APPENDIX 4:

PIN-E CAPE PEEL INTERMEDIATE
DISTANT EARLY WARNING (DEW)
LINE SITE REMEDIATION PROJECT

REMEDIAL ACTION PLAN

Public Works and Government Services Canada

Northern Contaminated Sites Program

Remedial Action Plan
PIN-E, Cape Peel Intermediate DEW Line Site

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Project Number:

2977-393-01

Date:

March 8, 2010

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March 8, 2010

Matt McElwaine, P.Eng.
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Dear Mr. McElwaine:

Project No: 2977-393-01

Regarding: Remedial Action Plan, PIN-E Cape Peel Intermediate DEW Line Site

AECOM Canada Ltd. is pleased to submit the final Remedial Action Plan for the PIN-E, Cape Peel DEW Line Site. We thank you for the opportunity to complete this work on behalf of Public Works and Government Services Canada.

Should you have any questions or require additional information, please do not hesitate to contact the undersigned at (780) 486-7000.

Sincerely,
AECOM Canada Ltd.

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Revision Log

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0	Nick Oke	December 21, 2009	Draft
1	Barry Fedorak	March 8, 2010	Final

AECOM Signatures

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Date March 9, 2010
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Executive Summary

PIN-E, Cape Peel is located on the south coast of Victoria Island in Nunavut (69º04'N,107º17'W) on the north shore of the Dease Strait. The nearest community and air charter base is located in Cambridge Bay, 80 km to the east and Yellowknife, where larger charter planes are available, is located approximately 800 km to the south.

AECOM completed a Phase III Environmental Site Assessment (ESA) at PIN-E in August 2009. The objective of the ESA was to collect all data necessary to develop a detailed clean-up design. The results of this assessment were used to develop the following Remedial Action Plan (RAP) according to the Abandoned Military Site Remediation Protocol (INAC 2009), the Canadian Environmental Protection Act (CEPA) and the Transportation of Dangerous Goods (TDG) Act and Regulations.

The PIN-E site areas are connected via gravel roads. The roads are generally in good condition, but will require some upgrading during construction for heavy equipment use and two-way traffic. The airstrip is in good condition and generally suitable for use by aircraft as large as a Hercules C-130 under dry conditions. During wet conditions, the granular structure may not be sufficient to accommodate the largest of the aircraft considered (Hercules C-130). There is some frost cracking on the airstrip, which will have to repaired in order to land larger planes. Aircraft with wide tires are best suited to the sandy gravel surface that by its nature may tend to rut. All landings at the site will be at the discretion of the pilot. There is barge access to the site along the coast of the Dease Strait and a suitable beach landing area is present. Barge landing is not expected to be a concern. The site is also in relatively close proximity to Cambridge Bay and ice road access can be considered for contractor mobilization to PIN-E.

An archaeological investigation has been completed by Golder Associates for PIN-E and the "Archaeological Impact Assessment" Report is provided in this RAP in Appendix E.

The investigation and delineation of contaminated soil at PIN-E was completed for the contaminants of concern listed in the INAC Abandoned Military Site Remediation Protocol (INAC 2009). This protocol specifies numerical clean-up criteria for inorganic elements, petroleum hydrocarbons (PHCs), and PCBs.

Fourteen existing dump sites and were investigated during the 2009 ESA. The total area of buried debris within the dump sites is approximately 4,450 m^2. Based on the location and condition of the dumps and contaminant migration assessment results, each dump site was assigned as a Class A, B or C dump according to the INAC protocol. The remedial requirements for each dump were initially assessed according to the recommended remedial method specified in the INAC protocol for the various dump classifications. In addition, for development of remedial recommendations, site specific information for each dump was considered, such as proximity to surface water bodies, presence and sensitivity of down-gradient receptors (terrestrial and aquatic), and long term geotechnical stability potential. Where two remedial options were considered appropriate, a cost comparison was also completed to be factored into the decision. Based on these evaluations, seven dump areas (Lobes N, P, R, S, T, Y and Z) have been recommended for regrading and seven dump areas (Lobe L, M, O, Q, V, W and X) have been recommended for excavation with a total excavation volume estimated at 640 m^3. An estimate on waste stream breakdown (percent debris, contaminated soil, non-hazardous and hazardous debris, and clean fill) was completed for dump excavation; these quantities have been included in the derivation of remedial recommendations for contaminated soil treatment and non-hazardous waste disposal.

Based on the surface debris assessment, demolition inventory and sampling, barrel inventory and sampling, and the estimated component to be derived from dump excavations, the volume of hazardous waste identified at PIN-E is 30 m^3. The estimated volume of non-hazardous waste is 309 m^3.

Based on the volume of non-hazardous waste, the quantities and types of granular materials identified during the 2009 investigation, and the identification of several suitable sites for new landfill development, a Non-Hazardous Waste Landfill (NHWL) could be constructed at PIN-E. The preferred location for construction of this facility is at Proposed Landfill A, located in the station vicinity. The volume of non-hazardous waste at PIN-E is relatively small and consideration should be given, if timing allows, to transporting this waste to the PIN-D DEW Line Site for disposal.

The following volumes of contaminated soil were identified at PIN-E:

- Tier I soil: 86 m^3, of which 78 m^3 is derived from dump excavations;
- Tier II soil: 92 m^3, of which 84 m^3 is derived from dump excavations;
- Type A soil: none identified during the 2009 site investigation; and,
- Type B soil: 1955 m^3, of which 1460 m^3 is from the Beach POL area which is subject to a more stringent criteria.

Tier I soil can be disposed of in a NHWL. The small volume of Tier II Contaminated Soil identified does not warrant the consideration for the construction of an on-site Secure Soil Disposal Facility (SSDF). It is recommended that Tier II soil be containerized and disposed of off-site. The recommended remedial option for treatment of Type B soil is landfarming. The Type B soils identified at the Beach POL are subject to the INAC near shore (more stringent) criteria while Type B soils at other locations, including the proposed landfarm site, are further away from water bodies and subject to the INAC Far Shore Criteria. The Beach POL soils, however, have sufficiently high PHC level that they will require treatment at the Landfarm to the Far Shore Criteria. The recommended location for the landfarm is Landfill/Landfarm 3, located southwest of the Beach Area.

Based on the above remedial recommendations, it is estimated that the clean-up at PIN-E will require one full construction season. When considering the timing for contractor mobilization by barge, the clean-up would occur over two calendar years. Contractor mobilization would be completed by barge during the late summer/fall of Season 1 and the contractor could initiate the work, weather permitting. Primary construction activities would be completed during Season 2, with contractor demobilization in the fall of Season 2. The number one priority for the contractor, in terms of main work elements, will be completion of the landfarm in Season 1, to allow for treatment of PHC-impacted soils to commence as soon as possible and to facilitate achieving the remedial endpoint criteria by the end of season 2. Following construction of the landfarm, the construction activity focus should switch to construction of the NHWL. Hazardous waste segregation from demolition components is also recommended for completion as early as possible while facility construction is occurring to allow building demolition to proceed once the NHWL is completed. Because of some unknowns related to barrel contents, barrel consolidation is recommended to be completed as much as possible during Season 1 to allow for collection of samples and analysis. Given the unknowns associated with Tier II soil volumes that may be derived during dump excavation, it is recommended that the landfill Lobe X be the initial focus.

