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LONG TERM MONITORING 2017

CAM-F, Sarcpa Lake, Nunavut

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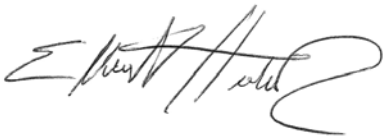
Kelsy Marois, B.Eng.

Field Assessor



Elliott Holden, B.Eng.

Field Assessor

Stephanie Joyce, Msc., C.Chem.

Project Manager

Troy Austrins, P.Eng., PMP

Senior Reviewer

LONG TERM MONITORING 2017

CAM-F, Sarcpa Lake, Nunavut

Prepared for:

Jean Allen

Contaminants Specialist

Indigenous and Northern Affairs Canada
Nunavut Regional Office

P.O. Box 2200,

Iqaluit, NU X0A 0H0

Prepared by:

Arcadis Canada Inc.

329 Churchill Avenue North

Suite 200

Ottawa

Ontario K1Z 5B8

Tel 613 721 0555

Fax 613 721 0029

Our Ref.:

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Date:

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ACRONYMS AND ABBREVIATIONS

AMSRP	Abandoned Military Site Remediation Protocol
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CALA	Canadian Association for Laboratory Accreditation
CCME	Canadian Council of Ministers of the Environment
CEQG	Canadian Environmental Quality Guidelines
CSQG	Canadian Soil Quality Guidelines
CWS	Canada Wide Standard
DEW	Intermediate Distant Early Warning
EC	Environment Canada
FCSAP	Federal Contaminated Sites Action Plan
FIGQG	Federal Interim Groundwater Quality Guidelines
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
INAC	Indigenous and Northern Affairs Canada (formerly AANDC)
LTM	Long Term Monitoring
NHWL	Non-Hazardous Waste Landfill
PCBs	Polychlorinated Biphenyls
PHCs	Petroleum Hydrocarbons
POL	Petroleum, Oil and Lubricants
QA/QC	Quality Assurance/Quality Control
RDL	Reportable Detection Limit
RPD	Relative Percent Difference
ULA	Upper Limit of Acceptability

EXECUTIVE SUMMARY

Arcadis Canada Inc. (Arcadis) was retained by Indigenous and Northern Affairs Canada (INAC) – Nunavut Regional Office to conduct Year 10 of the long-term monitoring (LTM) activities planned for the former CAM-F Distant Early Warning (DEW) Line site at Sarcpa Lake, Nunavut (the site) as prescribed by the CAM-F Sarcpa Lake LTM Plan. This was the seventh monitoring event to occur at CAM-F. This project was completed under INAC Standing Offer Number 4600000861, Order number 4500365458.

The CAM-F Sarcpa Lake site is located on the Melville Peninsula in the Baffin Region of Nunavut, 110 km southwest of Igloolik and 85 km west of Hall Beach. CAM-F was an Intermediate DEW line site constructed in 1957 and operated until 1963. The site was used as a scientific research station between 1977 and 1988.

An environmental remediation project was conducted at the site between 2005 and 2008. Activities included the demolition and disposal of buildings, structures and other debris, as well as the clean-up of hazardous materials. A secure soil disposal facility (SSDF) and non-hazardous waste landfill (NHWL) were constructed during remediation to contain some of the demolished materials and excavated soils. These structures and a hunting/emergency shelter cabin remain present at the site.

The Year 10 LTM efforts were conducted on August 19 and 20, 2017 while based out of Hall Beach. The LTM program consisted of a visual inspection of the SSDF and NHWL and the collection of groundwater samples. In addition, the natural environment was monitored; physical evidence and anecdotal evidence and information suggest that wildlife and local hunters continue use at this site, primarily due to its proximity to Hall Beach and the location of a hunting cabin on the site. The air strip on the CAM-F site was in good condition and the site was readily accessible during the site visit for the Year 10 monitoring activities.

Based on physical observations from the 2017 field activities, it appears that the two landfills, the SSDF and the NHWL, are performing as designed and continue to contain the enclosed waste. At no time during the present monitoring year has the active layer at the SSDF reached depths equal to or greater than the depth of the liner and the waste contained within.

Temperatures recorded in the SSDF indicate that the maximum depths of the active layer recorded since the last site visit are less than in previous years. Maximum thawing of the SSDF's cover material between 2015 and 2017 was recorded by thermistor VT-03 at a depth of 2.07 m. As the SSDF's cover is approximately 3 m thick, the non-hazardous contaminated soil contained within the SSDF continues to remain frozen year-round.

In addition to physical and temperature observations, Arcadis collected groundwater samples to assess the performance of the SSDF and NHWL. Concentrations of contaminants of concern in groundwater were compared to historical groundwater results from 2006 to 2014. Several metals reported concentrations above the Canadian Council of Ministers of the Environment (CCME) Federal Interim Groundwater Quality Guidelines (FIGQGs) pathway specific guidelines for protection of freshwater life. Arcadis believes that as the freshwater life pathway is very conservative for this site, these concentrations are not indicative of leachate plumes associated with the landfill sites.

Physical and thermal observations of the landfills and results of the groundwater chemical analysis conducted during the 2017 site visit indicate that the containment facilities at CAM-F continue to operate as designed and that the site continues to pose no threat to human health or the natural environment.

This executive summary should be read in conjunction with the main report and is subject to the same limitations described in Section 10.0.

1 INTRODUCTION

Arcadis Canada Inc. (Arcadis) was retained by Indigenous and Northern Affairs Canada (INAC) – Nunavut Regional Office to conduct long-term monitoring (LTM) activities (Year 10, seventh monitoring event) at the Intermediate Distant Early Warning (DEW) Line site, CAM-F, located in Sarcpa Lake, Nunavut. Monitoring of the site is to be delivered in three phases, with two phases scheduled over the next 25 years, as prescribed by INAC's CAM-F LTM Plan. This project was completed under INAC Standing Offer Number 4600000861, Order number 4500365458.

This report describes the monitoring activities completed for INAC at CAM-F and was prepared in accordance with the Arcadis proposal 510264-000 dated May 16, 2017.

Throughout this report, the DEW Line site CAM-F will be referred to as "the site".

1.1 Project Objectives

The objective of the 2017 LTM was to complete Year 10, the seventh monitoring event to assess the performance of the Secure Soil Disposal Facility (SSDF) and Non-Hazardous Waste Landfill (NHWL) to verify that they are performing as intended. Monitoring included visual observations, chemical analyses (where beneficial and/or possible) and interviews with members of the nearby community knowledgeable about local activities at the site to assess the condition of the natural environment and whether the site infrastructure is performing as designed.

1.2 Scope of Work

Consistent with the previous monitoring events, the scope of work, as described in the CAM-F Sarcpa Lake LTM Plan (INAC, 2007) was as follows:

1. Visual Inspection of the NHWL and SSDF, including
    - Visually checking the physical integrity of the NHWL and SSDF looking for evidence of settlement, erosion, lateral movement, frost action, animal burrows, vegetation, staining, vegetation stress, seepage points, exposed debris, and the condition of wells;
    - Taking photographs to document the condition of the NHWL and SSDF to substantiate the recorded observations.
2. Active Layer Groundwater Monitoring, including
    - Collection of groundwater samples from the two monitoring wells installed downgradient of both the NHWL and SSDF and the one well installed upgradient of each. These samples were to be analysed and the results compared to those from background samples.
    - Examination and analysis of the groundwater samples for colour, odour, hardness, pH, conductivity, temperature, total and dissolved metals (arsenic, cadmium, chromium, cobalt, copper, lead, nickel and, zinc) polychlorinated biphenyls (PCBs), petroleum hydrocarbons (PHCs), major ions, total dissolved solids (TDS) and total suspended solids (TSS).

3. Soil Monitoring (as required)
    - Soil sampling was to be limited to locations where seepage and/or staining was/were identified as part of the visual monitoring.
4. Thermal monitoring of the SSDF, including:
    - Collection of data from automatic data loggers attached to four thermistor strings with beads at selected depth intervals to provide ground temperature profiles at various locations within the SSDF.
    - Service of the dataloggers, as required.
5. Natural Environment Monitoring, including
    - Collection of direct and indirect evidence of wildlife presence and activity;
    - Observations of the revegetation of disturbed areas.
6. Preparation of a 2017 monitoring program report.

The following tasks were conducted to fulfill the scope:

- Review of the CAM-F Sarcpa Lake LTM Plan, previous LTM reports for CAM-F and the Abandoned Military Site Remediation Protocol (AMSRP; INAC, 2009);
- Preparation of a health and safety plan;
- Preparation of a sampling plan for soil and groundwater;
- Collection of groundwater level data and observation of monitoring well condition at the site;
- Collection of groundwater and soil samples (if required);
- Visual monitoring, measurement of notable site features and photo documentation of the site;
- Interviews with local residents and officials to understand land use and wildlife trends; and
- Report preparation.

2 BACKGROUND INFORMATION

2.1 Site Description

CAM-F Sarcpa Lake, Nunavut was an Intermediate DEW Line site, constructed in 1957 and abandoned in 1963. Its location is presented in Figure 1. The site was converted into a scientific research station in 1977 by the Science Institute of the Northwest Territories and the Department of Indian Affairs and Northern Development (currently INAC) and operated seasonally until 1988.

The CAM-F DEW line site consisted of two main parts – the former station area and the former construction camp area at Sarcpa Lake. Before remediation was completed in 2008, the DEW line site facilities consisted of an airstrip, a small module train, a warehouse, a garage, a Quonset hut, an Inuit house, two former landfill areas, and petroleum, oil and lubricants (POL) storage facilities. The site contained approximately 10,000 barrels of unknown contents, a radar tower that had been dismantled, other debris and contaminated soil. There were also small volumes of miscellaneous waste and chemical residues remaining from the research facility.

The beach area at Sarcpa Lake included the former construction camp, the remnants of which consisted primarily of scattered barrels of unknown contents (in and around the lake), abandoned construction equipment and a small machine shop and generator pad.

A remediation project was conducted at the site between 2005 and 2008. The remediation involved the demolition and disposal of buildings, structures and other debris, as well as the clean-up of hazardous materials. A SSDF and NHWL were constructed during remediation from July 2006 to September 2007 (Figures 2 and 3, respectively).

The SSDF was designed to contain Tier II and PHC contaminated soils. The design was based on the characteristics of the contaminants in the soil and the local geothermal and permafrost properties. The design uses permafrost as the primary containment barrier with both the contents and perimeter berms remaining in a frozen state. It was assumed that the SSDF would reach a frozen state within three to four years of construction, and ground temperature data loggers were installed at each of the four corners of the facility to monitor the freeze-back of the contents and berms. The thickness of the cover material was calculated to prevent the thaw of the contaminated soil even after 10 consecutive 1-in-100 warm years. In response to Arctic climate change studies, the initial design was modified in 2007 and an additional metre of cover was added, increasing the total cover material thickness from 2.3 to 3.3 m. The SSDF contains the following:

- Tier II contaminated soil (as defined by the DEW Line Cleanup Criteria, presented in INAC's Abandoned Military Sites Remediation Protocol (AMSRP)); and
- Soils impacted with benzene, toluene, ethylbenzene and xylenes (BTEX) and PHC fractions F1 and F2.

The NHWL was designed to contain non-hazardous materials only. It was constructed on the natural ground surface with the organic matter stripped and consists of four perimeter berms constructed of granular material. The non-hazardous waste was reportedly placed in the landfill in layers consisting of 0.5 m lifts of waste, covered by 0.15 m of granular fill. The waste layers were compacted and a final cover

consisting of a minimum of 3.3 m of granular fill was used to cap the landfill. The NHWL contains the following:

- Tier I contaminated soil (i.e., soil with lead content between 200 and 500 parts per million (ppm) and PCB content between 1 and 5 ppm);
- Soils impacted with PHC fractions F3 and F4;
- Non-hazardous demolition debris, such as timbers, plywood, and sheet metal;
- Non-hazardous debris, such as scrap metal and wood;
- Non-hazardous debris/soil excavated from landfills;
- Creosote timbers; and
- Double bagged asbestos

The site is not regularly inhabited, and groundwater is not considered to be used for water supply purposes. Surface water was historically used for drinking water supply. The only remaining structure at the site is a cabin located between the two landfills. The cabin was built after the remediation of the site to provide shelter for hunters and fishermen. Hunters and fishermen are known to visit the site on a regular basis.

2.2 Previous Monitoring Programs

The 2017 monitoring program at CAM-F Sarcpa Lake was the seventh (Year 10) of a proposed ten that are scheduled over a 25-year period. Information from the 2008, 2009, 2010, 2011, 2012 and 2014 investigations were incorporated into this year's sampling plan. Data collected in 2008-2014 were combined with the latest data, as well as that from pre-landfill construction in 2006 and 2007, and analysed.

Monitoring procedures adopted by INAC for this site are based on those defined in INAC's AMSRP.

Prior to the field program, Arcadis reviewed the following reports pertaining to the CAM-F DEW Line site, which include previous site investigations and remedial activities:

- *CAM-F Sarcpa Lake Long-Term Monitoring Plan*, January 23, 2007, Indian and Northern Affairs Canada;
- *CAM-F Borehole Logs*, UMA/AECOM, July 24, 2006;
- *CAM-F SSDF Monitoring Well Installations*, February 17, 2005, UMA Engineering Ltd.;
- *Long Term Monitoring 2008*, CAM-F DEW Line Site, NU, January 8, 2009, UMA Engineering Ltd.;
- *Long Term Monitoring 2009*, CAM-F Sarcpa Lake, Nunavut, November 27, 2009, Franz Environmental Inc.;
- *Long Term Monitoring 2010,* CAM-F Sarcpa Lake, Nunavut, December 10, 2010, Franz Environmental Inc.;
- *Long Term Monitoring 2011,* CAM-F Sarcpa Lake, Nunavut, January 11, 2012, Franz Environmental Inc.;

- *Long Term Monitoring 2012,* CAM-F Sarcpa Lake, Nunavut, January 2013, Franz Environmental Inc.;
- *Long Term Monitoring 2014,* CAM-F Sarcpa Lake, Nunavut, March 2015, Franz Environmental Inc.; and
- *Abandoned Military Site Remediation Protocol*, March 2009, Indian and Northern Affairs Canada, Contaminated Sites Program.

3 REGULATORY AND OTHER GUIDELINES

3.1 Guideline Review

Where guidelines were developed, criteria presented in Table 2 of the CAM-F Sarcpa Lake LTM Plan (INAC, 2007) were used to compare both soil and groundwater analytical results. Federal and select provincial guidelines were applied where site-specific criteria were absent and/or were less strict than the federal and provincial standards.

3.2 Groundwater

3.2.1 Comparison to Background Concentrations

There were no groundwater guidelines provided in the CAM-F LTM Plan. In the absence of site-specific guidelines, the AMSRP (INAC, 2009) guidance on post-construction monitoring indicates that "comparison to background and baseline values is recommended." The AMSRP (INAC, 2009) provides the following table for the assessment of analytical data in groundwater.

Table 3-1: Groundwater Assessment

Geochemical Assessment	Acceptable	Marginal	Significant	Unacceptable
Groundwater concentrations within average ± three standard deviations or within analytical variability	Performing as expected			
Increasing trend in contaminant data over two or more successive monitoring events (variation in excess of average ± three standard deviations or analytical variability)		Low risk of failure		
Groundwater concentrations in excess of three times average baseline concentrations in more than one monitoring event			Moderate risk of failure	
Where applicable, surface water concentrations in excess of surface water quality guidelines for the protection of aquatic life				Failure

Geochemical Assessment	Acceptable	Marginal	Significant	Unacceptable
Required Actions	Monitor as per schedule	Increase monitoring frequency. Monitor surface water quality, if applicable, in downgradient water bodies within 300 m.	Assess causes of increasing contaminant concentrations. Evaluate whether remediation is required.	Assess cause of contaminant concentrations. Develop remedial plan. Implement remedial plan.

