FRANZ ENVIRONMENTAL INC.
◆ CONSULTING ◆ ENGINEERING ◆ TECHNOLOGIES ◆

# FIELD REPORT - PHASE III ENVIRONMENTAL SITE ASSESSMENT VEHICLE DUMP AND COMMUNITY LANDFILL, IQALUIT, NUNAVUT

**DRAFT REPORT**

Prepared for:
Public Works & Government Services Canada
800 Burrard Street
Vancouver, BC
V6Z 2V8

On behalf of Transport Canada

Prepared by:
Franz Environmental Inc.
308-1080 Mainland Street
Vancouver, BC
V6B 2T4

Project No. 1584-0901
January 2010

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# VEHICLE DUMP AND COMMUNITY LANDFILL, IQALUIT, NUNAVUT

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# EXECUTIVE SUMMARY

## TABLE OF CONTENTS

**List of Figures:**

**List of Tables (in text):**

**Tables (Appendix A)**

**List of Tables :**

**Soil**

**Surface Water**

**Sediment**

**Vegetation**

**Materials**

**List of Appendices:**

## 1.0 INTRODUCTION

Franz Environmental Inc. (FRANZ) was retained by Public Works and Government Services Canada (PWGSC) and Transport Canada (TC), Prairie & Northern Region and Environmental affairs Division to complete a Phase III Environmental Site Assessment (ESA) of the Vehicle Dump/Community Landfill, Iqaluit, Nunavut (**Figure 1**).

This project was completed based on FRANZ proposal, P-2962, dated July, 2009 which followed the tasks outlined in PWGSC/TC's Terms of Reference (ToR), dated June, 2009.

### 1.1 Purpose and Project Objectives

The purpose of this project was to undertake a Phase III Environmental Site Assessment (ESA) at the Vehicle Dump and Community Landfill located adjacent to the Iqaluit Airport. Transport Canada will use this report to demonstrate due diligence and reduce liabilities in order to remediate/risk manage the site to an acceptable level. The purpose of this Phase III ESA was to determine the current environmental and physical conditions, including a detailed assessment of the site with respect to soil, sediment, surface water and vegetation targeting the Landfill Site, which has been divided into four Areas of Environmental Concern (AECs).

AEC 1 – Upgradient Buried Debris
AEC 2 – Vehicle Dump
AEC 3 – Main Landfill
AEC 4 – Downgradient, Off-site

### 1.1.1 Objectives

To accomplish this goal, the objectives included the following:

1. Develop a sampling plan for the collecting soil, sediment, water, vegetation, and hazardous materials to obtain sufficient data for the completion of a Phase III ESA;
2. Conduct a site investigation to:

    - Identify, document, sample, delineate and quantify actual and potential environmental impacts to soil, sediment, surface water, groundwater, and vegetation;
    - Identify, document, sample, delineate and quantify potentially hazardous materials;
    - Identify, document, sample and quantify non-hazardous wastes, including buried or partially buried wastes;
    - Identify and document physical hazards; and
    - Identify and document relevant site conditions and observations.

3. Produce a site visit progress report after the completion of the field visit. The progress report included a summary of field observations, limitations encountered during the site investigation, and analytical budget update;
4. Produce a Phase III ESA Report for the site based on previous Phase I/II ESA reports;
5. Provide recommendations for future assessment (Phase IIIA) and remediation activities where warranted for the site;

To accomplish this goal, the objectives included the following:

- Obtain representative soil, water, sediment, and vegetation samples in the four AECs; and
- Determine the source, type, and nature of contamination in soil, surface water, sediment, and vegetation.

## 1.2 Site Features and Background

Iqaluit (formerly named Frobisher Bay) is located on the southern tip of Baffin Island (**Figure 1**). Prior to July 1, 1995 Iqaluit Airport was owned by the Government of Canada and operated by the Quebec Region of the Department of Transport. From July 1, 1995 until April 1, 1999 the airport was owned by the Government of Northwest Territories and operated by the Arctic Airports Division of the Department of Transportation. Since April 1, 1999 the airport has been owned by the Government of Nunavut (GN) and operated by the Nunavut Airports Division of the Nunavut Department of Community Government, Housing and Transportation.

The Hudson’s Bay Company set up a trading post along the shores of Frobisher Bay in 1914. Much of the development of the community occurred as a result of both World War II and the Cold War. Between 1941 and 1945 the United States Air Force (USAF) occupied this region as it served as an air base in the North Atlantic Ferry Route to supply Europe during WWII. In the summer of 1942, 550 personnel and 15,000 tons of equipment were shipped to Iqaluit. In 1943 the airport runway was completed and over 300 airport arrivals were recorded. The site was never used as a ferry route and the US military left Iqaluit in 1945. In 1952, construction of the Distant Early Warning (DEW) Line sites began. The US Military returned and used Iqaluit as a Strategic Air Command Base and one of the stations of the Pole Vault communication systems. The site was also used as a major trans-shipment, communications, and construction center for the establishment of the eastern sites of the DEW line (Härtling, 1988).

The study area is located at the West 40 area on the border of Sylvia Grinnell Park and the Sylvia Grinnell River, 1.7 km southwest of the City of Iqaluit. USAF used this site from between 1955 to 1963 as a metal dump for vehicles, truck bodies, barrels and scrap metal. The majority of materials were deposited in 1963 when the US Military left Frobisher Bay. Shops, buildings, and other materials were simply bulldozed over the cliff. The cliff is a bedrock outcrop rising approximately 50 m above the tidal area where the Sylvia Grinnell River meets Frobisher Bay. The area to the north side of the slope was used by the USAF and the community of Iqaluit as a landfill site for household garbage until sometime in the 1970's.

## 1.3 Previous Environmental Investigations

Environmental investigations have previously been carried out including chemical analysis of selected media and a volume estimate of metal waste.

Any reference to specific documents is clearly documented in this report. Significant reports for this study include:

- Avati Ltd., 1993. Remediation Options For an Abandoned US Airforce Base and Two Waste Sites at Iqaluit, NWT. October 1993.
- Earth Tech Canada Inc., 2001. Desk Top Review of Scrap Metal Dump Site West of Iqaluit Airport, Iqaluit, Nunavut, Canada. Prepared for Transport Canada, Prairie and Northern Region-Programs.
- Härtling, J., 1988. PCB and Trace Metal Pollution from a Former Military Waste Disposal Site at Iqaluit, Northwest Territories. Master's Thesis.
- Peramaki, L.A and J.D. Decker, Lead in Soil and Sediment in Iqaluit, Nunavut, Canada and Links with Human Health, Environmental Monitoring and Assessment, 63: 329 – 339, 2000.
- Public Works Canada Literature Review, 1992.
- Royal Military College – Environmental Sciences Group, Victoria, BC, 1995. Environmental Study of a Military Installation and Six Waste Disposal Sites at Iqaluit, NWT. Prepared for Department of Indian and Northern Affairs Canada & Environment Canada.
- Franz Environmental Inc., 2009. Phase I/II Environmental Site Assessment, Vehicle Dump and Community Landfill, Iqaluit, Nunavut. Prepared for Public Works and Government Services Canada on behalf of Transport Canada. February, 2009.

## 1.4 Project Team

This project was undertaken by a multi-disciplinary team. Key individuals and their respective roles are summarized below:

- Richard Wells, P.Eng., Project Manager
- Steve Livingstone, M.Sc., P.Geo(I), Senior Hydrogeologist, Reviewer
- Ryan Fletcher, C.Tech, CEPIT, Environmental Technician
- Julie Dittburner, BSc, Dipl. Tech, Project Scientist

## 1.5 Report Format

The Phase III ESA report presented herein is structured as follows:

***Chapter 1 – Introduction:*** Provides general background information, and outlines the scope and objectives of this study.

***Chapter 2 – Study Area Characteristics:*** Describes the site overview, current land use, and climatic conditions.

***Chapter 3 – Physical Site Characteristics:*** Describes the regional and physical setting of the site and general site characteristics.

***Chapter 4 - Historical Review:*** Summarizes the historical conditions of the property based on the various sources such as air photos, maps and other studies completed on the site.

***Chapter 5 – Regulatory Review and Environmental Quality Guidelines:*** Presents the evaluation guidelines used for the assessment of chemical impacts and provides context to the use of certain environmental quality guidelines used for assessing impacts and screening chemicals of concern.

***Chapter 6 – Supplemental Field Investigation:*** Presents the methodology, level of effort and details of the field investigation.

***Chapter 7 – Chemical Distributions and Impacts:*** Presents an evaluation of the chemical impacts and distributions of contaminants detected at levels exceeding Environmental Quality Guidelines in the areas of concern.

## 2.0 STUDY AREA CHARACTERISTICS

### 2.1 Site Overview

Solid waste disposal both from military activities and the community itself have resulted in the creation of several landfill sites. Historically, the subject site has been referred to as Sylvia Grinnell Park Dump and West 40 – Dump Site # 1. For the purpose of this report, the subject property will be referred to as the Vehicle Dump and Community Landfill or simply "site".

As shown in **Figure 2**, the study area is divided into two distinct areas:

The main debris/community landfill area, which includes exposed metal debris. A portion of the waste including 45 gallon drum dumps are located at the toe of the bedrock escarpment; and the vehicle dump approximately to the south and parallel with the main landfill

The landfill site is situated on the slope of an escarpment leading to the Sylvia Grinnell River and has several shallow ravines and coulees partially filled with metal debris. The debris is scattered over a large area and consists of vehicles, equipment, barrels, and scrap metal. Areas of concern include the low areas within the ravines, containing the scrap metal; the base of the escarpment; and the soft bog area where the barrels are stockpiled at the base of the escarpment.

Also, as shown in **Figure 2**, the study area is further divided into four AECs:

**AEC 1 – Upgradient Buried Debris**
The area of the landfill directly upgradient from the vehicle dump contained buried metal debris identified during the Phase I/II ESA.

**AEC 2 – Vehicle Dump**
The second area of concern is the vehicle dump located in the drainage feature to the east of the main Landfill area. This area is composed of vehicles, such as trucks, cars, trailers, boilers, tankers, and others. A drainage channel runs directly through the center of this debris pile discharging to the ponds, then the river.

**AEC 3 – Main Landfill**
The third area is the main landfill area consisting of a mixture of debris spread across a steep graded bedrock slope. The top of the landfill area has been capped with granular material and the toe is left exposed with debris scattered throughout the area.

**AEC 4 – Downgradient, Off-site**
The fourth AEC is comprised of the downgradient area and areas within Sylvia Grinnell Park. All downgradient and off-site sampling locations were given a separate sampling

nomenclature in order to clearly differentiate their results from those of the on-site sampling locations.

## 2.2 Current Use of the Landfill Sites and Adjacent Lands

Due to the remote location of the landfill, current use of the site is minimal. Deposition of landfill waste has been discontinued. Local residents occasionally use the site for dumping personal waste and as an access point to Silvia Grinnell Park. The Sylvia Grinnell River is located on the southern side of the landfill site (see **Figure 2**).

Sylvia Grinnell Territorial Park, the oldest of Nunavut's territorial parks borders the site to the north-western extent. Sylvia Grinnell Park is divided in two by the Sylvia Grinnell River. The park plays a vital role in the community of Iqaluit by providing an important fishing ground for Arctic Char.

## 2.3 Current Permit Information and Future Land Use

FRANZ understands that there are no current plans for the use of the property. The property remains undeveloped and part of Transport Canada's inventory of sites. A request put in to INAC mining records department, on November 17, 2008, to search for past and present mineral claims on the property turned up negative. No land claims have been made on the subject property.

## 2.4 Climate

Iqaluit is located within an arctic climatic zone despite being well outside of the Arctic Circle. The average daily temperature range is -28°C to 7.7 °C. The area is characterized by very cold winters and short summers that permit the growth of very small, stunted trees. The average monthly temperature is below freezing for eight months of the year. The average annual precipitation is 412.1 mm, which is much wetter than many other localities in the Canadian Arctic islands. There is 198.3 mm annual rainfall and 235.8 mm annual snowfall (www.climate.weatheroffice.ec.gc.ca).

## 2.5 Natural Environment – Overview

The landfill site covers an area of approximately 72,500 $m^2$. Iqaluit lies within the low arctic tundra zone, which is ecologically sensitive. The area is underlain by continuous permafrost. Soils are nutrient-poor, silty, shallow and have little, if any profile development (Peramaki and Decker, 2000). The topography, structural geology and drainage of the study area follow a northwest-southeast trend. Ground cover is a combination of black, silty sand with organic soil, bedrock outcrops, grass and lichens.

Sylvia Grinnell Park is also home to Arctic Hare, Arctic Fox, Caribou, lemmings and other small mammals. Polar Bear have even been sighted on occasion, although they do not frequent the area. The park also plays a significant role in bird migration and over 40 species have been recorded in the park at different times of the year. The park is also the most southern breeding ground for the Ringed Plover. The local vegetation above and below the cliff consists of wet grassland tundra species including mosses, grasses and sedges. On the cliff and bedrock outcrops vegetation is sparse and consists of lichens with patches of grasses and mosses.

# 3.0 PHYSICAL SITE CHARACTERISTICS

## 3.1 Regional and Local Topography

The study area is characterized by rolling terrain that slopes towards the Sylvia Grinnell River. The bedrock over which the metal debris was dumped is approximately 30 m above the River valley. Local terrain consists mainly of bare rocky outcrops with a thin layer of glacial and marine sediments in low lying areas between outcrops.

The elevation of the landfill site is approximately 20 to 30 metres above sea level (m asl) and the Sylvia Grinnell River is at approximately 0 to 5 m asl (http://atlas.nrcan.gc.ca).

## 3.2 Regional and Local Drainage

The Sylvia Grinnell River is the principal drainage system in the region which discharges into Frobisher Bay. The river is influenced by the tidal action of the ocean which has some of the largest tides in Canada. The river is a major migratory route for Arctic Char.

The natural drainage around the study area is influenced by the bedrock structure and numerous small, elongated ponds that have formed along fault lines and joints. The ponds are shallow (approximately less than 0.5 m deep), and are poorly drained. The high ratio of sediment surface to pond volume allows maximal exchange between the sediment and the water. In the winter, the ponds are frozen to the bottom. There are four large ponds and two smaller ponds. There are small intermittent drainages that join these water bodies (See **Figure 2**).

### 3.2.1 Tidal Influx

Coastal areas, including Iqaluit, are affected by tidal cycles generating a low and high tide events bi-daily (approximately every 12.5 hours). The water located within three (3) of the ponds onsite are considered brackish marine estuaries. Water within these ponds (Ponds 1, 3, and 4) are intruded with saline water twice daily during high tide. **Figure 3** indicates the water level during the high tide events.

### 3.2.2 Pond Systems

**Pond 1** is located adjacent to the river and is fed from the southeast and north. From the southeast side feed, a metallic sheen in the water and orange staining along the shoreline and water bed was observed. The flow rate is low but sourced directly below the west end of the landfill. The north side feed is of medium flow rate, also with a metallic sheen and orange staining. This north side feed discharges from Pond 2. Surface sediments in Pond 1 consisted of mainly orangey, decomposed organic matter mixed with fine black sand. This pond has a discharge into the river with a measured flow rate of 1.10 L/s. Pond 1 is directly affected by the tidal influx and is flushed twice daily with brackish sea water, therefore classifying the pond as a marine estuary.

**Pond 2** appears to be fed from the southeast and northeast by slow groundwater discharge seeps possibly through fractured bedrock. Minor orange staining was observed around the shoreline and debris was present in the pond (tires). The pond is approximately 1 to 1.5 m deep. The pond discharges to the south towards Pond 1. A measured flow rate of 0.60 L/s from Pond 2 into Pond 1 was observed. Sediments in Pond 2 consist of fine brown sand mixed with a thin top layer of decomposed organic matter. Tidal influx does not affect this pond.

**Pond 3** is directly down-gradient from the main landfill site. Two gullies are present on the northeast side that would direct rain water and overland flow into the pond. A feed on the northeast side was observed in a flat, low lying area. The discharge is from the southwest corner and is only visibly active during tidal events. Surface sediments in Pond 3 consisted of brown to black decomposed organic matter mixed with brown and black fine sand. Pond 3 is directly affected by the tidal influx and is flushed twice daily with brackish sea water, therefore classifying the pond as a marine estuary.

**Pond 4** is at a slightly lower elevation than Pond 3 and seemingly not connected hydraulically. It is located downstream of the landfill with a high recharge from the vehicle dump area. The main inflow point into Pond 4 had a measured flow rate of 0.90 L/s. Discharge is from the southwest corner of the pond into several small intermittent ponds before discharging to the river. Surface sediments in Pond 4 consisted of black to dark grey fine sand with trace decomposed organic matter. Pond 4 is directly affected by the tidal influx and is flushed twice daily with brackish sea water, therefore classifying the pond as a marine estuary.

**Pond 5** was also observed to have orange staining along the shoreline. It is located upgradient of Pond 4, approximately 85 m southwest of the vehicle dump. Pond 5 is heavily vegetated with grasses and contains thick sediment in comparison to the larger ponds (Pond 1, 2, 3, and 4). The flow was measured in the small channel draining into Pond 5 from Pond 6 at a rate of 2.50 L/s. Discharge from the SW side of Pond 5 drains into Pond 4. Tidal influx does not affect this pond.

**Pond 6** is located below the escarpment, directly below the vehicle dump. Seeps are present primarily from the north (from vehicle dump), with small seeps from the east and west. Pond 6 is also heavily vegetated with grasses and contains thick sediment in comparison to the larger ponds (Pond 1, 2, 3, and 4). The channel draining directly from the vehicle dump (escarpment) area had a measured flow rate of 0.70 L/s. The flow rate at the discharge point from Pond 6 into Pond 5 was 2.40 L/s. The inflow of surface water and groundwater from the surrounding higher elevations accounts for the increase in discharge at the outflow of Pond 6. Sediments in both Ponds 5 and 6 consisted of 50% decomposed black organic matter and 50% black fine sand. Tidal influx does not affect this pond.

The up gradient area, known as AEC2 - Vehicle Dump, has a large catchment area that drains towards the escarpment eventually reaching the down gradient ponded areas. Six flow rates were measured within the major drainage channel that runs from the roadway, through the vehicle dump and down the escarpment into Pond 6. The low lying, upper portion of the vehicle dump with little elevation change had an average measured flow rate of 0.55 L/s. The lower portion of the vehicle dump just up gradient of the escarpment had a greater elevation change. The average measured flow rate here was 2.45 L/s. These flow rates are influenced by an increase of surface water runoff and elevation change at the sample locations.

## 3.3 Geological Characterization

### 3.3.1 Regional Bedrock Geology

The southern portion of Baffin Island consists of primarily Precambrian Canadian Shield crystalline rocks. The regional bedrock geology in the study area is part of the Churchill Structural province. The bedrock in the study area is from the Aphebian Era and consists of a variety of metamorphic rocks. Quartz-feldspar-gneissic rocks are the predominant facies in the area around Iqaluit (Härtling, 1988).

The structural geology follows the general northwest – southeast trend of the area. The northwest – southeast aligned fault system in southern Baffin Island were the result of the Upper Cretaceous and early Tertiary rifting associated with the spreading in the Baffin Bay and Davis Strait. The study area lies at the boundary between the Frobisher Bay graben and the Hall Peninsula horst, and the cliff line and the bedrock outcrops follow the overall trend. This structural feature greatly impacts the migration of contaminants from the waste disposal site (Härtling, 1988).

### 3.3.2 Regional Surficial Soils

The major landforms developed along lines of weakness related to the Upper Cretaceous to Tertiary faulting and along pre-existing draining systems. During the Cenozoic, the area was affected by several glacial advances and retreats. Glacial ice streams flowed southeastward along the Sylvia Grinnell valley and surrounding areas. The landscape was developed during deglaciation when glacial, glaciofluvial and glaciomarine processes dominated (Mode and Jacobs, 1987). Following glacial retreat of the Frobisher Bay outlet glacier past the study area, the Sylvia Grinnell valley was covered by marine waters until approximately 2 – 3,000 years ago. This would limit the time for modern soil development in the area downslope of the lower cliff line. The area above the cliff line became free of marine influence approximately 5,000 years ago and thus had a longer time for soil development. This time would be too short for substantial bedrock weathering, thus reducing the influence of the bedrock geochemistry on the overlying soils. Both areas would be subject to fluvial and colluvial processes. The predominant weathering process would be mechanical disintegration by differential thermal expansion, frost action and salt weathering in the Sylvia Grinnell estuary (Härtling, 1988).

The shallow soils observed on the site were primarily black sands with some gravel and silts. The soil would have been deposited during glaciation (till) and by marine deposition (silts).

