this report for Public Works and Government Services Canada – Pacific Region on behalf of Transport Canada. The material in this report reflects Franz Environmental Inc.'s judgment in light of the information available to us at the time of preparation.

There is no warranty expressed or implied that this risk assessment has resolved all potential environmental liabilities associated with the subject site. It is believed however, that the level of detail carried out for this work is appropriate to meet the study objectives. The findings and conclusions are site-specific and were developed in a manner consistent with the level of care and skill normally exercised by environmental professionals currently practicing under similar conditions in the area. The undersigned believe this report to be accurate, however they cannot guarantee the completeness or accuracy of information supplied to them.

Any use of which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibility of such third parties. The authors accept no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

If new information is discovered in the future, Franz Environmental Inc. should be requested to re-evaluate the conclusions of this report and provide amendments as required prior to any reliance upon the information provided herein.

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13.0 REFERENCES

Arctic Insect News, 2, 1991. Adaptations and Ecology of Arctic Insects, Arctic Springtails-Collembola, pp. 4-6.

Aiken, S.J. Dallwitz, M.J., Consaul, L.L., McJannet, C.L., Gillespie, L.J., Boles,R.L., Argus,G.W., Gillet, J.M., Scott,P.J., Elven, R., LeBlanc, M.C., Brysting, A.K., Solstad, H. 1999 onwards. Flora of the Canadian Arctic Archipelago: Descriptions, Illustrations, Identifications, and Information Retrieval. Version: 29th April 2003. http://www.mun.ca/biology/delta/arcticf/

Canadian Council of Ministers of the Environment (CCME). 1999. Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba.

Canadian Council of Ministers of the Environment (CCME). 2008. Canada Wide Standards for Petroleum Hydrocarbons (PHC) in Soil.

Canadian Wildlife Service, 2003. Hinterland Who's Who Lemming Fact Sheet: http://www.hww.ca/hww2.asp?id=91

Canadian Wildlife Service, 2003. Hinterland Who's Who-Snowy Owl Fact Sheet: http://www.hww.ca/hww2.asp?id=76

Chiarenzelli, J., Aspler, L., Dunn, C., Cousens, B., Ozarko, D., POwis, K. 2001. Multi-element and rare earth element composition of lichens, mosses, and vascular plants from the Central Barrenlands, Nunavut, Canada.

Dillon Consulting Ltd., 1995. Environmental Baseline Study Resolute Bay Airport. April 6, 1995.

Dillon Consulting Ltd, 1999. Resolute Bay Airport Landfill Environmental Site Investigation. April 1999.

Environment Canada. National Climate Data and Information Archive. Canadian Climate Normals 1971-2000. www.climate.weatheroffice.ec.gc.ca. (accessed on August 20, 2009).

Fletcher, W.J. 2005. The application of qualitative risk assessment methodology to prioritize issues for fisheries management. ICES Journal of Marine Science 62: 1576-1587.

Franz Environmental Inc. 2010. Phase II/III Environmental Site Assessment, Draft Field Report, Resolute Bay Airport Landfill Sites, Resolute Bay, Nunavut. Prepared for Public Works and Government Services Canada and Transport Canada.

Health Canada. 2004, 2007 and 2009. *Federal Contaminated Site Risk Assessment in Canada: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA) (Part I, II III, IV)*. Environmental Health Assessment Services, Safe Environments Program, Health Canada.

Health Canada Sodium- Technical Document Updated December 1992. http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/sodium/index-eng.php

Jacques Whitford. 2006. Final Report – Resolute Bay Airport, Environmental Site Investigation, Resolute Bay, Nunavut. Prepared for Transport Canada.

Kojima, Satoru.1991.Vegetation and Environment of the Canadian High Arctic With Special Reference to Cornwallis Island, Proc. NIPR Symp. Polar Biol. 4, pp.135-154.

Law, R., Kelly, C., Baker, K., Jones, J. McIntosh, A., Moffat, C. 2002. Toxic equivalency factors for PAH and their applicability in shellfish pollution monitoring studies. J. Environ. Monit., 2002, 4, 383-388.

Lange, Kenneth. 1959. Biological Observations and General Comments on Cornwalis Island, N.W.T. Journal of the Arizona-Nevada Academy of Science, 1(2), pp. 72-75.

PWC, 1993. Resolute Bay Airport Environmental Audit Documentation. December 1993.

Richardson, G.M. 1997. *Compendium of Canadian Human Exposure Factors for Risk Assessment*. Ottawa: O'Connor Associates Environmental Inc.

Stocker and Hynes, 1976. Studies on the tributaries of Char Lake, Cornwallis Island. Hydrobiologia, 49 (2), pp. 97-102.

Transport Canada, 2000. Resolute Bay Airport Landfill 2000 Summary Report. March 2000.

Transport Canada, 2000. Resolute Bay Airport Landfill. July 2000.

Wilson Scientific Consulting Inc. and Meridian Environmental Inc, 2007. Final Report-Guidance on Issues Related to Acute and Sub-chronic Human Health Risk Assessment at

Federal Sites. Prepared for Health Canada –Health environments and Consumer Safety Branch.

FIGURES

Figure 6.1 Resolute Bay Landfills and Vehicle Storage Site
Human Health (PQRA) Conceptual Model

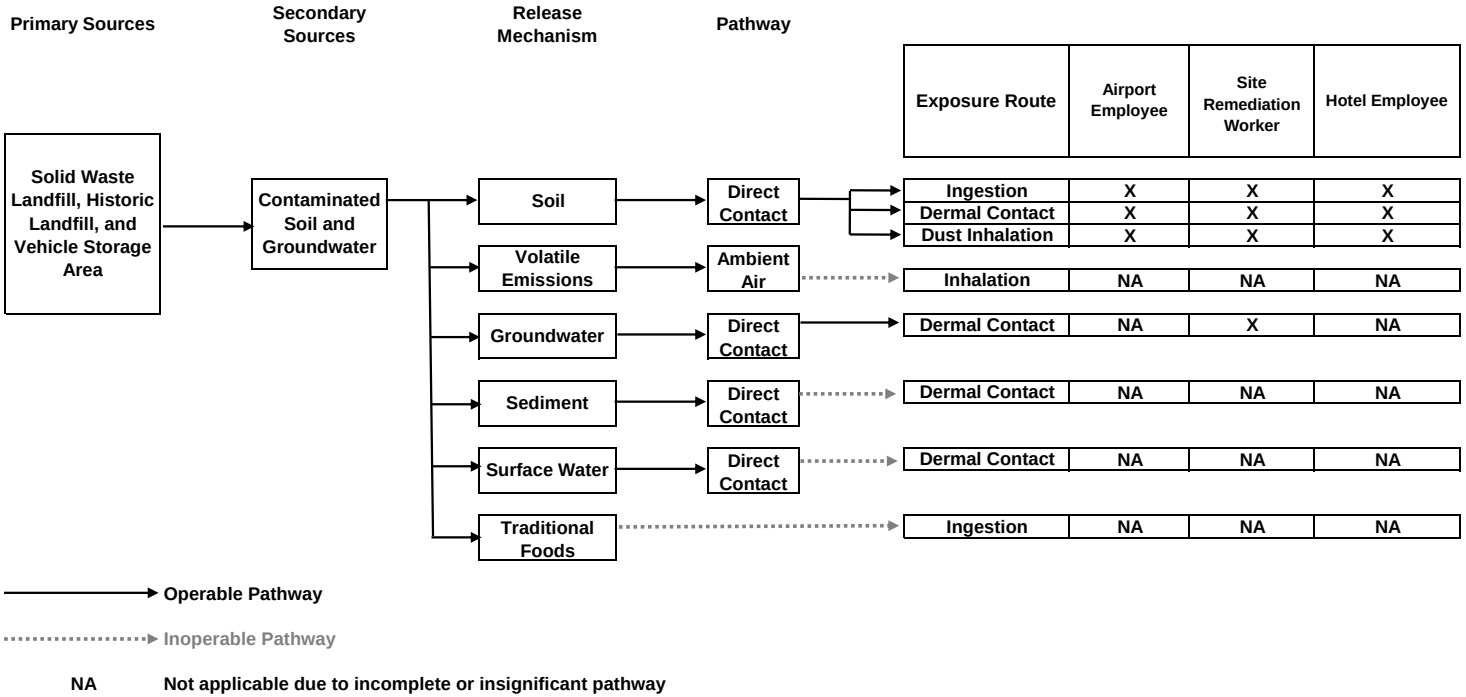
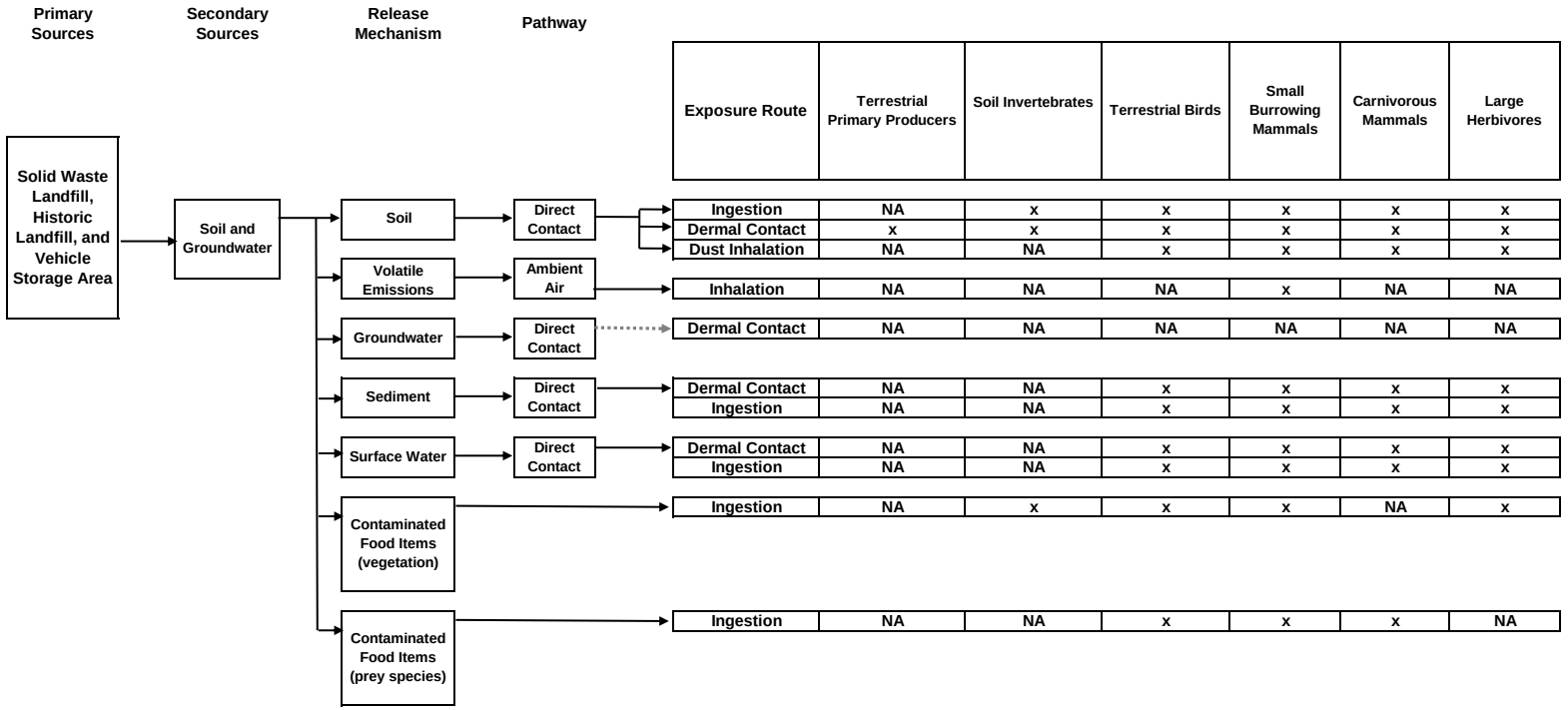


Figure 10-1 Resolute Bay Landfills and Vehicle Storage Site
Ecological Risk Assessment Conceptual Model



Operable Pathway

Inoperable Pathway

NA Not applicable due to incomplete or insignificant pathway

APPENDIX A

Risk Assessment Data Summary Tables

Soil Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

Parameter	Media	Eco RA Screening Criterial	EcoRA Screening Criteria Source	HHRA Screening Criteria	HHRA Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into HHRA/ PQRA?
Benzene	soil	0.03	CL EQG, CCME 2007	0.03	CL EQG, CCME 2007		ug/g	23	0.04	nc	0.02	0.04	na	100%	no (ND)	no (ND)
Ethylbenzene	soil	0.082	CL EQG, CCME 2007	0.082	CL EQG, CCME 2007		ug/g	23	0.08	nc	0.02	0.1	na	100%	no (ND)	no (ND)
Toluene	soil	0.37	CL EQG, CCME 2007	0.37	CL EQG, CCME 2007		ug/g	23	0.08	nc	0.02	0.1	na	100%	no	no
Xylenes (total)	soil	11	CL EQG, CCME 2007	11	CL EQG, CCME 2007		ug/g	24	0.40	0.61	0.04	2.9	FL-TP8-SA1 (AEC2)	83%	no	no
F1 (C6-C10)	soil	320	CL CWS, CCME 2008 (cg, surface)	19000	CL CWS, CCME 2008 (cg, surface, dir Cont.)-tech guidance		ug/g	39	17.82	23.59	10	120	FL-TP8-SA1 (AEC2)	54%	no	no
F2 (C10-C16)	soil	260	CL CWS, CCME 2008 (cg, surface)	10000	CL CWS, CCME 2008 (cg, surface, dir. Cont.)-tech guidance		ug/g	39	395.69	1182.87	10	6100	2-TP-8	46%	yes	no
F3 (C16-C34)	soil	1700	CL CWS, CCME 2008 (cg, surface)	23000	CL CWS, CCME 2008 (cg, surface, dir. Cont.)-tech guidance		ug/g	39	417.33	1767.34	10	11000	3-TP-3	31%	yes	no
F4 (C34-C50)	soil	3300	CL CWS, CCME 2008 (cg, surface)	30000	CL CWS, CCME 2008 (cg, surface, dir. Cont.)-tech guidance		ug/g	39	78.46	235.88	10	1440	SWF-TP2-SA1 (AEC1)	44%	no	no
Antimony	soil	40	CL, Table 3, OMOE 2009	40	CL EQG, CCME 2007		ug/g	39	0.99	0.93	0.2	3.0	1-TP-11	100%	no	no
Arsenic	soil	12	CL EQG, CCME 2007	12	CL EQG, CCME 2007		ug/g	40	1.50	0.60	1.0	3.0	1-TP-11	33%	no	no
Barium	soil	2000	CL EQG, CCME 2007	2000	CL EQG, CCME 2007		ug/g	39	24.55	36.29	3.9	227	SWF-TP2-SA1 (AEC1)	0%	no	no
Beryllium	soil	8	CL EQG, CCME 2007	8	CL EQG, CCME 2007		ug/g	39	0.17	0.05	0.1	0.3	2-TP-8	21%	no	no
Boron	soil	2	AL EQG, CCME 2007	2	AL EQG, CCME 2007		ug/g	25	0.59	0.48	0.1	1.8	1-BH-13	0%	no	no
Cadmium	soil	22	CL EQG, CCME 2007	22	CL EQG, CCME 2007		ug/g	39	0.68	2.12	0.1	13	1-TP-10	36%	no	no
Chromium	soil	87	CL EQG, CCME 2007	87	CL EQG, CCME 2007		ug/g	39	5.05	3.38	1.0	19	1-TP-10	0%	no	no
Chromium (VI)	soil	1.4	CL EQG, CCME 2007	1.4	CL EQG, CCME 2007		ug/g	39	0.24	nc	nc	0.3	na	100%	no	no
Cobalt	soil	300	CL EQG, CCME 2007	300	CL EQG, CCME 2007		ug/g	39	1.28	0.80	0.2	3.2	1-TP-11	0%	no	no
Copper	soil	91	CL EQG, CCME 2007	91	CL EQG, CCME 2007		ug/g	39	56.29	191.74	0.7	870	1-TP-9	13%	yes	yes
Lead	soil	260	CL EQG, CCME 2007	260	CL EQG, CCME 2007		ug/g	39	20.82	32.92	1.0	170	1-TP-11	18%	no	no
Mercury	soil	24	CL EQG, CCME 2007	24	CL EQG, CCME 2007		ug/g	39	0.06	0.06	0.1	0.4	1-TP-11	92%	no	no
Molybdenum	soil	40	CL EQG, CCME 2007	40	CL EQG, CCME 2007		ug/g	40	0.68	0.45	0.5	2.7	1-TP-10	28%	no	no
Nickel	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	39	4.31	1.65	1.0	8.0	SWF-TP4-SA1 (AEC1)	31%	no	no
Selenium	soil	2.9	CL EQG, CCME 2007	2.9	CL EQG, CCME 2007		ug/g	40	0.50	nc	nc	0.5	na	100%	no	no
Silver	soil	40	CL EQG, CCME 2007	40	CL EQG, CCME 2007		ug/g	39	0.56	0.68	0.2	4.0	FL-TP4-SA1 (AEC2)	97%	no	no
Thallium	soil	1	CL EQG, CCME 2007	1	CL EQG, CCME 2007		ug/g	40	0.41	nc	nc	1	na	100%	no	no
Vanadium	soil	130	CL EQG, CCME 2007	130	CL EQG, CCME 2007		ug/g	39	6.62	2.30	3.0	12.2	FL-TP6-SA2* (AEC2)	31%	no	no
Zinc	soil	360	CL EQG, CCME 2007	360	CL EQG, CCME 2007		ug/g	39	62.06	81.03	5.0	385.0	FL-TP4-SA1 (AEC2)	3%	yes	yes
Acenaphthene	soil	96	CL, Table 3, OMOE 2009	96	CL, Table 3, OMOE 2009		ug/g	24	0.06	0.12	0.01	0.47	FL-TP6-SA1 (AEC 2)	92%	no	no
Acenaphthylene	soil	0.15	CL, Table 3, OMOE 2009	0.15	CL, Table 3, OMOE 2009		ug/g	24	0.03	0.04	0.005	0.2	3-TP-3	96%	no	no
Anthracene	soil	32[E]	CL SoQG for PAH, CCME 2008	0.67	CL, Table 3, OMOE 2009		ug/g	24	0.03	0.06	0.005	0.3	3-TP-3	96%	no	no
Benzo(a)anthracene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	24	0.12	0.49	0.01	2.4	3-TP-3	92%	no	no
Benzo(a)pyrene	soil	72[E]	CL SoQG for PAH, CCME 2008	5.3 (BaP TPE)[HH]	CL SoQG for PAH, CCME 2008		ug/g	24	0.07	0.26	0.005	1.3	3-TP-3	92%	no	no
Benzo(b+j)fluoranthene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	24	0.13	0.53	0.01	2.6	3-TP-3	88%	no	no
Benzo(g,h,i)perylene	soil	6.8[PW]	CL SoQG for PAH, CCME 2008	6.8[PW]	CL SoQG for PAH, CCME 2008		ug/g	24	0.09	0.26	0.02	1.3	3-TP-3	96%	no	no
Benzo(k)fluoranthene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	24	0.05	0.14	0.01	0.7	3-TP-3	96%	no	no
Chrysene	soil	6.2[R/PL]	CL SoQG for PAH, CCME 2008	2.1[PW]	CL SoQG for PAH, CCME 2008		ug/g	24	0.14	0.57	0.01	2.8	3-TP-3	92%	no	yes
Dibenz(a,h)anthracene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	24	0.07	nc	nc	0.8	na	100%	no	no
Fluoranthene	soil	180[E]	CL SoQG for PAH, CCME 2008	9.6	CL, Table 3, OMOE 2009		ug/g	24	0.07	0.26	0.005	1.3	3-TP-3	79%	no	no
Fluorene	soil	15.4[I*]	CL SoQG for PAH, CCME 2008	62	CL, Table 3, OMOE 2009		ug/g	24	0.13	0.39	0.005	1.81	FL-TP6-SA1 (AEC 2)	92%	no	no
Indeno(1,2,3-cd)pyrene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	24	0.08	0.24	0.02	1.2	3-TP-3	96%	no	no
1-Methylnaphthalene	soil	76	CL, Table 3, OMOE 2009	76	CL, Table 3, OMOE 2009		ug/g	19	0.70	2.98	0.005	13	2-TP-8	68%	no	no
2-Methylnaphthalene	soil	76	CL, Table 3, OMOE 2009	76	CL, Table 3, OMOE 2009		ug/g	24	1.56	5.35	0.005	22.8	FL-TP6-SA1 (AEC 2)	71%	no	no
Naphthalene	soil	22	CL EQG, CCME 2007	22	CL EQG, CCME 2007		ug/g	24	0.11	0.28	0.005	1	2-TP-8	79%	no	no
Phenanthrene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	24	0.07	0.16	0.005	0.69	FL-TP6-SA1 (AEC 2)	75%	no	no
Pyrene	soil	100	CL EQG, CCME 2007	100	CL EQG, CCME 2007		ug/g	24	0.27	1.22	0.005	6	3-TP-3	75%	no	no
Aroclor 1016	soil	3.9	USEPA Region 9, Dec 2009	3.9	USEPA Region 9, Dec 2009		ug/g	23	0.01	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1221	soil	0.14	USEPA Region 9, Dec 2009	0.14	USEPA Region 9, Dec 2009		ug/g	23	0.02	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1232	soil	0.14	USEPA Region 9, Dec 2009	0.14	USEPA Region 9, Dec 2009		ug/g	23	0.01	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1242	soil	0.22	USEPA Region 9, Dec 2009	0.22	USEPA Region 9, Dec 2009		ug/g	23	0.02	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1248	soil	0.22	USEPA Region 9, Dec 2009	0.22	USEPA Region 9, Dec 2009		ug/g	23	0.01	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1254	soil	0.22	USEPA Region 9, Dec 2009	0.22	USEPA Region 9, Dec 2009		ug/g	23	0.02	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1260	soil	0.22	USEPA Region 9, Dec 2009	0.22	USEPA Region 9, Dec 2009		ug/g	23	0.01	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1262	soil	NC	NC	NC	NC		ug/g	23	0.01	nc	nc	nc	na	100%	no (ND)	no (ND)
Aroclor 1268	soil	NC	NC	NC	NC		ug/g	23	0.01	nc	nc	nc	na	100%	no (ND)	no (ND)
Polychlorinated biphenyls	soil	33	CL EQG, CCME 2007	33	CL EQG, CCME 2007		ug/g	25	0.02	0.01	0.01	0.07	SWF-TP2-SA1 (AEC 1)	92%	no	no
Acetone	soil	16	CL, Table 3, OMOE 2009	16	CL, Table 3, OMOE 2009		ug/g	16	0.41	nc	nc	5	na	100%	no	no
Benzene	soil	0.03	CL EQG, CCME 2007	0.03	CL EQG, CCME 2007		ug/g	23	0.09	0.17	0.004	0.69	2-TP-12	35%	yes	yes
Bromodichloromethane	soil	18	CL, Table 3, OMOE 2009	18	CL, Table 3, OMOE 2009		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Bromoform	soil	0.61	CL, Table 3, OMOE 2009	0.61	CL, Table 3, OMOE 2009		ug/g	18	0.12	nc	nc	1	na	100%	no (ND)	no (ND)
Bromomethane	soil	0.05	CL, Table 3, OMOE 2009	0.05	CL, Table 3, OMOE 2009		ug/g	18	0.24	nc	nc	2	na	100%	no (ND)	no (ND)
Carbon tetrachloride	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Chlorobenzene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Chlorodibromomethane	soil	13	CL, Table 3, OMOE 2009	13	CL, Table 3, OMOE 2009		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Chloroform	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Dibromoethane	soil	0.034*	USEPA Region 9, Dec 2009	0.034*	USEPA Region 9, Dec 2009		ug/g	16	0.01	nc	nc	0.1	na	100%	no (ND)	no (ND)
1,2-Dichlorobenzene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,3-Dichlorobenzene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,4-Dichlorobenzene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,1-Dichloroethane	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,2-Dichloroethane	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,1-Dichloroethene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no

Soil Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

Parameter	Media	Eco RA Screening Criterial	EcoRA Screening Criteria Source	HHRA Screening Criteria	HHRA Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into HHRA/ PQRA?
cis-1,2-Dichloroethene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
trans-1,2-Dichloroethene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Dichloromethane	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,2-Dichloropropane	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
cis-1,3-Dichloropropene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
trans-1,3-Dichloropropene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Ethylbenzene	soil	0.082	CL EQG, CCME 2007	0.082	CL EQG, CCME 2007		ug/g	23	0.14	0.31	0.004	**0.7**	**2-TP-12**	35%	**yes**	**yes**
Hexachlorobenzene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	9	0.00	nc	nc	0.002	na	100%	no	no
Methyl ethyl ketone	soil	70	CL, Table 3, OMOE 2009	70	CL, Table 3, OMOE 2009		ug/g	16	0.09	nc	nc	1	na	100%	no	no
Methyl isobutyl ketone	soil	31	CL, Table 3, OMOE 2009	31	CL, Table 3, OMOE 2009		ug/g	16	0.09	nc	nc	1	na	100%	no	no
Methyl-tert-butylether	soil	11	CL, Table 3, OMOE 2009	11	CL, Table 3, OMOE 2009		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Styrene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,1,1,2-Tetrachloroethane	soil	0.087	CL, Table 3, OMOE 2009	0.087	CL, Table 3, OMOE 2009		ug/g	16	0.01	nc	nc	0.1	na	100%	no (ND)	no (ND)
1,1,2,2-Tetrachloroethane	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Tetrachloroethene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Toluene	soil	0.37	CL EQG, CCME 2007	0.37	CL EQG, CCME 2007		ug/g	23	0.20	0.38	0.013	**1.4**	**2-TP-12**	35%	**yes**	**yes**
1,1,1-Trichloroethane	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
1,1,2-Trichloroethane	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Trichloroethene	soil	50	CL EQG, CCME 2007	50	CL EQG, CCME 2007		ug/g	18	0.12	nc	nc	1	na	100%	no	no
Vinyl chloride	soil	0.032	CL, Table 3, OMOE 2009	0.032	CL, Table 3, OMOE 2009		ug/g	18	0.12	nc	nc	1	na	100%	no (ND)	no (ND)
m+p-Xylene	soil	26	CL, Table 3, OMOE 2009	26	CL, Table 3, OMOE 2009		ug/g	21	0.09	0.17	0.006	0.6	2-TP-8	24%	no	no
o-Xylene	soil	26	CL, Table 3, OMOE 2009	26	CL, Table 3, OMOE 2009		ug/g	21	0.11	0.37	0.003	1.7	2-TP-8	24%	no	no
Xylenes (total)	soil	11	CL EQG, CCME 2007	11	CL EQG, CCME 2007		ug/g	23	0.44	0.95	0.009	3	SWF-TP2-SA1 (AEC 1)	30%	no	no
Aldrin	soil	0.088	CL, Table 3, OMOE 2009	0.088	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Chlordane	soil	0.05	CL, Table 3, OMOE 2009	0.05	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
alpha-Chlordane	soil	0.05	CL, Table 3, OMOE 2009	0.05	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
trans-Chlordane	soil	0.05	CL, Table 3, OMOE 2009	0.05	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
2,4'-DDD	soil	4.6	CL, Table 3, OMOE 2009	4.6	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
4,4'-DDD	soil	4.6	CL, Table 3, OMOE 2009	4.6	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
DDD (total)	soil	4.6	CL, Table 3, OMOE 2009	4.6	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
2,4'-DDE	soil	0.52	CL, Table 3, OMOE 2009	0.52	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
4,4'-DDE	soil	0.52	CL, Table 3, OMOE 2009	0.52	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
DDE (total)	soil	0.52	CL, Table 3, OMOE 2009	0.52	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
2,4'-DDT	soil	12[E]	CL EQG, CCME 2007	1.4	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
4,4'-DDT	soil	12[E]	CL EQG, CCME 2007	1.4	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
DDT plus metabolites	soil	12[E]	CL EQG, CCME 2007	1.4	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
DDT (total)	soil	12[E]	CL EQG, CCME 2007	1.4	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Dieldrin	soil	0.014	CL, Table 1, AENV Tier 1	0.088	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Endosulfan	soil	0.3	CL, Table 3, OMOE 2009	0.3	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
alpha-Endosulfan	soil	0.3	CL, Table 3, OMOE 2009	0.3	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
beta-Endosulfan	soil	0.3	CL, Table 3, OMOE 2009	0.3	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Endosulfan sulphate	soil	0.3	CL, Table 3, OMOE 2009	0.3	CL, Table 3, OMOE 2009		ug/g	9	0.003	nc	nc	nc	na	100%	no (ND)	no (ND)
Endrin	soil	0.04	CL, Table 3, OMOE 2009	0.04	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Endrin aldehyde	soil	0.04	CL, Table 3, OMOE 2009	0.04	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Endrin ketone	soil	0.04	CL, Table 3, OMOE 2009	0.04	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
alpha-HCH	soil	0.01[Ag]	CL EQG, CCME 2007	0.01[Ag]	CL EQG, CCME 2007		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
beta-HCH	soil	0.01[Ag]	CL EQG, CCME 2007	0.01[Ag]	CL EQG, CCME 2007		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
delta-HCH	soil	0.01[Ag]	CL EQG, CCME 2007	0.01[Ag]	CL EQG, CCME 2007		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
gamma-HCH	soil	0.01[Ag]	CL EQG, CCME 2007	0.01[Ag]	CL EQG, CCME 2007		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Heptachlor	soil	0.19	CL, Table 3, OMOE 2009	0.19	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Heptachlor epoxide	soil	0.05	CL, Table 3, OMOE 2009	0.05	CL, Table 3, OMOE 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Hexachlorobenzene	soil	10	CL EQG, CCME 2007	10	CL EQG, CCME 2007		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Methoxychlor	soil	1.6	CL, Table 3, OMOE 2009	1.6	CL, Table 3, OMOE 2009		ug/g	9	0.008	nc	nc	nc	na	100%	no (ND)	no (ND)
Mirex	soil	0.027*	USEPA,Region 9, Dec 2009	0.027*	USEPA,Region 9, Dec 2009		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Octachlorostyrene	soil	NC	NC	NC	NC		ug/g	9	0.002	nc	nc	nc	na	100%	no (ND)	no (ND)
Toxaphene	soil	6.3	CL, Table 1, AENV Tier 1	6.3	CL, Table 1, AENV Tier 1		ug/g	9	0.080	nc	nc	nc	na	100%	no (ND)	no (ND)

[R/PL]-Soil quality guideline for the protection of soil and food ingestion for Residental/ Parkland land use (Environmental Health Guideline, CCME SoQC PAH 2008).