This table is reproduced from AMSRP (INAC, 2009) Chapter 11, Table 4.2

This is the seventh monitoring event at CAM-F, and the second in Phase II of the LTM Plan, to be implemented within the first 25 years. At the NHWL, five groundwater samples had been collected prior to 2017; three in 2012 and two in 2014. At the SSDF, numerous groundwater samples have been collected since 2006. Using the data, upper limits of acceptability (ULAs, calculated as the average ± three standard deviations) were calculated for total and dissolved metals and some inorganic parameters. Analytical results from 2017 were compared to these ULAs. There is insufficient historical or baseline data to obtain significant means or standard deviations for the remaining parameters (e.g. PHCs and PCBs).

3.2.2 Federal Groundwater Quality Guidelines

In May 2010, Environment Canada (EC) under Federal Contaminated Sites Action Plan (FCSAP) released the *Federal Interim Groundwater Quality Guidelines* (FIGQG) for Federal Contaminated Sites. The guidelines were released based on the observed need for federal custodians and others to apply appropriate groundwater guidelines at federal sites. Previously, a mixture of provincial standards, federal surface water guidelines, and drinking water quality guidelines were applied to groundwater at federal sites. The FIGQGs remove the need for this patchwork of regulations, which were not consistently applied at federal sites. The FIGQGs were updated in June 2016.

The FIGQGs were not developed with the scientific rigour associated with the Canadian Environmental Quality Guidelines published by the Canadian Council of Ministers of the Environment (CCME). Instead, EC requested the development of guidelines based on a review and evaluation of existing approaches in other jurisdictions.

The FIGQGs follow a tiered framework, consistent with the Canadian Soil Quality Guidelines (CSQGs) development through the CCME. The tiers are:

- Tier 1: direct application of the generic numerical guidelines; specifically, application of the lowest guideline for any pathway;
- Tier 2: allows for the development of site-specific remediation objectives through the consideration of site-specific conditions, by modifying (within limits) the numerical guidelines based on site-specific conditions and focusing on exposure pathways and receptors that are applicable to the site; and

- Tier 3: use of site-specific risk assessment to develop Site-Specific Remediation Objectives.

The FIGQGs are based on the consideration of a number of potential receptors and exposure pathways, including:

- Groundwater transport to surface water at least 10 m from the contamination and subsequent exposure of freshwater and marine life;
- Direct contact of soil organisms with contaminated groundwater;
- Use of groundwater for irrigation water;
- Use of groundwater for livestock watering;
- Groundwater transport to surface water at least 10 m from the contamination and subsequent ingestion by wildlife;
- Migration of contaminant vapours to indoor air and subsequent inhalation by humans; and
- Use of groundwater for human consumption (i.e., drinking water).

The generic guidelines are point estimates of a chemical concentration in groundwater associated with an approximate no-effect to low-effects level based on toxicological information about the chemical, along with a screening-level evaluation and environmental fate and transport and estimated intake rates, or exposure, by potential receptors.

As a result, the “Table 2 *Federal Interim Groundwater Quality Guidelines*, *Generic Guidelines for Residential/Parkland Land Uses”* Tier 1, Freshwater Life pathway for coarse grained soil (FIGQG Table 2 Tier 1) were referenced for comparison purposes.

4 INVESTIGATIVE METHODOLOGY

The Year 10 monitoring event was carried out at the CAM-F DEW Line site on August 19th and 20th, 2017 by field assessors Kelsy Marois and Elliot Holden of Arcadis and Noah Shovinga of Nunatta Environmental Services Inc. from Iqaluit, NU, accompanied by INAC representative Jean Allen. The site was accessed via charter aircraft provided by Kenn Borek Air of Calgary, AB. Wildlife monitoring services were provided by Joe Mike of Iqaluit, NU. Weather conditions on August 19th were partly cloudy, with winds of approximately 8 km/hr and a high of 7 °C. Weather conditions on August 20th were partly cloudy, with winds of approximately 24 km/hr and a high of 12 °C. The program consisted of the following:

- Completing a health and safety kick-off meeting;
- Visually observing and photographically documenting the physical integrity of the landfills and the reporting of observable conditions over the rest of the site;
- Monitoring the natural environment and gathering information from knowledgeable persons regarding local wildlife and human activity;
- Collecting landfill temperature data from previously installed thermistor strings at the SSDF;
- Sampling of groundwater and soil (soils only to be collected if evidence of leaching/seeping and staining was observed); and
- Submitting soil and groundwater samples, including duplicates, for applicable laboratory analysis.

The field investigation procedures are described below.

4.1 Health and Safety Plan

Before commencing with site activities, a site-specific health and safety plan (HASP) was developed. The HASP identified and provided mitigative actions for potential physical and chemical hazards associated with the monitoring work. The HASP also contained a listing of emergency contact numbers and provided protocols to follow in the event of an emergency.

A copy of the HASP was presented to INAC for their approval before site activities began. The HASP was brought to the site by both Arcadis and INAC personnel. Prior to conducting any work on site, the plan was distributed and discussed with all personnel involved in the investigative program. A copy of the HASP has been retained on file at Arcadis and at the INAC Nunavut Regional Office.

4.2 Visual Inspection

The physical integrity of the SSDF, the NHWL and surrounding areas were assessed using systematic visual observations and empirical measurements to record evidence of erosion, ponding, frost action, settlement and lateral movement. Definitions for completing the checklist are found in Table 4-1. Visual inspection checklists, presented in the CAM-F LTM Plan, were completed for the SSDF and NHWL and are found in Table 5-2 and Table 6-2 in Sections 5.3 and 6.3, respectively. A photographic record was completed to document the condition of the structures and substantiate the visual observations. A portion of this photographic record appears in Appendices A-1 and A-2; and is presented in its entirety on the accompanying DVD.

Table 4-1: Preliminary Visual Inspection Report - Definitions

Performance / Severity Rating	Description
Acceptable	Noted features are of little consequence. The landfill is performing as designed. Minor deviations in environmental or physical performance may be observed, such as isolated areas of erosion, settlement.
Marginal	Physical/environmental performance appears to be deteriorating with time. Observations may include an increase in size or number of features of note, such as differential settlement, erosion or cracking. No significant impact on landfill stability to date, but potential for failure is assessed as low or moderate.
Significant	Significant or potentially significant changes affecting landfill stability, such as significant changes in slope geometry, significant erosion or differential settlement; scarp development. The potential for failure is assessed as imminent.
Unacceptable	Stability of landfill is compromised to the extent that ability to contain waste materials is compromised. Examples may include: • Debris exposed in erosion channels or areas of differential settlement. • Liner exposed. • Slope failure.
Extent	**Description**
Isolated	Singular feature
Occasional	Features of note occurring at irregular intervals/locations
Numerous	Many features of note, impacted less than 50% of the surface area of the landfill
Extensive	Impacting greater than 50% of the surface area of the landfill

Similar to previous years, the 2017 visual inspection was conducted with the aid of a Trimble Pro XRT Global Positioning System (GPS) unit to locate features of note and to collect Geographic Information System (GIS) information to be used in report preparation. A detailed data dictionary (Trimble file) was created prior to the site visit to capture all required information as outlined in the LTM Plan. The Standard Storage Format (SSF) file from 2014 was used in the field, updated with observations made in 2017. The updated Trimble files are included in the appended DVD to be used in future site investigations.

4.3 Wildlife Survey

Arcadis made observations of the natural environment at the time of the site visit and recorded the observations in field notes. Observations included direct sightings of wildlife (ravens, snow geese, brown birds and snow bunting), other evidence of wildlife (e.g., droppings, tracks, feathers/fur, burrows), wildlife activities (migrating, nesting, etc.), numerical estimates of wildlife (3), and observations of vegetation (low

lying mosses and grasses). Where possible, observations by Arcadis have been compared to previously recorded observations.

4.4 Thermistor Monitoring

A thermistor string was installed at each of the four corners of the SSDF in September 2007 to monitor the temperature of the contained contaminated soil and its cover. Each string consists of 11 or 12 temperature sensing thermocouple beads connected to a Lakewood Systems UltraLogger (RX-16) data logger, programmed to continually record values twice daily.

During the 2017 site visit, all four data loggers were replaced with new, fully serviced data loggers from Lakewood Systems with the exception of the data logger at thermistor VT-04 (located on the northeast corner of the SSDF). A connection port on the newly serviced data logger for thermistor VT-04 was not functioning correctly during the site visit. To avoid data acquisition interruptions, the batteries and desiccants from the newly serviced data logger for thermistor VT-04 were installed in the data logger previously connected at thermistor VT-02 (serial number 4000723). This data logger was then installed at thermistor VT-04. The three data loggers that were removed from the SSDF in 2017 along with the datalogger with the faulty connection port were transported back to Ottawa, ON, for servicing by Lakewood Systems.

The data loggers installed in 2017 were programmed to record temperature data twice daily (at noon and midnight local time). To maintain a record of the most up-to-date temperature data at the SSDF, Arcadis programmed the data loggers to replace old temperature data with the newest temperature data should the datalogger's memory capacity be reached prior to the extraction of the data during the next scheduled site visit. The batteries in all four dataloggers are estimated to expire in October 2024.

At each thermistor string, the resistances at each bead were measured manually. These data points were then converted to temperature values which were compared to the last values logged by the data loggers. The manual resistance check confirms the functionality of each bead, and the comparison with the logged data confirms that the analog data channels of the data logger are operating correctly. As expected, the beads and loggers were performing well and the manually collected data had close agreement with the data collected by the data loggers. Manual resistance check data are presented in Table B-2 in Appendix B.

Upon completion of the manual resistance check, thermistor data for the period from February 5, 2015 to August 19, 2017 were downloaded from the four data loggers, using a laptop with Lakewood Systems' Prolog2 (v.2.226) software. Datasets from each data logger were inspected to verify completeness and data validity prior to resetting the data logger units. Data logger battery voltages, memory usage, and programming were noted, and a visual inspection of the housing equipment was performed. Thermistor inspection records are presented in Table B-1, Appendix B. The serial numbers for the data loggers currently installed at the SSDF are summarized in Table 4-2.

Table 4-2: Summary of Installed Data Loggers at the SSDF

Thermistor ID	Data Logger Serial Number
CAMF-01-VT	07060500
CAMF-02-VT	07040040
CAMF-03-VT	07060501
CAMF-04-VT	14000723

The SSDF ground temperature record, containing continuous information since September 2007 was updated. A discussion, along with plots of temperature versus depth and time, are presented in Section 5.4 and in Appendix B. Raw data are provided on the attached DVD.

4.5 Groundwater Sample Collection

No frost action was observed around or inside the casing of the wells at the time of the site visit. Groundwater levels at all the monitoring wells were measured upon arrival at the site. Groundwater was present in all six monitoring wells during the time of the site visit, and eight groundwater samples were collected during the visit (six samples plus two sample duplicates).

A peristaltic pump was used to purge the monitoring wells prior to sample collection. The wells were purged of three well volumes. A YSI 556 water quality meter was calibrated prior to arriving in the field and used to measure *in situ* field parameters including temperature, conductivity, dissolved oxygen, pH and oxidation-reduction potential. Field parameters results are presented in Table 10 at the end of this report. The groundwater samples were collected once stabilization of parameters was reached. The groundwater samples submitted for dissolved metals analyses were field-filtered.

All groundwater samples collected were submitted for analysis of total and dissolved metals, PCBs, PHCs, BTEX, suspended and dissolved solids, major ions, hardness, pH and conductivity. Two duplicate samples were also collected from monitoring wells MW0601 and MW0604. Each sample was collected in laboratory supplied sample containers with preservative (when appropriate). Groundwater samples were shipped to the laboratory in coolers equipped with ice.

General well conditions were also recorded, and the well casings were re-locked using keyed-alike padlocks. Additional details on the groundwater sampling are presented in the groundwater sample records provided in Appendix C. Chain of custody forms are provided in Appendix D.

4.6 Soil Sample Collection

Soil monitoring point sampling was discontinued in favour of soil sample collection based on physical evidence and observation. No evidence of landfill leaching, or staining was observed during the 2017 monitoring event, therefore no soil samples were collected.

5 SECURE SOIL DISPOSAL FACILITY (SSDF)

5.1 Area Summary

The SSDF is located to the east of the southern end of the airstrip at the CAM-F site. The general coordinates of the landfill are 68° 32' 47.47" N and 83° 18' 19.40" W. Monitoring of the SSDF landfill included visual observations to assess its physical integrity, including evidence of erosion, ponding, frost action, settlement and lateral movement. Four groundwater samples were collected from the area surrounding the SSDF (one sample from each monitoring well plus one duplicate sample).

The SSDF groundwater sample locations and photographic Viewpoints are shown on Figure 2 at the end of this report. Results of the visual inspection are presented in Section 5.3 below.

5.2 Photographic Record

The photographic record of the SSDF has been completed as per the Statement of Work (Viewpoints 1 to 97; attached DVD). Those portions of the photographic record referenced in the body of this document are included in Appendix A-1. The complete photographic record, of full resolution photographs, is provided in the attached DVD. Note that in this report, Photo numbers refer to the selected photos in Appendix A-1 and Viewpoint numbers refer to the photos on the DVD.

5.3 Visual Inspection Checklist

The physical integrity of the SSDF was assessed by collecting visual evidence of erosion, ponding, frost action, settlement and lateral movement. A plan view of the SSDF indicating photographic Viewpoints, salient observations and locations of groundwater monitoring wells is shown in Figure 2. The visual inspection checklist provided in the CAM-F LTM Plan has been completed and pertinent information is summarized in Table 5-1 of this report. Table 5-2 presents the visual inspection results for the SSDF at CAM-F.

Table 5-1: CAM-F SSDF Preliminary Visual Inspection Report

Feature	Presence (Y/N)	Severity Rating	Extent
Settlement	Y	Acceptable	Occasional
Erosion	Y	Acceptable	Occasional
Frost Action	N	Not Observed	None
Animal Borrows	Y	Acceptable	Occasional
Vegetation	Y	Acceptable	Isolated
Staining	Y	Acceptable	Isolated
Vegetation Stress	N	Not Observed	None
Seepage / Ponded Water	Y	Acceptable	Occasional
Debris Exposure	Y	Acceptable	Isolated
Monitoring Well Condition	-	Good condition - Acceptable	

Settlement

The minor settlement that was observed over most of the southern half of the SSDF in 2009 was less evident in 2010 and not observed since, suggesting that the entire top of the SSDF has settled evenly. The depth of settling over the area is minimal (< 10 cm). No new settlement areas were identified during the 2017 monitoring event.

Settlement Features A and B were observed to the north of the landfill, with no significant change from previous monitoring events (see Photographs 7 and 8, Appendix A-1). Other settlement depressions depicted on Figure 2, Features E (Photo 9, Appendix A-1), G (Photo 11, Appendix A-1) were observed to be minor and not significantly changed from the previous year. Former Feature U was not observed and was removed from Figure 2, refer to Table 5-2 for more details. These settlement features do not pose any risk to the landfill integrity. The minor settlement cracking that was observed along the landfill's perimeter and located approximately 4 m up the face of the berm from the toe (see Features C, D, F, K, M, and T; Figure 2) was less evident in 2017 than that observed in 2014.