### 3.3.3 Local Scale Geology

The surficial geology in the region has been described as a thin layer of silty sand with trace to some gravel. The soil is dark brown to black with a high organic content and the presence of rootlets. Bedrock was encountered between 0.8 to 1.6 m bgs (Area 1); 0.1 m bgs (Area 2); between 0.1 and 0.4 m bgs (Area 3); and between 0.3 to 0.8 m bgs (Area 4). Logs for the test pits completed by FRANZ are provided in **Appendix A, Tables A-1 and A-2**.

Grain size analysis was completed on soils and sediments in various locations across the site during the 2008 field investigation. Results of the grain size analysis indicate that both soils and sediments are considered course grained, with the majority of particle size falling in the 2.0mm - 0.063mm range. Detailed grain size data are provided in **Appendix A, Table A-3**.

## 3.4 Hydrogeological Characterization

### 3.4.1 Regional Hydrogeology

Overland flow is the primary mode of water transport in the area. Groundwater associated with fractures in the bedrock and through the thin overburden would be likely be minor. Groundwater is not used as a drinking water source in the area. The site lies within the continuous permafrost zone. Permafrost occurs when the ground remains at or below a temperature of $0^{o}C$ for a minimum of two years. Almost all the moisture in permafrost occurs in the form of ground ice. Within the continuous permafrost zone, permafrost underlies most types of terrain except rivers, lakes and newly consolidated soils, and is at depth under well–drained, coarse-grained landforms such as eskers and kames.

Based on the regional geology, and the presence of permafrost, the groundwater flow directions and velocities are likely complex and controlled by topography, surface water bodies and large faults and fracture zones. It is expected that the surface water bodies are expressions of the water table and are discharge zones for fractured bedrock.

### 3.4.2 Site Hydrogeology

The shallow soil and presence of bedrock did not allow for the installation of any monitoring wells. Groundwater flow on site is assumed to be southwest towards the Sylvia Grinnell River.

## 4.0 HISTORICAL OVERVIEW

Based on the available historical information, the Vehicle Dump and Community Landfill has had a varied history since the mid 1940s and the construction of the Iqaluit Airport. The known uses, from the past to present, are outlined as follows:

| **Site Use** | **Approximate Timelines** |
|---|---|
| 1. Vacant Land | 1930s to 1940s |
| 2. Airport Runway – End of the old airstrip terminated at this point. Actual site use remained vacant. | 1942/43 to late 1940s |
| 3. Landfill and Metal Dump | Late 1950s-Present |

The reader is referred to FRANZ (2009) for detailed site-specific historical review and evaluation details.

### 4.1 Historical Site Features and Overview

Based on a review of the available information, and the interpretation completed by Royal Military College – Environmental Sciences Group in 1995, the historical development is described as follows:

The Iqaluit Airport was constructed in the year of 1942-1943 in an effort by the joint effort of a United States and Canadian military initiative known as the "Crimson Route". This route was mandated as a flight path designed to ferry aircraft and equipment to Europe during World War II. The city of Iqaluit was formed as part of an airbase for military support purposes. Activities in Iqaluit eventually diminished with the end of the Second World War.

However, the spark of the Cold War inspired a resurgence of activity at the Iqaluit Airport and the City of Iqaluit as a whole. The main function of this new activity was the construction of the Distant Early Warning (DEW) Line, a series of radar stations stretching from Greenland on the Yukon-Alaska border. The Iqaluit Airport served as a base station for much of the construction activities in the eastern arctic region.

The study area was vacant from the conception of the airbase until a time between 1958 and 1964 as noted during aerial photographs review. According to Härtling, 1988; it is believed that the site was first used as a disposal facility in 1963. These dates concur with the United States Air Force (USAF) withdrawal from the area. The nature of the debris in the main landfill and scrap metal dump suggest that the USAF was likely responsible for depositing a large portion of the wastes currently found on the site.

The site was believed to be used for the disposal of small quantities of municipal waste from the town of Iqaluit in the 1960's, but was abandoned in the early 1970's in favour of the newly constructed Apex dump site. Upon closure of the site, it is believed that a cap consisting of granular material was placed on top and on the face of the landfill site to cover much of the debris (ESG, 1994). A few examples of municipal wastes disposed of at the site include food cans and bottles, kitchen appliances, bicycles, tires, wooden pallets, animal remains, water heaters, toys, etc.

The site has seen little activity since its abandonment in the 1970's. The site is now used as a location for burning of wood debris and a rogue dumping area for residents of the community (these types of activities were observed during the field investigation). Some residents occasionally scavenge the vehicle dump for parts and useful items.

## 4.2 Aerial Photographs

Aerial photographs (recent and historical) of the study area were obtained from the National Air Photo Library in Ottawa, Ontario. Historical land use changes as well as potential sources of environmental impacts observed from the photographs were noted.

Aerial photographs of the area taken in 1948, 1953, 1955, 1964, 1976, and 1985 were available and are presented in **Appendix C.** The following table 4-1 describes observations about current and historical land use for the subject property and surrounding properties that were noted during review of aerial photographs.

**Table 4-1**: Summary of Aerial Photographs

| Date | Roll # (Scale) | Review |
|---|---|---|
| 1948<br>1948/07/23 | A11535-43<br>(1:20,000) | The immediate area does not appear to be impacted by human activity at this point. No evidence of debris or disturbed land is present on the subject property.<br>The runway does not appear to be in use for aircraft at the time of the air photo. This is supported by the presence of debris and drums stacked in rows on the tarmac. One single roadway runs off the center of the runway heading east to the location of the current tank farm and municipal landfill.<br>Visible drainage patterns and water ponding appears to be unchanged with respect to the 2008 site visit observations and the Google (2008) satellite images. |

| Date | Roll # (Scale) | Review |
|---|---|---|
| 1952<br>1952/07/21 | A13519-343<br>(1:15,000) | The immediate area does not appear to be impacted by human activity at this point. No evidence of debris or disturbed land is present on the subject property.<br><br>The runway is not in use for aircraft at the time of the air photo. There is a large quantity of debris stacked in the center of the airstrip and a roadway is clearly visible down the center of the airstrip. No roadways or paths are visible extending from the southeast extent of the runway. One single roadway runs from the center of the runway heading east to what appears to be three large above ground storage tanks (likely the construction of the current tank farm area).<br><br>Drainage patterns on site appear in the same as those observed during the 2008 site visit. |
| 1955<br>1955/07/23 | A14869-3<br>(1:15,000) | The immediate area does not appear to be impacted by human activities. No evidence of debris or disturbed land is evident in the current position of the landfill.<br><br>The runway is no longer in use for aircraft. Large quantities of debris are present stacked in rows on the far southeast portion of the airstrip. Items visible include vehicles and drums. Vehicle tracks are visible north of the subject property in the marshy area. A small road is beginning off the southeast extent of the runway.<br><br>Drainage patterns on site appear in the same as those observed during the 2008 site visit. |
| 1964<br>1964/08/14 | VRR2618-195<br>(1:6000) | The main landfill area (APEC 3) is clearly impacted by dumping activities. The extents of the main landfill appear to coincide with the current landfill extents. The landfill does not appear to be capped and scattered debris is also visible throughout all landfill areas. The vehicle dump (APEC 2) area appears to be more centrally located in the drainage gully than was observed in this past field investigation (2008). The land surrounding the up gradient suspected dumping area (APEC 1) seems to be disturbed by heavy machinery. This is evidenced by many tracks crossing the tundra all throughout the area and clearly disturbed soil in parts of the area.<br><br>The runway appears to be completely decommissioned and a heavy roadway runs down the center of it. One rough roadway leads from the southeast extent to the vehicle dump and one defined roadway leads from the southeast extent to the main landfill area. |

| Date | Roll # (Scale) | Review |
|---|---|---|
| | | Drainage is difficult to see on this aerial photograph, but appears to be the same as that observed during the 2008 site visit. |
| 1976<br>1976/08/19 | A24492-70<br>(1:20,000) | The main landfill area (APEC 3) is clearly impacted by dumping activities. The extents of the main landfill appear to coincide with those observed during the 2008 site investigation. The vehicle dump (APEC 2) area appears to be more centrally located and not spread up the hillside as was observed during the field program. No evidence of dumping is noticeable in the up gradient (APEC 1) area.<br>The runway is no longer in use for aircraft and a defined roadway (in its current position) is seen down the center of the airstrip. One roadway runs off the far southeast end of the runway leading to the landfill area. One other, less defined, roadway also leads off the southeast extent of the airstrip and heads east across the marshy area and to the top of the adjacent hillside. A roadway also leads off to the west (also in its current position).<br>Drainage appears concurrent with 2008 observations. |
| 1985<br>1985/07/10 | A26763-22<br>(1:10,000) | Observations of the immediate area remain unchanged from the previous (1976) aerial photo.<br>The less defined roadway is now intermittent and does not appear to be in use. It appears that the tank farm has been expanded from the previous aerial photo reviewed.<br>Drainage appears concurrent with 2008 observations. |
| 2008 | Google Earth | Observations of the immediate area remain unchanged from the previous (1976 & 1985) aerial photos.<br>The less defined roadway is now gone and no evidence of its use exists. The tank farm appears in its current state.<br>Drainage is as observed during the 2008 site visit. |

After a review of the aerial photographs, it appears that the debris was stored for a period of time and then simply bulldozed off the cliff to lie in its current position. The aerial photographs confirmed that the landfill site was created between 1955 and 1964.

## 4.3 Previous Environmental Investigations and Outcomes

Numerous environmental investigations have been carried out including chemical analysis of selected media. To date, much of the work has focused on historical reviews and the potential for impacted soil and surface water with metals, polychlorinated biphenyls (PCBs), and to a lesser degree with petroleum hydrocarbons (PHCs), pesticides, and polycyclic aromatic hydrocarbons (PAHs).

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

**Härtling, 1988**

Sylvia Grinnell Park was the focus of a thesis paper written by Härtling, and Joachim Walter titled "PCB and Trace Metal Pollution from a Former Military Waste Disposal Site at Iqaluit, Northwest Territories". The purpose of Härtling's Thesis was to study the concentrations of PCBs and inorganics in soil, surface water, and sediments within the vicinity of the Sylvia Grinnell Landfill Site.

This thesis states that historical PCB sampling was completed in the fall of 1984 by the Environmental Protection Service. Two of the samples showed "significant" levels of Aroclor 1260 (actual concentration unavailable for review). PCB and inorganic elements in soil and sediments were sampled in the summer of 1987 for the purpose of producing the thesis paper.

It was found that soil concentrations of inorganic elements at the toe of the main landfill (APEC 3), namely arsenic and zinc, exceeded DCC Tier II levels (ESG, 1995). The Härtling thesis did not make comparisons against any specific environmental criteria. Elevated levels of PCBs were detected at the toe of the main landfill and below the vehicle dump site (APEC 2), these PCB levels ranged from 0.02 to 0.5 ppm (µg/g). One elevated (in comparison to the remainder of results) surface water sample was collected from an oily puddle and produced PCB concentrations of 11.1 ppb (µg/L); however, this sample is not expected to be representative of the average surface water conditions at the site.

PCB concentrations were found at minor concentrations in soil and sediments below the main landfill in the area directly impacted by landfill debris. PCB concentrations were also present in the surface sediments of the ponds directly down gradient of the main landfill area and the vehicle dump.

It was concluded that several series of parallel bedrock outcrops are limiting the migration of both PCB and inorganics in soils and surface waters within the site. Minor amounts of the contaminants of concern could be migrating to the River; however, these elements are in trace amounts.

**PWGSC, 1992**

Public Works and Government Services Canada, Pacific-Western Region, Manitoba Division conducted a literature review in 1992 titled “Literature Review on Abandoned and Waste Disposal Sites in the Iqaluit Area, Northwest Territories.” The review focused on all landfill sites around Iqaluit, but summarizes data obtained mainly by Härtling, 1988 on pages 6 and 7 of the review.

During the years of 1986-1989 DIAND initiated a cleanup of the area which included the removal of 97 pieces of electrical equipment and steel drums thought to contain PCBs. These items were removed from the site, stored in barrels in a concrete building near the landfill and then transported to the Ministry of Transport PCB storage facility at the airport. Drums from the landfill were also collected and piled in their current positions at the toe of the main landfill (APEC 3).

**Finley, C., 1992**

C. Finley from the University of Toronto reviewed the Avati report and the 1992 PWGSC literature review in a publication summary of the state of solid waste disposal in Iqaluit. No new information pertaining to the site was brought to light with this report.

**Avati, 1993**

Avati Ltd. completed an environmental assessment on Sylvia Grinnell Dump site in 1993 (volume 1993a). During this investigation, four surface water samples and 14 soil samples were collected. Inorganic elements were tested in 11 of the soil samples, none of which exceeded the CCME Residential/Parkland (R/P) criteria at that time. Three of the water samples contained concentrations of inorganic elements that exceeded the CCME FAL criteria at that time. Avati Ltd. also completed a remedial options analysis (volume 1993b). This volume of their report did not address the above mentioned exceedances.

PCBs were detected and exceeded the CCME R/P Remediation Criteria at that time in three soil samples collected during the 1993 investigation.

Remedial options presented included:

- Excavating all debris, sorting, and shipping south all materials or
- Excavating all debris, sorting, and shipping only hazardous materials south and burying remaining debris in local landfill facility.

### ESG, 1995

Royal Military College, Environmental Services Group (ESG) conducted an environmental site assessment of the site in 1995. Eight soil samples, one surface water sample, three vegetation samples, and three sediment samples were collected as part of this investigation.

*Inorganics*

Four of the seven soil samples analyzed contained elevated concentrations of inorganic elements (specifically lead and zinc) which exceeded the DEW Line Cleanup Criteria (DCC). One vegetation sample analyzed for inorganics contained concentrations of zinc elevated when compared to the soil samples taken in the same location. One of the three sediment samples analyzed contained concentrations of chromium exceeding the Environment Canada Interim Freshwater Sediment Quality Guidelines (ISQG); however, elevated levels of chromium were also detected in background sediment samples.

*PCBs*

Eight soil samples were analyzed for PCBs and all contained concentrations below the DCC criteria at that time. It should be noted that soil samples were elevated considerably in comparison to background sample locations. One vegetation sample was analyzed for PCBs and contained concentrations 41 times background. The three sediment samples contained detectable levels of PCBs, but remained below the Environment Canada ISQG.

Pesticides were tested in one soil sample and contained concentrations below the applicable criteria at that time. Two soil samples were also analyzed for PAHs, most PAH analytes were present, but below the CCME R/P criteria.

*Recommendations & Conclusions*

*Inorganics*

It was found that lead (409, 414, and 1140 ug/g) and zinc (720 and 12820 ug/g) were elevated in soils; however, plants remained unaffected by the elevated inorganic elements. Sediments from Sylvia Grinnell River contained trace inorganic elements only slightly elevated when compared to background. It was suggested that sediment loading was not occurring in Sylvia Grinnell River as a result of land filling activities at the site.

*PCBs*

Soils at the toe of the main landfill (APEC 3) were elevated (mean level of 0.13 ug/g, high of 0.71 ug/g) and approached the DCC criteria, while concentrations elsewhere remained low. PCBs remained un-detected in surface water collected below the vehicle dump (APEC 2). Vegetation appeared to be impacted due to the presence of elevated PCB concentrations in soil at the toe of the main landfill. No evidence was established to suggest migration of PCBs to the Sylvia Grinnell River.

*Cleanup Recommendations*

It was recommended that soil remediation take place at the toe of the landfill site to address the elevated levels of inorganic elements identified through this and previous environmental investigations. Soils should be removed from contact with the arctic ecosystem between the toe of the landfill and the first set of parallel bedrock outcrops.

It was recommended that all metallic debris be removed from the site and be recycled and/or shipped south. The stability of the main landfill (APEC 3) should also be addressed, as it presents an immediate physical hazard and risk to those using the area for recreational purposes. It was proposed that sufficient amounts of granular material be added to the landfill face to achieve a safe and suitable slope angle and ensure that all debris remains buried at an adequate depth. The newly obtained slope should be seeded to prevent erosion and help maintain slope stability.

**Peramaki, A., Decker, J.F., 1998**

A study was conducted with regard to lead contamination at the Landfill Site. The study was conducted to determine the spatial distribution of soil and sediment-associated lead.

Sylvia Grinnell Park exhibited the highest concentrations of lead found in any of the sites considered during this investigation. These lead concentrations were found to be in the same order of magnitude as previously reported by ESG, 1995.

**FRANZ, 2009**

In 2008, FRANZ conducted a Phase I/II Environmental Site Assessment (ESA) of the vehicle dump and community landfill, and reported the following findings:

- Various inorganic elements (Al, As, Cd, Cr, Cu, Pb, Zn) and PCBs exceeded applicable guidelines in surface waters and sediments throughout the site, and sediments in APEC 2 also exceeded guidelines for DDT and its degradation products (DDD, DDE).
- Metals (Ba, Cd, Cu, Pb, Zn) were also detected above guideline levels in surficial soils (APECs 1, 2 and 3).
- Soils in APECs 2 and 3 exceeded guidelines for PCBs.
- Some APEC 3 soils contained noncompliant levels of PAHs and F2-F4 petroleum hydrocarbon fractions.

- Surface waters in APEC 4 (downgradient and off-site) exceeded CCME FWAL criteria for cadmium and copper, indicating that the site may contribute low levels of metal loading to the Sylvia Grinnell River.
- One exceedance of trichloroethylene (a volatile organic carbon compound, or VOC) was also detected in surface water collected from the Sylvia Grinnell River (APEC 4).

## 4.4 Present Conditions

The Vehicle Dump and Community Landfill is not in active use. **Figure 2** presents an aerial view of the site and representative photos for each AEC are shown in **Appendix D**.

The site was abandoned as a landfill in the mid 1970's. Since then it has remained relatively unchanged. The extent of the vehicle dump area has increased and approximately 100 pieces of electrical equipment were removed between 1987 and 1989. No buildings or infrastructure are present on the site. Site use is understood to be strictly recreational with no known development strategies for the future.

The site consists of a main landfill area, a vehicle dump, and a series of streams and ponds meandering their way to the Sylvia Grinnell River via linear surficial features.

## 4.5 AECs and Contaminants of Concern (COCs)

Based on the previous environmental assessment activities completed to date and the historical records review, the following Areas of Environmental Concern (AECs) and Contaminants of Concern (COCs) formed the basis for the Phase III ESA.

Please note that the AEC/APEC boundaries have been altered from the Areas of Potential Environmental Concern (APECs) defined in FRANZ (2009) to better accommodate contaminant migration evaluation. Therefore, some samples annotated with 'A3' (from the 2008 investigation) are now located in AEC 2. Other small variations in sample nomenclature may also exist.

The Vehicle Dump and Community Landfill has four main areas that contain a zone(s) of contamination and has been divided into four AECs as follows (See **Figure 2**).

*AEC 1 – Upgradient Buried Debris*

The area of the landfill directly upgradient from the vehicle dump contained evidence of potential buried metal debris during the site visit. The area also appears to be disturbed on the 1964 aerial photographs.

### AEC 2 – Vehicle Dump

The second area of concern is the vehicle dump located in the drainage feature to the east of the main Landfill area. This area is composed of vehicles, such as trucks, cars, trailers, boilers, tankers, and others. A drainage channel runs directly through the center of this debris pile discharging to the ponds, then the river.

### *AEC 3 – Main Landfill*

The third area is the main landfill area consisting of a mixture of debris spread across a steep graded bedrock slope. The top of the landfill area has been capped with granular material and the toe is left exposed with debris scattered throughout the area.

### *AEC 4 – Downgradient, Off-site*

The fourth are is comprised of any section of the site that is off-site and in Sylvia Grinnell Park. All downgradient and off-site sampling locations were given a separate sampling nomenclature in order to clearly differentiate their results from those of the on-site sampling locations.

The AECs, PCOCs and COCs are summarized in the following **Table 4-2**:

**Table 4-2**: Summary of AECs and COCs

| AEC | COCs/PCOCs |
|---|---|
| AEC 1- Up Gradient Buried Debris | PHCs, Metals, PCBs, and Pesticides |
| AEC 2 – Vehicle Dump | PHCs, PAHs, Volatile Organic Compounds (VOCs), Metals, PCBs, and Pesticides |
| AEC 3 – Main Landfill | PHCs, PAHs, VOCs, Metals, PCBs, and Pesticides |
| AEC 4 – Down Gradient, Off Site | PHCs, PAHs, VOCs, Metals, PCBs, and Pesticides |

# 5.0 REGULATORY REVIEW AND ENVIRONMENTAL QUALITY CRITERIA

## 5.1 Soil, Sediment, Surface Water, and Hazardous Materials Guidelines

### 5.1.1 Regulatory Framework

The Contaminated Sites Management Working Group for federal government departments has defined a contaminated site as a site at which substances occur in concentrations that either: 1) are above background levels and pose, or are likely to pose, an immediate or long-term hazard to human health or the environment; or 2) exceed levels specified in policies and/or regulations. For the latter, the Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines (CCME, 1999 and annual updates), including the Canada-Wide Standards for Petroleum Hydrocarbons in Soil (CCME, 2001 and updates) were applied in the numerical comparison of laboratory data to determine whether the site should be deemed a contaminated site.

