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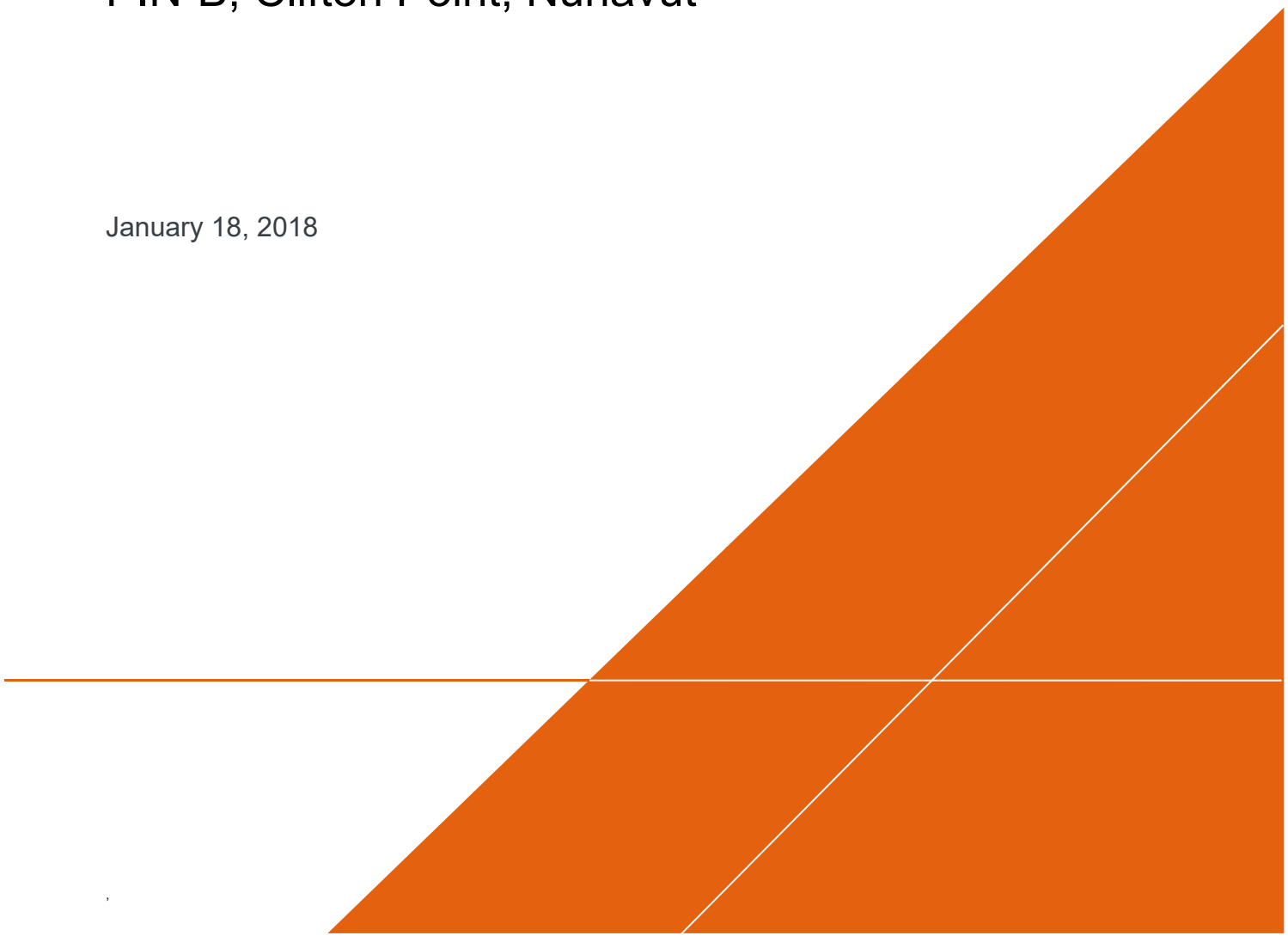
Indigenous and Northern Affairs Canada – Nunavut Regional Office

LONG TERM MONITORING, 2017

PIN-B, Clifton Point, Nunavut

January 18, 2018



LONG TERM MONITORING, 2017

PIN-B, Clifton Point, Nunavut

Alisha Williamson, C. Tech

Field Assessor

Steven Hannington, B.Sc., EPt

Field Assessor

Stephanie Joyce, M.Sc., C.Chem.

Project Manager

Troy Austrins, P.Eng., PMP

Senior Reviewer

Prepared for:

Jean Allen

Contaminants Specialist

Indigenous and Northern Affairs Canada – Nunavut Regional Office

969 Qinugiuk Building, 2nd Floor

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

INAC	Indigenous and Northern Affairs Canada
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
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	Indian Affairs and Northern Development
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 7 of the long-term monitoring (LTM) activities planned for the former Distant Early Warning (DEW) Line site PIN-B. This was the fourth monitoring event to occur at PIN-B. This project was completed under INAC Standing Offer Number 4600000861, Order number 4500365458.

The site is approximately 1.5 km inland from the Amundsen Gulf on the mainland in the westernmost part of Nunavut. It once contained a five-module building train, a warehouse, a garage, a small house for Inuit staff, a petroleum, oil and lubricants storage facility with associated distribution system, and a felled radar tower. Site buildings were demolished and environmental impacts remediated in 2009-2010.

The 2017 LTM program was carried out at the site on August 3, 2017. The landfill monitoring program consisted of a visual inspection of the Non-Hazardous Waste Landfill (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 two small animal burrows on the slope of the north corner; two drainage pathways on the southwest and southeast sides; and, five minor settlement areas, three of which were new in 2017. The minor settlement areas are located along the northeast berm and surface of the NHWL. None of these features are considered to have any significant impact on the integrity or performance of the NHWL.

During remediation (2009-2010), four monitoring wells were installed at the site to allow for active layer water monitoring. During the 2017 LTM program, Arcadis collected groundwater samples from two of the wells; there was insufficient water in the remaining wells for sample collection. Using results from 2013 and 2015 (a total of three 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. The groundwater results from 2017 exhibited concentrations of aluminum, arsenic, copper, cadmium, chromium, iron, silver and zinc above the Federal Interim Groundwater Quality Guidelines (FIGQGs). When compared to previous results from 2013 and 2015, no obvious trends were noted (i.e. parameter concentrations were not consistently higher or lower in 2017 when compared to previous results). It is worth noting that a groundwater sample was collected in 2017 from monitoring well MW2. This is the first time a groundwater sample has been collected from this monitoring well. Analytical results report much higher concentrations of total metals for the sample collected from monitoring well MW2 than previously reported. This is likely attributed to the fact the sample submitted for MW2 consisted of purge water, as the monitoring well went dry during sampling. 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 Lake, Beach, Mid- and Upper Station Areas were also observed and found to be in good condition. Physical evidence, supported by interviews with persons with firsthand knowledge of the site and with members of the nearby community's Hunters and Trappers Organization, indicate that wildlife continues to frequent this site but due to the distance to nearby communities, people do not.

This executive summary should be read in conjunction with the main report and is subject to the same limitations described in Section 8.0.

1 INTRODUCTION

Arcadis Canada Inc. (Arcadis) was retained by Indigenous and Northern Affairs Canada (INAC) to conduct long-term monitoring (LTM) activities at the former Distant Early Warning (DEW) Line site PIN-B, Clifton 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-B and was prepared in accordance with the Arcadis proposal 510264-000 dated May 16, 2017.

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

1.1 Project Objectives

LTM of the PIN-B 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 7, the first of three planned monitoring events in Phase 2 of the monitoring program for the PIN-B site, as described in the PIN-B (Clifton Point) LTM Plan (INAC, 2011). Monitoring included visual observations, chemical analyses of soil and groundwater (where warranted 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-B LTM Plan, dated April 15, 2011, 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 wells;
    - Taking photographs to document the condition of the NHWL and substantiate the recorded observations.
2. Active Layer Water Monitoring, including
    - Collecting 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 sampling (as required)
    - Collecting soil samples at locations where seepage or staining was identified as part of the visual inspection.
4. Natural Environment Monitoring, including
    - Collecting 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 fulfill the scope:

a) Review of the PIN-B LTM Plan, previous LTM reports for PIN-B and the *Abandoned Military Site Remediation Protocol* (AMSRP, INAC, 2009);
b) Preparation of a health and safety plan;
c) Preparation of a sampling plan for soil and groundwater;
d) Collection of groundwater level data and observation of monitoring well condition at the site;
e) Collection of groundwater and soil samples (if applicable);
f) Visual inspection, measurement and photo documentation of the site;
g) Interviews with local residents and officials to understand land use and wildlife trends; and
h) Preparation of a report.

