ARCADIS Design & Consultancy for natural and built assets

Indigenous and Northern Affairs Canada – Nunavut Regional Office

LONG TERM MONITORING, 2017

PIN-D, Ross Point, Nunavut

January 18, 2018

LONG TERM MONITORING, 2017

PIN-D, Ross Point, Nunavut

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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
DEW	Distant Early Warning
DLCC	DEW Line Clean-Up Criteria
DND	Department of National Defense
EC	Environment Canada
EHTO	Ekaluktutiak Hunters and Trappers Organization
ESG	Environmental Sciences Group
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
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

EXECUTIVE SUMMARY

Arcadis Canada Inc. (Arcadis) was retained by Indigenous and Northern Affairs Canada (INAC) – Nunavut Regional Office (NRO) to conduct long-term monitoring activities at the former Distant Early Warning (DEW) Line site PIN-D, Ross Point, Nunavut. This project was completed under INAC Standing Offer Number 4600000861, Order number 4500365458.

PIN-D Ross Point was an Intermediate DEW Line site, located on the north shore of Johansen Bay, overlooking Coronation Gulf, approximately 500 m from the coast. The site is situated on a mesa approximately 150 m above sea-level and was typical of Intermediate DEW Line sites. It consisted of a module train, warehouse, garage, Inuit house, petroleum/oil/lubricant (POL) tanks, and a Doppler antenna. In addition to the main site, a beach landing area was constructed along with gravel roads linking the various facilities. Two airstrips were constructed at the site. A remediation project was conducted at the site between 2011 and 2012, which involved the demolition and disposal of buildings, structures and other debris, as well as the clean-up of hazardous materials and contaminated soil. Construction of the Non-Hazardous Waste Landfill (NHWL) at PIN-D started in 2011 and was completed in August 2012.

The 2017 monitoring program was carried out at the site on August 2, 2017. The landfill LTM program consisted of visual monitoring of the NHWL, active layer water monitoring and natural environment monitoring.

Based on systematic visual observations and measurements, supported with photographic documentation, Arcadis determined that the NHWL is in acceptable condition, is performing as designed, and is containing the enclosed waste. Minor features noted at the NHWL included four minor depressions (one of which was new in 2017) located in the southwest corner, northwest corner, and on the surface along the east side. Three potholes were also identified, one of which was new in 2017. A minor mound, new in 2017, was also identified along the toe of the southeast berm of the landfill. None of these features are considered to have any significant impact on the integrity or performance of the NHWL.

During remediation at the site (2011-2012), four monitoring wells were installed at the site to allow for active layer water monitoring. During the 2017 monitoring program, Arcadis collected groundwater samples from one of the wells; there was insufficient water in the remaining three wells for sample collection. Using results from 2013 and 2015 (a total of four groundwater samples collected), upper limits of acceptability (ULAs) were calculated for total and dissolved metals and inorganic parameters. There was insufficient historical information to calculate ULAs for other parameters (PHCs and PCBs). Groundwater results from 2017 exhibited concentrations of total iron and total zinc above the Federal Interim Groundwater Quality Guidelines (FIGQGs). Dissolved concentrations of zinc exceeded the FIGQG as well as the ULA. When compared to the 2013 and 2015 results, no obvious trends were noted (i.e. parameter concentrations were not consistently higher or lower in 2017 when compared to 2013 and 2015 results). At this time, these occasional exceedances of the FIGQGs are not an immediate concern; however, metal concentrations in groundwater samples should continue to be monitored.

The access roads, airstrip, and Main Station Area were observed and found to be in good condition with little to no change from 2015. The East Beach Area was only observed visually from the air and no apparent changes were observed.

In 2017, a 205 litres steel drum was located adjacent to the runway area. The drum was full, labelled “A-1 Jet Fuel” and was stored on its side. A contact label for “S. Sather, Department of Environment, Government of Nunavut” was present on the drum.

Two additional red steel drums were observed to be located several kilometres east of the runway area and a few hundred metres north of the shoreline. The drums were located in between the main station area and the east beach area. These drums were located too far to be inspected on foot by Arcadis personnel. The condition and contents of the drums are unknown.

Physical evidence, supported by interviews with persons with first-hand knowledge of the site and with members of the nearby community’s Hunters and Trappers Organization, indicate that wildlife continue to frequent this site. In 2017 remnants of a campfire were observed along the access road to the main station area. A bullet casing and several caribou and muskox skulls, bones, and antlers were also observed along the access road to the main station area.

As 2017 represented Year 5 of the LTM Plan and the end of Phase I of the LTM program, a review of data collected to date was conducted. Based on systematic visual observations and measurements, photographic documentation and analytical results, the PIN-D NHWL is considered to be in acceptable condition, is performing as designed, and is containing the enclosed waste. A few metals have been reported in groundwater samples at concentrations that exceed the FIGQGs; specifically, aluminium, iron and zinc. Arcadis recommends that monitoring activities progress to Phase II of the LTM Plan. Additional data would provide more confidence that the higher metal concentrations are considered to be representative of background conditions, if that is the case, or reveal any trends, if metals are leaching from the NHWL. In addition, given the uncertainty of the future arctic environment due to potential climate changes, continued monitoring would be a prudent decision.

This executive summary should be read in conjunction with the main report and is subject to the same limitations described in Section 9.0.

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 at the former Distant Early Warning (DEW) Line site PIN-D, Ross Point, Nunavut. This project was completed under INAC Standing Offer Number 4600000861, Order number 4500365458.

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

Throughout this report, the INAC DEW Line site PIN-D will be referred to as "the site".

1.1 Project Objectives

LTM of the PIN-D site uses a three-phased approach with evaluation of further monitoring requirements to be completed after the completion of each phase. The objective of the 2017 LTM was to complete Year 5, the final planned monitoring event in Phase I of the monitoring program for the PIN-D site, as described in the PIN-D (Ross Point) LTM Plan (INAC, 2013). Monitoring included visual observations, chemical analyses of soil and groundwater (where necessary and possible) and interviews with members of the nearby community knowledgeable about local activities at the site to determine the condition of the natural environment and whether the site infrastructure is performing as designed.

1.2 Scope of Work

Consistent with the previous year's monitoring, the scope of work, as described in the PIN-D LTM Plan, dated March 28, 2013, was as follows:

1. Visual Monitoring of the Non-Hazardous Waste Landfill (NHWL), including
    - Visually checking the physical integrity of the NHWL and looking for evidence of settlement, erosion, lateral movement, frost action, animal burrows, vegetation, staining, vegetation stress, seepage points, exposed debris, and the condition of monitoring wells;
    - Taking photographs to document the condition of the NHWL and substantiate the recorded observations.
2. Active Layer Water Monitoring, including
    - The collection of groundwater samples from the four monitoring wells installed around the NHWL. These samples were to be analysed and the results compared to those from background samples.
3. Soil Monitoring (as required)
    - Soil sampling was to be limited to locations where seepage or staining was identified as part of the visual monitoring.
4. Natural Environment Monitoring, including
    - The collection of direct and indirect evidence of wildlife presence and activity;
    - Making observations regarding the revegetation of disturbed areas.

5. Preparation of a 2017 monitoring program report.

The following tasks were assessed as necessary to fulfil the scope:

- Review of the PIN-D LTM Plan, previous LTM reports for PIN-D 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;
- Visual monitoring, measurement 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

PIN-D Ross Point was an Intermediate DEW Line site, located on the north shore of Johansen Bay, overlooking Coronation Gulf, approximately 500 m from the coast. Figure 1, located at the end of the report, shows the location of the site. The nearest communities are Kugluktuk, approximately 185 km to the southwest, and Cambridge Bay, approximately 250 km to the east. The site is located at 68°35'48.74" N, 111°07'3.47" W. The Ross Point site was reserved by the Department of National Defence (DND) in 1956. The PIN-D Intermediate DEW Line Site was constructed in 1959 and deactivated in 1963.

The site is situated on a mesa approximately 150 m above sea-level and was typical of Intermediate DEW Line sites. It consisted of a module train, warehouse, garage, Inuit house, petroleum/oil/lubricant (POL) tanks, and a Doppler antenna. In addition to the main site, a beach landing area was constructed along with gravel roads linking the various facilities. Two airstrips were constructed at the site. The minor airstrip (~300 m long) is closest to the station area and oriented northeast-southwest. The main airstrip (~500 m long) has an approximate east-west orientation and closely approaches the minor airstrip at its eastern end.

The area is characterized by low mesas and hills composed of dolomite and glacial till. The station facilities were constructed on one of the mesas. A steep cliff extends along the southern edge of the station with gentler slopes leading out east and west. A gentle slope to the north leads towards the major airstrip and freshwater lake; access to these areas is provided by a road. The main landfill is located at the west end of the minor airstrip. A second small landfill is located at the top edge of a slope above a small lake at the northeast base of the mesa. There is very little soil at the upper site and, as such, little vegetation. During previous monitoring programs, it has been noted that the lower slopes and depressions previously undisturbed contained a fair amount of vegetation; mainly grasses, sedges, and willows. Very little vegetation growth was observed around disturbed surface areas. The wildlife typically found in this region includes polar bears, caribou, muskoxen, wolf, arctic fox, snowshoe hare, raven, osprey, shorebirds, seabirds, and waterfowl.

In 1985, some of the surface contaminants at PIN-D were cleaned up under a program conducted by DND, Environment Canada (EC), and INAC. An investigation was conducted in 1994; at that time the module train and garage were still intact but had suffered damage from prolonged weathering. The warehouse had been dismantled down to the concrete base. The four POL tanks (two at the beach and two at the main station) had been removed but the station pumphouse was intact, although the pump had been removed. The pipeline connecting the beach and station tanks was mostly intact and marked with barrels. The refuelling pipeline at the beach was mostly removed but pieces remained.

A remediation project was conducted at the site between 2011 and 2012, which involved the demolition and disposal of buildings, structures and other debris, as well as the clean-up of hazardous materials and contaminated soil. Construction of the NHWL at PIN-D started in 2011 and was completed in August 2012.

The NHWL was designed to contain non-hazardous materials only. It was constructed on native ground with the organic matter stripped and consists of four perimeter berms constructed of granular material. The non-hazardous waste was placed in the landfill in layers consisting of 0.5 m lifts of waste covered by

0.15 m of granular fill. Once all the layers were completed, a final cover consisting of a minimum of 1.0 m of granular fill was used to cap the landfill.

The NHWL at PIN-D contains the following types of waste:

- Type A hydrocarbon-impacted soil;
- Non-hazardous site debris, such as scrap metal and wood;
- Creosote timbers;
- Double-bagged asbestos; and
- Tier 1 contaminated soil (Lead concentration between 200 and 500 parts per million (ppm) and polychlorinated biphenyl (PCB) concentrations between 1 and 5 ppm).

Waste of the types noted above from PIN-E Cape Peel were also disposed of in the PIN-D NHWL. These items were transported from PIN-E to PIN-D for disposal in mid-August 2012.

2.2 Baseline Soil and Groundwater Data

Remediation at PIN-D was contracted with PIN-E (Cape Peel) and all wastes from both sites were disposed of in the NHWL at PIN-D. During the site remediation activities at PIN-D, AECOM Canada Ltd. (AECOM) collected baseline soil data to use for comparison during future monitoring events. In 2011, four monitoring wells (MW1 through MW4) were installed around the perimeter of the NHWL. Baseline groundwater data were not collected in 2011 due to the late season well installation.