There were no areas of settlement and areas of ponded water and saturated soils observed on top of the landfill cap or on the slopes of the landfill during the site visit.

Erosion

The small preferred-drainage channels observed in previous years at the toe on the southwest side of the SSDF are still apparent (see Features I (Photo 12), J (Photo 17), N (Photo 14), and Q (Photo 13); Figure 2; Appendix A-1). Based on a comparison with photo documentation from 2008 to 2014, there does not appear to be an appreciable increase in the length or depth of these channels. The channels associated with Features I and J were observed to be dry during the 2017 monitoring event; however, there was running water in Features N and Q. No staining and no areas of ponded water were observed.

Angular cobbles have been exposed in a small, localized area, where fine-grained fill has been washed out on some of the structure's slopes and top, although no significant change from previous years is apparent. Potholes observed in 2008, 2009, 2010, 2011, 2012 and 2014 were not significantly changed in 2017.

The erosion observed in 2017 has not increased significantly since the 2014 monitoring event.

Frost Action

No evidence of heaving or cracking was observed on the top or on the berms of the SSDF. Additionally, no frost action was observed at any of the thermistor housing units or at the surface near the monitoring wells.

Evidence of Burrowing Animals

There was some evidence of burrowing animals observed in the area surrounding the SSDF.

Re-establishment of Vegetation

Vegetative re-growth was observed mainly in one location (see Feature S; Figure 2) on the southeast corner of the SSDF berm. Additional indications of vegetative re-growth observed in previous years were confirmed in 2017. New growth was observed on the top of the landfill and mid-way up the south, west and east facing slopes of the landfill, the new growth is schematically shown in Figure 2, near previously identified features J, T, F and G (Appendix A-1 and Figure 2). It is believed that the previously identified passive seepage points may be contributing to the re-vegetation, as the more saturated areas of the landfill slope are associated with areas of revegetation.

Staining

No staining on or around the SSDF was observed in 2017, which is consistent with previous monitoring observations.

Seepage Points

Four seepage points (see Features I, J, N, and Q; Figure 2) were observed along the southern toe of the landfill in 2011 and 2012. During the 2011 and 2012 LTM events, two of the seepage points (Features J and I; Figure 2, Photos 12 and 17, Appendix A-1) exhibited flowing water. Two of the seepage points (Features I and Q; Figure 2, Photos 12 and 13; Appendix A-1) terminated at standing ponded water. No flowing seepage was observed in 2014. Flowing seepage water was observed at Feature I and Feature Q during the 2017 site visit, consistent with some previous investigations (2011 and 2012).

These seepage features directly correlate with the observations of erosion noted above. These features should be monitored closely, as they may present a pathway for landfill content exposure should the seepages worsen in the future.

Two areas of ponded water that were present in 2011 and 2012 but not in 2014 were present again in 2017. The area around monitoring well MW0604 along the north face of the landfill was fully saturated (Photo 5 Appendix A-1) and an area at the southeast corner of the landfill between Features Q and S also contained ponded water. These areas do not pose a threat to the integrity of the landfill but should continue to be monitored in upcoming years.

Four passive seepage points (formerly labelled as features H, L, P, and V) were identified in 2011; however, these features were not observed during subsequent monitoring events. These seepage features are most likely directly related to heavy precipitation events. No rivulets or erosion channels associated with these passive seepage points were observed. As these features have not been observed in the past three LTM events, they have been removed from Figure 2.

Debris

A small area of metal debris was observed in an area to the southwest of the landfill. Upon inspection, it does not appear to be associated with the landfill. The area surrounding the emergency cabin contains a significant amount of waste and debris (caribou antlers and bones, empty containers, household waste, evidence of burned waste) as well as a significant amount of overturned, partially full and empty barrels of unknown contents. One of these barrels was also found next to the water body along the north side of the SSDF on the other side of the access road. This debris is not associated with the landfill site; however, it should be noted for continued observation in the future.

Discussion

The features discussed above are currently considered to be of little consequence to the physical integrity of the SSDF. All physical observations indicate that the SSDF is performing as designed and is containing the enclosed waste.

Table 5-2, on the next few pages, summarizes the results of the visual inspection.

Table 5-2: CAM-F SSDF Visual Inspection Checklist

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (cm)	Depth (cm)	Extent	Description (Change)	Additional Comments	Viewpoint
Settlement	A	Near the road, 12 m east of northeast of MW604	20 m^2		<2	<1%	Ponded water, increased in size in 2012, dry in 2014	Visible in 2017	54
Settlement	B	Near the road, 14 m north of the SSDF northwest corner	17 m^2		<10	<1%	Large Depression: No significant change (NSC) 2012	Decreased in area from 2012 in 2017	55
Settlement	C	Along toe of the landfill, at the northwest corner of the SSDF	12	<1	<1	<1%	Minor cracking and a slightly low lying area; NSC 2014	NSC 2017	56-57
Settlement	D	Along the northwest side of the landfill, 12 m south of the northwest corner of the SSDF	16	<1	<1	<1%	Minor settlement cracks; less evident/NSC 2014	Less evident 2017	58-59
Settlement	E	Along the side of the landfill, near toe of the SSDF along the west side, 31 m south of the northwest corner	12 m^2		<12	<1%	Minor settlement and cracking, Pothole; NSC 2014	Decreased in area in 2017 (16 m^2 in 2014 to 12 m^2 in 2017)	60-61
Settlement	F	Along the side of the landfill, near toe of the SSDF along the west side, 33 m north of the southwest corner	25	<1	<3	<1%	Minor settlement cracks; NSC 2014	NSC 2017	67
Settlement	G	Along the side of the landfill, near toe of the SSDF along the west side, 35 m north of the southwest corner	0.03 m^3			<1%	Two small settlement features – potholes; NSC 2014	NSC 2017	70
Settlement	H	Along the side of the landfill in the southwest corner of the SSDF	-				not observed in 2017	**Removed from Figure 2 in 2015**	71
Seepage	I	Toe of the landfill in the southwest corner of the SSDF	13 m^2		<25	<1%	Seepage areas observed to be moist in 2017	North ponded area	73-75
			41 m^2		<25	<1%		South ponded area	
			7	<100	<15	<1%		North channel	
			8.8	<100	<20	<1%		South channel	
Seepage	J	14 m southeast from the southwest corner of the SSDF near the toe	7.3	<50	<15	<1%	Active Seepage; not flowing in 2014/2017	NSC 2017	-
Settlement	K	9 m east from the southwest corner of the SSDF alongside of landfill	13.6	<1	<1	<1%	Cracking; less evident in 2012; NCS 2014	NSC 2017	76-77
Seepage	L	15 m east from the southwest corner of the SSDF alongside of landfill	-				Not observed in 2014/2017	**Removed from Figure 2**	17
Settlement	M	37 m east from the southwest corner of the SSDF alongside of landfill	16.5	<1	<5	<1%	Very minor settlement cracking; not observed in 2012 or 2014	NSC 2017	78
Erosion Channel	N	28 m east from the southwest corner of the SSDF near the toe	9.6	<5	N/A	<1%	Seepage face and associated drainage; drainage channel running in 2017	Seepage Face – saturated	79-80
			40	<40	<30	<1%		Drainage channel- looks mechanically derived	
Settlement	O	24 m west from the southeast corner of the SSDF alongside of landfill	-			-	not observed 2014/2017	**Removed from Figure 2**	81
Seepage	P	20 m west from the southeast corner of the SSDF alongside of landfill	-			-	not observed in 2012 or 2014/2017	**Removed from Figure 2**	26

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (cm)	Depth (cm)	Extent	Description (Change)	Additional Comments	Viewpoint
Erosion Channel	Q	11 m west from the southeast corner of the SSDF at the toe of the landfill	12	<5	N/A	<1%	Seepage face, associated drainage and ponded water; Soil saturated, and running in 2017.	Seepage Face	82 to 84
			0.25	<45	<25	<1%		West channel	
			0.15	<40	<15	<1%		East channel	
			42 m^2		<2	<1%		Ponded water	
Seepage	R	Southeast corner of the SSDF at toe	11.1	<10	N/A	<1%	Seepage face and saturated soil area with ponded water; less evident in 2012; dry in 2014; soil saturated in 2017	Seepage face - dry	23
			5 m^2		N/A	<1%		Saturated soil area - decreased	
Vegetation	S	Southeast corner of the SSDF along the side slope	N/A			<1%	Area of vegetation; increased density of growth in 2012; increased density of growth in 2017	Vegetation establishing on top of landfill and along eastern and southern slopes	85, 91 to 97
Settlement	T	40 m north from the southeast corner of the SSDF along the side slope	7.8	<10	<1	<1%	Settlement cracks; less evident in 2012; less evident in 2014, NSC 2017	South crack	86
			8.9	<10	<1			North crack	
Settlement	U	28 m south from the northeast corner of the SSDF along the side slope	-		-	-	not observed in 2017.	**Removed from Figure 2**	87
Seepage	V	18 m south from the northeast corner of the SSDF along the side slope	-			-	not observed in 2017	**Removed from Figure 2**	36 and 38
Ponded Water	W	MW06-04	~55 m^2		N/A	<1%	Ponded/puddled water. No ponding observed in 2014. Observed in 2017	Ponded water observed in 2017	40, 90

5.4 Thermal Monitoring Data

As described in the initial annual monitoring report (UMA, 2008), two thermistor strings (VT-01 and VT-02) were installed from the SSDF surface to the top of the key trench and two thermistor strings (VT-03 and VT-04) were installed from 1.5 m below the surface to the middle of the key trench.

All thermistor beads positioned below the ground surface were found to yield temperatures within the standard ± 0.2 ºC margin of error when compared to field resistance readings, except for bead 1 and 2 on both VT-01 and VT-02 and beads 11 and 12 on both VT-03 and VT-04. The discrepancies noted on bead 1 and 2 on both VT-01 and VT-02 ranged between 0.6 ºC and 7.2 ºC. Minor discrepancies (≤ 0.5 ºC) were noted for beads 11 and 12 on both VT-03 and VT-04. A larger margin of error between manually and automatically recorded temperatures is considered acceptable for beads positioned above or near the ground surface, as is the case for bead 1 on VT-01 and bead 1 on VT-02. The larger margin of error is attributable to fluctuation in atmospheric temperature over the duration of the test period. As such, the data from these beads are considered useable and was retained. Additional details of the manual verification test are presented in Table B-2, Appendix B.

The position of the 0 ºC isotherm was calculated at each thermistor location from ground temperatures collected on August 19, 2017 and was compared to its position established in previous years (refer to Table 5-3). The maximum depth of the active layer – depth to the 0 ºC isotherm, or permafrost – was interpolated from the deepest points during the year at which temperatures straddled the freezing point. Temperature profile plots of depth versus temperature and temperature versus time for each thermistor string between 2015 and 2017 are presented in Figures B-1 to B-12, Appendix B.

Table 5-3: Maximum Depth to Permafrost in the SSDF (m - all values interpolated)

Thermistor	VT-01	VT-02	VT-03	VT-04
Max between Jan. 1, 2008 to December 31, 2008 (date established (YYYY-MM-DD))	2.29 2008/08/17	2.33 2008/09/07	2.49 2008/10/08	2.12 2008/09/06
Max between Jan. 1, 2009 to December 31, 2009 (date established (YYYY-MM-DD))	1.84 2009/09/07	2.23 2009/09/07	2.37 2009/09/06	2.23 2010/09/10
Max between Jan. 1, 2010 to December 31, 2010 (date established (YYYY-MM-DD))	1.79 2010/09/09	2.26 2010/08/26	2.39 2010/08/29	2.27 2010/08/30
Max between Jan. 1, 2011 to December 31, 2011 (date established (YYYY-MM-DD))	1.77 2011/08/28	2.15 2011/08/30	2.30 2011/08/29	2.19 2011/08/30
Max between Jan. 1, 2012 to December 31, 2012 (date established (YYYY-MM-DD))	1.44 2012/09/02	1.89 2012/09/02	*NA	1.97 2012/09/08
Max between Jan. 1, 2013 to December 31, 2013 (date established (YYYY-MM-DD))	1.52 2013/08/23	1.86 2013/08/24	*NA	1.89 2013/08/24
Max between Jan. 1, 2014 to August 24, 2014 (date established (YYYY-MM-DD))	1.43 2014/08/07	1.76 2014/08/14	*NA	1.89 2014/08/16
Max between Feb. 18, 2015 to December 31, 2015 (date established (YYYY-MM-DD))	1.29 2015/09/04	1.71 2015/09/04	1.72 2015/09/03	1.68 2015/09/04
Max between Jan. 1 2016 to December 31, 2016 (date established (YYYY-MM-DD))	1.60 2016/08/30	1.93 2016/09/01	2.07 2016/09/03	2.01 2016/09/07
Max between Jan. 1 2017 to August 19, 2017 (date established (YYYY-MM-DD))	1.43 2017/08/18	1.75 2017/08/18	1.82 2017/08/18	1.82 2017/08/19

*insufficient data to calculate a depth

Based on the data in Table 5-3, the maximum depths of the active layer recorded since the last site visit are less than in previous years. Maximum thawing of the SSDF's cover material between 2015 and 2017 was recorded by VT-03 at 2.07 m. As the SSDF's cover is approximately 3 m thick, the non-hazardous contaminated soil contained within the SSDF continues to remain frozen year-round.

Arcadis recommends the Guard locks (40 mm universal-key padlocks, No. 834, key number 102) be replaced on all four data logger housings. Additional details can be found in the thermistor annual maintenance monitoring report (Table B-1, Appendix B). Field notes relating to the thermistor inspection are included in Appendix C. A verification of the data collected by the thermistors was performed by comparing the logged temperature versus the recorded resistance. Results indicate that all temperature sensing beads of the four thermistor strings are functioning well. Details of the tests are presented in Table B-2, Appendix B.

5.5 Analytical Results- Groundwater

As described in Section 4.5, three groundwater samples (plus one blind field duplicate) were submitted to Maxxam Analytics in Mississauga, Ontario for analyses of PHCs, metals, PCBs and inorganic parameters from the SSDF. Analytical results are presented at the end of this report in Tables 1 through 5. Historical results and calculations of the ULAs are found in Tables 6 through 9. Results of data collected in the field are presented in Table 10. Laboratory certificates of analyses for the 2017 groundwater samples are provided in Appendix D.

PHCs

Laboratory analytical results for PHCs are shown in Table 1. Sample concentrations for all parameters were below laboratory reportable detection limits and thus fall below the maximum acceptable concentrations. While historical data does not permit the meaningful calculation of mean and standard deviation for BTEX compounds, none of these compounds exceeded detection limits.

Metals

Laboratory analytical results for total metals are shown in Table 2. Visual results of select average metal concentrations (total and dissolved) are presented in Appendix C. Note that when reported concentrations are below detection limits, one half of the detection limit was used for calculations and graphing purposes. Concentrations of total copper, total cadmium, total uranium and total zinc were reported above the CCME FIGQGs for freshwater life pathway for all samples collected from the monitoring wells at the SSDF (monitoring wells MW0604, MW0605 and MW0606). The sample collected from monitoring well MW06906 reported selenium concentrations greater than the FIGQG of 1 µg/L.

Laboratory analytical results for dissolved metals are shown in Table 3. Concentrations of dissolved uranium and zinc exceeded the CCME FIGQGs in samples collected from all SSDF monitoring wells (MW0604, MW0605 and MW0606). Dissolved copper concentrations exceeded the CCME FIGQGs in the samples collected from monitoring wells MW0604 and MW0605. Cadmium concentrations in samples collected from monitoring wells MW0605 and MW0606 and selenium concentrations in samples collected from monitoring well MW0606 also exceeded the FIGQGs.