The PIN-E site is approximately 80 km from Cambridge Bay and there is potential for independent development of an ice road for contractor mobilization. Mobilization by ice road offers more flexibility for a longer summer construction season as the contractor typically mobilizes his equipment and camp to site in March or April, clears snow from critical areas and re-mobilizes his staff to set up the camp and start work early in the summer. Barge access can be restricted in the early summer by ice conditions and barge availability can also be an issue. Mobilization by ice road could allow for the remediation work activities, excluding landfarm treatment, to be completed in one summer construction season. If the Contractor is able to stage his equipment, camp and materials at Cambridge Bay, the construction of an ice road to PIN-E would be considered a viable option for contractor mobilization.

Table of Contents

List of Figures

List of Tables

Appendices

1. Introduction

AECOM was retained by Public Works and Government Services Canada (PWGSC), on behalf of Indian and Northern Affairs Canada (INAC), Nunavut Regional Office Contaminated Sites Program, to complete a Phase III Environmental Site Assessment (ESA) and a Remedial Action Plan (RAP) with Class C Cost Estimate for the PIN-E, Cape Peel former Intermediate DEW Line site.

The scope of work for the Phase III ESA included the assessment of:

- Contaminated soil areas;
- Surface water and sediment quality;
- Building materials and demolition requirements, including identification of hazardous materials;
- Existing dumps (aided by the completion of a geophysical survey of the area);
- Barrel contents;
- Areas of surface debris;
- Any other potentially hazardous materials on-site other than barrels or demolition items;
- The sources and volume of non-hazardous waste materials;
- Site access roads, barge landing areas, and airstrip;
- Borrow sources for use during clean-up activities; and
- Traditional knowledge regarding past and present land use of the site from the elders of the nearby communities.

The results of the Phase III ESA have been reported previously (AECOM 2009).

This report discusses remedial options for site issues identified during the Phase III ESA, and provides recommendations for the preferred option. Where different remedial options have been evaluated, a cost estimate comparing the options has been prepared. These estimates have been appended to the Class C cost estimate for overall site remediation, which is provided under separate cover from this report. This report has been structured as follows:

- Section 2.0 outlines the background information that forms the basis of the remedial option evaluations and recommendations;
- Section 3.0 discusses remedial options for site dumps;
- Section 4.0 identifies remedial requirements for hazardous waste elements at the site;
- Section 5.0 summarizes the sources of non-hazardous waste at the site and provides recommendations for disposal;
- Section 6.0 summarizes the findings of the contaminated soil investigation and assesses remedial options for the various types of contaminated soil;
- Finally, Section 7.0 discusses issues related to the implementation of the recommended remedial options - for dumps, demolition of buildings, surface debris pick-up, treatment of barrel contents, the construction of new containment facilities (landfills and/or landfarm), hazardous waste disposal, availability of required granular borrow sources and contract efficiencies for combining PIN-E and PIN-D projects.

Figures are presented in Appendix A.

2. Background

2.1 Site Location and History

PIN-E, Cape Peel was constructed as an Intermediate DEW Line site in 1959 by the Department of National Defence (DND). The station was abandoned as part of the DEW Line system in 1963, at which time site responsibility was assumed by INAC. The site is located on the south coast of Victoria Island in Nunavut, at 69º04'N,107º17'W, and on the north shore of Dease Strait. The nearest community and charter base is Cambridge Bay, located approximately 80 km to the east of PIN-E. Only smaller planes, such as DCH-6 Twin Otter, Embraer Bandeirante ("Bandit"), and possibly Beechcraft King Air are available out of Cambridge Bay. Larger charter aircraft, such as DC-3, DC-4, DCH-5 and Hercules, are available out of Yellowknife, which is located approximately 800 km to the south of PIN-E.

The only structure that remains standing at PIN-E is one of the modules (powerhouse) from the original five-module building train (the "module train"). The other site infrastructure includes the concrete foundations from the former warehouse and garage, concrete foundations from petroleum, oil and lubricants (POL) storage facility with associated distribution system and a downed radar tower. In addition to the Station Area, the East Beach POL area was constructed at a location about 2.5 kilometres east of the station, along Dease Strait. This area was used historically as a barge landing area. Only the concrete foundations from the POL tanks and pumphouse remain at the East Beach POL. The fate of the POL tanks, pumphouses, garage and warehouse structure are undetermined.

One airstrip was constructed at this site with a length of approximately 1,000 m in an east-west orientation. A fresh water lake is located approximately 750 metres west of the airstrip. Gravel roads were built linking the airstrips, beach areas and fresh water lake to the station facilities. Overall site plans showing the site infrastructure are shown on Figures 1 and 2.

2.2 Remedial Protocols and Criteria

The remedial recommendations provided herein are based primarily on the latest version of the INAC Abandoned Military Site Remediation Protocol (AMSRP) (INAC 2009). This protocol provides assessment and remedial guidelines for dumps, disposal of barrel contents and provides clean-up criteria for contaminated soil. There are no criteria for the classification of hazardous waste at federal sites, except for materials regulated under the Canadian Environmental Protection Act (CEPA), including the Inter-provincial Movement of Hazardous Waste Regulations. The classification and remedial recommendations for materials not covered under CEPA has been based on the Transportation of Dangerous Goods (TDG) Regulations and the Nunavut/NWT Guideline for the General Management of Hazardous Waste (1998), under the territorial Environmental Protection Act (R.S.N.W.T 1998 c.E-7). More detailed information related to remedial guidelines or requirements under the sources noted above is provided in the issue-specific sections below.

2.3 Site Specific Remedial Considerations

The following sections provide site specific considerations that have been applied in the development of this remedial action plan.

2.3.1 Off-Site Access

The PIN-E site is located along the coast and barges have historically landed at the East Beach Area. The ground at the beach is comprised of generally well-drained, coarse-grained beach deposits, which are competent and are not expected to pose a problem for beaching or using heavy equipment in the area for movement of materials upon landing. No significant change in the position of shoreline due to tidal influences was noted during the 2009 investigation, suggesting that the near shore water conditions are not excessively shallow. Tidal prediction rates for August and September are available for nearby Cambridge Bay, to the east, from the Department of Fisheries and Oceans (DFO) website. For this time of year, tidal fluctuations are in the order of approximately 0.6 m at Cambridge Bay. Based on the above information, barge landing at Cape Peel is not expected to pose a significant challenge.

The PIN-E site is 80 km east of Cambridge Bay and there is potential for independent development of an ice road that would be of use for contractor mobilization. Mobilization by ice road offers more flexibility for a longer summer construction season as the contractor typically mobilizes his equipment and camp to site in March or April, clears snow from critical areas and can mobilize his staff to set up the camp and start work early in the summer. Barge access can be restricted in the early summer by ice conditions and barge availability can also be an issue. If the Contractor is able to stage his equipment, camp and materials for PIN-E out of Cambridge Bay, overland mobilization (i.e. cat train) would be considered a viable option for contractor mobilization. It has therefore been assumed for the preparation of this RAP, and its associated cost estimate, that access to the site for mobilization and demobilization of contractor equipment and supplies during remediation will be either via barge or ice road.