Twelve (12) baseline soil samples were collected from the NHWL footprint prior to construction in 2011 and tested for select metals; benzene, toluene, ethylbenzene, xylenes (BTEX); petroleum hydrocarbons (PHCs) and PCBs. The results of the analytical testing showed no exceedances of the DEW Line Clean-up Criteria (DLCC) for Tier I and II in soils (AECOM, 2012). Table 8 (at the end of this report) depicts the baseline soil analytical data for PIN-D's NHWL footprint.

Environmental Sciences Group (ESG) of the Royal Military College of Canada (RMC) conducted a background geochemical assessment at PIN-D in 2009 (ESG, 2010). The background geochemical assessment was undertaken to establish the natural levels of inorganic elements in the surrounding environment at the site. As a result of ESG's statistical analysis, it was recommended that the DLCC be used for cadmium and lead as all samples reported non-detectable concentrations. In addition, using the logs of the data and then using the exponentiation of the results for arsenic, cobalt, chromium, nickel and zinc, it yielded extreme outlier values that were below the DLCCs. It is recommended that the DLCC also be used for these elements.

Background concentrations encountered during the geochemical assessment were elevated for copper. Using the logs of the data and then using the exponentiation of the results, it yielded mild outlier values of 80 ppm for Cass Fiord Formation (Cc) and 63 ppm for Neoproterozoic Nelson Head Formation (Nnh), and extreme outlier values of 254 ppm for unit Cc and 221 ppm for unit Nnh, which are above the DLCC. The highest copper concentration found during the ESG geochemical assessment was below both the DLCC and the calculated mild outlier level. It was recommended that the DLCC for copper be used as a reference point and the higher of the two extreme outlier limits, 254 ppm, be used as a site specific control level (ESG, 2010).

Table 9 (at the end of this report) depicts the soil analytical data collected by ESG during their geochemical assessment at PIN-D, collected in 2009.

In general, the average concentrations of selected metals were higher across the entire site than at the NHWL footprint with the exception of arsenic and lead. Lead was reported as non-detectable for all samples collected by ESG in 2009; however, the average concentration for the samples collected at the NHWL was 11.2 mg/kg. Arsenic was reported at marginally higher concentrations at the NHWL (3.9 mg/kg) in comparison to site-wide levels (1.8 mg/kg). Zinc, conversely, reported non-detectable concentrations at the NHWL and an average concentration of 19.4 mg/kg site-wide. Table 1 compares the average concentrations in soil of selected metals collected site-wide and at the NHWL footprint.

Table 1: Average Soil Analytical Results - Site Wide vs. NHWL Footprint

Parameters	NHWL Footprint		Site Wide	
	Avg. Conc. (mg/kg)	Std. Dev.	Avg. Conc. (mg/kg)	Std. Dev.
As	3.9	2.9	1.8	0.7
Cd	ND	---	ND	---
Cr	13	7.1	25	5.0
Co	2.3	0.8	6.4	1.3
Cu	7.1	1.9	16.7	9.5
Pb	11.2	3.2	ND	---
Ni	8.3	3.2	8.0	2.7
Zn	ND	---	19.4	4.2

Std. Dev. = Standard Deviation

ND = Non-Detect

--- = Not Calculable

Data collected from Appendix B, Table B1 through B3 (AECOM, 2012) and Appendix B, Table B-1 (ESG, 2010).

2.3 Previous Monitoring Programs

The 2017 monitoring program at PIN-D was the third (Year 5) of a proposed eight that are scheduled over a 25 year period. To become familiar with the site, Arcadis reviewed the following reports pertaining to DEW Line sites:

- *Long Term Monitoring, 2015, PIN-D, Ross Point, Nunavut*, dated January 20, 2016 by Arcadis (formerly Franz Environmental Inc.);
- *Long Term Monitoring, 2013, PIN-D, Ross Point, Nunavut*, dated January 20, 2014 by Arcadis (formerly Franz Environmental Inc.);
- PIN-D (Ross Point) Long-Term Monitoring Plan, March 28, 2013, Aboriginal Affairs and Northern Development Canada.
- Abandoned Military Site Remediation Protocol, March 2009, Indian and Northern Affairs Canada, Contaminated Sites Program.

3 REGULATORY AND OTHER GUIDELINES

3.1 Guidelines Review

Arcadis reviewed the PIN-D, Ross Point, LTM Plan and the AMSRP for mention of specific guidelines to use for comparison purposes. Federal guidelines were used where site-specific criteria were absent and/or were less strict than federal standards.

3.2 Groundwater

3.2.1 Comparison to Background Concentrations

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

Table 2: 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
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.

Note: This table is reproduced from AMSRP Chapter 11, Table 4.2

This is the third monitoring event for the LTM plan to be implemented within the first five years at PIN-D. Two groundwater samples from two separate wells were collected during each of the first event (in 2013) and second event (in 2015), for a total of four samples. Using the data, upper limits of acceptability

(ULAs, calculated as the average ± three standard deviations) were calculated for total and dissolved metals and inorganic parameters. 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.

3.2.2 Federal Interim 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 May 2016.

The FIGQGs were not developed with the scientific rigour associated with the Canadian Environmental Quality Guidelines (CEQGs). 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 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 monitoring program was carried out at the PIN-D DEW Line site on August 2, 2017 by field assessors Steve Hannington and Alisha Williamson of Arcadis. Wildlife monitoring services were provided by a representative (Kirk Kapakatoak) from the Kugluktuk Hunters and Trappers Organization (HTO), in Kugluktuk, NU. During the field investigation, weather conditions were overcast, with a slight wind and temperature of approximately 15 ^{o}C. The program consisted of the following:

- Completing a health and safety plan with field briefing;
- Visually observing, measuring and documenting through photographs the physical integrity of the landfill;
- Collecting groundwater samples from existing wells (if possible);
- Collecting soil samples (if necessary, as per the LTM Plan); and
- Gathering information through first hand observation as well as through knowledgeable persons regarding local wildlife and human activity.

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 (SSHASP) was developed. The SSHASP identified and provided mitigative actions for potential physical and chemical hazards associated with the monitoring work. The SSHASP also contained a listing of emergency contact numbers and provided protocols to follow in the event of an emergency.

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

4.2 Visual Monitoring

The physical integrity of 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 of the landfills. Definitions for completing the checklist are found in Table 3 (below). A visual monitoring checklist, presented in the PIN-D LTM Plan, was completed for the landfill and is found in Table 4 and Table 5 in Section 5.3. 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 Appendix A; and is presented in its entirety on the accompanying CD-ROM.

Table 3: Preliminary Visual Monitoring Report NHWL - 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 monitoring 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 sound set file (SSF) from 2015 was not updated due to malfunctions in the field. Therefore the 2013 file was updated with changes to previous features and additions of new features identified in 2015 and 2017. The Trimble files are included in the appended CD-ROM 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 (rough-legged hawk, arctic hare, and pelicans), other evidence of wildlife (e.g., droppings, tracks, feathers/fur, and bones), wildlife

activities (migrating, nesting, etc.), numerical estimates of wildlife, and vegetation observations. Where possible, observations by Arcadis have been compared to previously recorded observations.

As part of the investigation, Arcadis representatives contacted the HTO in Kugluktuk where land uses by humans and wildlife as well as changes over time were discussed. The manager of the HTO was not able to provide much information in regards to the site area. In addition, Arcadis interviewed the wildlife monitor (Kirk Kapakatoak), who also had limited first-hand knowledge of the area.

4.4 Groundwater Sample Collection

Upon arrival at the PIN-D site, the Aracdis field assessors made an attempt to measure groundwater levels at each of the wells. Using a water level tape, the field assessors found that only one of the four monitoring wells contained groundwater (MW3). The remaining monitoring wells (MW1, MW2 and MW4) were dry and no groundwater sample was collected from these wells.

A peristaltic pump was used to purge monitoring well MW3 prior to sample collection. The well was 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. The groundwater sample was collected once stabilization of parameters was reached. The groundwater sample submitted for analysis of dissolved metals analyses was field-filtered.

The sample collected from monitoring well MW3 was submitted for analysis of various parameters: total and dissolved metals, PCBs, PHCs, BTEX, suspended and dissolved solids, major ions, hardness, pH and conductivity. A duplicate sample was also collected from monitoring well MW3. The sample was collected in the appropriate sample containers supplied by the testing laboratory and was pre-charged with the appropriate chemical preservatives. Groundwater samples were stored in laboratory supplied coolers equipped with ice from the time of collection until delivery to the laboratory.

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 B. Chain of custody forms are provided in Appendix C.

4.5 Soil Sample Collection

There were no indications of seepage or staining made as part of the visual monitoring of the NHWL; therefore, no soil samples were collected during the 2017 monitoring activities, as per the LTM Plan for the site.

4.6 Quality Assurance/Quality Control

Field personnel employed Arcadis' Quality Assurance/Quality Control (QA/QC) protocols, including appropriate techniques for groundwater sampling, sample storage, shipping and handling, as well as collection of duplicates.

4.6.1 Field

Groundwater samples were collected from monitoring wells and placed in appropriately sized and prepared laboratory containers. Sample numbers were clearly marked on the containers. The water

bottles were filled to capacity with minimum headspace and stored in coolers with ice to moderate temperature fluctuations during transport to the laboratory.

As a quality control measure, one groundwater blind field duplicate sample was collected and analyzed for identical parameters (total and dissolved metals, PCBs, PHCs, BTEX, suspended and dissolved solids, major ions, hardness, pH and conductivity).

The samples, accompanied by a Chain of Custody form, were shipped via Canadian North to Maxxam Analytics (Maxxam) in Yellowknife. There, the samples were re-packaged and shipped by Maxxam to the appropriate analytical laboratory in either Edmonton or Calgary. Copies of the Chain of Custody forms are provided in Appendix C.

Analytical results from these samples were compared with the analytical results from previous annual monitoring events.

4.6.2 Laboratory

The selected laboratory, Maxxam, is certified by the Canadian Association for Laboratory Accreditation, Inc. (CALA) and has an internal QA/QC protocol. The internal QA/QC protocol includes the analysis of matrix spikes, spike blanks and method blanks. The laboratory QA/QC documentation is provided with the analytical report and was reviewed by Arcadis as part of the QA/QC protocol.

4.7 Analytical Program

The groundwater samples were received by Maxxam in Edmonton and Calgary, Alberta for chemical analyses of the target compounds previously identified. The laboratory certificates of analysis and chain of custody forms are presented in Appendix C.

5 NON-HAZARDOUS WASTE LANDFILL

5.1 Area Summary

The NHWL is located along the access road between the Main Station Area and the minor airstrip, at an approximate elevation of 150 m asl. The coordinates of the landfill are 68°35'42.130"N and 111°06'44.771"W. A site plan is available in Figure 2, at the end of this report. The monitoring of the landfill included visual observations to assess its physical integrity, including evidence for erosion, ponding, frost action, settlement and lateral movement. The surface and the berms of the NHWL are generally graded flat. The slope of the landfill is towards the north, with a minor slope towards the east side.