2 BACKGROUND INFORMATION

2.1 Site Description

According to the PIN-B LTM Plan (INAC, 2011), the PIN-B Intermediate DEW Line Site was constructed in 1957 and closed and abandoned in 1963. The site comprised a five-module building train, a warehouse, a garage, a small house for Inuit staff, a petroleum, oil and lubricants (POL) storage facility with associated distribution system, and a felled radar tower. In addition to the main station facilities, a cargo handling area was constructed at the beach area. A second POL storage facility was also located at this beach area (INAC, 2011).

Two airstrips were constructed at the site: the primary airstrip (approximately 1 km long), located south of the beach area, and a second airstrip northwest of the main strip with a length of 300 m. Gravel roads were built linking the airstrip, the site's water supply lake and the beaching area with the main station area. A small construction camp was erected during the building of the site facilities but was demolished once construction was completed. The former camp of an Inuit family is located approximately 1.5 km south of the site (INAC, 2011).

A NHWL was constructed at the site between 2009 and 2010. Final remediation activities were completed and the NHWL was closed on August 18, 2010. The NHWL was designed to contain non-hazardous materials only. It is situated approximately 1.5 km from the shore of Admundsen Gulf. It was reportedly constructed on native ground surface (elevation: approximately 30 m above mean sea level) with the organic matter stripped and consists of four perimeter berms constructed of granular material. 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. The layers were compacted and a final cover consisting of a minimum of 1.0 m of granular fill was used to cap the landfill (INAC, 2011). The NHWL at PIN-B contains the following types of waste:

- Soil impacted with petroleum hydrocarbon (PHC) fractions F3 and F4;
- Non-hazardous demolition debris, such as timbers, plywood, and sheet metal;
- Non-hazardous site debris, such as scrap metal and wood;
- Non-hazardous debris/soil excavated from landfills;
- 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).

The area has been reported not to be used by hunters and fishermen from the nearby community of Kugluktuk, and is likely to be infrequently visited by persons from other communities in the region. A surface water sample collected from the Drinking Water Lake in 2007 suggests that some chronic inputs

of inorganic elements may have occurred over time; however, contaminant levels were reported to be low and no significant impacts were identified.

2.2 Previous Monitoring Programs

The 2017 monitoring program at PIN-B was the fourth (Year 7) 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-B, Clifton Point, Nunavut* dated January 20, 2015 by Arcadis (formerly Franz Environmental Inc.);
- *Long Term Monitoring, 2013, PIN-B, Clifton Point, Nunavut*, dated January 20, 2014 by Arcadis (formerly Franz Environmental Inc.);
- *Long Term Monitoring, 2011, PIN-B, Clifton Point, Nunavut* dated January 17, 2012 by Arcadis (formerly Franz Environmental Inc.);
- *PIN-B (Clifton Point) Long-Term Monitoring Plan* dated April 15, 2011 by Indian and Northern Affairs Canada; and
- *Abandoned Military Site Remediation Protocol* dated March 2009 by Indian and Northern Affairs Canada, Contaminated Sites Program.

3 REGULATORY AND OTHER GUIDELINES

3.1 Guidelines Review

Arcadis reviewed the PIN-B, Clifton Point, LTM Plan and 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-B 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 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 2 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	

Geochemical Assessment	Acceptable	Marginal	Significant	Unacceptable
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 fourth monitoring event at PIN-B, and the first in Phase II of the LTM Plan, to be implemented within the first 25 years. Three groundwater samples had been collected prior to 2017; one in 2013 and two in 2015. 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. 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 Interim Groundwater Quality Guidelines

In May 2010, Environment Canada (EC) under the 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. 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, Environment Canada 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-effects 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-B DEW Line site on August 3, 2017 by field assessors Steve Hannington and Alisha Williamson of Arcadis. Wildlife monitoring services were provided by a representative from the Kugluktuk Hunters and Trappers Organization, in Kugluktuk, NU. During the field investigations, weather conditions were overcast, with scattered showers, slight wind, and approximately 15 ºC. 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;
- Collection of groundwater samples from existing wells (if possible);
- Collection of 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 (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 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 HASP was brought to site by Arcadis and INAC personnel. 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 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 landfill. Definitions for completing the checklist are found in Table 2 (below). A visual monitoring checklist, presented in the PIN-B LTM Plan, was completed for the landfill and is found in Table 3 and Table 4 in Section 5.3. A photographic record was completed to document the condition of the structures and substantiate the visual observations (Appendix A).

Table 2: Preliminary Visual Inspection 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 inspection was conducted with the aid of a Trimble Pro XRT global positioning system (GPS) unit to locate features of note and to collect geographical 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 updated with any changes to previous features and addition of any new features. The Trimble files are included in the CD ROM (Attachment 1) 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 (caribou, Canada goose, falcon, and arctic ground squirrel), other evidence of wildlife (e.g., droppings, tracks, feathers/fur), 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 Kugluktuk Hunters and Trappers Organization in Kugluktuk where land uses by humans and wildlife as well as changes over time were discussed. In addition, Arcadis interviewed the wildlife monitor (Kirk Kapakatoak), who, however, had limited first-hand knowledge of the area.

4.4 Groundwater Sample Collection

Upon arrival at the PIN-B site, the Arcadis field assessors made an attempt to measure groundwater levels at each of the wells. Using a water level tape, the field assessors found that two of the monitoring wells, MW2 and MW3, contained groundwater; while the two other monitoring wells were dry.

A peristaltic pump was used to purge the monitoring wells prior to sample collection. Wells were purged of three well volumes except where poor recharge rates made it necessary to sample sooner. A YSI 556 water quality meter was calibrated and used to measure *in situ* field parameters including temperature, conductivity, dissolved oxygen, pH and oxidation-reduction potential. As groundwater recharge rates have historically been very slow at this site, measurement of these parameters occurred during sample collection. Water samples submitted for dissolved metals analyses were field-filtered.

As a precaution, purge water from each monitoring well was bottled. In the event that insufficient water was present to fill all sample bottles following purging, these purge water samples could be submitted for analysis. This was the case with the sample collected from monitoring well MW2. There was only sufficient water to fill the total metals bottle. As metal exceedances are known to be present at the site, total metals analysis was considered to be the priority.

Approximately one litre of water was purged from monitoring well MW3 prior to sampling. Sample MW3 was submitted for analysis of various parameters: total and dissolved metals; PCBs; PHCs; benzene, toluene, ethylbenzene and total xylenes (BTEX); suspended and dissolved solids; major ions; hardness;

pH and conductivity. A duplicate sample was also collected from monitoring well MW3. Each sample was collected in the appropriate sample containers supplied by the testing laboratory which were 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 C. Chain of custody forms are provided in Appendix B.

4.5 Soil Sample Collection

There were no indications of seepage or staining as part of the visual inspection 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 soil 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 vessels. 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 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 B.

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

4.6.2 Laboratory

The selected laboratory, Maxxam Analytics (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

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 B.

5 NON-HAZARDOUS WASTE LANDFILL

5.1 Area Summary

The NHWL is located at the Main Station Area, approximately 1.5 km southwest of the Beach Area, at an elevation of 30 m above mean sea level (see Figure 1). The coordinates of the landfill are 69º12'16.778"N and 118º37'59.675"W. The monitoring of the landfill included visual observations to assess its physical integrity, including evidence for erosion, ponding, frost action, settlement and lateral movement. Groundwater samples were collected from two of the previously installed monitoring wells at the NHWL (monitoring wells MW2 and MW3; the sample from monitoring well MW3 was analysed for total metals only). Due to insufficient sample volumes in MW1 and MW4, groundwater samples could not be collected from the remaining wells. Soil samples were deemed unnecessary by the Arcadis field assessors. The visual inspection report, including supporting photos and drawing, 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 1 to 73, Attachment 1: 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 CD-ROM (Attachment 1). Note that in this report, Photo numbers refer to the selected photos in Appendix C and Viewpoint numbers refer to the photos on the CD-ROM (Attachment 1).

5.3 Visual Inspection Checklist

The physical integrity of the NHWL was assessed by collecting visual evidence of erosion, ponding, frost action, settlement and lateral movement. A plan view of the NHWL indicating photographic viewpoints, salient observations and locations of ground water monitoring wells can be seen in Figure 2, attached to the end of the report. The visual monitoring checklist provided in the PIN-B LTM Plan has been completed and pertinent information is summarized in Table 4 of this report. Table 3 presents the preliminary visual inspection results for the NHWL at PIN-B.