An inspection of the primary airstrip at the site was completed during the 2009 Phase III ESA. The airstrip is about 1000 m long and 25 m wide. The airstrip is constructed with good quality granular materials similar to Type 2 Granular Fill. The west end of the airstrip is mostly covered with vegetation, but the majority of airstrip has sparse vegetation. The airstrip is generally in good condition with certain features which may need regrading/repair, over excavation and backfill including:

- Settlement (~ 10 m wide, across the whole width of the airstrip) approximately 35 m from the east end of airstrip;
- Ponding on the north side of airstrip where settlement was noted;
- Culvert approximately 700 m from the east end of airstrip; erosion was noted on the outlet and ponding at the inlet of the culvert; and,
- Several frost cracks along the length of the airstrip varying in size from 150-450 mm wide to 100-200 mm deep and running across the whole width of the airstrip.

The charter pilots from Arctic Sunwest and Summit Air considered the airstrip to be in good condition for the landing of the planes used for the site investigation with the exception of the frost cracks, which will hamper the landing of larger aircraft. Landing a Twin Otter and Skyvan did not present any difficulties. Both in-situ CBR testing with a Dynamic Cone Penetrometer (DCP) and lab CBR testing was undertaken to confirm the suitability of the airstrip for larger and heavier aircraft. Results of the in-situ and lab CBR testing indicate a very competent gravel surfacing and subgrade material, even in a saturated condition. The testing suggests that all of the following aircrafts (with full loads) would be able to use the airstrip during dry conditions at the site: Otter DHC-3, Twin Otter DHC-6, Shorts Skyvan, DC-3, Buffalo DHC-5, DC-4, DC-9 and Hercules C-130. Under saturated conditions, all of the noted aircrafts would still be able to land, with the exception of the Hercules C-130. However, because the testing did not consider the internal stability of the granular fill and potential for rutting, it is nonetheless considered essential that the airstrip be inspected by aircraft crews familiar with the necessary gravel surfacing requirements prior to its use, in particular for aircraft the size and weight of a Hercules C-130.

For the purposes of this RAP, it has therefore been assumed that aircraft access to the site will not be an issue, especially given the assumption that the primary mobilization of contractor equipment will be via barge or ice road. All landing at the site will be at the discretion of the pilot.

2.3.2 On-Site Access

There are a number of gravel roads throughout the site connecting the Station Area with the Airstrip, Fresh Water Lake, Existing Landfills and Beach Areas. All of the major roadways were surveyed during the site investigation. The roadway sections include “Section 1” from the Airstrip to the Station; “Section 2” from the Station to the Beach; “Section 3” which branches off from Section 2 and provides access to existing Landfill lobe Q; and “Section 4” from the Station to the Freshwater Lake.

Sections 1 and 2 are approximately 5 to 6 m wide and in good condition for heavy equipment. A pull-out section exists at the road bend within this section and is approximately 35 m long and 12 m wide and considered sufficient to allow passage of two way traffic. There is a 600 mm diameter barrel culvert at the start of Section 2, which is corroded and needs to be replaced, as it may fail under the weight of haul trucks and construction equipment.

Section 3 is approximately 3 m wide and it ends on a 15 m by 10 m wide landfill which can be used to turn around. The Section 3 road surface is very rough and will require regrading and widening to allow for construction traffic. Section 4 is approximately 4 to 4.5 m wide and is generally in good condition.

The roads are constructed with local sandy gravel and are well drained. The patches of vegetation are typical along the roadways, but are of no concern with respect to trafficability. The roads are in good condition for heavy equipment although regular grading will be required. The top width of the roads varies from 4 to 6 m with an average of about 5.0 m. The top widths of Sections 1 and 2 are satisfactory for single lane traffic. Widened or pull out sections, similar to the one on Section 1, will be required for two way heavy equipment traffic.

A potential suitable location for the camp/laydown area is around the location of the pull-out section in Road Section 1. If necessary, the area could be expanded to the north.

2.3.3 Environmental Considerations

Information regarding traditional knowledge and land use of the site was obtained during the site investigation from residents of Cambridge Bay. A meeting was arranged at the Kitnuna office on August 15, 2009 with four elders familiar with the areas including Mr. Tommy Kiloudluk, Mrs. Mary Kiloudluk, Mr. Sammy Anghiatok and Mr. Allen Kitigon. These elders indicated that this area is used for polar bear hunting, although polar bears are typically hunted in areas in the north of Victoria Island.

Characteristic wildlife of the region includes muskox, caribou, arctic hare, arctic fox, snowy owl, raptors, polar bear, seal, seabirds, and waterfowl. Specific wildlife identified during the 2009 site investigation included herds of muskoxen, arctic fox, seals (at the East Beach), ravens, tundra swans, and geese. Caribou droppings were also noted around the site.

Vegetation in the Amundsen Gulf Lowlands eco-region is characterized by a nearly continuous cover of dwarf tundra vegetation, consisting of dwarf birch, willow, northern Labrador tea, *Dryas spp.*, and *Vaccinium* spp. As noted in the 1995 ESG report, there is extensive vegetation at the PIN-E Station Area and in the shallow depressions immediately south of the station. Species present include grasses (*Poa* spp.), willows (*Salix* spp.) and sedges (*Carex* spp.). More specific information related to vegetative cover is described in area-specific discussion below.

2.3.4 Geology/Geomorphology/Hydrology

The PIN-E site is characterized by hummocks, low rolling hills and raised beaches composed of coarse-grained gravel over bedrock.

Regional overland drainage from the site is generally towards the Dease Strait to the east. The Station Area is situated on a low hill and the natural drainage flows radially from this area. Low-lying terrain typically contains small ponds and bogs, many of which appear to contain water only periodically e.g. in early summer. There is a deep ravine, running in a northwest-southeast direction and river which flows into the ocean at the Beach Area.

Based on the results of the 2009 investigation, there are no areas of site activities exhibiting signs of erosion as a result of existing site drainage. None of the soil types identified are particularly prone to erosion. However, areas near the coast may be subject to future erosion by wave action in the event of sea level rise with global warming. Any borrow development in the vicinity of the Beach Area may require drainage control to prevent sediment loading to the coastal area. Areas identified for new development (borrow and potential new landfill construction) in the Station Area are not considered at risk for any significant erosion.

2.3.5 Archaeological Features

An archaeological investigation has been completed by Golder Associated and the “Archaeological Impact Assessment” Report is provide in Appendix F of this report and identifies heritage features needing protection or avoidance during site remedial activities.

2.3.6 Site Assessment Information

The preparation of this RAP has been based on data from the following reports:

- AECOM, November 2009, Phase III Environmental Assessment Report, PIN-E Cape Peel Intermediate DEW Line Site, prepared for Public Works and Government Services Canada;
- ESG, March 1995 - Environmental Study of Abandoned DEW Line Sites: One Auxiliary and Eight Intermediate Sites in the Canadian Arctic, prepared for Department of National Defence.