A groundwater sample was collected from monitoring well MW3 on the north side of the NHWL. Due to insufficient groundwater volumes in monitoring wells MW1, MW2 and MW4, groundwater samples at these locations could not be collected. The collection of soil samples were deemed unnecessary by the Arcadis field assessors and the on-site INAC representative due to the absence of visible staining or leaching of the NHWL. The visual monitoring report, including supporting photos and drawings, is presented in the following pages.

5.2 Photographic Record

The photographic record of the NHWL (and other areas of the site) has been completed as per the Terms of Reference (Photographs P1 to P61, attached CD-ROM). Those portions of the record referenced in the body of this document are included in Appendix A. The complete photographic record, of full-resolution photographs, is provided in the attached CD-ROM. Note that in this report, Photo numbers refer to the selected photos in Appendix A and Viewpoint numbers refer to the photos on the CD-ROM.

5.3 Visual Monitoring Checklist

Landfill monitoring consisted of collecting visual observations of the NHWL to assess its physical integrity, by collecting evidence of erosion, ponding, frost action, settlement and lateral movement. A plan view of the NHWL indicating photographic viewpoints, salient observations and locations of groundwater monitoring wells can be seen in Figure 2, attached to the end of the report. Table 4 presents the preliminary visual monitoring results for the NHWL at PIN-D. The visual monitoring checklist provided in the PIN-D LTM Plan has been completed and pertinent information is summarized in Table 5 of this report.

Table 4: Preliminary Visual Monitoring Report NHWL

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

Settlement

The three minor depressions previously observed in the area of the NHWL remained unchanged (Features A, C and D). One of these depressions is located on the eastern side of the surface of the landfill (Feature D, Table 5). Another small depression is located at the southwest corner of the landfill at the toe of the berm (Feature A, Table 5). The final minor depression was observed at the northwest corner of the landfill at the toe of the berm (Feature C, Table 5). All of these features appeared to be the result of poor final grading. They are considered minor in scale (<1 m diameter and 0.1 m deep) and are not considered to affect landfill integrity.

The two potholes[1] previously observed in the area of the NWHL remain unchanged (Features B and E). One pothole was observed at the southeast corner of the toe of the landfill berm in 2013 (Feature B, Table 5) and the second pothole (Feature E, Table 5) was observed in the southwest corner of the landfill surface in 2015. Pothole B appears to be the result of poor grading while pothole E was a result of a minor slump where the edge of the surface of the landfill and the slope meet. Both potholes are considered minor in scale (<1 m diameter and 0.1 m deep) and are not considered to affect landfill integrity.

[1] Note that the term pothole refers to a small, narrow depression. These features have been referred to as potholes in previous reports, so this term is kept for consistency.

Two additional settlement features were identified at the NWHL in 2017. A minor depression was observed along the surface of the landfill in the northeast corner (Feature F, Table 5). A small pothole was observed along the slope of the southeast berm (Feature H, Table 5). These newly identified settlement features appear to be minor in scale and are not considered to affect landfill integrity.

Erosion

No indication of erosion was observed in the area of the NHWL.

Frost Action

A small mound (approx. 0.2 m high) of rock and gravel was observed along the toe of the southeast berm (Feature G, Table 5). The mound may be a result of frost action, or erosion. It is minor in scale and is not considered to affect landfill integrity.

Evidence of Burrowing Animals

No evidence of a burrowing animal was observed at the NHWL.

Re-establishment of Vegetation

No increase in vegetation growth from previous site visits has occurred along the surface or berms of the landfill. Based on the regional setting of this landfill, full re-establishment of vegetation will likely not occur within the timeframe of the first phase of long term monitoring. Very minor vegetation growth was observed at southeast corner of the landfill (Photo 2, Appendix A). No vegetation growth was observed on the surface of the landfill.

Staining

No staining was observed in the area of the NHWL.

Seepage Points

Seepage was not observed during the NHWL inspection.

Debris

Minor construction debris (a screw, a bolt, and piping) was exposed southeast of the NWHL. Debris was sitting exposed at ground surface (Photos 13 and 14, Appendix A).

Drainage Pathways

No drainage pathway was observed during the NHWL inspection.

Discussion

All physical observations suggest that the NHWL is performing as designed and is containing the enclosed waste. During future monitoring events all depression areas and exposed debris noted at the NHWL should be inspected for changes.

Table 5, on the following page, summarizes the results of the visual monitoring.

Table 5: PIN-D, Ross Point, Visual Monitoring Checklist

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Viewpoint Reference
Settlement	A	Toe of berm, southwest corner of the NHWL	1.0	0.35	0.2	<1%	Depression area as a result of final grading. Whole area is poorly graded	Feature appears mechanical. Does not affect the landfill integrity at this point	38
Settlement	B	Toe of berm, southeast corner of the NHWL	1.0	1.0	0.1	<1%	Pothole, appears to be result of grading, minor vegetation growth	Feature appears mechanical. Does not affect the landfill integrity at this point	40
Settlement	C	On toe of berm at northwest corner of NHWL	1.5	0.75	0.1	<1%	Settlement area, minor, appears to be result of final grading, minor vegetation growth	Feature appears mechanical. Does not affect the landfill integrity at this point	42
Settlement	D	On surface of NHWL along east side of landfill	2.5	1.75	0.15	<1%	Minor depression on surface of landfill, appears to be result of grading, minor vegetation growth	Feature appears mechanical. Does not affect the landfill integrity at this point	43
Settlement	E	On surface of NHWL along south side of landfill	0.75	0.75	0.10	<1%	Minor pothole on edge of landfill, feature identified in 2015	Feature appears to be a result of minor slumping. Does not affect the landfill integrity at this point	44
Settlement	F	On surface of NHWL along east side of landfill, 5 m north of settlement D	1.5	1.5	0.10	<1%	New feature in 2017, minor depression on surface of landfill, minor vegetation growth	Does not affect the landfill integrity at this point	50

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Viewpoint Reference
Frost Action	G	Toe of berm, southeast corner of landfill, 5 m east of pothole B	2.0	0.45	0.2	<1%	New feature in 2017, mound of rock and gravel approximately 20 cm high	Does not affect the landfill integrity at this point	51
Settlement	H	On slope of southeast corner of NHWL, northeast of settlement/pothole B	0.2	0.2	0.1	<1%	New feature in 2017, pothole	Does not affect the landfill integrity at this point	52

5.4 Analytical Results – Groundwater

5.4.1 Results

As described in Section 4.4, one groundwater sample plus one duplicate were submitted to Maxxam Analytics in Edmonton and Calgary, Alberta for analyses of BTEX, PHCs, metals, PCBs and inorganic parameters. Analytical results are discussed below. Using results from 2013 and 2015 (a total of four groundwater samples collected), ULAs were calculated for total and dissolved metals and inorganic parameters. There is insufficient historical information to calculate ULAs for other parameters. Results were compared to both the FIGQGs as well as the calculated ULAs, where available. Laboratory certificates of analyses for the 2017 groundwater samples are provided in Appendix C.

Physical Parameters

Physical parameters such as pH, conductivity, dissolved oxygen, temperature and oxygen reduction potential were collected at each sampled monitoring well prior to sampling. The following tables present the physical parameters collected at each well.

Table 6: MW3 Physical Parameters

Time	Temperature (°C)	pH	ORP (mV)	DO (mg/L)	Conductivity (mS/cm)
11:35 AM	5.24	8.30	55.2	13.51	0.444
11:40 AM	4.45	8.29	60.7	10.75	0.398
11:45 AM	4.16	8.29	62.9	10.34	0.392
11:50 AM	3.89	8.31	6.9	29.83	0.393
11:55 AM	Well went dry – allowed to re-charge				
12:14 PM	7.57	8.08	-16.4	10.87	0.390
12:19 PM	6.98	8.12	-10.4	11.35	0.397
12:24 PM	6.68	8.06	-3.1	11.29	0.393
12:25 PM	Sample Collected – approximately 1 L of purge volume				

PHCs

Analytical results for BTEX/PHCs are shown in Table 10. Concentrations for all BTEX/PHC parameters were reported below laboratory detection limits and below FIGQGs. This is similar to the historical results.

Metals

Analytical results for dissolved and total metals in groundwater are shown in Table 11 and 12. Samples collected from monitoring well MW3 had low concentrations of several total and dissolved metals. The following exceedances of the FIGQGs were noted:

- Total iron concentrations measured in the groundwater sample collected from monitoring well MW3 (parent sample only) exceeded the FIGQG of 300 μg/L. No exceedance of the ULA was reported. Dissolved iron concentration measured in this sample was below the detection limit, suggesting that the total iron concentration is likely associated with the presence of sediment in the sample. It should be noted that the analytical results from the duplicate sample did not show an exceedance. A RPD value of 117% was calculated between the parent and duplicate samples for total iron;
- Measure total and dissolved zinc concentrations in the samples collected from monitoring well MW3 (sample and duplicate) were higher than the FIGQG of 10 µg/L. The ULA for dissolved zinc concentrations (13 µg/L) was also exceeded; and
- The reportable detection limit (RDL) for dissolved cadmium in 2017 exceeded the calculated ULA of 0.017 ug/L. The low ULA is due to several of the historical analytical results showing dissolved cadmium concentrations below detection limits. To calculate the ULA, a value of one half of the RDL was used when results were below RDLs, which could contribute to an ULA lower than the RDL.

The measured total iron concentration in the sample collected from monitoring well MW3 exceeded the FIGQGs, while the dissolved iron concentration did not. This is strong evidence that the iron particles are associated with sediment in the sample. As the duplicate sample did not report total iron concentrations greater than the FIGQG, sediment may have been unevenly distributed between the parent sample and the duplicate sample.

Total zinc exceedances were reported from the sample collected from monitoring well MW2 in 2015. The measured concentrations of total and dissolved zinc in 2017 had greatly increased compared to the concentrations measured in previous samples.

Total boron concentrations were above detection limits in the sample collected from monitoring well MW3 in 2017. Boron had not previously been detected in samples collected from PIN-D. Reported concentrations are very low, and near detection limits.

The dissolved potassium concentration measured in the sample collected from monitoring well MW3 in 2017 was higher than previously reported. No guideline exists for potassium. The higher concentrations are likely due to natural fluctuations in groundwater quality.

When compared to the historical results, no obvious trends were noted (i.e. parameter concentrations were not consistently higher or lower in 2017 when compared to historical results). At this time, these occasional exceedances of the FIGQGs are not an immediate concern; however, metal concentrations in groundwater samples should continue to be monitored. High metal concentrations in one particular year are common, so future zinc results should be reviewed to assess if concentrations decrease. Increases in

concentration of a particular parameter over two or more years may require an increase in monitoring frequency (as per the AMSRP, Volume II, Chapter 11, Table 4-2).

PCBs

Analytical results for PCBs in groundwater are shown in Table 13. Concentrations for all PCB parameters were reported below the laboratory RDLs. This is similar to the historical results. The FIGQGs do not specify guidelines for PCBs.

Inorganics

Laboratory analytical results for inorganics are shown in Table 14. Concentrations of alkalinity (phenolphthalein (PP) as $CaCO_3$), carbonate (CO_3^-), hydroxide (OH^-), nitrite (NO_2^-) and dissolved nitrite (NO_2^-, calculated) were reported below the laboratory RDL for sample MW3 collected in 2017. All other inorganic and calculated parameters showed concentrations above the laboratory RDLs but below the FIGQGs, where they exist. Reported concentrations of all parameters were below the calculated ULA.