In Nunavut, environmental site assessments and site remediation projects are typically based on the use of federally developed generic guidelines. Risk assessment principles have been used extensively in developing federal generic clean-up criteria for contaminated sites. However, as the term “generic” implies, they are intended for broad applications and are usually over-protective to avoid underestimating potential risks associated with a wide range of site conditions and potential land uses.

The chemical data obtained during this Phase III ESA were preferentially compared to established guidelines from the federal CCME. The federal guidelines are relevant since the site(s) is currently federally managed and Nunavut has adopted the CCME approach.

The federal CCME guidelines were derived based on potential impacts to humans and ecological receptors.

### 5.1.2 Federal Guidance

The CCME Canadian Environmental Quality Guidelines (1999) publication compiled all previously released soil and groundwater criteria and guidelines into one publication. Updates have been issued for selected chemicals over the past several years. These guidelines for soil, sediment and water are numerical limits intended to maintain, improve or protect environmental quality and human health at contaminated sites And have been derived using toxicological data. There are four separate sets of guidelines for soil quality and five sets of guidelines for water quality. The guidelines are separated into groups for different types of land and water use.

*Soil*

The soil analytical results were compared to the Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, specifically the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health (CSQG), and with the Canada-Wide Standards (CWS) for Petroleum Hydrocarbons (PHC) in soil. These are applied to most federal contaminated sites. The criteria are numerical limits intended to maintain, improve or protect environmental quality and human health at contaminated sites. The guidelines are derived using toxicological data and aesthetic considerations.

The standards and guidelines adopted for this evaluation are as follows:

- Canadian Environmental Quality Guidelines (CEQGs; CCME, 2007) for commercial/industrial land use (residential/parkland land use standards were also shown for comparison purposes); and
- Canada-Wide Standards for Petroleum Hydrocarbon (CWS) in soil (CCME, 2008a) – Tier 1 Levels for commercial land use (residential/parkland land use standards were also shown for comparison purposes).

The Canada-Wide Standards for Petroleum Hydrocarbon in soil (CCME, 2008a) presents criteria for petroleum hydrocarbons in soil. These numerical standards are based on the assessment and consistent management of risks posed to humans, plants, animals and environmental processes under four common land uses (agricultural, residential/parkland, commercial and industrial). Under Tier 1 of the CWS, specific numerical levels are presented for the four land uses, two soil textures (coarse and fine) and the four defined petroleum hydrocarbon fractions (F1 (nC6-nC10); F2 (nC10-nC16); F3 (NC16-nC34); F4 (nC34+)). There are several additional levels for fractions F1 and F2 to protect surface water where groundwater discharges to surface water, where groundwater is used for potable purposes and where residential buildings have slab-on-grade construction. These levels are deemed to be protective of all receptors based on the defined conditions in all settings.

The CWS also includes the option to generate Tier 2 levels where site-specific information indicates that site conditions exist that modify human or ecological exposure to PHC contamination. Such conditions may alter risks significantly relative to the generic conditions used to derive Tier 1 levels. Furthermore, Tier 3 under the CWS involves developing site-specific cleanup levels and management options using general and site-specific information in conducting a risk assessment.

Given the nature of the work, only the Tier 1 levels are used as comparison criteria. The appropriate levels are presented with the laboratory analytical data in tables.

*Sediment*

Canadian Sediment quality guidelines (CSQGs) are provided in the CCME Canadian Sediment Quality Guidelines for the Protection of Aquatic Life summary tables (Tables 1 and 2), Update 2002. Sediment assessment guidelines depend on the probability of an effect to occur in organisms inhabiting the sediment. The CCME has established Interim Sediment Quality Guidelines (ISQG) and Probable Effect Limits (PEL) for common contaminants in sediment. Sediment quality guidelines are scientific tools that synthesize information regarding the relationships between sediment concentrations of chemicals and any adverse biological effects resulting from exposure to these chemicals. For each parameter, CCME guidelines have identified two numerical limits: the lesser limit is termed the “Interim Sediment Quality Guideline” (ISQG) value and the greater limit is called the “Probable Effect Level” (PEL). Sediment chemical concentrations below ISQG values are not expected to be associated with any adverse biological effects, while concentrations above PEL values are expected to be frequently associated with biological effects. Chemical concentrations between the ISQG and PELs represent the range in which effects are occasionally observed.

The CSQGs include the option to allow comparison against freshwater conditions (Table 1) and marine environments (Table 2). Given the complex conditions at the lower site, both Tables 1 and 2 have been referenced in the sediment summary tables (**Tables 7-13** through **7-18**).

*Surface Water*

Canadian water quality guidelines are intended to provide protection of freshwater and marine life from anthropogenic stressors such as chemical inputs or changes to physical conditions. In 1999, CCME also updated the surface water quality guidelines for the protection of aquatic life. The Freshwater Aquatic Life (FWAL) and Marine Aquatic Life (MWAL) water quality guidelines were applied to the surface waters at the site depending on the location on site.

The guidelines adopted for this evaluation are summarized as follows:

- Surface water quality was compared to the CCME guidelines for the protection of freshwater aquatic life (FWAL) and marine aquatic life (MWAL); 2007 Update.
- CCME 2000 Canada-Wide Standards for Petroleum Hydrocarbons (PHC) in Soil. For the assessment of surface water, the Tier 1 Commercial guidelines for coarse-grained soils were used in addition to the residential/parkland guidelines for comparison purposes.

### 5.1.3 Chemical Evaluation – Process for Selection of Environmental Criteria

The chemical evaluation was conducted by comparing the detected concentrations for each substance to the CCME guideline for Commercial (CL) and residential/parkland (RD/PL) land use standards. The following selection process was used to identify which EQG to use for the chemical evaluation.

- If only one guideline was available from the federal CCME for a chemical, then it was adopted for use
- If normal average background concentrations for a chemical in the study area were higher than CCME criteria, then the background concentration was selected as the appropriate point of comparison. It should be noted that the average background concentrations were below the CCME guidelines.
- If the guideline was below the laboratory's method detection limit, it was (not worried about as current technology does not allow any lower detection limits).

## 5.2 Designated Substances

### 5.2.1 Selection of Environmental Quality Guidelines

Criteria, rationale and regulatory jurisdictions for each component of the designated substances survey are presented below.

| Material Type | Classifications | Evaluation Criteria |
|---|---|---|
| Lead-Based Paints | Lead-based paints with leachable lead > 5 mg/L are hazardous materials under Schedule 6 of the Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (May 17, 2005) of CEPA (1999). | Paints in excess of 5 mg/L leachable lead (TCLP analysis) were deemed hazardous. Where insufficient paint was available for $Pb_{TCLP}$ analysis, the territorial criteria of 600 mg/kg total lead was used for classification purposes. |
| PCBs in Soils | PCBs in soils are regulated under the Canadian Environmental Protection Act (CEPA) and transported according to TDGA and CEPA. | PCB content >50 ug/g is considered a hazardous waste. Materials with PCBs above the CCME soil criteria (e.g., 1.3 ug/g) but below 50 ug/g is not hazardous waste |
| Liquids/Chemicals | Waste solvents and liquids are a contaminant under the EPA of Nunavut and must be managed as a hazardous waste. | Absence/presence of liquids/chemicals in containers. |
| Batteries | Waste batteries are a contaminant under the EPA of Nunavut and must be managed as a hazardous waste | Absence/presence of waste batteries. |

## 5.3 Vegetation Evaluation Guidelines

The Ontario Ministry of the Environment (MOE) “Upper Limit of Normal” contaminant guidelines (ULN) represent the expected maximum concentrations of contaminants in surface soil (non-agricultural), foliage (deciduous and current year coniferous trees and shrubs), grass, moss bags and/or snow from areas of Ontario not subject to the influence of point sources of emissions. Rural guidelines are based upon samples collected from undeveloped areas.

These guidelines do not represent maximum desirable or allowable levels of contaminants. Rather, they serve as levels which, if exceeded, would prompt further investigation on a case-by-case basis to determine the significance, if any, of above-normal concentrations. Concentrations which exceed the guidelines are not necessarily toxic to plants, animals or humans. Concentrations below the guidelines would not normally be considered toxic (MOEE HCB Phytotoxicology Field Investigation Manual – 014-3511-93).

## 6.0 SUPPLEMENTAL FIELD INVESTIGATION

### 6.1 Field Reconnaissance

Following the mobilization of the field sampling crew to the site and a site health and safety briefing, FRANZ completed a brief site reconnaissance tour on September 15, 2009. The purpose of this tour was to assess the current physical site conditions, identify any changes from the 2008 field investigation, locate potential soil, surface water and sediment sampling locations, and to inspect any other potential environmental impacts.

The conditions on site remained consistent with that observed during the 2008 investigation. General site descriptions, as well as AEC designations are provided in Section 4 of this report.

The information collected above, in combination with the complete historical records review, was used in the design of the detailed sampling plan.

### 6.2 Detailed Sampling Plan

This sampling plan was prepared and designed to perform a detailed assessment of the site with respect to soil, sediment, groundwater, surface water, vegetation and waste material inventory. It is based on discussions with PWGSC/Transport Canada, a review of the Terms of Reference (ToR) dated June 2009 for an Environmental Site Assessment (ESA) and the Franz Environmental Phase I/II Environmental Site Assessment, Vehicle Dump and Community Landfill, Iqaluit, Nunavut, Dated February 2009.

The sampling plan described our prescribed sampling methods and types of measurements/tests to be conducted during the Phase III ESA including:

- Proposed sampling locations and quantities
- Proposed sampling or measurement methods
- Parameters being sampled
- Description of objectives with rationale
- Proposed QA/QC methods
- Proposed background sampling protocols
- Proposed health and safety plan (separate)

During the field activities, areas of environmental concern were prioritized and assessed in accordance with the proposed scope of work. In addition, based on visual observations at the time of the field program, sampling locations were refined from the initial sampling plan to target the most likely impacted areas and/or to attempt coarse grid delineation of impacts.

## 6.3 Health and Safety Procedures

FRANZ field programs are always subject to a site-specific Health and Safety Plan (HSP). We use a Corporate Health and Safety Plan as a general guide in developing the site-specific plan to which all team members and subcontractors must adhere. Protection of the public and personnel from exposure to any contaminated materials at the site was priority during the field program.

Prior to conducting any of the onsite work, a site-specific health and safety plan was developed, distributed and discussed with all field personnel (See **Appendix E**). As a minimum, full personal protective equipment (e.g., hard hats, safety glasses, reflective vests and Nitrile gloves) were worn at all times during field activities. Tyvek overalls and respirators were made available to all field personnel, should the site health and safety officer (SHSO) find their use necessary.

## 6.4 Sampling Methodology

### 6.4.1 Test Pit Excavations

Test-pitting was considered the appropriate method for conducting observations of soil conditions and collecting near-surface soil samples in areas of environmental concern (AECs). Between September 14, 2009 and September 18, 2009, 13 test pits were excavated by FRANZ personnel up to a maximum depth of 1.5 m. One soil sample from each test pit was analyzed for various contaminants of concern. All the test pits in AEC 1 were completed with a backhoe to the maximum achievable depth. Several of these test pits encountered refusal at various depths or encountered permafrost. All other test pits were completed with a trowel or spade shovel to the maximum achievable depth.

At each test pit location, composite soil samples were collected using a decontaminated trowel. Depending on the depth of the test pit, the nature of the stratigraphy, and any evidence of contamination, composite samples were generally collected over a range of 50-60 cm. Prior to sampling, soil descriptions including approximate grain size, colour, moisture content, stratigraphy and any evidence of contamination were recorded (**Appendix A, Tables A-1 and A-2**)

Four (4) additional test pits were advanced, though not sampled, at the top of the landfill in AEC 3. The purpose of this test pitting was to determine the approximate thickness of landfill soil capping material and to make observations as to the contents of the landfill. These test pits were also logged and annotated as 'T1 through T4' in the test pit logs.

Following the completion of the test pit field log and prior to backfilling the pit to grade, soil samples were collected and stored in sealable polyethylene bags (for soil vapour headspace analysis) and dedicated glass sample containers (for laboratory analysis). Following sample collection, jarred soils were refrigerated and/or stored on ice in laboratory-supplied coolers from the day of collection until delivery to the project laboratory in Ottawa, Ontario.

Test pit locations are indicated on the appropriate site plans (**Figures 4 through 9**).

#### 6.4.1.1 Soil Sampling Field Vapour Screening

Vapour screening is a frequently used method for detecting and measuring the quantity of volatile organic compounds present in soil when dealing with soils potentially impacted with hydrocarbons. When taken continuously from the ground surface to the end of a test pit, vapour readings can provide an indication of the relative level of contamination and whether it originated from a localized source or migrated from a more distant one. As a result, field screening is a useful tool to facilitate selection of samples to be submitted for laboratory analysis.

During the investigation, field vapour screening was completed by partially filling and sealing standard volumes of soil into dedicated polyethylene bags. When stored at room temperature, headspace vapours were allowed to develop and equilibrate in the sealed bag. Gas samples retrieved by inserting a small tube into the bag were then analyzed with an RKI Eagle organic vapour meter (OVM), and the concentration of combustible gases present (other than methane) by volume (ppm) of the calibrating gas (hexane) was measured. Only those soil samples suspected of hydrocarbon contamination were tested for head space vapours. The results of the soil vapour headspace analyses are included in the test pit logs **(Appendix A, Tables A1 and A2)**.

#### 6.4.1.2 Selection Criteria for Soil Chemical Analyses

Soils were analyzed based upon three distinct rationales:

To delineate, confirm or refute potential soil impacts related to land filling procedures;
To provide a better understanding of contaminant concentrations in the soil and other native materials across the site; and
To generate a thorough understanding of environmental receptors, as well as fate and transport of contaminants of concern (COCs).

Soil sample selection for contaminant analyses was based on a detailed review of previous soil analyses completed on the various soil types found on the site and near impacted source areas, as well as visual site inspection of potential source areas and natural environmental pathways and receptors.

All samples were screened for soil vapour concentrations. In general, soil samples submitted for VOC or hydrocarbon analysis were based on their location, odour and/or staining.

All samples were analyzed for metal concentration, and other contaminant analyses were selected based on historical site usage and visual impacts.

### 6.4.2 Surface Water Characterization

A total of 31 surface water samples were collected from the four (4) AEC areas in 2009. One (1) sample was collected in AEC 1, 11 samples were collected in AEC 2, three (3) samples were collected in AEC 3 and 16 samples were collected from AEC 4, down-gradient receptors.

The surface water samples were collected from the shores of the ponded areas and/or streams or by wading into the ponds with rubber hip waders. The surface water sampling locations corresponded with sediment sampling locations in most cases; however, sediment was not collected from stations directly in the Silvia Grinnell River. Specific sample locations for each site are indicated on **Figures 4 through 9**.

The samples were collected at the water surface, into laboratory supplied sample containers. Field parameters including pH, temperature and conductivity were measured at each surface water station at the time of sample collection using a Horiba U-22 multi parameter probe. Each sample was labelled and refrigerated and/or kept on ice until they were relinguished to the project laboratory. Results of the field parameters are presented in **Appendix A, Tables A4 and A5**.

#### 6.4.2.1 Stream Flow Measurements

Measurements of stream flows were taken in several areas where flowing water was present during the 2009 investigation.

Simple stream flow calculations were conducted using the Q=VkA method, where Q = total rate of discharge, V = velocity, A = area and k = correction factor (0.85). The site of the field measurements was selected based on the following available criteria:

- Slope of the stream not too great;
- Roughness of the channel bottom; and
- Not in proximity to backwater effects, eddy currents, or other influencing factors.

The selected site was prepared by first removing any debris or large cobbles from the stream bed and clearing any obstructions from the stream walls.

Velocity measurements were conducted using a Global FP101 Water Flow Probe. Velocity measurements were collected in feet/second and later converted to metres/second once back in the office.

For each station, the area of the stream cross-section was obtained by collecting depth measurements at four (4) locations across the stream transect and averaging out the depth and multiplying that by the stream width.

### 6.5 Sediment Characterization

A total of 25 pond and stream sediment samples were collected across the four (4) AECs. One (1) sample was collected in AEC 1, 11 samples were collected in AEC 2, three (3) samples were collected in AEC 3, and 10 samples were collected in AEC 4. The sediment sampling locations corresponded with surface water sampling locations in most cases; however, sediment was not collected from stations directly in the Silvia Grinnell River. Specific sample locations for each site are indicated on **Figures 4 through 9**.

The sediment sampling was completed using either an Eckman sediment grab sampler or a stainless steel hand trowel. For each sample collected, a depth measurement, GPS coordinates, and description of the sediment (including colour, odour, sheens, staining, water depth, grain size, sample recovery and % natural organic material), the presence of debris and any unusual characteristics were recorded. Sediment samples at each location were collected from the top 0-15 cm of pond and stream sediments into laboratory-supplied containers with the aid of a hand trowel and nitrile gloves. The samples were then refrigerated and/or kept on ice until they could be delivered to the project laboratory in Ottawa, Ontario. Sample locations are indicated on **Figures 4 through 9** and sediment logs are summarized in **Appendix A, Tables A6 and A7**.

### 6.6 Vegetation Sampling

The 2009 field investigation included the collection of 11 vegetation samples throughout the four (4) AECs. Two (2) samples were collected in AEC 1, three (3) in AEC 2, three (3) in AEC 3, and three (3) in AEC 4. Blueberries were collected from the terrestrial vegetation samples, with only the fruit being collected and analyzed. Grasses and algae were collected from aquatic vegetation samples depending on the type of vegetation available in a given area. Each sample location was photographed and mapped. The samples were placed in polyethylene bags and refrigerated and/or kept on ice until they could be delivered to the project laboratory. Specific sample locations are indicated on **Figures 4 through 9** and vegetation is summarized in **Appendix A, Table A8**.

## 6.7 Paint Sampling

In the Northwest Territories, products containing lead over 600 parts per million are considered hazardous waste and must be managed according to the GNWT *Environmental Guideline for Waste Lead and Lead Paint* (April 2004).

Painted surfaces were screened for potential lead content. Paint was sampled by removing paint chips with a stainless steel blade and placing them in a clean re-sealable plastic bag. Paint samples were submitted to Maxxam Analytical Services for lead analysis. The samples were analyzed by inductively coupled plasma using a mass spectral detector (ICP-MS). Lead concentrations are reported in terms of percentage of lead and converted to a weight fraction of paint [micrograms/gram (µg/g) or ppm]. Composite samples of each paint colour were collected from the vehicles present in AEC 2.

## 6.8 Waste Debris Inventory

For the purpose of future landfill decommissioning and potential removal of debris, an inventory of site waste in each AEC was completed. The waste materials were identified as hazardous or non-hazardous to assist in characterizing materials for potentials disposal considerations.

Waste materials associated with the main landfill area and the vehicle dump were quantified by measuring their in-situ dimensions (length and width) using the DGPS system.

The other site waste was itemized as individual scattered pieces (e.g., drums, scrap metal, scrap wood and abandoned vehicles, etc.).

A complete summary of waste material characterization and associated inventories categorized by AEC and location is provided in Section 7.8.1, Table 7-22.

### 6.8.1 Site Survey

A complete site survey was carried out during the 2009 field program. The site survey consisted of georeferencing site features and sample locations with the use of a Global Positioning System (GPS) unit.

The survey data was placed on a 2008 Google Earth image (2008, Google) and georeferenced to correspond with data points collected during the field survey.

## 6.9 Background Sampling Program

Background sampling was completed as part of the 2008 investigation (FRANZ, 2009); therefore, no further background sampling was completed in 2009.

## 6.10 Chemical and Physical Analysis

### 6.10.1 Chemical and Physical Analysis Program

Maxxam Analytics (Ottawa) was selected to complete the analytical testing for this project. Maxxam is certified by the Canadian Association of Environmental Analytical Laboratories (CAEAL), and follows strict internal quality assurance/quality control (QA/QC) protocols. The Maxxam quality control program includes replicate analyses, blank spikes, matrix spikes, instrument calibration, internal standards, method blanks and internal QC checks. The standard Maxxam analytical quality control protocols meet or exceed the requirements of all United States and Canadian regulators. A copy of the chain-of-custody forms used for sample submission is provided with the laboratory reports (**Appendix F**).