PCBs

Laboratory analytical results for PCBs, and the maximum acceptable concentrations (based on historical results) are shown in Table 4. As shown in the table, PCB concentrations were below the RDLs and thus satisfy the standards applied to the site.

Inorganics

Laboratory analytical results for inorganics are shown in Table 5. Concentrations of fluoride and dissolved sulphate were reported above the CCME FIGQGs for freshwater life pathway in all samples collected from the SSDF monitoring wells (MW0604, MW0605 and MW0606).

5.6 Analytical Results- Soil

Soil monitoring point sampling was discontinued in favour of soil sample collection based on physical evidence and observation. No evidence of landfill leaching, or staining was observed during the 2017 monitoring event, therefore no soil samples were collected.

6 NON-HAZARDOUS WASTE LANDFILL (NHWL)

6.1 Area Summary

The NHWL is located to the northeast of the airstrip. The general coordinates of the landfill are 68° 33' 6.55" N and 83° 18' 48.96" W. Monitoring of the NHWL included visual observations to assess its physical integrity, such as evidence of erosion, ponding, frost action, settlement and lateral movement. Groundwater samples were also collected at locations up and downgradient of the NHWL.

A plan view of the NHWL indicating photographic viewpoints can be seen in Figure 3. The visual inspection report, including supporting photos and drawings is presented in Sections 6.2 and 6.3 below.

6.2 Photographic Record

The photographic record of the NHWL (and other areas of the site) has been completed as per the Statement of Work (Viewpoints 1 to 51, attached DVD). Those portions of the record referenced in the body of this document are included in Appendix A-2. The complete photographic record, of full-resolution photographs, is provided in the attached DVD. Note that in this report, Photo numbers refer to the selected photos in Appendix A-2 and Viewpoint numbers refer to the photos on the DVD.

6.3 Visual Inspection Checklist

The physical integrity of the NHWL was assessed by collecting visual evidence of erosion, ponding, frost action, settlement and lateral movement. The visual inspection checklist provided in the CAM-F LTM Plan has been completed and pertinent information is summarized in Table 6-2 of this report, see Table 4-1 in Section 4.2 for definitions. Table 6-1 presents the preliminary visual inspection results for the NHWL at CAM-F.

Table 6-1: CAM-F NHWL Preliminary Visual Inspection Report

Feature	Presence (Y/N)	Severity Rating	Extent
Settlement	Y	Acceptable	Occasional
Erosion	Y	Acceptable	Isolated
Frost Action	N	Not Observed	None
Animal Borrows	N	Not Observed	None
Vegetation	N	Not Observed	None
Staining	N	Not Observed	None
Vegetation Stress	N	Not Observed	None
Seepage / Ponded Water	N	Not Observed	None
Debris Exposure	N	Not Observed	None
Monitoring Well Condition	NA	Good condition - Acceptable	

NA: Not Applicable

Settlement

Settlement on the landfill top (see Features A and B, Photos 8 and 9; Appendix A-2) is similar to that described in previous years (two small locations on the northwest sector; refer to Figure 3). There is no obvious cause to this settlement, which is considered minor. There is no evidence of significant water infiltration and no ponding was observed at or around the NHWL.

The same settlement areas (see Features C and D, Photos 10 and 11; Appendix A-2) were also observed beyond the toe of the NHWL between the northwest corner and the southwest side (see Figure 3) where a maximum depth of settlement of 0.3 to 0.4 m was reached. A new area of minor settlement located approximately 25 m north of the NHWL was documented as Feature E in 2012, which showed no significant change in subsequent years (see Figure 3 and Photo 4; Appendix A-2) including 2017.

Erosion

Evidence of erosion is similar to that observed in previous years: there exists minor erosion on the side slopes of the NHWL, likely due to down-slope washing of fine-grained fill between cobbles. There is no apparent downgradient erosion from the landfill.

Frost Action

No evidence of heaving or cracking was observed on the top or sides of the NHWL. There were no apparent signs of frost action observed in 2017.

Evidence of Burrowing Animals

Indications of burrowing animals were not observed surrounding the NHWL in 2017.

Re-establishment of Vegetation

Based on the regional setting of this landfill and the very coarse materials used to construct the landfill cap, reestablishment of vegetation is likely to take a significant amount of time. A small area of revegetation was noted on the top of the landfill during the 2017 LTM event (Photo 7; Appendix A-2).

Staining

Indications of staining on or around the NHWL were not observed in 2017.

Seepage Points

Small rill or erosion channels observed on the sides of the slopes in 2009 were interpreted as evidence that seepage had occurred on all side slopes of the NHWL; no indication of rills or erosion channels associated with seepage were observed during subsequent site visits. As proposed above, evidence of apparent potential seepage may be closely linked to timing of precipitation events over the short term. No water ponding within the vicinity of the NHWL was observed. Conditions seem relatively unchanged from previous LTM events.

Debris

No debris within the vicinity of the NHWL was observed in 2017.

Discussion

The features discussed above are currently considered to be of little consequence to the physical integrity of the NHWL. All physical observations indicate that the NHWL is performing as designed and is containing the enclosed waste.

Table 6-2, on the next page, summarizes the results of the visual inspection.

Table 6-2: CAM-F NHWL - Visual Inspection Checklist

Checklist Item	Feature Letter	Relative Location	Area (m^2)	Depth (cm)	Extent	Description (Change)	Additional Comments	Viewpoint
Settlement	A	Top of NHWL, 24.6 m east from the northwest top ledge	12.9	<2	<1%	Small depression; NSC in 2017	-	47, 48
Settlement	B	Top of NHWL, 15.4 m east from the northwest top ledge	32.3	<10	<1%	Large Depression; NSC in 2017	-	49
Settlement	C	3.3 m west of the west corner of the NHWL	6.6	<20	<1%	Slight low area; NSC in 2017	Appears to be mechanical	50
Settlement	D	10.8 m southwest of the south corner of the NHWL	16.3	<25	<1%	Settlement; NSC in 2017	-	51
Settlement	E	25 m north of the north corner of the NHWL	20	<25	<1%	Slight low area; NSC in 2017	-	27

NSC: No significant change

6.4 Analytical Results – Groundwater

As described in Section 4.5, three groundwater samples (plus one blind field duplicate) were submitted to Maxxam Analytics in Mississauga, Ontario for analyses of PHCs, metals, PCBs and inorganic parameters. Analytical results are presented at the end of this report in Tables 1 through 5. Historical results and calculations of the ULAs are found in Tables 6 through 9. Results of the data collected in the field are presented in Table 10.

PHCs

Laboratory analytical results for PHCs are shown in Table 1. Concentrations for all parameters were below laboratory reportable detection limits and thus fall below the maximum acceptable concentrations. While historical data does not permit the meaningful calculation of mean and standard deviation for BTEX compounds, none of these compounds exceeded detection limits.

Metals

Laboratory analytical results for total metals are shown in Table 2. Concentrations of total copper and zinc were reported above the CCME FIGQGs for freshwater life pathway in all samples collected from the monitoring wells at the NHWL (MW0601, MW0602 and MW0603). Total aluminium, cadmium, chromium and iron concentrations also exceeded the CCME FIGQGs in the sample collected from monitoring well MW0602. The ULA for cobalt was exceeded in the sample collected from MW0601 and its duplicate.

Laboratory analytical results for dissolved metals are shown in Table 3. Concentrations of dissolved copper and zinc exceeded FIGQGs in all samples collected from the monitoring wells at the NHWL (MW0601, MW0602 and MW0603). Cadmium concentrations slightly exceeded the FIGQGs in the samples collected from monitoring wells MW0602 and MW0603.

PCBs

Laboratory analytical results for PCBs are shown in Table 4. As shown in the table, PCB concentrations were below the RDLs and thus satisfy the standards applied to the site.

Inorganics

Laboratory analytical results for inorganics are shown in Table 5. Concentrations of fluoride were reported above the CCME FIGQGs for freshwater life pathway in samples collected from monitoring wells MW0601 and MW0602. The concentration of nitrate exceeded the FIGQGs in the duplicate sample collected from monitoring well MW0601 (DUP02); however, the concentration was still below the ULA.

Laboratory certificates of analyses for the 2017 groundwater samples are provided in Appendix D.

6.5 Analytical Results – Soil

Soil monitoring point sampling was discontinued in favour of soil sample collection based on physical evidence and observation. No evidence of landfill leaching, or staining was observed during the 2017 monitoring event, therefore no soil samples were collected.

7 SURROUNDING AREAS

As proposed, an assessment of outlying areas on site was completed during the Year 10 LTM event.

The landing strip allowing access to the site was in a good condition and the team arrived at the site via charter aircraft out of Iqaluit. With the exception of the cabin area between the NHWL and SSDF, which is in frequent use, the site was found to be clean and in good order. A significant amount of scattered debris including fuel drums, animal remains, garbage and remnants of fires is present around the hunting cabin. The grading of the borrow areas to the west of the NHWL was noted to be less smooth and level than the other re-graded areas.

8 NATURAL ENVIRONMENT

Information regarding the natural environment was gathered directly through observation. The CAM-F LTM Plan recommends monitoring the following parameters:

- Wildlife sightings;
- Other evidence of recent presence of wildlife (e.g. droppings, tracks);
- Wildlife activity (e.g. nesting, migration);
- Qualitative assessment of relative numbers versus previous years; and
- Revegetation of disturbed areas versus previous years.

Wildlife and Human Activity

The areas around the SSDF and NHWL are used for hunting and fishing by residents of Hall Beach. There is evidence of caribou in the area (i.e. tracks, antlers and bones). Approximately fifteen empty and partially empty barrels were observed outside the cabin, some of which contained various quantities of fuel oil and other unknown fluids (see Photo 12, Appendix A-2). The barrels have accumulated in number since the completion of the remediation work, likely due to the presence of hunters in the area using the emergency shelter.

Wildlife observed during the site visit include;

- Snow Geese
- Canada Geese
- Snow Bunting

Evidence of wildlife observed during the site visit include;

- Caribou (tracks, antlers, bones, etc.)
- Fox (tracks)
- Small rodents (burrows)

Re-establishment of Vegetation

Major site remedial work, comprised of excavation and construction activities, was completed in the summer of 2007, ten years prior to the 2017 site monitoring visit. Evidence of revegetation was initially observed in August 2011 and appears to have established further in 2017; however, given the regional setting of the CAM-F DEW Line site and growth observed at other similar sites in the Nunavut region, it is reasonable to assume that it will continue to take many years for native vegetation to become fully re-established at the site.

9 CONCLUSIONS AND RECOMMEDNATIONS

Based on physical observations from the 2017 field activities, it appears that the two landfills, the SSDF and the NHWL, are performing as designed and continue to contain the enclosed waste. Settlement features previously observed at both the SSDF and NHWL have not changed significantly. Several features of concern at the SSDF were not observed at all in 2017. At no time during the present monitoring year has the active layer at the SSDF reached depths equal to or greater than the depth of the liner and the waste contained within. The non-hazardous contaminated soil contained within the SSDF continues to remain frozen year-round.

Groundwater samples were collected from the three monitoring wells at the SSDF and the three monitoring wells at the NHWL. Several metals reported concentrations above the CCME FIGQGs pathway specific guidelines for protection of freshwater life. Arcadis believes that as the freshwater life pathway is very conservative for this site, these concentrations are not indicative of leachate plumes associated with the landfill sites.

Based on the results of Year 10 LTM, the facility appears in acceptable condition. It is recommended that monitoring continue as per the schedule set out in the LTM Plan. Given the low solubility of PCBs in water, analyses of PCBs could be discontinued as they were not detected in the first ten years of monitoring, as per the AMSRP. Concentrations of PHCs have also not been detected in any of the collected groundwater samples and could be discontinued. The next monitoring event (Year 15) should be scheduled for 2022.

10 LIMITATIONS

This report has been prepared exclusively for Indigenous and Northern Affairs Canada (INAC). Any other person or entity may not rely upon the report without express written consent from Indigenous and Northern Affairs Canada.

Any use, which a third party makes of this report, or any reliance on decisions made based on it, is the responsibility of such third parties. Arcadis Canada Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

Some of the information presented in this report was provided through existing documents and interviews. Although attempts were made, whenever possible, to obtain a minimum of two confirmatory sources of information, Arcadis Canada Inc., in certain instances, has been required to assume that the information provided is accurate.

The conclusions presented represent the best judgment of the assessors based on current environmental standards and on the site conditions observed on August 19 and 20, 2017. Due to the nature of the investigation and the limited data available, the assessors cannot warrant against undiscovered environmental liabilities.

Should additional information become available, Arcadis Canada Inc. requests that this information be brought to our attention so that we may re-assess the conclusions presented herein.

There is no warranty, expressed or implied that the work reported herein has uncovered all potential environmental liabilities, nor does the report preclude the possibility of contamination outside of the areas of investigation. The findings of this report were developed in a manner consistent with a level of care and skill normally exercised by members of the environmental science and engineering profession currently practicing under similar conditions in the area.

A potential remains for the presence of unknown, unidentified, or unforeseen surface and sub-surface contamination. Any evidence of such potential site contamination would require appropriate surface and sub-surface exploration and testing.

If new information is developed in future work (which may include excavations, borings, or other studies), Arcadis Canada Inc. should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