5.4.2 Quality Assurance/Quality Control Results

A groundwater duplicate sample, DUP2, was collected from monitoring well MW3. As a quality control check, a Relative Percent Difference (RPD) was calculated when analytical results from both samples were greater than five times the RDL. As per CCME Guidance (Guidance Manual for Environmental Site Characterization in Support of Human and Health Risk Assessment, Volume I Guidance Manual, CCME, 2016), the RPDs for parameters of duplicate groundwater samples should not exceed 40%.

Several parameters exhibit RPD values in exceedance of the alert limit. They are:

- Total aluminium, copper, iron, sodium, uranium and zinc;
- Dissolved potassium; and
- Ion balance.

The duplicate sample was collected at a later time than the parent sample to allow for adequate groundwater recharge within the well. Thus, the duplicate sample was not collected in conjunction with the parent sample, as per standard field protocols. Overall, the analytical results are considered acceptable.

6 SURROUNDING AREAS

Some of the outlying areas at the site were observed by foot and by aerial fly over during the site visit.

The access roads and airstrips appeared in good condition. Minor vegetation growth was observed on the airstrip and access roads. The main station area was void of any debris; however, evidence of the remediation was prominent with equipment marks and graded areas. Three cement platforms remain that are likely the former foundations of the tower braces. The main Station Area is located on high table lands consisting of bedrock. Very little vegetation was observed at the Station Area as the area is lacking soils to support growth.

A 205 L steel drum was located adjacent to the runway area (Photos 18 and 19, Appendix A). The drum was full, labelled “A-1 Jet Fuel” and was stored on its side. A contact label for “S. Sather, Department of Environment, Government of Nunavut” was observed on the drum.

Two additional red steel drums were observed to be located several kilometres east of the runway area and a few hundred metres north of the shoreline (Photo 24, Appendix A). The drums were located in between the main station area and the east beach area. These drums were located too far to be inspected on foot by Arcadis personnel. The condition and contents of the drums are unknown.

The East Beach Area was observed by aerial fly over. No apparent changes were seen. This area is at a much lower elevation then the Main Station. An increase of vegetation growth including mosses and grasses was observed at the East Beach Area. Remnants of a derelict camp remain. A partially standing plywood cabin, old camp equipment and caribou antlers were observed in 2013. The access road from this beach area connecting to the airstrip was observed to be in fair to good condition.

7 NATURAL ENVIRONMENT

Information regarding the natural environment was gathered directly, through observation, and indirectly, through consultation with knowledgeable local persons in order to better understand the presence and temporal change of wildlife. The PIN-D 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
- Revegetation of disturbed areas versus previous years

Wildlife and Human Activity

According to observations by Kugluktuk community members, and a previous wildlife monitor (2013) O.J. Bernhardt, this site is frequently used for hunting caribou and muskox. As far as Mr. Bernhardt is aware, these are the only animals hunted in the area. The area is not used for fishing. In Mr. Bernhardt's opinion as stated in 2013, the number of animals available for harvest has not changed in the past years. As far back as he can remember, the number of animals has remained consistent.

During the 2017 site investigation, wildlife monitor Kirk Kapakatoak, believed the area to be located too far from nearby communities to be used as hunting grounds. However, in 2017, remnants of a campfire were observed along the access road to the main station area (Photo 20, Appendix A). A bullet casing (Photo 21, Appendix A) and several caribou and muskox skulls, bones, and antlers (Photo 23, Appendix A) were also observed along the access road to the main station area.

During the site visit, the Arcadis field assessors observed evidence (e.g. scat, tracks, nesting areas, burrows or visual observation) of a number of animals. Caribou, arctic fox muskox, and hare scat was observed (Photo 22, Appendix A). Two rough-legged hawks, an arctic hare and its burrow (Photo 15, Appendix A), and pelicans were visually confirmed.

Re-establishment of Vegetation

Based on the regional setting of this site, re-establishment of vegetation is not likely in the near future. Minor growth was again observed on the south side of the NHWL, at the toe of landfill (Photo 2, Appendix A), in a similar location to 2015 observations. No vegetation growth was observed on the surface or remaining berms of the landfill.

8 PHASE I ASSESSMENT

LTM activities have been conducted at the PIN-D site in 2013, 2015 and 2017. This represents the end of Phase I, as outlined in the LTM Plan (INAC, 2013). An assessment of the data collected to date is included, to consider if monitoring should continue according to the LTM Plan, or if modifications are required.

8.1 Evaluation of PIN-D Data

8.1.1 Visual Monitoring Summary

The physical integrity of the NHWL and surrounding areas were assessed during each monitoring event using systematic visual observations and empirical measurements to record evidence of erosion, ponding, frost action, settlement and lateral movement of the landfills. A photographic record was completed to document the condition of the structures and substantiate the visual observations.

Features of note at the NHWL included minor areas of settlement and potholes. Four of these features were noted in the first year of monitoring, and appeared to be the result of final surface grading. One new pothole was identified in 2015, and three new areas of settlement were observed in 2017. All features are considered minor and are not expected to affect NHWL stability.

Table 5, in Section 5.3, summarizes the features observed during the visual monitoring conducted in 2013, 2015 and 2017.

Despite new features being identified each year, it appears that the NHWL is fairly stable. The features are isolated and of little consequence. Based on evaluation criteria from the AMSRP Volume II: Technical Supporting Documentation (Chapter 11), the landfill performance is rated as acceptable (see Table 4 in this report).

8.1.2 Analytical Monitoring Summary

8.1.2.1 Summary of Sample Collected

The following table summarizes the samples collected during Years 1, 3 and 5 of the LTM activities.

Table 7: Summary of Samples Collected during LTM Events at PIN-D

Year	GW Samples	Soil Samples
2013	Groundwater samples were collected from monitoring wells MW2 and MW3, with a duplicate sample collected from MW2 (BTEX/PHCs) and MW3 (Remaining parameters).	None – no evidence of seepage or staining observed
2015	Groundwater samples were collected from monitoring well MW1 and MW2, with a duplicate sample collected from monitoring well MW2.	None – no evidence of seepage or staining observed
2017	One groundwater sample and its duplicate were collected from MW3.	None – no evidence of seepage or staining observed

8.1.2.2 Summary of Results for PIN-D

Soil

No soil sample collection has been conducted to date, as no indications of seepage or staining were noted during the visual monitoring.

Groundwater

Over the three LTM events, only five groundwater samples have been collected. Of these, one sample has been collected from monitoring well MW1 and two samples have been collected from each of monitoring wells MW2 and MW3. One monitoring well, MW4, has never been sampled.

The groundwater results from 2013 consisted of two groundwater samples collected from monitoring wells MW2 and MW3. No metal concentrations in excess of the FIGQGs were reported, although sulphate concentrations were reported to be greater than the FIGQG of 100 mg/L in both samples. The groundwater results from 2015, consisting of groundwater samples collected from monitoring wells MW1 and MW2, reported concentrations of total aluminium, total iron and total zinc above the FIGQGs. The single groundwater sample collected from monitoring well MW3 in 2017 reported total iron and total and dissolved zinc concentrations greater than the FIGQGs. Visual results of select average metal concentrations (total and dissolved) are presented in Appendix D. Note that when reported concentrations are below detection limits, one half of the detection limit was used for calculations and graphing purposes.

The FIGQGs apply to groundwater samples collected by standard methods, which means field filtering and preserving samples. For the analysis of total metals, samples were not field filtered and would include metal ions adsorbed to sediment particles in the result. As a result, the FIGQGs represent very conservative guidelines in this situation. Therefore, the total metal exceedances (in sample MW2 in 2015 and sample MW3 in 2017) are not a significant concern. Dissolved zinc concentrations reported in 2017 were significantly above (i.e. three to four times greater) the FIGQG of 10 µg/L. However, given the sparse background data available, it is difficult to assess if this is part of normal groundwater quality fluctuation, or a result of NHWL impacts. Further groundwater quality monitoring is warranted to assess if this is an increasing trend, or part of natural fluctuations.

PHCs and PCBs have never been detected in any of the samples collected from the monitoring wells at PIN-B.

When the results from all years were compared, no obvious trends were noted (i.e. parameter concentrations were not consistently higher or lower in 2017 when compared to 2015 or 2013 results). No exceedances have consistently been reported.

As no background groundwater samples were collected during remediation activities, none are available for comparison. These exceedances could well be considered background concentrations; however, there isn't enough data available for definitive conclusions. Further groundwater data collection would establish baseline conditions in order to evaluate if these exceedances are part of the background water quality, or reveal any trends, such as increasing concentrations leaching from the NHWL.

9 CONCLUSIONS AND RECCOMENDATIONS

Based on systematic visual observations and measurements, photographic documentation and analytical results, the PIN-D NHWL is considered to be in acceptable condition, is performing as designed, and is containing the enclosed waste. A few metals have been measured in groundwater samples at concentrations that exceed the FIGQGs; specifically, aluminium, iron and zinc. Background concentrations are not available at PIN-D for comparison purposes and only five groundwater samples have been collected to date. With the sparse data available, possible increasing trends due to the potential leaching of metals from the NHWL cannot be determined. These metal exceedances may be attributed to background conditions but again, given the sparse analytical data available, definitive conclusions are hard to make.

Several settlement features have been observed over the years: three minor settlement areas and two pothole areas have been previously observed. No changes were noted to the previously identified settlement features. Two new settlement features (a minor depression and a pothole) were identified in 2017. The settlement features appear to be the result of poor grading activities or minor settlement activities. A small mound was also observed in 2017, which may be due to frost action. All identified features are minor in scale and do not appear to currently affect the integrity of the NHWL.

A 205 L steel drum was located adjacent to the runway area during the 2017 site visit. The drum was full, labelled “A-1 Jet Fuel” and was stored on its side. A contact label for “S. Sather, Department of Environment, Government of Nunavut” was observed on the drum. Two additional red steel drums were observed to be located several kilometres east of the runway area and a few hundred metres north of the shoreline. The drums were located in between the main station area and the east beach area. These drums were located too far to be inspected on foot by Arcadis personnel. The condition and contents of the drums are unknown. Care should be taken during subsequent site visits to inspect any storage drums for potential changes to their condition.

At PIN-D Ross Point, Arcadis recommends that monitoring activities progress to Phase II of the LTM Plan. Additional data would provide more confidence that the higher metal concentrations are considered to be representative of background conditions, if that is the case, or reveal any trends, if metals are leaching from the NHWL. In addition, given the uncertainty of the future arctic environment due to potential climate changes, continued monitoring would be a prudent decision.

Given the low solubility of PCBs in water, analyses of PCBs could be discontinued as they were not detected in the first five 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.

10 LIMITATIONS

This report has been prepared exclusively for Indigenous and Northern Affairs Canada. 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 2, 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.

11 REFERENCES

Aboriginal Affairs and Northern Development Canada, March 28, 2013. *PIN-D Ross Point Long Term Monitoring Plan*.

AECOM Canada Ltd., April 2012. PIN-D, Ross Point, Final Interim Construction Summary.

Arcadis Canada Inc., January 20, 2016. Long Term Monitoring, 2015, PIN-D, Ross Point, Nunavut.