[PW] Soil quality guideline for the protection of potable water (Human Health Guidelines, CCME SoQG PAH2008)

[I] Soil Quality guideline for the protection of soil and food ingestion (Environmental Health Guideline, CCME SoQC PAH 2008).

[E] Soil quality guideline for environmental health (CCME SoQG PAH2008)

CL, Table 3, OMOE 2009- Ontario MOE, Table 3, 2009 Update, Soil standards for non-potable groundwater conditions, commercial land use and coarse grained soils

CL CWS, CCME 2008 (cg, surface, dir. Cont.) Table 3, Tier 1 levels for PHCs for Coarse Grained Surface Soils, Direct Contact (Ingestion+Dermal Contact)Technical Guidance Document

* As no commercial guideline exists for this chemical parameter the Residential/ Parkland guideline was applied.

USEPA Region 9, Dec 2009- USEPA Regional Screening Level (RSL) Master Summary Table, Residential Soil Standards, December 2009 Update

CL, Table 1, AENV Tier 1- Alberta Environment, Table 1. Soil Remediation Guidelines for Coarse Soils, CL use, February 2009 update

NC-No Criteria Available for this parameter

EcoRA Screening Criteria	Screening Criteria Source	HH/PQRA Screening Criteria	Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into PQRA?	95%UCLM	90th Percentile
0.03	CL EQG, CCME 2007	0.03	CL EQG, CCME 2007	0.02-0.04	ug/g	11	0.02	0.01	0.02	0.05	2-SD-3	91%	yes	yes	0.03	0.04
0.082	CL EQG, CCME 2007	0.082	CL EQG, CCME 2007	0.02-0.04	ug/g	11	0.03	0.01	0.02	0.055	2-SD-3	91%	no	no	0.03	0.04
0.89	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.37	CL EQG, CCME 2007	0.02-0.04	ug/g	11	0.03	0.04	0.02	0.15	2-SD-3	91%	no	no	0.06	0.04
0.025	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	11	CL EQG, CCME 2007	0.04-0.08	ug/g	11	0.05	0.01	0.04	0.08	1-SD-15 (bk)	91%	yes	no	0.05	0.057
0.025	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	11	CL EQG, CCME 2007	0.02-0.04	ug/g	11	0.02	0.01	0.02	0.04	1-SD-15 (bk)	91%	no	no	0.03	0.026
0.025	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	11	CL EQG, CCME 2007	0.04-0.08	ug/g	11	0.05	0.02	0.04	0.083	2-SD-3	91%	yes	no	0.06	0.08
320	CL CWS, CCME 2008 (cg, surface)	320	CL CWS, CCME 2008 (cg, surface)	10	ug/g	22	21.36	51.11	10	250	1-SD-6	95%	no	no	42.72	10
320	CL CWS, CCME 2008 (cg, surface)	320	CL CWS, CCME 2008 (cg, surface)	10	ug/g	22	21.36	51.11	10	250	1-SD-6	95%	no	no	42.72	10
260	CL CWS, CCME 2008 (cg, surface)	260	CL CWS, CCME 2008 (cg, surface)	10	ug/g	22	36.95	119.17	10	570	1-SD-6	91%	yes	yes	86.75	19
1700	CL CWS, CCME 2008 (cg, surface)	1700	CL CWS, CCME 2008 (cg, surface)	10	ug/g	22	22.91	41.58	10	200	1-SD-4	86%	no	no	40.28	28.1
3300	CL CWS, CCME 2008 (cg, surface)	3300	CL CWS, CCME 2008 (cg, surface)	10	ug/g	22	13.91	16.24	10	86	1-SD-4	95%	no	no	20.70	10
25	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	40	CL EQG, CCME 2007	0.2	ug/g	24	0.20	0.02	0.2	0.3	2-SD-11	96%	no	no	0.21	0.2
5.9	CCME ISQG 2002	6	Table 1, OMOE 2009	1	ug/g	24	1.71	0.75	1	3	1-SD-6	88%	no	no	2.01	3
20-60	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	2000	CL EQG, CCME 2007	-	ug/g	24	13.95	11.79	2	42	1-SD-6	0%	no	no	18.67	35.3
8	CL EQG, CCME 2007	8	CL EQG, CCME 2007	0.2	ug/g	24	0.22	0.05	0.2	0.4	3-SD-10	88%	no	no	0.24	0.29
2	AL EQG, CCME 2007	2	AL EQG, CCME 2007	-	ug/g	24	1.04	0.94	0.14	4.7	1-SD-15 (bk)	0%	yes	yes	1.42	1.69
0.6	CCME ISQG 2002	0.6	Table 1, OMOE 2009	0.1	ug/g	24	0.13	0.05	0.1	0.3	1-SD-8	58%	no	no	0.15	0.2
37.3	CCME ISQG 2002	26	Table 1, OMOE 2009	-	ug/g	24	4.83	2.71	2	13	1-SD-8	0%	no	no	5.92	8
1.4	CL EQG, CCME 2007	1.4	CL EQG, CCME 2007	0.2	ug/g	24	0.20	nc	nc	0.2	nc	100%	no	no	nc	nc
50	Table 1, OMOE 2009	50	Table 1, OMOE 2009	-	ug/g	24	1.18	1.04	0.1	3.9	3-SD-10	4%	no	no	1.60	2.69
35.7	CCME ISQG 2002	16	Table 1, OMOE 2009	-	ug/g	24	3.29	2.75	0.5	9.9	1-SD-1	96%	no	no	4.39	6.45
35.0	CCME ISQG 2002	31	Table 1, OMOE 2009	5	ug/g	24	6.25	3.15	1	13	2-SD-3	13%	no	no	7.51	9
0.17	CCME ISQG 2002	0.2	Table 1, OMOE 2009	0.05	ug/g	24	0.05	nc	nc	0.05	nc	100%	no	no	nc	nc
40	CL EQG, CCME 2007	40	CL EQG, CCME 2007	0.5	ug/g	24	0.62	0.43	0.5	2.6	2-SD-19	75%	no	no	0.79	0.6
16	Table 1, OMOE 2009	16	Table 1, OMOE 2009	2.5	ug/g	24	3.33	1.95	1	7.5	3-SD-10	21%	no	no	4.11	6.9
2.9	CL EQG, CCME 2007	2.9	CL EQG, CCME 2007	0.5	ug/g	24	0.50	nc	nc	0.5	nc	100%	no	no	nc	nc
0.5	Table 1, OMOE 2009	0.5	Table 1, OMOE 2009	0.2	ug/g	24	0.20	nc	nc	0.2	nc	100%	no	no	nc	nc
1	CL EQG, CCME 2007	1	CL EQG, CCME 2007	0.05	ug/g	24	0.05	0.00	0.05	0.07	1-SD-6	88%	no	no	0.05	0.05
130	CL EQG, CCME 2007	130	CL EQG, CCME 2007	5	ug/g	24	8.25	3.66	5	18	2-SD-6	25%	no	no	9.72	14.7
123	CCME ISQG 2002	120	Table 1, OMOE 2009	5	ug/g	24	19.08	11.32	5	57	1-SD-8	4%	no	no	23.61	25.8
0.00671	CCME ISQG 2002	0.072	Table 1, Bkg. Soil Standard , OMOE 2009	0.01-0.04	ug/g	18	0.02	0.01	0.01	0.02	1-SD-6	94%	yes	no	nc	nc
0.00587	CCME ISQG 2002	0.093	Table 1, Bkg. Soil Standard , OMOE 2009	0.005-0.02	ug/g	18	nc	nc	nc	0.02	nc	100%	no (ND)	no	nc	nc
0.0469	CCME ISQG 2002	0.22	Table 1, OMOE 2009	0.005-0.02	ug/g	18	nc	nc	nc	0.02	nc	100%	no (ND)	no	nc	nc
0.0317	CCME ISQG 2002	0.32	Table 1, OMOE 2009	0.01-0.04	ug/g	18	nc	nc	nc	0.04	nc	100%	no (ND)	no	nc	nc
0.0319	CCME ISQG 2002	0.37	Table 1, OMOE 2009	0.005-0.02	ug/g	18	nc	nc	nc	0.02	nc	100%	no	no	nc	nc
10	CL EQG, CCME 2007	10	CL EQG, CCME 2007	0.01-0.04	ug/g	18	nc	nc	nc	0.04	nc	100%	no	no	nc	nc
0.17	Table 1, OMOE 2009	0.17	Table 1, OMOE 2009	0.02-0.08	ug/g	18	nc	nc	nc	0.08	nc	100%	no	no	nc	nc
0.24	Table 1, OMOE 2009	0.24	Table 1, OMOE 2009	0.01-0.04	ug/g	18	nc	nc	nc	0.04	nc	100%	no	no	nc	nc
0.0571	CCME ISQG 2002	0.34	Table 1, OMOE 2009	0.01-0.04	ug/g	18	nc	nc	nc	0.04	nc	100%	no	no	nc	nc
0.00622	CCME ISQG 2002	0.06	Table 1, OMOE 2009	0.02-0.08	ug/g	18	nc	nc	nc	0.08	nc	100%	no (ND)	no (ND)	nc	nc
0.111	CCME ISQG 2002	0.75	Table 1, OMOE 2009	0.005-0.02	ug/g	18	nc	nc	nc	0.02	nc	100%	no	no	nc	nc
0.0212	CCME ISQG 2002	0.19	Table 1, OMOE 2009	0.005-0.02	ug/g	18	0.01	0.01	0.005	0.028	1-SD-6	94%	yes	no	0.01	0.02
0.2	Table 1, OMOE 2009	0.2	Table 1, OMOE 2009	0.02-0.08	ug/g	18	nc	nc	nc	0.08	nc	100%	no	no	nc	nc
0.0202	CCME ISQG 2002	0.59	Table 1, Bkg. Soil Standard , OMOE 2009	0.005-0.02	ug/g	18	0.03	0.09	0.005	0.4	1-SD-6	94%	yes	no	0.07	0.02
0.0202	CCME ISQG 2002	0.59	Table 1, Bkg. Soil Standard , OMOE 2009	0.005-0.02	ug/g	18	0.03	0.09	0.005	0.39	1-SD-6	89%	yes	no	0.07	0.02
0.0346	CCME ISQG 2002	22	CL EQG, CCME 2007	0.005-0.02	ug/g	18	0.01	0.02	0.005	0.11	1-SD-6	94%	yes	no	0.02	0.02
0.0419	CCME ISQG 2002	0.56	Table 1, OMOE 2009	0.005-0.02	ug/g	18	0.01	0.00	0.005	0.02	1-SD-4	94%	no	no	0.01	0.0137
0.053	CCME ISQG 2002	0.49	Table 1, OMOE 2009	0.005-0.02	ug/g	18	nc	nc	nc	0.02	nc	100%	no	no	nc	nc
0.0075	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.0075	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no (ND)	no (ND)	nc	nc
0.14	USEPA Region 9, Dec 2009	0.14	USEPA Region 9, Dec 2009	0.01-0.03	ug/g	16	nc	nc	nc	0.03	nc	100%	no	no	nc	nc
0.14	USEPA Region 9, Dec 2009	0.14	USEPA Region 9, Dec 2009	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no	no	nc	nc
0.01	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.01	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no (ND)	no (ND)	nc	nc
0.035	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.035	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no (ND)	no (ND)	nc	nc
0.06	CCME ISQG 2002	0.06	CCME ISQG 2002	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no	no	nc	nc
0.24	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.24	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no	no	nc	nc
NC	NC	NC	NC	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no (ND)	no (ND)	nc	nc
NC	NC	NC	NC	0.01-0.02	ug/g	16	nc	nc	nc	0.02	nc	100%	no (ND)	no (ND)	nc	nc
0.0341	CCME ISQG 2002	0.07	Table 1, OMOE 2009	0.01-0.03	ug/g	16	nc	nc	nc	0.03	nc	100%	no	no	nc	nc
0.5	Table 1, Bkg. Soil Standard , OMOE 2009	0.5	Table 1, Bkg. Soil Standard , OMOE 2009	0.1	ug/g	12	0.10	0.00	0.1	0.1	nc	92%	no	no	nc	0.1
0.03	CL EQG, CCME 2007	0.03	CL EQG, CCME 2007	-	ug/g	12	0.03	0.03	0.007	0.097	2-SD-4	0%	yes	yes	0.04	0.0493
0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
650	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.003	ug/g	12	0.00	0.00	0.003	0.003	nc	100%	no (ND)	no (ND)	nc	0.003
1.2	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.82	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	10	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.0004	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.034	USEPA,Region 9, Dec 2009	0.034	USEPA,Region 9, Dec 2009	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.34	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	10	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
1.7	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	10	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.35	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	10	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.003	ug/g	12	0.00	0.00	0.003	0.006	1-SD-7	100%	no (ND)	no (ND)	0.00	0.003
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.082	CL EQG, CCME 2007	0.082	CL EQG, CCME 2007	0.002	ug/g	12	0.04	0.03	0.008	0.12	2-SD-4	0%	no (ND)	no (ND)	0.06	0.0662
0.02	Table 1, OMOE 2009	10	CL EQG, CCME 2007	0.002	ug/g	6	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.5	Table 1, Bkg. Soil Standard , OMOE 2009	0.5	Table 1, Bkg. Soil Standard , OMOE 2009	0.03	ug/g	12	0.03	0.00	0.03	0.03	nc	100%	no (ND)	no (ND)	nc	0.03
0.5	Table 1, Bkg. Soil Standard , OMOE 2009	0.5	Table 1, Bkg. Soil Standard , OMOE 2009	0.03	ug/g	12	0.03	0.00	0.03	0.03	nc	100%	no (ND)	no (ND)	nc	0.03
0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.37	CL EQG, CCME 2007	0.37	CL EQG, CCME 2007	0.002	ug/g	12	0.09	0.08	0.024	0.28	2-SD-4	0%	no	no	0.14	0.168
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002

Sediment Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

EcoRA Screening Criteria	Screening Criteria Source	HH/PQRA Screening Criteria	Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into PQRA?	95%UCLM	90th Percentile
50	CL EQG, CCME 2007	50	CL EQG, CCME 2007	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.02	Table 1, Bkg. Soil Standard , OMOE 2009	0.02	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	12	0.00	0.00	0.002	0.002	nc	100%	no (ND)	no (ND)	nc	0.002
0.025	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	11	CL EQG, CCME 2007	0.002	ug/g	12	0.06	0.06	0.008	0.2	1-SD-6	0%	yes	no	0.09	0.1596
0.025	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	11	CL EQG, CCME 2007	0.002	ug/g	12	0.04	0.08	0.004	0.3	1-SD-6	0%	yes	no	0.09	0.0794
0.025	CCME ISQG 2002	11	CL EQG, CCME 2007	0.002	ug/g	12	0.11	0.17	0.013	0.6	1-SD-6	0%	yes	no	0.20	0.2345
0.002	Table 1, OMOE 2009	0.002	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.0045	CCME ISQG 2002	0.007	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.0045	nc	100%	no (ND)	no (ND)	nc	nc
0.0045	CCME ISQG 2002	0.007	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.0045	CCME ISQG 2002	0.007	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00354	CCME ISQG 2002	0.008	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00354	CCME ISQG 2002	0.008	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00354	CCME ISQG 2002	0.008	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.00354	nc	100%	no (ND)	no (ND)	nc	nc
0.00142	CCME ISQG 2002	0.005	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00142	CCME ISQG 2002	0.005	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00142	CCME ISQG 2002	0.005	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00119	CCME ISQG 2002	0.007	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00119	CCME ISQG 2002	0.007	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00119	CCME ISQG 2002	0.007	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00285	CCME ISQG 2002	0.002	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.00285	nc	100%	no (ND)	no (ND)	nc	nc
0.0054	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.04	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.0029	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.04	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.014	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.04	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.0029	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.04	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00267	CCME ISQG 2002	0.003	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.00267	nc	100%	no (ND)	no (ND)	nc	nc
0.00267	CCME ISQG 2002	0.003	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00267	CCME ISQG 2002	0.003	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00094	CCME ISQG 2002	0.01[AL]	CL EQG, CCME 2007	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00094	CCME ISQG 2002	0.01[AL]	CL EQG, CCME 2007	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00094	CCME ISQG 2002	0.01[AL]	CL EQG, CCME 2007	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.00094	CCME ISQG 2002	0.01	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.002	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.0006	CCME ISQG 2002	0.005	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.02	Table 1, OMOE 2009	0.02	Table 1, OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.019	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.05	Table 1, Bkg. Soil Standard , OMOE 2009	0.002	ug/g	10	nc	nc	nc	0.008	nc	100%	no (ND)	no (ND)	nc	nc
0.007	EC, Environ. Quality Benchmarks, 1999, Appendix 3-1	0.0007	EC, Environ. Quality Benchmarks, 1999, Appendix 3-4	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.005	EC, Environ. Quality Benchmarks, 1999, Appendix 3-3	0.005	EC, Environ. Quality Benchmarks, 1999, Appendix 3-3	0.002	ug/g	10	nc	nc	nc	0.002	nc	100%	no (ND)	no (ND)	nc	nc
0.1	CCME ISQG 2002 (updated 2009)	0.02	EC, Environ. Quality Benchmarks, 1999, Appendix 3-4	0.08	ug/g	10	nc	nc	nc	0.08	nc	100%	no (ND)	no (ND)	nc	nc

Appendix 3-1 - Compendium of Environmental Quality Benchmarks (Environment Canada 1999), Appendix 3-1 A Summary of the Available Sediment Quality Criteria and Guidelines for the Protection of Freshwater Aquatic Life
inisters of the Environment, Table 1, Interim freshwater sediment quality guidelines and probable effects levels for the pretection of aquatic life, Update 2002
, Schedule 9, Generic Numerical Sediment Criteria, Freshwater Sediment (Typical)
9- OMOE Table 1. Full Depth Background Site Condition Soil Standard for RL/P/I/C Land Use, 2009
l Depth Background Site Condition Sediment Standard (All Land Use)
ercial land use, agricultural land use guideline was applied
Appendix 3-3. A Summary of the Available Sediment Quality Criteria and Guidelines for the Protection of Wildlife Utilizing Freshwater, Estuarine, and Marine Environments
Appendix 3-4-A Summary of the Available Sediment Quality Criteria and Guidelines for Protection of Human Health.
[AL] Regional Screening Level (RSL) Master Summary Table, Residential Soil Standards, December 2009 Update