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TABLES

Tables 1 to 10

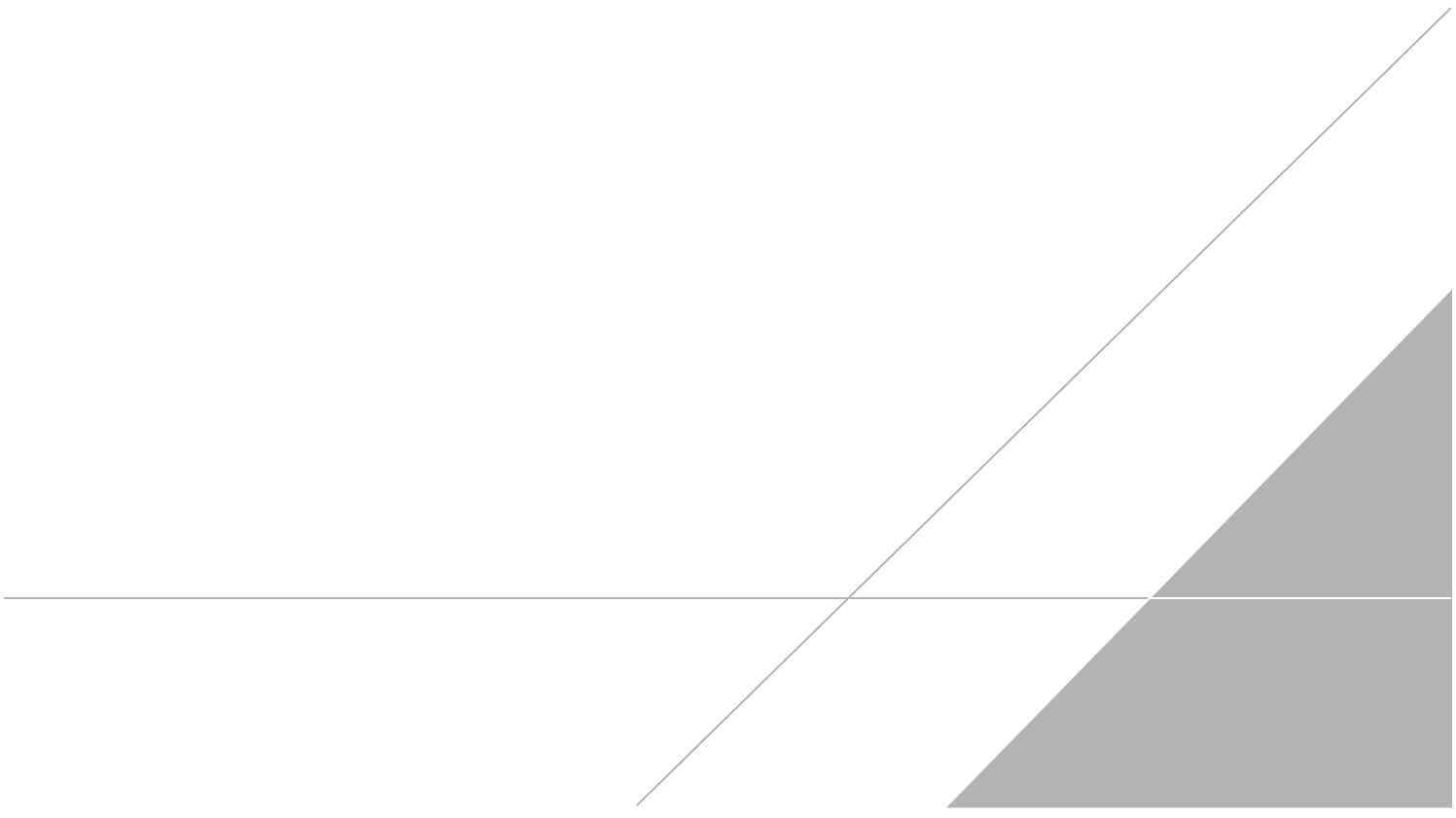


Table 1
Groundwater Chemical Concentrations - PHCs
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	NHWL									SSDF							
				MW0601			MW0602			MW0603			MW0604				MW0605		MW0606	
				2012-08-06	2017-08-20	DUP02 2017/08/20	2012-08-06	2014-08-24	2017-08-20	2012-08-06	2014-08-25	2017-08-20	2012-08-06	2014-08-24	2017-08-19	DUP 01 '2017-08-19	2012-08-06	2017-08-20	2012-08-06	2017-08-20
BTEX & F1 Hydrocarbons (ug/L)																				
Benzene	140	NC/NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Toluene	83	NC/NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Ethylbenzene	1100	NC/NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
o-Xylene	NG	NC/NC	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p+m-Xylene	NG	NC/NC	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
Total Xylenes	3900	NC/NC	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40
F1 (C6-C10)	810	NC/156	25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
F1 (C6-C10) - BTEX	NG	NC/NC	25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
F2-F4 Hydrocarbons (ug/L)																				
F2 (C10-C16 Hydrocarbons)	1300	NC/148	100	<100	<100	**<300**	<100	<100	<100	<100	-	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	NG	NC/148	100	<200	<200	**<600**	<200	<200	<200	<200	-	<200	<200	<200	<200	<200	<200	<200	<200	<200
F4 (C34-C50 Hydrocarbons)	NG	NC/148	100	<200	<200	**<600**	<200	<200	<200	<200	-	<200	<200	<200	<200	<200	<200	<200	<200	<200
Reached Baseline at C50	-	-	NA	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:
1 = Table 1: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Freshwater Life pathway for coarse grained soils.
2 = Upper Limit of Acceptability is determined as described in Report Section 3.2. Upper limits of acceptability are clcaulated using mean of previous sampling rounds +3 standard deviations. First ULA provided is for NHWL, second ULA is for SSDF.
NG = No guideline
NC = Not calcuated
21 = Exceeds FIGQGs
<100 RDL raised due to dilution to achieve analysis

Table 2
Groundwater Chemical Concentrations - Total Metals
INAC Nunavut Regional Office
CAM-F Sarcpa Lake, Nunavut

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	NHWL										SSDF								
				MW0601		DUP02	RPD (%)	MW0602			MW0603			MW0604			DUP01	RPD (%)	MW0605		MW0606	
				2012-08-06	2017-08-20	2017-08-20		2012-08-06	2014-08-25	2017-08-20	2012-08-06	2014-08-25	2017-08-20	2012-08-06	2014-08-25	2017-08-19	2017-08-19		2012-08-06	2017-08-20	2012-08-06	2017-08-20
Metals (µg/L)																						
Total Aluminum (Al)	100	NC	3.0	11	30.8	20.9	38.3%	92	1,100	1,140	1300	2,500	4.11	17.0	20.0	14.6	11.3	25.5%	11	6.06	150	164
Total Antimony (Sb)	2000	NC	0.60	<0.60	0.108	0.108	0%	0.66	<0.60	0.313	<0.60	<0.60	0.302	<0.60	<0.60	0.207	0.199	3.9%	<0.60	0.054	<0.60	0.062
Total Arsenic (As)	5	1.3/2.4	0.20	0.34	0.289	0.286	1.0%	0.23	0.41	0.222	0.61	0.94	0.215	0.24	<0.20	0.177	0.184	3.9%	0.37	0.349	0.3	0.289
Total Barium (Ba)	500	NC	10	25	24.4	24.8	1.6%	35	57	46.9	43	58	21.5	<10	<10	13.2	13.5	2.2%	39	31.3	32	25
Total Beryllium (Be)	5.3	NC	1.0	<1	<0.010	<0.010	N/A	<1.0	<1.0	0.031	<1.0	<1.0	<0.010	<1.0	<1.0	<0.010	<0.010	N/A	<1.0	<0.010	<1.0	0.01
Total Boron (B)	5000	NC	20	<20	16	16	0%	86	940	1,000	<20	25	<10	34.0	22.0	70	72	2.8%	22	47	21	50
Total Cadmium (Cd)	0.017	0.38/0.60	0.005	0.0099	<0.0050	<0.0050	N/A	0.010	<0.020	0.019	0.039	0.25	0.006	0.017	<0.02	0.02	0.017	16.2%	0.037	0.022	0.011	0.03
Total Calcium (Ca)	NG	NC	300	60,000	55,000	55,100	0.2%	68,000	110,000	82,900	37,000	65,000	30600	120,000	64,000	87,300	89,100	2.0%	180,000	130,000	120,000	104,000
Total Chromium (Cr)	8.9	37/73	1.0	<1.0	0.25	0.22	12.8%	3.5	6.4	11.1	3.0	25	0.2	<1.0	<1.0	0.12	<0.10	N/A	<1.0	0.13	<1.0	1.38
Total Cobalt (Co)	NG	338/5.8	0.30	220	**363**	**349**	3.9%	<0.3	1.3	0.141	1.6	3.5	0.267	0.8	0.6	1.25	1.27	1.6%	0.75	0.507	0.39	0.422
Total Copper (Cu)	4	70/52	0.20	7.4	10.7	10.4	2.8%	4.0	9.8	4.02	37	38	16.6	6.7	2.4	4.74	4.74	0%	7.3	4.09	6.3	4.64
Total Iron (Fe)	300	NC	60	<60	26	25.5	1.9%	72	1,400	402	1,200	4,100	7.4	<60	<60	17.7	12.6	33.7%	<60	1.8	170	183
Total Lead (Pb)	7	7/4.3	0.20	<0.20	0.018	0.023	24.4%	<0.20	0.89	0.42	2.2	4.5	0.057	<0.20	<0.20	0.02	0.018	10.5%	<0.20	0.011	<0.20	0.187
Total Lithium (Li)	NG	NC	20	<20	22.4	22.8	1.8%	<20	<20	6.85	<20	<20	4.1	40	35	64.1	66	2.9%	34	64.9	37	59.6
Total Magnesium (Mg)	NG	NC	200	21,000	21,500	21,700	0.9%	13,000	24,000	17,100	9,300	21,000	10,700	74,000	48,000	101,000	104,000	2.9%	100,000	150,000	68,000	118,000
Total Manganese (Mn)	NG	NC	4.0	76	68.6	66.6	3.0%	<4.0	28	4.06	23	100	3.41	18.0	24.0	47.5	49.9	4.9%	5.9	10.4	20	17.7
Total Mercury (Hg)	0.026	NC	0.01		<0.01	<0.01				<0.01			<0.01			<0.01	<0.01			<0.01	-	<0.01
Total Molybdenum (Mo)	73	NC	0.20	11	8.86	9	1.6%	1.3	1.1	1.08	0.72	2.5	1.34	9.5	11.0	13	13.2	1.5%	2.7	4.97	5.2	8.62
Total Nickel (Ni)	150	54/89	0.50	25	24.1	23.3	3.4%	1.2	7.6	1.9	12	32	5.46	3.9	3.9	6.8	7.15	5.0%	4.2	4.24	6.4	5.42
Total Phosphorus (P)	NG	NC	100	<100	---	---	N/A	<100	<100	---	<100	210	---	<100	<100	---	---	N/A	<100	---	<100	---
Total Potassium (K)	NG	NC	300	7,000	7,990	7,730	3.3%	3,800	6,200	4,500	4,800	7,400	4,640	6,700	6,100	10,200	10,200	0%	6,700	9,560	8,600	8,680
Total Selenium (Se)	1	NC	0.20	0.4	0.145	0.128	12.5%	<0.20	<0.20	0.095	<0.20	0.23	0.145	0.5	0.41	0.521	0.513	1.5%	0.44	0.485	1.4	3.4
Total Silicon (Si)	NG	NC	100	1,900	2430	2,440	0.4%	2,400	5,200	5,910	5,400	9,000	2,680	2,300	2,100	2450	2340	4.6%	2,900	2,620	3,300	2,680
Total Silver (Ag)	0.1	NC	0.10	<0.10	0.018	0.011	48.3%	<0.10	0.44	0.032	0.65	2.3	0.018	<0.10	<0.10	0.01	0.011	N/A	<0.10	0.018	0.12	0.021
Total Sodium (Na)	NG	NC	500	41,000	29,500	28,600	3.1%	8,000	14,000	13,500	7,800	7,200	8,890	68,000	47,000	51,700	51,800	0.2%	31,000	398,600	25,000	30,700
Total Strontium (Sr)	NG	NC	20	93	89.4	89.4	0.0%	63	120	91.3	60	180	92	300	180	324	343	5.7%	340	470	220	342
Total Sulphur (S)	NG	NC	200	26,000	13,600	13,400	1.5%	11,000	11,000	10,000	1,000	2,400	<3000	170,000	77,000	161,000	163,000	1.2%	220,000	258,000	130,000	206,000
Total Thallium (Tl)	0.8	NC	0.20	<0.2	0.005	0.006	18.2%	<0.20	<0.20	0.004	<0.20	<0.20	0.006	<0.20	<0.20	0.012	0.012	0%	<0.20	0.021	<0.20	0.008
Total Tin (Sn)	NG	NC	1.0	<1	<0.20	<0.20	N/A	<1.0	<1.0	<0.20	<1.0	<1.0	<0.20	<1.0	<1.0	<0.20	<0.20	N/A	<1.0	<0.20	<1.0	0.2
Total Titanium (Ti)	100	NC	1.0	<1	1.03	1.17	12.7%	3.6	64	12.3	43	170	<0.50	<1.0	<1.0	0.56	0.6	6.9%	<1.0	<0.50	8.1	8.6
Total Uranium (U)	15	NC	0.10	5.3	7.58	7.86	3.6%	5.0	11	9.98	2.4	11	5.72	77.0	86	154	142	8.1%	150	256	94	181
Total Vanadium (V)	NG	NC	1.0	<1.0	<0.20	<0.20	N/A	<1.0	2.8	0.6	2.1	6.0	0.53	<1.0	<1.0	<0.20	<0.20	N/A	<1.0	<0.20	<1.0	0.55
Total Zinc (Zn)	10	633/4312	3.0	300	484	483	0.2%	170	53	159	160	410	103	34.0	11.0	22.6	20.8	8.3%	32	40	260	157

1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations. First ULA provided is for NHWL, second ULA is for SSDF.
NG No guideline
NC Not calculated
RDL Reportable Detection Limit
20 = Exceeds FIGQGs.
20 = Result exceeds Upper Limit of Acceptability
(1) Dissolved greater than total. Results within acceptable limits of precision.
Note that when results were less than the RDL, one half of the RDL was used in average calculations.
All results in µg/L