Environmental Sciences Group, Royal Military College, Kingston, ON, January 2010. *Background Geochemical Assessment of PIN-D, Ross Point, Nunavut*.

Federal Interim Groundwater Quality Guidelines (FIGQG). 2013. Table 1. Generic Guidelines for Residential/Parkland Land Uses Tier 1, Freshwater Life pathway for coarse-grained soil.

Federal Interim Groundwater Quality Guidelines (FIGQG). 2013. Table 2. Generic Guidelines for Residential/Parkland Land Uses Tier 1, Freshwater Life pathway for coarse-grained soil.

Franz Environmental Inc., January 20, 2014. Long Term Monitoring, 2013, PIN-D, Ross Point, Nunavut.

Indian and Northern Affairs Canada. March 2009. *Abandoned Military Site Remediation Protocol*, Contaminated Sites Program.

TABLES

Tables 8 through 15

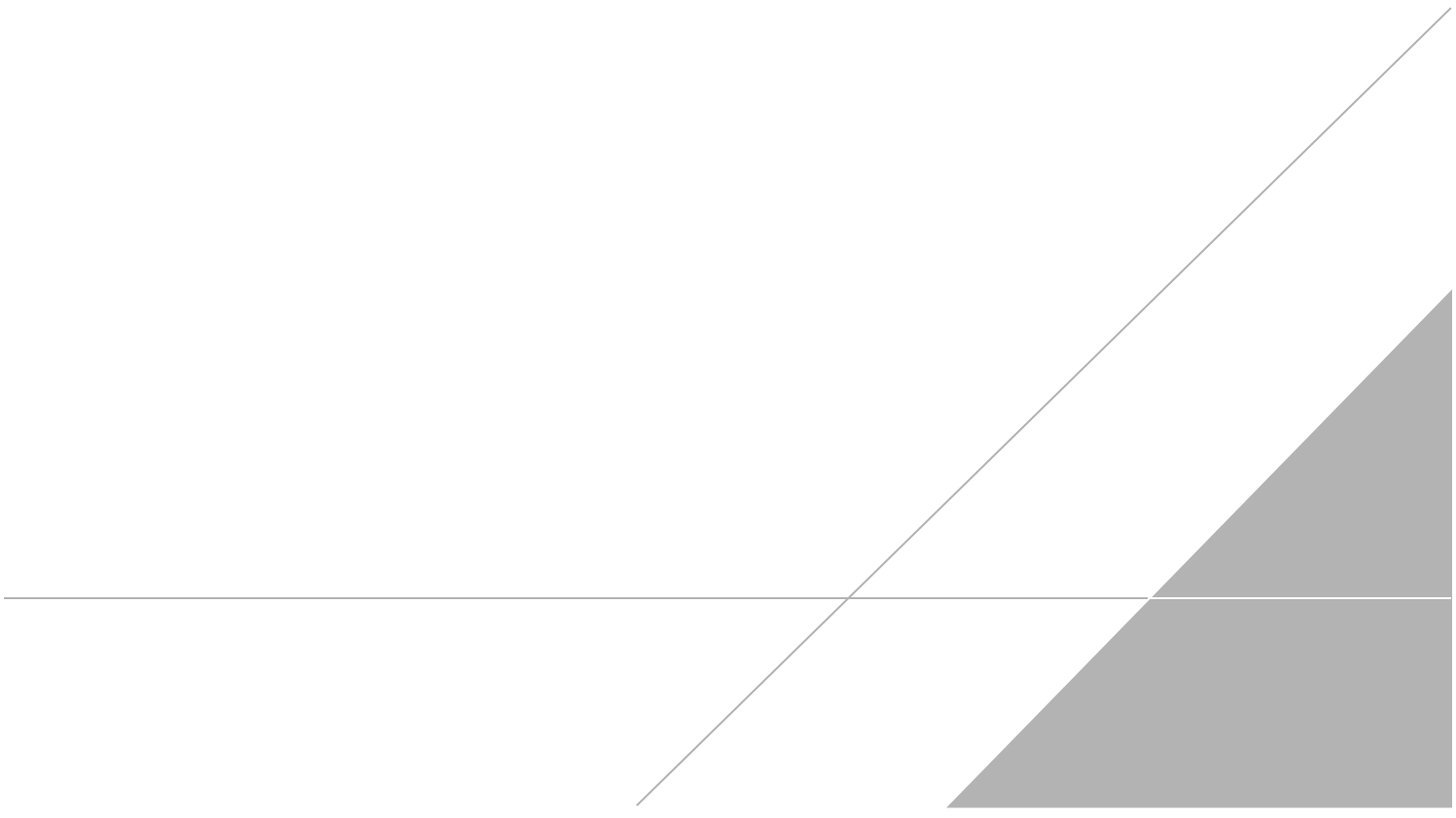


Table 8
Baseline Soil Analytical Data from NHWL Footprint
PIN-D, Ross Point, Nunavut

ARCADIS Design & Consultancy for natural and built assets

Parameter (mg/kg)	11-0400	11-0401	11-0402	11-0403	11-0404	11-0405	11-0406	11-0407	11-0408	11-0409	11-0410	11-0411	Avg. Conc.	Std. Dev.
Depth (cm)	0-10	0-10	40-50	0-10	40-50	0-10	40-50	0-10	40-50	0-10	40-50	40-50		
As	3	3	3	3	3	1	2	2	12	3	6	6	3.9	2.9
Cd	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
Cr	11	9	32	13	16	6	12	19	6	13	12	7	13.0	7.1
Co	ND	1	2	2	3	2	2	2	3	4	2	2	2.3	0.8
Cu	ND	ND	6	5	10	8	8	ND	5	8	ND	ND	7.1	1.9
Pb	14	15	12	9	11	4	8	10	14	13	14	10	11.2	3.2
Ni	7	5	16	8	11	5	7	11	7	9	8	5	8.3	3.2
Zn	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
Hg	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
Xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
F1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
F1-BTEX	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
F2	ND	ND	ND	ND	62	ND	ND	ND	ND	30	42	61	48.8	15.5
F3	ND	ND	ND	ND	63	ND	ND	ND	ND	120	57	62	75.5	29.8
F4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---
Total PCBs	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	---	---

Sample ID	Terrain Unit	Depth (cm)	As (ppm)	Cd (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Ni (ppm)	Pb (ppm)	Zn (ppm)
DCC Tier I	---	---	---	---	---	---	---	---	200	---
DCC Tier II	---	---	***30***	***5***	***50***	***250***	***100***	***100***	***500***	***500***
09-30960/61	Cc	20	2.1	ND	8.3	21	24	14	ND	24
09-30962	Cc	10	ND	ND	7.6	ND	27	11	ND	20
09-30963	Cc	10	ND	ND	ND	ND	14	6	ND	ND
09-30964	Cc	0	ND	ND	ND	22	34	11	ND	16
09-30965	Cc	0	ND	ND	ND	ND	12	ND	ND	ND
09-30966	Cc	30	ND	ND	7.3	21	26	12	ND	18
09-30967	Cc	10	1.5	ND	5.9	ND	30	8	ND	ND
09-30968	Cc	10	1.3	ND	ND	ND	6.5	7.7	ND	ND
09-30969	Cc	0	ND	ND	ND	ND	ND	ND	ND	ND
09-30970/71	Cc	20	ND	ND	ND	ND	20	ND	ND	ND
09-30972	Cc	10	ND	ND	5.3	ND	21	7.9	ND	ND
09-30973	Cc	10	1.3	ND	ND	ND	29	6.1	ND	ND
09-30974	Cc	10	1.4	ND	ND	ND	25	5.1	ND	19
09-30975	Cc	20	1.5	ND	5.2	ND	19	7.7	ND	ND
09-30976	Cc	20	1.2	ND	5.1	ND	17	8	ND	ND
09-30977	Cc	10	ND	ND	5.2	ND	5.9	5.8	ND	17
09-30978	Cc	10	2.3	ND	5.6	ND	18	7.5	ND	ND
09-30979	Cc	10	ND	ND	ND	ND	8.5	ND	ND	ND
09-30980/81	Cc	10	1.4	ND	ND	ND	14	ND	ND	ND
09-30982	Cc	10	ND	ND	ND	ND	10	5.1	ND	ND
09-30983	Cc	0	ND	ND	ND	ND	21	5.4	ND	ND
09-30984	Cc	10	2	ND	5.7	ND	49	10	ND	17
09-30985	Cc	10	ND	ND	ND	ND	6.2	ND	ND	ND
09-30986	Cc	20	ND	ND	ND	ND	8.4	5.3	ND	ND
09-30987	Cc	10	ND	ND	ND	ND	40	ND	ND	ND
09-30988	Cc	10	4	ND	5	ND	12	8	ND	ND
09-30989	Cc	0	2.4	ND	6.8	ND	24	11	ND	17
09-30990/91	Cc	10	ND	ND	ND	ND	5.6	ND	ND	ND
09-30992	Cc	20	1.1	ND	ND	ND	10	ND	ND	ND
09-30993	Cc	10	ND	ND	ND	ND	5.2	5.2	ND	ND
09-30994	Cc	0	ND	ND	ND	ND	16	7.6	ND	ND
09-30995	Cc	10	ND	ND	ND	ND	ND	ND	ND	ND
09-30996	Cc	0	1.1	ND	5.2	ND	26	7.9	ND	ND
09-30997	Cc	0	1.6	ND	5.3	ND	26	9.4	ND	ND
09-30998	Cc	0	ND	ND	ND	ND	12	5.6	ND	16
09-30999	Cc	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31000/01	Cc	0	2.9	ND	8.8	30	26	16	ND	30
09-31002	Cc	10	3.3	ND	ND	ND	16	6.4	ND	ND
09-31003	Cc	10	2.1	ND	5	ND	17	9	ND	ND
09-31004	Cc	10	1.4	ND	ND	ND	16	7.4	ND	ND
09-31005	Nnh	10	1.7	ND	ND	ND	7.3	6.5	ND	ND
09-31006	Nnh	10	1.6	ND	ND	ND	12	6	ND	ND
09-31007	Nnh	10	1.1	ND	ND	ND	15	5.7	ND	ND
09-31008	Nnh	20	ND	ND	ND	ND	5.5	ND	ND	ND