Table 3: Preliminary Visual Inspection 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 Borrows	Y	Acceptable	Occasional
Vegetation	Y	Acceptable	Occasional
Staining	N	Not Observed	None
Vegetation Stress	N	Not Observed	None
Seepage / Ponded Water	N	Not Observed	None
Drainage Pathway	Y	Acceptable	Occasional
Debris Exposure	N	Not Observed	None
Monitoring Well Condition	N	Good condition - Acceptable	
Overall Landfill Performance		**Acceptable**	

Settlement

Two, previously observed, minor depressions were again observed in the area of the NHWL. The one small depression on the surface of the landfill at the southeast corner is still present (Feature D, Table 4). This depression appears to be the result of final grading. A second small depression, noted on the northeast side berm of the landfill, was also still present (Feature E, Table 4). This appears to be the result of settlement. Both features are considered minor in scale (<0.1 m deep) and no changes were noted when compared to the 2015 observations.

Three, newly observed, minor depressions were noted along the surface of the NHWL. The small depressions were noted along the southeast corner (Feature G, Table 4), the southwest surface edge (Feature H, Table 4), and the northwest surface edge (Feature I, Table 4). All newly observed settlement features are considered to be minor in scale (<0.1 m deep).

Erosion

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

Frost Action

No indication of frost action was observed in the area of the NHWL.

Evidence of Burrowing Animals

Evidence of a burrowing animal was still present on the slope in the north corner of the NHWL (Feature A, Table 4). In 2015, it appeared as though an animal had dug a small burrow and deposited the soil to one side, exposing larger cobbles (Photo 7, Appendix A). The length and width of the animal burrow appears to have decreased but the depth has slightly increased, to 0.6 m deep, compared to the observations made in 2015. Arctic ground squirrel droppings were observed adjacent to the burrow (Photo 9, Appendix A). The integrity of the NWHL has not been impacted by the burrow.

A second animal burrow, or attempted burrow (Feature F) was noted in 2015. This was located in the same corner of the NHWL as the previously-noted burrow, but approximately 1.5 m up-slope. This partial burrow was slightly wider, but shallower, with noted dimensions of 0.6 m long, 0.4 m wide and 0.2 m deep. The attempted animal burrow remains unchanged and was partially filled in with the surrounding material by Arcadis personnel (Photo 8, Appendix A).

Re-establishment of Vegetation

Based on the regional setting of this landfill, full re-establishment of vegetation will likely take a significant amount of time. Increased growth of vegetation was noted on all four sides of the NHWL (Photo 21 and 22 Appendix A). Very minor vegetation is scattered along the NHWL surface. (Photos 23 Appendix A).

Staining

No staining was observed in the area of the NHWL.

Seepage Points

Seepage was not observed during the NHWL inspection.

Debris

Exposed debris was not observed.

Drainage Pathways

Two drainage pathways were again noted during the NHWL inspections that have remained unchanged since 2011. One was observed on the southeast side of the landfill (Feature C, Table 4) and one on the southwest side (Feature B, Table 4). Both drainage pathways appeared to be natural features of the topography in the area (Photo 11 and 12, Appendix A). Erosion does not appear to be taking place in these drainage pathways, therefore the physical integrity of the NHWL has not been impacted.

Discussion

All physical observations suggest that the NHWL is performing as designed and is containing the enclosed waste. Care should be taken during future monitoring events to observe the condition of the current animal burrow (Feature A) at the northern corner of the NHWL for increased size and depth and the potential of exposure of landfill debris.

Table 4, on the next two pages, summarizes the results of the visual inspection.

Table 4: PIN-B, Clifton Point – Visual Monitoring Checklist

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Viewpoint Reference
Animal Burrow	A	On slope of northern corner of the NHWL	0.35	0.25	0.6	<1%	Animal burrow exposing larger cobbles. Depth slightly increased from 0.35 to 0.6 m.	Does not affect the landfill integrity at this point	45
Drainage Pathway	B	On southwest side of NHWL, draining in a SW direction towards MW2	25	0.5	0.1	<1%	Minor drainage pathway originating from NHWL, running towards SW	Feature appears natural. Does not affect the landfill integrity at this point	46
Drainage Pathway	C	On southeast side of NHWL, draining in a SE to SW direction towards MW3	24	0.6	0.25	<1%	Drainage pathway originating from the base of the SE side of the NHWL	Feature appears natural. Does not affect the landfill integrity at this point	47
Settlement	D	On surface of NHWL at southeast corner	2	0.75	0.1	<1%	Minor depression on surface of landfill, appears to be result of grading	Feature identified in 2013. Feature appears mechanical. Does not affect the landfill integrity at this point	58
Settlement	E	On slope of northeast corner of NHWL	1	1	0.1	<1%	Minor depression on berm of landfill, appears to be slight settlement	Feature identified in 2013. Does not affect the landfill integrity at this point	5
Animal Burrow	F	On slope of north corner of landfill	0.6	0.4	0.1	<1%	Attempted animal burrow that exposes some larger cobbles	Feature identified in 2015. Does not affect landfill integrity at this point.	50/51/52/53

Checklist Item	Feature Letter	Relative Location	Length (m)	Width (m)	Depth (m)	Extent	Description (Change)	Additional Comments	Viewpoint Reference
Settlement	G	On surface of southeast corner of NHWL	2.5	1	0.1	<1%	Minor depression on surface of landfill, appears to be result of grading	Feature appears mechanical. Does not affect the landfill integrity at this point	54
Settlement	H	On surface of NHWL along northwest edge	1	0.5	0.1	<1%	Minor depression on surface of landfill, appears to be result of grading	Feature appears mechanical. Does not affect the landfill integrity at this point	55
Settlement	I	On surface of NHWL along southwest edge	2	1	0.1	<1%	Minor depression on surface of landfill, appears to be result of grading	Feature appears mechanical. Does not affect the landfill integrity at this point	56/57

5.4 Analytical Results – Groundwater

5.4.1 Results

As described in Section 4.4, three groundwater samples, including one duplicate, were submitted to Maxxam Analytics in Edmonton and Calgary, Alberta for analyses of PHCs, metals, PCBs and inorganic parameters. Analytical results are discussed below. Using results from 2013 and 2015 (a total of three groundwater samples collected), ULAs were calculated for total and dissolved metals and inorganic parameters. There was insufficient historical information to calculate ULAs for other parameters. Laboratory certificates of analyses for the 2017 groundwater samples are provided in Appendix B.

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 5: MW3 Physical Parameters

Time	Temperature (°C)	pH	ORP (mV)	DO (mg/L)	Conductivity (mS/cm)
11:47 AM	8.56	8.49	61.3	12.94	0.362
11:52 AM	6.69	8.48	64.9	12.28	0.351
11:57 AM	6.63	8.46	64.6	12.19	0.347
12:02 PM	6.61	8.45	61.8	12.24	0.339
12:07 PM	6.60	8.45	60.6	12.23	0.338
12:15 PM	Sample Collected – approximately 0.5 L of purge volume				

Table 6: MW2 Physical Parameters

Time	Temperature (°C)	pH	ORP (mV)	DO (mg/L)	Conductivity (mS/cm)
11:12 AM	12.12	-	34.0	8.58	0.675
11:17 AM	Well went dry – collected sample from purge water				

PHCs

Analytical results for PHCs are shown in Table 7. Concentrations for all BTEX/PHC parameters were reported below laboratory detection limits. This is similar to previous results.

There were no exceedances to be noted of the FIGQGs. This is also similar to previous results.

Metals

Analytical results for dissolved and total metals in groundwater are shown in Tables 8 and 9. 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 analytical results for the sample collected from monitoring well MW3 exhibited low concentrations of several total and dissolved metals. Higher total metal concentrations were measured in the sample collected from monitoring well MW2. The following exceedances of the FIGQGs were noted:

- Concentrations of total aluminium, total arsenic, total cadmium, total chromium, total copper, total iron, total silver and total zinc are greater than the FIGQG in sample MW2; and
- Sample MW3 exhibited concentrations of total and dissolved zinc concentrations greater than the FIGQG.

The following exceedances of the ULAs were noted:

- The sample collected from monitoring well MW2 exhibited concentrations of aluminium, arsenic, cadmium, chromium, copper, iron, lead, nickel and selenium greater than the calculated ULA.

The sample collected from monitoring well MW2 exhibited numerous metal exceedances at higher concentrations than have been reported in samples from previous years. This may be due to the fact that the sample constitutes purge water, and not fresh groundwater. Purge water may have been stagnant in

the monitoring well for a period of time and undergone changes that alter the water quality. The concentration of total and dissolved metals may be affected.

At this time, these exceedances of the FIGQGs and ULAs are not an immediate concern; however metal concentrations measured in groundwater samples should continue to be monitored. In particular, groundwater samples collected from monitoring well MW2 would be useful, to provide additional data regarding the groundwater quality in this well.