### 6.10.2 Selection Process for Chemical Analyses

Samples were analyzed for three reasons: to document pesticide, PCB, metal, VOC, PAH, and PHC concentrations across the sites; to delineate the spatial distribution of impacts for the identified contaminants of concern; and to determine the current environmental and physical conditions which represent the most important potential risks to human and environmental health. Sample locations and analytical parameters were selected on the basis of a review of previous results and site history.

### 6.10.3 Chemical Analytical Program

The quantity of soil, sediment, surface water, and vegetation samples by parameter, and the associated testing protocols are listed in the following **Table 6-1**:

**Table 6-1**: 2009 Chemical Analytical Program

| Analysis | | Medium | | | | |
|---|---|---|---|---|---|---|
| | Soil | Sediment | Surface Water | Vegetation | Material Sampling | Totals |
| PHCs | 11 (2) | 18 (2) | 7 (1) | | | 36 (5) |
| Metals | 13 (1) | 25 (2) | 31 (2) | 11 (1) | 2 | 82 (6) |
| VOCs | 11 (1) | 4 (1) | 7 (1) | | | 22 (3) |
| PAHs | 5 (1) | 3 (1) | 5 (1) | | | 13 (3) |
| PCBs | 6 (2) | 18 (2) | 9 (1) | 2 | | 35 (5) |
| Pesticides | 1 (1) | 18 (2) | 10 (1) | | | 29 (4) |
| Total Organic Carbon (TOC) | 0 | 25 (2) | 0 | | | 25 (2) |
| Dissolved Organic Carbon (DOC) | 0 | 0 | 31 (2) | | | 31 (2) |
| Total number of analyses | 47 (8) | 111 (12) | 100 (9) | 13 (1) | 2 | 273 (30) |

(XX) Denotes number of QA/QC samples.

## 6.11 Quality Assurance/Quality Control

The purpose of the quality assurance/quality control (QA/QC) program was to confirm that field sampling methods and laboratory analysis were reliable. In implementing the QA/QC program, FRANZ verified that the quality of the reported results was suitable to support the environmental impact (and human health risk) conclusion drawn from the data.

The 2009 field program included the following QA/QC protocol elements:

- Decontamination (Alcanox wash and distilled water rinse) of sampling equipment / instrumentation between all sample locations;
- Fresh, chemical-resistant nitrile gloves at each sampling location;
- Proper documentation of all aspects of the sampling program, with particular detail to the introduction of potential bias;
- Elimination of headspace for all volatile parameters (soils and water);
- Collection of one blind analytical duplicate for approximately every 10 samples of environmental media;
- Calculation of the relative percent difference between a sample and its duplicate; and
- Calibration of field instruments.

### 6.12 Data Reduction and Validation

Data reduction of the investigation results primarily involved summary tabulation of analytical results and transcription of field observations. Following data reduction, data validation was performed to ensure that the raw data was not altered and that an audit trail was developed for managing the data. Data validation was also performed to verify that the quantitative and qualitative reliability of the information. A comparative review of sample collection records, chain-of-custody records, holding times, dilution factors, Estimated Quantitation Limits (EQLs), and laboratory and field QC sample records were evaluated against original laboratory reports.

### 6.13 Quality Assurance/Quality Control Samples

Laboratory reports detailing the handling and secure storage of samples, and the significant dates with respect to sample delivery, extraction, and analysis were reviewed by FRANZ and found to be within control limits.

External QA/QC samples in the form of blind duplicates were submitted by FRANZ for laboratory analysis. Approximately one duplicate was collected per 10 samples for a given medium. The nomenclature of each duplicate ensured that the sample number corresponding to the blind duplicate was not evident to the lab, allowing the external verification of laboratory accuracy and precision.

### 6.14 Data Validation of QA/QC Samples

Sampling procedures and laboratory analytical precision were evaluated by calculating the relative percent difference (RPD) for a sample and duplicate pair according to the following equation:

$RPD = | X_1 – X_2 | / X_{avg} X 100$

Where $X_1$ and $X_2$ are the concentrations and $X_{avg}$ is the mean of these two values.

The duplicate results were evaluated using criteria developed by Zeiner (1994), which draw from several data validation guidelines developed by the United Stated Environmental Protection Agency (USEPA). According to these criteria, the RPD for duplicate samples should be less than 20% for aqueous samples and less than 40% for solid samples. RPDs can only be calculated when the compound is detected in both the original and the duplicate sample at a concentration five times above the reportable detection limit (or method detection limit – MDL).

**Criteria for the Evaluation of Blind and Duplicate Sample Results**[1]

| Scenario | Result A | Result B | Criteria for Acceptance | |
|---|---|---|---|---|
| | | | Aqueous (Water) | Soil (Soil) |
| A | ND | ND | Acceptable precision; no evaluation required | |
| B | ND | positive | result B - 0.5 x MDL < MDL | result B - 0.5 x MDL < 2 x MDL |
| C | positive and > 5 x MDL | positive and > 5 x MDL | RPD < 20% | RPD < 40% |
| D | positive and < or = 5 X MDL | positive | \|result B - result A\| < MDL | \|result B - result A\| < 2 x MDL |

Notes:
ND – not detected
RPD – relative percent difference, (result A – result B) / (result A + result B) / 2 *100

The results of the data validation are presented in the **Tables** section of this report along with the analytical results. The precision is considered acceptable when evaluation criteria are met, or when both results are below the MDL. When the evaluation criteria are not satisfied, the following apply:

- ND vs positive – unacceptable imprecision: the positive result is considered an estimate and the ND result is considered inconclusive.
- Positive vs positive – unacceptable imprecision: the results are considered an estimate.

## 6.15 Data Evaluation – Results of Duplicate Analysis

Blind field duplicates were submitted for PHC (2), PAHs (1), VOCs (1), metals (1), PCBs (2), and pesticides (1) analysis in soils. Blind field duplicates were submitted for PHC (2), PAHs (1), VOCs (1), metals (2), PCBs (2), and pesticides (2) analysis in sediment. For surface water, blind field duplicates were submitted for PHC (1), PAHs (1), VOCs (1), metals (2), PCBs (1), and pesticides (1). For vegetation, blind field duplicates were submitted for metals (1) analyses.

In general, the results show satisfactory precision. The following discussion presents the results of the RPD calculations.

<u>Soil</u>

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[1] Source: Zeiner, S.T., Realistic Criteria for the Evaluation of Field Duplicate Sample Results, Proceedings of Superfund XV, November 29-December 1, 1994, Sheraton Washington Hotel, Washington, D.C. – modified to use Method Detection Limit (MDL) or Reportable Detection Limit (RDL) in lieu of the Quantitation Limit (QL), the Instrument Detection Limit (IDL) and/or Laboratory Reporting Limit (LRL).

In the comparison of soil test samples and their duplicates, VOCs, PCBs, pesticides all showed concentrations within the acceptable precision. PAH's showed concentrations within the acceptable precision with exception to phenanthrene. PHCs showed concentrations within acceptable limits for BTEX F3, and F4; however, the F1 and F2 fractions exhibited unsatisfactory results.

The minor variance in the PAH phenanthrene sample is likely due to the low concentrations of the analyte. It should also be noted that phenanthrene was below the selected EQG and therefore is considered acceptable. The variances in the PHC F1 and F2 fractions are likely due to the heterogeneity of the soil and/or presence clay material in the sample medium. The PHC soil samples are above the applicable EQG in the original sample (A1-TP09-3-2) for F1, F2, and F3 and below the EQG for F1 and F2 in the duplicate sample (TP09-DUP1). Field observations noted high hydrocarbon like odour in the sample; therefore the analysis from the original sample (A1-TP09-3-2) is considered valid.

### Sediment

In the comparison of sediment test samples and their duplicates, PAHs, PCBs, Pesticides, and VOCs all showed concentrations within the acceptable precision. PHCs showed acceptable precision with exception to sample and duplicate, AEC4-SD09-11/SD09-DUP2, exhibiting unsatisfactory results for F3 and F4 fractions. Metals analysis showed acceptable precision with the exception of sample and duplicate, AEC2-SD09-9/SD09-DUP1, for the analytes arsenic, molybdenum, potassium, and sodium.

The minor variances noted in PHC samples AEC4-SD09-11 and SD09-DUP2 are likely due to the low chemical concentrations and heterogeneity of the soil samples. Note that the PHC results are well below the selected EQG and are therefore are considered acceptable. The variances exhibited in metals samples AEC2-SD09-9/SD09-DUP1 are due to sample dilution at the laboratory during analytical testing, generating differing detection limits between the two samples. Note that all metal analytes in question were below the selected EQG. The results from the sediment sampling are considered valid.

### Surface Water

Surface water duplicate analysis was completed for PHCs, metals, VOCs, PAHs, VOCs, PCBs, and pesticides, and all concentrations were within acceptable precision with the exception to metals analysis for duplicate pair AEC4-SW09-10/AEC4-SW09-DUP2 nickel analytes, which showed an unsatisfactory result. This variance is likely due to suspended particles in the surface water sample. The variance is minor and the overall results from the surface water sampling are considered valid.

### Vegetation

Duplicate analysis was completed on the vegetation samples AEC1-AQ-VEG09-1/VEG09-DUP1 for metals analysis. All concentrations were within acceptable precision with the exception to sodium, which showed unsatisfactory results between the sample pair. The minor variance is likely due to small amounts of dissimilar plant species in the sample population which may exhibit slightly different up-take characteristics. The variance is minor and the overall results from the vegetation sampling are considered valid.

# 7.0 CHEMICAL DISTRIBUTIONS AND IMPACTS

## 7.1 Introduction

Chemical data from the 2009 field program were integrated with the data obtained from the 2008 field investigation. Tables were prepared with the information displayed by medium and location (**Tables 7-1A/B through 7-21A**). The chemical data was compared to the appropriate guidelines for soil (CCME Residential/Parkland (PL) and Commercial (CL)), sediment (CCME Freshwater and Marine ISQG and PEL), surface water (Freshwater and Marine) for protection of aquatic life, vegetation (MOE-ULN) and building materials established by both federal and provincial authorities as indicated in Section 5 and collectively referred to as the Environmental Quality Guidelines (EQGs).

The EQGs are numerical limits or statements which can be used for comparison with measured contaminant levels at a site in order to determine whether further investigation or action is required; however, the definition of impact does not necessarily imply significant risks to human health and the environment. Natural attenuation mechanisms (such as biodegradation and adsorption), exposure pathways, frequency of exposure and proximity to potential receptors must be considered to determine the potential for specific risks and impacts.

Field and laboratory results are discussed in this section. Data are presented in the attached tables and figures, as listed below in **Table 7-1**.

**Table 7-1:** Summary of Data Presentation

| Media | Parameters | Tables (2009) | Tables (2008) | Figures |
|---|---|---|---|---|
| Soil | Metals | 7-1A | 7-1B | 10, 13, 16, and 19 |
| | PHC | 7-2A | 7-2B | |
| | PAHs | 7-3A | 7-3B | |
| | PCBs | 7-4A | 7-4B | |
| | Pesticides | 7-5A | 7-5B | |
| | VOCs | 7-6A | 7-6B | |

| Media | Parameters | Tables (2009) | Tables (2008) | Figures |
|---|---|---|---|---|
| Surface Water | Metals | 7-7A | 7-7B | 11, 14, 17, and 20 |
| | PHC | 7-8A | 7-8B | |
| | PAHs | 7-9A | 7-9B | |
| | PCBs | 7-10A | 7-10B | |
| | Pesticides | 7-11A | 7-11B | |
| | VOCs | 7-12A | 7-12B | |
| Sediment | Metals | 7-13A | 7-13B | 12, 15, 18, and 21 |
| | PHC | 7-14A | 7-14B | |
| | PAHs | 7-15A | 7-15B | |
| | PCBs | 7-16A | 7-16B | |
| | Pesticides | 7-17A | 7-17B | |
| | VOCs | 7-18A | 7-18B | |
| \Vegetation | Metals | 7-19A | 7-19B | 11, 13, 17, and 20 |
| | PCBs | | 7-20B | |
| Paint | Metals (lead) | 7-21A | 7-21B | N/A |

The original analytical reports are included in **Appendix F**.

## 7.2 AECs

As identified earlier and for the purpose of this discussion, the site was divided into four AECs depending on their setting, historical use, PCOCs and field investigations. The different areas are listed below:

AEC 1 – Up Gradient Buried Debris;
AEC 2 – Vehicle Dump;
AEC 3 – Main Landfill; and
AEC 4 – Down Gradient;

A summary of the AECs and PCOCs is provided in **Table 4-2**; Section 4.8. Sampling locations for the various AECs and sampled media are provided on **Figures 4 through 9**. Analytical Results for the various AECs and sampled media are proved on **Figures 10 through 21**.

## 7.3 Background Sites

### 7.3.1 Background Sampling Locations

Background sample locations were collected, during the 2008 field investigation, from two sites located up river (Sylvia Grinnell River) from AEC 4 where no evidence of impacts from the community landfill or any other source was visible. Surface water and sediment samples were collected along the shoreline of the river and soil and vegetation samples were collected approximately ten meters inland. All background samples were submitted for metals analysis. (See **Figure 5** for sample locations and analytical results).

### 7.3.2 Field Observations

Background sample station one (BK-1) was located approximately 2.20 kilometres upriver from the main landfill. Background sample station two (BK-2) was 200 meters downstream of BK-1 at a distance of 2 kilometres from the landfill. At both locations, similar site conditions were observed, including topography and vegetation characteristics. Inland samples (soil and vegetation) were taken from grass areas between the shoreline and the bedrock outcrops approximately 10 meters inland.

Each soil sample was a composite of three sub samples collected from the overburden unit, not including the surface organic layer (0.025 m). There was no visible evidence of point or nonpoint source activities in the area. No debris or other objects were identified during the background sampling activities.

Background vegetation samples were collected in locations corresponding with the soil samples. Composite samples were collected from the low lying blueberry bushes adjacent to TP-BK locations. Three handfuls of blueberries were collected in sterile polyethylene bags.

Surface water and sediment samples were collected from two locations on the shoreline of the Sylvia Grinnell River. SD-BK-1 and SD-BK-2 and their corresponding surface water samples were collected roughly 1.5 m out from the shore where the water depth was approximately 1 m deep. The shoreline was rock outcrop, with no appreciable littoral zone. No aquatic vegetation was collected at either location as no macrophytes were observed.

The pH of both surface water samples was slightly alkaline (>6.5) and hardness was low (31.9 and 15.9 mg/L). The water was clear and colourless, and sediments were characterized by the same fine to coarse, sand and small gravel that was typical of the sediments within the river.

### 7.3.3 Results of Chemical Analysis

#### 7.3.3.1 Soil

Two background soil samples were submitted for total metals analysis. Samples TP-BK-1 and TP-BK-2 were below the applicable EQGs for all metals parameters.

#### 7.3.3.2 Surface Water

Two background surface water samples were submitted for metals analysis. Samples SW-BK-1 and SW-BK-2 were below the applicable EQGs for all metals parameters.

#### 7.3.3.3 Sediment

Two background sediment samples were submitted for metals analysis. Samples SD-BK-1 and SD-BK-2 were below the applicable EQGs for all metals parameters.

#### 7.3.3.4 Vegetation

Two samples were collected as background reference samples and submitted for metals analysis. Samples VEG-BK-1 and VEG-BK-2 were below the applicable EQGs.

## 7.4 AEC 1: Up Gradient Buried Debris

### 7.4.1 Summary of AEC Location and Features

AEC 1 is located up gradient from the vehicle dump (**Figure 6**). AEC 1 is bordered by the property boundary and an access road to the NW and marsh land to the NE and SE. There is a drainage ditch that runs south west on the SW side of the site and then west towards the escarpment. This drainage ditch divides AEC1 from AEC 2.

### 7.4.2 Sampling/Investigation Rationale

The previous environmental investigation conducted by FRANZ (2009) included the collection of three soil samples, one surface water sample and one vegetation sample. Copper and lead in soil exceeded EQGs, as did aluminum in surface water. Debris was observed in test pits, therefore requiring delineation of sub-surface debris.

### 7.4.3 Field Observations

There were three large debris mounds dispersed across the site, as well as one larger pool of water towards the northern extent of AEC 1. There is one drainage path located at the southwest side of AEC 1 and oriented in a west to south configuration, leading from AEC 1 towards the vehicle dump (AEC 2). There is a marshy area to the east and southeast side of the site.

Site stratigraphy (0.0 to 1.6 m bgs) can be generalized as a brown fine to coarse sand, gravel and cobble mix with buried debris. Permafrost was encountered at 1.6 to 1.7 m bgs. The buried debris was observed in AEC1-TP09-1 and AEC1-TP09-6 and included tires, drums, wood, iron bracing, vehicle parts, rubber hose, cable wire, and rods. There was visible debris protruding from the ground surface on the debris mounds.

Hydrocarbon odours were observed in AEC1-TP09-3-2. Field vapour screening measured from 0 to 5 ppm.

### 7.4.4 Results of Chemical Analysis of Environmental Media

#### 7.4.4.1 Soil

**2009**

A total of seven test pits were excavated using a backhoe. Eight samples and one duplicate were collected in AEC 1. Five samples were submitted for total metals, four samples plus one duplicate for PHCs, two samples plus one duplicate for PAHs, four samples plus one duplicate for PCBs and one sample plus one duplicate for pesticides and herbicides.

The analytical results are provided in **Tables 7-1A** through **7-6A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 10**.

Total Metals Impacts

Sample AEC1-TP09-5-1, collected closest to the drainage ditch on the southwest side of AEC 1 exhibited an exceedance of lead (150 µg/g) greater than the CCME PL EQG but lower than the CCME CL EQG. The remaining samples analyzed for metals did not exceed the EQGs.

Petroleum Hydrocarbon Impacts

Sample AEC1-TP09-3-2 exceeded the F1 CCME PL with a concentration of 180 µg/g but was below the CCME CL EQG. The same sample also exceeded in F2 (1100 µg/g) and F3 (3900 µg/g) for both CCME PL and CL EQGs.

Polycyclic Aromatic Hydrocarbons Impacts

Samples AEC1-TP09-1-1 and AEC1-TP09-3-2 were analyzed for PAHs. Both samples were below the applicable EQGs.

Polychlorinated biphenyls Impacts

Samples AEC1-TP09-1-2, -3-2, -4-1 and -5-2, plus TP09-DUP1 were analyzed for PCBs. All samples were below the applicable EQGs.

Pesticide/Herbicide Impacts

Samples AEC1-TP09-3-2 and TP09-DUP1 were submitted for pesticide and herbicide analysis. Both samples were below the applicable EQGs.

**2008**

The sampling program at AEC 1 (formerly APEC 1) included three soil samples (A1-TP08-1, -2 and -3), one surface water sample (A1-SW08-1) and one vegetation sample (VEG-6).

The analytical results are provided in **Tables 7-1B** through **7-6B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 10**.

Total Metals Impacts

Samples A1-TP08-1, A1-TP08-2, and A2-TP09-3 were submitted for metals analysis. Sample A1-TP08-1 exhibited a copper concentration of 103 mg/kg which exceeds both the CCME PL and CL EQGs. The same sample contains a lead concentration (190 mg/kg) which exceeds the CCME PL EQG (140 mg/kg) but remains lower than the CL EQG. Metal analytical results from test pits A1-TP08-2 and 3 were below the CCME PL and CL EQGs.

Petroleum Hydrocarbon Impacts

Sample A1-TP08-3 was submitted for PHCs analysis. The sample was below the applicable EQG.

Polychlorinated biphenyls Impacts

Sample A1-TP08-3 was submitted for PCBs analysis. The sample was below the applicable EQG.

Pesticide/Herbicide Impacts

Sample A1-TP08-3 was submitted for pesticide analysis. The sample was below the applicable EQG.

#### 7.4.4.2 Surface water

**2009**

One surface water sample was taken from AEC 1 and analyzed for PHCs, metals, PAHs, VOCs, PCBs, pesticides and herbicides. There were no exceedances of PHCs, PAHs, VOCs, PCBs, pesticides or herbicides. AEC1-SW09-1 exceeded CCME freshwater EQG of 5 µg/L for aluminum with a concentration of 9 µg/L, chromium guidelines of 1.5 µg/L with a concentration of 2.8 µg/L and lead guidelines of 300 µg/L with a concentration of 2200 µg/L.

The analytical results are provided in **Tables 7-7A** through **7-12A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 11**.

**2008**

Metals and PCBs were analyzed from the surface water sample A1-SW08-1 collected at AEC 1 (formerly APEC 1). Metal analytical results indicated that the aluminum concentration (14.4 µg/L) was greater than the CCME FWAL EQG of 5 µg/L. PCB concentrations were below the laboratory detection limit.