Sample ID	Terrain Unit	Depth (cm)	As (ppm)	Cd (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Ni (ppm)	Pb (ppm)	Zn (ppm)
DCC Tier I	---	---	---	---	---	---	---	---	200	---
DCC Tier II	---	---	***30***	***5***	***50***	***250***	***100***	***100***	***500***	***500***
09-31009	Nnh	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31010/11	Nnh	10	ND	ND	ND	ND	5.3	ND	ND	ND
09-31012	Nnh	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31013	Nnh	10	1.7	ND	ND	ND	17	7.9	ND	ND
09-31014	Nnh	0	1.2	ND	ND	ND	ND	ND	ND	ND
09-31015	Nnh	0	2.1	ND	5.8	ND	15	8.6	ND	17
09-31016	Nnh	10	2.7	ND	ND	ND	13	7.1	ND	18
09-31017	Nnh	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31018	Nnh	10	2.1	ND	7	ND	23	9.4	ND	17
09-31019	Nnh	10	1.4	ND	ND	ND	18	7.3	ND	ND
09-31020/21	Nnh	0	1.2	ND	ND	ND	10	6.2	ND	ND
09-31022	Nnh	10	1.3	ND	ND	ND	11	5.6	ND	ND
09-31023	Nnh	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31024	Nnh	10	ND	ND	ND	ND	7.8	ND	ND	16
09-31025	Nnh	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31026	Nnh	10	1.5	ND	ND	ND	18	7.1	ND	ND
09-31027	Nnh	0	ND	ND	ND	ND	6.2	ND	ND	ND
09-31028	Nnh	0	ND	ND	ND	ND	8.8	5.7	ND	18
09-31029	Nnh	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31030/31	Nnh	20	ND	ND	ND	ND	10	ND	ND	ND
09-31032	Nnh	20	ND	ND	ND	ND	21	5	ND	ND
09-31033	Nnh	10	ND	ND	ND	ND	14	ND	ND	ND
09-31034	Nnh	0	ND	ND	ND	ND	9	5.5	ND	16
09-31035	Nnh	0	1.1	ND	ND	ND	15	ND	ND	16
09-31036	Nnh	0	ND	ND	ND	ND	6.4	5.1	ND	ND
09-31037	Cc	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31038	Cc	20	2.3	ND	7	24	17	13	ND	22
09-31039	Cc	10	3	ND	9.1	34	18	13	ND	ND
09-31040/41	Cc	0	ND	ND	ND	ND	17	6.2	ND	ND
09-31042	Cc	0	ND	ND	ND	ND	11	ND	ND	19
09-31043	Cc	10	ND	ND	5.8	ND	52	7.4	ND	ND
09-31044	Nnh	0	2.6	ND	6.3	ND	27	9.5	ND	28
09-31045	Nnh	0	1.8	ND	ND	ND	6.5	8.1	ND	ND
09-31046	Nnh	0	ND	ND	ND	ND	6.5	5.9	ND	ND
09-31047	Nnh	20	ND	ND	ND	ND	ND	ND	ND	ND
09-31048	Nnh	0	1.4	ND	9.3	27	16	16	ND	26
09-31049	Nnh	0	ND	ND	ND	ND	ND	5.5	ND	ND
09-31050/51	Nnh	0	ND	ND	ND	ND	ND	ND	ND	ND
09-31052	Nnh	0	2.3	ND	ND	ND	21	ND	ND	ND
09-31053	Nnh	10	1.3	ND	5.8	ND	25	8.9	ND	ND
09-31054	Nnh	20	ND	ND	ND	ND	9	ND	ND	ND
09-31055	Nnh	20	ND	ND	ND	ND	12	5.5	ND	ND
09-31056	Nnh	10	ND	ND	ND	ND	5.4	ND	ND	ND
09-31057	Nnh	10	ND	ND	ND	ND	ND	ND	ND	ND

Sample ID	Terrain Unit	Depth (cm)	As (ppm)	Cd (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Ni (ppm)	Pb (ppm)	Zn (ppm)
DCC Tier I	---	---	---	---	---	---	---	---	200	---
DCC Tier II	---	---	***30***	***5***	***50***	***250***	***100***	***100***	***500***	***500***
09-31058	Nnh	10	2.9	ND	6.2	ND	23	9.5	ND	ND
09-31059	Nnh	10	1.2	ND	5.9	ND	19	10	ND	ND
Avg. Conc.	---	---	1.8	---	6.4	25.6	16.7	8.0	---	19.4
Std. Dev.	---	---	0.7	---	1.3	5.0	9.5	2.7	---	4.2

PARAMETER	CCME FIGQGs[1]	RDL	MW1	MW2				MW3		DUP-1	
			2015-07-22	2013-08-21	DUP 2013-08-21	2015-07-22	DUP 2015-07-22	2013-08-21	2017-08-02	2017-08-02	RPD
BTEX & F1 Hydrocarbons (µg/L)											
Benzene	140	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA
Toluene	83	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA
Ethylbenzene	11000	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA
o-Xylene	NC	0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	NA
p+m-Xylene	NC	0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	NA
Total Xylenes	3900	0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	<0.80	NA
F1 (C6-C10)	810	100	<100	<100	<100	<100	<100	<100	<100	<100	NA
F1 (C6-C10) - BTEX	NC	100	<100	<100	<100	<100	<100	<100	<100	<100	NA
F2-F4 Hydrocarbons (ug/L)											
F2 (C10-C16 Hydrocarbons)	1300	100	<100	<100	<100	<100	<100	<100	<100	<100	NA
F3 (C16-C34 Hydrocarbons)	NC	200	-	<200	<200	-	-	<200	-	-	NA
F4 (C34-C50 Hydrocarbons)	NC	200	-	<200	<200	-	-	<200	-	-	NA
Reached Baseline at C50	NA	NA	-	Yes	Yes	-	-	Yes	-	-	NA

Notes:

1 = Table 1: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.

NA = Not Applicable

NC = No Criteria

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Table 11
Groundwater Chemical Concentrations - Total Metals
PIN-D, Ross Point, Nunavut

PARAMETER	CCME FIGQGs[1]	ULA	RDL	MW1	MW2			MW3				
				2015-07-22	2013-08-21	2015-07-22	DUP 2015-07-22	2013-08-21	DUP 2013-08-21	2017-08-02	DUP 2017-08-02	RPD (%)
Metals (µg/L)												
Total Aluminum (Al)	1420*	7000	3/0.5	11	33	4,000	3,500	21	20	11	37	*108%*
Total Antimony (Sb)	2000	NC	0.6/0.02	<0.6	0.027	<0.6	<0.6	0.081	0.079	<0.60	<0.60	NC
Total Arsenic (As)	5	5.8	0.2/0.02	0.26	0.19	3.4	3.1	0.13	0.11	0.57	0.22	NC
Total Barium (Ba)	500	NC	10/0.02	15	39	65	62	31	31	16	17	NC
Total Beryllium (Be)	5.3	NC	1/0.01	<1	<0.010	<1	<1	<0.010	<0.010	<1.0	<1.0	NC
Total Bismuth (Bi)	NG	NC	5/0.005	<5	<0.0050	<5	<5	<0.0050	0.0050	-	-	NC
Total Boron (B)	1500	NC	20/50	<20	<50	<20	<20	<50	<50	33	31	NC
Total Cadmium (Cd)	0.09	0.12	0.02/0.005	<0.020	0.0080	0.074	0.061	0.012	0.0090	<0.020	<0.020	NC
Total Calcium (Ca)	NG	NC	300/50	40000	23000	19,000	18,000	68,900	62,400	37,000	42,000	13%
Total Chromium (Cr)	8.9	5.3	1/0.1	<1	1.5	3.1	2.7	<0.10	0.15	1.3	3.5	NC
Total Cobalt (Co)	NG	4.6	0.3/0.005	<0.3	0.36	2.7	2.5	0.19	0.20	<0.30	<0.30	NC
Total Copper (Cu)	28.4-56.8*	24	0.2/0.05	3.2	7.3	15	12	3.1	3.1	2.7	8.1	*100%*
Total Iron (Fe)	300	12,000	60/1	<60	41	7,100	6,500	23	19	570	150	*117%*
Total Lead (Pb)	14.2-99.4*	17	0.20/0.005	0.26	0.13	9.8	8.7	0.10	0.095	2.8	0.51	NC
Total Lithium (Li)	NG	NC	20/0.5	<20	1.7	<20	<20	1.4	1.6	<20	<20	NC
Total Magnesium (Mg)	NG	NC	200/50	21000	41100	20,000	20,000	49,200	49,600	28,000	32,000	NC
Total Manganese (Mn)	NG	NC	4/0.05	<4	63	140	130	26	27	8.2	1.7	NC
Total Molybdenum (Mo)	73	NC	0.2/0.05	0.52	1.7	1.7	1.6	0.79	0.84	0.96	0.99	NC
Total Nickel (Ni)	355-2130*	10	0.5/0.02	1.5	6.0	4.5	4.0	1.9	2.0	2.3	4.1	NC
Total Potassium (K)	NG	NC	300/50	600	1540	2,600	2,500	1,320	1,340	1,000	3,400	NC
Total Selenium (Se)	1	0.65	0.2/0.04	<0.2	0.23	0.38	0.37	0.36	0.33	<0.20	<0.20	NC
Total Silicon (Si)	NG	NC	100	780	823	11,000	10,000	1,170	1,040	1,000	1,100	10%
Total Silver (Ag)	0.1	NC	0.1/0.005	<0.1	<0.0050	<0.1	<0.1	<0.0050	<0.0050	<0.10	<0.10	NC
Total Sodium (Na)	NG	NC	500/50	2800	8180	16,000	16,000	8,090	8,210	3,400	6,100	*57%*
Total Strontium (Sr)	NG	NC	20/0.05	<20	55	37	36	60	59	27	33	NC
Total Sulphur (S)	NG	NC	200/3000	2700	40200	3,100	3,100	70,400	70,200	18,000	24,000	29%
Total Thallium (Tl)	0.8	NC	0.2/0.002	<0.20	0.014	0.23	0.22	0.033	0.033	<0.20	<0.20	NC
Total Tin (Sn)	NG	NC	1/0.2	<1	<0.20	1.1	1.1	<0.20	<0.20	<1.0	<1.0	NC
Total Titanium (Ti)	100	NC	1/0.5	<1	1.2	92	89	<0.50	<0.50	3.2	1.5	NC
Total Uranium (U)	15	NC	0.1/0.002	0.74	4.1	2.3	2.1	6.9	6.8	1.5	2.3	*42%*
Total Vanadium (V)	NG	NC	1/0.2	<1	0.23	7.8	6.9	<0.20	0.20	<1.0	<1.0	NC
Total Zinc (Zn)	10	86	3/0.1	9.1	0.64	50	42	0.95	0.81	37	67	*58%*
Total Zirconium (Zr)	NG	NC	3/0.1	<3	<0.10	<3	3.5	<0.10	<0.10	NA	NA	NC

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.

* = Value from Canadian Environmental Water Quality Guidelines, Water Quality Guidelines for the Protection of Freshwater Aquatic Life, with a groundwater water factor of 14.2 applied (as nearest surface water body is approximatley 400 m away).