PCBs

Analytical results for PCBs in groundwater are shown in Table 10. Concentrations for all PCB parameters were reported below the laboratory detection limit. This is similar to previous results. The FIGQGs do not specify guidelines for PCBs.

Inorganics

Laboratory analytical results for inorganics are shown in Table 11. Concentrations of total suspended solids (TSS), alkalinity (PP as CO_3), carbonate (CO_3^-), hydroxide (OH^-) and nitrite (NO_2^-) were reported below the laboratory detection limit for the one sample collected. All other inorganic and calculated parameter concentrations measured were above the laboratory detection limit but below the FIGQGs, where they exist. The pH of the sample collected from monitoring well MW3 was outside of the acceptable range based on historical samples collected (calculated to be 7.8 < 8.1). The reported pH of 8.11 (8.13 for the duplicate sample) is not considered abnormal and only slightly above the ULA. The narrow range of the limits of acceptability is likely due to low variance reported in the samples collected in 2013 and 2015.

5.4.2 Quality Assurance/Quality Control Results

A duplicate groundwater sample 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 reportable detection limit (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%.

All analytes tested for both the groundwater parent (MW3) and duplicate sample (DUP) reported acceptable RPDs with the exception of the total aluminum analysis, which reported an RPD of 95%. This difference can be attributed to the minor natural variations in the groundwater or the potential for a suspended solid within the groundwater sample. As the aluminum concentration in the parent and duplicate sample do not exceed the FIGQG and given the number of acceptable analytes tested, Arcadis does not consider the one variance reported to compromise the dataset. Analytical results are considered reliable.

6 SURROUNDING AREAS

Station Area

This area lies adjacent to the NHWL, and is the site of the former PIN-B Main Station (see Area 7, Figure 1). Prior to remediation, this area consisted of a five-module building train, a warehouse, a garage, an Inuit staff house, and a POL storage facility, a felled radar tower, a PCB temporary storage area and an outdoor wash house. In addition, three borrow source areas (borrow area 1A, 1B, and 4) existed close to the station area. Currently, four concrete pads are present in the area (Photo 10, Appendix A). The area has been completely graded and appeared in good condition at the time of the site visit. No changes nor anomalies were observed in 2017.

Beach Area

To the north of the NHWL lies the Beach Area (Figure 1), in which three distinct dump areas were previously identified (Areas 2, 3, and 4), as well as the main 1 km long airstrip. Just south of the airstrip is the site of the former petroleum hydrocarbon contaminated soil treatment area and a small abandoned airstrip, both of which have been re-graded. Three former borrow source areas (borrow areas 3, 6 and 7) were also identified at the Beach Area. These re-graded areas appear to be in good condition, with only one minor anomaly: a small erosion channel, attributed to a natural drainage pathway, was observed on the south side of the active airstrip; it does not have any significant negative impact to the re-graded area. Bird and animal tracks, as well as a falcon nest, were noted in this area (Photo 19, Appendix A). No changes were observed in 2017.

Station Dump Area

To the northwest of the NHWL, along the west side of the access road, lies the Station West Dump (Area 5, Figure 1). This area contained a small amount of site debris, a treatment lagoon, and a small surface water body (lake). A small stain (area < 1 m^2) along the access road with a slight PHC-like odour was observed in 2011, but has not been observed since. This was likely left by the re-grading machinery; it does not appear connected to the failure or malfunctioning of any former on-site facility. The area has been completely graded and appeared in good condition (Photo 24, Appendix A). No anomalies were observed.

Construction Camp Area

The Construction Camp Area is located just to the north of the NHWL between the Beach Area and the NHWL (Area 6, Figure 1). This camp was set up and used during the construction of the Station at the site. This area consisted of the camp and associated tents and buildings, two small dump areas and a barrel stockpile and washing area. Some poor grading was noted in the area (Photo 25, Appendix A). However, this area appeared in good condition and no anomalies were observed at the time of the site visit.

Access Road

The recently constructed road, used to access the Main Station area and NHWL from the airstrip (Beach Area), appeared to be in good condition. An additional trail/partial access road was also observed in good condition connecting the airstrip to the Main Station Area. Several animal burrows, nests, tracks, and droppings were observed along the access road (Photos 17, 18, and 26, Appendix A).

Surface Water Bodies

Four freshwater surface water bodies are present at the PIN-B site. The largest of these, located just northwest of the active airstrip, was used as the freshwater supply lake during the active years of the DEW Line site. Visual impacts to the freshwater surface water bodies were not observed at PIN-B in 2017.

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-B 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

According to observations by a member of the PIN-B remediation workforce present on-site over a nine-week period in 2010, some wildlife species that frequent the site include caribou, snow geese, Canada geese, grizzly bears, ground squirrels, and various birds. Evidence of human activities at the site was present but limited, and much was historical. Due to the large distance between the site and the nearest communities, it is not believed to be frequently visited or used by people. Limited human use of the PIN-B site was reported by the Kugluktuk Hunters and Trappers Organization, which responded that they and the local conservation office did not recall people from Kugluktuk using the site to hunt or fish recently. A former bear monitor, O.J. Bernhardt, believes that the area is infrequently used for hunting of caribou and muskox. When questioned in 2013, he indicated that the number of animals available for harvest has not changed in recent years.

During the 2017 site visit, the Arcadis field assessors observed two caribou (from the plane), arctic ground squirrel, and falcons. Evidence (e.g. scat, tracks, nesting areas, burrows or visual observation) that muskox, Canada geese, squirrels, lemmings, and owls have frequented the area was also present (Photos 17, 18, and 25, Appendix A). During previous site visits, evidence of loons, grizzly bears, black bears, wolverines, ravens, ducks and bunting birds were also observed on-site. A large raptor nest, presumed to be falcons, was observed at the Beach Area (Photo 19, Appendix A). The nest is moss covered and appears to be abandoned.

Re-establishment of Vegetation

Based on the regional setting of this site, re-establishment of vegetation is not likely in the near future. Increased vegetation was noted on all four sides of the NHWL, especially the southeast, southwest, and northeast sides (Photos 21 and 22, Appendix A). Minor vegetation was scattered along the surface of the NWHL (Photo 23, Appendix A).

8 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. Several settlement features have been observed over the years: two minor settlement areas have been previously observed and three new settlement features were identified in 2017. No changes were noted to the two previously identified settlement features. The settlement features appear to be the result of poor grading activities or minor settlement activities. All identified settlement features are minor in scale and do not appear to currently affect the integrity of the NHWL.

One current animal burrow and a second attempted animal burrow were observed on the north corner of the NHWL in 2015. The length and width of the current animal burrow had slightly decreased during the 2017 site visit, however, the depth of the animal burrow had increased. Arctic ground squirrel droppings were also present, adjacent to the current burrow. No changes were noted to the attempted animal burrow. Care should be taken during future monitoring events to observe the condition of the current animal burrow at the northern corner of the NHWL for increased size and depth and the potential of exposure of landfill debris.

Two drainage pathways were again noted during the NHWL inspections that have remained unchanged since 2011. One was observed on the southeast side of the landfill and one on the southwest side. Both drainage pathways appeared to be natural features of the topography in the area. Erosion does not appear to be taking place in these drainage pathways, therefore the physical integrity of the NHWL has not been impacted.

Groundwater samples were collected from two of the four monitoring wells (MW2 and MW3). However, MW2 went dry during purging activities and a sample was submitted from the purge water. The analytical results for the sample collected from monitoring well MW3 exhibited low concentrations of several total and dissolved metals. Higher total metal concentrations were measured in the sample collected from monitoring well MW2. The sample collected from monitoring well MW2 also exhibited concentrations of aluminum, arsenic, cadmium, chromium, copper, iron, lead, nickel and selenium greater than the calculated ULA. At this time, these exceedances of the FIGQGs and ULAs are not an immediate concern; however metal concentrations measured in groundwater samples should continue to be monitored.

Several surrounding areas including the station area, beach area, station dump area, construction camp, beach area, and several surface water bodies were visually inspected on foot. The surrounding areas appeared in good condition and no changes were observed. It is recommended to that a visual inspection of the surrounding areas continues to monitor the areas for any potential changes.

Based on the results of Year 7 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 seven 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 10) should be scheduled for 2020.

9 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 INAC.

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 3, 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.

10 REFERENCES

Canadian Council of Ministers of the Environment. 2016. Guidance Manual for Environmental Site Characterization in Support of Environmental and Human Health Risk Assessment, Volume I Guidance Manual.

Federal Contaminated Sites Action Plan Secretariat, November 2015 (Version 3). Guidance Document on Federal Interim Groundwater Quality Guidelines (FIGQG): 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-B, Clifton Point, Nunavut.