The analytical results are provided in **Tables 7-7B** through **7-12B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 11**.

#### 7.4.4.3 Sediment

**2009**

One sediment sample was collected in AEC 1 and analyzed for PHCs, metals, PAHs, PCBs, VOCs and pesticides and herbicides. AEC1-SD09-1 exceeded both the CCME ISQG and PEL freshwater sediment EQGs for total DDD. DDE and DDT in the same sample exceeded the CCME ISQG freshwater EQG but remained below the PEL. All other parameters were below the selected EQGs.

The analytical results are provided in **Tables 7-13A** through **7-18A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 12**.

#### 7.4.4.4 Vegetation

**2009**

Two vegetation samples (one terrestrial and one aquatic), and one duplicate sample were collected in AEC 1 (AEC1-AQ-VEG09-1 and AEC1-VEG09-1). AEC1-AQ-VEG09-1 exceeded MOE-ULN EQGs for manganese, molybdenum and sodium with concentrations of 321 µg/g, 1.52 µg/g and 120 µg/g, where the MOE-ULN guidelines were 50 µg/g, 1.5 µg/g and 50 µg/g, respectively. AEC1-VEG09-1 was analyzed for metals and PCBs and concentrations were below the EQGs.

The analytical results are provided in **Tables 7-19A** and **7-20A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 11**.

**2008**

One representative vegetation sample (VEG-6) from AEC 1 (formerly APEC 1) was submitted for metals and PCBs analysis. Metal results are below the MOE-ULN EQGs and PCB results are lower than the laboratory detection limit.

The analytical results are provided in **Tables 7-19B** and **7-20B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 11**.

### 7.4.5 Chemical Impacts Summary – AEC 1

#### 7.4.5.1 Impacted Soils

**Evaluation of Metal Impacts in Soil**

Metal impacted soil was identified in AEC 1 in two samples. Exceedances of lead were identified in both samples above the PL EQG. Copper also exceeded both the PL and CL EQG in one of the samples. Elevated metals concentrations are likely associated with the buried metal debris identified in the area and the use of lead paint on metal debris.

**Evaluation of Hydrocarbon Impacts in Soil**

Hydrocarbon impacts were identified in AEC 1 in one sample location (AEC1-TP09-3-2). Exceedances of PHC F1, F2, and F3 exceeding both the PL and CL EQG were present. Buried drums were noted during test pitting in the area and the identified impacts are likely directly associated with these sources. Two test pits were advanced (AEC1-TP09-6 and -7) in an attempt to delineate the suspected hydrocarbon impacts. Although no chemical analysis was conducted on either of the delineation test pits, field observations and olfactory evidence indicated the absence of PHC impacts. Therefore, it is suspected that the PHC impact identified is discrete location. It should be noted that no delineation test pitting was possible to the ENE due to wet boggy conditions.

**Evaluation of PAH, PCB & Pesticide Impacts in Soil**

PAH, PCB and pesticide exceedances were not identified in soil and therefore are not considered an issue.

The following table summarizes the results of the soil investigation in AEC 1.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | PL | CL |
| Metals | lead | yes | no |
| | copper | yes | yes |
| Petroleum Hydrocarbons | PHC fractions F1, F2, F3 | yes | yes |
| PAHs, PCBs and Pesticides | no impacts reported | no | no |

### 7.4.5.2 Impacted Surface Water

**Evaluation of Metal Impacts in Surface Water**

Metal impacted surface water was identified in AEC 1 in samples collected in 2008 and 2009. Concentrations exceeded the freshwater EQG for aluminum, lead, and chromium. The only surface water available for surface water sampling in AEC 1 was stagnant ponded water with no active recharge or discharge. Elevated metal concentrations are likely due to the dissolution of buried metal waste and chemical loading of the localized surface waters.

**Evaluation of PHC, VOC, PAH, PCB & Pesticide Impacts in Surface Water**

PHC, VOC, PAH, PCB, and pesticide exceedances were not identified in surface water and therefore are not considered an issue.

The following table summarizes the results of the Surface Water investigation in AEC 1.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **freshwater** | **marine** |
| Metals | aluminum | yes | N/A |
| | lead | yes | N/A |
| | chromium | yes | N/A |
| Petroleum Hydrocarbons | no impacts reported | yes | N/A |
| PAHs, VOCs, PCBs and Pesticides | no impacts reported | no | N/A |

### 7.4.5.3 Impacted Sediment

**Evaluation of Pesticide Impacts in Sediment**

Pesticide impacts in sediment were identified in the one and only sample analyzed in AEC 1. DDD exceeded both the ISQG and PEL freshwater EQGs. DDE and DDT exceeded only the ISQG freshwater EQGs.

**Evaluation of Metal, PHC, PAH, & PCB Impacts in Sediment**

Metal, PHC, PAH, and PCB exceedances were not identified in sediments and therefore are not considered an issue.

The following table summarizes the results of the Surface Water investigation in AEC 1.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **ISQG** | **PEL** |
| Pesticides | DDD | yes | yes |
| | DDE | yes | no |
| | DDT | yes | no |
| Metals | no impacts reported | no | no |
| Petroleum Hydrocarbons | no impacts reported | no | no |
| PAHs and PCBs | no impacts reported | no | no |

### 7.4.5.4 Impacted Vegetation

Two terrestrial and one aquatic vegetation samples were analyzed. The two terrestrial samples contained concentrations below the applicable EQGs, while the one aquatic sample exhibited concentrations of manganese, molybdenum and sodium elevated above the applicable EQG. The following table summarizes the results of the vegetation investigation in AEC 1.

| COC | Description |
|---|---|
| Metals | • metal concentrations of manganese, molybdenum and sodium as exceendances. |
| PCBs | • no impacts reported |

## 7.5 AEC 2: Vehicle Dump

### 7.5.1 Summary of AEC Location and Features

AEC 2 is located to the east of the main Landfill (AEC 3) and downgradient of AEC 1 (**Figure 7**). AEC 2 has been used as a disposal area for trucks, cars, trailers, boilers, tankers and other large mechanical debris. There is a main drainage channel that runs along the AEC1 and AEC 2 divide, through the debris pile towards the escarpment, through two small freshwater ponds (Ponds 5 and 6) and one brackish pond (Pond 6 in AEC 4) eventually discharging into Sylvia Grinnell River. Major features located in AEC 2 include the large vehicle debris pile and the drainage channel that traverses AEC towards the river. Two small ponds (Ponds 5 and 6) are also located in AEC 2

### 7.5.2 Sampling/Investigation Rationale

The previous environmental investigation conducted by FRANZ (2009) included the collection of three soil samples, six surface water and sediment samples and one vegetation sample. Analytical results from 2008 found exceedances in soils (metals and PCBs), sediments (metals and pesticides), surface water (metals) and vegetation (metals). Further delineation of impacts and confirmation sampling was required.

### 7.5.3 Field Observations

The upper portion (adjacent to AEC 1) of AEC 2 is a low lying wet grassy area. Moving downgradient the vehicle debris area is encountered, which lies on the bedrock outcrop escarpment. The drainage channel runs parallel to the divide from AEC 1 in the low lying grassy area through the vehicle debris and down the escarpment. At the bottom of the escarpment are two small ponds (Pond 5 and 6) connected to the drainage channel. Debris is present throughout the AEC. The large vehicles and metal pieces are concentrated along the bedrock outcrops and smaller items of waste is scattered in the low lying grassy area and throughout the escarpment area.

### 7.5.4 Sampling

In some instances sediment and surface water samples were collected in the same locations as in the 2008 field investigation in order to confirm/refute the presence of COCs/PCOCs. Due to the increased sample density of the 2009 field sampling, sample numbers do not correspond. The following **Table 7-2** summarizes the samples collected in AEC 2 and arrows indicate the relationship between sample locations.

**Table 7-2**: Sample Relationships – AEC 2

| Area | Medium | Year | |
|---|---|---|---|
| | | **2009** | **2008** |
| APEC 2 / AEC 2 - Vehicle Dump | Sediment | AEC2-SD09-1 --> | A2-SD08-1 |
| | | AEC2-SD09-4 --> | A2-SD08-2 |
| | | AEC2-SD09-5 --> | A2-SD08-3 |
| | | AEC2-SD09-7 --> | A2-SD08-4 |
| | | AEC2-SD09-8 --> | A3-SD08-4 |
| | | AEC2-SD09-10 --> | A3-SD08-3 |
| | Surface Water | AEC2-SW09-1 --> | A2-SW08-1 |
| | | AEC2-SW09-4 --> | A2-SW08-2 |
| | | AEC2-SW09-5 --> | A2-SW08-3 |
| | | AEC2-SW09-7 --> | A2-SW08-4 |
| | | AEC2-SW09-8 --> | A3-SW08-4 |
| | | AEC2-SW09-10 --> | A3-SW08-3 |

Note: Arrow indicates samples collected at the same physical location

Eleven surface water and sediment samples were collected at intermittent locations along the drainage channel. Sediments have been generally characterized as being a dark grey to brown, fine to coarse sand and gravel. Orange staining was also observed at sample locations within the vehicle dump. Three surface soil samples were collected from the flat bedrock area within the vehicle dump. The soils in this AEC have been characterized as being dark brown, fine to medium sand with trace gravel and some organics. The three vegetation samples were collected from the bottom of the escarpment. The aquatic vegetation samples were collected from Ponds 5 and 6, while the terrestrial sample was collected just along the shoreline of Pond 6 beside the inlet from the drainage channel. Two paint samples were also collected from vehicles in AEC 2.

### 7.5.5 Results of Chemical Analysis of Environmental Media

### 7.5.5.1 Soil

__**2009**__

A total of three shallow test pits were excavated to bedrock by hand. Three samples and one duplicate were submitted for PHCs, PCBs and metals.

The analytical results are provided in **Tables 7-1A** through **7-6A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 13**.

Total Metals Impacts

Samples AEC2-TP09-1 and AEC2-TP09-2 were analyzed for metals. AEC2-TP09-2 reported an exceedance of CCME PL and CL EQG for copper at 93 µg/g. AEC2-TP09-1 did not exceed the EQGs.

Petroleum Hydrocarbon Impacts

Samples AEC2-TP09-1, AEC2-TP09-2, and AEC3-TP09-1 were analyzed for PHCs. All samples were below the applicable EQGs.

Polychlorinated biphenyls Impacts

Samples AEC2-TP09-1, AEC2-TP09-2, and AEC3-TP09-1 were analyzed for PCBs. Two samples (AEC2-TP09-1, -2) exceeded the CCME PL EQG with concentrations of 12 µg/g and 9 µg/g respectively but remained below the CCME CL EQG. AEC3-TP09-1 was below the applicable EQGs.

### 2008

A total of three shallow test pits (A2-TP08-1, A2-TP08-2 and A3-TP08-2) were excavated to bedrock by hand at AEC 2 (formerly APEC 2). Samples were submitted for PHCs, metals, PCBs, VOCs, PAHs and pesticide analysis.

The analytical results are provided in **Tables 7-1B** through **7-6B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 13**.

Total Metals Impacts

Sample A2-TP08-1 exceeded the CCME PL and CL EQGs for cadmium with a concentration of 22.4 µg/g. A2-TP08-2 and A3-TP08-1 were below the applicable EQGs.

Petroleum Hydrocarbon Impacts

Samples A2-TP08-1 and A2-TP08-2 were analyzed for PHCs. Both samples were below the applicable EQGs. A3-TP08-2 exceeded the PL and CL EQGs for F2, F3, and F4 at 450, 44,400, and 6,960 mg/kg respectively.

Polychlorinated biphenyls Impacts

Samples A2-TP08-1 and A3-TP09-2 were submitted for PCBs analysis. Both samples exceeded the total PCB CCME PL EQG but remained below the CCME CL EQG.

Polycyclic Aromatic Hydrocarbon Impacts

Samples A2-TP08-1 and A2-TP09-2 were submitted for PAH analysis. Both samples were below the applicable EQGs.

Volatile Organic Compound Impacts

Samples A2-TP08-1 and A2-TP09-2 were submitted for VOC analysis. Both samples were below the applicable EQGs.

Pesticide Impacts

Samples A2-TP08-1 and A2-TP09-2 were submitted for pesticide analysis. Both samples were below the applicable EQGs.

#### 7.5.5.2 Surface water

**2009**

A total of eleven surface water samples and one duplicate sample were submitted at AEC 2 and analyzed for PHCs, metals, PAHs, VOCs, PCBs, pesticides and herbicides. There were no exceedances of CCME freshwater EQGs for PHCs, PAHs, VOCs, pesticides and herbicides. All samples analyzed for PCBs were below detection limits.

The analytical results are provided in **Tables 7-7A** through **7-12A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 14**.

Total Metals Impacts

Three samples submitted for metals analysis exceeded CCME freshwater EQG of 5 µg/L for aluminum and ten samples exceeded CCME FWAL EQG of 300 µg/L for iron. AEC2-SW09-2 had an aluminum concentration of 6 µg/L and iron concentration of 620 µg/L. AEC2-SW09-3 exceeded with an aluminum concentration of 6 µg/L and iron of 320 µg/L. AEC2-SW09-4 had an aluminum concentration of 45 µg/L, 9x the EQG and iron with a concentration of 1400 µg/L, >4x the EQG. AEC-SW09-5 exceeded for iron with a concentration of 8900 µg/L which is >29x the EQG and AEC2-SW09-6 exceeded with a concentration of 1700 µg/L, >5x the EQG. AEC2-SW09-7 and AEC-SW09-8 exceeded the EQG for iron with concentrations of 560 µg/L and 810 µg/L respectively. AEC2-SW09-9, and its duplicate SW09-DUP1, both exceeded for iron with concentrations >2x the EQGs. AEC2-SW09-10 and AEC-SW09-11 also exceeded the applicable EQGs with iron concentrations of 790 µg/L and 420 µg/L.

**2008**

Five surface water samples were collected during the 2008 sampling event. Samples were submitted for PHCs, metals, PCBs and pesticides. All samples that were submitted for PHCs, PCBs and pesticides were found to be below CCME FWAL EQGs.

The analytical results are provided in **Tables 7-7B** through **7-12B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 14**.

Total Metals Impacts

Four samples exceeded EQGs for metals. A2-SW08-1 exceeded aluminum EQG of 5 µg/L with a concentration of 28.8 µg/L, cadmium EQG of 0.017 µg/L with a concentration of 0.047 µg/L and copper EQG of 2 µg/L with a concentration of 3.7 µg/L. A2-SW08-2 exceeded EQGs for aluminum and copper with concentrations of 11.2 µg/L and 3.7 µg/L respectively. A2-SW08-3 exceeded an EQG of 1 µg/L for lead with a concentration of 2 µg/L. In addition, A2-SW08-3 was also above EQGs for aluminum, cadmium and copper. A2-SW08-4 exceeded for aluminum, cadmium and copper with concentrations of 24.7 µg/L, 0.087 µg/L and 2.3 µg/L.

#### 7.5.5.3 Sediment

**2009**

A total of eleven sediment samples were collected in AEC 2 and analyzed for PHCs, metals, PCBs, pesticides and herbicides.

The analytical results are provided in **Tables 7-13A** through **7-18A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 15**.

Total Metals Impacts

A total of ten samples, plus one duplicate contained exceedances for metals. AEC2-SD09-2 exceeded zinc freshwater sediment ISQG of 123 ug/g with a concentration of 230 ug/g. AEC2-SD09-3 and AEC2-SD09-4 exceeded CCME CL use EQG for chromium IV and ISQG for zinc. AEC2-SD09-5 exceeded freshwater PEL EQG of 3.5 ug/g for cadmium and 91 ug/g for lead with concentrations of 6.1 ug/g and 150 ug/g respectively, as well as freshwater ISQG EQGs for total chromium and zinc. AEC2-SD09-6 had exceedances of EQGs for cadmium, chromium VI, copper, lead and zinc. Sample AEC2-SD09-7 exceeded CCME PEL for cadmium and lead with concentrations of 4.4 ug/g and 150 ug/g and CCME ISQG for copper and zinc with concentrations of 42 ug/g and 300 ug/g. Cadmium, lead and zinc exceeded CCME PEL EQGs for AEC2-SD09-8, as did chromium and copper for CCME ISQG EQGs. Samples AEC2-SD09-9, AEC2-SD09-10 and AEC2-SD09-11 all were in exceedance of EQGs for cadmium, lead and zinc.

Petroleum Hydrocarbon Impacts

A total of eleven samples plus one duplicate were submitted for PHC analysis. Six samples had exceedances for PHC fractions F2, F3 or F4. AEC2-SD09-4 exceeded CCME CL use EQGs for F2 (240 µg/g), F3 (1700 µg/g) and F4 (3300 µg/g) with concentrations of 1500 µg/g, 4100 µg/g and 4500 µg/g respectively. AEC2-SD09-6 was in exceedance of CCME PL EQG of 300 µg/g for F3 with a concentration of 620 µg/g. AEC2-SD09-7 had an F3 concentration of 330 µg/g, which was just above the CCME PL EQG. AEC2-SD09-9 exceeded CCME PL use EQGs with concentrations of 180 µg/g for F2 and 1000 µg/g for F3. Sample AEC2-SD09-10 had a F3 concentration of 470 µg/g, just above the EQG of 300 µg/g. AEC2-SD09-11 had a F2 concentration of 1500 µg/g, 10x the EQG of 150 µg/g and a F3 concentration of 1200 ug/g, 4x the CCME PL EQG.

Polychlorinated biphenyls Impacts

A total of eleven samples plus one duplicate were submitted for PCBs analysis. Nine of these were in exceedance of both the CCME ISQG (0.0341 µg/g) and PEL (0.277 µg/g) EQGs. AEC2-SD09-2 and AEC2-SD09-8 were just above the EQG with concentrations of 0.3 µg/g. AEC2-SD09-4 and AEC2-SD09-7 were >2x the EQG with a concentration of 0.7 µg/g. AEC2-SD09-5 exceeded the EQG with a concentration of 0.6 µg/g. AEC2-SD09-6 and AEC2-SD09-11 had concentrations of 2.0 µg/g, >7x the EQG. AEC2-SD09-9 had a concentration of total PCBs at 15 µg/g, which is >54x the EQG. Finally, AEC2-SD09-10 was above the EQG with a concentration of 1.0 µg/g.

Pesticide Impacts

A total of eleven samples plus one duplicate were submitted for pesticides and herbicides analysis. Ten samples exceeded either the CCME ISQG or PEL EQGs for one or more parameters. AEC2-SD09-1, AEC2-SD09-2, AEC2-SD09-3, and AEC2-SD09-6 exceeded both CCME ISQG and PEL EQGs for total DDD, total DDE and total DDT with the highest concentrations found in AEC2-SD09-2 at 0.26 µg/g for DDD, 0.055 µg/g for DDE, and 0.29 µg/g for DDT. Samples AEC2-SD09-4, AEC2-SD09-9, AEC2-SD09-10, and AEC2-SD09-11 all exceeded both CCME ISQG and PEL EQGs for total DDD and total DDE. Sample AEC2-SD09-7 exceeded CCME ISQG for DDE and both the ISQG and PEL for DDD and AEC2-SD09-8 exceeded CCME ISQG for DDD.

### 2008

Six sediment samples were collected during the 2008 sampling event. Samples were submitted for PHCs, metals, PCBs, PAHs, VOCs and pesticides. All samples that were submitted for PHCs, PAHs and VOCs were found to be below applicable CCME ISQG and PEL EQGs.

The analytical results are provided in **Tables 7-13B** through **7-18B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 15**.

Total Metals Impacts

All six samples were submitted for metals analysis and had one or more parameters that exceeded either the CCME ISQG or PEL EQGs. A2-SD08-1 exceeded both the ISQG and PEL EQGs for zinc at a concentration of 499 µg/g. A2-SD08-2 exhibited copper exceedances of the CCME PEL EQG with a concentration of 292 µg/g. A2-SD08-3 exceeded both the ISQG and PEL EQGs for lead and the ISQG EQGs for cadmium, chromium, copper. A2-SD08-4 exhibited exceedances of the ISQG EQG for arsenic, cadmium, chromium, and copper, as well as exceedances of both the ISQG and PEL EQGs for lead and zinc. Both A3-SD08-3 and A3-SD08-4 exhibited exceedances of the ISQG EQGs for cadmium, lead, and zinc.

Petroleum Hydrocarbon Impacts

Six samples were submitted for PCH analysis. Sample A3-SD08-3 exhibited concentrations of F2 (535 µg/g) above the CCME CL EQG and F3 (568 µg/g) above the CCME PL EQG. All other samples were below the selected EQGs.