NG = No Guideline

NA = Not Available

NC = Not calculated

RPD = Relative Percent Difference

RDL= Reportable Detection Limit

20 Exceeds selected guideline.

20 Exceeds Upper Limit of Acceptability (ULA)

Italics = RPD Alert Limit Exceeded

PARAMETER	CCME FIGQGs[1]	ULA	RDL	MW1	MW2			MW3				
				2015-07-22	2013-08-21	2015-07-22	DUP 2015-07-22	2013-08-21	DUP2 2013-08-21	2017-08-02	DUP2 2017-08-02	RPD (%)
Metals (µg/L)												
Dissolved Aluminum (Al)	1420*	46	0.5/3	4.3	28	7.3	7.4	17	21	4.7	4.4	NC
Dissolved Antimony (Sb)	2000	NC	0.02/0.6	<0.6	0.025	<0.6	<0.6	0.086	0.095	<0.60	<0.60	NC
Dissolved Arsenic (As)	5	0.45	0.02/0.2	<0.2	0.15	0.31	0.27	0.13	0.13	<0.20	<0.20	NC
Dissolved Barium (Ba)	500	NC	0.02/10	15	38	12	12	31	31	15	17	NC
Dissolved Beryllium (Be)	5.3	NC	0.01/1	<1	<0.010	<1	<1	<0.010	<0.010	<1.0	<1.0	NC
Dissolved Bismuth (Bi)	NG	NC	0.005/5	<5	<0.0050	<5	<5	<0.0050	0.0130	-	-	NC
Dissolved Boron (B)	1500	NC	50/20	<20	<50	<20	<20	<50	<50	31	34	NC
Dissolved Cadmium (Cd)	0.09	0.017	0.005/0.02	<0.020	0.013	<0.020	<0.020	0.013	0.012	**<0.020**	**<0.020**	NC
Dissolved Calcium (Ca)	NG	NC	50/300	40,000	27,100	17,000	17,000	68,500	67,500	38,000	39,000	3%
Dissolved Chromium (Cr)	8.9	NC	0.1/1	<1	<0.10	<1	<1	<0.10	<0.10	<1.0	<1.0	NC
Dissolved Cobalt (Co)	NG	0.53	0.005/0.3	<0.3	0.37	<0.3	<0.3	0.22	0.24	<0.30	<0.30	NC
Dissolved Copper (Cu)	28.4-56.8*	3.6	0.05/0.2	1.5	2.0	1.3	0.95	2.6	2.9	1.6	1.9	17%
Dissolved Iron (Fe)	300	64	1/60	<60	1.6	<60	<60	3.7	3.3	<60	<60	NC
Dissolved Lead (Pb)	14.2-99.4*	0.20	0.005/0.20	<0.2	0.020	<0.2	<0.2	0.014	0.033	<0.20	<0.20	NC
Dissolved Lithium (Li)	NG	NC	0.5/20	<20	1.5	<20	<20	1.7	1.5	<20	<20	NC
Dissolved Magnesium (Mg)	NG	NC	50/200	21,000	44,100	20,000	20,000	50,300	53,300	28,000	30,000	7%
Dissolved Manganese (Mn)	NG	NC	0.05/4	<4	61	6.8	6.6	27	29	<4.0	<4.0	NC
Dissolved Molybdenum (Mo)	73	NC	0.05/0.20	0.46	1.9	0.85	0.81	0.77	0.89	0.84	0.77	NC
Dissolved Nickel (Ni)	355-2130*	5.8	0.02/0.50	1.0	3.5	<0.5	<0.5	1.9	2.2	1.6	3.0	NC
Dissolved Potassium (K)	NG	NC	50/300	590	1,540	980	940	1,310	1,360	1,700	3,100	*58%*
Dissolved Selenium (Se)	1	0.54	0.04/0.20	<0.2	0.24	<0.2	<0.2	0.34	0.33	<0.20	<0.20	NC
Dissolved Silicon (Si)	NG	NC	100	770	898	640	640	1,140	1,110	1,000	1,100	10%
Dissolved Silver (Ag)	0.1	NC	0.005/0.10	<0.1	<0.0050	<0.1	<0.1	<0.0050	<0.0050	<0.10	<0.10	NC
Dissolved Sodium (Na)	NG	NC	50/500	2,600	8,700	9,100	9,200	8,250	8,640	4,400	6,300	36%
Dissolved Strontium (Sr)	NG	NC	0.05/20	<20	54	28	28	57	58	28	32	NC
Dissolved Sulphur (S)	NG	NC	3,000/200	2,700	4,250	2,700	2,700	68,200	74,300	20,000	24,000	18%
Dissolved Thallium (Tl)	0.8	NC	0.002/0.20	<0.20	0.013	<0.2	<0.2	0.033	0.034	<0.20	<0.20	NC
Dissolved Tin (Sn)	NG	NC	0.2/1	<1	<0.20	<1	<1	<0.20	<0.20	<1.0	<1.0	NC
Dissolved Titanium (Ti)	100	NC	0.5/1	<1	<0.50	<1	<1	<0.50	<0.50	<1.0	<1.0	NC
Dissolved Uranium (U)	15	NC	0.002/0.1	0.65	4.4	0.63	0.59	7.1	7.1	1.5	1.9	24%
Dissolved Vanadium (V)	NG	NC	0.2/1	<1	0.21	<1	<1	0.23	0.22	<1.0	<1.0	NC
Dissolved Zinc (Zn)	10	13	0.1/3	8.0	2.7	<3	<3	2.1	2.3	**33**	**40**	19%
Dissolved Zirconium (Zr)	NG	NC	0.1/3	<3	<0.10	<3	<3	0.12	0.10	NA	NA	NC

Notes:

1 = Table 1: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.

* = Value from Canadian Environmental Water Quality Guidelines, Water Quality Guidelines for the Protection of Freshwater Aquatic Life, with a groundwater water factor of 14.2 applied (as nearest surface water body is approximatley 400 m away).

NG = No Guideline

NC = Not Calculated

RPD = Relative Percent Difference

RDL= Reportable Detection Limit

20 Exceeds selected guideline.

20 Exceeds Upper Limit of Acceptability (ULA)

PARAMETER	CCME FIGQGs[1]	RDL	MW1	MW2			MW3				
			2015-07-22	2013-08-22	2015-07-22	DUP 2015-07-22	2013-08-22	DUP 2013-08-22	2017-08-02	DUP 2017-08-02	RPD
PCBs (ug/L)											
Aroclor 1016	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1221	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1232	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1242	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1248	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1254	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1260	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1262	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Aroclor 1268	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA
Total Aroclors	NC	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	NA

Notes:

1 = Table 1: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use (µg/L), Tier 1, Lowest Guideline for coarse grained soils.
NA = Not Applicable
NC = No Criteria
RDL = Reportable Detection Limit
RPD = Relative Percent Difference

PARAMETER		CCME FIGQGs[1]	ULA	RDL	MW1	MW2			MW3				
					2015-07-22	2013-08-21	2015-07-22	DUP 2015-07-22	2013-08-21	DUP 2013-08-21	2017-08-02	DUP 2017-08-02	RPD
Inorganics	**Units**												
True Colour	PtCo	NC	NC	2	6.8	3.6	4.9	39	3.8	2.7	-	-	NC
Conductivity	uS/cm	NC	1073	1.0	370	520	270	270	730	730	380	410	8%
Total Dissolved Solids	mg/L	3000	855	10	190	NA	150	140	500	490	220	240	9%
Fluoride (F-)	mg/L	0.12	0.11	0.050	<0.050	0.061	0.066	0.064	<0.050	<0.050	-	-	NC
Orthophosphate (P)	mg/L	NC	NC	0.0030	<0.0030	0.0030	0.014	0.013	<0.0030	0.0032	-	-	NC
pH	pH	6.5-9	7 < 9	NA	7.8	8.01	8.7	8.7	7.99	7.92	8.05	8.05	0%
Total Suspended Solids	mg/L	NC	NC	1.0	2.7	NA	270	300	0.5	0.46	4.0	3.3	NC
Alkalinity (PP as $CaCO_3$)	mg/L	NC	NC	0.50	<0.50	<0.50	3.6	3.9	<0.50	<0.50	<0.50	<0.50	NC
Alkalinity (Total as $CaCO_3$)	mg/L	NC	60 < 225	0.50	170	110	130	130	160	160	140	140	0%
Bicarbonate (HCO_3)	mg/L	NC	NC	0.50	200	130	150	140	190	190	170	170	0%
Carbonate (CO_3)	mg/L	NC	NC	0.50	<0.50	<0.50	4.3	4.7	<0.50	<0.50	<0.50	<0.50	NC
Hydroxide (OH)	mg/L	NC	NC	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NC
Dissolved Sulphate (SO_4)	mg/L	100	355	1.0	8.6	130	12	12	190	200	56	59	5%
Dissolved Chloride (Cl)	mg/L	120	37	1.0	5.7	22	7.1	7.2	18	19	5.3	6.7	23%
Nitrite (N)	mg/L	0.06	NC	0.003/0.010	<0.010	<0.0030	<0.010	<0.010	<0.0030	0.0050	<0.010	<0.010	NC
Nitrate (N)	mg/L	13	3	0.003/0.010	1.6	0.31	0.38	0.39	1.0	1.0	1.8	1.9	5%
Calculated Parameters													
Hardness (CaCO3)	mg/L	NC	555	0.50	190	260	120	120	370	390	210	220	5%
Ion Balance	NA	NC	NC	NA	1.0	1.0	0.96	0.97	1.0	1.0	2.9	5.0	*53%*
Dissolved Nitrate (NO3)	mg/L	NC	NC	0.044	7.2	1.4	1.7	1.7	4.6	4.6	7.9	8.4	6%
Nitrate plus Nitrite (N)	mg/L	NC	3	0.0140	1.6	0.31	0.38	0.39	1.0	1.0	1.8	1.9	5%
Dissolved Nitrite (NO2)	mg/L	NC	NC	0.033	<0.033	<0.0099	<0.033	<0.033	<0.0099	0.016	<0.033	<0.033	NC
Total Dissolved Solids	mg/L	NC	NC	10	190	300	150	140	430	450	220	240	9%

Notes:

1 = Table 1: Federal Interim Groundwater Quality Guidelines, Generic Guidelines for Residential/Parkland Land Use, Tier 1, Lowest Guideline for coarse grained soils.

NA = Not Applicable
NC = No Criteria
RDL= Reportable Detection Limit
RPD = Relative Percent Difference
200 Exceeds selected guideline.
20 Exceeds Upper Limit of Acceptability (ULA)

Table 15
Groundwater Chemical Concentrations - Inorganic Parameters
PIN-D, Ross Point, Nunavut

Sample #	Date	Metals (µg/L)														
		Total														
		Al	As	Cd	Co	Cr	Cu	Fe	Ni	Pb	Se	Zn	Al	As	Cd	Co
Surface Water Samples																
MW2 (2013)	2013	33	0.194	0.008	0.36	1.50	7.29	41	6.0	0.13	0.23	0.64	28	0.15	0.013	0.37
MW3 (2013)	2013	21	0.131	0.012	0.19	<0.10	3.11	23	1.9	0.1	0.36	1	17.30	0.134	0	0
MW1 (2015)	2015	11	0.260	<0.020	<0.3	<1	3.2	<60	1.5	0.26	<0.2	9	4.30	<0.2	<0.020	<0.3
MW2 (2015)	2015	4000	3.400	0.07	3	3	15	7100	4.5	9.80	0.38	50	7.30	0	<0.020	<0.3
MW3 (2017)	2017	11	0.570	<0.020	<0.30	1.3	3	570	2.3	2.8	<0.20	37	4.70	<0.20	<0.020	<0.30
Statistics																
N Value		5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
N Value [2013-2015 only]		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Average		815.24	0.91	0.02	0.71	1.29	6.26	1552.70	3.24	2.62	0.23	19.54	12.30	0.16	0.01	0.21
Average [2013-2015 only]		1016.30	1.00	0.03	0.85	1.29	7.15	1798.38	3.48	2.57	0.27	15.17	14.20	0.17	0.01	0.22
Minimum		11	0.131	0.008	0.15	0.05	2.7	22.8	1.5	0.101	0.1	0.64	4.3	0.1	0.01	0.15
Maximum		4000	3.4	0.074	2.7	3.1	15	7100	5.98	9.8	0.38	50	27.9	0.31	0.013	0.371
Standard Deviation (s)* [2013-2015 only]		1989.2	1.6	0.0	1.2	1.4	5.6	3534.4	2.1	4.8	0.1	23.5	10.7	0.1	0.0	0.1
Acceptable Range (Average +/- 3s)		0 < 6984	0 < 5.8	0 < 0.12	0 < 4.6	0 < 5.3	0 < 24	0 < 12402	0 < 10	0 < 17	0 < 0.65	0 < 86	0 < 46	0 < 0.45	0 < 0.017	0 < 0.53