3. Dump Remediation

3.1 Dump Remedial Protocol

The assessment of dumps at PIN-E Cape Peel was completed with the goal of classifying the dumps according to the three categories specified under the INAC Abandoned Military Site Remediation Protocol:

- ***Class A:*** buried debris is located in an unstable, high erosion location. Remediation will involve relocation of dump contents to an engineered landfill.
- ***Class B:*** the dump is in a suitable, stable location, but there is evidence of contaminant migration. Remedial solutions include the installation of an engineered containment system, or relocation, whichever is deemed more cost effective.
- ***Class C:*** the dump is in a suitable, stable location, and there is no evidence of contaminant migration. In such cases, the debris may be left in place, with the placement of additional granular cover as required.

Dump assessment involved the collection of soil samples up and down-gradient of the dumps, at surface and depth. Contaminant concentrations obtained from down-gradient samples were compared to those from up-gradient samples, and also to average levels of contaminants from all of the dump assessment samples. Where down-gradient samples were consistently higher than up-gradient (by at least two times the concentration of average or up-gradient samples), and elevated concentrations were present over a significant proportion of the total sample locations (i.e. more than one isolated event), the dump was evaluated to have evidence of contaminant migration. The potential for surface soil contamination was also assessed by noting any staining or the presence of types of debris that might act as contaminant sources (such as battery debris). In areas where contamination was suspected, surface and shallow depth soil samples were collected to assess and delineate the extent of contamination.

The following sections describe specifics related to the three recommended requirements for each of the three classes of dumps. For all dumps, it is recommended that any surface debris or surface contaminated soil be removed prior to initiating the dump remediation remedial requirements outlined above.

3.1.1 Excavation/Relocation (Class A Dump)

All dumps have the potential to contain buried hazardous waste materials and contaminated soil, in addition to the expected non-hazardous waste debris. For this reason, where the recommended remedial action is excavation and relocation of dump contents, the contents of the dump will require segregation during excavation to allow classification of the various waste streams. Debris should be separated from soil, with segregation of hazardous and non-hazardous waste. Soil should be sampled to identify any contaminant levels. Contaminated soil identified during sampling should be disposed of according to the requirements outlined in the INAC AMSRP.

Through work on the DND DEW Line sites, AECOM has developed and maintained a database recording the breakdown in dump excavation components. This database is currently comprised of dump excavation information from 15 sites. From this database, the average excavation volume breakdown is as follows:

- Tier I soil: 15%
- Tier II soil: 20%
- Non-hazardous debris: 15%
- Hazardous debris: 2%

- Clean fill: 48%

For excavation of dumps on DND DEW Line sites, AECOM has typically applied these standard percentages during the design stage. However, where site-specific information suggests a higher or lower level of contaminated soil (based on the results of environmental sampling), a higher level of hazardous debris component (based on exposed debris observations), or different concentration of debris (i.e. higher or lower debris content based on extent of cover or a weak and/or spotty geophysical anomaly), the percentages have been modified accordingly.

It should be noted that module trains at other DEW Line Sites are typically have been painted with PCB Amended Paint (PAP). If the module train is buried in one of the lobes designated for excavation, then an increased percentage of Tier II or hazardous soil may be present. The recommendations in this RAP allow for less than 20% of the estimated existing landfill volume to be excavated and over 80% of the volume to be regraded. If the module train was buried on-site, it is likely that it is buried in one of the landfills that will be regraded.

Based on observations from other intermediate DEW Line sites under INAC's jurisdiction, and on observations from historical air photo review completed at DND DEW Line sites, it was common during the early stages of site operation that debris disposal at dumps did not, generally, involve the placement of cover over debris upon disposal. Dumps in these circumstances were typically comprised almost entirely of debris and oftentimes had contaminated soil associated with them as a result of the type of debris disposed, but there was little-to-no surface cover. At the DND sites, however, where the sites were in operation over a longer period of time, dump operations gradually evolved such that debris began to be covered with granular fill. It became common implementation for excavation of existing ground, stockpiling of excavated granular material and placement of debris, with subsequent debris backfilling with the stockpiled granular material. The DND dumps typically have reasonably good surface cover overlying debris, with the majority of debris exposure restricted to along the toe, where backfilling was not so thorough. Observations from PIN-E, suggest that a “trench and cover” debris disposal methodology was implemented from the start during operations at this site. For this reason, the same design principles applied at DND DEW Line sites, regarding dump excavation component breakdown, have been applied for the evaluation of dump excavation quantities at PIN-E.

However, a review of the site and dump-specific quantity breakdowns from the DND dump excavation database was undertaken to further determine the appropriateness for applying these average concentrations to dumps at PIN-E. It was noted during this review that the component breakdown from excavations, particularly related to contaminated soil quantities, could be fairly well correlated with the amount of contaminated soil identified at the landfill surface or down-gradient, and/or with the strength of evidence regarding contaminant migration. The results could also be well correlated with the other factors such as the strength of the geophysical anomaly (which is indicative of the density of debris within the dump). This suggests that the average component concentrations noted above should be more strictly used as a starting point for evaluation, with ultimate component breakdown derived from much more consideration of dump-specific information (where that information is available from the site investigations).

The results of the geophysical surveys at PIN-E dumps (in terms of anomaly strength) suggest that a lower concentration of debris is present in these landfills, compared to typical DND site landfills, which is consistent with their operation over a much shorter timeframe. However, a definitive comparison could not be completed because the geophysical method used at PIN-E was slightly different than that which has been used at DND sites. However, contaminated soil was rarely identified at the PIN-E dumps, and contaminant levels observed down-gradient were never at significantly high concentrations. These observations suggest that a lower level of contaminated soil should be expected from within landfill contents. The standard component breakdown for dumps at the PIN-E site has therefore been assumed as the following:

- Tier I soil: 10%
- Tier II soil: 10 - 15%
- Non-hazardous debris: 20%
- Hazardous debris: 1%
- Clean fill: 54 - 59%

The volume of non-hazardous debris has been assumed to be the same as the average breakdown from DND sites because of the inability to compare the geophysical survey results directly. This is felt to be a conservative measure. The percentages of Tier II and Tier I soils, and hazardous debris has been decreased, with a corresponding increase in the volume of clean fill. And as noted above, these standard percentages have been further modified where warranted by dump-specific information.

Class A dumps should be excavated to the limits of debris. Where contaminated soil has been detected in the excavated contents, it is also recommended that confirmatory testing of the excavation base be completed to ensure no contaminated soil remains. The excavation area should be backfilled and graded to conform to surrounding terrain, and provide positive drainage.

3.1.2 Leachate Containment (Class B Dump)

The typical design that has been used for leachate containment at existing DEW Line dumps involves the excavation of a trench just beyond the limits of the buried debris. The trench extends into either ice rich permafrost or saturated ground, typically at a depth of about 1.0 m at the PIN-E site. A geosynthetic liner system is placed extending from the base of the trench over the dump area. The trench is then backfilled with low-permeability (Type 4) granular fill which may also extend upslope of the trench. Well graded sand and gravel (Type 2 fill) is placed and compacted over the surface to a thickness that will promote permafrost aggradation through the key trench and into the landfill contents. A schematic diagram showing a typical leachate containment system is provided in Figure 9 in Appendix A. The primary long-term containment system is the saturated granular fill. Once the material freezes, it becomes a low-permeable containment barrier. The geosynthetic liner provides essential short-term containment until permafrost aggrades into the landfill and continues to provide longer-term containment following freeze back.