Surface Water Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

Parameter	Media	EcoRA Screening Criteria	EcoRA Screening Criteria Source	HHRA Screening Criteria	HHRA/PQRA Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into HHRA/PQRA?	95%UCLM	90th Percentile
Benzene	surface water	370	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.1-0.5	ug/L	19	0.22	nc	nc	0.5	nc	100%	no	no	nc	0.26
Ethylbenzene	surface water	90	FWAL, CCME 2007	2.4	DWQ, Health Canada 2008	0.1-0.5	ug/L	19	0.22	0.11	0.1	0.3	2-SW-9	95%	no	no	0.26980225	0.34
Toluene	surface water	2	FWAL, CCME 2007	24	DWQ, Health Canada 2008	0.2-0.5	ug/L	19	0.23	0.09	nc	0.5	nc	100%	no	no	nc	0.26
Xylenes (total)	surface water	300	OMOE 2009, GW,Table 8.	300	DWQ, Health Canada 2008	0.1-0.4	ug/L	19	0.37	0.22	0.1	1.1	2-SW-9	89%	no	no	0.47063622	0.42
F1 (C6-C10)	surface water	420	OMOE 2009, GW,Table 8.	420	OMOE 2009, GW,Table 8.	100	ug/L	25	100.00	nc	nc	100	nc	100%	no	no	nc	100
F2 (C10-C16)	surface water	150	OMOE 2009, GW,Table 8.	150	OMOE 2009, GW,Table 8.	100	ug/L	25	104.00	nc	nc	200	nc	100%	no (ND)	no (ND)	nc	100
F3 (C16-C34)	surface water	500	OMOE 2009, GW,Table 8.	500	OMOE 2009, GW,Table 8.	100	ug/L	23	100.00	nc	nc	100	nc	100%	no	no	nc	100
F4 (C34-C50)	surface water	500	OMOE 2009, GW,Table 8.	500	OMOE 2009, GW,Table 8.	100	ug/L	23	100.00	nc	nc	100	nc	100%	no	no	nc	100
Aluminum	surface water	100[a,c]	FWAL, CCME 2007	100	DWQ, Health Canada 2008	5	ug/L	24	5.79	1.69	5	12	2-SW-6	71%	no	no	6.46917305	7.6
Antimony	surface water	200	BC CSR, Schedule 6, FWAL,2009	6	DWQ, Health Canada 2008	0.5-1	ug/L	24	0.70	0.35	0.5	2	SWF-SW2 (AEC 1)	67%	no	no	0.84157116	1.07
Arsenic	surface water	5	FWAL, CCME 2007	10	DWQ, Health Canada 2008	1-5	ug/L	24	1.63	nc	1	3	1-SW-6	88%	no	no	nc	nc
Beryllium	surface water	53	BC CSR, Schedule 6, FWAL,2009	73	USEPA, Region IX, Tapwater, 2009	0.5-1	ug/L	24	0.56	nc	nc	1	nc	100%	no	no	nc	nc
Boron	surface water	200	PWQO, OMOE 1994	5000	DWQ, Health Canada 2008	10-50	ug/L	23	78.22	63.82	10	250	1-SW-6	4%	no?	no	104.298535	150
Cadmium	surface water	0.017	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.1	ug/L	24	0.11	0.07	0.01	0.4	1-SW-7	83%	yes	no	0.14027574	0.1
Calcium	surface water	1000000	BC CSR, Schedule 6, [c,e]	NC	NC	-	ug/L	5	67600.00	20366.64	46000	100000	SWF-SW2 (AEC 1)	0%	no	no	85451.8185	88800
Chromium	surface water	8.9	FWAL, CCME 2007	50	DWQ, Health Canada 2008	5-7	ug/L	23	nc	nc	nc	7	SWF-SW2 (AEC 1)	100%	no	no	nc	nc
Chromium (VI)	surface water	1	FWAL, CCME 2007	0.043	USEPA, Region IX, Tapwater, 2009	0.5	ug/L	21	nc	nc	nc	0.8	2-SW-6	100%	no	no (ND)	nc	nc
Cobalt	surface water	0.9	PWQO, OMOE 1994	11	USEPA, Region IX, Tapwater, 2009	0.5-5	ug/L	23	1.07	nc	0.5	2.7	1-SW-6	83%	no	no	nc	nc
Copper	surface water	4[a,c]	FWAL, CCME 2007	1000	DWQ, Health Canada 2008	1-2	ug/L	24	2.25	2.21	1	10.9	SWF-SW2 (AEC 1)	50%	yes	no	3.13167333	4
Iron	surface water	300	FWAL, CCME 2007	300	DWQ, Health Canada 2008	6-100	ug/L	23	160.30	134.38	100	590	1-SW-6	74%	yes	yes	215.222259	349
Lead	surface water	7[a,c]	FWAL, CCME 2007	10	DWQ, Health Canada 2008	0.5-1	ug/L	24	0.76	0.38	0.5	2	SWF-SW2 (AEC 1)	63%	no	no	0.91578366	1.17
Magnesium	surface water	2000-35000	Compendium BC 2006	35000	Appendix 2-1, C.E.Q.B., EC 1999	-	ug/L	19	17931.58	4862.33	10000	27000	2-SW-7	0%	no	no	20117.9103	24200
Mercury	surface water	0.026	FWAL, CCME 2007	1	DWQ, Health Canada 2008	0.05-0.1	ug/L	23	0.10	0.01	0.05	0.1	1-SW-1	100%	no (ND)	no	0.1015393	0.1
Molybdenum	surface water	73	FWAL, CCME 2007	250	BC CSR, Schedule 6, DW,2009	1-6	ug/L	23	1.52	1.44	1	6	SWF-SW2 (AEC 1)	78%	no	no	2.11101246	4.8
Nickel	surface water	150[a,c]	FWAL, CCME 2007	1800	USEPA, Region IX, Tapwater, 2009	1-8	ug/L	23	3.17	3.95	1	15	SWF-SW2 (AEC 1)	57%	no	no	4.78831801	8.8
Selenium	surface water	1	FWAL, CCME 2007	10	DWQ, Health Canada 2008	1-2	ug/L	24	1.88	0.34	1	2	1-SW-1	100%	no (ND)	no	2.01015845	2
Silver	surface water	0.1	FWAL, CCME 2007	180	USEPA, Region IX, Tapwater, 2009	0.1	ug/L	24	0.10	0.00	0.1	0.1	nc	100%	no	no	nc	0.1
Thallium	surface water	0.8	FWAL, CCME 2007	2	OMOE 2009, GW,Table 8.	0.05-0.08	ug/L	24	0.14	0.25	0.05	0.8	SWF-SW2 (AEC 1)	100%	no	no	0.24511884	0.8
Uranium	surface water	3000	BC CSR, Schedule 6, FWAL,2009	20	DWQ, Health Canada 2008	0.1-1	ug/L	24	0.44	0.27	0.1	1	SWF-SW2 (AEC 1)	13%	no	no	0.54973978	0.91
Vanadium	surface water	7	Appendix 2-4, C.E.Q.B., EC 1999	2.6	USEPA, Region IX, Tapwater, 2009	1-50	ug/L	23	5.30	nc	1	2	1-SW-5	96%	no	no	nc	nc
Zinc	surface water	30	FWAL, CCME 2007	5000	DWQ, Health Canada 2008	5	ug/L	23	14.13	24.55	5	110	1-SW-7	61%	yes	no	24.1639835	27
Zirconium	surface water	4	PWQO, OMOE 1994	4	PWQO, OMOE 1994	1-5	ug/L	23	1.35	1.15	1	5	SWF-SW2 (AEC 1)	100%	no (ND)	no (ND)	1.81879642	1
Acenaphthene	surface water	5.8	FWAL, CCME 2007	2200	USEPA, Region IX, Tapwater, 2009	0.05-0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no	no	nc	nc
Acenaphthylene	surface water	1	OMOE 2009, GW,Table 8.	1	OMOE 2009, GW,Table 8.	0.05-0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no	no	nc	nc
Anthracene	surface water	0.012	FWAL, CCME 2007	11000	USEPA, Region IX, Tapwater, 2009	0.05-0.01	ug/L	18	nc	nc	nc	0.05	nc	100%	no (ND)	no	nc	nc
Benzo(a)anthracene	surface water	0.018	FWAL, CCME 2007	0.029	USEPA, Region IX, Tapwater, 2009	0.05-0.01	ug/L	18	nc	nc	nc	0.05	nc	100%	no (ND)	no (ND)	nc	nc
Benzo(a)pyrene	surface water	0.015	FWAL, CCME 2007	0.01	DWQ, Health Canada 2008	0.01	ug/L	18	nc	nc	nc	0.01	nc	100%	no	no	nc	nc
Benzo(b+j)fluoranthene	surface water	0.1	OMOE 2009, GW,Table 8.	0.029	USEPA, Region IX, Tapwater, 2009	0.05-0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no	no (ND)	nc	nc
Benzo(g,h,i)perylene	surface water	0.00002	PWQO, OMOE 1994	0.2	OMOE 2009, GW,Table 8.	0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no (ND)	no	nc	nc
Benzo(k)fluoranthene	surface water	0.0002	PWQO, OMOE 1994	0.29	USEPA, Region IX, Tapwater, 2009	0.05-0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no (ND)	no	nc	nc
Chrysene	surface water	0.0001	PWQO, OMOE 1994	2.9	USEPA, Region IX, Tapwater, 2009	0.05-0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no (ND)	no	nc	nc
Dibenz(a,h)anthracene	surface water	0.002	PWQO, OMOE 1994	0.0029	USEPA, Region IX, Tapwater, 2009	0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no (ND)	no (ND)	nc	nc
Fluoranthene	surface water	0.04	FWAL, CCME 2007	1500	USEPA, Region IX, Tapwater, 2009	0.04-0.05	ug/L	18	nc	nc	nc	0.05	nc	100%	no (ND)	no	nc	nc
Fluorene	surface water	3	FWAL, CCME 2007	1500	USEPA, Region IX, Tapwater, 2009	0.05-0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no	no	nc	nc
Indeno(1,2,3-cd)pyrene	surface water	0.0038	Appendix 2-4, C.E.Q.B., EC 1999	0.029	USEPA, Region IX, Tapwater, 2009	0.01-0.1	ug/L	18	nc	nc	nc	0.1	nc	100%	no (ND)	no	nc	nc
1-Methylnaphthalene	surface water	2	PWQO, OMOE 1994	2.3	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	16	nc	nc	nc	0.05	nc	100%	no	no	nc	nc
2-Methylnaphthalene	surface water	2	PWQO, OMOE 1994	150	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	16	nc	nc	nc	0.05	nc	100%	no	no	nc	nc
Naphthalene	surface water	1.1	FWAL, CCME 2007	0.14	USEPA, Region IX, Tapwater, 2009	0.05-1	ug/L	18	nc	nc	nc	1	nc	100%	no	no (ND)	nc	nc
Phenanthrene	surface water	0.4	FWAL, CCME 2007	1	OMOE 2009, GW,Table 8.	0.05-0.3	ug/L	18	nc	nc	nc	0.3	nc	100%	no	no	nc	nc
Pyrene	surface water	0.025	FWAL, CCME 2007	4.1	OMOE 2009, GW,Table 8.	0.02-0.05	ug/L	18	nc	nc	nc	0.05	nc	100%	no (ND)	no	nc	nc
Aroclor 1016	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.96	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	10	nc	nc	nc	0.05	nc	100%	no (ND)	no	nc	nc
Aroclor 1221	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.0068	USEPA, Region IX, Tapwater, 2009	0.1	ug/L	10	nc	nc	nc	0.1	nc	100%	no (ND)	no (ND)	nc	nc
Aroclor 1232	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.0068	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	10	nc	nc	nc	0.05	nc	100%	no (ND)	no (ND)	nc	nc
Aroclor 1242	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.034	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	10	nc	nc	nc	0.05	nc	100%	no (ND)	no (ND)	nc	nc
Aroclor 1248	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.034	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	10	nc	nc	nc	0.05	nc	100%	no (ND)	no (ND)	nc	nc
Aroclor 1254	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.034	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	10	nc	nc	nc	0.05	nc	100%	no (ND)	no (ND)	nc	nc
Aroclor 1260	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.034	USEPA, Region IX, Tapwater, 2009	0.05	ug/L	10	nc	nc	nc	0.05	nc	100%	no (ND)	no (ND)	nc	nc
Aroclor 1262	surface water	NC	NC	NC	NC	0.05	ug/L	3	nc	nc	nc	0.05	nc	100%	no	no	nc	nc
Aroclor 1268	surface water	NC	NC	NC	NC	0.05	ug/L	3	nc	nc	nc	0.05	nc	100%	no	no	nc	nc
Polychlorinated biphenyls	surface water	0.001	FWAL, CCME 2007	3	Ont. DWQ Standards, 2006, Table 2	0.1	ug/L	10	nc	nc	nc	0.1	nc	100%	no (ND)	no	nc	nc
Acetone	surface water	2700	OMOE 2009, GW,Table 8.	33000	BC CSR Schedule 10, 2009	10	ug/L	10	nc	nc	10	10	nc	100%	no	no	nc	nc
Benzene	surface water	370	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.1-5	ug/L	26	nc	nc	0.1	5	nc	100%	no	no	nc	nc
Bromodichloromethane	surface water	100	BC CSR, Schedule 6, LW,2009	16	DWQ, Health Canada 2008	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
Bromoform	surface water	100	BC CSR, Schedule 6, LW,2009	100	BC CSR Schedule 10, 2009	0.2-5	ug/L	12	nc	nc	0.2	5	nc	100%	no	no	nc	nc
Bromomethane	surface water	0.9	Interim PWQO, OMOE 1994	51	BC CSR Schedule 10, 2009	0.5-20	ug/L	12	nc	nc	0.5	20	nc	100%	no (ND)	no	nc	nc
Carbon tetrachloride	surface water	13.3	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
Chlorobenzene	surface water	1.3	FWAL, CCME 2007	80	DWQ, Health Canada 2008	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no (ND)	no	nc	nc
Chlorodibromomethane	surface water	100	BC CSR, Schedule 6, LW,2009	100	BC CSR Schedule 10, 2009	0.2-10	ug/L	12	nc	nc	0.2	10	nc	100%	no	no	nc	nc
Chloroform	surface water	1.8	FWAL, CCME 2007	0.19	Appendix 2-1, C.E.Q.B., EC 1999	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no (ND)	no (ND)	nc	nc
Dibromoethane	surface water	0.2	OMOE 2009, GW,Table 8.	0.34	BC CSR Schedule 10, 2009	0.2	ug/L	10	nc	nc	0.2	0.2	nc	100%	no	no	nc	nc
1,2-Dichlorobenzene	surface water	0.7	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.2-5	ug/L	12	nc	nc	0.2	5	nc	100%	no (ND)	no	nc	nc
1,3-Dichlorobenzene	surface water	150	FWAL, CCME 2007	59	OMOE 2009, GW,Table 8.	0.2-5	ug/L	12	nc	nc	0.2	5	nc	100%	no	no	nc	nc
1,4-Dichlorobenzene	surface water	26	FWAL, CCME 2007	200	DWQ, Health Canada 2008	0.2-5	ug/L	12	nc	nc	0.2	5	nc	100%	no	no	nc	nc
1,1-Dichloroethane	surface water	200	PWQO, OMOE 1994	3700	BC CSR Schedule 10, 2009	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
1,2-Dichloroethane	surface water	100	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.1-5	ug/L	12	nc	nc	0.2	5	nc	100%	no	no	nc	nc
1,1-Dichloroethene	surface water	200	PWQO, OMOE 1994	14	DWQ, Health Canada 2008	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
cis-1,2-Dichloroethene	surface water	200	Appendix 2-4, C.E.Q.B., EC 1999	370	BC CSR Schedule 10, 2009	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
trans-1,2-Dichloroethene	surface water	200	Appendix 2-4, C.E.Q.B., EC 1999	730	BC CSR Schedule 10, 2009	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
Dichloromethane	surface water	98.1	FWAL, CCME 2007	50	DWQ, Health Canada 2008	0.05-20	ug/L	12	nc	nc	0.5	20	nc	100%	no	no	nc	nc
1,2-Dichloropropane	surface water	0.7	PWQO, OMOE 1994	9.9	BC CSR Schedule 10, 2009	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no (ND)	no	nc	nc
cis-1,3-Dichloropropene	surface water	0.5	OMOE 2009, GW,Table 8.	6.7	BC CSR Schedule 10, 2009	0.1-5	ug/L	12	nc	nc	0.2	5	nc	100%	no (ND)	no	nc	nc
trans-1,3-Dichloropropene	surface water	7	PWQO, OMOE 1994	6.7	BC CSR Schedule 10, 2009	0.1-5	ug/L	12	nc	nc	0.2	5	nc	100%	no (ND)	no	nc	nc
Ethylbenzene	surface water	90	FWAL, CCME 2007	2.4	DWQ, Health Canada 2008	0.1-5	ug/L	26	nc	nc	0.1	5	nc	100%	no	no (ND)	nc	nc
Hexachlorobenzene	surface water	0.0065	PWQO, OMOE 1994	0.042	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
Methyl ethyl ketone	surface water	400	PWQO, OMOE 1994	22000	BC CSR Schedule 10, 2009	5	ug/L	10	nc	nc	5	5	nc	100%	no	no	nc	nc
Methyl isobutyl ketone	surface water	640	OMOE 2009, GW,Table 8.	2900	BC CSR Schedule 10, 2009	5	ug/L	10	nc	nc	5	5	nc	100%	no	no	nc	nc
Methyl-tert-butylether	surface water	10000	FWAL, CCME 2007	15	DWQ, Health Canada 2008	0.2-5	ug/L	12	nc	nc	0.2	7.3	nc	100%	no	no	nc	nc

Surface Water Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

Parameter	Media	EcoRA Screening Criteria	EcoRA Screening Criteria Source	HHRA Screening Criteria	HHRA/PQRA Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into HHRA/PQRA?	95%UCLM	90th Percentile
Styrene	surface water	72	FWAL, CCME 2007	1600	USEPA, Region IX, Tapwater, 2009	0.2-5	ug/L	12	nc	nc	0.2	5	nc	100%	no	no	nc	nc
1,1,1,2-Tetrachloroethane	surface water	20	PWQO, OMOE 1994	26	BC CSR Schedule 10, 2009	0.1	ug/L	10	nc	nc	0.1	0.1	nc	100%	no	no	nc	nc
1,1,2,2-Tetrachloroethane	surface water	1100	BC CSR Schedule 6, FWAL, 2009	3.4	BC CSR Schedule 10, 2009	0.2-5	ug/L	12	nc	nc	0.2	5	nc	100%	no	no (ND)	nc	nc
Tetrachloroethene	surface water	111	FWAL, CCME 2007	30	DWQ, Health Canada 2008	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
Toluene	surface water	2	FWAL, CCME 2007	24	DWQ, Health Canada 2008	0.2-5	ug/L	26	nc	nc	0.2	5	nc	100%	no (ND)	no	nc	nc
1,1,1-Trichloroethane	surface water	37	Appendix 2-4, C.E.Q.B., EC 1999	10000	BC CSR Schedule 10, 2009	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
1,1,2-Trichloroethane	surface water	800	PWQO, OMOE 1994	12	BC CSR Schedule 10, 2009	0.2-5	ug/L	12	nc	nc	0.2	5	nc	100%	no	no	nc	nc
Trichloroethene	surface water	21	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.1-5	ug/L	12	nc	nc	0.1	5	nc	100%	no	no	nc	nc
Vinyl chloride	surface water	600	PWQO, OMOE 1994	2	DWQ, Health Canada 2008	0.2-20	ug/L	12	nc	nc	0.2	20	nc	100%	no	no (ND)	nc	nc
m+p-Xylene	surface water	2	PWQO, OMOE 1994	1200	USEPA, Region IX, Tapwater, 2009	0.1-0.4	ug/L	24	nc	nc	0.1	1.1	nc	100%	no	no	nc	nc
o-Xylene	surface water	40	PWQO, OMOE 1994	1200	USEPA, Region IX, Tapwater, 2009	0.1-0.2	ug/L	24	nc	nc	0.1	0.2	nc	100%	no	no	nc	nc
Xylenes (total)	surface water	300	OMOE 2009, GW,Table 8.	300	DWQ, Health Canada 2008	0.1-20	ug/L	26	nc	nc	0.1	20	nc	100%	no	no	nc	nc
Aldrin	surface water	1.5	AENV, FWAL, 1999 (USEPA SOURCE)	0.7	BC CSR Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
Chlordane	surface water	0.006	FWAL, CCME 2007	7	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
alpha-Chlordane	surface water	0.006	FWAL, CCME 2007	7	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
trans-Chlordane	surface water	0.006	FWAL, CCME 2007	7	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
2,4'-DDD	surface water	0.06	Appendix 2-4, C.E.Q.B., EC 1999	0.28	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
4,4'-DDD	surface water	0.06	Appendix 2-4, C.E.Q.B., EC 1999	0.28	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
DDD (total)	surface water	0.06	Appendix 2-4, C.E.Q.B., EC 1999	0.28	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
2,4'-DDE	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.2	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
4,4'-DDE	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.2	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
DDE (total)	surface water	0.014	Appendix 2-4, C.E.Q.B., EC 1999	0.2	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
2,4'-DDT	surface water	0.001	FWAL, CCME 2007	30	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
4,4'-DDT	surface water	0.001	FWAL, CCME 2007	30	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
DDT plus metabolites	surface water	0.001	FWAL, CCME 2007	30	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
DDT (total)	surface water	0.001	FWAL, CCME 2007	30	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
Dieldrin	surface water	0.24	AENV, FWAL, 1999 (USEPA SOURCE)	0.7	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
Endosulfan	surface water	0.02	FWAL, CCME 2007	220	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
alpha-Endosulfan	surface water	0.02	FWAL, CCME 2007	220	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
beta-Endosulfan	surface water	0.02	FWAL, CCME 2007	220	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
Endosulfan sulphate	surface water	0.02	FWAL, CCME 2007	220	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.01	nc	100%	no	no	nc	nc
Endrin	surface water	0.0023	FWAL, CCME 2007	11	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
Endrin aldehyde	surface water	0.0023	FWAL, CCME 2007	11	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
Endrin ketone	surface water	0.0023	FWAL, CCME 2007	11	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
alpha-HCH	surface water	0.01	FWAL, CCME 2007	0.01	FWAL, CCME 2007	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
beta-HCH	surface water	0.01	FWAL, CCME 2007	0.37	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.01	nc	100%	no	no	nc	nc
delta-HCH	surface water	0.01	FWAL, CCME 2007	0.11	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
gamma-HCH	surface water	0.01	FWAL, CCME 2007	4	Ont. DWQ Standards, 2006, Table 2	0.003	ug/L	7	nc	nc	0.003	0.003	nc	100%	no	no	nc	nc
Heptachlor	surface water	0.26	AENV, FWAL, 1999 (USEPA SOURCE)	3	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
Heptachlor epoxide	surface water	0.01	FWAL, CCME 2007	3	Ont. DWQ Standards, 2006, Table 2	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
Hexachlorobenzene	surface water	0.0065	PWQO, OMOE 1994	0.042	USEPA, Region IX, Tapwater, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no	no	nc	nc
Methoxychlor	surface water	0.03	AENV, FWAL, 1999 (USEPA SOURCE)	900	DWQ, Health Canada 2008	0.01	ug/L	7	nc	nc	0.01	0.01	nc	100%	no	no	nc	nc
Mirex	surface water	0.001	Appendix 2-4, C.E.Q.B., EC 1999	0.37	BC CSR, Schedule 10, 2009	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
Octachlorostyrene	surface water	0.0005	Appendix 2-9, C.E.Q.B., EC 1999	0.2	Appendix 2-1, C.E.Q.B., EC 1999	0.005	ug/L	7	nc	nc	0.005	0.005	nc	100%	no (ND)	no	nc	nc
Toxaphene	surface water	0.008	FWAL, CCME 2007	0.61	BC CSR Schedule 10, 2009	0.2	ug/L	7	nc	nc	0.2	0.2	nc	100%	no (ND)	no	nc	nc
Diethylene glycol	surface water	11000	PWQO, OMOE 1994	370	BC CSR Schedule 10, 2009	5000	ug/L	4	nc	nc	5000	5000	nc	100%	no	no (ND)	nc	nc
Ethylene glycol	surface water	192000	FWAL, CCME 2007	15000	BC CSR Schedule 10, 2009	5000	ug/L	4	nc	nc	5000	5000	nc	100%	no	no	nc	nc
Propylene glycol	surface water	500000	FWAL, CCME 2007	18000	BC CSR Schedule 10, 2009	5000	ug/L	4	nc	nc	5000	5000	nc	100%	no	no	nc	nc
Total Glycol	surface water	NC	NC	NC	NC	5000	ug/L	4	nc	nc	5000	5000	nc	100%	no	no	nc	nc

[a] CCME Copper guideline
[b] CCME Lead guideline
[c] CCME Nickel guideline
[d] Average calculated hardness: APEC 1 = 274 mg/L and APEC 2 = 216 mg/L
[e] An average pH of 8.2 was calculated from all the groundwater data. The lowest pH was 7.8.
[f] CCME aluminum guideline = 100 ug/L at pH $\geq$ 6.5.
[g] The methyl napthalene standards are applicable to both 1-methyl napthalene and 2-methyl napthalene with the provision that if both are detected the sum of the two must not exceed the standard (Table 3, OMOE 2009)
DWQ, Health Canada 2008= Health Canada Guidelines for Canadian Drinking Water Quality, 2008 Update
Appendix 2-1, C.E.Q.B., EC 1999 - Environmenta Canada, Compendium of Environmental Quality Benchmarks, 1999-Appendix 2-1 Available Water Quality Criteria and Guidelines for the Protection of Human Health (Water Supplies)
Appendix 2-4, C.E.Q.B., EC 1999- Environmenta Canada, Compendium of Environmental Quality Benchmarks, 1999-Appendix 2-4 Available Water Quality Criteria and Guidelines for the Protection of Freshwater Aquatic Life
* Guideline- (ANZEEC 1993), Higher Values may be accepted in harder waters
OMOE, Water Management- Policies, Guidelines, Provincial Water Quality Objectives, Table of PWQOs and Interim PWQOs (July 1994),
BC CSR Schedule 10, January 2009- BC CSR, Schedule 10, Generic Numerical Soil and Water Standards, DW Standards, January 2009 Update
USEPA, Region IX, Tapwater Screening Level Criteria for the Protection of Human Health, December 2009
BC CSR, Schedule 6, FWAL,2009- BC CSR, Schedule 6, Numerical Water Standards for the Protection of Aquatic Life (AW), January 2009
LW=Livestock Watering Guideline
AENV FWAL 1999, Surface Water Quality Guidelines for Use in Alberta (USEPA Source)
OMOE 2009, GW,Table 8. Ontario Ministry of the Environment, Table 8. Generic Site Conditions for Use within 30m of a Water Body in a Potable Groundwater Condition. These regulations were used as they assume no dilution of groundwater to surface water, and are protective of human and aquatic life
Appendix 2-9, C.E.Q.B., EC 1999- Appendix 2-9, A Summary of the Available Water Quality Criteria for the Protection of Wildlife (Bioaccumulation in Aquatic Organisms)
Ont. DWQ Standards, 2006, Table 2=Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines, June 2003 (Revised June 2006) Table 2-Chemical Standards

Ground Water Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

Parameter	Media	Ecological Screening Criteria	Ecological Screening Criteria Source	Human Health Screening Criteria	Human Health Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into HHRA/PQRA?	95%UCLM	90th Percentile
Benzene	groundwater	370	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.04	ug/L	9	0.397778	0.731194	0.04	2	FL-MW8 (AEC 2)	0.777778	no	no	0.87548231	1.44
Ethylbenzene	groundwater	90	FWAL, CCME 2007	2.4	DWQ, Health Canada 2008	0.1	ug/L	9	4.655556	12.22049	0.1	37.1	FL-MW8 (AEC 2)	0.666667	no	yes	12.6394597	10.3
Toluene	groundwater	2	FWAL, CCME 2007	18000	Table 3, OMOE 2009	0.1	ug/L	9	10.42222	26.1043	0.1	79.1	FL-MW8 (AEC 2)	0.555556	yes	no	27.4767177	26.3
Xylenes (total)	groundwater	4200	Table 3, OMOE 2009	4200	Table 3, OMOE 2009	0.3	ug/L	9	50.87778	130.0889	0.3	396	FL-MW8 (AEC 2)	0.666667	no	no	135.867643	107.6
F1 (C6-C10)	groundwater	750	Table 3,OMOE 2009	750	Table 3,OMOE 2009	100	ug/L	6	478.33	883.37	100	2280	FL-MW8 (AEC 2)	0.67	yes	yes	1185.16	1235
F1 (C6-C10) minus BTE	groundwater	750	Table 3,OMOE 2009	750	Table 3,OMOE 2009	100	ug/L	14	210	469.1564	10	1800	FL-MW8 (AEC 2)	0.785714	yes	yes	455.754616	330
F2 (C10-C16)	groundwater	150	Table 3,OMOE 2009	150	Table 3,OMOE 2009	100	ug/L	14	770.3	2544.375	1.6	9600	SWF-TP2 (AEC 1)	0.642857	yes	yes	2103.10079	384
F3 (C16-C34)	groundwater	500	Table 3,OMOE 2009	500	Table 3,OMOE 2009	100	ug/L	5	100	0	100	100	nc	1	no	no	nc	100
F4 (C34-C50)	groundwater	500	Table 3,OMOE 2009	500	Table 3,OMOE 2009	100	ug/L	5	100	0	100	100	nc	1	no	no	nc	100
Aluminum	groundwater	100[e,f]	FWAL, CCME 2007	100	DWQ, Health Canada 2008	5	ug/L	11	5.727273	1.678744	5	10	SWF-TP4 (AEC 1)	0.727273	no	no	6.71932888	8
Antimony	groundwater	20000	Table 3, OMOE 2009	6	DWQ, Health Canada 2008	0.5 - 1	ug/L	8	0.7625	0.255999	0.5	1	2-MW-8	0.75	no	no	0.9398953	1
Arsenic	groundwater	5	FWAL, CCME 2007	10	DWQ, Health Canada 2008	1 - 5	ug/L	11	3.454545	1.809068	1	2	SWF-TP2 (AEC 1)	0.727273	no	no	nc	nc
Beryllium	groundwater	67	Table 3, OMOE 2009	67	Table 3, OMOE 2009	0.5 - 1	ug/L	11	0.772727	0.261116	0.5	1	SWF-TP2 (AEC 1)	1	no	no	0.92703442	1
Boron	groundwater	1500	FWAL, CCME, Boron 2009 Update	5000	DWQ, Health Canada 2008	50	ug/L	11	43	12.09959	16	55	1-MW-14	0.454545	no	no	50.1502675	50
Cadmium	groundwater	0.017	FWAL, CCME 2007	5	DWQ, Health Canada 2008	0.1	ug/L	11	0.075455	0.03908	0.01	0.11	SWF-TP4 (AEC 1)	0.363636	yes	no	0.09854912	0.1
Chromium	groundwater	810	Table 3, OMOE 2009	50	DWQ, Health Canada 2008	5 -7	ug/L	11	6.090909	1.044466	5	7	SWF-TP2 (AEC 1)	1	no	no	6.70813767	7
Chromium (VI)	groundwater	1	FWAL, CCME 2007	140	Table 3, OMOE 2009	0.5	ug/L	5	0.5	0	0.5	0.5	nc	1	no	no	nc	0.5
Cobalt	groundwater	66	Table 3, OMOE 2009	66	Table 3, OMOE 2009	0.5 - 5	ug/L	11	3.190909	2.121063	0.5	5	SWF-TP2 (AEC 1)	0.727273	no	no	4.44435431	5
Copper	groundwater	4[e,d]	FWAL, CCME 2007	1000	DWQ, Health Canada 2008	1 - 2	ug/L	11	20.72727	59.47115	1	200	SWF-TP6 (AEC 1)	0.090909	yes	no	55.8718332	5
Iron	groundwater	300	FWAL, CCME 2007	300	DWQ, Health Canada 2008	6 - 100	ug/L	11	314	402.0162	25	1100	1-MW-13	0.090909	yes	yes	551.572008	1100
Lead	groundwater	7[e,d]	FWAL, CCME 2007	10	DWQ, Health Canada 2008	0.5 - 1	ug/L	11	3.272727	6.772901	0.5	23.6	SWF-TP2 (AEC 1)	0.363636	yes	yes	7.27518217	3
Mercury	groundwater	0.026	FWAL, CCME 2007	1	DWQ, Health Canada 2008	0.05 - 0.1	ug/L	11	0.072727	0.026112	0.05	0.1	1-MW-13	1	no (ND)	no	0.08815799	0.1
Molybdenum	groundwater	73	FWAL, CCME 2007	9200	Table 3, OMOE 2009	1 - 6	ug/L	11	3.818182	2.522625	1	6	SWF-TP2 (AEC 1)	0.909091	no	no	5.30893047	6
Nickel	groundwater	150[c,d]	FWAL, CCME 2007	490	Table 3, OMOE 2009	1 - 8	ug/L	11	5.727273	3.466725	1	10	FL-MW3 (AEC 2)	0.636364	no	no	7.7759386	8
Selenium	groundwater	1	FWAL, CCME 2007	10	DWQ, Health Canada 2008	1 - 2	ug/L	8	1.625	0.517549	1	2	1-MW-13	1	no (ND)	no	1.98363669	2
Silver	groundwater	0.1	FWAL, CCME 2007	1.5	Table 3, OMOE 2009	0.1	ug/L	11	0.1	1.46E-17	0.1	0.1	nc	1	no (ND)	no	nc	0.1
Thallium	groundwater	0.8	FWAL, CCME 2007	510	Table 3, OMOE 2009	0.05 - 0.8	ug/L	11	0.459091	0.391675	0.05	0.8	SWF-TP2 (AEC 1)	1	no (ND)	no	0.69055163	0.8
Uranium	groundwater	420	Table 3, OMOE 2009	20	DWQ, Health Canada 2008	0.3 - 1	ug/L	11	0.809091	0.280908	0.2	1	SWF-TP2 (AEC 1)	0.545455	no	no	0.97509365	1
Vanadium	groundwater	250	Table 3, OMOE 2009	250	Table 3, OMOE 2009	1 - 50	ug/L	11	27.90909	25.38289	1	50	SWF-TP2 (AEC 1)	0.818182	no	no	42.9091424	50
Zinc	groundwater	30	FWAL, CCME 2007	5000	DWQ, Health Canada 2008	5	ug/L	11	9.181818	6.660603	5	27	SWF-TP6 (AEC 1)	0.454545	no	no	13.1179109	14
Zirconium	groundwater	NC	NC	NC	NC	1 - 5	ug/L	11	3.181818	2.088932	1	5	SWF-TP2 (AEC 1)	0.909091	no	no	4.41627535	5
Acenaphthene	groundwater	5.8	FWAL, CCME 2007	600	Table 3, OMOE 2009		ug/L	7	0.104286	0.102283	0.05	0.33	2-MW-8	0.857143	no	no	0.18005696	0.192
Acenaphthylene	groundwater	1.8	Table 3, OMOE 2009	1.8	Table 3, OMOE 2009		ug/L	7	0.064286	0.024398	0.05	0.1	SWF-TP2 (AEC 1)	1	no	no	0.0823593	0.1
Anthracene	groundwater	0.012	FWAL, CCME 2007	2.4	Table 3, OMOE 2009		ug/L	7	0.038571	0.019518	0.01	0.05	1-MW-13	1	no (ND)	no	0.0530303	0.05
Benzo(a)anthracene	groundwater	4.7	Table 3, OMOE 2009	4.7	Table 3, OMOE 2009		ug/L	7	0.038571	0.019518	0.01	0.05	1-MW-13	0.714286	no	no	0.0530303	0.05
Benzo(a)pyrene	groundwater	0.015	FWAL, CCME 2007	0.01	DWQ, Health Canada 2008		ug/L	7	0.01	0	0.01	0.01	nc	1	no (ND)	no	nc	0.01
Benzo(b+j)fluoranthene	groundwater	0.75	Table 3, OMOE 2009	0.75	Table 3, OMOE 2009		ug/L	7	0.064286	0.024398	0.05	0.1	SWF-TP2 (AEC 1)	1	no (ND)	no	0.0823593	0.1
Benzo(g,h,i)perylene	groundwater	0.2	Table 3, OMOE 2009	0.2	Table 3, OMOE 2009		ug/L	7	0.1	1.5E-17	0.1	0.1	nc	1	no (ND)	no	nc	0.1
Benzo(k)fluoranthene	groundwater	0.4	Table 3, OMOE 2009	0.4	Table 3, OMOE 2009		ug/L	7	0.064286	0.024398	0.05	0.1	SWF-TP2 (AEC 1)	1	no (ND)	no	0.0823593	0.1
Chrysene	groundwater	1	Table 3, OMOE 2009	1	Table 3, OMOE 2009		ug/L	7	0.064286	0.024398	0.05	0.1	SWF-TP2 (AEC 1)	1	no (ND)	no	0.0823593	0.1
Dibenz(a,h)anthracene	groundwater	0.52	Table 3, OMOE 2009	0.52	Table 3, OMOE 2009		ug/L	7	0.1	1.5E-17	0.1	0.1	nc	1	no (ND)	no	nc	0.1
Fluoranthene	groundwater	0.04	FWAL, CCME 2007	130	Table 3, OMOE 2009		ug/L	7	0.047143	0.00488	0.04	0.05	1-MW-13	1	no (ND)	no	0.05075758	0.05
Fluorene	groundwater	3	FWAL, CCME 2007	400	Table 3, OMOE 2009		ug/L	7	0.195714	0.342241	0.05	0.97	2-MW-8	0.857143	no	no	0.44924495	0.448
Indeno(1,2,3-cd)pyrene	groundwater	0.2	Table 3, OMOE 2009	0.2	Table 3, OMOE 2009		ug/L	7	0.074286	0.043916	0.01	0.1	1-MW-13	1	no	no	0.10681818	0.1
1-Methylnaphthalene	groundwater	1800[g]	Table 3, OMOE 2009	1800	Table 3, OMOE 2009		ug/L	5	9.158	19.47928	0.06	44	2-MW-8	0	no	no	26.2320273	26.74
2-Methylnaphthalene	groundwater	1800	Table 3, OMOE 2009	1800	Table 3, OMOE 2009		ug/L	5	13.642	29.27174	0.07	66	2-MW-8	0	no	no	39.2993385	40
Naphthalene	groundwater	1.1	FWAL, CCME 2007	1400	Table 3, OMOE 2009		ug/L	7	6.672857	14.36691	0.11	39	2-MW-8	0	yes	no	17.3158145	18.72
Phenanthrene	groundwater	0.4	FWAL, CCME 2007	580	Table 3, OMOE 2009		ug/L	7	0.14	0.119164	0.05	0.3	SWF-TP2 (AEC 1)	0.857143	no	no	0.22827612	0.3
Pyrene	groundwater	68	Table 3, OMOE 2009	68	Table 3, OMOE 2009		ug/L	7	0.041429	0.014639	0.02	0.05	1-MW-13	0.857143	no	no	0.05227273	0.05
Aroclor 1016	groundwater	0.96	USEPA,Region 9, Dec 2009	0.96	USEPA,Region 9, Dec 2009		ug/L	4	0.05	nc	nc	0.05	nc	1	no (ND)	no (ND)	nc	nc
Aroclor 1221	groundwater	0.0068	USEPA,Region 9, Dec 2009	0.0068	USEPA,Region 9, Dec 2009		ug/L	4	0.1	nc	nc	0.1	nc	1	no (ND)	no (ND)	nc	nc
Aroclor 1232	groundwater	0.0068	USEPA,Region 9, Dec 2009	0.0068	USEPA,Region 9, Dec 2009		ug/L	4	0.05	nc	nc	0.05	nc	1	no (ND)	no (ND)	nc	nc