Polychlorinated biphenyls Impacts

Three samples were submitted for PCB analysis. A2-SD08-3 exceeded the CCME ISQG EQG of 0.034 µg/g for total PCBs with a concentration of 0.22 µg/g. A2-SD08-4 exceeded the CCME PEL EQG of 0.277 µg/g for total PCBs with a concentration of 0.56 µg/g. A3-SD08-4 exceeded both the ISQG and PEL EQGs for PCBs at a concentration of 0.496 µg/g.

Pesticide Impacts

One sample (A2-SD08-4) was submitted for pesticides analysis. There were exceedances of CCME ISQG EQG for DDD and CCME PEL EQG for DDE and DDT.

#### 7.5.5.4 Vegetation

**2009**

There were two aquatic and one terrestrial vegetation samples collected in AEC 2. Samples were submitted for metals analysis. The manganese concentration in AEC2-AQ-VEG09-1 was above the MOE-ULN guideline of 50 µg/g at 68.4 µg/g. AEC1-AQ-VEG09-1 also exceeded for sodium with a concentration of 293 µg/g, >5x the EQG of 50 ug/g. AEC2-AQ-VEG09-2 exceeded EQGs for iron, manganese and sodium, where concentrations were 894 µg/g, 309 µg/g and 1570 µg/g respectively. AEC1-VEG09-1 had concentrations below all applicable EQGs.

The analytical results are provided in **Tables 7-19A** and **7-20A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 13**.

**2008**

One vegetation sample (VEG-4) was collected from APEC 2 and submitted for metals and PCBs analysis. VEG-4 exceeded MOE-ULN sodium EQG of 50 ug/g with a concentration of 55 ug/g. PCB parameters were below the applicable EQGs.

The analytical results are provided in **Tables 7-19B** and **7-20B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 13**.

#### 7.5.5.5 Paint

Two paint samples were collected from the vehicle pile located at AEC 2. Both samples, AEC2-PB09-1 (ORANGE) and AEC2-PB09-2 (GREEN), exceeded the Northwest Territories (NWT) EQGs for lead in paint of 600 mg/kg at 75,000 mg/kg and 57,000 mg/kg respectively.

### 7.5.6 Chemical Impacts Summary – AEC 2

#### 7.5.6.1 Impacted Soils

**Evaluation of Metal Impacts in Soil**

Metal impacted soil was identified in AEC 2 in two samples. Exceedances of copper were identified in one sample above the PL and CL EQG. Cadmium also exceeded the PL EQG in one sample. Elevated metals concentrations are likely associated with the buried metal debris identified in the area.

**Evaluation of Hydrocarbon Impacts in Soil**

Hydrocarbon impacts were identified in AEC 2 in one sample location (A3-TP08-2). Exceedances of PHC F2, F3, and F4 exceeding both the PL and CL EQG were present. The impacted soil sample was collected in an area of soil staining directly downgradient of buried waste debris. One delineation test pit was advanced downgradient and reported concentrations below the applicable EQGs. Bedrock outcropping prevented delineation test pitting on the east and west sides of the impacted sample.

**Evaluation of PCB Impacts in Soil**

PCB impacts were detected in AEC 2 in one sample (A3-TP08-2). Exceedances of the PL EQG were reported. The impacted soil sample was collected in an area of soil staining directly downgradient of buried waste debris. One delineation test pit was advanced downgradient and reported concentrations below the applicable EQGs. Bedrock outcropping prevented delineation test pitting on the east and west sides of the impacted sample.

**Evaluation of PAH, VOCs & Pesticide Impacts in Soil**

PAH, VOCs and pesticide exceedances were not identified in soil and therefore are not considered an issue.

The following table summarizes the results of the soil investigation in AEC 2.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | PL | CL |
| Metals | copper | yes | yes |
| | cadmium | yes | no |

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **PL** | **CL** |
| Petroleum Hydrocarbons | PHC fractions F2, F3, F4 | yes | yes |
| PCBs | Total PCBs (1260) | yes | no |
| PAHs, VOCs and Pesticides | no impacts reported | no | no |

### 7.5.6.2 Impacted Surface Water

**Evaluation of Metal Impacts in Surface Water**

Metal impacted surface water was identified in AEC 2 in samples collected in 2008 and 2009. Concentrations exceeded the freshwater EQG for aluminum (7), cadmium (3), copper (3), iron (10), and lead (1). Surface water was collected from the drainage running directly through the vehicle dump area. Elevated metal concentrations are believed to be associated with the dissolution of exposed metal waste and chemical loading of the localized soils, sediment, and surface water.

Samples collected during the 2008 event reported exceedances of cadmium (3), copper (3), and lead (1). It should be noted that samples collected during the 2009 event failed to replicate the aforementioned exceedances and only exhibited exceedances in aluminum (3) and iron (10).

**Evaluation of PHC, VOC, PAH, PCB & Pesticide Impacts in Surface Water**

PHC, VOC, PAH, PCB, and pesticide exceedances were not identified in surface water and therefore are not considered an issue.

The following table summarizes the results of the Surface Water investigation in AEC 2.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **freshwater** | **marine** |
| Metals | aluminum | yes | N/A |
| | cadmium | yes | N/A |
| | copper | yes | N/A |
| | iron | yes | N/A |
| | lead | Yes | N/A |
| PHCs, PAHs, VOCs, PCBs and Pesticides | no impacts reported | no | N/A |

### 7.5.6.3 Impacted Sediment

**Evaluation of Metal Impacts in Sediment**

Metals impacts in sediment were identified in AEC 2 in sixteen samples from the 2008 and 2009 sampling events. Concentrations exceeded only the ISQG EQG for arsenic (1), cadmium (6), chromium (5), copper (5), lead (5), and zinc (11). Concentrations exceeded both the ISQG and PEL EQGs for copper (1), cadmium (3), lead (5), and zinc (3). Chromium VI exceeded the

CCME PL EQG for soil in three sediment samples. Elevated metal concentrations are believed to be associated with the dissolution of exposed metal waste and chemical loading of the localized soils, sediment, and surface water.

### Evaluation of PHC Impacts in Sediment

Hydrocarbon impacts in sediment were identified in AEC 2 in six samples collected in the 2009 sampling event; however, the six samples analyzed from the 2008 event reported only one sample with exceedances of the applicable CCME soil criteria. Elevated concentrations above the CCME PL EQG, but below the CL EQG were detected for PHC F2 (1) and F3 (5). Elevated concentrations above the CCME CL EQG were detected for PHC F2 (3), F3 (2), and F4 (1). Elevated PHC concentrations are likely due to the disposal of fuel drums and vehicle fuel tanks in the area and directly in the drainage pathway. Some historical fuel spillage in the area (as indicated by localized soil staining in the vicinity of the drainage) is also likely.

### Evaluation of PCB Impacts in Sediment

PCB impacts in sediment were identified in AEC 2 in twelve samples collected during the 2008 and 2009 sampling events. Eleven samples exceeded the PEL EQGs and one sample exceeded only the ISQG EQG for total PCBs. PCB concentrations are higher downgradient of the vehicle dump, indicating that impacts are likely directly related to the disposal of vehicles and associated vehicle fluids in the drainage pathway. Higher PCB concentrations in downgradient sample locations are likely a product of loading over time.

### Evaluation of Pesticide Impacts in Sediment

Pesticide impacts in sediment were identified in AEC in eleven samples collected during the 2008 and 2009 sampling events. Pesticide concentrations exceeded the ISQG EQG for DDD (2) and DDE (2). Furthermore, pesticide concentrations exceeded both the ISQG and PEL EQGs for DDD (9), DDE (9), and DDT (5).

### Evaluation of PAH and VOC Impacts in Sediment

PAHs and VOCs exceedances were not identified in sediment and therefore are not considered an issue.

The following table summarizes the results of the Sediment investigation in AEC 2.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | ISQG | PEL |
| Metals | arsenic | yes | no |
| | cadmium | yes | yes |
| | chromium | yes | no |
| | chromium VI | CCME PL Soil EQG | |

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **ISQG** | **PEL** |
| | copper | yes | yes |
| | lead | yes | yes |
| | zinc | yes | yes |
| PHCs<br>(CCME PL and CL EQGs for soil used for comparison only) | F2 (PL/CL) | N/A | N/A |
| | F3 (PL/CL) | N/A | N/A |
| | F4 (CL) | N/A | N/A |
| PCBs | PCBs | yes | yes |
| Pesticides | DDD | yes | yes |
| | DDE | yes | yes |
| | DDT | yes | yes |
| PAHs and VOCs | no impacts reported | no | no |

### 7.5.6.4 Impacted Vegetation

Two terrestrial samples and two aquatic vegetation samples were collected in AEC 2 during the 2008 and 2009 sampling events. Samples reported exceedances of manganese (2), iron (1), and sodium (3). Vegetation metals impacts (manganese and iron) were only identified in the aquatic samples and are believed to be related to the disposal of metallic debris in the area. High sodium concentrations are likely a product of the sites close proximity to saline ocean water.

The following table summarizes the results of the vegetation investigation in AEC 2.

| COC | Description |
|---|---|
| Metals | • metal concentrations of manganese, iron, and sodium as exceendances. |
| PCBs | • no impacts reported |

## 7.6 AEC 3: Main Landfill

### 7.6.1 Summary of AEC Location and Features

AEC 3 is bordered by AEC 4 to the south, which lies adjacent to Sylvia Grinnell River, and AEC 2 to the east. The main landfill area consists of a mixture of debris and wastes spread across a steep graded bedrock slope (~70%). The top of the landfill has been capped with granular material and the toe is left exposed with debris scattered throughout the area. The majority of the landfill material is located within AEC 3.

Major features located in AEC 3 include the main landfill and Pond 3. At the bottom of the escarpment there are two small barrel caches, approximately 15 m apart, where a stained area is visible between. There are two low lying wet areas where ponded water can accumulate.

These wet areas are located in the apparent drainage pathways from the west side escarpment/landfill towards Pond 1 and Pond 2. (See **Figure 8**).

### 7.6.2 Sampling/Investigation Rationale

The previous environmental investigation conducted by FRANZ (2009) included the collection of 18 soil samples, four surface water and sediment samples and four vegetation samples. Analytical results from 2008 found exceedances in soils (PHCs, metals and PCBs), sediments (metals and PCBs), surface water (metals) and vegetation (metals). Further delineation of impacts and confirmation sampling was required.

### 7.6.3 Field Observations

The main landfill in AEC 3 was created by dumping the debris and wastes on the top of the escarpment and bulldozing it over the edge towards the river. Attempts to cap the landfill were likely accomplished in the same manner. Four exploratory test pits were excavated on top of the landfill to gather information on the depth of the capped material and it was observed that the maximum depth to debris was 0.15 m.

Soil vapour readings measured between 0 and 5 ppm.

### 7.6.4 Sampling

Five soil samples were collected at the bottom of the escarpment. Two test pits were along the drainage area pathways into Ponds 1 and 2, two adjacent to the barrel cache and stained area and one along the bedrock ridges down the side of the escarpment. The soils at the bottom of the escarpment (toe of landfill) are characterized as black/brown fine to medium sand, some silt and gravel and some organics. Three surface water and sediment samples were collected from Pond 3. Samples were taken from the north, south and west side of Pond 3. Sediments collected from Pond 3, one of the largest ponds on the site, are characterized as being black, fine to coarse sand and gravel, no organics, no decomposition and no odour. One aquatic vegetation sample was also collected from the middle of Pond 3. The two terrestrial vegetation samples were collected from the drainage area from the escarpment, one towards Pond 1 and one towards Pond 2.

### 7.6.5 Results of Chemical Analysis of Environmental Media

#### 7.6.5.1 Soil

**2009**

A total of six samples were submitted at AEC 3. Four samples were analyzed for PHCs and total metals, two samples analyzed for PAHs and VOCs, and one sample analyzed for PCBs.
The analytical results are provided in **Tables 7-1A** through **7-6A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 16**.

Total Metals Impacts

Samples AEC3-TP09-4 through AEC3-TP09-7 were analyzed for total metals. All samples were below the applicable EQGs.

Petroleum Hydrocarbon Impacts

Samples AEC3-TP09-1, AEC3-TP09-3, AEC3-TP09-6 and AEC3-TP09-7 were analyzed for PHCs. All samples were below the applicable EQGs.

Polychlorinated biphenyls Impacts

Sample AEC3-TP09-1 was analyzed for PCBs. The sample was below the applicable EQG.

Polycyclic Aromatic Hydrocarbon Impacts

Samples AEC3-TP09-6 and AEC3-TP09-7 were submitted for PAHs analysis. Both samples were below the applicable EQGs.

Volatile Organic Compound Impacts

Samples AEC3-TP09-6 and AEC3-TP09-7 were submitted for VOCs analysis. Both samples were below the applicable EQGs.

**2008**

A total of 18 soil samples were collected at APEC 3. Samples were submitted for PHCs, metals, PCBs, VOCs, PAHs and pesticide analysis.

The analytical results are provided in **Tables 7-1B** through **7-6B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 16**.

Total Metals Impacts

A total of 17 samples plus two duplicates were submitted for metals analysis. Sample A3-TP08-12 indicated a copper concentration of 82 µg/g exceeding the CCME PL EQG of 63 µg/g, a lead concentration of 256 µg/g exceeding the CCME PL EQG of 140 µg/g and a zinc concentration of 488 µg/g exceeding the CCME CL EQG of 360 µg/g. A3-TP08-13 exhibited a zinc exceedance of the CCME PL EQG of 200 µg/g with a concentration of 205 µg/g. A number of samples (A3-TP08-2, -4, -6, -7, -10, -11, and -16 through -18) were outside the pH of 6 to 8. These samples all had pHs ranging from 5.03 to 5.98. All remaining samples were below the applicable EQGs.

Petroleum Hydrocarbon Impacts

A total of 15 samples plus two duplicates were submitted for PHCs analysis. Sample A3-TP08-2 exceeded the CCME CL EGQ for PHC fraction F2 with a concentration of 50 µg/g. A3-TP08-2 also exceeded CCME CL for PHC fraction F3 and F4 with concentrations that were >26x the EQG of 1700 µg/g and >3x the EQG of 3300 µg/g, respectively. A3-TP08-3 was just above the CCME PL EQG for F3 with a concentration of 343 µg/g. All remaining samples were below the applicable EQGs.

Polychlorinated biphenyls Impacts

A total of nine samples and one duplicate were submitted for PCBs analysis. All samples were below the applicable EQGs.

Polycyclic Aromatic Hydrocarbon Impacts

Five samples plus one duplicate were submitted for PAH analysis. Sample A3-TP08-13 exhibited concentrations of benzo(a)anthracene (1.14 µg/g) and benzo(b)flouranthene (1.78 µg/g) were above the CCME PL EQG. Benzo(a)pyrene (1.31 µg/g) reported concentrations above the CL EQGs. All other samples were below the applicable EQGs.

Volatile Organic Compound Impacts

Three samples and one duplicate were submitted for VOC analysis. All samples were below the applicable EQGs.

Pesticide Impacts

Two samples and one duplicate were submitted for pesticide analysis. All samples were below the applicable EQGs.

#### 7.6.5.2 Surface water

**2009**

Three surface water samples were submitted for AEC 3 and analyzed for metals, PCBs, pesticides, and herbicides. There were no exceedances of EQGs for pesticides and herbicides. All samples analyzed for PCBs were below detection limits.

Two samples submitted for metals analysis exceeded CCME FWAL EQGs. Both AEC3-SW09-1 and AEC3-SW09-3 exceeded the CCME FWAL EQG for iron with concentrations of 330 µg/L and 430 µg/L respectively. AEC3-SW09-3 also exceeded the EQG for lead with a concentration of 1 µg/L.

The analytical results are provided in **Tables 7-7A** through **7-12A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 17**.

<u>2008</u>

Two surface water samples were collected during the 2008 sampling event in AEC 3 (formerly APEC 3). Samples were submitted for PHCs, metals, and PCBs. All samples that were submitted for PHCs and PCBs were found to be below CCME FWAL EQGs.

Sample A3-SW08-1 exceeded for aluminum (43.4 µg/L), cadmium (0.129 µg/L), copper (4.7 µg/L), lead (2.77 µg/L), and zinc (163 µg/L). A3-SW08-3 and A3-SW08-4 both exceeded the EQG for cadmium with concentrations of 0.024 µg/L and 0.018 µg/L respectively. The remaining sample (AEC3-SW09-2) was below the applicable EQGs.

The analytical results are provided in **Tables 7-7B** through **7-12B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 17**.

### 7.6.5.3 Sediment

<u>2009</u>

Three sediment samples were collected in AEC 3 and analyzed for PHCs, metals, PCBs, pesticides and herbicides. Based on the bi-daily influx of brackish water during high tide events, marine sediment guidelines were applied.

The analytical results are provided in **Tables 7-13A** through **7-18A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 18**.

<u>Total Metals Impacts</u>

Sample AEC3-SD09-1 exceeded both CCME marine ISQG and PEL EQGs for arsenic (2 µg/g), cadmium (0.1 µg/g), chromium (13 µg/g), copper (7.5 µg/g), and lead (18 µg/g). AEC3-SD09-2 exceeded marine ISQG and PEL EQGs for chromium (17 µg/g), copper (4.7 µg/g) and lead (5 µg/g). Sample AEC3-SD09-3 also exceeded marine ISQGs and PELs for arsenic (7 µg/g), cadmium (0.3 µg/g), chromium and copper (18 µg/g) and lead (63 µg/g). AEC3-SD09-3 also exceeded CCME PL use EQG for molybdenum with a concentration of 11 µg/g.

<u>Petroleum Hydrocarbon Impacts</u>

Sample AEC3-SD09-3 exceeded CCME PL use EQG of 300 µg/g for F3 with a concentration of 360 µg/g. The other two samples were both below the applicable EQGs.

<u>Polychlorinated biphenyls Impacts</u>

All three samples were submitted for PCBs analysis. All samples were below the applicable EQGs.

Pesticide Impacts

Sample AEC3-SD09-3 exceeded freshwater PEL EQG for total DDD (0.02 µg/g) and total DDE (0.014 µg/g). Sample AEC3-SD09-1 remained below the applicable EQGs.

**2008**

One sediment sample was collected during the 2008 sampling event. The sample was submitted for PHCs, metals, and PCBs.

The analytical results are provided in **Tables 7-13B** through **7-18B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 18**.

Total Metals Impacts

Sample AEC3-SD09-2 exceeded the CCME marine ISQGs and PELs for chromium (14.2 µg/g) and copper (4.5 µg/g).

Petroleum Hydrocarbon Impacts

Sample AEC3-SD09-2 was below the applicable EQGs.

Polychlorinated biphenyls Impacts

Sample AEC3-SD09-2 was below the applicable EQGs.

#### 7.6.5.4 Vegetation

**2009**

There was one aquatic and two terrestrial vegetation samples collected in AEC 3. All three samples were submitted for metals analysis and one sample for PCBs analysis.

Total Metals Impacts

Sample AEC3-AQ-VEG09-1 exceeded MOE-ULN EQGs for boron with (26.6 µg/g), iron ( 930 µg/g), manganese (711 µg/g), and sodium ( 3390 µg/g). The other two samples (AEC3-VEG09-1 and -2) were both below the applicable EQGs.

Polychlorinated biphenyls Impacts

Sample AEC3-AQ-VEG09-1 was below the applicable EQGs.

The analytical results are provided in **Tables 7-19A** and **7-20A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 17**.

**2008**

Four vegetation samples were collected from AEC 3 (formerly APEC 3) and submitted for metals and PCBs analysis (Veg-1, -2, -3, and -5).

The analytical results are provided in **Tables 7-19B** and **7-20B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 17**.

Total Metals Impacts
Sample VEG-1 exceeded MOE-ULN EQG for sodium (62 µg/g). Sample VEG-2 also exceeded for sodium with a concentration of 53 µg/g.

Polychlorinated biphenyls Impacts
PCBs parameters were below the applicable EQGs for all samples.

### 7.6.6 Chemical Impacts Summary – AEC 3

#### 7.6.6.1 Impacted Soils

**Evaluation of Metal Impacts in Soil**
Metal impacted soil was identified in AEC 3 in two samples during the 2008 sampling event. Exceedances of copper (1), lead (1), and zinc (1) were identified PL EQG. Exceedances of zinc (1) above the CL EQG were also identified. Elevated metals concentrations were taken in heavily stained areas and are likely associated with the metal debris located in the main landfill slope area. Delineation test pitting was completed during the 2009 sampling round and all reported concentrations below the applicable EQGs. Impacts are believed to be isolated to the stained soil areas.

**Evaluation of Hydrocarbon Impacts in Soil**
Hydrocarbon impacts were identified in AEC 3 in one sample location (A3-TP08-3). Exceedances of PHC F2, F3, and F4 exceeding both the PL and CL EQG were present. The impacted soil sample was collected in a drainage gully at the eastern extent of the main landfill area. One delineation test pit was advanced downgradient and reported concentrations below the applicable EQGs. Bedrock outcropping prevented delineation test pitting on the east and west sides of the impacted sample.