Geothermal modelling completed for the remedial design at the nearby PIN-4 Byron Bay site, where terrain and vegetative cover is similar, specified a design thickness of 3.8 m of Type 2 fill for freeze back of contents. Geothermal modelling considered soil type, soil thermal properties, presence or absence of insulating cover (vegetation or snow drift), measured ground temperatures at the site or at nearby sites, measured air temperature and climatic data (from 1959-1999 from Environment Canada), an estimated 1 in 100 warm year air temperatures, and an estimate of the effect of global warming. The effect of global warming was estimated using the most recently published data summarizing global warming rate estimates for Arctic environments (ACIA 2005). The design cover thickness specified for PIN-4 has been used for consideration of remedial options at PIN-E.

While the specific requirements for long-term dump monitoring at INAC abandoned military sites have not yet been agreed upon, at DND DEW Line sites, this remedial option has initiated the need for significant post clean-up monitoring, with the installation of thermistors within the dump to confirm that contents are frozen. To confirm that no further contamination migration is occurring, groundwater monitoring wells are installed up and down-gradient for the collection of groundwater samples and soil samples are collected adjacent to the monitoring wells. This monitoring has typically been done on a yearly basis for the first five years following site clean-up (which is the estimated time required to achieve thermal equilibrium), and then upon a reduced frequency after 5 years.

Because of the complicated construction requirements for the contractor and the need for long-term monitoring, this remedial option is oftentimes not cost-effective, when compared to excavation and relocation, for smaller dumps. For this reason, the option of excavation has also been evaluated in discussions below for dumps classified as Class B.

3.1.3 Regrading (Class C Dump)

For dumps located in a geotechnically stable location, with no evidence of contaminant migration, the recommended remedial action is regrading with the placement of additional granular cover. It is typically recommended that the extent of regrading be extended slightly beyond the extent of the identified limits of debris (a 2 m offset has been used historically). The granular fill cover placed over the dump should be well-graded (Type 2), erosion resistant, and well-compacted to limit infiltration of water. Where there is the potential for erosion from surface drainage, it is typical to strategically place armouring (rip rap) material. The placement of fill should be configured in such a way so as not to promote ponding of water, and graded to conform to surrounding terrain. Typically, a fill thickness of 0.75 m has been used, but for smaller areas, with no appreciable topographic expression, a smaller fill thickness of 0.5 m has been applied.

3.2 Lobe L Dump (Figure 3.0)

Lobe L is located on the east side of the road from the Airstrip to the Station Area, approximately 90 m east of the former Inuit Hut and 200 m southeast of the Station. This dump is located approximately 60 m off of the Airstrip-Station roadway. A geophysical survey indicated that the triangular shaped dump covers approximately 66 m^2.

No visible debris was noted on the surface of Lobe L and the cover soil consisted of sand and gravel. The surface of the lobe itself is relatively well covered with vegetation (approximately 70%), however the area surrounding is disturbed and has approximately 10% vegetation cover. The overall drainage is to the southeast toward a freshwater pond that is approximately 45 m away from Lobe L. The grade of the dump area is gentle to flat, with a 3 - 4% slope to the southeast. There was no evidence of erosion noted at this dump.

Results of the 2009 environmental investigation did not indicate contaminant migration from the dump. Also, it was indicated that the dump was situated in a geotechnically stable area. Originally, Lobe L was assessed as a Class C dump, with a recommended remedial action of regrading. However, considering the relatively small surface area (66 m^2) and depth of debris (0.7 m), the volume of debris buried within Lobe L is likely minimal (46 m^3). Additionally, to avoid long-term monitoring required with regraded dump areas, it is recommended that Lobe L be assessed as a Class A landfill and excavated in its entirety. Because no contamination or hazardous waste materials were observed at the dump, the estimated excavation component breakdown has been assumed as 10% Tier I, 10% Tier II, 20% non-hazardous debris, 59% clean fill, with a hazardous waste allowance of 1%.

3.3 Lobe M Dump (Figure 3.0)

Lobe M is located approximately 100 m west of the Sewage Outfall and 170 m northwest of the Station Area. Access from the Station Area to the dump is considered to be fair. A geophysical survey of Lobe M identified a dump surface area of approximately 67 m^2.

Debris noted at Lobe M was limited to a 1.5 m piece of pipe protruding from the toe of the dump. No other visible debris was noted. The cover soil consists of gravel and sand. There is approximately 50% vegetation cover on the lobe area and approximately 90% cover at the toe of the lobe. The top of the lobe is relatively flat; however the west facing edge slopes at approximately 10% to the toe. Overall drainage is to the west-northwest. At the time of the 2009 assessment, there was ponded water at the toe of the lobe. The distance to the nearest freshwater habitat is approximately 190 m (northeast). No evidence of erosion was noted at this dump.

The results of the 2009 ESA showed elevated copper levels down-gradient of the dump at several locations along the west-northwest edge. Elevated copper and arsenic levels were also detected in an up-gradient location. The elevated metal parameters were present in the surface samples (0.1 m) collected near the dump toe and on the plateau up-gradient of the dump. This was therefore evaluated as evidence of contaminant migration.

Because of the evidence of contaminant migration, the Lobe M Dump was classified as a Class B dump, requiring either leachate containment or excavation and relocation. Based on a relatively small dump excavation volume (101 m^3) and the difficulties associated with constructing and monitoring a suitable leachate containment system, it is recommended that Lobe M be excavated in its entirety.

Up-gradient drainage control will be required for the excavation of this dump. Because no contamination or hazardous waste materials were observed on the surface of the dump, the estimated excavation component breakdown has been assumed as the average values: 10% Tier I, 12% Tier II, 20% non-hazardous debris, 57% clean fill, with a hazardous waste allowance of 1%.

3.4 Lobe N Dump (Figure 3.0)

Lobe N is located approximately 150 m west-northwest of the Station Area. Access to the dump from the Station Area is considered to be fair. A geophysical survey of Lobe N identified a dump area of approximately 109 m^2.

Debris noted at Lobe N was limited to one piece rebar sticking out of the dump surface. No other visible surface debris was noted. The cover soil consists of sand and gravel. There is approximately 60% vegetation cover on the lobe area and approximately 80% cover down-gradient of the lobe. The lobe is flat, with a gentle 1-2% slope to the west. At the time of the 2009 assessment, there were what appeared to be ephemeral ponds 25 m and 40 m to the west of the lobe. The distance to the nearest freshwater habitat is approximately 250 m (northeast). There was no evidence of erosion noted at this dump.

Results of the 2009 environmental investigation showed elevated levels of arsenic, cobalt, copper and lead at one location up-gradient of the dump. Samples collected down-gradient of the dump did not indicate elevated levels of target metals. Therefore, sample results suggest that leachate or contaminant migration is not present at Lobe N. As a result, the dump is assessed as Class C, which requires regrading of the full dump area.

3.5 Lobe O Dump (Figure 3.0)

Lobe O is located approximately 100 m west-northwest of the Station Area, near the north end of the fallen Communication Tower. Access to the dump from the Station Area is considered to be fair. A geophysical survey of Lobe O identified a dump area of approximately 122 m^2.