Ground Water Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

Parameter	Media	Ecological Screening Criteria	Ecological Screening Criteria Source	Human Health Screening Criteria	Human Health Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into HHRA/PQRA?	95%UCLM	90th Percentile
Aroclor 1242	groundwater	0.034	USEPA,Region 9, Dec 2009	0.034	USEPA,Region 9, Dec 2009		ug/L	4	0.05	nc	nc	0.05	nc	1	no (ND)	no (ND)	nc	nc
Aroclor 1248	groundwater	0.034	USEPA,Region 9, Dec 2009	0.034	USEPA,Region 9, Dec 2009		ug/L	4	0.05	nc	nc	0.05	nc	1	no (ND)	no (ND)	nc	nc
Aroclor 1254	groundwater	0.034	USEPA,Region 9, Dec 2009	0.034	USEPA,Region 9, Dec 2009		ug/L	4	0.05	nc	nc	0.05	nc	1	no (ND)	no (ND)	nc	nc
Aroclor 1260	groundwater	0.034	USEPA,Region 9, Dec 2009	0.034	USEPA,Region 9, Dec 2009		ug/L	4	0.05	nc	nc	0.05	nc	1	no (ND)	no (ND)	nc	nc
Polychlorinated biphen	groundwater	0.001	FWAL, CCME 2007	7.8	Table 3, OMOE 2009		ug/L	4	0.1	nc	nc	0.1	nc	1	no (ND)	no (ND)	nc	nc
Acetone	groundwater	130000	Table 3, OMOE 2009	130000	Table 3, OMOE 2009		ug/L	5	10.6	1.341641	10	13	1-MW-14	0.8	no	no	11.7759784	11.8
Benzene	groundwater	370	FWAL, CCME 2007	44	Table 3, OMOE 2009		ug/L	7	1.214286	1.80963	0.1	5	SWF-TP6 (AEC 1)	0.857143	no	no	2.55485398	3.08
Bromodichloromethane	groundwater	85000	Table 3, OMOE 2009	16	DWQ, Health Canada 2008		ug/L	7	1.5	nc	nc	5	nc	1	no (ND)	no (ND)	nc	nc
Bromoform	groundwater	380	Table 3, OMOE 2009	380	Table 3, OMOE 2009		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Bromomethane	groundwater	5.6	Table 3, OMOE 2009	5.6	Table 3, OMOE 2009		ug/L	7	6.071429	nc	nc	20	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Carbon tetrachloride	groundwater	13.3	FWAL, CCME 2007	5	DWQ, Health Canada 2008		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Chlorobenzene	groundwater	1.3	FWAL, CCME 2007	630	Table 3, OMOE 2009		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Chlorodibromomethane	groundwater	82000	Table 3, OMOE 2009	82000	Table 3, OMOE 2009		ug/L	7	3	nc	nc	10	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Chloroform	groundwater	1.8	FWAL, CCME 2007	2.4	Table 3, OMOE 2009		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Dibromoethane	groundwater	0.34	BC CSR Schedule 10, DW	0.34	BC CSR Schedule 10, DW		ug/L	5	0.2	nc	nc	0.2	1-MW-13	1	no (ND)	no (ND)	nc	nc
1,2-Dichlorobenzene	groundwater	0.7	FWAL, CCME 2007	200	DWQ, Health Canada 2008		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
1,3-Dichlorobenzene	groundwater	150	FWAL, CCME 2007	9600	Table 3, OMOE 2009		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
1,4-Dichlorobenzene	groundwater	26	FWAL, CCME 2007	5	DWQ, Health Canada 2008		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
1,1-Dichloroethane	groundwater	320	Table 3, OMOE 2009	320	Table 3, OMOE 2009		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
1,2-Dichloroethane	groundwater	100	FWAL, CCME 2007	5	DWQ, Health Canada 2008		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
1,1-Dichloroethene	groundwater	1.6	Table 3, OMOE 2009	14	DWQ, Health Canada 2008		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
cis-1,2-Dichloroethene	groundwater	1.6	Table 3, OMOE 2009	1.6	Table 3, OMOE 2009		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
trans-1,2-Dichloroethen	groundwater	1.6	Table 3, OMOE 2009	1.6	Table 3, OMOE 2009		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Dichloromethane	groundwater	98.1	FWAL, CCME 2007	50	DWQ, Health Canada 2008		ug/L	7	6.071429	nc	nc	20	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
1,2-Dichloropropane	groundwater	16	Table 3, OMOE 2009	16	Table 3, OMOE 2009		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
cis-1,3-Dichloropropene	groundwater	5.2	Table 3, OMOE 2009	5.2	Table 3, OMOE 2009		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
trans-1,3-Dichloroprope	groundwater	5.2	Table 3, OMOE 2009	5.2	Table 3, OMOE 2009		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Ethylbenzene	groundwater	90	FWAL, CCME 2007	2.4	DWQ, Health Canada 2008		ug/L	7	1.814286	nc	nc	5	SWF-TP6 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Hexachlorobenzene	groundwater	3.1	Table 3, OMOE 2009	3.1	Table 3, OMOE 2009		ug/L	4	0.005	nc	nc	0.005	1-MW-13	1	no (ND)	no (ND)	nc	nc
Methyl ethyl ketone	groundwater	470000	Table 3, OMOE 2009	470000	Table 3, OMOE 2009		ug/L	5	5	nc	nc	5	1-MW-13	1	no (ND)	no (ND)	nc	nc
Methyl isobutyl ketone	groundwater	140000	Table 3, OMOE 2009	140000	Table 3, OMOE 2009		ug/L	5	5	nc	nc	5	1-MW-13	1	no (ND)	no (ND)	nc	nc
Methyl-tert-butylether	groundwater	10000	FWAL, CCME 2007	15	DWQ, Health Canada 2008		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Styrene	groundwater	72	FWAL, CCME 2007	1300	Table 3, OMOE 2009		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
1,1,1,2-Tetrachloroetha	groundwater	3.4	Table 3, OMOE 2009	3.4	Table 3, OMOE 2009		ug/L	5	0.1	nc	nc	0.1	1-MW-13	1	no (ND)	no (ND)	nc	nc
1,1,2,2-Tetrachloroetha	groundwater	3.2	Table 3, OMOE 2009	3.2	Table 3, OMOE 2009		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Tetrachloroethene	groundwater	111	FWAL, CCME 2007	30	DWQ, Health Canada 2008		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Toluene	groundwater	2	FWAL, CCME 2007	24	DWQ, Health Canada 2008		ug/L	7	5.128571	7.090537	0.2	17	2-MW-8	0.571429	yes	no	10.3812182	14.66
1,1,1-Trichloroethane	groundwater	640	Table 3, OMOE 2009	640	Table 3, OMOE 2009		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no	no	nc	nc
1,1,2-Trichloroethane	groundwater	4.7	Table 3, OMOE 2009	4.7	Table 3, OMOE 2009		ug/L	7	1.571429	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Trichloroethene	groundwater	21	FWAL, CCME 2007	5	DWQ, Health Canada 2008		ug/L	7	1.5	nc	nc	5	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
Vinyl chloride	groundwater	0.5	Table 3, OMOE 2009	2	DWQ, Health Canada 2008		ug/L	7	5.857143	nc	nc	20	SWF-TP2 (AEC 1)	1	no (ND)	no (ND)	nc	nc
m+p-Xylene	groundwater	4200	Table 3, OMOE 2009	300	DWQ, Health Canada 2008		ug/L	5	7.6	16.43715	0.1	37	2-MW-8	0.6	no	no	22.0075351	22.48
o-Xylene	groundwater	4200	Table 3, OMOE 2009	300	DWQ, Health Canada 2008		ug/L	5	10.82	23.58128	0.1	53	2-MW-8	0.4	no	no	31.4895278	32.12
Xylenes (total)	groundwater	4200	Table 3, OMOE 2009	300	DWQ, Health Canada 2008		ug/L	7	21.04286	33.32396	0.1	90	2-MW-8	0.428571	no	no	45.7291372	57.3
Aldrin	groundwater	8.5	Table 3, OMOE 2009	8.5	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Chlordane	groundwater	0.006	FWAL, CCME 2007	28	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
alpha-Chlordane	groundwater	28	Table 3, OMOE 2009	28	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
trans-Chlordane	groundwater	28	Table 3, OMOE 2009	28	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
2,4'-DDD	groundwater	45	Table 3, OMOE 2009	45	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
4,4'-DDD	groundwater	45	Table 3, OMOE 2009	45	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
DDD (total)	groundwater	45	Table 3, OMOE 2009	45	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005

Ground Water Chemistry - Summary
Resolute Airport Landfills and Boneyard
Franz Project # 1747-0901

Parameter	Media	Ecological Screening Criteria	Ecological Screening Criteria Source	Human Health Screening Criteria	Human Health Screening Criteria Source	MDL	Units	Number of Samples	Average	Standard Deviation	Minimum	Maximum	Location of Max	% ND	Screened into EcoRA?	Screened into HHRA/PQRA?	95%UCLM	90th Percentile
2,4'-DDE	groundwater	20	Table 3, OMOE 2009	20	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
4,4'-DDE	groundwater	20	Table 3, OMOE 2009	20	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
DDE (total)	groundwater	20	Table 3, OMOE 2009	20	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
2,4'-DDT	groundwater	0.001	FWAL, CCME 2007	2.8	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
4,4'-DDT	groundwater	0.001	FWAL, CCME 2007	2.8	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
DDT plus metabolites	groundwater	0.001	FWAL, CCME 2007	2.8	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
DDT (total)	groundwater	0.001	FWAL, CCME 2007	2.8	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Dieldrin	groundwater	0.75	Table 3, OMOE 2009	0.75	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Endosulfan	groundwater	0.003	FWAL, CCME, Update 2010	1.5	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
alpha-Endosulfan	groundwater	0.003	FWAL, CCME, Update 2010	1.5	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
beta-Endosulfan	groundwater	0.003	FWAL, CCME, Update 2010	1.5	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Endosulfan sulphate	groundwater	0.02	FWAL, CCME 2007	1.5	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Endrin	groundwater	0.0023	FWAL, CCME 2007	0.48	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Endrin aldehyde	groundwater	0.48	Table 3, OMOE 2009	0.48	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Endrin ketone	groundwater	0.48	Table 3, OMOE 2009	0.48	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
alpha-HCH	groundwater	0.01	FWAL, CCME 2007	1.2	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
beta-HCH	groundwater	0.01	FWAL, CCME 2007	1.2	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
delta-HCH	groundwater	0.01	FWAL, CCME 2007	1.2	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
gamma-HCH	groundwater	0.01	FWAL, CCME 2007	1.2	Table 3, OMOE 2009		ug/L	4	0.003	nc	0.003	0.003	nc	1	no (ND)	no (ND)	nc	0.003
Heptachlor	groundwater	0.01	FWAL, CCME 2007	2.5	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Heptachlor epoxide	groundwater	0.01	FWAL, CCME 2007	0.048	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Hexachlorobenzene	groundwater	3.1	Table 3, OMOE 2009	3.1	Table 3, OMOE 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Methoxychlor	groundwater	6.5	Table 3, OMOE 2009	900	DWQ, Health Canada 2008		ug/L	4	0.01	nc	0.01	0.01	nc	1	no (ND)	no (ND)	nc	0.01
Mirex	groundwater	0.001	Appendix 2-4, Compendium of Environmental Quality Benchmarks, 1999	0.0037	USEPA,Region 9, Dec 2009		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Octachlorostyrene	groundwater	0.0005	Appendix 2-9, Compendium of Environmental Quality Benchmarks, 1999	0.2	Appendix 2-1, Compendium of Environmental Quality Benchmarks, 1999		ug/L	4	0.005	nc	0.005	0.005	nc	1	no (ND)	no (ND)	nc	0.005
Toxaphene	groundwater	0.008	FWAL, CCME 2007	0.0002	CL, Table 2, AENV Tier 1		ug/L	4	0.2	nc	0.2	0.2	nc	1	no (ND)	no (ND)	nc	0.2
Diethylene glycol	groundwater	11000	PWQO, OMOE 1994	370	BC CSR Schedule 10, 2009		ug/L	3	nc	nc	nc	5000	nc	1	no (ND)	no (ND)	nc	nc
Ethylene glycol	groundwater	192000	FWAL, CCME 2007	15000	BC CSR Schedule 10, 2009		ug/L	3	nc	nc	nc	5000	nc	1	no (ND)	no (ND)	nc	nc
Propylene glycol	groundwater	500000	FWAL, CCME 2007	18000	BC CSR Schedule 10, 2010		ug/L	3	nc	nc	nc	5000	nc	1	no (ND)	no (ND)	nc	nc
Total Glycol	groundwater	NC	NC	NC	NC		ug/L	1	nc	nc	nc	5000	nc	1	no	no	nc	nc

[a] CCME Copper guideline = 4 ug/L at a water hardness of >180 mg/L (very hard) as $CaCO_3$
[b] CCME Lead guideline = 7 ug/L at a water hardness of >180 mg/L (very hard) as $CaCO_3$
[c] CCME Nickel guideline = 150 ug/L at a water hardness of >180 mg/L (very hard) as $CaCO_3$
[d] Average calculated hardness: APEC 1 = 274 mg/L and APEC 2 = 216 mg/L
[e] An average pH of 8.2 was calculated from all the groundwater data. The lowest pH was 7.8.
[f] CCME aluminum guideline = 100 ug/L at pH $\geq$ 6.5.
g The methyl napthalene standards are applicable to both 1-methyl napthalene and 2-methyl napthalene with the provision that if both are detected the sum of the two must not exceed the standard (Table 3, OMOE 2009)

DWQ, Health Canada 2008= Health Canada Guidelines for Canadian Drinking Water Quality, March 2008 Update
Environment Canada, Compendium of Environmental Quality Benchmarks, 1999 -Appendix 2-9, A Summary of the Available Water Quality Criteria and Guidelines for the Protection of Wildlife (Bioaccumulation in Aquatic Organisms)
Environmenta Canada, Compendium of Environmental Quality Benchmarks, 1999-Appendix 2-1 Available Water Quality Criteria and Guidelines for the Protection of Human Health (Water Supplies)
Environmenta Canada, Compendium of Environmental Quality Benchmarks, 1999-Appendix 2-4 Available Water Quality Criteria and Guidelines for the Protection of Freshwater Aquatic Life
CL, Table 2, AENV Tier 1- Alberta Environment, Table 2. Groundwater Remediation Guidelines for Coarse Soils, CL use, February 2009 update
USEPA Region 9, Dec 2009- USEPA Regional Screening Level (RSL) Master Summary Table, Tapwater Standards, December 2009 Update
BC CSR Schedule 10, DW- BC CSR Contaminated Sites Regulation, Schedule 10, Drinking Water Standard
FWAL, CCME, Update 2010- CCME, Table 1. CWQG for Endosulfan for the Protection of Aquatic Life (Long Term Exposure), 2010 Update
FWAL, CCME, Boron 2009 Update- CCME Table 1. CWQG for Boron for the Protection of Aquatic Life, Long Term Exposure , 2009 Update

APPENDIX B

PQRA Input and Output Tables
Human Health Model Spreadsheets

Airport Employee

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	metals

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	No	Yes
Ingestion of contaminated food	No	No

Exposure Scenario		
	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult-Airport Employee	

Contaminant Concentrations

Chemical Name	required	Boron (and borates)	Copper		Lead	Zinc	
Soil (mg/kg)	required	1.8	870		170	385	
Groundwater - source (mg/L)	optional		0.2		0.0236	0.027	
Drinking water (mg/L)	optional	0.25	0.0109		0.002	0.11	
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult-Airport Emp	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.02	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)		1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	5720	5720
- total	9110	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	0	22.5
Hours per day (outdoors)	4	1.5
Days per week	1	7
Weeks per year	14	52
Dermal exposure events/day	1	1
Water contact events per day	0	1
Duration of water contact event (h)	0	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	60	60
Years for carcinogen amortization	60	60

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult-Airport Employee **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	metals

Exposure Scenario:	**User-Defined**	**User-Defined Receptor Characteristics**	Skin surface area (cm2) - hands: 890	
Native population not considered		Body weight (kg): 70.7	- arms: 2500	Food ingestion rates (g/d)
Cancer Risks Calculated?	**Yes**	Soil ingestion rate (g/d): 0.02	- legs: 5720	Root vegetables: 188
		Inhalation rate (m3/d): 15.8	- total: 9110	Other vegetables: 137
		Water ingestion rate (L/d): 1.5	Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
			- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**Boron (and borates)**	**Copper**		**Lead**	**Zinc**	
Tolerable daily intake	mg/kg/d	0.0175	0.141	NA	0.0036	0.566	NA
Tolerable concentration	mg/m^3	NA	NA	NA	NA	NA	NA
Oral slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	NA	NA	NA	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		TDI	TDI	NA	TDI	TDI	NA
Critical inhalation exposure benchmark		NA	NA	NA	NA	NA	NA
Relative dermal absorption factor	unitless	0.01	0.06	1	0.006	0.1	1

Chemical Concentrations	**Units**	**Boron (and borates)**	**Copper**		**Lead**	**Zinc**	
Soil	mg/kg	1.80E+00	8.70E+02	0.00E+00	1.70E+02	3.85E+02	0.00E+00
Drinking water	mg/L	2.50E-01	1.09E-02	NA	2.00E-03	1.10E-01	NA
Bathing/swimming water	mg/L	NA	NA	NA	NA	NA	NA
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air particulate	mg/m^3	1.37E-09	6.61E-07	0.00E+00	1.29E-07	2.93E-07	0.00E+00
Amortized total air concentration	mg/m^3	8.76923E-12	4.23846E-09	0	8.28205E-10	1.87564E-09	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

	Exposure (mg/kg/d)					
	Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Inadvertent ingestion of contaminated soil	1.96E-08	9.47E-06	0.00E+00	1.85E-06	4.19E-06	0.00E+00
Inhalation of contaminated soil particles	1.96E-12	9.47E-10	0.00E+00	1.85E-10	4.19E-10	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	1.68E-09	4.86E-06	0.00E+00	9.50E-08	3.59E-06	0.00E+00
Dermal contact with water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	1.96E-08	9.47E-06	0.00E+00	1.85E-06	4.19E-06	0.00E+00
Total dermal exposure	1.68E-09	4.86E-06	0.00E+00	9.50E-08	3.59E-06	0.00E+00
Ingestion + dermal exposure	2.13E-08	1.43E-05	0.00E+00	1.94E-06	7.77E-06	0.00E+00
Total inhalation exposure	1.96E-12	9.47E-10	0.00E+00	1.85E-10	4.19E-10	0.00E+00
Total Exposure (all pathways)	2.13E-08	1.43E-05	0.00E+00	1.94E-06	7.77E-06	0.00E+00

		Hazard/Risk Estimates					
		Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Hazard Quotient - Oral/Dermal		1.21E-06	1.02E-04	NA	5.40E-04	1.37E-05	NA
Hazard Quotient - Inhalation		1.12E-10	6.72E-09	NA	5.14E-08	7.41E-10	NA
Hazard Index - Total		1.22E-06	1.02E-04	NA	5.40E-04	1.37E-05	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name: Franz Environmental Inc. **Site:** Resolute Bay Airport Landfills and Boneyard
Proponent: Transport Canada **File #:** 1747-0901
Date: **Comment:** metals

		Maximum Hazard/Risk Estimates					
		Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Hazard Quotient - Oral/Dermal		1.21E-06	1.02E-04	NA	5.40E-04	1.37E-05	NA
Hazard Quotient - Inhalation		1.12E-10	6.72E-09	NA	5.14E-08	7.41E-10	NA
Hazard Index - Total		1.22E-06	1.02E-04	NA	5.40E-04	1.37E-05	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Oral/Dermal - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Inhalation - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Total - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Oral - cancer effects	NA	NA	NA	NA	NA	NA
Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - cancer effects	NA	NA	NA	NA	NA	NA
Total - cancer effects	NA	NA	NA	NA	NA	NA
Source of indoor air vapours	NA	NA	NA	NA	NA	NA
Model used for vapour transport	NA	NA	NA	NA	NA	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions
All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	Petroleum Hydrocarbons

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	No	Yes
Ingestion of contaminated food	No	No

Exposure Scenario		
	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult Airport Employee	

Contaminant Concentrations

Chemical Name	required	F1	F2	Benzene	Toluene	Ethylbenzene	
Soil (mg/kg)	required	120	6100	0.69	1.4	0.7	
Groundwater - source (mg/L)	optional	2.28	9.6	0.005	0.0791	0.0371	
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						
		See also PHC Sheet	See also PHC Sheet				

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult Airport Emp	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.02	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)	1.5	1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	5720	5720
- total	9110	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	0	22.5
Hours per day (outdoors)	4	1.5
Days per week	1	7
Weeks per year	14	52
Dermal exposure events/day	1	1
Water contact events per day	0	1
Duration of water contact event (h)	0	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	60	60
Years for carcinogen amortization	60	60

PHC Fraction Composition (%)	Soil		Note: water and air defaults are calculated based on soil properties Water		Air (Vapour)	
Fraction 1		Default		Default		Default
Aliphatics C_6-C_8		55		60.5		85.3
Aliphatics $C_{>8}$-C_{10}		36		6.3		14.2
Aromatics $C_{>8}$-C_{10}		9		33.2		0.4
Total		100		100		100
Fraction 2						
Aliphatics $C_{>10}$-C_{12}		36		2.4		76.7
Aliphatics $C_{>12}$-C_{16}		44		0.1		20.6
Aromatics $C_{>10}$-C_{12}		9		60.3		2.3
Aromatics $C_{>12}$-C_{16}		11		37.1		0.5
Total		100		100		100
Fraction 3						
Aliphatics $C_{>16}$-C_{21}		56		9.54E-03		89.79
Aliphatics $C_{>21}$-C_{34}		24		2.58E-07		7.83
Aromatics $C_{>16}$-C_{21}		14		95		2.37
Aromatics $C_{>21}$-C_{34}		6		5		0.01
Total		100		100		100
Fraction 4						
Aliphatics $C_{>34}$		80		0		0
Aromatics $C_{>34}$		20		100		0
Total		100		100		0

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult Airport Employee **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	Petroleum Hydrocarbons