**Evaluation of PAH Impacts in Soil**
PAH impacts were identified in AEC 3 in one sample location (A3-TP08-13) during the 2008 sampling event. The impacted soil sample was collected directly beneath debris in a heavily orange stained area. The sample location is isolated by bedrock outcropping and no other PAH impacts were detected in surrounding test pits during either the 2008 or 2009 sampling events.

**Evaluation of VOCs & Pesticide Impacts in Soil**
VOCs and pesticide exceedances were not identified in soil and therefore are not considered an issue.

The following table summarizes the results of the soil investigation in AEC 3.

| **COC** | **Exceeding Analytes** | **Exceedance of EQG** | |
|---|---|---|---|
| | | **PL** | **CL** |
| Metals | copper | yes | no |
| | lead | yes | no |
| | zinc | yes | yes |
| Petroleum Hydrocarbons | F2 | yes | yes |
| | F3 | yes | yes |
| | F4 | yes | yes |
| PAHs | benzo(a)anthracene,<br>benzo(b)flouranthene | yes | no |
| | benzo(a)pyrene | yes | yes |
| PCBs, VOCs and Pesticides | no impacts reported | no | no |

### 7.6.6.2 Impacted Surface Water

**Evaluation of Metal Impacts in Surface Water**

Metal impacted surface water was identified in AEC 3 in four samples collected in 2008 and 2009. Concentrations exceeded the freshwater EQG for aluminum (1), cadmium (3), copper (1), iron (2), lead (1), and zinc (1). The exceedances for aluminum, copper, and zinc were from sample A3-SW08-3 collected in a small pool of standing water directly adjacent to the toe of the main landfill slope. This small ponded water area was not present during the 2009 sampling event; therefore, no confirmation sampling could be completed. The remaining surface water samples were collected from Pond 3. Elevated metal concentrations are believed to be associated with the dissolution of exposed and buried metal waste and chemical loading of the localized soils, sediment, and surface water.

**Evaluation of PHC, PCB & Pesticide Impacts in Surface Water**

PHC, PCB, and pesticide exceedances were not identified in surface water and therefore are not considered an issue.

The following table summarizes the results of the Surface Water investigation in AEC 3.

| **COC** | **Exceeding Analytes** | **Exceedance of EQG** | |
|---|---|---|---|
| | | **freshwater** | **marine** |
| Metals | aluminum | yes | N/A |
| | cadmium | yes | N/A |
| | copper | yes | N/A |
| | iron | yes | N/A |
| | lead | Yes | N/A |
| | zinc | Yes | N/A |

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **freshwater** | **marine** |
| PHCs, PCBs and Pesticides | no impacts reported | no | no |

### 7.6.6.3 Impacted Sediment

**Evaluation of Metal Impacts in Sediment**

Metals impacts in sediment were identified in AEC 3 in four samples from the 2008 and 2009 sampling events. Concentrations exceeded the marine ISQG and PEL EQGs for arsenic (2), cadmium (2), chromium (4), copper (4), and lead (3). Molybdenum exceeded the CCME PL EQG for soil in one of the sediment samples. Elevated metal concentrations are believed to be associated with the dissolution of exposed metal waste and chemical loading of the localized soils, sediment, and surface water.

**Evaluation of PHC Impacts in Sediment**

Hydrocarbon impacts in sediment were identified in AEC 3 in one sample collected during the 2009 sampling event. Elevated concentrations above the CCME PL EQG, but below the CL EQG were detected for PHC F3. Elevated PHC concentrations are likely due to the disposal of fuel drums and vehicle fuel tanks in the area upgradient of Pond 3.

**Evaluation of Pesticide Impacts in Sediment**

Pesticide impacts in sediment were identified in AEC 3 in one sample collected during the 2009 sampling event. Pesticide concentrations exceeded the freshwater ISQG and PEL EQGs for DDD and DDE.

**Evaluation of PCB Impacts in Sediment**

PCB exceedances were not identified in sediment and therefore are not considered an issue.

The following table summarizes the results of the Sediment investigation for AEC 3.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **ISQG** | **PEL** |
| Metals | arsenic | yes | yes |
| | cadmium | yes | yes |
| | chromium | yes | yes |
| | copper | yes | yes |
| | lead | yes | yes |
| | molybdenum | CCME PL EQG | |
| PHCs<br>(CCME PL and CL EQGs for soil used for comparison only) | F3 (PL) | N/A | N/A |
| Pesticides | DDD | yes | yes |

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | **ISQG** | **PEL** |
| | DDE | yes | yes |
| PCBs | no impacts reported | no | no |

#### 7.6.6.4 Impacted Vegetation

Five terrestrial samples and one aquatic vegetation sample was collected in AEC 3 during the 2008 and 2009 sampling events. The one aquatic sample reported exceedances of boron, iron, manganese, and sodium. The two terrestrial samples collected during the 2008 event reported exceedances in sodium and the two terrestrial samples collected in 2009 had no exceedances.

The following table summarizes the results of the vegetation investigation for AEC 3.

| COC | Description |
|---|---|
| Metals | • metal concentrations of boron, iron, manganese, and sodium |
| PCBs | • no impacts reported |

## 7.7 AEC 4: Down Gradient and Off Site Areas

### 7.7.1 Summary of AEC Location and Features

AEC 4 encompasses two distinct areas, one between AEC 3/AEC 2 and Sylvia Grinnell River and one to the west of AEC 3, on Sylvia Grinnell National Park land. See **Figure 9**. There are three ponds in AEC 4 in which a portion of the surface water, sediment and aquatic vegetation samples were collected. Pond 1 and Pond 2 are located on the downgradient side of the main landfill and receive drainage waters from the landfill and from the Sylvia Grinnell Park off site side. Pond 2 drains into Pond 1 which discharges into the river. Pond 4 is located on the east side of AEC 4 adjacent and downgradient to AEC 2. This pond is a receptor of up gradient waters from the main drainage channel running through AEC 2 (Vehicle Dump).

Ponds 1 and 4 are directly connected to the Sylvia Grinnell River during times of high tide.

### 7.7.2 Sampling/Investigation Rationale

The previous environmental investigation conducted by FRANZ (2009) included the collection of two soil samples, eight surface water and sediment samples and three vegetation samples. Analytical results from the 2008 field program found exceedances in surface water (metals and VOCs) and vegetation (metals). Further delineation of impacts and confirmation sampling was required.

### 7.7.3 Field Observations

It was observed that high tide levels completely submersed the low-lying areas to the southeast of Pond 1 and between Pond 1 and the Sylvia Grinnell River. High tides also completly submersed the area between Pond 4 and the Sylvia Grinnell River.

Heavy orange surface staining was noted to the southeast of Pond 1 in the low-lying area. Areas east of Pond 2 and below the cliff band had dried up and did not contain standing surface water as was observed during the 2008 investigation. Heavy surface staining and sheen was noted on stagnant ponded water approximately 50 m southeast towards the main landfill area (location of AEC4-SW09-16).

Very little debris was noted in AEC 4, just a few small pockets along the grass bedrock interface; however, an ATV was partially submerged along the northeast shoreline of Pond 2.

Soil vapour readings measured between 0 and 5 ppm.

### 7.7.4 Sampling

Two test pits were excavated in the drainage pathways downgradient from the main landfill into ponds 1 and 2. The soil was characterized as a dark grey/brown fine to medium sand with some organic matter.

Moving from Pond 2 towards Pond 1, two sediment and surface water samples were collected in Pond 2, one at the south east side of the pond where the main landfill waters drain into the pond and one at the outlet that drains into Pond 1. Three sediment and surface water samples were collected in Pond 1, one at the inlet from Pond 2, one at the south east side where the drainage pathway from the main landfill is located and one at the outlet that drains into Sylvia Grinnell River. Sediments within AEC 4 have been characterized as being brown, fine to coarse sand/silt, organic matter, and high decomposition with some organic odour.

Three sediment and surface water samples were collected from Pond 4 to encompass all possible drainage into the pond. One sample was collected at the inlet from Pond 5, one sample each from the northwest and southeast sides of the pond. Two sediment and surface water samples were collected from the intermittent small pools of water that are a part of the drainage system from Pond 4 into the Sylvia Grinnell River.

Five surface water samples were collected directly from Sylvia Grinnell River. All were located at locations where drainage from the site enters the river. Three aquatic vegetation samples were collected, one from the center of each pond.

In some instances sediment and surface water samples were collected in the same locations as the 2008 field investigation in order to confirm/refute the presence of COCs/PCOCs. Due to the increased sample density of the 2009 field sampling, sample numbers do not correspond. The following **Table 7-3** summarizes the samples collected in AEC 4 and arrows indicate the relationship between sample locations.

**Table 7-3**: Sample Relationships – AEC 4

| Area | Medium | Year | |
|---|---|---|---|
| | | 2009 | 2008 |
| APEC 4 / AEC 4 - Down Gradient & Off Site | Sediment | AEC4-SD09-1 --> | A4-SD08-3 |
| | | AEC4-SD09-11 --> | A4-SD08-2 |
| | | AEC4-SD09-15 --> | A4-SD08-1 |
| | Surface Water | AEC4-SW09-1 --> | A4-SW08-3 |
| | | AEC4-SW09-6 --> | A4-SW08-7 |
| | | AEC4-SW09-7 --> | A4-SW08-8 |
| | | AEC4-SW09-8 --> | A4-SW08-6 |
| | | AEC4-SW09-9 --> | A4-SW08-5 |
| | | AEC4-SW09-10 --> | A4-SW08-4 |
| | | AEC4-SW09-11 --> | A4-SW08-2 |
| | | AEC4-SW09-15 --> | A4-SW08-1 |

Note: Arrow indicates samples collected at the same physical location

### 7.7.5 Results of Chemical Analysis of Environmental Media

#### 7.7.5.1 Soil

**2009**

Two samples were collected in AEC 4. Both samples were submitted for total metals, PHCs, and VOCs. One sample (AEC4-TP09-1) was submitted for PAHs. Both samples were below the applicable EQGs for all parameters tested.

The analytical results are provided in **Tables 7-1A** through **7-6A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 19**.

**2008**

A total of two shallow test pits (A4-TP08-1 and A4-TP08-2) were excavated at AEC 4 (formerly APEC 4). Both samples were submitted for PHCs, metals, and PCBs analysis. Both samples were below the applicable EQGs for all parameters tested.

The analytical results are provided in **Tables 7-1B** through **7-6B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 19**.

### 7.7.5.2 Surface water

**2009**

A total of 16 surface water samples and one duplicate sample were analyzed for PHCs, metals, PAHs, VOCs, PCBs, pesticides and herbicides in AEC 4. There were no exceedances of EQGs for PHCs, PAHs, PCBs, or pesticides and herbicides.

The analytical results are provided in **Tables 7-7A** through **7-12A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 20**.

Total Metals Impacts

All 16 samples were analyzed for metals. Sample AEC4-SW09-2 exceeded the CCME FWAL EQG for iron (330 µg/L). AEC4-SW09-3 exceeded the CCME FWAL EQG for aluminum (27 µg/L), copper (3 µg/L) and iron (610 µg/L). AEC4-SW09-11, AEC4-SW09-13, AEC4-SW09-14, AEC4-SW09-15 all exceeded the CCME FWAL EQG for iron with concentrations of 1,400 µg/L, 310 µg/L, 330 µg/L and 10,000 µg/L (>3x EQG).

Volatile Organic Carbon (VOCs)

Four samples and one duplicate were analyzed for VOCs. AEC4-SW09-16 exceeded the CCME FWAL EQG for tetrachlorethene (210 µg/L) and trichlorethene (62 µg/L). All remaining samples were below the applicable EQGs.

**2008**

Eight surface water samples were collected during the 2008 sampling event. Samples were submitted for PHCs, metals, PAHs, VOCs, PCBs and pesticides. All samples that were submitted for PHCs, PAHs, PCBs and pesticides were found to be below CCME FWAL EQGs.

The analytical results are provided in **Tables 7-7B** through **7-12B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 20**.

Total Metals Impacts

Three samples exceeded EQGs for metals. Sample A4-SW08-3 exceeded CCME FWAL for cadmium (0.146 µg/L) and copper EQG (5.7 µg/L). Samples A4-SW08-4 and A4-SW08-7 both exceeded for cadmium with concentrations of 0.044 µg/L and 0.082 µg/L.

Volaite Organic Carbon (VOCs) Impacts

Sample A4-SW08-2 exceeded the EQG for trichloroethylene at a concentration of 22.6 µg/L.

#### 7.7.5.3 Sediment

Based on the bi-daily influx of brackish water during high tide events, marine sediment guidelines were applied.

**2009**

A total of eleven sediment samples were analyzed for PHCs, metals, PAHs, VOCs, PCBs, pesticides and herbicides in AEC 4. Samples submitted for PHCs and PAHs were below all applicable EQGs.

The analytical results are provided in **Tables 7-13A** through **7-18A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 21**.

Total Metals Impacts

All eleven samples, plus one duplicate were submitted for metals analysis. Samples AEC4-SD09-1 through AEC4-SD09-13 were screened against the CCME sediment marine EQGs. AEC4-SD09-14 and AEC4-SD09-15 were screened against the CCME freshwater marine EQGs. Sample AEC4-SD09-1 exceeded the CCME marine ISQG and PEL EQGs for cadmium (0.2 µg/g), chromium (20 µg/g), copper (7.2 µg/g) and lead (9 µg/g). Sample AEC4-SD09-2 exceeded the marine ISQG and PEL EQGs for arsenic (2 µg/g), cadmium (0.2 µg/g), chromium (15 µg/g), copper (7.6 µg/g), and lead (9 µg/g). AEC4-SD09-3 and AEC4-SD09-4 both exceeded CCME marine EQGs for arsenic (1 and 1 µg/g), cadmium (0.1 and 0.2 µg/g), chromium (17 and 18 µg/g), copper (7.6 and 8 µg/g) and lead (11 and 8 µg/g). Sample AEC4-SD09-3 aslo exceeded CCME PL EQGs for chromium VI (0.7 µg/g). AEC4-SD09-5 exceeded ISQGs and PELs for chromium (13 µg/g), copper (5.6 µg/g) and lead (2 µg/g). AEC4-SD09-11 exceeded ISQGs and PELs for arsenic (1 µg/g), chromium (17 µg/g), copper (6.3 µg/g) and lead (3 µg/g). AEC4-SD09-12 exceeded ISQGs and PELs for chromium, copper and lead with concentrations of 30 µg/g, 6.3 µg/g and 2 µg/g respectively. AEC4-SD09-13 also exceeded ISQGs and PELs for chromium, copper and lead with concentrations of 20 µg/g, 5.8 µg/g and 3 µg/g respectively. AEC4-SD09-14 and AEC4-SD09-15 did not have measured values above the CCME freshwater EQGs.

Polychlorinated biphenyls Impacts

Three samples plus one duplicate were submitted for PCBs analysis. Sample AEC4-SD09-1 exceeded the CCME marine ISQG EQG for total PCBs with a concentration of 0.03 µg/g, but remained below the PELs. AEC4-SD09-15 exceeded the CCME freshwater ISQG EQG for total PCBs with a concentration of 0.04 µg/g, but also remained below the PELs. AEC4-SD09-11 was below all applicable EQGs.

Pesticide Impacts

Three samples plus one duplicate were submitted for pesticides and herbicides analysis. AEC4-SD09-1 exceeded CCME marine ISQG EQG for total DDD with a concentration of 0.004 µg/g. AEC4-SD09-15 exceeded CCME freshwater ISQG EQG of 0.00354 µg/g with a concentration of 0.004 µg/g. Both AEC4-SD09-1 and 15 remained below the CCME marine PELs. AEC4-SD09-11 was below all applicable EQGs.

Volatile Organic Carbons (VOCs)

Three samples and one duplicate were analyzed for VOCs. Sample AEC4-SD09-11 was above the CCME PL EQG for tetrachloroethene (0.24 µg/g) and trichloroethene (0.10 µg/g). The remaining samples (AEC4-SD09-1 and -15) were below all applicable EQGs.

**2008**

Seven sediment samples were collected during the 2008 sampling event. Samples were submitted for PHCs, metals, PCBs, PAHs, VOCs and pesticides. All samples that were submitted for PHCs, PCBs, PAHs, VOCs, and pesticides were found to be below applicable EQGs.

The analytical results are provided in **Tables 7-13B** through **7-18B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 21**.

Total Metals Impacts

All seven samples were submitted for metals analysis. Samples A4-SD08-2 through A4-SD08-8 all exceeded both CCME marine ISQGs and PELs for both chromium and copper. The maximum concentration of chromium that exceeded the EQG was 15.5 µg/g found at A4-SD08-4, the minimum concentration was 9.3 µg/g found at A4-SD08-3. For copper, the maximum exceeded concentration was 6.7 µg/g at A4-SD08-3 and the minimum concentration was 4.6 µg/g.

#### 7.7.5.4 Vegetation

**2009**

Three aquatic vegetation samples were collected in AEC 4. Samples were submitted for metals analysis. Sample AEC4-AQ-VEG09-1 exceeded the MOE-ULN EQG for iron (1890 µg/g), sodium (310 µg/g), and manganese (57.6 µg/g). Sample AEC4-AQ-VEG09-2 exceeded EQGs for iron, manganese and sodium, where concentrations of 808 µg/g, 119 µg/g and 1180 µg/g, respectively, were present. AEC4-AQ-VEG09-3 exceeded the EQG for arsenic (1.1 µg/g), iron (2410 µg/g) and sodium (241 µg/g).

The analytical results are provided in **Tables 7-19A** and **7-20A**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 20**.

**2008**

Three terrestrial vegetation samples and one duplicate were collected from AEC 4 (formerly APEC 4) and submitted for metals and PCBs analysis. VEG-1 exceeded MOE-ULN EQG for sodium (2660 µg/g) and the iron (7880 µg/g). VEG-2 was in exceedance of iron and sodium EQGs with concentrations of 627 µg/g and 6790 µg/g (>135x EQG) respectively. VEG-3 exceeded for iron (853 µg/g) and sodium (6180 µg/g) (>123x EQG). PCBs parameters were below the applicable EQGs.

The analytical results are provided in **Tables 7-19B** and **7-20B**. Sampling locations with parameters that exceed applicable EQGs are presented in **Figure 20**.

### 7.7.6 Chemical Impacts Summary – AEC 4

### 7.7.6.1 Impacted Soils

**Evaluation of Metal, PHC, PAH, PCB, Pesticide, and VOC Impacts in Soil**

Metal, PHC, PAH, PCB, Pesticide, and VOC exceedances were not identified in soil and therefore are not considered an issue.

The following table summarizes the results of the soil investigation in AEC 4.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | PL | CL |
| Metals, PHC, PAH, PCB, Pesticide, and VOCs | no impacts reported | no | no |

### 7.7.6.2 Impacted Surface Water

**Evaluation of Metal Impacts in Surface Water**

Metal impacted surface water was identified in AEC 4 in nine samples collected in 2008 and 2009. Concentrations exceeded the freshwater EQG for aluminum (1), cadmium (3), copper (2), and iron (6). Elevated metal concentrations are believed to be associated with the dissolution of exposed and buried metal waste and chemical loading of the localized soils, sediment, and surface water.

**Evaluation of VOC Impacts in Surface Water**

VOC impacted surface water was identified in AEC 4 in two samples collected in 2008 and 2009. The 2008 sample (A4-SW08-2) was collected in Pond 1 and contained concentrations of trichloroethene just above the EQG. The 2009 sample (AEC4-SW09-16) was collected upgradient of Pond 1 towards the main landfill, in a small stained ponded water area. The 2009 sample reported concentrations of trichloroethene and tetrachloroethene in exceedance of the EQGs. Higher concentrations in the upgradient sample and the inability to duplicate the 2008 results from the same sample location as A4-SW08-2 in 2009 suggest the VOC source location to be upgradient of Pond 1 towards the main landfill area. This conclusion is further supported by the observation of trichloroethene written on a drum at the toe of the landfill (note that the drums have been moved from their original positions during past remediation attempts).

**Evaluation of PHC, PAH, PCB & Pesticide Impacts in Surface Water**

PHC, PAH, PCB, and pesticide exceedances were not identified in surface water and therefore are not considered an issue.