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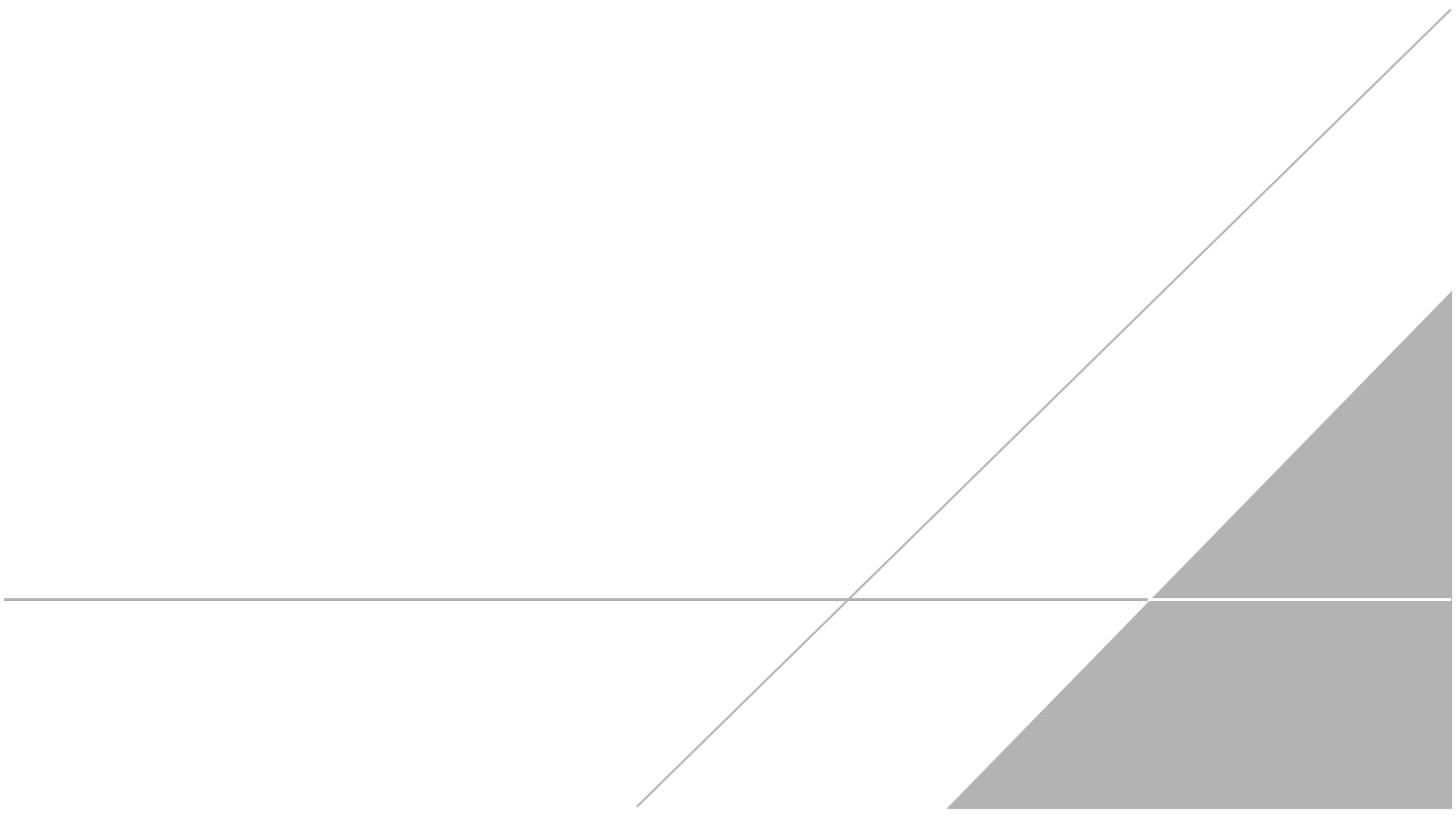
Indian and Northern Affairs Canada. April 15, 2011. *PIN-B (Clifton Point) Long-Term Monitoring Plan* (PIN-B LTM Plan, 2011).

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

TABLES

Tables 7 through 12



ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME FIGQGs[1]	RDL	MW1	MW3					RPD
			2015-07-24	2013-08-22	2015-07-24	24/07/2015 DUP	2017-08-03	2017-08-03 DUP	
BTEX & F1 Hydrocarbons (ug/L)									
Benzene	140	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	NA
Ethylbenzene	11000	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	NA
p+m-Xylene	NC	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	NA
F1 (C6-C10)	810	100	<100	<100	<100	<100	<100	<100	NA
F1 (C6-C10) - BTEX	NC	100	<100	<100	<100	<100	<100	<100	NA
F2-F4 Hydrocarbons (ug/L)									
F2 (C10-C16 Hydrocarbons)	1300	100	<100	<100	<100	<100	<0.10	<0.10	NA
F3 (C16-C34 Hydrocarbons)	NC	200	-	<200	-	-	<0.10	<0.10	NA
F4 (C34-C50 Hydrocarbons)	NC	200	-	<200	-	-	<0.20	<0.20	NA
Reached Baseline at C50	NC	NA	-	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

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME FIGQGs[1]	ULA	RDL	MW1	MW2	MW3					RPD
				2015-07-24	2017-08-03	2013-08-22	2015-07-24	DUP 24/07/2015	2017-08-03	2017-08-03 DUP	
Metals (µg/L)											
Aluminum (Al)	540*	608	0.5/3	320	**8300**	26.1	150	140	76	27	95.1
Antimony (Sb)	2000	NC	0.02/0.6	<0.60	1.3	0.08	<0.60	<0.60	<0.60	<0.60	NA
Arsenic (As)	5	0.8	0.02/0.2	0.51	**6.7**	0.19	0.28	0.3	0.31	0.29	NA
Barium (Ba)	500	NC	0.02/10	53	150	62.7	53	52	40	40	0.0
Beryllium (Be)	5.3	NC	0.01/1	<1	2.1	<0.01	<1.0	<1.0	<1.0	<1.0	NA
Bismuth (Bi)	NC	NC	0.005/5	<5	–	<0.005	<5	<5	–	–	NA
Boron (B)	1500	NC	50/20	23	79	<50	<20	<20	<20	<20	NA
Cadmium (Cd)	0.09	0.1	0.005/0.02	0.024	**0.24**	0.009	0.029	<0.020	<0.020	<0.020	NA
Calcium (Ca)	NC	NC	50/300	36000	54000	37700	36000	36000	27000	27000	0.0
Chromium (Cr)	8.9	1.0	0.10/1	<1	**32**	0.11	<1.0	<1.0	<1.0	<1.0	NA
Cobalt (Co)	NC	20	0.005/0.3	<0.30	6.0	0.045	<0.30	<0.30	<0.30	<0.30	NA
Copper (Cu)	10.8-21.6*	16	0.05/0.2	9.7	**280**	4.26	3.3	3.5	3.6	3.7	2.7
Iron (Fe)	300	640	1/60	330	**11000**	13.8	150	150.0	<60.0	<60.0	NA
Lead (Pb)	5.4-37.8*	0.9	0.005/0.2	0.44	**22**	0.05	0.38	0.4	0.2	<0.2	NA
Lithium (Li)	NC	NC	0.5/20	<20	24	1.73	<20	<20	<20	<20	NA
Magnesium (Mg)	NC	NC	50/200	14000	25000	24800	18000	18000	19000	19000	0.0
Manganese (Mn)	NC	NC	0.05/4	7.4	390	4.74	8.3	8.2	<4.0	<4.0	NA
Molybdenum (Mo)	73	NC	0.05/0.2	0.54	29	1.40	0.35	0.3	0.47	0.43	NA
Nickel (Ni)	664*	3.8	0.02/0.5	2.2	**56**	1.58	2.7	2.5	1.1	1.3	16.7
Phosphorus (P)	NC	NC	100	-	-	-	-	-	1100	1100	0.0
Potassium (K)	NC	NC	50/300	1300	29000	2110	860	850	1100	1100	NA
Selenium (Se)	1	0.8	0.04/0.2	<0.20	**0.86**	0.44	<0.20	<0.20	<0.20	0.2	NA
Silicon (Si)	NC	NC	100	1700	21000	1200	1300	1200	1000	1100	9.5
Silver (Ag)	0.25	NC	0.005/0.1	<0.10	2.5	<0.005	<0.10	<0.10	<0.10	<0.10	NA
Sodium (Na)	NC	NC	50/500	9400	140000	40200	18000	18000	15000	15000	0.0
Strontium (Sr)	NC	NC	0.05/20	53	330	69.5	90	90	41	41	NA
Sulphur (S)	NC	NC	3000/200	2200	25000	16500	3300	3400	2500	2500	0.0
Thallium (Tl)	0.8	NC	0.002/0.2	<0.20	<0.20	0.009	<0.20	<0.20	<0.20	<0.20	NA
Tin (Sn)	NC	NC	0.2/1	<1	3.6	<0.2	<1.0	<1.0	<1.0	<1.0	NA
Titanium (Ti)	100	NC	0.5/1	8.9	82	<0.5	3.1	2.6	<1.0	<1.0	NA
Uranium (U)	15	NC	0.002/0.1	0.62	13	1.4	0.38	0.4	0.66	0.59	NA
Vanadium (V)	NC	NC	0.2/1	<1	15	0.21	<1.0	<1.0	<1.0	<1.0	NA
Zinc (Zn)	10	1380	0.1/3	29	200	16.4	680	670	63	68	7.6
Zirconium (Zr)	NC	NC	0.1/3	5.5	–	0.26	<3	<3	–	–	NA

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.