Other than a few pieces of rebar protruding from the dump area, there was very little surface debris noted at Lobe O. The cover soil consists of gravel and sand. There is approximately 50% vegetation cover on the lobe and the surrounding area. The lobe is flat, with a gentle 1-2% slope to the northwest. At the time of the 2009 assessment, there were what appeared to be ephemeral ponds 75 m and 90 m to the west of the lobe, which are the same ponds mentioned down-gradient of Lobe N. The distance to the nearest freshwater habitat is approximately 220 m (northeast). There was no evidence of erosion noted at this dump.

Results of the 2009 ESA showed elevated metal parameters at several locations down-gradient, as well as one location up-gradient of the dump. Elevated levels of arsenic, cobalt and/or copper were detected in three locations down-gradient of the dump, and elevated levels of arsenic were measured in one location up-gradient of the dump. The elevated metal parameters were present in the surface samples (0.1 m) collected near the dump toe and on the plateau up-gradient of the dump. This was therefore evaluated as evidence of contaminant migration.

Because of the evidence of contaminant migration, the Lobe O Dump was classified as a Class B dump, requiring either leachate containment or excavation. Based on a relatively small dump excavation volume (85 m^3) and the difficulties associated with constructing and monitoring a suitable leachate containment system, it is recommended that Lobe O be excavated in its entirety.

Up-gradient drainage control will be required for the excavation of this dump. Because no contamination or hazardous waste materials were observed at the dump, the estimated excavation component breakdown has been assumed as the average values: 10% Tier I, 12% Tier II, 20% non-hazardous debris, 57% clean fill, with a hazardous waste allowance of 1%.

3.6 Lobe P Dump (Figure 5.0)

Lobe P is located approximately 500 m southwest of the Station Area, immediately south of the Barrel Storage Area A. Access to the dump from the West Water Supply Road and Barrel Storage Area A is considered to be good. A geophysical survey of Lobe P identified a dump area of approximately 316 m^2.

No visible surface debris was noted at Lobe P. The cover soil consists of sand and gravel, and there is approximately 90-100% vegetation cover on the lobe area and surrounding area. The lobe is comprised of a slightly raised mound that is generally flat, with a gentle 1-2% slope. At the time of the 2009 assessment, low-lying saturated areas were noted near the airstrip, which is 500 m of the dump. The distance to the nearest freshwater habitat, down-gradient of the dump, is approximately 750 m (south). There was no evidence of erosion noted at this dump.

Results of the 2009 environmental investigation showed elevated copper at one location down-gradient of the dump. A surface sample collected from surface soils (0.1 m) at the south toe of the dump had slightly elevated copper concentrations. That being said, all other samples collected down-gradient and up-gradient of the dump did not show elevated levels for any metal parameters and the dump is situated in a geotechnically stable area. Consequently, although there was one location down-gradient of the dump with slightly elevate copper, there does not appear to be significant contaminant migration. Therefore, Lobe P is assessed as Class C, which requires regrading of the full dump area.

3.7 Lobe Q Dump (Figure 4.0)

Lobe Q (formerly called Landfill 4) is located approximately 500 m west-northwest of the Station Area. Access to the dump from the Station Area is considered to be fair, with the Access Road ending approximately 75 m short of the dump. A geophysical survey of Lobe Q identified a dump area of approximately 112 m^2.

Surface debris at the dump area was limited to two pieces of metal. There was also a yellow tank (approximately 500 gallons), possibly used for hauling water, that was located approximately 60 m northwest of the dump area. Otherwise there was very little surface debris noted at Lobe Q. The cover soil consists of gravel and cobble. The lobe itself is located within a disturbed area, possibly a former borrow area. Consequently, there is less than 5% vegetation cover on the lobe. Outside the disturbed area the vegetation cover is approximately 90%. The lobe is relatively flat, with an overall gentle slope to the north. The distance to the nearest freshwater habitat is approximately 250 m (north). There was no evidence of erosion noted at this dump. Although caribou, muskox, wolves and fox may pass through this area, it is unlikely that this would be their primary terrestrial habitat. This area has the potential to be used for hunting.

Results of the 2009 ESA showed elevated metal parameters at several locations surrounding Lobe Q. Elevated levels of arsenic and/or lead were detected in four locations down-gradient of the dump and elevated levels of cobalt and copper were measured in one location up-gradient of the dump. The elevated metal parameters were present in the surface samples (0.1 m) collected near the dump toe and up-gradient of the dump. This was therefore evaluated as evidence of contaminant migration.

Because of the evidence of contaminant migration, the Lobe Q Dump was classified as a Class B dump, requiring either leachate containment or excavation. Based on a relatively small dump excavation volume (112 m^3) and the difficulties associated with constructing and monitoring a suitable leachate containment system, it is recommended that Lobe Q be excavated in its entirety.

Up-gradient drainage control will be required for the excavation of this dump. Because no contamination or hazardous waste materials were observed at the dump, the estimated excavation component breakdown has been assumed as the average values: 10% Tier I, 12% Tier II, 20% non-hazardous debris, 57% clean fill, with a hazardous waste allowance of 1%.

3.8 Lobe R Dump (Figure 6.0)

Lobe R (formerly called Landfill 1) is located approximately 650 m east of the Station Area, at the southwest end of the Landfill Road. Access to the dump from the Landfill Road is considered to be good. A geophysical survey of Lobe R identified a dump area of approximately 502 m^2.

There was extensive surface debris noted at Lobe R. Debris includes, but is not limited to, garbage cans, barrels, tin cans, and miscellaneous metal, wood and glass debris. The debris is scattered up to 100 m from the Lobe R area identified in Figure 5.0. The cover soil consists of sand and gravel. The surface of the lobe has approximately 10% vegetation cover, whereas the south face of the lobe and down-gradient of the lobe have approximately 25% and 60% vegetation cover, respectively. The lobe is located at the end of a road, where debris was pushed over the edge of the built-up road base. Down-gradient is generally level, with a 5% slope to the southeast. The distance to the nearest freshwater habitat, down-gradient of the dump, is approximately 250 m (southeast). There was no evidence of erosion noted at this dump. Although caribou, muskox, wolves and fox may pass through this area, it is unlikely that this would be their primary terrestrial habitat. This area has the potential to be used for hunting.

The 2009 environmental investigation showed a surface stain, approximately 2 m x 2 m, on the west face of the lobe. Field observations and sample results identified the stain as a Type A hydrocarbon contamination plume that extends to a depth of approximately 0.3 m. That being said, results of samples collected around the toe of Lobe R, up-gradient and down-gradient of the dump, did not indicate contaminant migration from the dump. Also, it was indicated that the dump was situated in a geotechnically stable area. Consequently, although there is extensive surface debris on and surround the dump, as well as a hydrocarbon contamination plume, there does not appear to be significant contaminant migration. Therefore, the Lobe R is assessed as Class C, which requires regrading of the full dump area. Regrading is to be completed only once the surface stain has been excavated and the surface debris removed.