		User-Defined Receptor Characteristics		
Exposure Scenario:	**User-Defined**	Body weight (kg): 70.7	Skin surface area (cm2) - hands: 890	
Native population not considered		Soil ingestion rate (g/d): 0.02	- arms: 2500	Food ingestion rates (g/d)
Cancer Risks Calculated?	**Yes**	Inhalation rate (m3/d): 15.8	- legs: 5720	Root vegetables: 188
		Water ingestion rate (L/d): 1.5	- total: 9110	Other vegetables: 137
			Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
			- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**F1**	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Tolerable daily intake	mg/kg/d	NA	NA	NA	0.22	0.1	NA
Tolerable concentration	mg/m^3	NA	NA	NA	3.8	1	NA
Oral slope factor	$(mg/kg/d)^{-1}$	NA	NA	0.226	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	NA	NA	0.0146	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	NA	NA	0.0033	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		NA	NA	slope factor	TDI	TDI	NA
Critical inhalation exposure benchmark		NA	NA	unit risk	TC	TC	NA
Relative dermal absorption factor	unitless	0.2	0.2	0.03	0.03	0.03	1

Chemical Concentrations	**Units**	**F1**	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Soil	mg/kg	1.20E+02	6.10E+03	6.90E-01	1.40E+00	7.00E-01	0.00E+00
Drinking water	mg/L	NA	NA	NA	NA	NA	NA
Bathing/swimming water	mg/L	NA	NA	NA	NA	NA	NA
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	2.05E-02	3.87E-01	5.07E-03	6.51E-03	1.88E-03	0.00E+00
Outdoor air particulate	mg/m^3	7.57E-08	4.60E-06	4.18E-10	9.30E-10	4.92E-10	0.00E+00
Amortized total air concentration	mg/m^3	4.84975E-10	2.95081E-08	2.67649E-12	5.96428E-12	3.15298E-12	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

	Exposure (mg/kg/d)					
	F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Inadvertent ingestion of contaminated soil	1.31E-06	6.64E-05	7.51E-09	1.52E-08	7.62E-09	0.00E+00
Inhalation of contaminated soil particles	1.08E-10	6.59E-09	5.98E-13	1.33E-12	7.05E-13	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	2.24E-06	1.14E-04	1.93E-09	3.91E-09	1.96E-09	0.00E+00
Dermal contact with water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	1.31E-06	6.64E-05	7.51E-09	1.52E-08	7.62E-09	0.00E+00
Total dermal exposure	2.24E-06	1.14E-04	1.93E-09	3.91E-09	1.96E-09	0.00E+00
Ingestion + dermal exposure	3.54E-06	1.80E-04	9.44E-09	1.91E-08	9.57E-09	0.00E+00
Total inhalation exposure	1.08E-10	6.59E-09	5.98E-13	1.33E-12	7.05E-13	0.00E+00
Total Exposure (all pathways)	3.54E-06	1.80E-04	9.44E-09	1.91E-08	9.57E-09	0.00E+00

		Hazard/Risk Estimates					
		F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Hazard Quotient - Oral/Dermal		2.11E-05	2.34E-03	NA	8.70E-08	9.57E-08	NA
Hazard Quotient - Inhalation		4.68E-10	5.32E-08	NA	1.57E-12	3.15E-12	NA
Hazard Index - Total		2.11E-05	2.34E-03	NA	8.70E-08	9.57E-08	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	1.70E-09	NA	NA	NA
Cancer Risk - Dermal		NA	NA	4.36E-10	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	2.13E-09	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	8.83E-15	NA	NA	NA
Cancer Risk - Total		NA	NA	2.13E-09	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	Petroleum Hydrocarbons

		Maximum Hazard/Risk Estimates					
		F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Hazard Quotient - Oral/Dermal		2.11E-05	2.34E-03	NA	8.70E-08	9.57E-08	NA
Hazard Quotient - Inhalation		4.68E-10	5.32E-08	NA	1.57E-12	3.15E-12	NA
Hazard Index - Total		2.11E-05	2.34E-03	NA	8.70E-08	9.57E-08	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	1.70E-09	NA	NA	NA
Cancer Risk - Dermal		NA	NA	4.36E-10	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	2.13E-09	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	8.83E-15	NA	NA	NA
Cancer Risk - Total		NA	NA	2.13E-09	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Oral/Dermal - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Inhalation - non-cancer effects	All Age Groups	All Age Groups	NA	All Age Groups	All Age Groups	NA
Total - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Oral - cancer effects	NA	NA	Adult	NA	NA	NA
Dermal - cancer effects	NA	NA	Adult	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	Adult	NA	NA	NA
Inhalation - cancer effects	NA	NA	Adult	NA	NA	NA
Total - cancer effects	NA	NA	Adult	NA	NA	NA
Source of indoor air vapours	Soil	Soil	Soil	Soil	Soil	NA
Model used for vapour transport	Health Canada	Health Canada	Health Canada	Health Canada	Health Canada	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	PAHs

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	No	Yes
Ingestion of contaminated food	No	No

Exposure Scenario	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult-Airport Employee	

Contaminant Concentrations

Chemical Name	required	Chrysene						
Soil (mg/kg)	required	2.8						
Groundwater - source (mg/L)	optional	0.0001						
Drinking water (mg/L)	optional	0.0001						
Bathing/swimming water (mg/L)	optional							
Indoor air - vapours (mg/m^3)	optional							
Outdoor air - vapours (mg/m^3)	optional							
Outdoor air - particulate (mg/m^3)	optional							
Root vegetables (mg/kg wet weight)	optional							
Other vegetables (mg/kg wet weight)	optional							
Fish (mg/kg wet weight)	optional							
Wild game (mg/kg wet weight)	optional							
		PAH-Carcinogenic						

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult-Airport Emp	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.02	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)		1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	5720	5720
- total	9110	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	0	22.5
Hours per day (outdoors)	4	1.5
Days per week	1	7
Weeks per year	14	52
Dermal exposure events/day	1	1
Water contact events per day	0	1
Duration of water contact event (h)	0	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	60	60
Years for carcinogen amortization	60	60

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult-Airport Employee **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	PAHs

Exposure Scenario:	**User-Defined**	**User-Defined Receptor Characteristics**	Skin surface area (cm2) - hands: 890	
Native population not considered		Body weight (kg): 70.7	- arms: 2500	Food ingestion rates (g/d)
Cancer Risks Calculated?	**Yes**	Soil ingestion rate (g/d): 0.02	- legs: 5720	Root vegetables: 188
		Inhalation rate (m3/d): 15.8	- total: 9110	Other vegetables: 137
		Water ingestion rate (L/d): 1.5	Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
			- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**Chrysene**					
Tolerable daily intake	mg/kg/d	NA	NA	NA	NA	NA	NA
Tolerable concentration	mg/m^3	NA	NA	NA	NA	NA	NA
Oral slope factor	$(mg/kg/d)^{-1}$	0.023	NA	NA	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	0.00137	NA	NA	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	0.00031	NA	NA	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		slope factor	NA	NA	NA	NA	NA
Critical inhalation exposure benchmark		unit risk	NA	NA	NA	NA	NA
Relative dermal absorption factor	unitless	0.13	1	1	1	1	1

Chemical Concentrations	**Units**	**Chrysene**					
Soil	mg/kg	2.80E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Drinking water	mg/L	1.00E-04	NA	NA	NA	NA	NA
Bathing/swimming water	mg/L	NA	NA	NA	NA	NA	NA
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	3.85E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air particulate	mg/m^3	2.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Amortized total air concentration	mg/m^3	1.36409E-11	0	0	0	0	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

	Exposure (mg/kg/d)					
	Chrysene					
Inadvertent ingestion of contaminated soil	3.05E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminated soil particles	3.05E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	3.39E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	3.05E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total dermal exposure	3.39E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion + dermal exposure	6.44E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total inhalation exposure	3.05E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Exposure (all pathways)	6.44E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

		Hazard/Risk Estimates					
		Chrysene					
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		NA	NA	NA	NA	NA	NA
Hazard Index - Total		NA	NA	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		7.01E-10	NA	NA	NA	NA	NA
Cancer Risk - Dermal		7.80E-10	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		1.48E-09	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		4.23E-15	NA	NA	NA	NA	NA
Cancer Risk - Total		1.48E-09	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	PAHs

		Maximum Hazard/Risk Estimates					
		Chrysene					
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		NA	NA	NA	NA	NA	NA
Hazard Index - Total		NA	NA	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		7.01E-10	NA	NA	NA	NA	NA
Cancer Risk - Dermal		7.80E-10	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		1.48E-09	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		4.23E-15	NA	NA	NA	NA	NA
Cancer Risk - Total		1.48E-09	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Chrysene					
Oral/Dermal - non-cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - non-cancer effects	NA	NA	NA	NA	NA	NA
Total - non-cancer effects	NA	NA	NA	NA	NA	NA
Oral - cancer effects	Adult	NA	NA	NA	NA	NA
Dermal - cancer effects	Adult	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	Adult	NA	NA	NA	NA	NA
Inhalation - cancer effects	Adult	NA	NA	NA	NA	NA
Total - cancer effects	Adult	NA	NA	NA	NA	NA
Source of indoor air vapours	Soil	NA	NA	NA	NA	NA
Model used for vapour transport	Health Canada	NA	NA	NA	NA	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.
All carcinogenic PAH present at the site must be treated additively

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

Hotel Employee

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	metals

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	No	Yes
Ingestion of contaminated food	No	No

Exposure Scenario	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	Yes	No
specify:	Hotel User	

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult- Hotel Employee	

Contaminant Concentrations

Chemical Name	required	Boron (and borates)	Copper		Lead	Zinc	
Soil (mg/kg)	required	1.8	870		170	385	
Groundwater - source (mg/L)	optional		0.2		0.0236	0.027	
Drinking water (mg/L)	optional	0.25	0.0109		0.002	0.11	
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult- Hotel Emp	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.02	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)		1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	5720	5720
- total	9110	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	8	22.5
Hours per day (outdoors)	1.5	1.5
Days per week	5	7
Weeks per year	50	52
Dermal exposure events/day	1	1
Water contact events per day	0	1
Duration of water contact event (h)	0	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	60	60
Years for carcinogen amortization	60	60

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult- Hotel Employee **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	metals

Exposure Scenario:	**User-Defined**	**User-Defined Receptor Characteristics**	Skin surface area (cm2) - hands: 890	
Native population not considered		Body weight (kg): 70.7	- arms: 2500	Food ingestion rates (g/d)
Cancer Risks Calculated?	**Yes**	Soil ingestion rate (g/d): 0.02	- legs: 5720	Root vegetables: 188
		Inhalation rate (m3/d): 15.8	- total: 9110	Other vegetables: 137
		Water ingestion rate (L/d): 1.5	Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
			- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**Boron (and borates)**	**Copper**		**Lead**	**Zinc**	
Tolerable daily intake	mg/kg/d	0.0175	0.141	NA	0.0036	0.566	NA
Tolerable concentration	mg/m^3	NA	NA	NA	NA	NA	NA
Oral slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	NA	NA	NA	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		TDI	TDI	NA	TDI	TDI	NA
Critical inhalation exposure benchmark		NA	NA	NA	NA	NA	NA
Relative dermal absorption factor	unitless	0.01	0.06	1	0.006	0.1	1

Chemical Concentrations	**Units**	**Boron (and borates)**	**Copper**		**Lead**	**Zinc**	
Soil	mg/kg	1.80E+00	8.70E+02	0.00E+00	1.70E+02	3.85E+02	0.00E+00
Drinking water	mg/L	2.50E-01	1.09E-02	NA	2.00E-03	1.10E-01	NA
Bathing/swimming water	mg/L	NA	NA	NA	NA	NA	NA
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air particulate	mg/m^3	1.37E-09	6.61E-07	0.00E+00	1.29E-07	2.93E-07	0.00E+00
Amortized total air concentration	mg/m^3	5.87225E-11	2.83826E-08	0	5.54602E-09	1.25601E-08	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

	Exposure (mg/kg/d)					
	Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Inadvertent ingestion of contaminated soil	3.50E-07	1.69E-04	0.00E+00	3.30E-05	7.48E-05	0.00E+00
Inhalation of contaminated soil particles	1.31E-11	6.34E-09	0.00E+00	1.24E-09	2.81E-09	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	2.99E-08	8.68E-05	0.00E+00	1.70E-06	6.40E-05	0.00E+00
Dermal contact with water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	3.50E-07	1.69E-04	0.00E+00	3.30E-05	7.48E-05	0.00E+00
Total dermal exposure	2.99E-08	8.68E-05	0.00E+00	1.70E-06	6.40E-05	0.00E+00
Ingestion + dermal exposure	3.80E-07	2.56E-04	0.00E+00	3.47E-05	1.39E-04	0.00E+00
Total inhalation exposure	1.31E-11	6.34E-09	0.00E+00	1.24E-09	2.81E-09	0.00E+00
Total Exposure (all pathways)	3.80E-07	2.56E-04	0.00E+00	3.47E-05	1.39E-04	0.00E+00

		Hazard/Risk Estimates					
		Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Hazard Quotient - Oral/Dermal		2.17E-05	1.81E-03	NA	9.65E-03	2.45E-04	NA
Hazard Quotient - Inhalation		7.50E-10	4.50E-08	NA	3.44E-07	4.96E-09	NA
Hazard Index - Total		2.17E-05	1.81E-03	NA	9.65E-03	2.45E-04	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	metals

		Maximum Hazard/Risk Estimates					
		Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Hazard Quotient - Oral/Dermal		2.17E-05	1.81E-03	NA	9.65E-03	2.45E-04	NA
Hazard Quotient - Inhalation		7.50E-10	4.50E-08	NA	3.44E-07	4.96E-09	NA
Hazard Index - Total		2.17E-05	1.81E-03	NA	9.65E-03	2.45E-04	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Oral/Dermal - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Inhalation - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Total - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Oral - cancer effects	NA	NA	NA	NA	NA	NA
Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - cancer effects	NA	NA	NA	NA	NA	NA
Total - cancer effects	NA	NA	NA	NA	NA	NA
Source of indoor air vapours	NA	NA	NA	NA	NA	NA
Model used for vapour transport	NA	NA	NA	NA	NA	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	Petroleum Hydrocarbons

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	No	Yes
Ingestion of contaminated food	No	No

Exposure Scenario		
	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	Yes	No
specify:	Hote Employee	

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult Hotel Employee	

Contaminant Concentrations

Chemical Name	required	F1	F2	Benzene	Toluene	Ethylbenzene	
Soil (mg/kg)	required	120	6100	0.69	1.4	0.7	
Groundwater - source (mg/L)	optional	2.28	9.6	0.005	0.0791	0.0371	
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						
		See also PHC Sheet	See also PHC Sheet				

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult Hotel Empl	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.02	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)	1.5	1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	5720	5720
- total	9110	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	8	22.5
Hours per day (outdoors)	1.5	1.5
Days per week	5	7
Weeks per year	50	52
Dermal exposure events/day	1	1
Water contact events per day	0	1
Duration of water contact event (h)	0	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	60	60
Years for carcinogen amortization	60	60

PHC Fraction Composition (%)	Soil		Note: water and air defaults are calculated based on soil properties Water		Air (Vapour)	
Fraction 1		Default		Default		Default
Aliphatics C_6-C_8		55		60.5		85.3
Aliphatics $C_{>8}$-C_{10}		36		6.3		14.2
Aromatics $C_{>8}$-C_{10}		9		33.2		0.4
Total		100		100		100
Fraction 2						
Aliphatics $C_{>10}$-C_{12}		36		2.4		76.7
Aliphatics $C_{>12}$-C_{16}		44		0.1		20.6
Aromatics $C_{>10}$-C_{12}		9		60.3		2.3
Aromatics $C_{>12}$-C_{16}		11		37.1		0.5
Total		100		100		100
Fraction 3						
Aliphatics $C_{>16}$-C_{21}		56		9.54E-03		89.79
Aliphatics $C_{>21}$-C_{34}		24		2.58E-07		7.83
Aromatics $C_{>16}$-C_{21}		14		95		2.37
Aromatics $C_{>21}$-C_{34}		6		5		0.01
Total		100		100		100
Fraction 4						
Aliphatics $C_{>34}$		80		0		0
Aromatics $C_{>34}$		20		100		0
Total		100		100		0

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult Hotel Employee **Adult**

User Name: Franz Environmental Inc. **Site:** Resolute Bay Airport Landfills and Boneyard
Proponent: Transport Canada **File #:** 1747-0901
Date: **Comment:** Petroleum Hydrocarbons

Exposure Scenario: **User-Defined**
Native population not considered
Cancer Risks Calculated? **Yes**

User-Defined Receptor Characteristics
Body weight (kg): 70.7
Soil ingestion rate (g/d): 0.02
Inhalation rate (m3/d): 15.8
Water ingestion rate (L/d): 1.5
Skin surface area (cm2) - hands: 890
- arms: 2500
- legs: 5720
- total: 9110
Soil loading (g/cm2-event) - hands: 0.0001
- other: 0.00001
Food ingestion rates (g/d)
Root vegetables: 188
Other vegetables: 137
Fish: 111
Wild game: 0

Chemical Properties	Units	F1	F2	Benzene	Toluene	Ethylbenzene	
Tolerable daily intake	mg/kg/d	NA	NA	NA	0.22	0.1	NA
Tolerable concentration	mg/m^3	NA	NA	NA	3.8	1	NA
Oral slope factor	$(mg/kg/d)^{-1}$	NA	NA	0.226	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	NA	NA	0.0146	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	NA	NA	0.0033	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		NA	NA	slope factor	TDI	TDI	NA
Critical inhalation exposure benchmark		NA	NA	unit risk	TC	TC	NA
Relative dermal absorption factor	unitless	0.2	0.2	0.03	0.03	0.03	1

Chemical Concentrations	Units	F1	F2	Benzene	Toluene	Ethylbenzene	
Soil	mg/kg	1.20E+02	6.10E+03	6.90E-01	1.40E+00	7.00E-01	0.00E+00
Drinking water	mg/L	NA	NA	NA	NA	NA	NA
Bathing/swimming water	mg/L	NA	NA	NA	NA	NA	NA
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	2.05E-02	3.87E-01	5.07E-03	6.51E-03	1.88E-03	0.00E+00
Outdoor air particulate	mg/m^3	7.57E-08	4.60E-06	4.18E-10	9.30E-10	4.92E-10	0.00E+00
Amortized total air concentration	mg/m^3	3.2476E-09	1.97599E-07	1.79229E-11	3.99394E-11	2.11137E-11	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

	Exposure (mg/kg/d)					
	F1	F2	Benzene	Toluene	Ethylbenzene	
Inadvertent ingestion of contaminated soil	2.33E-05	1.19E-03	1.34E-07	2.72E-07	1.36E-07	0.00E+00
Inhalation of contaminated soil particles	7.26E-10	4.42E-08	4.01E-12	8.93E-12	4.72E-12	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	3.99E-05	2.03E-03	3.44E-08	6.99E-08	3.49E-08	0.00E+00
Dermal contact with water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	2.33E-05	1.19E-03	1.34E-07	2.72E-07	1.36E-07	0.00E+00
Total dermal exposure	3.99E-05	2.03E-03	3.44E-08	6.99E-08	3.49E-08	0.00E+00
Ingestion + dermal exposure	6.32E-05	3.21E-03	1.68E-07	3.42E-07	1.71E-07	0.00E+00
Total inhalation exposure	7.26E-10	4.42E-08	4.01E-12	8.93E-12	4.72E-12	0.00E+00
Total Exposure (all pathways)	6.32E-05	3.21E-03	1.68E-07	3.42E-07	1.71E-07	0.00E+00

		Hazard/Risk Estimates					
		F1	F2	Benzene	Toluene	Ethylbenzene	
Hazard Quotient - Oral/Dermal		3.77E-04	4.18E-02	NA	1.55E-06	1.71E-06	NA
Hazard Quotient - Inhalation		3.13E-09	3.56E-07	NA	1.05E-11	2.11E-11	NA
Hazard Index - Total		3.77E-04	4.18E-02	NA	1.55E-06	1.71E-06	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	3.03E-08	NA	NA	NA
Cancer Risk - Dermal		NA	NA	7.78E-09	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	3.81E-08	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	5.91E-14	NA	NA	NA
Cancer Risk - Total		NA	NA	3.81E-08	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	Petroleum Hydrocarbons

		Maximum Hazard/Risk Estimates					
		F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Hazard Quotient - Oral/Dermal		3.77E-04	4.18E-02	NA	1.55E-06	1.71E-06	NA
Hazard Quotient - Inhalation		3.13E-09	3.56E-07	NA	1.05E-11	2.11E-11	NA
Hazard Index - Total		3.77E-04	4.18E-02	NA	1.55E-06	1.71E-06	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	3.03E-08	NA	NA	NA
Cancer Risk - Dermal		NA	NA	7.78E-09	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	3.81E-08	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	5.91E-14	NA	NA	NA
Cancer Risk - Total		NA	NA	3.81E-08	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Oral/Dermal - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Inhalation - non-cancer effects	All Age Groups	All Age Groups	NA	All Age Groups	All Age Groups	NA
Total - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Oral - cancer effects	NA	NA	Adult	NA	NA	NA
Dermal - cancer effects	NA	NA	Adult	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	Adult	NA	NA	NA
Inhalation - cancer effects	NA	NA	Adult	NA	NA	NA
Total - cancer effects	NA	NA	Adult	NA	NA	NA
Source of indoor air vapours	Soil	Soil	Soil	Soil	Soil	NA
Model used for vapour transport	Health Canada	Health Canada	Health Canada	Health Canada	Health Canada	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	PAHs

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	No	Yes
Ingestion of contaminated food	No	No

Exposure Scenario	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	Yes	No
specify:	Hotel Employee	

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult- Hotel Employee	

Contaminant Concentrations

Chemical Name	required	Chrysene					
Soil (mg/kg)	required	2.8					
Groundwater - source (mg/L)	optional	0.0001					
Drinking water (mg/L)	optional	0.0001					
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						
		PAH-Carcinogenic					

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult- Hotel Emp	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.02	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)		1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	5720	5720
- total	9110	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	8	22.5
Hours per day (outdoors)	1.5	1.5
Days per week	5	7
Weeks per year	50	52
Dermal exposure events/day	1	1
Water contact events per day	0	1
Duration of water contact event (h)	0	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	60	60
Years for carcinogen amortization	60	60

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult- Hotel Employee **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	PAHs

Exposure Scenario:	**User-Defined**	**User-Defined Receptor Characteristics**	Skin surface area (cm2) - hands: 890	
Native population not considered		Body weight (kg): 70.7	- arms: 2500	Food ingestion rates (g/d)
Cancer Risks Calculated?	**Yes**	Soil ingestion rate (g/d): 0.02	- legs: 5720	Root vegetables: 188
		Inhalation rate (m3/d): 15.8	- total: 9110	Other vegetables: 137
		Water ingestion rate (L/d): 1.5	Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
			- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**Chrysene**					
Tolerable daily intake	mg/kg/d	NA	NA	NA	NA	NA	NA
Tolerable concentration	mg/m^3	NA	NA	NA	NA	NA	NA
Oral slope factor	$(mg/kg/d)^{-1}$	0.023	NA	NA	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	0.00137	NA	NA	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	0.00031	NA	NA	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		slope factor	NA	NA	NA	NA	NA
Critical inhalation exposure benchmark		unit risk	NA	NA	NA	NA	NA
Relative dermal absorption factor	unitless	0.13	1	1	1	1	1

Chemical Concentrations	**Units**	**Chrysene**					
Soil	mg/kg	2.80E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Drinking water	mg/L	1.00E-04	NA	NA	NA	NA	NA
Bathing/swimming water	mg/L	NA	NA	NA	NA	NA	NA
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	3.85E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air particulate	mg/m^3	2.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Amortized total air concentration	mg/m^3	9.13453E-11	0	0	0	0	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

		Exposure (mg/kg/d)				
	Chrysene					
Inadvertent ingestion of contaminated soil	5.44E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminated soil particles	2.04E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	6.05E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	5.44E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total dermal exposure	6.05E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion + dermal exposure	1.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total inhalation exposure	2.04E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Exposure (all pathways)	1.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

		Hazard/Risk Estimates					
		Chrysene					
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		NA	NA	NA	NA	NA	NA
Hazard Index - Total		NA	NA	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		1.25E-08	NA	NA	NA	NA	NA
Cancer Risk - Dermal		1.39E-08	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		2.64E-08	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		2.83E-14	NA	NA	NA	NA	NA
Cancer Risk - Total		2.64E-08	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	PAHs

		Maximum Hazard/Risk Estimates					
		Chrysene					
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		NA	NA	NA	NA	NA	NA
Hazard Index - Total		NA	NA	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		1.25E-08	NA	NA	NA	NA	NA
Cancer Risk - Dermal		1.39E-08	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		2.64E-08	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		2.83E-14	NA	NA	NA	NA	NA
Cancer Risk - Total		2.64E-08	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Chrysene					
Oral/Dermal - non-cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - non-cancer effects	NA	NA	NA	NA	NA	NA
Total - non-cancer effects	NA	NA	NA	NA	NA	NA
Oral - cancer effects	Adult	NA	NA	NA	NA	NA
Dermal - cancer effects	Adult	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	Adult	NA	NA	NA	NA	NA
Inhalation - cancer effects	Adult	NA	NA	NA	NA	NA
Total - cancer effects	Adult	NA	NA	NA	NA	NA
Source of indoor air vapours	Soil	NA	NA	NA	NA	NA
Model used for vapour transport	Health Canada	NA	NA	NA	NA	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	NA	NA	NA	NA	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.
All carcinogenic PAH present at the site must be treated additively

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

Remedial Worker

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	metals

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	Yes	Yes
Ingestion of contaminated food	No	No

Exposure Scenario	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult- Site Remediation Worker	

Contaminant Concentrations

Chemical Name	required	Boron (and borates)	Copper		Lead	Zinc	
Soil (mg/kg)	required	1.8	870		170	385	
Groundwater - source (mg/L)	optional		0.2		0.0236	0.027	
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult- Site Reme	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.1	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)	1.5	1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	0	5720
- total	3390	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	0	22.5
Hours per day (outdoors)	10	1.5
Days per week	6	7
Weeks per year	14	52
Dermal exposure events/day	1	1
Water contact events per day	1	1
Duration of water contact event (h)	1	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	5	60
Years for carcinogen amortization	5	60

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult- Site Remediation Worker **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	metals

Exposure Scenario: **User-Defined**
Native population not considered
Cancer Risks Calculated? **Yes**

User-Defined Receptor Characteristics

Body weight (kg): 70.7	Skin surface area (cm2) - hands: 890	
Soil ingestion rate (g/d): 0.1	- arms: 2500	Food ingestion rates (g/d)
Inhalation rate (m3/d): 15.8	- legs: 0	Root vegetables: 188
Water ingestion rate (L/d): 1.5	- total: 3390	Other vegetables: 137
	Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
	- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**Boron (and borates)**	**Copper**		**Lead**	**Zinc**	
Tolerable daily intake	mg/kg/d	0.0175	0.141	NA	0.0036	0.566	NA
Tolerable concentration	mg/m^3	NA	NA	NA	NA	NA	NA
Oral slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	NA	NA	NA	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		TDI	TDI	NA	TDI	TDI	NA
Critical inhalation exposure benchmark		NA	NA	NA	NA	NA	NA
Relative dermal absorption factor	unitless	0.01	0.06	1	0.006	0.1	1

Chemical Concentrations	**Units**	**Boron (and borates)**	**Copper**		**Lead**	**Zinc**	
Soil	mg/kg	1.80E+00	8.70E+02	0.00E+00	1.70E+02	3.85E+02	0.00E+00
Drinking water	mg/L	NA	NA	NA	NA	NA	NA
Bathing/swimming water	mg/L	0.00E+00	2.00E-01	0.00E+00	2.36E-02	2.70E-02	0.00E+00
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air particulate	mg/m^3	1.37E-09	6.61E-07	0.00E+00	1.29E-07	2.93E-07	0.00E+00
Amortized total air concentration	mg/m^3	1.31538E-10	6.35769E-08	0	1.24231E-08	2.81346E-08	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