* Guideline is for Surface Water (Protection of Aquatic Life), multplied by an adjustment factor of 5.4, as surface water is approximately 180 m away (as per Appendix B of the FIGQGs). Note that some guidelines are dependent on water hardness and are calculated for each well.

ULA = Upper Limit of Acdeptability (calculated as average +/- 3*stndard deviation (based on samples collected in 2013 and 2015)
NA = Not Applicable
NC = No Criteria
RDL= Reportable Detection Limit
RPD= Relative Percent Difference
20 = Exceeds selected guideline.
20 = Exceeds calculated ULA

Table 9
Groundwater Chemical Concentrations - Dissolved Metals
PIN-B, Clifton Point, Nunavut

ARCADIS Design & Consultancy for natural and built assets

PARAMETER	CCME FIGQGs[1]	ULA	RDL	MW1	MW3					RPD
				2015-07-24	2013-08-22	2015-07-24	DUP 2015-07-24	2017-08-03	2017-08-03 DUP	
Metals (µg/L)										
Aluminum (Al)	540*	39	0.5/3	7.2	22.4	6.9	4.4	6.5	6.5	0
Antimony (Sb)	2000	NC	0.02/0.6	<0.60	0.085	<0.60	<0.60	<0.6	<0.6	NA
Arsenic (As)	5	0.7	0.02/0.2	0.38	0.225	<0.20	<0.20	<0.2	<0.2	NA
Barium (Ba)	500	NC	0.02/10	45	60.5	48	48	39	39	0
Beryllium (Be)	5.3	NC	0.01/1	<1	<0.010	<1	<1	<1.0	<1.0	NA
Bismuth (Bi)	NC	NC	0.005/5	<5	<0.0050	<5	<5	-	-	NA
Boron (B)	1500	NC	50/20	24	<50	<20	<20	<20	<20	NA
Cadmium (Cd)	0.09	0.03	0.005/0.02	<0.020	0.013	0.021	0.02	<0.02	<0.02	NA
Calcium (Ca)	NC	NC	50/300	36000	40000	36000	36000	26000	26000	0
Chromium (Cr)	8.9	NC	0.10/1	<1	<0.1	<1	<1	<1.0	<1.0	NA
Cobalt (Co)	NC	10	0.005/0.3	<0.30	0.11	<0.30	<0.30	<0.30	<0.30	NA
Copper (Cu)	10.8-21.6*	9	0.05/0.2	5.6	4.68	2.4	2.2	2.9	2.7	7
Iron (Fe)	300	67	1/60	<60	3.4	<60	<60	<60	<60	NA
Lead (Pb)	5.4-37.8*	0.2	0.005/0.2	<0.20	0.025	<0.20	<0.20	<0.20	<0.20	NA
Lithium (Li)	NC	NC	0.5/20	<20	1.6	<20	<20	<20	<20	NA
Magnesium (Mg)	NC	NC	50/200	13000	26700	18000	18000	18000	18000	0
Manganese (Mn)	NC	NC	0.05/4	<4	4.61	<4	<4	<4.0	<4.0	NA
Molybdenum (Mo)	73	NC	0.05/0.2	0.42	1.5	0.21	0.23	0.41	0.36	NA
Nickel (Ni)	664*	4	0.02/0.5	2.2	1.88	0.61	0.64	0.60	0.56	7
Phosphorus (P)	NC	NC	100.000	-	-	-	-	<0.10	<0.10	NA
Potassium (K)	NC	NC	50/300	1200	2240	760	780	1000	1100	NA
Selenium (Se)	1	0.9	0.04/0.2	<0.20	0.482	<0.20	<0.20	0.23	<0.20	NA
Silicon (Si)	NC	NC	100	940	1300	790	790	950	950	0
Silver (Ag)	0.25	NC	0.005/0.1	<0.10	<0.0050	<0.10	<0.10	<0.10	<0.10	NA
Sodium (Na)	NC	NC	50/500	8800	43200	17000	17000	16000	16000	0
Strontium (Sr)	NC	NC	0.05/20	48	69	82	82	41	41	NA
Sulphur (S)	NC	NC	3000/200	2100	17300	3400	3300	2500	2400	4
Thallium (Tl)	0.8	NC	0.002/0.2	<0.20	0.01	<0.20	<0.20	<0.20	<0.20	NA
Tin (Sn)	NC	NC	0.2/1	<1	<0.20	<1	<1	<1.0	<1.0	NA
Titanium (Ti)	100	NC	0.5/1	<1	<0.50	<1	<1	<1.0	<1.0	NA
Uranium (U)	15	NC	0.002/0.1	0.41	1.5	0.27	0.26	0.54	0.51	NA
Vanadium (V)	NC	NC	0.2/1	<1	0.34	<1	<1	<1.0	<1.0	NA
Zinc (Zn)	10	944	0.1/3	31	18.8	470	470	50	48	4
Zirconium (Zr)	NC	NC	0.1/3	<3	0.33	<3	<3	-	-	NA

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.

* Guideline is for Surface Water (Protection of Aquatic Life), multplied by an adjustment factor of 5.4, as surface water is approximately 180 m away (as per Appendix B of the FIGQGs). Note that some guidelines are dependent on water hardness and are calculated for each well.

NA = Not Applicable
NC = No Criteria
RDL= Reportable Detection Limit
RPD= Relative Percent Difference
20 = Exceeds selected guideline.
20 = Exceeds calculated ULA

Table 10
Groundwater Chemical Concentrations - PCBs
PIN-B, Clifton Point, Nunavut

PARAMETER	CCME FIGQGs[1]	RDL	MW1	MW3					
			2015-07-24	2013-08-22	2015-07-24	24/07/2015 DUP	2017-08-03	2017-08-03 DUP	RPD
PCBs (ug/L)									
Aroclor 1016	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1221	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1232	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1242	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1248	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1254	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1260	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1262	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Aroclor 1268	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA
Total Aroclors	NC	0.05/0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	NA

Notes:

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

NC = No Criteria

RDL= Reportable Detection Limit

RPD= Relative Percent Difference

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PARAMETER		CCME FIGQGs[1]	ULA	RDL	MW1	MW3					
					2015-07-24	2013-08-09	2015-07-24	24/07/2015 DUP	2017-08-03	2017-08-03 DUP	RPD
Inorganics											
True Colour	PtCo	NC	NC	20	11	5.0	8.8	9.7	-	-	NA
Conductivity	uS/cm	NC	934	1.0	320	630	390	390	330	330	0
Total Dissolved Solids	mg/L	NC	625	10	190	410	250	270	200	190	5
Fluoride (F^-)	mg/L	0.12	0.13	0.050	<0.050	0.077	<0.050	<0.050	–	–	NA
Orthophosphate (P)	mg/L	NC	NC	0.003	0.003	0.0041	<0.003	0.003	–	–	NA
pH	pH	6.5-9	7.8<8.1	NA	8.00	8.01	7.93	7.96	**8.11**	**8.13**	0
Total Suspended Solids	mg/L	NC	NC	0.40	1.3	2.9	13	13	<1.0	<1.0	NA
Alkalinity (PP as $CaCO_3$)	mg/L	NC	NC	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NA
Alkalinity (Total as $CaCO_3$)	mg/L	NC	99<134	0.50	120	120	110	110	110	110	0
Bicarbonate (HCO_3)	mg/L	NC	NC	0.50	140	150	130	140	140	140	0
Carbonate (CO_3)	mg/L	NC	NC	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NA
Hydroxide (OH)	mg/L	NC	NC	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	NA
Dissolved Sulphate (SO_4)	mg/L	100	88	1.0	6.3	47	11	11	7.1	6.9	3
Dissolved Chloride (Cl)	mg/L	120	130	1.0	10	71	33	33	24	24	0
Dissolved Nitrite (N)	mg/L	0.06	0.03	0.003	<0.010	0.016	0.011	0.011	<0.010	<0.010	NA
Dissolved Nitrate (N)	mg/L	13	9.5	0.003	7.3	8.2	8.2	8.2	5.1	5.1	0
Calculated Parameters											
Hardness ($CaCO_3$)	mg/L	NC	62<278	0.50	140	210	160	160	140	140	0
Ion Balance	na	NC	NC	0.010	0.98	1.0	1.0	1.0	1.2	1.5	22
Dissolved Nitrate (NO_3)	mg/L	NC	NC	0.013	32	36	36	36	23	22	4
Nitrate plus Nitrite (N)	mg/L	NC	9.5	0.0030	7.3	8.2	8.3	8.2	5.1	5.1	NA
Dissolved Nitrite (NO_2)	mg/L	NC	NC	0.0099	<0.033	0.053	0.035	0.035	<0.033	<0.033	NA
Total Dissolved Solids	mg/L	NC	NC	10	180	340	220	220	180	180	0