3.9 Lobe S Dump (Figure 6.0)

Lobe S (formerly called Landfill 2) is located approximately 800 m east-northeast of the Station Area, along the east side of the Landfill Road. Access to the dump from the Landfill Road is considered to be good. A geophysical survey of Lobe S identified a dump area of approximately 374 m^2.

There was partly exposed debris within the lobe area, and very little debris scattered beyond the toe of the lobe. Partially exposed debris noted within Lobe S includes, but is not limited to, barrels, cat tracks, pipe, wood, cable, and rebar. The cover soil consists of sand and gravel. The surface of the lobe has approximately 90% vegetation cover. The surface of Lobe S is relatively flat, with a gentle slope toward the east. A small drainage channel runs adjacent to the south side of the lobe, which appears to drain to a small pond approximately 150 m east of the lobe. The nearest freshwater habitat is a river that runs along the north side of East Beach Road; however, it is very unlikely that the river could be impacted by drainage from the lobe. Consequently, the nearest water habitat down-gradient of Lobe S is the ocean, which lies more than 1 km to the east. There was no evidence of erosion noted at this dump. Although caribou, muskox, wolves and fox may pass through this area, it is unlikely that this would be their primary terrestrial habitat. This area has the potential to be used for hunting.

The 2009 environmental investigation evaluated Lobes S and T jointly, as there is only a small break between the two lobes. Results of the 2009 ESA did not indicate contaminant migration from either dump area, nor were there indications of surface staining. Also, it was indicated that Lobe S was situated in a geotechnically stable area. Therefore, Lobe S was assessed as a Class C dump and requires regrading of the full dump area. Regrading is to be completed only once the surface debris has been removed.

3.10 Lobe T Dump (Figure 6.0)

Lobe T (formerly called Landfill 2) is located approximately 750 m east-northeast of the Station Area, along the east side of the Landfill Road. Access to the dump from the Landfill Road is considered to be good. A geophysical survey of Lobe T identified a dump area of approximately 1791 m^2.

Minor amounts of surface debris were noted at Lobe T, very little of which was scattered beyond the toe of the lobe. Debris noted within Lobe T included pipe, cable, communication cable and barrel strapping. The cover soil consists of sand and gravel. There is approximately 60% vegetation cover on the surface of the lobe, with the exception of the lobe area that lies beneath the access road. The surface of Lobe T is relatively flat, with a gentle slope toward the east. A small drainage channel runs adjacent to the south side of the lobe, which appears to drain to a small pond approximately 200 m east of the lobe. The nearest freshwater habitat is a river that runs along the north side of East Beach Road; however, it is very unlikely that the river could be impacted by drainage from the lobe. Consequently, the nearest water habitat down-gradient of Lobe T is the ocean, which lies more than 1 km to the east. There was no evidence of erosion noted at this dump.

The 2009 environmental investigation evaluated Lobes S and T jointly, as there is only a small break between the two lobes. Results of the 2009 ESA did not indicate contaminant migration from the either dump area, nor were there indications of surface staining. Also, it was indicated that the Lobe T was situated in a geotechnically stable area. Therefore, Lobe T was assessed as a Class C dump and requires regrading of the full dump area. Regrading is to be completed only once the surface debris has been removed.

3.11 Lobe V Dump (Figure 7.0)

Lobe V (formerly part of Landfill 5) is located on a beachridge, approximately 150 m south-southeast of the Beach POL area. Access to the dump, along the shoreline or one of the beachridges, is considered to be fair. A geophysical survey of Lobe V identified a dump area of approximately 30 m^2.

Debris within Lobe V was limited to 3 empty barrels. The cover soil consists of gravel and sand. There is no vegetative cover on the surface of the lobe; however there is approximately 80% vegetation cover up-gradient. Lobe V is located within 10 m of the ocean’s (Dease Strait) high water mark and is likely subject to wave action and ice scour.

The 2009 environmental investigation did not identify surface staining within Lobe V. Based on the proximity to the ocean, and the likelihood of erosion from wave action and ice scour, Lobe V was determined to be situated in an unstable location. For that reason, down-gradient samples to assess contaminant migration were not collected, as the Lobe V was assessed as a Class A dump and requires excavation. The estimated depth of debris is 0.5 m, for an excavation volume of 15 m^3. Down-gradient drainage control will be required for the excavation of this dump. Because no contamination or hazardous waste materials were observed at the dump, the estimated excavation component breakdown has been assumed as 10% Tier I, 10% Tier II, 20% non-hazardous debris, 59% clean fill, with a hazardous waste allowance of 1%.

3.12 Lobe W Dump (Figure 7.0)

Lobe W (formerly part of Landfill 5) is located on a beachridge, approximately 130 m south-southeast of the Beach POL area. Access to the dump, along the shoreline or one of the beachridges, is considered to be fair. A geophysical survey of Lobe W identified a dump area of approximately 13 m^2.

There was no surface debris noted within Lobe W. The cover soil consists of gravel, with no vegetation on the surface of the lobe. There is however approximately 80% vegetation cover up-gradient of the lobe. Lobe W is located within 10 m of the ocean’s (Dease Strait) high water mark and is likely subject to wave action and ice scour.

The 2009 environmental investigation did not identify surface staining within Lobe W. Based on the proximity to the ocean, and the likelihood of erosion from wave action and ice scour, Lobe W was determined to be situated in an unsuitable and unstable location. For that reason, down-gradient samples to assess contaminant migration were not collected, as the Lobe W was assessed as a Class A dump and requires excavation. The estimated depth of debris is 0.5 m, for an excavation volume of 6.4 m^3. Down-gradient drainage control will be required for the excavation of this dump. Because no contamination or hazardous waste materials were observed at the dump, the estimated excavation component breakdown has been assumed as 10% Tier I, 10% Tier II, 20% non-hazardous debris, 59% clean fill, with a hazardous waste allowance of 1%.

3.13 Lobe X Dump (Figure 7.0)

Lobe X (formerly part of Landfill 5) is located on a beachridge, approximately 80 m southeast of the Beach POL area. Access to the dump, along the shoreline or one of the beachridges, is considered to be fair. A geophysical survey of Lobe X identified a dump area of approximately 388 m^2.

There was no surface debris noted within Lobe X, nor was there surface staining noted within the lobe area. The cover soil consists of gravel. The surface of the lobe has approximately 5% vegetation cover. There is however approximately 80% vegetation cover up-gradient of the lobe. The east toe of Lobe X is located within 10 m of the ocean's (Dease Strait) high water mark and is likely subject to wave action and ice scour.

Results of the 2009 ESA showed elevated arsenic levels at two locations down-gradient of Lobe X and elevated levels of copper were noted at one location less than 10 m north of the lobe. The elevated metal parameters were present in the surface samples (0.1 m) collected near the dump toe. This was therefore evaluated as evidence of contaminant migration. Additionally, Lobe X is situated in close proximity to the ocean, in an area likely subject to erosion from wave action and ice scour and therefore determined to be an unsuitable and unstable location. Because the dump is situated in an unsuitable location and results indicate evidence of contaminant migration, the Lobe X Dump was classified as a Class A dump and requires excavation. The estimated depth of debris is 0.7 m, for an excavation volume of 272 m^3. Down-gradient drainage control will be required for the excavation of this dump. Because no contamination or hazardous waste materials were observed at the dump, the estimated excavation component breakdown has been assumed as 10% Tier I, 10% Tier II, 20% non-hazardous debris, 59% clean fill, with a hazardous waste allowance of 1%.