The following table summarizes the results of the Surface Water investigation in AEC 4.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | freshwater | marine |
| Metals | aluminum | yes | N/A |
| | cadmium | yes | N/A |
| | copper | yes | N/A |
| | iron | yes | N/A |
| VOCs | trichloroethene | yes | N/A |
| | tetrachloroethene | yes | N/A |
| PHCs, PAHs, PCBs and Pesticides | no impacts reported | no | no |

### 7.7.6.3 Impacted Sediment

**Evaluation of Metal Impacts in Sediment**

Metals impacts in sediment were identified in AEC 4 in fourteen samples from the 2008 and 2009 sampling events. Concentrations exceeded the marine ISQG and PEL EQGs for arsenic (4), cadmium (4), chromium (14), copper (14), and lead (8). Chromium VI exceeded the CCME PL EQG for soil in one of the sediment samples. Elevated metal concentrations are believed to be associated with the dissolution of exposed metal waste and chemical loading of the localized soils, sediment, and surface water.

**Evaluation of PCB Impacts in Sediment**

PCB impacts in sediment were identified in AEC 4 in two samples collected during the 2009 sampling event. Elevated concentrations above the marine ISQG EQG, but below the PEL EQG were detected for DDD in both samples. One sample was collected from Pond 2 and one from Pond 4.

## Evaluation of Pesticide Impacts in Sediment

Pesticide impacts in sediment were identified in AEC 4 in two samples collected during the 2009 sampling event. Pesticide concentrations exceeded the marine ISQG for DDD in both samples. One sample was collected from Pond 2 and one from Pond 4.

## Evaluation of VOC Impacts in Sediment

VOC impacts in sediment were identified in AEC 4 in one sample collected during the 2009 sampling event. Tetrachloroethene concentrations above the marine ISQG, but below the PEL EQGs and trichloroethene concentrations above the marine ISQG were reported. These VOC impacts correspond with VOC impacts observed in surface water analytical data. Based on the sediment and surface water data, as well as field observations, the VOC source location is expected to be upgradient of Pond 1 towards the main landfill area.

## Evaluation of PHC and PAH Impacts in Sediment

PHC and PAH exceedances were not identified in sediment and therefore are not considered an issue.

The following table summarizes the results of the Sediment investigation for AEC 4.

| COC | Exceeding Analytes | Exceedance of EQG | |
|---|---|---|---|
| | | ISQG | PEL |
| Metals | arsenic | yes | yes |
| | cadmium | yes | yes |
| | chromium | yes | yes |
| | copper | yes | yes |
| | lead | yes | yes |
| | chromium VI | CCME PL EQG | |
| PCB | PCB | yes | no |
| Pesticides | DDD | yes | no |
| VOCs | tetrachloroethene | yes | no |
| | trichloroethene | yes | yes |
| PHC and PAH | no impacts reported | no | no |

#### 7.7.6.4 Impacted Vegetation

Three terrestrial and three aquatic vegetation samples were collected in AEC 4 during the 2008 and 2009 sampling events. The aquatic samples reported exceedances of arsenic (1), iron (2), manganese (2), and sodium (3). The terrestrial samples collected during the 2008 event reported exceedances in iron (3) and sodium (3).

The following table summarizes the results of the vegetation investigation for AEC 4.

| COC | Description |
|---|---|
| Metals | • metal concentrations of arsenic, iron, manganese, and sodium in exceedance |
| PCBs | • no impacts reported |

## 7.8 Overall Findings, Physical Hazards and Chemical Impacts

The results of the physical site conditions, an inventory of the site materials and an evaluation of the chemical distributions indicate that selected media and chemicals of concern are present at concentrations greater than the Environmental Quality Guidelines (EQG).

### 7.8.1 Inventory of Site Materials

The following (Table 7-22: Summary of Waste Debris) provides a summary of site materials:

| AREA | DIMENSIONS/SIZE/AREA | ITEM(S) | DESCRIPTION OF WASTE - COMPONENTS | PAINTED (Y/N) | COLOUR | POTENTIAL HAZARDOUS MATERIALS | OTHER COMMENTS |
|---|---|---|---|---|---|---|---|
| **APEC 1 - UP-GRADIENT DEBRIS AREA** | | | | | | | |
| A1-TP08-1 (mound) | 290 m$^{2}$ | Buried Debris | Drums, sheet metal, piping (steel), steel cable, vehicle parts (axles, bracing, chassis), steel 'I' beams, wheel rims (steel), wood debris | N | N/A | None observed | All metal debris was rusted and contained no paint. Barrels were observed to be crushed. Unable to advance test pit due to intermingled metallic debris. |
| A1-TP08-2 (mound) | ~ 1500 m$^{2}$ | Buried Debris | Drums, steel rods, sheet metal, wood debris | N | N/A | None observed | All metal debris was rusted and contained no paint. Barrels were crushed. Debris was not as concentrated as A1-TP08-1 mound. |
| A1-TP08-3 (mound) | 450 m$^{2}$ | Buried Debris | Tires, drums, iron bracing (heavy), vehicle parts (chassis, hinges, axle, springs), rubber hose, steel cable, wire (electrical and bare), steel rods, sheet metal | N | N/A | None observed | All metal debris was rusted and contained no paint. Barrels were crushed. Debris in this mound seemed more concentrated than the previous two areas. Unable to advance test pit due to intermingled debris. |
| **APEC 2 - VEHICLE DUMP** | | | | | | | |
| UPPER SECTION | 750 m$^{2}$ | Vehicles | Water trucks, cars, boilers, flat bed trucks (military), fuel trucks (military and transport), vehicle engines, plows, dump trucks, boat | Y | Military green, blue, yellow, and orangey red | Asbestos may be present (brake lining, insulation materials)<br>Lead-amended paint present on vehicles | The upper section contained vehicles which have recently been removed from the main vehicle pile with intentions of recycling (word of mouth). The upper section contains approximately 23 vehicles. |
| | | Scattered Debris | Partial vehicles, tanks, drums, vehicle parts, brackets, sheet metal, wood debris, material (fabric), steel cables, tires, bicycle frames, electrical parts, leaf springs, radiators, scrap metal debris, inner tubes, batteries, hydraulic cylinders and equipment | Y | Military green, blue, yellow, and orangey red | Vehicle batteries<br>Asbestos may be present (brake lining, insulation materials)<br>Lead-amended paint present on vehicles | |
| LOWER SECTION | 1400 m2 | Vehicles | Water trucks, cars, boilers, flat bed trucks (military - green), fuel trucks (military and transport - orange), vehicle engines, plows, dump trucks, boat | Y | military green, Blue, yellow, and orangey red | Asbestos may be present (brake lining, insulation materials)<br>Lead-amended paint present on vehicles | The lower section contains a higher concentration of vehicles and vehicle parts, as well as miscellaneous debris. There are approximately 63 vehicles in the lower section. The vehicles are stacked on top of one another in the drainage gully. Most of the drums on site were found in the lower section (two identifiable as kerosene and lubricating oil). Much scrap and random debris is located within the vehicle pile towards the bottom beneath the vehicles. |
| | | Scattered Debris | Partial vehicles, tanks, drums, vehicle parts, brackets, sheet metal, wood debris, material (fabric), steel cables, tires, bicycle frames, electrical parts, leaf springs, radiators, scrap metal debris, inner tubes, batteries, hydraulic cylinders and equipment | Y | Military green, blue, yellow, and orangey red | Vehicle batteries<br>Asbestos may be present (brake lining, insulation materials)<br>Lead-amended paint present on vehicles | |

| AREA | DIMENSIONS/SIZE/AREA | ITEM(S) | DESCRIPTION OF WASTE - COMPONENTS | PAINTED (Y/N) | COLOUR | POTENTIAL HAZARDOUS MATERIALS | OTHER COMMENTS |
|---|---|---|---|---|---|---|---|
| **APEC 3 - MAIN LANDFILL** | | | | | | | |
| UPPER SECTION - EAST | 1150 $m^2$ | Scattered debris | Tires (~70), metal culverts, food waste (cans, bottles, aluminum, plastic), drums, some vehicle parts, snowmobiles (3), scrap metal, car (1), camp stove, mattress springs, metal strapping, steel studding (construction debris), metal piping, wood debris, plastic debris, pressure tank, sheet metal, re-bar, propane cylinder, tarpaulin, kerosene fuel cans (camping), computer parts, cook stoves (camp - 2), paint cans | Y | Multiple colours | Lead-amended paint likely present on some of the painted surfaces | The upper east section is a small area of exposed debris suspected to have been used recently as a dumping area for locals. Items seemed in newer condition than those observed at the bottom of the landfill area. Faint hydrocarbon odour from area surrounding A3-TP08-2. No capping material applied to this small area. |
| UPPER SECTION - CENTER | 3700 $m^2$ | Buried debris | Scrap metal debris, some plastic, some wood debris. | N | N/A | None observed | This area is well capped with granular fill. Some minor areas of exposed debris exist. The area is heavily vegetated with grass and sedges. |
| LOWER SECTION | 3400 $m^2$ | Buried, exposed, and scattered debris | Drums (~150 crushed), fuel tanks (~15-20), scrap metal, snow machines, steel hut, camp fuel cans (30), cooking stoves/ovens, culverts, piping, refrigerators (several), tires (many), washer/dryers (several), vehicle engines, vehicles (cars, truck, parts), paint thinner jugs, fire extinguishers, compressed gas cylinders (several), radiators, burnt wood debris, wood debris, propane cylinders, electric motors, food waste debris (cans, bottles, plastic, aluminum, etc...), mattress springs, generator (yellow), paint cans (many - some still with contents), pails (unknown contents), oil cans/bottles | Y | Multiple colours | Vehicle batteries<br>Asbestos may be present (brake lining, insulation materials)<br>Lead-amended paint present on vehicles<br>Used paint remaining in cans | This area includes the slope and debris at the toe of the landfill. The debris is mixed with granular fill material. Most of the larger debris has collected at the toe of the slope. Much of the debris appears to be exposed, although it is very difficult to extrapolate debris thicknesses. Heavy orange staining is present at the toe of the slope. |
| DRUM PILE 1 | ~ 55 drums | piled drums | No identifiable drums present, metal culvert (18"), large compressed gas cylinder | N | N/A | Unknown, no evidence observed | This drum pile contained rusted drums with no legible writing. Contents of drums unknown. Stressed vegetation was observed on SE corner of drum pile. |
| DRUM PILE 2 | ~ 184 drums | piled drums | No identifiable drums present, few contained green paint | Y | Military green | Lead-amended paint may be present drums | This drum pile contained rusted drums with no legible writing. Contents of drums unknown. Large black soil stain was observed on west side of drum pile. |
| DRUM PILE 3 | ~ 73 drums | piled drums | Rusted drums, few contained orange and yellow paint | Y | Orange and yellow | Lead-amended paint may be present drums | This drum pile contained mostly rusted drums with no legible writing with the exception of one drum labelled "Kerosene". Very stressed vegetation was observed on the SE corner of the drum pile. |
| DRUM PILE 4 | ~ 22 drums | piled drums | Rusted drums, none contained painted surfaces | N | N/A | None observed | This drum pile contained mostly rusted drums with no legible writing with the exception of one drum labelled "Perchloroethylene". |
| **APEC 4 - DOWN GRADIENT AND OFF SITE AREAS** | | | | | | | |
| LOWER BENCH | ~ 8 Ha | Scattered Debris | Scrap metal debris, tires, plastic, tent, some wood debris | N | N/A | None observed | This area contains only a very few pieces of scattered debris. Some debris is also present in the bottom of the ponds buried in the sediment. |

### 7.8.2 Summary of Contaminant Impacts

A summary of the contaminant impacts and the associated physical hazards is provided on Table 7-23 below. Within this table, the COCs have been identified with there corresponding degree of hazard and the potential scale of impact based on physical site observations and chemical analysis. Following this summary of finds, details on the impacts and inventories are provided for the main categories of concern.

Notes:

1. Maximum Exceedance - denotes the COCs relative ratio of the contaminant exceedance to the Environmental Quality Guidelines.
2. Contaminant Exceedance Factor- references the CCME National Classification System (2008) section (I) Contaminant Characteristics-3. Contaminant Exceedance Factor. The factor is the ratio between the measured contaminant concentration and the applicable EQGs.
3. Hazard Ranking- references the CCME National Classification System (2008) section (I) Contaminant Characteristics- 2. Chemical Hazard. This is based on the FCSAP and list of substances and their associated hazard of low, medium or high.
4. Scale of Impact – is based on professional judgement, site conditions and chemical concentrations to determine if the impact is significant and as such a primary issue or minor and likely a secondary issue for future delineation and action planning.

**Table 7-23:** Summary of Findings

| AEC/Source | Media | COCs | Maximum Exceedance[1] | 2008 | 2009 | Contaminant Exceedance Factor (mobile, L, M or H)[2] | Hazard Ranking (L, M or H)[3] | Scale of Impact [4] | | Area of Impact | Delineation Complete? (Y/N) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Primary | Secondary | | |
| AEC 1 - Upgradient Buried Debris | Soil | F1 | 6x | | * | L | H | √ | | Likely associated with former activities | Y |
| | | F2 | > 4x | | * | L | M | √ | | | Y |
| | | F3 | > 2x | | * | L | L | | √ | | Y |
| | | Lead | > 1x | * | * | L | H | √ | | | Y |
| | | Copper | > 1x | * | | L | L | | √ | | Y |
| | Sediment | Total DDD | > 1x | * | | L | H | √ | | Pesticides associated with former site activities | N |
| | | Total DDE | > 3x | * | | L | H | √ | | | N |
| | | Total DDT | > 1x | * | | L | H | √ | | | N |
| | Surface Water | Aluminum | > 1x | * | | L | L | | √ | Metals likely associated with former activities | N |
| | | Chromium (VI) | > 2x | | * | L | H | √ | | | N |
| | | Iron | > 7x | | * | L | L | | √ | | N |
| | Vegetation | Manganese | > 4x | | * | L | L | | √ | Metals likely associated with former activities | Y |
| | | Sodium | > 4x | | * | L | L | | √ | | Y |
| | | Molybdenum | >1x | | * | L | L | | √ | | Y |
| AEC 2 - Vehicle Dump | Soil | Copper | > 1x | | * | L | L | | √ | Associated with buried debris and former activities | Y |
| | | Cadmium | > 1x | * | | L | H | √ | | | Y |
| | | Total PCBs | > 9x | | * | L | H | √ | | | Y |
| | Sediment | F2 | > 5x | | * | L | M | √ | | PHCs likely associated with former activities | Y |
| | | F3 | > 2x | | * | L | L | | √ | | Y |
| | | F4 | > 1x | | * | L | L | | √ | | Y |
| | | Cadmium | > 4x | * | | L | H | √ | | | Y |
| | | Chromium (VI) | > 1x | | * | L | H | √ | | Exceeds CCME CSQG for commercial land use | Y |
| | | Chromium | > 1x | * | * | L | M | √ | | Associated with metal debris and former activities | Y |
| | | Copper | > 1x | * | * | L | L | | √ | | Y |
| | | Lead | > 1x | * | * | L | H | √ | | | Y |
| | | Zinc | > 1x | | * | L | L | | √ | | Y |
| | | Arsenic | > 1x | * | | L | H | √ | | | Y |
| | | Total PCBs | > 54x | | * | M | H | √ | | | Y |
| | | Total DDD | > 32x | | * | M | H | √ | | | Y |
| | | Total DDE | > 20x | * | | M | H | √ | | | Y |
| | | Total DDT | > 65x | | * | M | H | √ | | | Y |

**Table 7-23:** Summary of Findings Continued

| AEC/Source | Media | COCs | Maximum Exceedance[1] | 2008 | 2009 | Contaminant Exceedance Factor (mobile, L, M or H)[2] | Hazard Ranking (L, M or H)[3] | Scale of Impact [4] | | Area of Impact | Delineation Complete? (Y/N) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Primary | Secondary | | |
| AEC 2 - Vehicle Dump Con't | Surface Water | Aluminum | > 23x | * | | M | L | | √ | Metals associated with debris and former activities | Y |
| | | Chromium (VI) | > 3x | | * | L | H | √ | | | Y |
| | | Iron | > 29x | | * | M | L | | √ | | Y |
| | | Cadmium | > 11x | | * | M | H | √ | | | Y |
| | | Copper | > 35x | * | | M | L | | √ | | Y |
| | | Lead | > 2x | * | | L | H | √ | | | Y |
| | Vegetation | Manganese | > 6x | | * | L | L | | √ | Associated with former activities | Y |
| | | Sodium | > 31x | | * | M | L | | √ | | Y |
| | | Iron | > 1x | | * | L | L | | √ | | Y |
| | Building Mats. | Lead in Paint | > 125x | | * | H | H | √ | | Painted Vehicle Debris | N |
| AEC 3 - Main Landfill | Soil | F2 | > 1x | * | | L | M | √ | | Associated with landfill activities and debris | Y |
| | | F3 | > 26x | * | | M | L | | √ | | Y |
| | | F4 | > 2x | * | | L | L | | √ | | Y |
| | | Benz(a)anthracene | > 1x | * | | L | H | | √ | | Y |
| | | Benzo(a)pyrene | > 1x | * | | L | H | | √ | | Y |
| | | Benzo(b)fluoranthene | > 1x | * | | L | H | | √ | | Y |
| | | Total PCBs | > 13x | * | | M | H | √ | | | Y |
| | Sediment | Arsenic | > 1.6 billion x | | * | H | H | √ | | Associated with landfill activities and debris | Y |
| | | Cadmium | > 714 million x | | * | H | H | √ | | | Y |
| | | Chromium | > 1.6 billion x | | * | H | M | √ | | | Y |
| | | Copper | > 1.6 billion x | | * | H | L | | √ | | Y |
| | | Lead | > 5.6 billion x | | * | H | H | √ | | | Y |
| | | Molybdenum | > 1x | | * | L | L | | √ | Exceeds CCME CSQG for residential land use | Y |
| | | F3 | > 1x | | * | L | L | | √ | Associated with landfill activities and debris | Y |
| | | Total DDD | > 2x | | * | L | H | √ | | | Y |
| | | Total DDE | > 6x | | * | L | H | √ | | | Y |
| | | Total PCBs | > 2x | * | | L | H | √ | | | Y |
| | Surface Water | Iron | > 2x | | * | L | L | | √ | Associated with landfill activities and debris | Y |
| | | Lead | > 1x | * | * | L | H | √ | | | Y |
| | | Aluminum | > 86x | * | | M | L | | √ | | Y |
| | | Cadmium | > 7x | * | | L | H | √ | | | Y |
| | | Copper | > 23x | * | | M | L | | √ | | Y |
| | Vegetation | Boron | > 1x | | * | L | L | | √ | Associated with landfill activities and debris | Y |
| | | Iron | > 1x | | * | L | L | | √ | | Y |
| | | Manganese | > 14x | | * | M | L | | √ | | Y |
| | | Sodium | > 67x | | * | M | L | | √ | | Y |

**Table 7-23:** Summary of Findings Continued

| AEC/Source | Media | COCs | Maximum Exceedance[1] | 2008 | 2009 | Contaminant Exceedance Factor (mobile, L, M or H)[2] | Hazard Ranking (L, M or H)[3] | Scale of Impact [4] | | Area of Impact | Delineation Complete? (Y/N) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Primary | Secondary | | |
| AEC 4 - Downgradient, Off Site | Soil | None Identified | None Identified | | | None Identified | None Identified | None Identified | None Identified | None Identified | Y |
| | Sediment | Arsenic | > 480 million x | | * | H | H | √ | | Associated with landfill activities and debris | Y |
| | | Cadmium | > 476 million x | | * | H | H | √ | | | Y |
| | | Chromium | > 1.8 billion x | | * | H | M | √ | | | Y |
| | | Chromiun (VI) | > 2x | | * | L | H | √ | | Exceeds CCME CSQG for residential land use | Y |
| | | Copper | > 980 million x | | * | H | L | | √ | Associated with landfill activities and debris | Y |
| | | Lead | > 740 million x | | * | H | H | √ | | | Y |
| | | Total PCBs | > 1x | | * | L | H | √ | | | N |
| | | Total DDD | > 2x | | * | L | H | √ | | | N |
| | | Total DDE | > 1x | | * | L | H | √ | | | N |
| | | Total DDT | > 1x | | * | L | H | √ | | | N |
| | | Tetrachloroethane | > 1x | | * | L | M | √ | | | N |
| | | Trichloroethene | > 1x | | * | L | M | √ | | | N |
| | Surface Water | Iron | > 33x | | * | M | L | | √ | Associated with landfill activities and debris | Y |
| | | Trichloroethylene | > 1x | * | | L | H | √ | | | N |
| | Vegetation | Arsenic | > 2x | | * | L | H | √ | | Associated with landfill activities and debris | Y |
| | | Iron | > 15x | * | | M | L | | √ | | Y |
| | | Manganese | > 2x | | * | L | L | | √ | | Y |
| | | Sodium | > 135x | * | | H | L | | √ | | Y |