Notes:

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

NA = Not Applicable
NC = No Criteria
RDL= Reportable Detection Limit
RPD= Relative Percent Difference

Table 12
Historical Groundwater Chemical Concentrations and ULA Calculation
PIN-B, Clifton Point, Nunavut

Sample #	Date	Metals (µg/L)																	
		Total											Dissolved						
		Al	As	Cd	Co	Cr	Cu	Fe	Ni	Pb	Se	Zn	Al	As	Cd	Co	Cr	Cu
Groundwater Samples																			
MW3 (2013)	2013	26.1	0.190	0.009	0.045	0.11	4.26	13.8	1.6	0.05	0.44	16.4	22.4	0.225	0.013	4.68	<0.1	4.68
MW1 (2015)	2015	320	0.510	0.024	9.7	<1	9.7	330	2.2	0.4	<0.20	29	7.20	0.380	<0.020	<0.30	<1	5.60
MW3 (2015)	2015	150	0.280	0.029	<0.30	<1.0	3.3	150	2.7	0.38	<0.20	680	6.90	<0.20	0.021	<0.30	<1	2.40
MW2 (2017)	2017	8300	6.700	0.24	280	32	280	11000	56.0	22	0.86	200						
MW3 (2017)	2017	76	0.310	<0.020	<0.30	<1.0	4	<60.0	1.1	0.2	<0.20	63	6.50	<0.2	<0.02	<0.30	<1.0	2.90
Statistics																			
N Value		5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4
N Value [2013-2015 only]		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average		1774.42	1.60	0.06	58.01	6.72	60.17	2304.76	12.72	4.61	0.32	197.68	10.75	0.20	0.01	1.28	<0.5	3.90
Average [2013-2015 only]		165.37	0.33	0.02	3.30	0.37	5.75	164.60	2.16	0.29	0.21	241.80	12.17	0.24	0.01	1.66	<0.5	4.23
Minimum		26.1	0.19	0.009	0.045	0.11	3.3	13.8	1.1	0.05	0.1	16.4	6.5	0.1	0.01	0.15	<0.05	2.4
Maximum		8300	6.7	0.24	280	32	280	11000	56	22	0.86	680	22.4	0.38	0.021	4.68	<0.5	5.6
Standard Deviation (s)* [2013-2015 only]		147.6	0.2	0.0	5.5	0.2	3.5	158.6	0.6	0.2	0.2	379.5	8.9	0.1	0.0	2.6	NC	1.6
Acceptable Range (Average +/- 3s)		0 < 608	0 < 0.8	0 < 0.1	0 < 20	0 < 1.05	0 < 16	0 < 640	0 < 3.8	0 < 0.9	0 < 0.8	0 < 1380	0 < 39	0 < 0.7	0 < 0.032	0 < 10	NC	0 < 9.2

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.

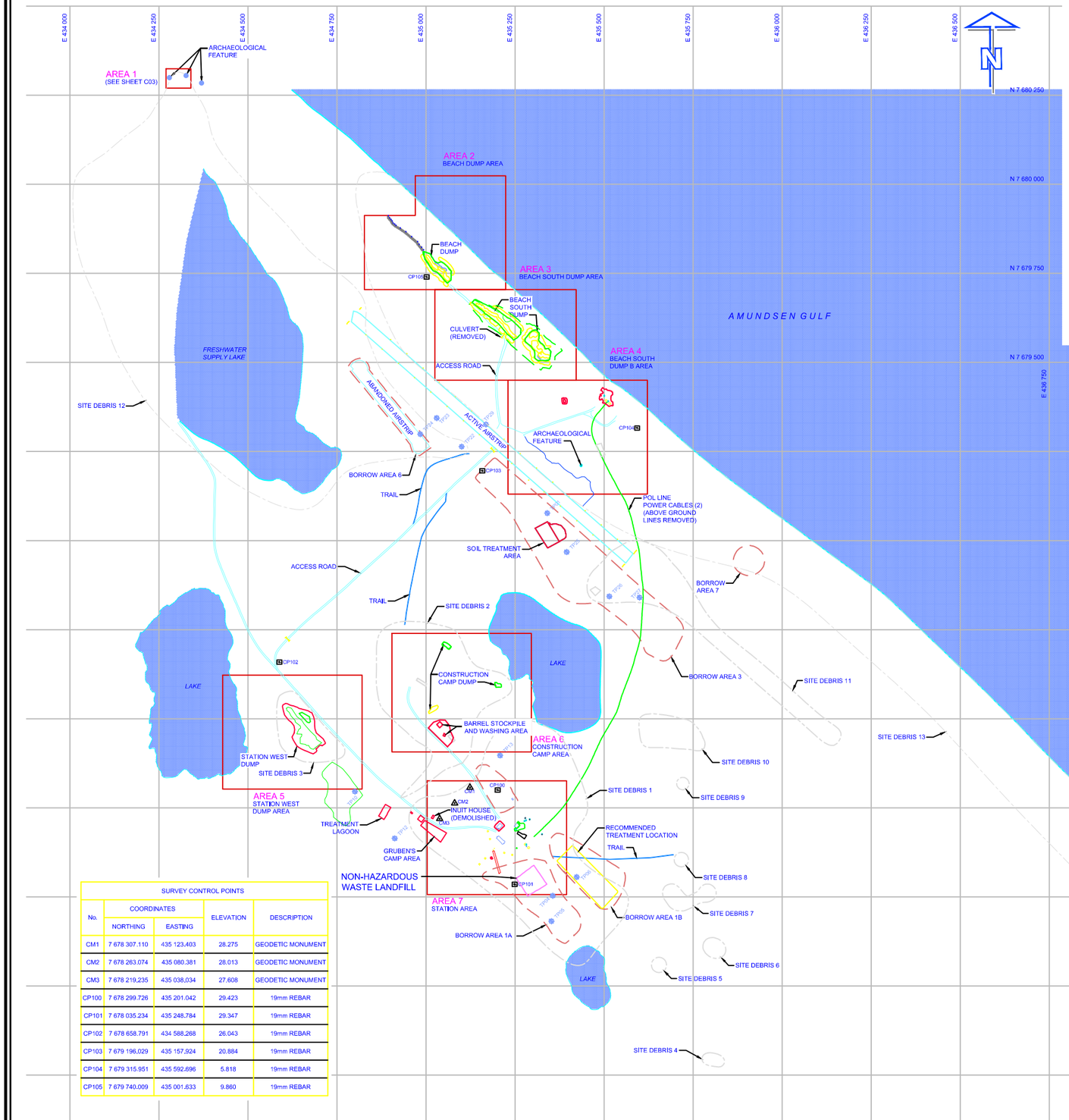
Table 12
Historical Groundwater Chemical Concentrations and ULA Calculation
PIN-B, Clifton Point, Nunavut

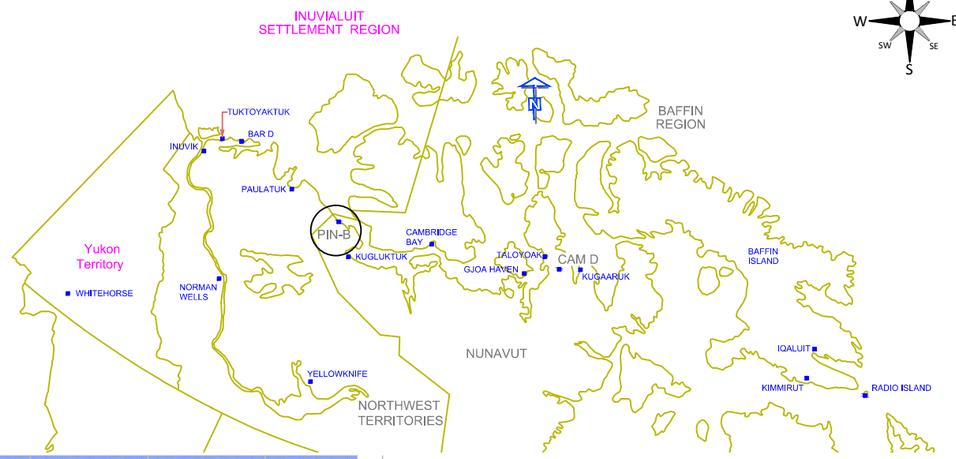
ARCADIS Design & Consultancy for natural and built assets