One half the detection limit is used for calculations 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 15
Groundwater Chemical Concentrations - Inorganic Parameters
PIN-D, Ross Point, Nunavut

Dissolved							Inorganic Parameters (mg/L)										
Cr	Cu	Fe	Ni	Pb	Se	Zn	Alkalinity	Conductivity (uS/cm)	Hardness	Total Dissolved Solids	Fluoride (F-)	pH (Lab)	Dissolved Sulphate (SO4)	Dissolved Chloride (Cl)	Nitrite (N)	Nitrate (N)	Nitrate + Nitrite
<0.10	2.02	1.6	3.47	0.02	0.24	2.7	110	520	260		0.061	8.01	130	22	<0.0030	0.31	0.31
<0.10	2.63	3.70	1.86	0.014	0.34	2.1	160	730	370	500	<0.050	7.99	190	18	<0.0030	1	1
<1	1.50	<60	1.00	<0.2	<0.2	8	170	370	190	190	<0.050	7.79	8.6	5.7	<0.010	1.6	1.6
<1	1.30	<60	<0.5	<0.2	<0.2	<3	130	270	120	150	0.066	8.69	12	7.1	<0.010	0.38	0.38
<1.0	1.60	<60	1.60	<0.20	<0.20	33	140	380	210	220		8.05	56	5.3	<0.010	1.8	1.8
5	5	5	5	5	5	5	5	5	5	4	4	5	5	5	5	5	5
4	4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	4
<0.5	1.81	19.06	1.64	0.07	0.18	9.46	142.00	454.00	230.00	265.00	0.04	8.11	79.32	11.62	<0.005	1.02	1.02
<0.5	1.86	16.33	1.65	0.06	0.19	3.58	142.50	472.50	235.00	280.00	0.04	8.12	85.15	13.20	<0.005	0.82	0.82
<0.05	1.3	1.6	0.25	0.014	0.1	1.5	110	270	120	150	0.025	7.79	8.6	5.3	<0.0015	0.31	0.31
<0.5	2.63	30	3.47	0.1	0.337	33	170	730	370	500	0.066	8.69	190	22	<0.005	1.8	1.8
NC	0.6	15.8	1.4	0.0	0.1	3.0	27.5	200.1	106.6	191.6	0.0	0.4	89.8	8.0	NC	0.6	0.6
NC	0 < 3.6	0 < 64	0 < 5.8	0 < 0.202	0 < 0.54	0 < 13	60 < 225	0 < 1073	0 < 555	0 < 855	0 < 0.11	7 < 9	0 < 355	0 < 37	NC	0 < 2.6	0 < 2.6

FIGURES

Figures 1 and 2

Legend

Title: Site Location

ARCADIS

Project: PIN-D 100347-002

Date: October 2017

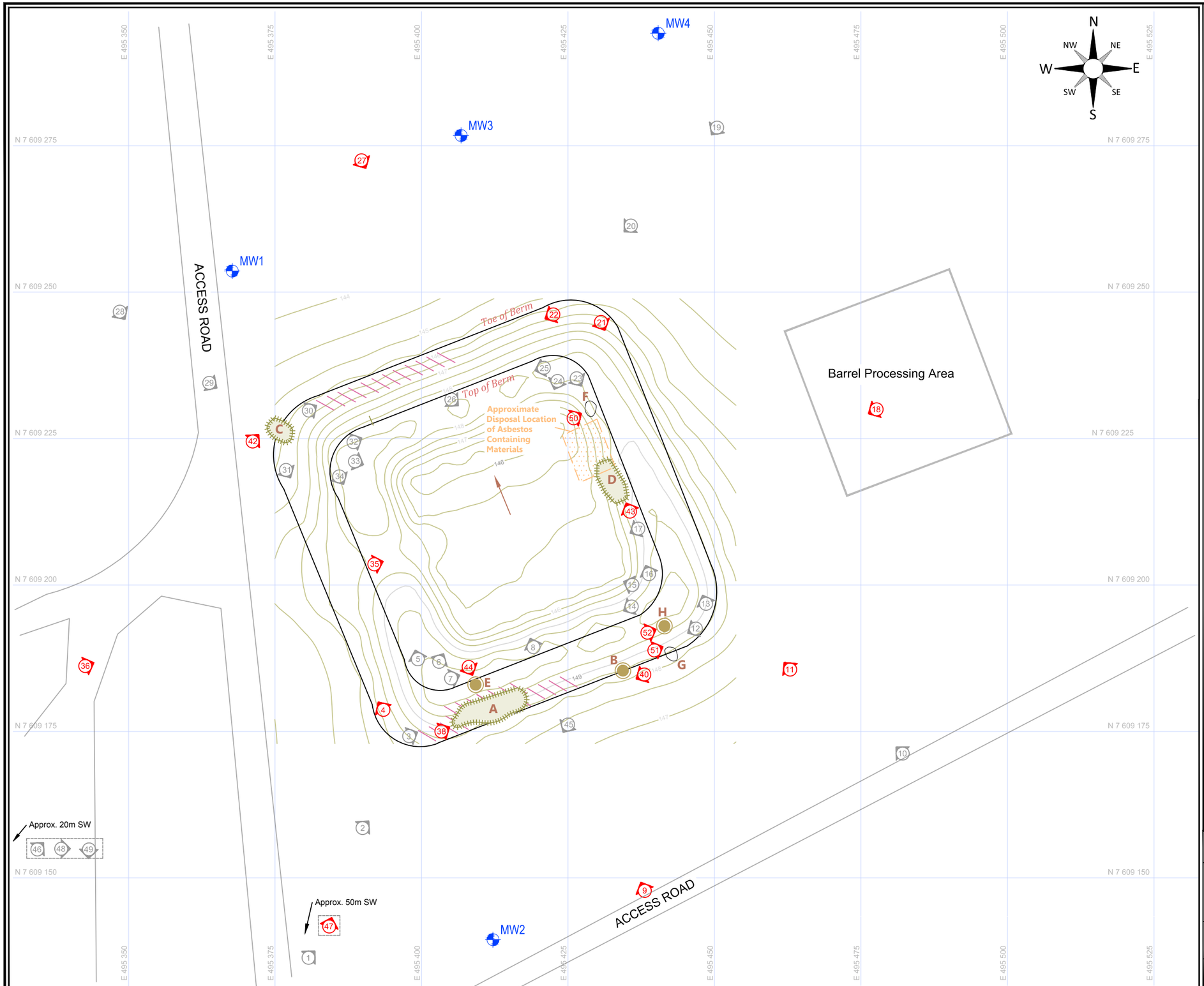
Client: Indigenous and Northern Affairs Canada

Metres
50,000 0 50,000 100,000
1:5,000,000

Figure 1

last saved by:dlogan on 24-Oct-17

Z:\Projects\2017\100347-002 INAC LTM\PIN-D\FIGURES\1-CAD\PIN-D 2017 Monitoring.dwg(layout)



Legend

- MW — Monitoring Well Locations
- 25 — Picture Viewpoint Number
- 8 — Viewpoint Photograph Included in Appendix B
- A — Settlement or Depression
- Pothole
- Mound
- A — Feature Reference Letter
- Slope Direction (based on visual observations - see note below)
- Poorly graded areas - large marks left by grader

Note:
Contours obtained from PIN-D, Ross Point; Final Interim Construction Summary (AECOM, April 10, 2012). The survey was conducted in 2011, following NHWL construction. The contour lines are inconsistent with field observations made in 2017.

Note:
Viewpoint numbers refer to photograph names as they appear on the attached cd-rom.

Title: Non-Hazardous Waste Landfill

ARCADIS

Project: PIN-D 100347-002

Date: October 2017

Client: Indigenous and Northern Affairs Canada

Metres 7.5 0 7.5 15 — 1:650

Figure 2

last saved by:dlogan on 28-Nov-17

Z:\Projects\2017\100347-002 INAC LTM\PIN-D\FIGURES\1-CAD\PIN-D 2017 Monitoring.dwg(layout)

APPENDIX A

Site Photographs

Project Photographs

Long Term Monitoring, 2017
PIN-D, Ross Point, Nunavut

Photo: 1

Date:
August 2, 2017

Description:
South side of the NHWL

Location:
Viewpoint 9 (Figure 2)

Direction Taken:
N

Photo: 2

Date:
August 2, 2017

Description:
Along SE berm of the NHWL. Settlement/pothole (Feature B) visible in foreground. Most dense area of vegetation at the NHWL.

Location:
Viewpoint 40 (Figure 2)

Direction Taken:
SW

Project Photographs

Long Term Monitoring, 2017
PIN-D, Ross Point, Nunavut

Photo: 3

Date:
August 2, 2017

Description:
East side of the NHWL
Location:
Viewpoint 18 (Figure 2)
Direction Taken:
W

Photo: 4

Date:
August 2, 2017

Description:
Along northeast berm of NHWL
Location:
Viewpoint 21 (Figure 2)
Direction Taken:
SE

Project Photographs

Long Term Monitoring, 2017
PIN-D, Ross Point, Nunavut

Photo: 5

Date:
August 2, 2017

Description:
North side of the NHWL.
Location:
Viewpoint 27 (Figure 2)
Direction Taken:
S

Photo: 6

Date:
August 2, 2017

Description:
Northwest berm of the NHWL.
Location:
Viewpoint 22 (Figure 2)
Direction Taken:
E

Project Photographs

Long Term Monitoring, 2017
PIN-D, Ross Point, Nunavut

Photo: 7

Date:
August 2, 2017

Description:
West side of the NHWL.
Location:
Viewpoint 36 (Figure 2)
Direction Taken:
E

Photo: 8

Date:
August 2, 2017

Description:
Along the southwest berm of the NHWL.
Location:
Viewpoint 4 (Figure 2)
Direction Taken:
NW

Project Photographs

Long Term Monitoring, 2017
PIN-D, Ross Point, Nunavut

Photo: 9

Date:
August 2, 2017

Description:
View of grading on surface of NHWL.

Location:
Viewpoint 35 (Figure 2)

Direction Taken:
E

Photo: 10

Date:
August 2, 2017

Description:
View of depression on southwest corner of NHWL (Feature A). Also poorly graded.

Location:
Viewpoint 38 (Figure 2)

Direction Taken:
E

Project Photographs

Long Term Monitoring, 2017
PIN-D, Ross Point, Nunavut

Photo: 11

Date:
August 2, 2017

Description:
View of pothole at southwest corner of the NHWL (Feature E), **Location:**
Viewpoint 44 (Figure 2)
Direction Taken:
S

Photo: 12

Date:
August 2, 2017

Description:
View of depression on northwest corner of NHWL (Feature C).
Location:
Viewpoint 42 (Figure 2)
Direction Taken:
SE