Table 3
Groundwater Chemical Concentrations - Dissolved Metals
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	NHWL										SSDF								
				MW0601		DUP02	RPD (%)	MW0602			MW0603			MW0604			DUP01	RPD (%)	MW0605		MW0606	
				2012-08-06	2017-08-20	2017-08-20		2012-08-06	2014-08-25	2017-08-20	2012-08-06	2014-08-25	2017-08-20	2012-08-06	2014-08-25	2017-08-19	2017-08-19		2012-08-06	2017-08-20	2012-08-06	2017-08-19
Metals (µg/L)																						
Dissolved Aluminum (Al)	100	NC	3.0	4.3	1.85	1.97	6.28%	3.5	19	4.34	18.0	8.9	5.63 (1)	14.0	7.0	3.79	3.78	0.26%	7.00	7.83 (1)	10	6.51
Dissolved Antimony (Sb)	2000	NC	0.60	<0.60	0.108	0.111	2.74%	<0.60	<0.60	0.326	<0.60	<0.60	0.33	<0.60	<0.60	0.202	0.213	5.30%	<0.60	0.057	<0.60	0.058
Dissolved Arsenic (As)	5	0.53/0.99	0.20	0.33	0.3	0.326	8.31%	<0.2	<0.20	0.203	0.21	0.3	0.262	<0.20	<0.20	0.177	0.166	6.41%	0.32	0.364	0.24	0.257
Dissolved Barium (Ba)	500	NC	10	26	24.8	23.9	3.70%	35	48	45.5	31.0	26	25.6	<10	<10	13.3	13.3	0%	40	31.7	31	23.2
Dissolved Beryllium (Be)	5.3	NC	1.0	<1	<0.010	<0.010	N/A	<1.0	<1.0	<0.010	<1.0	<1.0	<0.010	<1	<1.0	<0.010	<0.010	N/A	<1.0	<0.010	<1.0	<0.010
Dissolved Boron (B)	5000	NC	20	<20	15	15	0.00%	87	870	996	<20	<20	<10	32.0	<20	65	68	4.51%	23.00	51	<20	55
Dissolved Cadmium (Cd)	0.017	0.05/0.51	0.005	0.0078	0.005	0.005	0.00%	0.012	<0.020	0.024	0.016	0.038	0.019	0.027	0.021	0.014	0.017	19.35%	0.049	0.026	0.016	0.022
Dissolved Calcium (Ca)	NG	NC	300	60,000	57,600	55,400	3.89%	69,000	110,000	80,500	37,000	44,000	33,100	120,000	65,000	87,400	88,200	0.91%	180,000	126,000	120,000	102,000
Dissolved Chromium (Cr)	8.9	5.1/NC	1.0	<1.0	0.19	0.17	11.11%	3.2	2.1	**9.08**	<1.0	<1.0	0.19	<1	<1.0	0.11	<0.10	N/A	<1.0	0.14	<1.0	0.14
Dissolved Cobalt (Co)	NG	367/2.9	0.30	210	365	358	1.94%	<0.3	0.61	0.067	0.57	0.91	0.234	0.75	0.50	1.2	1.16	3.39%	0.74	0.496	<0.30	0.311
Dissolved Copper (Cu)	2 to 4	37/16	0.20	7.0	9.85	9.57	2.88%	3.9	11	4.5	24	18	18.5	6.9	5.3	4.64	4.47	3.73%	7.70	4.43	5.6	3.46
Dissolved Iron (Fe)	300	NC	60	<60	<1.0	2.5	N/A	<60	<60	7.8	<60	<60	9 (1)	<60	<60	<1.0	<1.0	N/A	<60	6.9 (1)	<60	3.3
Dissolved Lead (Pb)	1 to 7	NC/5048	0.20	<0.20	<0.0050	<0.0050	N/A	<0.20	<0.20	0.08	<0.20	<0.20	0.085 (1)	<0.20	<0.20	<0.0050	<0.0050	N/A	<0.20	0.064 (1)	<0.20	0.063
Dissolved Lithium (Li)	NG	NC	20	<20	22.3	21.6	3.19%	<20	<20	6.69	<20	<20	4.24	40	31	61.5	60.5	1.64%	31.00	69.3	36	70.4
Dissolved Magnesium (Mg)	NG	NC	200	21,000	22,200	21,100	5.08%	13,000	22,000	16,500	9,100	14,000	9,840	75,000	48,000	103,000	98,400	4.57%	100,000	155,000	68,000	140,000
Dissolved Manganese (Mn)	NG	NC	4.0	77	65.2	63.6	2.48%	<4.0	4.3	0.966	6.60	18.0	4.12	18.0	23.0	45.5	43.6	4.26%	5.70	11.4	17	15.2
Dissolved Mercury (Hg)	0.026	NC	0.01		0.01	0.01		-	-	0.01			0.01			0.01	0.01			0.01		0.01
Dissolved Molybdenum (Mo)	73	NC	0.20	10	8.62	8.84	2.52%	1.2	1.0	1.1	0.47	1.8	1.33	9.2	9.7	13.2	13	1.53%	2.80	5.49	4.9	10.1
Dissolved Nickel (Ni)	150	36/50	0.50	24	23.0	22.8	0.87%	0.99	3.7	1.03	6.4	8.3	4.58	3.9	3.2	6.47	6.31	2.50%	4.40	3.84	6.3	4.27
Dissolved Phosphorus (P)	NG	NC	100	<100	---	---	N/A	<100	<100	---	<100	<100	---	<100	<100	---	---	N/A	<100	---	<100	---
Dissolved Potassium (K)	NG	NC	300	6,900	8,290	7,810	5.96%	3,900	5,900	4,660	4,400	6,000	4,670	6,900	5,900	10,600	10,400	1.90%	6,800	10,200	8,500	9,970
Dissolved Selenium (Se)	1	NC	0.20	0.3	0.136	0.144	5.71%	<0.20	<0.20	0.095	<0.20	0.2	0.154	0.52	0.41	0.535	0.549	2.58%	0.49	0.46	1.3	3.13
Dissolved Silicon (Si)	NG	NC	100	1,900	2,360	2,380	0.84%	2,200	2,900	2,970	2,200	3,100	2,600	2,400	2,000	2,440	2,330	4.61%	3,000	2,600	2,600	2,310
Dissolved Silver (Ag)	0.1	NC	0.10	<0.10	<0.0050	<0.0050	N/A	<0.10	<0.10	<0.0050	<0.10	<0.10	0.015	<0.10	<0.10	<0.0050	<0.0050	N/A	<0.10	<0.0050	<0.10	<0.0050
Dissolved Sodium (Na)	NG	NC	500	40,000	27,900	27,600	1.08%	8,000	14,000	13,400	5,400	6,000	8,880	69,000	41,000	53,200	51,600	3.05%	31,000	40,700	25,000	32,600
Dissolved Strontium (Sr)	NG	NC	20	92	93.7	89.1	5.03%	64	110	89.6	62	130.0	86.2	300.0	170.0	329	324	1.53%	340	493	220	395
Dissolved Sulphur (S)	NG	NC	200	26,000	12,600	13,200	4.65%	12,000	11,000	10,300	870	2,000	<3000	180,000	74,000	149,000	145,000	2.72%	220,000	248,000	130,000	222,000
Dissolved Thallium (Tl)	0.8	NC	0.20	<0.2	0.006	0.005	18.18%	<0.20	<0.20	0.002	<0.20	<0.20	0.006	<0.20	<0.20	0.011	0.011	0%	<0.20	0.023	<0.20	0.005
Dissolved Tin (Sn)	NG	NC	1.0	<1	<0.20	<0.20	N/A	<1.0	<1.0	4.43 (1)	<1.0	<1.0	8.42 (1)	<1.0	<10	<0.20	<0.20	N/A	<1.0	0.91	<1.0	0.49
Dissolved Titanium (Ti)	100	NC	1.0	<1	<0.50	<0.50	N/A	<1.0	<1.0	<0.50	<1.0	<1.0	0.52	<1.0	<1.0	<0.50	<0.50	N/A	<1.0	<0.50	<1.0	<0.50
Dissolved Uranium (U)	15	NC	0.10	5.0	7.34	7.25	1.23%	4.7	9.9	9.65	1.5	8.5	5.9	72	83	148	142	4.14%	150	267	89	212
Dissolved Vanadium (V)	NG	NC	1.0	<1.0	<0.20	<0.20	N/A	<1.0	<1.0	0.34	<1.0	<1.0	0.51	<1.0	<1.0	<0.20	<0.20	N/A	<1.0	<0.20	<1.0	0.29
Dissolved Zinc (Zn)	10	633/4097	3.0	270	546	525	3.92%	140	25	106	43	110	125	33.0	9.2	22.1	21.8	1.37%	35	43.1	240	123

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations. First ULA provided is for NHWL, second ULA is for SSDF.
NG = No guideline
NC = Not calculated
RDL= Reportable Detection Limit
20 = Exceeds FIGQGs.
20 = Result exceeds Upper Limit of Acceptability
(1) Dissolved greater than total. Results within acceptable limits of precision.
Note that when results were less than the RDL, one half of the RDL was used in average calculations.
All results in µg/L

Table 4
Groundwater Chemical Concentrations - PCBs
INAC Nunavut Regional Office
CAM-F Sarcpa Lake, Nunavut

PARAMETER	CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	NHWL								SSDF								
				MW0601		DUP02	RDL (%)	MW0602			MW0603	MW0604			DUP01	RDL (%)	MW0605		MW0606	
				2012-08-06	2017-08-20	2017-08-20		2012-08-06	2014-08-25	2017-08-20	2012-08-06	2012-08-06	2014-08-25	2017-08-19	2017-08-19		2012-08-06	2017-08-20	2012-08-06	2017-08-20
PCBs (ug/L)																				
Aroclor 1016	NG	NC	0.050	<0.050	---	---	NC	<0.050	<0.010	---	<0.050	<0.050	<0.050	---	---	NC	<0.050	---	<0.050	---
Aroclor 1221	NG	NC	0.050	<0.050	---	---	NC	<0.050	<0.010	---	<0.050	<0.050	<0.050	---	---	NC	<0.050	---	<0.050	---
Aroclor 1232	NG	NC	0.050	<0.050	---	---	NC	<0.050	<0.010	---	<0.050	<0.050	<0.050	---	---	NC	<0.050	---	<0.050	---
Aroclor 1242	NG	NC	0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.010	<0.05	<0.050	<0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.05	<0.050	<0.05
Aroclor 1248	NG	NC	0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.010	<0.05	<0.050	<0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.05	<0.050	<0.05
Aroclor 1254	NG	NC	0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.010	<0.05	<0.050	<0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.05	<0.050	<0.05
Aroclor 1260	NG	NC	0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.010	<0.05	<0.050	<0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.05	<0.050	<0.05
Aroclor 1262	NG	NC	0.050	<0.050	---	---	NC	<0.050	<0.010	---	<0.050	<0.050	<0.050	---	---	NC	<0.050	---	<0.050	---
Aroclor 1268	NG	NC	0.050	<0.050	---	---	NC	<0.050	<0.010	---	<0.050	<0.050	<0.050	---	---	NC	<0.050	---	<0.050	---
Total PCB	NG	NC	0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.010	<0.05	<0.050	<0.050	<0.050	<0.05	<0.05	NC	<0.050	<0.05	<0.050	<0.05

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3
NG = No guideline
NC = Not calculated
RDL= Reportable Detection Limit

Table 5
Groundwater Chemical Concentrations - Inorganics
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

PARAMETER		CCME FIGQGs[1]	Upper Limit of Acceptability[2]	RDL	NHWL									SSDF								
					MW0601		DUP02	RPD (%)	MW0602			MW0603		MW0604			DUP01	RPD (%)	MW0605		MW0606	
					2012-08-06	2017-08-20	2017-08-20		2012-08-06	2014-08-25	2017-08-20	2012-08-06	2017-08-20	2012-08-06	2014-08-24	2017-08-19	2017-08-19		2012-08-06	2017-08-20	2012-08-06	2017-08-20
Inorganics	**Units**																					
Colour	TCU	NC	71/63	20	<2	3.0	2	40.0%	5	8	6	42.0	29.0	4.0	4	<2	3.0	N/A	<2	3.0	5.0	3.0
Conductivity	umho/cm	NC	1084/4682	1.0	670	620	610	1.6%	480	660	580	270	270	1400	810	1500	1400	6.9%	1600	1800	1200	1500
Total Dissolved Solids	mg/L	3000	NC	10	398	372	370	0.5%	284	386	360	222	---	1060	578	1000	996	0.4%	1330	1410	900	1270
Fluoride (F-)	mg/L	0.12	NC	0.10	0.52	0.57	0.51	11.1%	0.16	0.17	0.15	0.12	---	0.34	0.53	0.78	0.61	24.5%	0.33	0.70	0.39	0.75
Orthophosphate (P)	mg/L	NC	NC	0.010	<0.010	<0.010	<0.010	N/A	<0.010	<0.010	<0.010	<0.010	---	<0.010	<0.010	<0.010	<0.010	N/A	<0.010	<0.010	<0.010	<0.010
pH	pH	6.5-9	8.0<8.2/7.6<8.3	NC	8.14	8.08	8.05	0.4%	8.07	8.14	**7.95**	8.10	**8.39**	7.95	8.09	7.92	7.97	0.6%	7.90	7.94	7.89	7.90
Total Suspended Solids	mg/L	NC	NC	3.0	<10	<10	<10	N/A	<10	80	21	100.0	---	<10	<10	<10	<10	N/A	<10	<10	14.0	20.0
Dissolved Sulphate (SO_4)	mg/L	100	NC	1.0	88	41	41	0.0%	35	33	32	<1	---	540	210	520	470	10.1%	640	710	380	640
Dissolved Chloride (Cl)	mg/L	NC	NC	6.0	10	8.7	9.3	6.7%	12	8	5.4	<1	---	28	12	21	20	4.9%	47	48	30	32
Nitrite (N)	mg/L	0.060	NC	0.010	0.02	<0.010	0.011	N/A	<0.010	<0.010	<0.010	<0.010	---	0.014	<0.010	<0.010	<0.010	N/A	<0.010	<0.010	<0.010	<0.010
Nitrate (N)	mg/L	13.0	NC	0.10	10	11.6	13.7	16.6%	7.2	2.94	2.68	<0.10	---	3.8	3.43	1.54	1.61	4.4%	1.3	1.12	2.8	0.51
Nitrate + Nitrite	mg/L	NC	NC	0.10	10	11.6	13.7	16.6%	7.2	2.94	2.68	<0.10	---	3.9	3.43	1.54	1.61	4.4%	1.3	1.12	2.8	0.51
Hardness ($CaCO_3$)	mg/L	NC	NC	0.50	240	235	225	4.3%	230	---	269	130	---	600		635	653	2.8%	880	942	580	746

Notes:
1 = Table 2: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use, Tier 1, Lowest Guideline for coarse grained soils.
2 = Upper Limit of Acceptability, calculated using mean of baseline data +3 standard deviations. First ULA provided is for NHWL, second ULA is for SSDF.
NG = No guideline
NC = Not calculated
RDL= Reportable Detection Limit
20 = Exceeds FIGQGs.
20 = Result exceeds Upper Limit of Acceptability
RPD = Relative Percent Difference

Table 6
NHWL Groundwater Chemical Concentrations - PHCs, PCBs and Inorganics
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

ARCADIS Design & Consultancy for natural and built assets

Sample #	Location	Date	PCBs [ug/L]	TPH Identity								Conductivity [µmho/cm]	pH	Colour
				Benzene	Toluene	Ethyl-benzene	Total Xylene	F1 [ug/L]	F2 [ug/L]	F3 [ug/L]	F4 [ug/L]			
Non-Haz Landfill Groundwater Samples														
MW1	MW06-01	2012	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	670	8.14	<2
MW2	MW06-02	2012	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	480	8.07	5
MW3	MW06-03	2012	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	270	8.10	42
MW0602	MW06-02	2014	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	660	8.14	8
MW0602	MW0602	2017	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	580	7.95	6
MW0603	MW06-03	2014	<0.05	<0.2	<0.2	<0.2	<0.4	<25	-	-	-			
MW0603	MW0603	2017	<0.05	<0.2	<0.2	<0.2	<0.4	<25	-	-	-	270	8.39	29
MW0601	MW0601	2017	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	620	8.08	3
DUP02	MW0601	2017	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<300	<600	<600	610	8.05	2
Statistics														
N Value			9	9	9	9	9	9	9	9	9	8	8	8
N Value [2006-2014 only]			6	6	6	6	6	6	6	6	6	4	4	4
Average			<0.025	<0.1	<0.1	<0.1	<0.2	<12.5	<150	<300	<300	520	8.115	12
Average [2006-2014 only]			<0.025	<0.1	<0.1	<0.1	<0.2	<12.5	<50	<50	<50	520	8.1125	14
Minimum			<0.025	<0.1	<0.1	<0.1	<0.2	<12.5	<50	<50	<50	270	7.95	1
Maximum			<0.025	<0.1	<0.1	<0.1	<0.2	<12.5	<150	<300	<300	670	8.39	42
Standard Deviation (s)* [2006-2014 only]			NC	NC	NC	NC	NC	NC	NC	NC	NC	188	0	19
Acceptable Range (Average +/- 3s) [2006-2014 only]			NC	NC	NC	NC	NC	NC	NC	NC	NC	0 < 1084	8.01 < 8.2	0 < 71

Sample duplicates underlined (primary sample listed above duplicate)
Detection limits are converted to results to calculate average and standard deviation
*Note that very high detection limits (25,000) for F1 are excluded from average and standard deviation calculations as outliers
Zero is substituted for negative values where average minus 3s is less than zero

NC: Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

Table 7
SSDF Groundwater Chemical Concentrations - PHCs, PCBs and Inorganics
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