	Exposure (mg/kg/d)					
	Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Inadvertent ingestion of contaminated soil	5.88E-07	2.84E-04	0.00E+00	5.55E-05	1.26E-04	0.00E+00
Inhalation of contaminated soil particles	2.94E-11	1.42E-08	0.00E+00	2.78E-09	6.29E-09	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	6.70E-09	1.94E-05	0.00E+00	3.80E-07	1.43E-05	0.00E+00
Dermal contact with water	0.00E+00	2.21E-06	0.00E+00	2.61E-08	1.79E-07	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	5.88E-07	2.84E-04	0.00E+00	5.55E-05	1.26E-04	0.00E+00
Total dermal exposure	6.70E-09	2.16E-05	0.00E+00	4.06E-07	1.45E-05	0.00E+00
Ingestion + dermal exposure	5.94E-07	3.06E-04	0.00E+00	5.59E-05	1.40E-04	0.00E+00
Total inhalation exposure	2.94E-11	1.42E-08	0.00E+00	2.78E-09	6.29E-09	0.00E+00
Total Exposure (all pathways)	5.94E-07	3.06E-04	0.00E+00	5.59E-05	1.40E-04	0.00E+00

		Hazard/Risk Estimates					
		Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Hazard Quotient - Oral/Dermal		3.40E-05	2.17E-03	NA	1.55E-02	2.48E-04	NA
Hazard Quotient - Inhalation		1.68E-09	1.01E-07	NA	7.71E-07	1.11E-08	NA
Hazard Index - Total		3.40E-05	2.17E-03	NA	1.55E-02	2.48E-04	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	metals

		Maximum Hazard/Risk Estimates					
		Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Hazard Quotient - Oral/Dermal		3.40E-05	2.17E-03	NA	1.55E-02	2.48E-04	NA
Hazard Quotient - Inhalation		1.68E-09	1.01E-07	NA	7.71E-07	1.11E-08	NA
Hazard Index - Total		3.40E-05	2.17E-03	NA	1.55E-02	2.48E-04	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		NA	NA	NA	NA	NA	NA
Cancer Risk - Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	NA	NA	NA	NA
Cancer Risk - Total		NA	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Boron (and borates)	**Copper**		**Lead**	**Zinc**	
Oral/Dermal - non-cancer effects	User-Defined Receptor	User-Defined Receptor	NA	User-Defined Receptor	User-Defined Receptor	NA
Inhalation - non-cancer effects	Adult	Adult	NA	Adult	Adult	NA
Total - non-cancer effects	User-Defined Receptor	User-Defined Receptor	NA	User-Defined Receptor	User-Defined Receptor	NA
Oral - cancer effects	NA	NA	NA	NA	NA	NA
Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - cancer effects	NA	NA	NA	NA	NA	NA
Total - cancer effects	NA	NA	NA	NA	NA	NA
Source of indoor air vapours	NA	NA	NA	NA	NA	NA
Model used for vapour transport	NA	NA	NA	NA	NA	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	NA	1.00E+00	NA	1.00E+00	1.00E+00	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	Petroleum Hydrocarbons

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	Yes	Yes
Ingestion of contaminated food	No	No

Exposure Scenario		
	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult Site Remediation Worker	

Contaminant Concentrations

Chemical Name	required	F1	F2	Benzene	Toluene	Ethylbenzene	
Soil (mg/kg)	required	120	6100	0.69	1.4	0.7	
Groundwater - source (mg/L)	optional	2.28	9.6	0.005	0.0791	0.0371	
Drinking water (mg/L)	optional						
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						
		See also PHC Sheet	See also PHC Sheet				

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult Site Remec	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.1	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)	1.5	1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	0	5720
- total	3390	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	0	22.5
Hours per day (outdoors)	10	1.5
Days per week	6	7
Weeks per year	14	52
Dermal exposure events/day	1	1
Water contact events per day	1	1
Duration of water contact event (h)	1	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	5	60
Years for carcinogen amortization	5	60

PHC Fraction Composition (%)	Soil		Note: water and air defaults are calculated based on soil properties Water		Air (Vapour)	
Fraction 1		Default		Default		Default
Aliphatics C_6-C_8		55		60.5		85.3
Aliphatics $C_{>8}$-C_{10}		36		6.3		14.2
Aromatics $C_{>8}$-C_{10}		9		33.2		0.4
Total		100		100		100
Fraction 2						
Aliphatics $C_{>10}$-C_{12}		36		2.4		76.7
Aliphatics $C_{>12}$-C_{16}		44		0.1		20.6
Aromatics $C_{>10}$-C_{12}		9		60.3		2.3
Aromatics $C_{>12}$-C_{16}		11		37.1		0.5
Total		100		100		100
Fraction 3						
Aliphatics $C_{>16}$-C_{21}		56		9.54E-03		89.79
Aliphatics $C_{>21}$-C_{34}		24		2.58E-07		7.83
Aromatics $C_{>16}$-C_{21}		14		95		2.37
Aromatics $C_{>21}$-C_{34}		6		5		0.01
Total		100		100		100
Fraction 4						
Aliphatics $C_{>34}$		80		0		0
Aromatics $C_{>34}$		20		100		0
Total		100		100		0

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult Site Remediation Worker **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	Petroleum Hydrocarbons

Exposure Scenario:	**User-Defined**	**User-Defined Receptor Characteristics**	Skin surface area (cm2) - hands: 890	
Native population not considered		Body weight (kg): 70.7	- arms: 2500	Food ingestion rates (g/d)
Cancer Risks Calculated?	**Yes**	Soil ingestion rate (g/d): 0.1	- legs: 0	Root vegetables: 188
		Inhalation rate (m3/d): 15.8	- total: 3390	Other vegetables: 137
		Water ingestion rate (L/d): 1.5	Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
			- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**F1**	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Tolerable daily intake	mg/kg/d	NA	NA	NA	0.22	0.1	NA
Tolerable concentration	mg/m^3	NA	NA	NA	3.8	1	NA
Oral slope factor	$(mg/kg/d)^{-1}$	NA	NA	0.226	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	NA	NA	0.0146	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	NA	NA	0.0033	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		NA	NA	slope factor	TDI	TDI	NA
Critical inhalation exposure benchmark		NA	NA	unit risk	TC	TC	NA
Relative dermal absorption factor	unitless	0.2	0.2	0.03	0.03	0.03	1

Chemical Concentrations	**Units**	**F1**	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Soil	mg/kg	1.20E+02	6.10E+03	6.90E-01	1.40E+00	7.00E-01	0.00E+00
Drinking water	mg/L	NA	NA	NA	NA	NA	NA
Bathing/swimming water	mg/L	2.28E+00	9.60E+00	5.00E-03	7.91E-02	3.71E-02	0.00E+00
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	2.05E-02	3.87E-01	5.07E-03	6.51E-03	1.88E-03	0.00E+00
Outdoor air particulate	mg/m^3	7.57E-08	4.60E-06	4.18E-10	9.30E-10	4.92E-10	0.00E+00
Amortized total air concentration	mg/m^3	7.27463E-09	4.42621E-07	4.01474E-11	8.94642E-11	4.72947E-11	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

			Exposure (mg/kg/d)				
		F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Inadvertent ingestion of contaminated soil		3.92E-05	1.99E-03	2.25E-07	4.57E-07	2.28E-07	0.00E+00
Inhalation of contaminated soil particles		1.63E-09	9.89E-08	8.97E-12	2.00E-11	1.06E-11	0.00E+00
Inhalation of contaminant vapours - indoor		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil		8.93E-06	4.54E-04	7.70E-09	1.56E-08	7.81E-09	0.00E+00
Dermal contact with water		4.20E-02	2.50E-01	1.29E-06	4.35E-05	3.72E-05	0.00E+00
Ingestion of contaminated food		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure		3.92E-05	1.99E-03	2.25E-07	4.57E-07	2.28E-07	0.00E+00
Total dermal exposure		4.20E-02	2.51E-01	1.30E-06	4.35E-05	3.72E-05	0.00E+00
Ingestion + dermal exposure		4.20E-02	2.53E-01	1.52E-06	4.40E-05	3.74E-05	0.00E+00
Total inhalation exposure		1.63E-09	9.89E-08	8.97E-12	2.00E-11	1.06E-11	0.00E+00
Total Exposure (all pathways)		4.20E-02	2.53E-01	1.52E-06	4.40E-05	3.74E-05	0.00E+00

		Hazard/Risk Estimates					
		F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Hazard Quotient - Oral/Dermal		2.83E-01	4.41E+00	NA	2.00E-04	3.74E-04	NA
Hazard Quotient - Inhalation		7.02E-09	7.97E-07	NA	2.35E-11	4.73E-11	NA
Hazard Index - Total		2.83E-01	4.41E+00	NA	2.00E-04	3.74E-04	NA
Target Hazard Index:	0.2	**Target Hazard Index Exceeded**	**Target Hazard Index Exceeded**				
Cancer Risk - Oral		NA	NA	5.09E-08	NA	NA	NA
Cancer Risk - Dermal		NA	NA	2.93E-07	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	3.44E-07	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	1.32E-13	NA	NA	NA
Cancer Risk - Total		NA	NA	3.44E-07	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	Petroleum Hydrocarbons

		Maximum Hazard/Risk Estimates					
		F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Hazard Quotient - Oral/Dermal		2.83E-01	4.41E+00	NA	2.00E-04	3.74E-04	NA
Hazard Quotient - Inhalation		7.02E-09	7.97E-07	NA	2.35E-11	4.73E-11	NA
Hazard Index - Total		2.83E-01	4.41E+00	NA	2.00E-04	3.74E-04	NA
Target Hazard Index:	0.2	**Target Hazard Index Exceeded**	**Target Hazard Index Exceeded**				
Cancer Risk - Oral		NA	NA	5.09E-08	NA	NA	NA
Cancer Risk - Dermal		NA	NA	2.93E-07	NA	NA	NA
Cancer Risk - Oral + Dermal		NA	NA	3.44E-07	NA	NA	NA
Cancer Risk - Inhalation		NA	NA	1.32E-13	NA	NA	NA
Cancer Risk - Total		NA	NA	3.44E-07	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	F1	**F2**	**Benzene**	**Toluene**	**Ethylbenzene**	
Oral/Dermal - non-cancer effects	User-Defined Receptor	User-Defined Receptor	NA	User-Defined Receptor	User-Defined Receptor	NA
Inhalation - non-cancer effects	All Age Groups	All Age Groups	NA	All Age Groups	All Age Groups	NA
Total - non-cancer effects	User-Defined Receptor	User-Defined Receptor	NA	User-Defined Receptor	User-Defined Receptor	NA
Oral - cancer effects	NA	NA	User-Defined Receptor	NA	NA	NA
Dermal - cancer effects	NA	NA	User-Defined Receptor	NA	NA	NA
Oral + Dermal - cancer effects	NA	NA	User-Defined Receptor	NA	NA	NA
Inhalation - cancer effects	NA	NA	Adult	NA	NA	NA
Total - cancer effects	NA	NA	User-Defined Receptor	NA	NA	NA
Source of indoor air vapours	Soil	Soil	Soil	Soil	Soil	NA
Model used for vapour transport	Health Canada	Health Canada	Health Canada	Health Canada	Health Canada	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

HEALTH CANADA PQRA SPREADSHEET
USER INPUT SHEET

User Name:	Franz Environmental Inc.	Site:	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	File #:	1747-0901
Date:		Comment:	PAHs

PROBLEM FORMULATION

Potential Land Uses (Yes/No)		Default
Agricultural	No	Yes
Residential/urban parkland	No	Yes
Commercial	Yes	Yes
Industrial	No	Yes
Occupational - outdoors	Yes	Yes
Recreational	No	Yes
Other	No	No
specify:		

Operative Pathways (Yes/No)		Default
Inadvertent ingestion of soil	Yes	Yes
Inhalation of soil particles	Yes	Yes
Inhalation of indoor contaminant vapours	No	Yes
Inhalation of outdoor contaminant vapours	No	Yes
Ingestion of drinking water	No	Yes
Dermal contact with soil	Yes	Yes
Dermal contact with water	Yes	Yes
Ingestion of contaminated food	No	No

Exposure Scenario	User-Defined	Commercial

Vapour Transport Modelling		
Vapour source for exposure calculations	Most Conservative	Most Conservative

Receptor Groups (Yes/No)		Default
General public or residents	No	Yes
Employees	Yes	Yes
Canadian native communities	No	No
Other	No	No
specify:		

Active Critical Receptors (Yes/No)		Default
Infant	No	No
Toddler	No	No
Child	No	No
Teen	No	No
Adult	No	Yes
Other	Yes	Yes
specify:	Adult- Site Remediation Worker	

Contaminant Concentrations

Chemical Name	required	Chrysene					
Soil (mg/kg)	required	2.8					
Groundwater - source (mg/L)	optional	0.0001					
Drinking water (mg/L)	optional	0.0001					
Bathing/swimming water (mg/L)	optional						
Indoor air - vapours (mg/m^3)	optional						
Outdoor air - vapours (mg/m^3)	optional						
Outdoor air - particulate (mg/m^3)	optional						
Root vegetables (mg/kg wet weight)	optional						
Other vegetables (mg/kg wet weight)	optional						
Fish (mg/kg wet weight)	optional						
Wild game (mg/kg wet weight)	optional						
		PAH-Carcinogenic					

Risk Assessment Endpoints		Default
Acceptable hazard index:	0.2	0.2
Acceptable cancer risk:	1.00E-05	1.00E-05

Precluding Conditions for Fate and Transport Models

Are non-aqueous phase liquids (NAPL) present?	No
Is groundwater contamination present in fractured bedrock?	No
Is groundwater contamination migrating through a confined aquifer?	No
Is there active pumping or drawdown of groundwater at the site?	No
Is contamination present within 1 m of building foundation?	No
Do any buildings within 5 m of contamination have earthen foundations?	No
Are any buildings constructed on very high permeability media?	No
Are there preferential vapour flow pathways connecting contamination to a building?	No

Fate and Transport Model Input

	Value	Default	Models Affected
Soil Type	coarse-grained	coarse-grained	PS, V-I, V-O, GW
Significant vehicle traffic on unpaved roads?	No	No	P-O
Site Characteristics			
Depth to Groundwater (m)	1	3	GW, V-O
Depth from Surface to Contamination (m)	0	0	GW, V-O
Distance - Contaminated Soil to Building (m)	1	1	V-I
Distance - Contaminated GW to Building (m)	1	1	V-I
Distance to potable water user (m)	0	0	GW
Distance to Bathing/Swimming Water (m)	0	0	GW
Particulate Concentration in Air (ug/m^3)	0.76	0.76	P-O
Building Type	Commercial/Industrial	Residential	V-I

Optional Sections

User-defined Chemicals

Note: user-defined chemicals should be named in this section before being selected in the 'Contaminant Concentrations' table above

		Chemical 1	Chemical 2	Chemical 3
Name				
CAS Number				
Chemical class (organic/inorganic)				
Tolerable daily intake (mg/kg/d) - infant	*Enter all applicable and appropriate toxicity benchmarks; values must be referenced and justified in the PQRA report.*			
Tolerable daily intake (mg/kg/d) - toddler				
Tolerable daily intake (mg/kg/d) - child				
Tolerable daily intake (mg/kg/d) - teen				
Tolerable daily intake (mg/kg/d) - adult				
Tolerable concentration (mg/m^3)				
Oral slope factor $(mg/kg/d)^{-1}$				
Inhalation slope factor $(mg/kg/d)^{-1}$				
Inhalation unit risk $(mg/m^3)^{-1}$				
Relative dermal absorption factor				
Organic carbon partitioning coefficient (mL/g) - Koc				
Log Kow (unitless)				
Henry's Law constant at 25°C (unitless) - H'				
Henry's Law constant at 25°C (atm-m3/mol) - H				
Water Solubility at 25°C (mg/L)				
Molecular Weight (g/mol)				
Vapour Pressure at 25°C (atm)				

Note: values in grayed cells will not be used; Health Canada default values are applied.

User-defined Receptor

Name	Adult- Site Reme	Defaults
Age group	Adult	Toddler
Body weight (kg)	70.7	70.7
Soil ingestion rate (g/d)	0.1	0.02
Inhalation rate (m^3/d)	15.8	15.8
Water ingestion rate (L/d)	1.5	1.5
Skin surface area (cm^2)		
- hands	890	890
- arms	2500	2500
- legs	0	5720
- total	3390	17640
Soil loading to exposed skin (g/cm^2/event)		
- hands	1.00E-04	0.0001
- surfaces other than hands	1.00E-05	0.00001
Food ingestion (g/d)		
- root vegetables	188	188
- other vegetables	137	137
- fish	111	111
- wild game	0	0
Evaluate Cancer Risks (Yes/No)?	Yes	Yes

User-defined Land-Use / Exposure Scenario

Scenario name	User-Defined	Defaults
Hours per day (indoors)	0	22.5
Hours per day (outdoors)	10	1.5
Days per week	6	7
Weeks per year	14	52
Dermal exposure events/day	1	1
Water contact events per day	1	1
Duration of water contact event (h)	1	1
Days/year contaminated food ingestion	0	365
Exposure duration (years)	5	60
Years for carcinogen amortization	5	60

HEALTH CANADA PQRA SPREADSHEET Version: March 16, 2009
OUTPUT SHEET - Adult- Site Remediation Worker **Adult**

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	PAHs

Exposure Scenario: **User-Defined**
Native population not considered
Cancer Risks Calculated? **Yes**

User-Defined Receptor Characteristics

Body weight (kg): 70.7	Skin surface area (cm2) - hands: 890	
Soil ingestion rate (g/d): 0.1	- arms: 2500	Food ingestion rates (g/d)
Inhalation rate (m3/d): 15.8	- legs: 0	Root vegetables: 188
Water ingestion rate (L/d): 1.5	- total: 3390	Other vegetables: 137
	Soil loading (g/cm2-event) - hands: 0.0001	Fish: 111
	- other: 0.00001	Wild game: 0

Chemical Properties	**Units**	**Chrysene**					
Tolerable daily intake	mg/kg/d	NA	NA	NA	NA	NA	NA
Tolerable concentration	mg/m^3	NA	NA	NA	NA	NA	NA
Oral slope factor	$(mg/kg/d)^{-1}$	0.023	NA	NA	NA	NA	NA
Inhalation slope factor	$(mg/kg/d)^{-1}$	0.00137	NA	NA	NA	NA	NA
Inhalation unit risk	$(mg/m^3)^{-1}$	0.00031	NA	NA	NA	NA	NA
Dermal slope factor	$(mg/kg/d)^{-1}$	NA	NA	NA	NA	NA	NA
Critical oral exposure benchmark		slope factor	NA	NA	NA	NA	NA
Critical inhalation exposure benchmark		unit risk	NA	NA	NA	NA	NA
Relative dermal absorption factor	unitless	0.13	1	1	1	1	1

Chemical Concentrations	**Units**	**Chrysene**					
Soil	mg/kg	2.80E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Drinking water	mg/L	1.00E-04	NA	NA	NA	NA	NA
Bathing/swimming water	mg/L	1.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indoor air vapours	mg/m^3	NA	NA	NA	NA	NA	NA
Outdoor air vapours	mg/m^3	3.85E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Outdoor air particulate	mg/m^3	2.13E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Amortized total air concentration	mg/m^3	2.04614E-10	0	0	0	0	0
Root vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Other vegetables	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Fish	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated
Wild game	mg/kg wet wt	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated	not evaluated

RESULTS

		Exposure (mg/kg/d)					
	Chrysene						
Inadvertent ingestion of contaminated soil	9.14E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminated soil particles	4.57E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - indoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inhalation of contaminant vapours - outdoor	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated drinking water	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with contaminated soil	1.35E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dermal contact with water	1.79E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion of contaminated food	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure	9.14E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total dermal exposure	1.93E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ingestion + dermal exposure	2.84E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total inhalation exposure	4.57E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Exposure (all pathways)	2.84E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

		Hazard/Risk Estimates					
		Chrysene					
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		NA	NA	NA	NA	NA	NA
Hazard Index - Total		NA	NA	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		2.10E-08	NA	NA	NA	NA	NA
Cancer Risk - Dermal		4.43E-08	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		6.53E-08	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		6.34E-14	NA	NA	NA	NA	NA
Cancer Risk - Total		6.53E-08	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

SUMMARY OF PQRA RESULTS Version: March 16, 2009

User Name:	Franz Environmental Inc.	**Site:**	Resolute Bay Airport Landfills and Boneyard
Proponent:	Transport Canada	**File #:**	1747-0901
Date:		**Comment:**	PAHs

		Maximum Hazard/Risk Estimates					
		Chrysene					
Hazard Quotient - Oral/Dermal		NA	NA	NA	NA	NA	NA
Hazard Quotient - Inhalation		NA	NA	NA	NA	NA	NA
Hazard Index - Total		NA	NA	NA	NA	NA	NA
Target Hazard Index:	0.2						
Cancer Risk - Oral		2.10E-08	NA	NA	NA	NA	NA
Cancer Risk - Dermal		4.43E-08	NA	NA	NA	NA	NA
Cancer Risk - Oral + Dermal		6.53E-08	NA	NA	NA	NA	NA
Cancer Risk - Inhalation		6.34E-14	NA	NA	NA	NA	NA
Cancer Risk - Total		6.53E-08	NA	NA	NA	NA	NA
Target Cancer Risk:	1.00E-05						

	Critical Receptors					
	Chrysene					
Oral/Dermal - non-cancer effects	NA	NA	NA	NA	NA	NA
Inhalation - non-cancer effects	NA	NA	NA	NA	NA	NA
Total - non-cancer effects	NA	NA	NA	NA	NA	NA
Oral - cancer effects	User-Defined Receptor	NA	NA	NA	NA	NA
Dermal - cancer effects	User-Defined Receptor	NA	NA	NA	NA	NA
Oral + Dermal - cancer effects	User-Defined Receptor	NA	NA	NA	NA	NA
Inhalation - cancer effects	Adult	NA	NA	NA	NA	NA
Total - cancer effects	User-Defined Receptor	NA	NA	NA	NA	NA
Source of indoor air vapours	Soil	NA	NA	NA	NA	NA
Model used for vapour transport	Health Canada	NA	NA	NA	NA	NA

Key Calculated Model Parameters						
Vapour Intrusion Model Parameters	Note: parameters show as "NA" if relevant exposure pathways are inoperative or if user-input concentration is used instead of modelled value					
Qsoil/Qbuilding	NA	NA	NA	NA	NA	NA
Soil alpha	NA	NA	NA	NA	NA	NA
Groundwater alpha	NA	NA	NA	NA	NA	NA
Groundwater model dilution factors						
DF1 (soil to leachate)	NA	NA	NA	NA	NA	NA
DF2 (leachate at source to water table):	NA	NA	NA	NA	NA	NA
DF3 (leachate at water table to groundwater):	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - drinking water:	NA	NA	NA	NA	NA	NA
DF4 (source to receptor) - bathing/swimming water:	1.00E+00	NA	NA	NA	NA	NA

Notes/Comments

Vapour Intrusion Model

Chemical Interactions

All chemicals of concern present at the site should be evaluated for potential additive effects based on target organs and mechanisms of effect.
All carcinogenic PAH present at the site must be treated additively

Concentration Checks

Precluding Conditions

Other Notes

Provide justification for all non-default model parameters in PQRA report

Appendix C

Human Health Risk Assessment
Exposure Equations
From
Health Canada

Human Health Preliminary Quantitative Risk Assessment (PQRA) guidance documents *Federal (Contaminated Site Risk Assessment in Canada - Part 1 (2007 Update)*

Risk Calculations for Acute Exposure of Site Remediation Worker
Resolute Bay Airport Landfills and Vehicle Storage Area Sites
1747-0901 Risk Assessment

Site Remediation worker acute exposure (10h/day, 6 day/wk, 14 wk)

COPC	Exposure averaged over a year (mg/kg/d)					Exposure after acute period (mg/kg/d)				
	Ingestion	Dermal Contact with Soil	Oral/Dermal Exposure	Inhalation of Soil Particles	Total Exposure	Ingestion (*365 days/98 days)	Dermal Contact with Soil (*365 days/98 days)	Oral /Dermal Exposure(*365 days/98 days)	Inhalation of Soil Particles(*365 days/98 days)	Total Exposure
Boron	5.88E-07	6.70E-09	5.94E-07	2.94E-11	5.94E-07	2.19E-06	2.50E-08	2.21E-06	1.10E-10	2.22E-06
Copper	2.84E-04	2.16E-05	3.06E-04	1.42E-08	3.06E-04	1.06E-03	8.04E-05	1.14E-03	5.29E-08	1.14E-03
Lead	5.55E-05	4.06E-07	5.59E-05	2.78E-09	5.59E-05	2.07E-04	1.51E-06	2.08E-04	1.04E-08	2.08E-04
Zinc	1.26E-04	1.45E-05	1.40E-04	6.29E-09	1.40E-04	4.69E-04	5.40E-05	5.23E-04	2.34E-08	5.23E-04
F1	3.92E-05	4.20E-02	4.20E-02	1.63E-09	4.20E-02	1.46E-04	1.56E-01	1.57E-01	6.07E-09	1.57E-01
F2	1.99E-03	2.51E-01	2.53E-01	9.89E-08	2.53E-01	7.41E-03	9.35E-01	9.42E-01	3.68E-07	9.42E-01
Benzene	*2.25E-07*	*1.30E-06*	1.53E-06	*8.97E-12*	*1.52E-06*	8.38E-07	4.84E-06	5.68E-06	3.34E-11	*5.68E-06*
Toluene	4.57E-07	4.35E-05	4.40E-05	2.00E-11	4.40E-05	1.70E-06	1.62E-04	1.64E-04	7.45E-11	1.64E-04
Ethylbenzene	2.28E-07	3.72E-05	3.74E-05	1.06E-11	3.74E-05	8.49E-07	1.39E-04	1.39E-04	3.95E-11	1.39E-04
Chrysene	*9.14E-07*	*1.93E-06*	2.84E-06	*4.57E-11*	*2.84E-06*	3.40E-06	7.19E-06	1.06E-05	1.70E-10	*1.06E-05*

Assume 100% bioavailability

HQ greater than 1 | HQ greater than 0.2

COPC	Chronic TRV-Oral/Dermal(mg/kg/d)		HQ for Acute Exposure
Boron	0.0175		**1.27E-04**
Copper	0.141		**8.07E-03**
Lead	0.0036		**5.78E-02**
Zinc	0.566		**9.25E-04**
F1	exceeded in chronic scenario		**expected exceedance in acute scenario**
F2	exceeded in chronic scenario		**expected exceedance in acute scenario**
Benzene			**carcinogen**
Toluene	0.22		**7.44E-04**
Ethylbenzene	0.1		**1.39E-03**
Chrysene			**carcinogen**

	Total Chronic Exposure(mg/kg/d)	Acute Exposure (mg/kg/d)(*365 days/98 days)	TRV(mg/kg/d)	TC (mg/m3)	HQ for Acute Exposure
F1					
Aliphatics C6-C8	2.37E-02	8.83E-02	5	18.4	**1.77E-02**
Aliphatics C8-C10	1.17E-02	4.36E-02	0.1	1	**4.36E-01**
Aromatics C8-C10	6.48E-03	2.41E-02	0.04	0.2	**6.03E-01**
F2					
Aliphatics C10-C12	8.12E-02	3.02E-01	0.1	1	**3.02E+00**
Aromatics C10-C12	4.52E-02	1.68E-01	0.1	1	**1.68E+00**
Aliphatics C12-C16	6.30E-02	2.35E-01	0.04	0.2	**5.87E+00**
Aromatics C12-C16	6.28E-02	2.34E-01	0.04	0.2	**5.85E+00**

TABLE 7. Recommended General Equations for Dose Estimation

Note: Presented below are generalized equations; actual equations presented by individual contractors may vary according to the manner in which different variables are presented, the units used, and the precise presentation of exposure frequency, exposure duration and averaging times. Abbreviations denoting variables have been harmonized through all equations; variables are not necessarily represented in every equation.