Sample #	Date	Inorganic Parameters (mg/L)																
		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
Groundwater Samples																		
MW3 (2013)	2013	3.4	1.88	0.025	0.482	18.8	120	630	210	410	0.077	8.01	47	71	0.016	8.2	8.2
MW1 (2015)	2015	<60	2.20	<0.20	<0.20	31	120	320	140	190	<0.050	8.00	6.3	10	<0.010	7.3	7.3
MW3 (2015)	2015	<60	0.61	<0.20	<0.20	470	110	390	160	250	<0.050	7.93	11	33	0.011	8.2	8.3
MW2 (2017)	2017																
MW3 (2017)	2017	<60	0.60	<0.20	0.230	50	110	330	140	200		8.11	7.1	24	<0.010	5.1	5.1
Statistics																		
N Value		4	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4
N Value [2013-2015 only]		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average		23.35	1.32	0.08	0.23	142.45	115.00	417.50	162.50	262.50	0.04	8.01	17.85	34.50	0.01	7.20	7.23
Average [2013-2015 only]		21.13	1.56	0.08	0.23	173.27	116.67	446.67	170.00	283.33	0.04	7.98	21.43	38.00	0.01	7.90	7.93
Minimum		3.4	0.6	0.025	0.1	18.8	110	320	140	190	0.025	7.93	6.3	10	0.005	5.1	5.1
Maximum		30	2.2	0.1	0.482	470	120	630	210	410	0.077	8.11	47	71	0.016	8.2	8.3
Standard Deviation (s)* [2013-2015 only]		15.4	0.8	0.0	0.2	257.1	5.8	162.6	36.1	113.7	0.0	0.0	22.3	30.8	0.0	0.5	0.6
Acceptable Range (Average +/- 3s)		0 < 67	0 < 4.1	0 < 0.2	0 < 0.9	0 < 944	99 < 134	0 < 934	62 < 278	0 < 625	0 < 0.13	7.8 < 8.1	0 < 88	0 < 130	0 < 0.03	6 < 9.5	6 < 10

One half the detection limit is use
Zero is substituted for negative va
NC: Not calculated. Where there

FIGURES





LEGEND:

- APPROXIMATE EXTENT OF BORROW AREA
- APPROXIMATE EXTENT OF SHORELINE
- ACCESS ROAD
- TRAIL
- EXTENT OF SITE DEBRIS AREAS
- CULVERT
- BODY OF WATER
- TP01 TESTPIT LOCATIONS
- CM1 SURVEY CONTROL MONUMENT
- CP100 SURVEY CONTROL POINTS

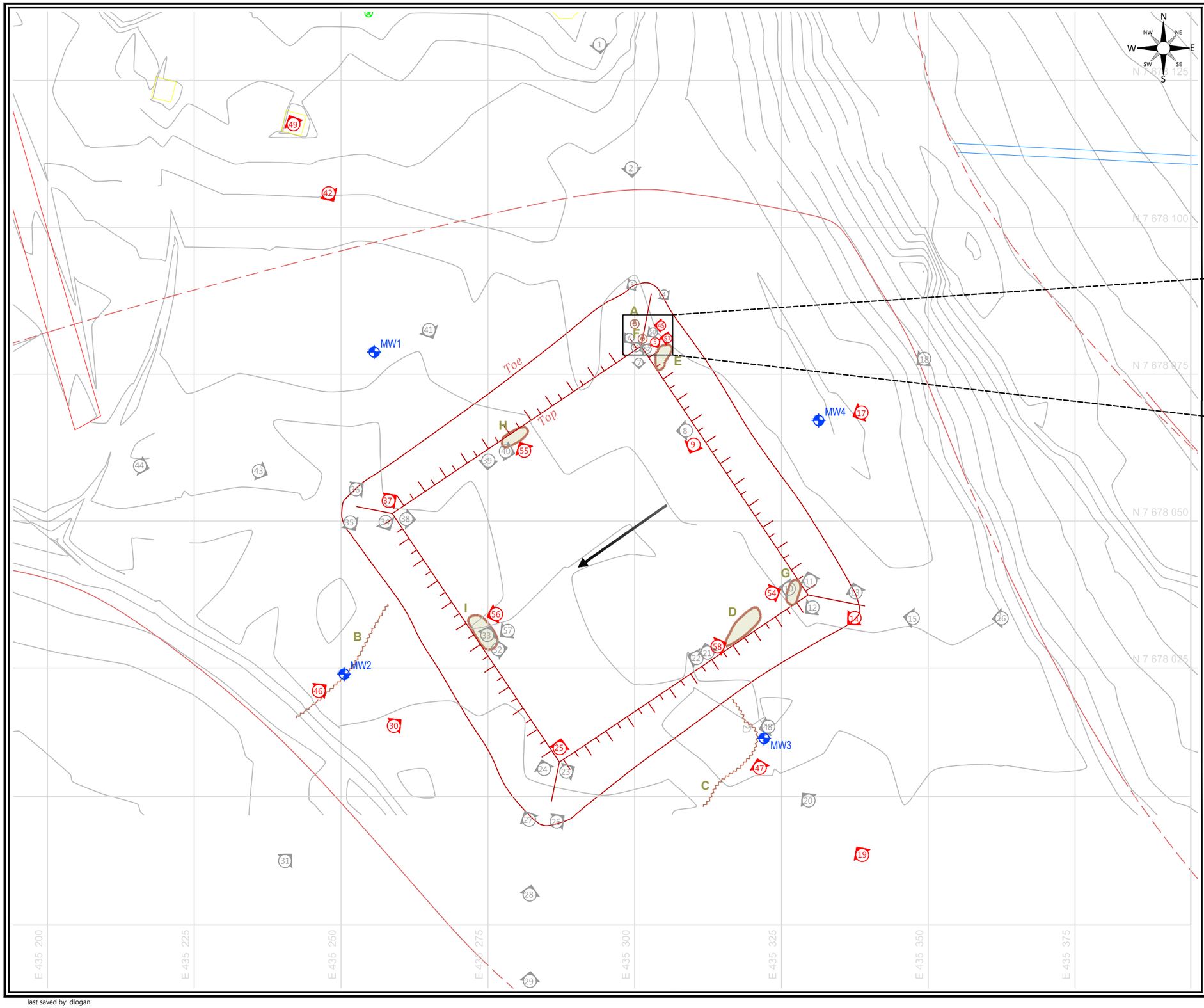
DRAFT

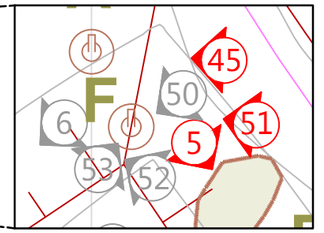
SURVEY CONTROL POINTS

No.	COORDINATES		ELEVATION	DESCRIPTION
	NORTHING	EASTING		
CM1	7 678 307.110	435 123.403	28.275	GEODETIC MONUMENT
CM2	7 678 263.074	435 080.381	28.013	GEODETIC MONUMENT
CM3	7 678 219.235	435 038.034	27.608	GEODETIC MONUMENT
CP100	7 678 299.726	435 201.042	29.423	19mm REBAR
CP101	7 678 035.234	435 248.784	29.347	19mm REBAR
CP102	7 678 658.791	434 588.268	26.043	19mm REBAR
CP103	7 679 196.029	435 157.924	20.884	19mm REBAR
CP104	7 679 315.951	435 592.696	5.818	19mm REBAR
CP105	7 679 740.009	435 001.633	9.860	19mm REBAR

Reference:
Figure adopted from SENES Consultants drawing C02, dated February 2011

Title: Overall Site Plan	
ARCADIS	Project: PIN-B Clifton Point 100347-002
Date: October 2017	Client: Indigenous and Northern Affairs Canada
1:12,500	Figure 1





Legend

- MW — Monitoring Well Locations
- 25 — Picture Viewpoint Number
- 25 — Viewpoint Photograph Included in Appendix A
- Erosion/Drainage
- Animal Burrow
- A — Feature Letter
- Settlement/Depression
- Slope Direction

DRAFT

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

Reference:
Figure adopted from SENES Consultants drawing C08, dated February 2011

Title: Non-Hazardous Waste Landfill

ARCADIS

Project: PIN-B Clifton Point 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

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