ARCADIS Design & Consultancy for natural and built assets

Sample #	Location	Date	PCBs [ug/L]	TPH Identity								Conductivity [µmho/cm]	pH	Colour
				Benzene	Toluene	Ethyl-benzene	Total Xylene	F1 [ug/L]	F2 [ug/L]	F3 [ug/L]	F4 [ug/L]			
SSDF Landfill GroundwaterSamples														
MW06-04	MW06-04	2006	<0.05									3110	7.9	
MW06-04	MW06-04	2008	<0.01					<100	<100	<100	<100	630	8.2	>70
MW0604-1	MW06-04	2009	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	3740	7.8	4
MW1004	MW06-04	2010	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	1980	8.0	4
DUP-1	MW06-04	2010	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	1950	8.0	3
MW06-04	MW06-04	2011	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	4020	7.86	3
AH-1	MW06-04	2011	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	3930	7.97	4
MW4	MW06-04	2012	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	1400	7.95	4
MW0604	MW06-04	2014	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	810	8.09	4
DUP0601	MW06-04	2014	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100			
MW0604	MW06-04	2017	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	1500	7.92	<2
DUP01	MW06-04	2017	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	1400	7.97	3
MW06-05	MW06-05	2006	<0.05									847	7.8	
MW06-05	MW06-05	2007	<0.10					<25	<100	<100	<100			
MW06-05	MW06-05	2008	<0.01					<100	<100	<100	<100	1010	8.1	60
MW06-07	MW06-05	2008	<0.01					<100	<100	<100	<100	1000	8.10	60
MW0605-1	MW06-05	2009	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	1520	7.80	3
MW1005	MW06-05	2010	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	1650	8.00	2
MW06-05	MW06-05	2011	<0.05	<0.2	<02	<0.2	<0.4	<25	<100	<100	<100	1500	7.95	4
MW5	MW06-05	2012	<0.05	<0.2	<02	<0.2	<0.4	<25	<100	<100	<100	1600	7.90	<2
DUP-1	MW06-05	2012	<0.05	<0.2	<02	<0.2	<0.4	<25	<100	<100	<100	1600	7.90	4
MO0605	MW0605	2017	<0.05	<0.2	<02	<0.2	<0.4	<25	<100	<100	<100	1800	7.94	3
MW06-06	MW06-06	2006	<0.05									2260	8.10	
MW06-06	MW06-06	2007	<0.10					<25	<100	<100	<100			
MW06-06	MW06-06	2008	<0.01					200	200	200	200	1060	8.00	>70
MW0606-1	MW06-06	2009	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	1530	8.10	3
DUP-01	MW06-06	2009	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	1650	7.90	5
MW1006	MW06-06	2010	<0.05	<0.2	<0.2	<0.2	<0.4	<100	<100	<100	<100	1510	8.00	< 2
MW06-06	MW06-06	2011	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	1440	8.19	3
MW6	MW06-06	2012	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	1200	7.89	5
MW0606	MW0606	2017	<0.05	<0.2	<0.2	<0.2	<0.4	<25	<100	<100	<100	1500	7.90	3

Statistics												
N Value	31	22	22	22	22	28	28	28	28	28	28	25
N Value [2006-2014 only]	27	18	18	18	18	24	24	24	24	24	24	21
Average	<0.025	<0.1	<0.1	<0.1	<0.2	33.9	55.4	55.4	55.4	1755.25	8.0	8.1
Average [2006-2014 only]	<0.025	<0.1	<0.1	<0.1	<0.2	37.5	56.3	56.3	56.3	1789	8.0	9.3
Minimum	<0.005	<0.1	<0.1	<0.1	<0.2	12.5	50	50	50	630	7.8	1
Maximum	<0.025	<0.1	<0.1	<0.1	<0.2	200	200	200	200	4020	8.2	60
Standard Deviation (s)* [2006-2014 only]	NC	NC	NC	NC	NC	39	31	31	31	964	0.12	18
Acceptable Range (Average +/- 3s) [2006-2014 only]	NC	NC	NC	NC	NC	0 < 156	0 < 148	0 < 148	0 < 148	0 < 4682	7.63 < 8.3	0 < 63

Sample duplicates underlined (primary sample listed above duplicate)
Detection limits are converted to results to calculate average and standard deviation
*Note that very high detection limits (25,000) for F1 are excluded from average and standard deviation calculations as outliers
Zero is substituted for negative values where average minus 3s is less than zero
NC: Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

Table 8
NHWL Groundwater Chemical Concentrations - Metals
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

Sample #	Location	Date	Diss. As [ug/l]	As [ug/l]	Diss. Cd [ug/l]	Cd [ug/l]	Diss. Co [ug/l]	Co [ug/l]	Diss. Cr [ug/l]	Cr [ug/l]	Diss. Cu [ug/l]	Cu [ug/l]	Diss. Ni [ug/l]	Ni [ug/l]	Diss. Pb [ug/l]	Pb [ug/l]	Diss. Zn [ug/l]	Zn [ug/l]	Diss. Hg [ug/l]	Hg [ug/l]
Non-Haz Landfill Groundwater Samples																				
MW1	MW06-01	2012	0.33	0.34	0.0078	0.0099	210	220	<1.0	<1.0	7	7.4	24	25	<0.2	<0.2	270	300		
MW2	MW06-02	2012	<0.20	0.23	0.012	0.01	<0.3	<0.30	3.2	3.5	3.9	4	0.99	1.2	<0.2	<0.2	140	170		
MW3	MW06-03	2012	0.21	0.61	0.016	0.039	0.57	1.6	<1.0	3	24	37	6.4	12	<0.2	2.2	43	160		
MW0602	MW06-02	2014	<0.2	0.41	<0.02	<0.02	0.61	1.3	2.1	6.4	11	9.8	3.7	7.6	<0.20	0.89	25	53		
MW0602	MW0602	2017	0.203	0.222	0.024	0.019	0.067	0.141	9.08	11.1	4.5	4.02	1.03	1.9	0.08	0.42	106	159		
MW0603	MW06-03	2014	0.3	0.94	0.038	0.25	0.91	3.5	<1	25	18	38	8.3	32	<0.02	4.5	110	410		
MW0603	MW0603	2017	0.262	0.215	0.019	0.006	0.234	0.267	0.19	0.2	18.5	16.6	4.58	5.46	0.085	0.057	125	103		
MW0601	MW0601	2017	0.3	0.289	0.005	<0.0050	365	363	0.19	0.25	9.85	10.7	23	24.1	<0.0050	0.018	546	484		
DUP02	MW0601	2017	0.326	0.286	0.005	<0.0050	358	349	0.17	0.22	9.57	10.4	22.8	23.3	<0.0050	0.023	525	483		

Statistics																		
N Value	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	0
N Value [2012-2014 only]	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0
Average	0.24	0.39	0.02	0.04	116.92	104.33	1.83	5.57	11.81	15.32	10.53	14.73	0.06	0.92	210.00	258.00	<0	<0
Average [2012-2014 only]	0.21	0.51	0.02	0.06	53.02	45.31	1.36	7.68	12.78	19.24	8.68	15.56	<0.1	1.56	117.60	218.60	<0	<0
Minimum	0.10	0.22	0.01	0.00	0.07	0.14	0.17	0.20	3.90	4.00	0.99	1.20	0.00	0.02	25.00	53.00	<0	<0
Maximum	0.33	0.94	0.04	0.25	365.00	363.00	9.08	25.00	24.00	38.00	24.00	32.00	0.10	4.50	546.00	484.00	<0	<0
Standard Deviation (s)* [2012-2014 only]	0.108	0.279	0.012	0.105	104.652	97.662	1.240	9.906	8.194	16.800	9.000	12.665	NC	1.855	97.372	138.274	NC	NC
Acceptable Range (Average +/- 3s) [2012-2014 only]	0 < 0.53	0 < 1.3	0 < 0.05	0 < 0.38	0 < 367	0 < 338	0 < 5.1	0 < 37	0 < 37	0 < 70	0 < 36	0 < 54	NC	0 < 7	0 < 410	0 < 633	NC	NC

Sample duplicates underlined (primary sample listed above duplicate)
One half of the detection limit is used in calcuations when results are below detection limits.
Zero is substituted for negative values where average minus 3s is less than zero
NC: Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

Table 9
SSDF Groundwater Chemical Concentrations - Metals
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

ARCADIS Design & Consultancy for natural and built assets

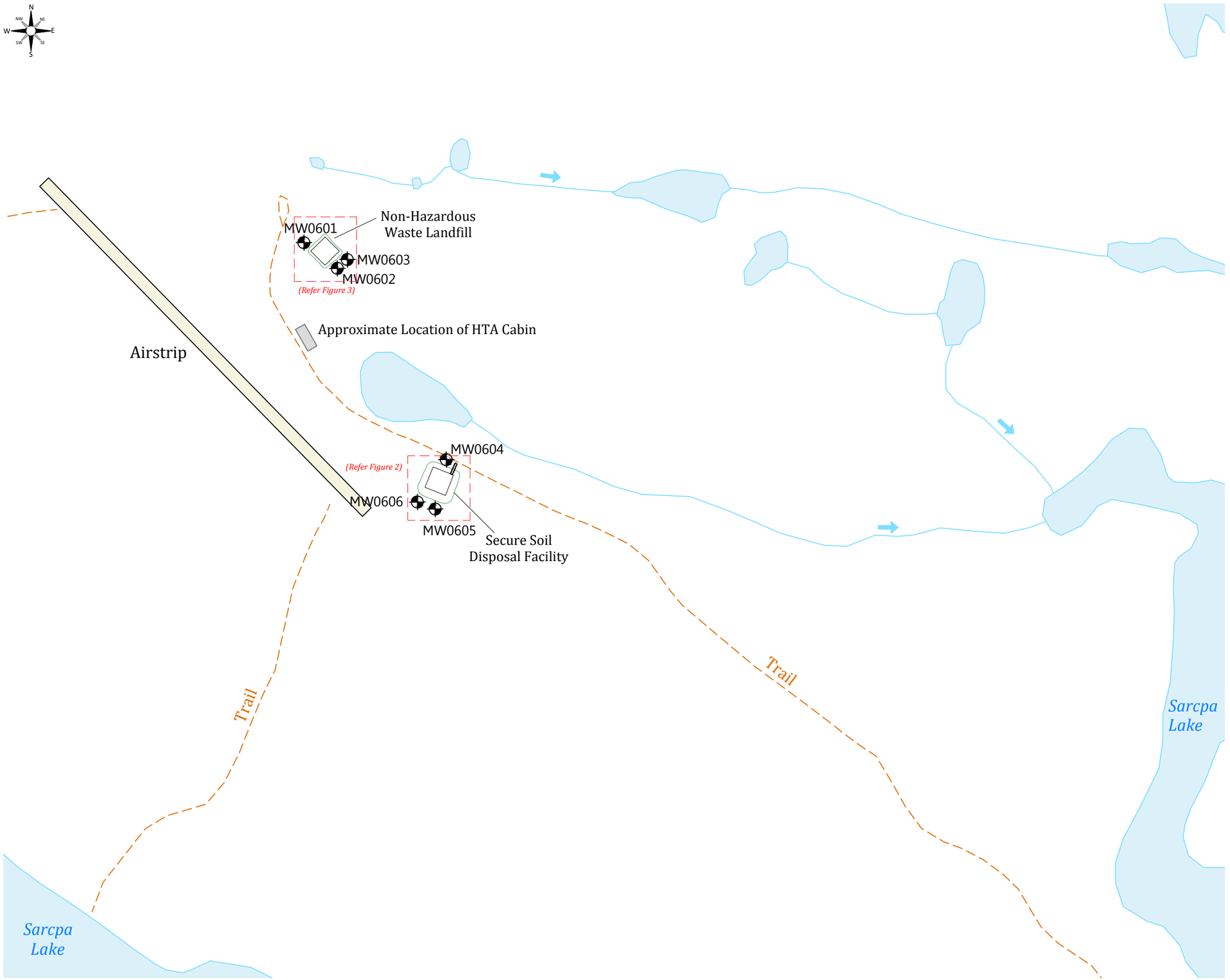
Sample #	Location	Date	Diss. As	As	Diss. Cd	Cd	Diss. Co	Co	Diss. Cr	Cr	Diss. Cu	Cu	Diss. Ni	Ni	Diss. Pb	Pb	Diss. Zn	Zn	Diss. Hg	Hg
			[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]	[ug/l]
SSDF Landfill GroundwaterSamples																				
MW06-04	MW06-04	2006	<1		<0.1		1		<5		2			4		<0.5		<5		
MW06-04	MW06-04	2008	<1	1	<0.025	0.163	1	3	<1	19	8	32	40	<3	3710	<1	234	50	<0.025	<0.025
MW0604-1	MW06-04	2009	<1	<1	<0.1	<0.1	2.1	2.5	<5	<5	1	7	8	9	1.1	<0.5	60	24		<0.1
MW1004	MW06-04	2010	<1	<0.5	<0.1	<0.05	0.8	0.77	<5	<2.5	6	5.9	4	4.4	<0.5	<0.25	10	9.9		
DUP-1	MW06-04	2010	<1	<0.5	<0.1	<0.05	0.6	0.82	<5	<2.5	7	6.3	4	4.7	<0.5	<0.25	9	10.1		
MW06-04	MW06-04	2011	<1	<1	<0.1	<0.1	2.1	2.1	<5	<5	<1	4	15	16	<0.5	<0.5	<5	7		
AH-1	MW06-04	2011	<1	<1	<0.1	<0.1	1.9	2.4	<5	<5	<1	4	14	17	<0.5	<0.5	<5	8		
MW4	MW06-04	2012	<0.20	0.24	0.027	0.017	0.75	0.8	<1.0	<1.0	6.9	6.7	3.9	3.9	<0.2	<0.2	33	34		
MW0604	MW06-04	2014	<0.20	<0.20	0.021	<0.02	0.5	0.6	<1	<1	5.3	2.4	3.2	3.9	<0.2	<0.2	9.2	11		
DUP0601	MW06-04	2014	<0.20	<0.20	0.021	0.027		0.61	<1	<1	-	2.1	3.3	3.8	<0.2	<0.2	<3	11		
MW0604	MW06-04	2017	0.177	0.177	0.014	0.02	1.2	1.25	0.11	0.12	4.64	4.74	6.47	6.8	<0.0050	0.02	22.1	22.6		
DUP01	MW06-04	2017	0.166	0.184	0.017	0.017	1.16	1.27	<0.10	<0.10	4.47	4.74	6.31	7.15	<0.0050	0.018	21.8	20.8		
MW06-05	MW06-05	2006	1		0.1		1.7		<5		8			15		<0.5		47		
MW06-05	MW06-05	2007		<1		<1		2		6		6	9		1		30			
MW06-05	MW06-05	2008	<1	2	<0.025	0.261	2	3	<1	11	12	12	20	6	807	<1	43	347	<0.025	<0.025
MW06-07	MW06-05	2008	<1	2	<0.025	0.307	2	2	<1	16	10	16	20	6	1100	<1	63	40	<0.025	<0.025
MW0605-1	MW06-05	2009	<1	<1	<0.1	<0.1	1.2	1.5	<5	<5	6	9	18	9	<0.5	<0.5	9	18		<0.1
MW1005	MW06-05	2010	<1	0.5	0.1	0.11	0.7	1.02	<5	<2.5	7	7.2	7	7	<0.5	0.37	73	63.5		
MW06-05	MW06-05	2011	<1	<1	0.3	<0.1	<0.5	<0.5	<5	<5	9	8	4	5	<0.5	<0.5	64	48		
MW5	MW06-05	2012	0.32	0.37	0.049	0.037	0.74	0.75	<1.0	<1.0	7.7	7.3	4.4	4.2	<0.2	<0.2	35	32		
DUP1	MW06-05	2012	0.3	0.37	0.044	0.044	0.8	0.67	<1.0	<1.0	6.4	6.8	4.4	4.3	<0.2	<0.2	29	32		
MW0605	MW0605	2017	0.364	0.349	0.026	0.022	0.496	0.507	0.14	0.13	4.43	4.09	3.84	4.24	0.064	0.011	43.1	40		
MW06-06	MW06-06	2006	<1		<0.1		<0.5		<5		4			3		<0.5		9		
MW06-06	MW06-06	2007		<1		<1		2		25		13	22		1		170			
MW06-06	MW06-06	2008	<1	2	<0.025	0.453	1	6	<1	97	13	46	30	8	7390	<1	6210	6650	<0.025	<0.025
MW0606-1	MW06-06	2009	<1	1	<0.1	0.1	0.5	2.3	<5	21	3	21	20	5	3.3	<0.5	330	120		<0.1
DUP-01	MW06-06	2009	<1	<1	<0.1	<0.1	0.6	2.3	<5	11	5	12	13	6	2.5	<0.5	170	170		<0.1
MW1006	MW06-06	2010	<1	<0.5	0.7	0.09	0.7	0.9	6	<2.5	8	7.8	49	38.8	<0.5	0.37	70	96.9		
MW06-06	MW06-06	2011	<1	1	<0.1	<0.1	0.6	4	<5	34	3	54	10	130	<0.5	6.6	52	670		
MW6	MW06-06	2012	0.24	0.3	0.016	0.011	<0.30	0.39	<1.0	<1.0	5.6	6.3	6.3	6.4	<0.2	<0.2	240	260		
MW0606	MW0606	2017	0.257	0.289	0.022	0.03	0.311	0.422	0.14	1.38	3.46	4.64	4.27	5.42	0.063	0.187	123	157		
Statistics																				
N Value			29	28	29	28	28	28	29	28	29	28	28	29	28	29	28	29	4	8
N Value [2012-2014 only]			25	24	25	24	24	24	25	24	25	24	24	25	24	25	24	25	4	8
Average			0.42	0.64	0.07	0.11	0.97	1.65	1.57	9.36	5.78	11.46	12.62	11.91	464.94	0.45	291.42	310.73	<0	<0
Average [2012-2014 only]			0.45	0.71	0.08	0.13	1.00	1.78	1.81	10.85	6.04	12.62	13.85	12.88	542.43	0.51	331.24	350.84	<0	<0
Minimum			0.10	0.18	0.01	0.01	0.15	0.25	0.05	0.05	0.50	2.10	3.20	1.50	0.00	0.01	1.50	2.50	<0	<0
Maximum			1.00	2.00	0.70	0.50	2.10	6.00	6.00	97.00	13.00	54.00	49.00	130.00	7390.00	6.60	6210.00	6650.00	<0	<0
Standard Deviation (s)* [2012-2014 only]			0.182	0.573	0.143	0.157	0.625	1.336	NC	20.576	3.316	13.242	12.067	25.539	1657.342	1.277	1255.263	1320.548	NC	NC
Acceptable Range (Average +/- 3s) [2012-2014 only]			0 < 0.99	0 < 2.4	0 < 0.51	0 < 0.6	0 < 2.9	0 < 5.8	NC	0 < 73	0 < 16	0 < 52	0 < 50	0 < 89	0 < 5514	0 < 4.3	0 < 4097	0 < 4312	NC	NC