Inadvertent Ingestion of Contaminated Soil

The predicted intake of each contaminant via ingestion of contaminated soil is calculated as:

$$Dose\ (mg/kg/day) = \frac{C_S \times IR_S \times RAF_{Oral} \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:

C_S = concentration of contaminant in soil (mg/kg)
IR_S = receptor soil ingestion rate (kg/d)
RAF_{Oral} = relative absorption factor from the GI tract (unitless)
D_2 = days per week exposed/7 days
D_3 = weeks per year exposed/52 weeks
D_4 = total years exposed to site (to be employed for assessment of carcinogens only)
BW = body weight (kg)
LE = life expectancy (yr) (to be employed for assessment of carcinogens only)

NOTE: the terms D_3 and D_4 should be omitted when considering exposures posed by chemicals with developmental (foetal) effects.

Inhalation of Contaminated Soil Particles

The predicted intake of each contaminant via inhalation of dust entrained into the air is calculated as:

$$Dose\ (mg/kg/day) = \frac{C_S \times P_{Air} \times IR_A \times RAF_{Inh} \times D_1 \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:

C_S = concentration of contaminant in soil (mg/kg)
P_{Air} = particulate concentration in air (kg/m^3)
IR_A = receptor air intake (inhalation) rate (m^3/day)
RAF_{Inh} = relative absorption factor by inhalation (unitless)
D_1 = hours per day exposed/24 hours
D_2 = days per week exposed/7 days
D_3 = weeks per year exposed/52 weeks
D_4 = total years exposed to site (to be employed for assessment of carcinogens only)
BW = body weight (kg)
LE = life expectancy (yr) (to be employed for assessment of carcinogens only)

Notes: P_{Air} may be directly measured or may be estimated using methods discussed in the text. Alternately, C_A (air-borne concentration; mg/m^3) may be

directly measured, negating the prediction of air-borne concentration using C_S and P_{Air}. The terms D_3 and D_4 should be omitted when considering exposures posed by chemicals with developmental (foetal) effects.

TABLE 7 (continued)
Recommended General Equations for Dose Estimation

Inhalation of Contaminant Vapours

The predicted intake of each contaminant via inhalation of vapours is calculated as:

$$Dose\ (mg/kg/day) = \frac{C_A \times IR_A \times RAF_{Inh} \times D_1 \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:
C_A = concentration of contaminant in air (mg/m^3)
IR_A = receptor air intake (inhalation) rate (m^3/day)
RAF_{Inh} = relative absorption factor for inhalation (unitless)
D_1 = hours per day exposed/24 hours
D_2 = days per week exposed/7 days
D_3 = weeks per year exposed/52 weeks
D_4 = total years exposed to site (to be employed for assessment of carcinogens only)
BW = body weight (kg)
LE = life expectancy (yr) (to be employed for assessment of carcinogens only)

Notes: C_A may be directly measured or may be estimated from soil-borne or groundwater-borne concentrations of volatile COPCs using methods discussed in the text. The terms D_3 and D_4 should be omitted when considering exposures posed by chemicals with developmental (foetal) effects.

Ingestion of Contaminated Drinking Water

The predicted intake of each contaminant via ingestion of contaminated drinking water is calculated as:

$$Dose\ (mg/kg/day) = \frac{C_w \times IR_w \times RAF_{Oral} \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:
C_w = concentration of contaminant in drinking water (mg/L)
IR_w = receptor water intake rate (L/d)
RAF_{Oral} = relative absorption factor from the GI tract (unitless)
D_3 = weeks per year exposed/52 weeks
D_4 = total years exposed to site (to be employed for assessment of carcinogens only)
BW = body weight (kg)

D_2 = days per week exposed/7 days

LE = life expectancy (yr) (to be employed for assessment of carcinogens only)

Notes: C_w may be directly measured or may be estimated from soil-borne or groundwater-borne concentrations of COPCs using methods discussed in the text. The terms D_3 and D_4 should be omitted when considering exposures posed by chemicals with developmental (foetal) effects.

TABLE 7 (continued)
Recommended General Equations for Dose Estimation

Dermal Absorption from Contaminated Soil

The predicted intake of each contaminant via dermal contact with contaminated soil is calculated as:

$$Dose\ (mg/kg/day) = \frac{[(C_S \times SA_H \times SL_H) + (C_S \times SA_O \times SL_O)] \times RAF_{Derm} \times D_2 \times D_3 \times D_4}{BW \times LE}$$

Where:

C_S = concentration of contaminant in soil (mg/kg)
SA_H = surface area of hands exposed for soil loading (cm^2)
SA_O = surface area exposed other than hands (cm^2)
SL_H = soil loading rate to exposed skin of hands (kg/cm^2-event)
SL_O = soil loading rate to exposed skin other than hands (kg/cm^2-event)
D_2 = days per week exposed/7 days
D_3 = weeks per year exposed/52 weeks
D_4 = total years exposed to site (for assessment of carcinogens only)
RAF_{Derm} = relative dermal absorption factor (unitless)
BW = body weight (kg)
LE = life expectancy (yr) (for assessment of carcinogens only)

NOTE: the terms D_3 and D_4 should be omitted when considering exposures posed by chemicals with developmental (foetal) effects.

Ingestion of Contaminated Foods (Produce, Fish, Game, etc.)

The predicted intake of each contaminant via ingestion of contaminated food is calculated as:

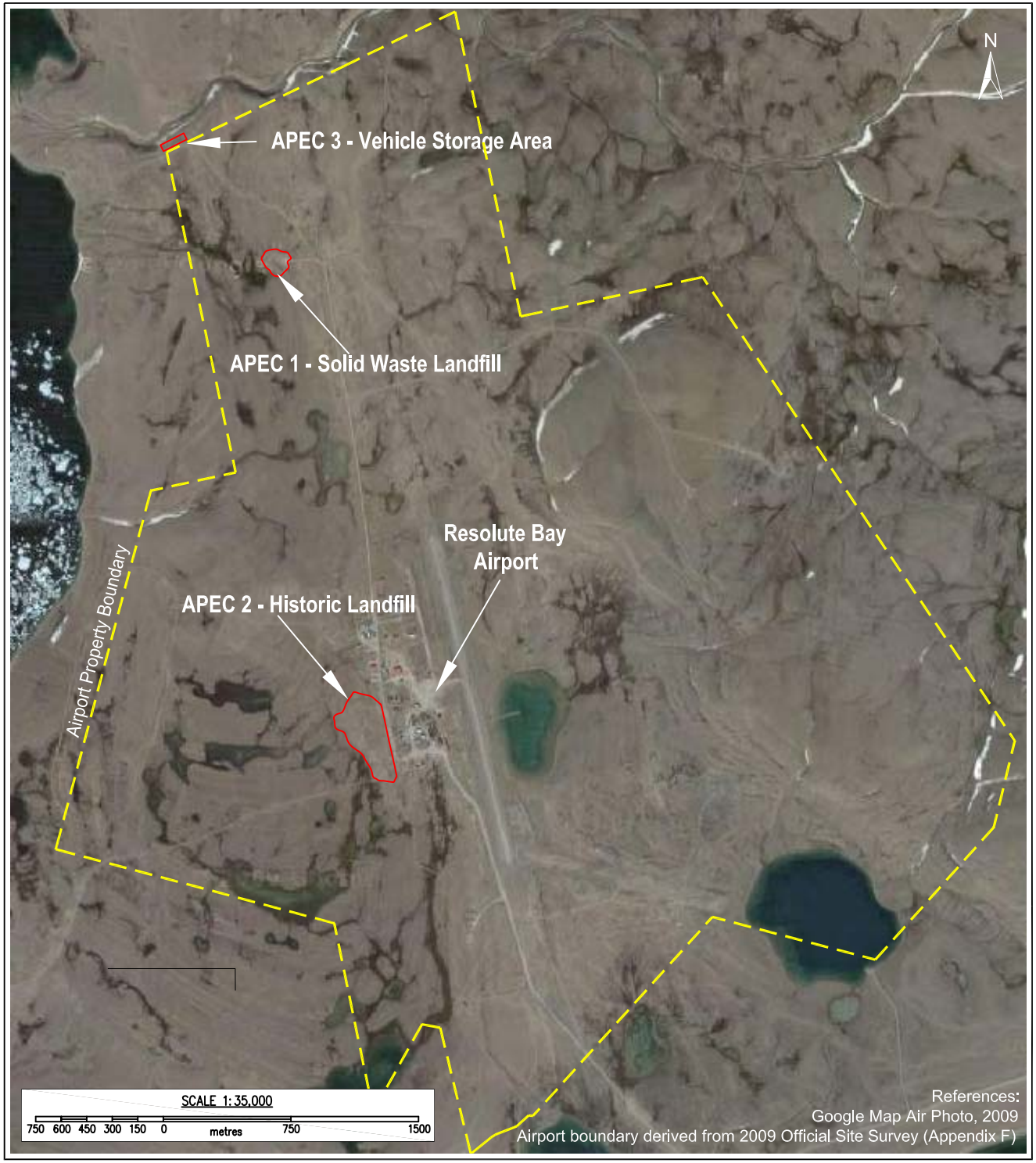
$$Dose\ (mg/kg\ day) = \frac{[\sum [C_{Food\ i} \times IR_{Foodi} \times RAF_{Orali} \times D_i]] \times D_4}{BW \times 365 \times LE}$$

Where:

C_{Foodi} = concentration of contaminant in food *i* (mg/kg)
IR_{Foodi} = receptor ingestion rate for food *i* (kg/d)
RAF_{Orali} = relative absorption factor from the GI tract for contaminant *i* (unitless)
D_i = days per year during which consumption of food *i* will occur (d/yr)
D_4 = total years exposed to site (for assessment of carcinogens only)
BW = body weight (kg)
LE = life expectancy (for assessment of carcinogens only)
365 = total days per year (constant) (d/yr)

Notes: Concentrations of contaminants in foods can be measured directly, or can be predicted using methods discussed in the text. The terms D_3 and D_4 should be omitted when considering exposures posed by chemicals with developmental (foetal) effects.

APPENDIX D
Excerpt Figures from Phase II/III ESA (FRANZ, 2010)



Title:
STUDY AREA AND APECS

Project:
RESOLUTE BAY AIRPORT LANDFILLS ENVIRONMENTAL SITE ASSESSMENT - FINAL REPORT

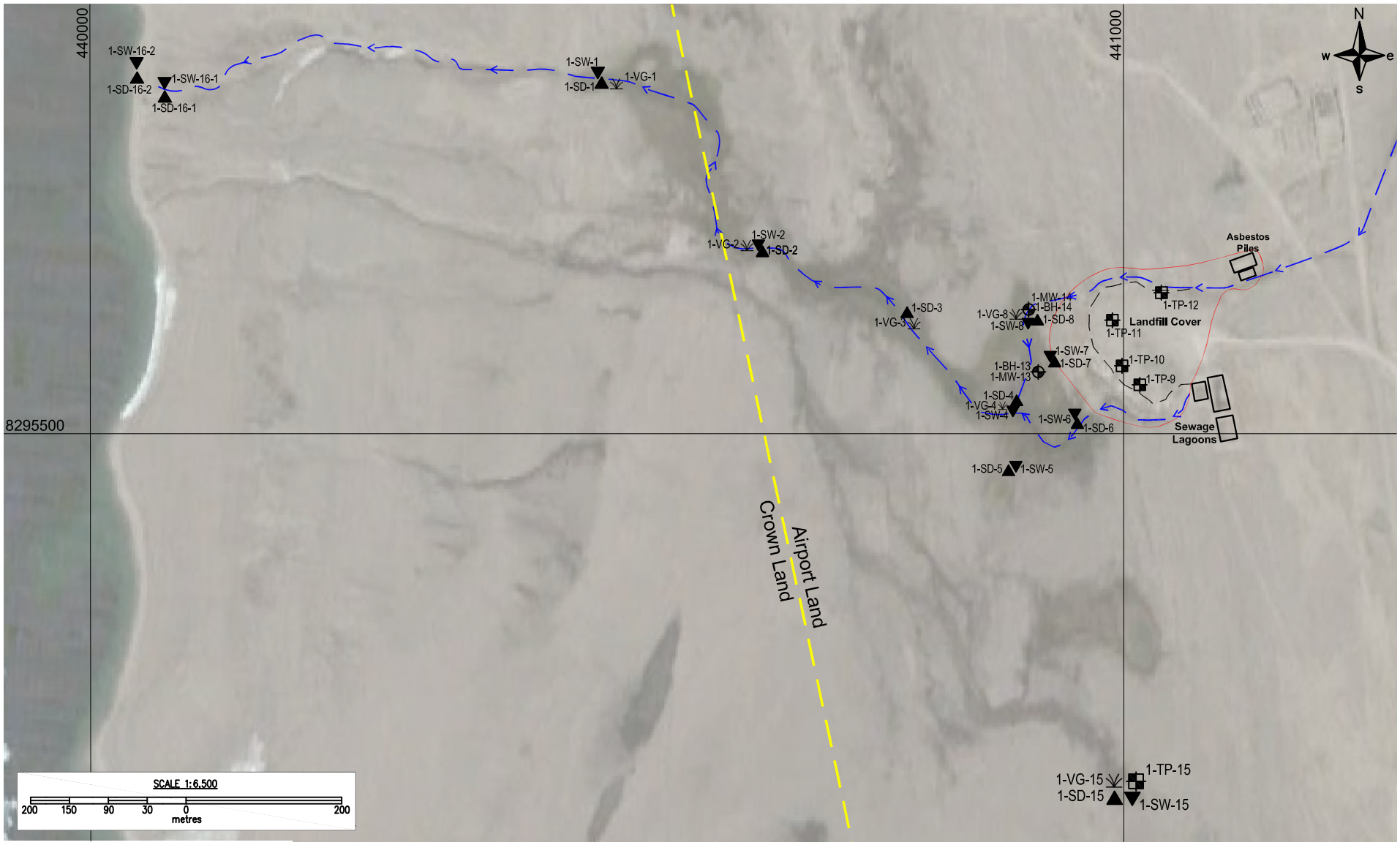
Client:
PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
TRANSPORT CANADA

FRANZ ENVIRONMENTAL INC.
♦ CONSULTING ♦ ENGINEERING ♦ TECHNOLOGIES ♦

Date:
MARCH 2010

FIGURE 1

1747-0901/CAD/Resolute Bay ESA Feb 10/10



LEGEND

- Landfill Extent
- Airport Property Boundary
- Surface Water & Direction of Flow
- Top edge of landfill
- Soil Sample (TP)
- Borehole / Monitoring Well
- Surface Water (SW)
- Sediment Sample (SD)
- Vegetation Sample (VG)

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
Airport boundary derived from 2009 Official Site Survey (Appendix F)

Title: APEC 1 - Sampling Locations

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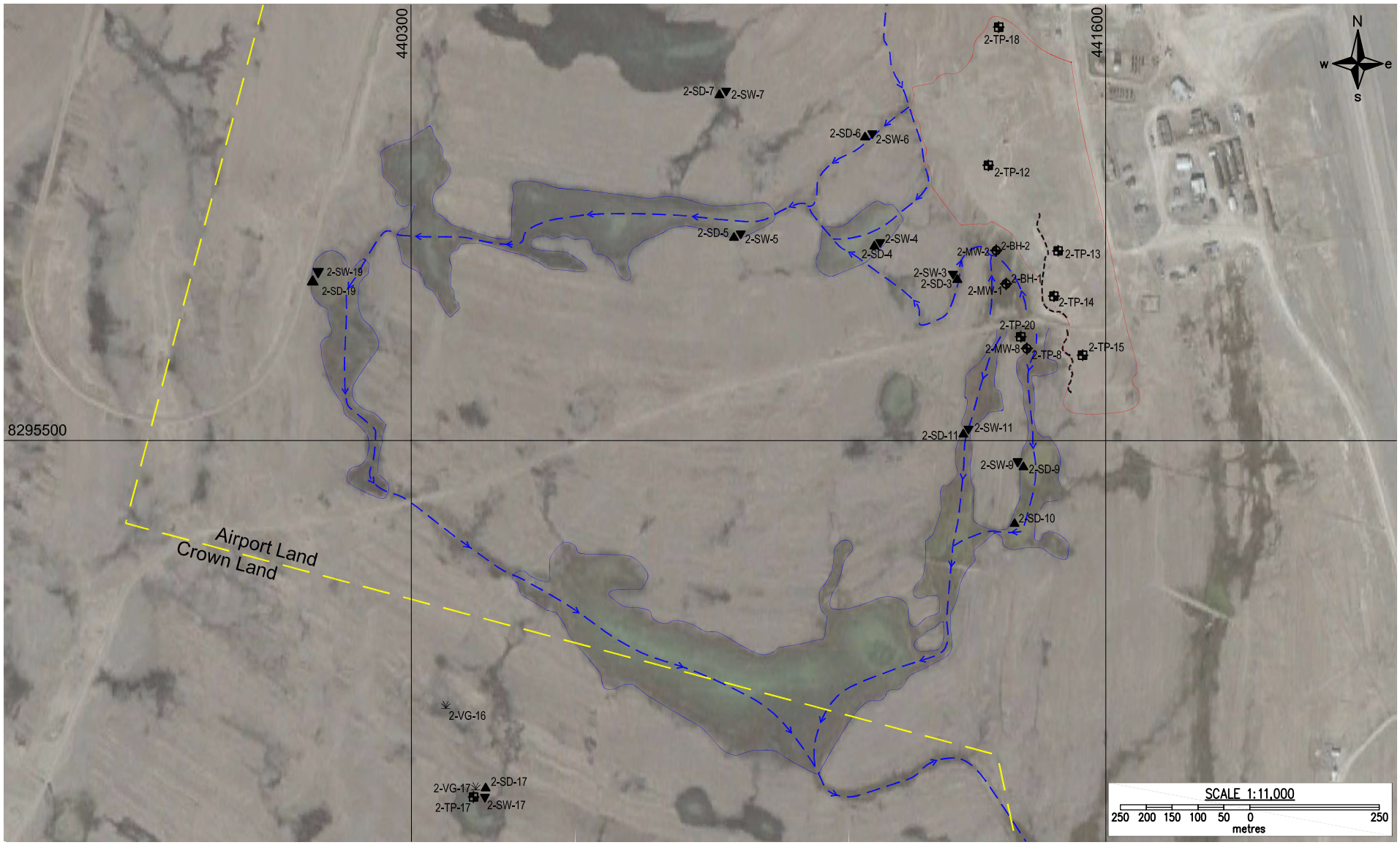
Scale: 1 : 6,500

FIGURE 2

1747-0901/CAD/Resolute Bay ESA Feb 22/10



LEGEND

- Landfill Extent
- Airport Property Boundary
- Surface Water Body
- Surface Water & Direction of Flow
- Top edge of landfill
- Borehole / Monitoring Well
- Surface Water (SW)
- Sediment Sample (SD)
- Vegetation Sample (VG)
- Soil Sample (TP)

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
Airport boundary derived from 2009 Official Site Survey (Appendix F)

Title: APEC 2 - Sampling Locations

FRANZ ENVIRONMENTAL INC.
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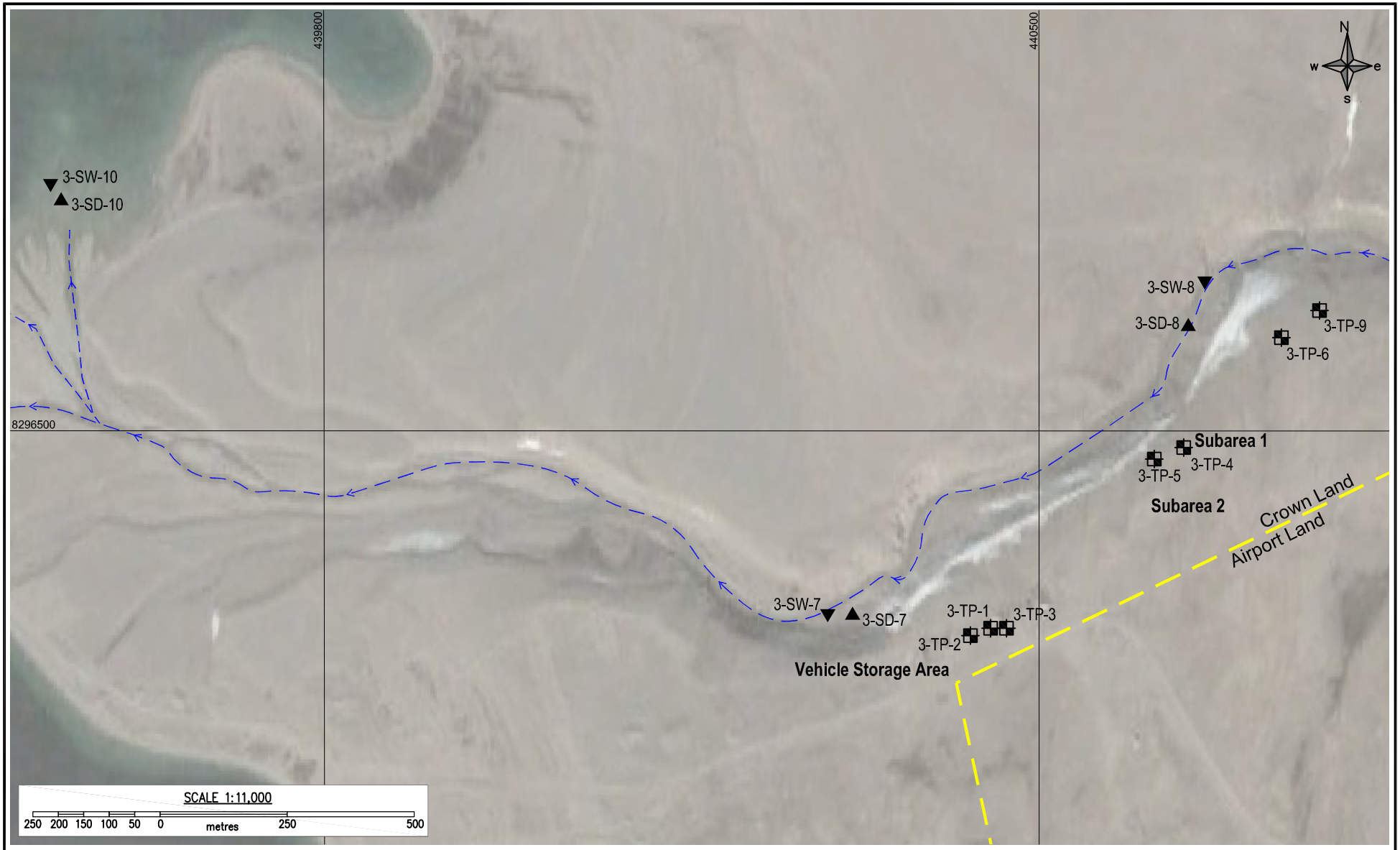
Scale: 1 : 11,000

FIGURE 3

1747-0901/CAD/Resolute Bay ESA Feb 10/10



LEGEND

- Extent of APEC
- Airport Property Boundary
- Surface Water & Direction of Flow
- Soil Sample (TP)
- Surface Water Sample (SW)
- Sediment Sample (SD)

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
Airport boundary derived from 2009 Official Site Survey (Appendix F)

Title: APEC 3 - Sampling Locations

FRANZ ENVIRONMENTAL INC.
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Scale: 1 : 11,000

FIGURE 4

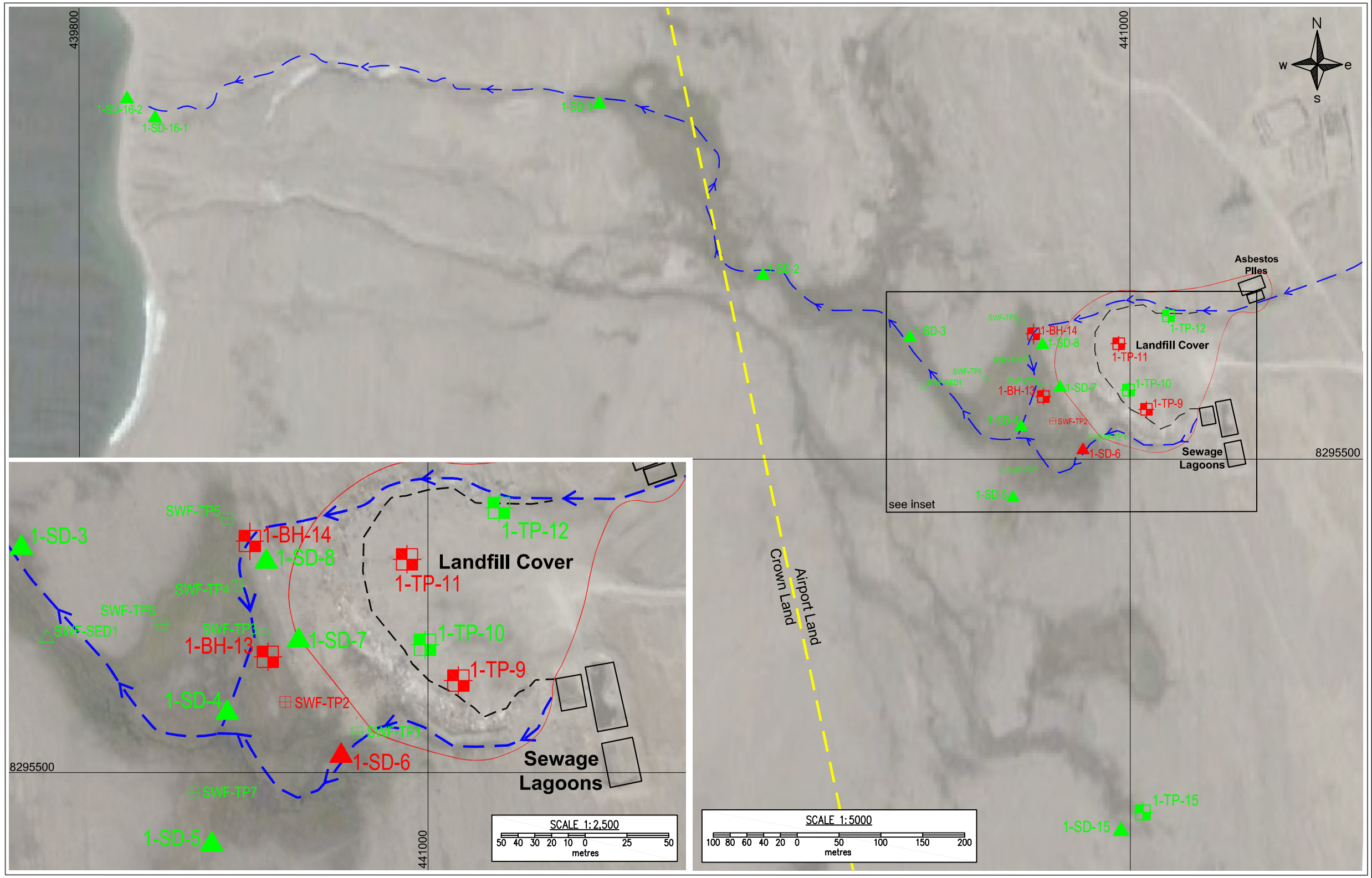
1747-0901/CAD/Resolute Bay ESA Feb 4/10

Station ID	CCME Soil CL (coarse, surface)	1-MW-13	1-MW-14	SWF-TP2
Field label		1-BH-13	1-BH-14	SWF-TP2
Sampled By		FRANZ 2009	FRANZ 2009	JWEL 2006
Date		15/Aug/09	15/Aug/09	-
Lab report ID		A9A8737	A9A8737	-
Depth (m)		0.05 – 0.66	0.1 – 0.62	-
BTEX/PHCs				
Benzene	0.03	0.031	0.032	-
F2 Hydrocarbons	260	-	-	827
F3 Hydrocarbons	1700	-	-	1840

Station ID	CCME Soil CL (coarse, surface)	1-TP-9	1-TF-11
Field label		1-TP-9	1-TF-11
Date		16/Aug/09	15/Aug/09
Sampled By		FRANZ 2009	FRANZ 2009
Lab report ID		A9A7367	A9A7367
Depth (m)		0.5 – 0.95	0 – 0.15
Metals			
Copper	91	870.0	150.0

SEDIMENT

Station ID	CCME ISQG (freshwater)	1-SD-6
Field label		1-SD-6
Date		17-Aug-09
Sampled By		FRANZ 2009
Lab report ID		A9A8632
Depth (m)		0.05 - 0.15
PAHs		
Acenaphthene	0.00671	0.02
Fluorene	0.0212	0.028
2-Methylnaphthalene	0.0202	0.39
Naphthalene	0.0346	0.11



LEGEND

- Landfill Extent
- Airport Property Boundary
- Surface Water Flow
- Top edge of landfill
- FRANZ soil sample (2009); compliant with CCME guidelines
- FRANZ soil sample (2009); exceeds CCME guidelines
- FRANZ sediment sample (2009); compliant w/ CCME guidelines
- FRANZ sediment sample (2009); exceeds CCME guidelines
- JWEL soil sample (2006); compliant with CCME guidelines
- JWEL soil sample (2006); exceeds CCME guidelines
- JWEL sediment sample (2006); compliant with CCME guidelines

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
Jacques Whitford (JWEL) analytical results for soil and sediment are in ug/g
JWEL sampling locations are shown for comparison purposes only.
For more detail, see the Jacques Whitford (2006) report
Airport boundary derived from 2009 Official Site Survey (Appendix F)
CCME Soil Guidelines for commercial land use in coarse soil (2008)
CCME Canada-Wide Standards for PHCs in soil (2008)
CCME Interim Sediment Quality Guidelines (ISQG, 2009)
FRANZ (2009) analytical results for soil and sediment are in ug/g and can be found in Appendix H & I.