Sample duplicates underlined (primary sample listed above duplicate)
One half of the detection limit is used in calcuations when results are below detection limits.
Zero is substituted for negative values where average minus 3s is less than zero
NC: Not calculated. Where there are no values other than "non-detect," no standard deviation is calculated. The acceptable range for these samples should be close to the detection limit.

Table 10
Field Data Results
INAC Nunvaut Regional Office
CAM-F Sarcpa Lake, Nunavut

Well ID	Date	Water Level [m btoc]	Depth to Bottom [m btoc]	Temprature [°C]	Conductivity [mS/cm]	Dissolved Oxygen [mg/L]	pH	ORP [mV]	Purged Water [L]	Water Observations
Non-Hazardous Waste Landfill (NHWL)										
MW0601	Aug. 20, 2017	1.577	1.867	5.20	0.607	11.25	8.19	-71.1	2	Clear, colourless, no sheen, no PHC odour
MW0602	Aug. 20, 2017	1.245	1.924	6.07	0.562	10.65	8.00	-251.6	1.5	Clear, colourless, no sheen, no PHC odour
MW0603	Aug. 20, 2017	2.171	2.437	-	-	-	-	-	0.7	Clear, brown colour, no sheen, no PHC odour
Secure Soil Disposal Facility (SSDF)										
MW0604	Aug. 20, 2017	0.546	1.643	6.07	13.25	6.53	7.95	-134.8	2	Clear, colourless, no sheen, no PHC odour
MW0605	Aug. 20, 2017	1.413	1.829	4.90	1.701	10.01	8.09	-116.3	1.7	Clear, colourless, no sheen, no PHC odour
MW0606	Aug. 20, 2017	1.434	1.952	4.57	1.554	3.82	8.02	-112.1	2	Clear, colourless, no sheen, no PHC odour

FIGURES



Legend

- Lake
- River
- Trail
- Water Flow Direction
- Monitoring Well Location

DRAFT

Title: Site Plan

ARCADIS

Project: CAM-F, Scarpa Lake, NU
100347-002

Date: December 2017

Client: Indigenous and Northern Affairs Canada

1:10,000

100 0 100 200 400m

Figure 1

last saved by:dlogan

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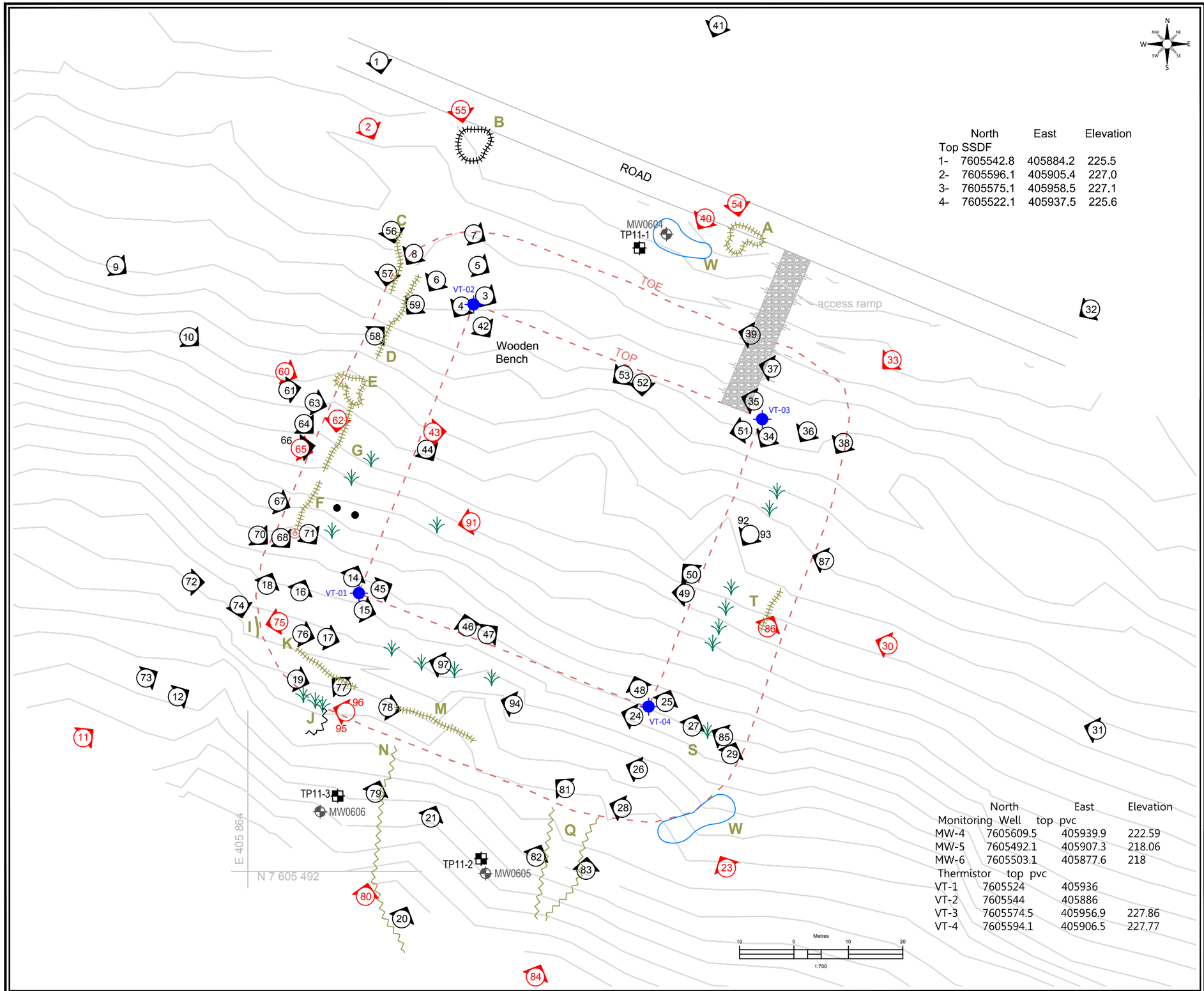

	North	East	Elevation
Top SSDF			
1-	7605542.8	405884.2	225.5
2-	7605596.1	405905.4	227.0
3-	7605575.1	405958.5	227.1
4-	7605522.1	405937.5	225.6

	North	East	Elevation
Monitoring Well top pvc			
MW-4	7605609.5	405939.9	222.59
MW-5	7605492.1	405907.3	218.06
MW-6	7605503.1	405877.6	218
Thermistor top pvc			
VT-1	7605524	405936	
VT-2	7605544	405886	
VT-3	7605574.5	405956.9	227.86
VT-4	7605594.1	405906.5	227.77

Legend

- MW — Monitoring Well Locations
- TP — Test Pit Locations
- 25 — Picture Viewpoint Number
- 25 — Viewpoint Photograph Included in Appendix B-1
- Erosion Channel (blue = active)
- Cracking
- Area of Depression/Settlement
- Vegetation Cover
- Exposed Debris
- Small Animal Burrow
- A — Feature Letter
- Thermistor Location
- Ponded Water

DRAFT

Note:
Picture numbers refer to photograph names as they appear in Appendix B-1

Title: Secure Soil Disposal Facility

ARCADIS

Project: CAM-F Sarcpa Lake, NU 100570-002

Date: December 2017

Client: Indigenous and Northern Affairs Canada

Scale: Scale as shown

Figure 2

last saved by:dlogan on 5-Dec-17

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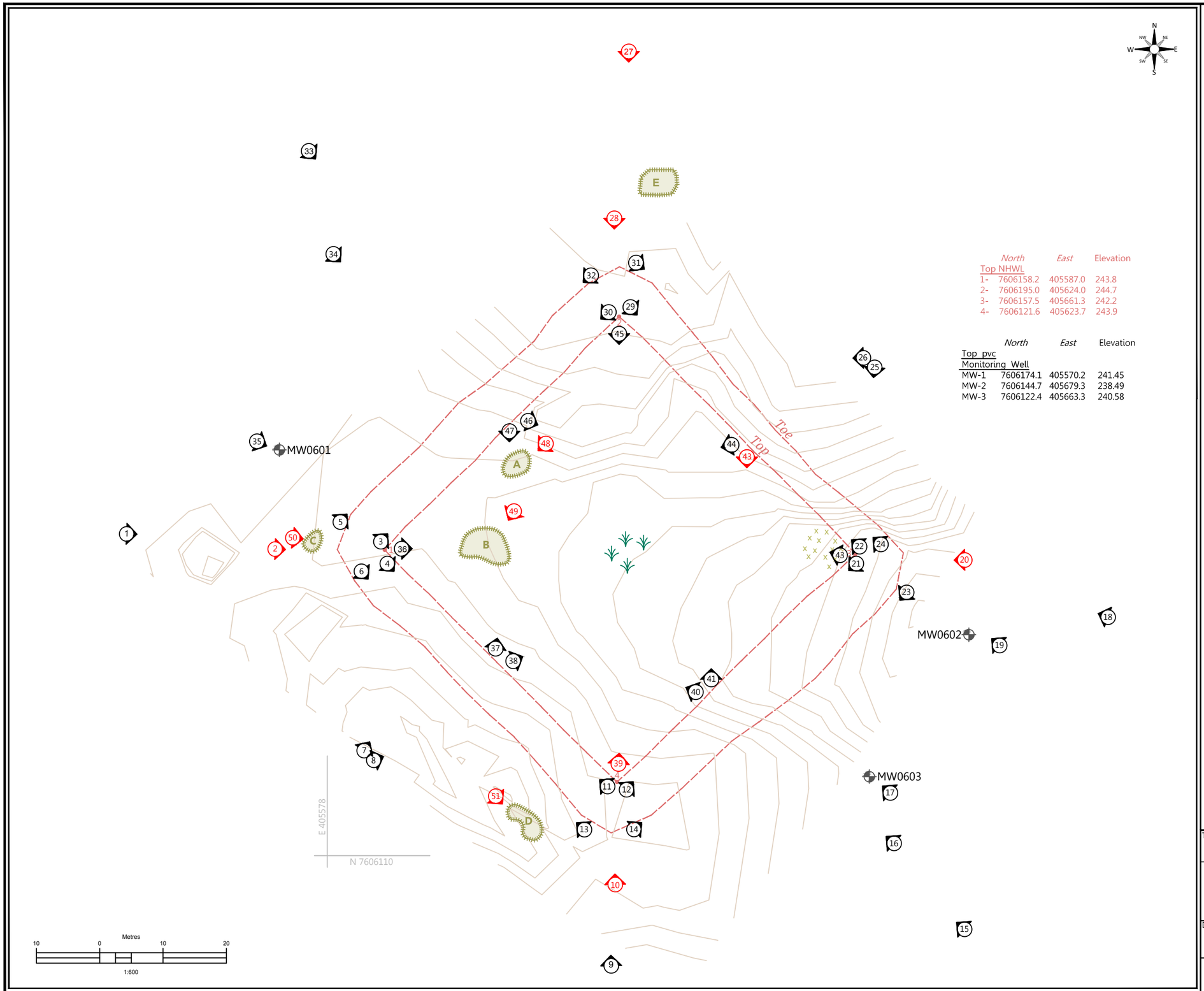

	North	East	Elevation
Top NHWL			
1-	7606158.2	405587.0	243.8
2-	7606195.0	405624.0	244.7
3-	7606157.5	405661.3	242.2
4-	7606121.6	405623.7	243.9

	North	East	Elevation
Top pvc Monitoring Well			
MW-1	7606174.1	405570.2	241.45
MW-2	7606144.7	405679.3	238.49
MW-3	7606122.4	405663.3	240.58

Legend

- MW — Monitoring Well Locations
- 25 — Picture Viewpoint Number
- A — Settlement
- Poor Grading
- 25 — Viewpoint Photograph Included in Appendix B-2
- Vegetation Cover

DRAFT

Note:
Picture numbers refer to photograph names as they appear in Appendix B-2

Title: Non-Hazardous Waste Landfill

ARCADIS

Project: CAM-F Sarcpa Lake, NU 100570-002

Date: December 2017

Client: Indigenous and Northern Affairs Canada

Scale as shown

Figure 3

last saved by:dlogan on 5-Dec-17

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APPENDIX A-1

Site Photographs - SSDF

Project Photographs

Long Term Monitoring, 2017
CAM-F Sarcpa Lake, Nunavut

Photo: 1

Date:
August 19, 2017

Description:
Northwest corner view of the SSDF.

Location:
SSDF, Viewpoint 2 (Figure 2)

Direction Taken:
SE

Photo: 2

Date:
August 19, 2017

Description:
Southwest corner view of the SSDF.

Location:
SSDF, Viewpoint 11 (Figure 2)

Direction Taken:
NE

Project Photographs

Long Term Monitoring, 2017
CAM-F Sarcpa Lake, Nunavut

Photo: 3

Date:
August 19, 2017

Description:
Southeast corner view of the SSDF. Area of ponded water in foreground.

Location:
SSDF, Viewpoint 23 (Figure 2)

Direction Taken:
NW

Photo: 4

Date:
August 19, 2017

Description:
Northeast corner view of the SSDF. Access road to landfill top in top right of photo.

Location:
SSDF, Viewpoint 33 (Figure 2)

Direction Taken:
SW