Title: APEC 1 - Analytical Results for Soil & Sediment

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Scale: See figures for scale

FIGURE 5

1747-0901/CAD/Resolute Bay ESA Feb 25/10

SURFACE WATER

APEC ID	CCME AW (Freshwater)	APEC 1	APEC 1	APEC 1	APEC 1
Station ID		1-SW-4	1-SW-5	1-SW-6	1-SW-7
Field label		1-SW-4	1-SW-5	1-SW-6	1-SW-7
Duplicate ID					FR-4
Date/Time		19-Aug-09	19-Aug-09	17-Aug-09	17-Aug-09
Sampled By		FRANZ 2009	FRANZ 2009	FRANZ 2009	FRANZ 2009
Lab report ID		A9A9300	A9A9300	A9A8511	A9A8511
Metals					
Cadmium	0.017	<0.1	<0.1	<0.1	0.4
Copper	2 - 4*	5	2	2	4
Iron	300	250	370	590	<100
Zinc	30	16	<5	13	110

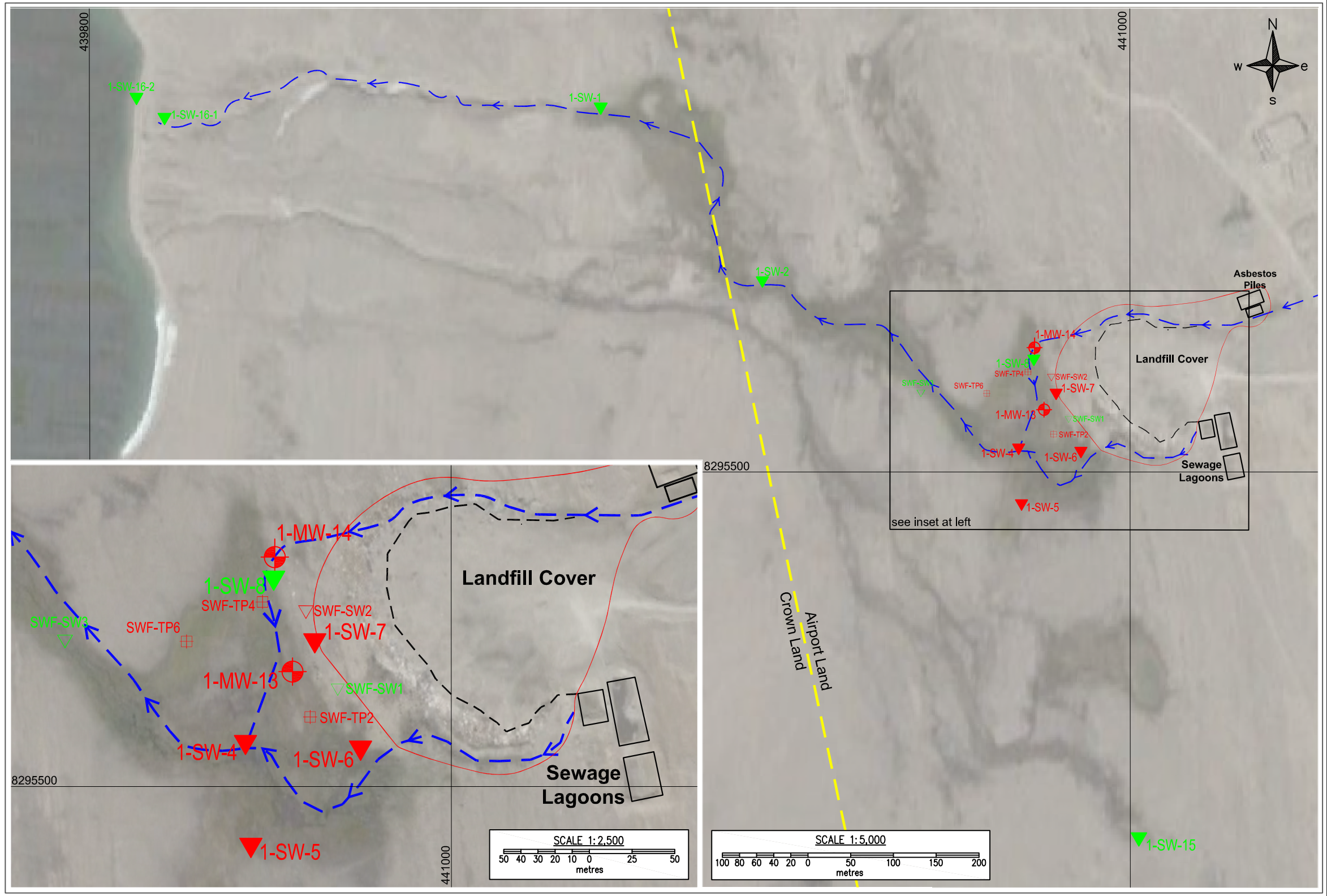
APEC ID	CCME AW (Freshwater)	APEC 1
Station ID		SWF-SW2
Field label		SWF-SW2
Date/Time		-
Sampled By		JWEL 2006
Lab report ID		-
Metals		
Cadmium	0.017	0.24
Copper	2-4*	10.9
Lead	7	472
Iron	300	66

* Copper guideline is hardness dependent - see Appendix I

GROUNDWATER

APEC ID	CCME AW (Freshwater)	APEC 1	APEC 1
Station ID		1-MW-13	1-MW-14
Field label		1-MW-13	1-MW-14
Sampled By		FRANZ 2009	FRANZ 2009
Date/Time		22-Aug-09	22-Aug-09
Lab report ID		A9A9979	A9A9979
Metals			
Iron	300	1100	1100
PAHs			
Naphthalene	1.1	5.2	

APEC ID	CCME AW (Freshwater)	APEC 1	APEC 1	APEC 1
Station ID		SWF-TP2	SWF-TP4	SWF-TP6
Field label		SWF-TP2	SWF-TP4	SWF-TP6
Sampled By		JWEL 2006	JWEL 2006	JWEL 2006
Date/Time		-	-	-
Lab report ID		-	-	-
BTEX/PHCs				
Fraction F2	1100	9600	-	-
Toluene	2	13.1	-	-
Metals				
Cadmium	0.017	-	-	0.07
Copper	4	5	-	-
Lead	7	23.6	-	-
Iron	300	-	391	-



LEGEND

- Landfill Extent
- Airport Property Boundary
- Surface Water & Direction of Flow
- Top Edge of Landfill
- FRANZ surface water sample (2009); compliant with CCME guidelines
- FRANZ surface Water sample (2009); exceeds CCME guidelines
- FRANZ groundwater sample (2009); exceeds CCME guidelines
- FRANZ groundwater sample (2009); compliant with CCME guidelines
- JWEL groundwater sample (2006); compliant with CCME guidelines
- JWEL groundwater sample (2006); exceeds CCME guidelines
- JWEL surface water sample (2006); compliant with CCME guidelines
- JWEL surface water sample (2006); exceeds CCME guidelines

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
Jacques Whitford (JWEL) analytical results for water are in ug/L
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Airport boundary derived from 2009 Official Site Survey (Appendix F)
CCME Water Quality Guidelines for the Protection of Aquatic Life (2009)
FRANZ (2009) analytical results for water are in ug/L
and can be found in Appendix H & I

Title: APEC 1 - Analytical Results for Surface Water & Groundwater

FRANZ ENVIRONMENTAL INC.
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Scale: See figures for scale

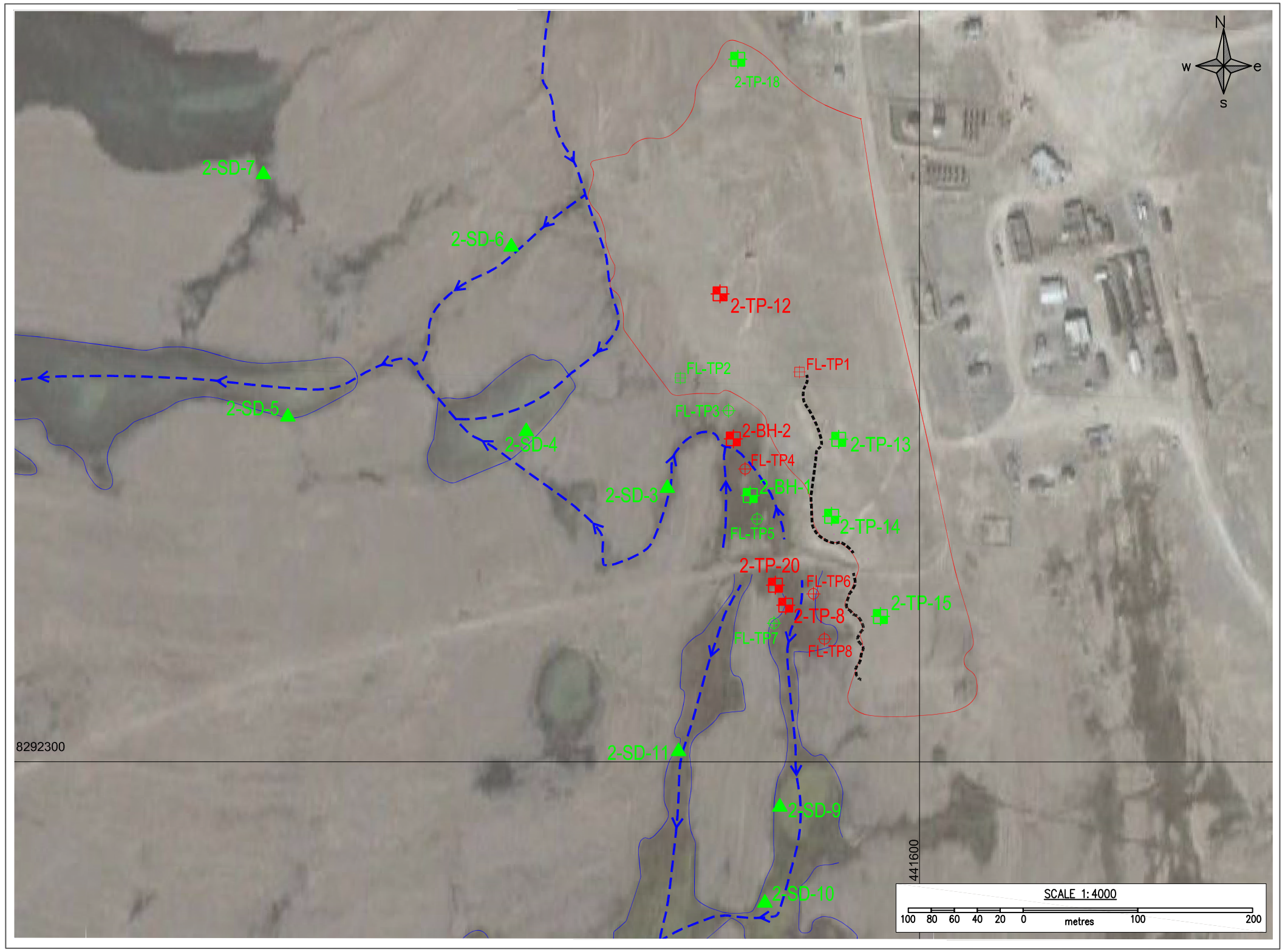
FIGURE 6

1747-0901/CAD/Resolute Bay ESA Feb 25/10

SOIL

Station ID	CCME Soil RL/PL (coarse, surface)	CCME Soil CL (coarse, surface)	2-MW-2	2-TP-12	2-TP-20	2-TP-20
Field label			2-BH-2	2-TP-12	2-TP-20	FR-6
Duplicate ID					FR-6	2-TP-20
Sampled By			FRANZ 2009	FRANZ 2009	FRANZ 2009	FRANZ 2009
Date			15/Aug/09	15/Aug/09	20/Aug/09	20/Aug/09
Lab report ID			A9A8737	A9A7367	A9A9979	A9A9979
Depth (m)			0.05 – 0.64	0.6 – 1.2	0.1 – 0.6	0.1 – 0.6
BTEX						
Benzene	0.03	0.03	0.037	0.69	0.056	0.051
Ethylbenzene	0.082	0.082	0.053	0.70	0.085	0.087
Toluene	0.37	0.37	0.12	1.4	0.19	0.17

Station ID	CWS for PHC		2-TP-8	FL-TP1	FL-TP4	FL-TP6	FL-TP8
Field label	Residential / Parkland (coarse, surface)	Commercial (coarse, surface)	2-TP-8	FL-TP1	FL-TP4	FL-TP6	FL-TP8
Sampled By			FRANZ 2009	JWEL 2006	JWEL 2006	JWEL 2006	JWEL 2006
Date			15/Aug/09	-	-	-	-
Lab report ID			A9A7367	-	-	-	-
Depth (m)			0.1 – 0.6	-	-	-	-
PHCs							
F2 (C10-C16)	150	260	6100	528	-	3780	2110
Metals							
Copper	63	91	-	-	851	-	-
Zinc	250	360	-	-	385	-	-



LEGEND

- Landfill Extent
- Airport Property Boundary
- Surface Water Body
- Surface Water Flow
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- FRANZ soil sample (2009); exceeds CCME guidelines
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- FRANZ sediment sample (2009); exceeds CCME guidelines
- JWEL soil sample (2006); compliant with CCME guidelines
- JWEL soil sample (2006); exceeds CCME guidelines
- JWEL borehole sample (2006); compliant w/ CCME guidelines
- JWEL borehole sample (2006); exceeds CCME guidelines

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
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Airport boundary derived from 2009 Official Site Survey (Appendix F)
CCME Soil Guidelines for commercial land use (coarse soil)
CCME Interim Sediment Quality Guidelines (ISQG, 2009)
FRANZ (2009) analytical results for soil and sediment are in ug/g
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Title: APEC 2 - Analytical Results for Soil and Sediment

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Scale: 1 : 4,000

FIGURE 7

1747-0901/CAD/Resolute Bay ESA Feb 26/10

FRANZ (2009) SURFACE WATER

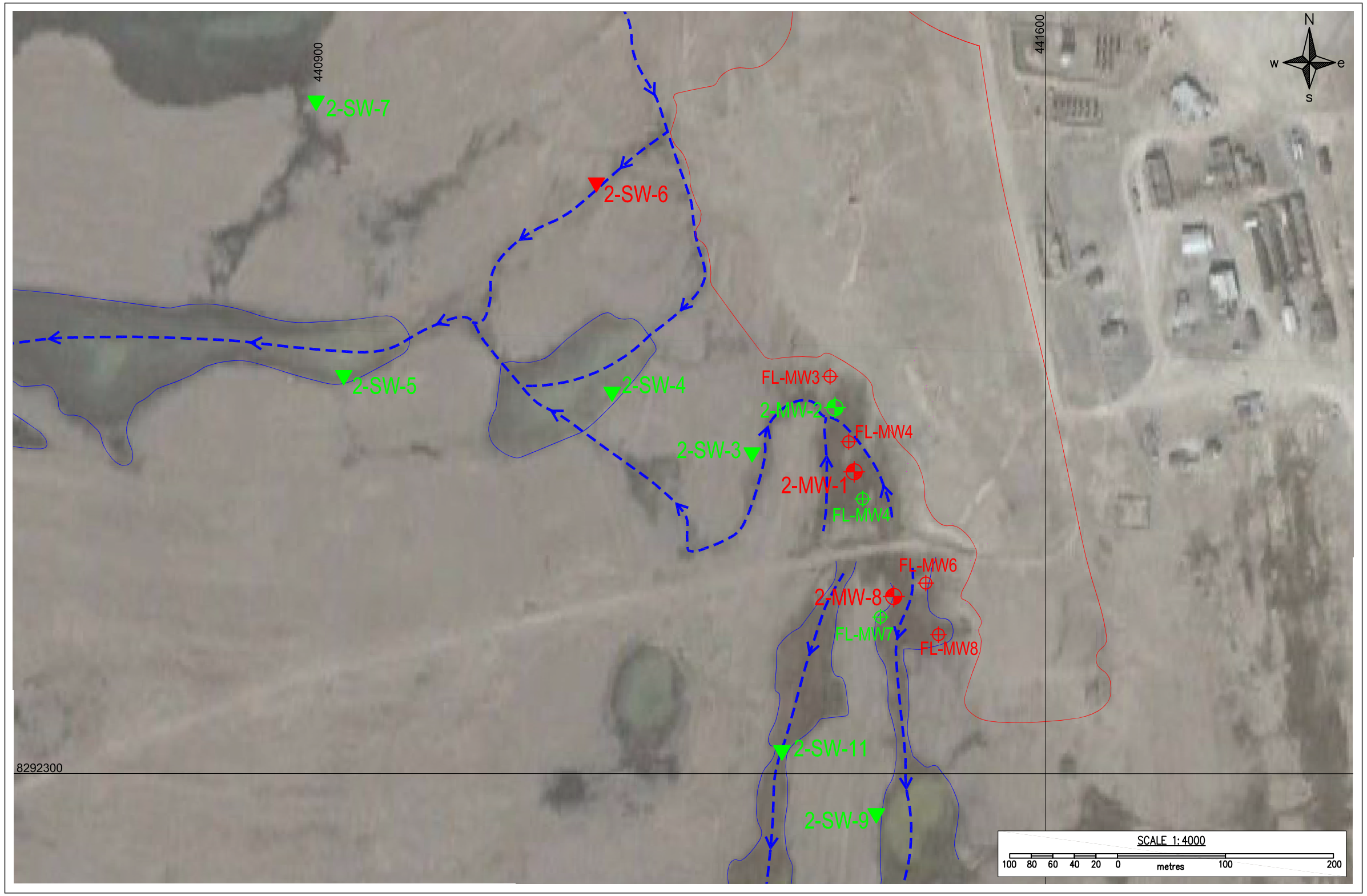
APEC ID	CCME AW (Freshwater)	APEC 1	APEC 1
Station ID		2-SW-6	2-SW-17
Field label		2-SW-6	2-SW-17
Sampled By		FRANZ 2009	FRANZ 2009
Date		18-Aug-09	18-Aug-09
Lab report ID		A9A8511	A9A8632
Aluminum	5	12	9

FRANZ (2009) GROUNDWATER

APEC ID	CCME AW (Freshwater)	APEC 1	APEC 1
Station ID		2-MW-1	2-MW-8
Field label		2-MW-1	2-MW-8
Sampled By		FRANZ 2009	FRANZ 2009
Date		22-Aug-09	22-Aug-09
Lab report ID		A9A9979	A9A9979
Metals			
Cadmium	0.017	0.1	0.1
BTEX & PHCs			
Toluene	2	<0.2	17.0
PAHs			
Naphthalene	1.1	0.15	39.00

JWEL (2006) GROUNDWATER

APEC ID	CCME AW (Freshwater)	APEC 1	APEC 1	APEC 1	APEC 1
Station ID		FL-MW3	FL-MW4	FL-MW6	FL-MW8
Field label		FL-MW3	FL-MW4	FL-MW6	FL-MW8
Sampled By		JWEL 2006	JWEL 2006	JWEL 2006	JWEL 2006
BTEX/PHCs					
Toluene	2				79.1
Metals					
Aluminum	5		8		
Cadmium	0.017	0.02		0.02	
Copper	4		5		



LEGEND

- Landfill Extent
- Airport Property Boundary
- Surface Water Body
- Surface Water Flow
- FRANZ surface water sample (2009); compliant w/ CCME guidelines
- FRANZ surface water sample (2009); exceeds CCME guidelines
- FRANZ groundwater sample (2009); compliant with CCME guidelines
- FRANZ groundwater sample (2009); exceeds CCME guidelines
- JWEL groundwater sample (2006); compliant w/ CCME guidelines
- JWEL groundwater sample (2006); exceeds CCME guidelines

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
Jacques Whitford (JWEL) analytical results for water are in ug/L and are shown for comparison purposes only
For more detail, see the Jacques Whitford (2006) report
Airport boundary derived from 2009 Official Site Survey (Appendix F)
CCME Water Quality Guidelines for the Protection of Aquatic Life (2009)
FRANZ (2009) analytical results for water are in ug/L and can be found in Appendix H & I

Title:
APEC 2 - Analytical Results for Surface Water & Groundwater

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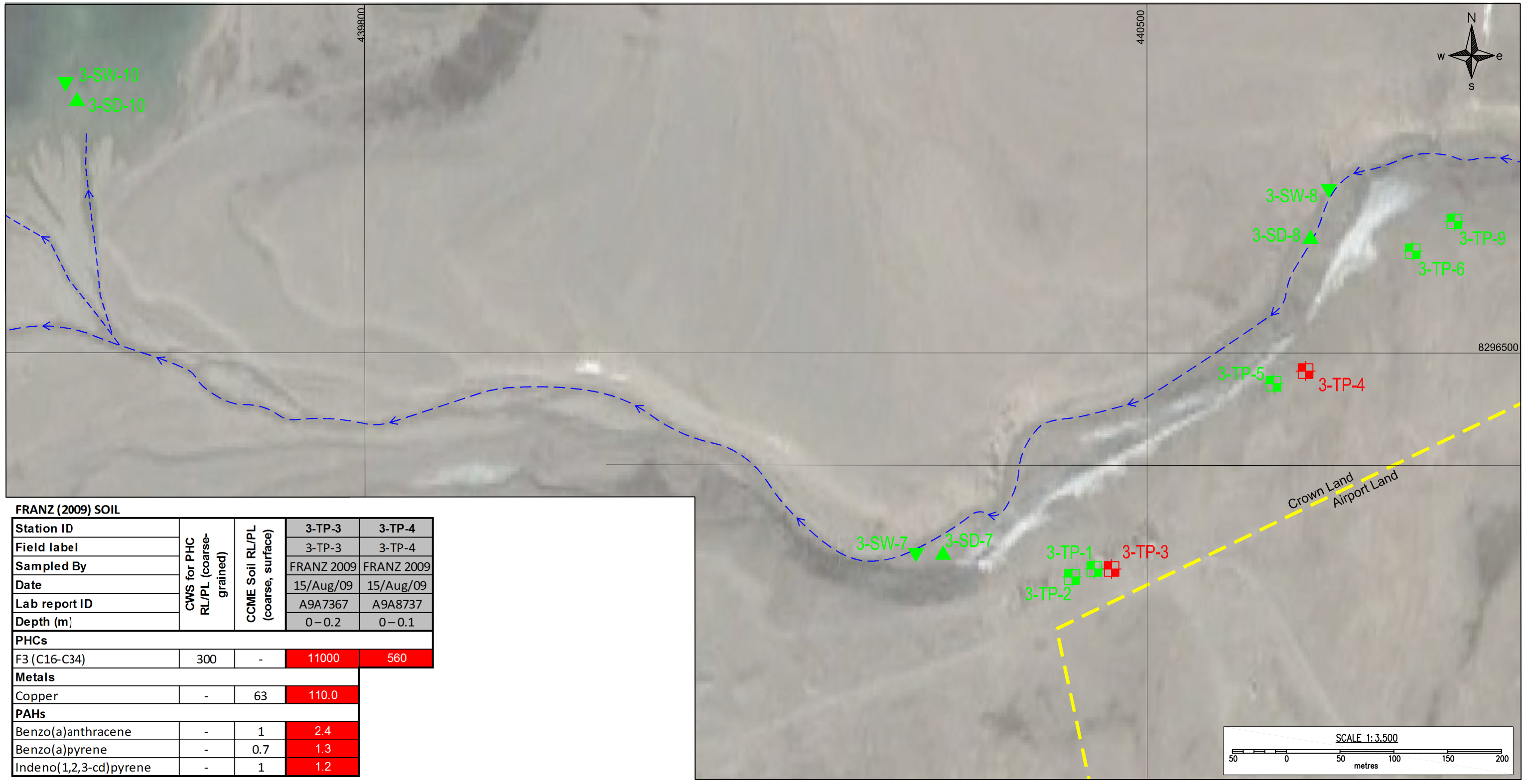
TRANSPORT CANADA

Scale:
1 : 4,000

FIGURE 8

1747-0901/CAD/Resolute Bay ESA Feb 26/10



FRANZ (2009) SOIL

Station ID	CWS for PHC RL/PL (coarse-grained)	CCME Soil RL/PL (coarse, surface)	3-TP-3	3-TP-4
Field label			3-TP-3	3-TP-4
Sampled By			FRANZ 2009	FRANZ 2009
Date			15/Aug/09	15/Aug/09
Lab report ID			A9A7367	A9A8737
Depth (m)			0 – 0.2	0 – 0.1
PHCs				
F3 (C16-C34)	300	-	11000	560
Metals				
Copper	-	63	110.0	
PAHs				
Benzo(a)anthracene	-	1	2.4	
Benzo(a)pyrene	-	0.7	1.3	
Indeno(1,2,3-cd)pyrene	-	1	1.2	

LEGEND

- Landfill Extent
- Airport Property Boundary
- Surface Water Flow
- FRANZ (2009) Soil Sample (TP); compliant with CCME guidelines
- FRANZ (2009) Soil Sample; exceeds CCME guidelines
- FRANZ (2009) Sediment Sample (SD); compliant with CCME guidelines
- FRANZ (2009) Surface Water Sample (SW); compliant with CCME guidelines

References:
Google Earth satellite image, 2009
Site locations based on dGPS coordinates (UTM - NAD 83)
Airport boundary derived from 2009 Official Site Survey (Appendix F)
CCME Soil Guidelines for residential land use (coarse soil)
FRANZ (2009) analytical results for soil and sediment are in ug/g and can be found in Appendix H & I

Title:
APEC 3 - Analytical Results for Soil, Sediment, Surface Water

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Scale:
1 : 3,500

FIGURE 9

1747-0901/CAD/Resolute Bay ESA Feb 26/10