3.14 Lobe Y Dump (Figure 7.0)

Lobe Y is located approximately 150 m north of the Beach POL area, immediately north of Barrel Storage Area D. Access to the dump from the road is considered to be fair to good. A geophysical survey of Lobe Y identified a dump area of approximately 230 m^2.

Approximately 25 empty barrels were noted at Lobe Y. No other surface debris was noted in this area. The cover soil consists of gravel and sand, with approximately 10% vegetation cover on the lobe surface and 50% down-gradient. The lobe is located on a flat pad, with a gentle slope to the north towards the river. The river is approximately 25 m north of Lobe Y, and the ocean is approximately 100 m to the east. There was no evidence of erosion noted at this dump.

Results of the 2009 environmental investigation showed elevated lead at one location at the top of the pad, which is up-gradient of Lobe Y. No down-gradient samples showed elevated levels for any metal parameters. Also, the dump is situated in a geotechnically stable area. Consequently, although there was one location with elevated lead concentrations, there is no evidence of contaminant migration. Therefore, the Lobe Y is assessed as Class C, which requires regrading of the full dump area. Regrading is to be completed only once the surface debris has been removed.

3.15 Lobe Z Dump (Figure 8.0)

Lobe Z is located on a beachridge, approximately 2 km north of the Beach POL area. Access to the dump is considered to be fair. A geophysical survey of Lobe Z identified a dump area of approximately 316 m^2.

Debris noted at Lobe Z included approximately 75-100 steel cylinders, which were located in a depression in the middle of the lobe. No other surface debris was noted in this area and no surface staining was noted. The cover soil consists of sand, with some gravel. There is approximately 80-90% vegetation cover on the lobe surface. Lobe Z is located in a depression on a former beachridge, which gradually slopes towards the ocean to the east. The ocean is approximately 90 m to the east-southeast. There was no evidence of erosion noted at this dump.

Results of the 2009 environmental investigation did not indicate contaminant migration from the dump. Also, it was indicated that the dump was situated in a geotechnically stable area. Consequently, Lobe Z is assessed as Class C, which requires regrading of the full dump area. Regrading is to be completed only once the surface debris has been removed.

4. Hazardous Waste Remediation

4.1 Protocols and Regulatory Requirements

The Abandoned Military Site Remediation Protocol (AMSRP 2009) defines hazardous waste materials as any materials, which are designated as "hazardous" under Nunavut Territorial or Federal legislation; or as "dangerous goods" under the Transportation of Dangerous Goods Act (TDGA) and regulations.

As part of the assessment of PIN-E Cape Peel, an inventory of hazardous waste materials was compiled and supplemented with sampling during the 2009 site investigation. Various hazardous waste materials identified during the survey included: demolition and site debris consisting of asbestos and PCB/lead amended painted materials, batteries, barrel contents and electrical components and miscellaneous chemicals.

The storage, treatment, and destruction of PCB materials with concentrations of greater than 50 mg/kg are regulated under the Chlorobiphenyls Regulations, which are governed by the Canadian Environmental Protection Act (CEPA)., The regulations have been amended recently and Part 1 Section 1(2) of SOR/2008-273, that came into effect on September 17, 2008, states, "*For the purposes of these Regulations, if a solid or a liquid containing PCBs is composed of several matrices, the concentration of PCBs is based on the mass of the matrix in which the PCBs are located*." This means that for classification of waste painted with PCB amended paint, the mass of the substrate cannot be factored in with the mass of the paint to determine a total PCB concentration for the painted item as a whole, as has been done previously. AECOM has assessed the classification of painted materials at PIN-E based on the new regulations.

Previously, where materials were not regulated under CEPA, classification of hazardous waste defaulted to the federal TDG Act and Regulation under Guideline for the General Management of Hazardous Waste. At PIN-E, materials classified under these regulations tend to be associated with painted materials where PCB concentrations were not in excess of CEPA concentrations, but where lead concentrations may be in excess of the leachate criterion stipulated under the TDG regulations, which have been amended (Amendment 6 - SOR/2008-34) so there is no longer a classification of materials with toxic leachate. Regulation regarding movement of these materials now falls to Environment Canada (EC) under the following two regulations: Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (1999, 2005 amendment), and Interprovincial Movement of Hazardous Waste and Hazardous Recyclable Material Regulations (1999, 2002 amendment). Both EC documents specify a criterion for lead leachate at 5 mg/L, which was the same criterion previously specified under the TDGR.

Projects that will result in the disturbance of asbestos-containing materials (ACMs) including vermiculite must satisfy the regulatory requirements under the Canada Labour Code - Part II and the Nunavut Environment Protection Act. In addition, the Canadian Occupational Safety and Health Regulations, Part X - Hazardous Substances would be applicable to asbestos-containing materials. The Environmental Guideline for Waste Asbestos (GN 2002) defines asbestos-containing materials as any type of material with greater than 1% asbestos by weight.

Treated of creosote-impregnated waste materials (poles) are only considered "toxic", as defined under Section 11 of CEPA, if the waste creosote or its component compounds enter or are likely to enter the environment in a concentration or quantities or under conditions that could lead to exposure of humans or other biota at levels that could cause adverse effects. At DEW Line sites, these components have been determined to be non-hazardous as the components leach at a very slow rate and as such, do not present a threat to the environment if properly contained.

4.2 Surface Debris Component

A surface debris inventory was completed by collecting hand-held GPS waypoints where debris was visible or where debris fields appeared to terminate. At PIN-E, there are essentially two large scattered debris areas, one of which encompasses the station pad and surrounding area and one which encompasses the area from the east beach shoreline to the location of the former Inuit huts. At the other isolated debris areas, the GPS waypoints were downloaded onto the site plan drawing to generate debris area perimeters. The areas of surface debris created with these perimeter limits were then assigned a numerical label. A total volume and description of debris types was recorded for each debris area. Where debris was identified sporadically within a large area, an individual description will be provided on the drawings as a reference to aid in locating these locations during site clean-up.

The survey identified approximately 5 m^3 of hazardous site debris consisting primarily of asbestos-containing materials. A summary of hazardous waste components identified from the surface debris inventory is provided in Table 1 of Appendix C. Specifics related to barrel contents are discussed below.

4.3 Barrel Component

The classification of barrel contents and remedial requirements is based on the Barrel Protocol outlined in the INAC AMSRP. This protocol provides specifics related to when hydrocarbon-containing barrels may be safely incinerated on-site, may be safely discharged (in the case of aqueous contents), and where contents require off-site disposal. The specifics of the protocol are provided in Appendix E.

Approximately 233 barrels were identified at PIN-E during the 2009 assessment. Most of the barrels were concentrated within Barrel Storage Areas A and D, the former station area and along the POL Line, where they were used as markers. Almost all of the barrels identified at PIN-E were empty, including those located at the Barrel Storage Areas. Three full barrels of Avgas belonging to Diamonds North were located on the north side of the runway adjacent to the access road to the station, and one full barrel was noted between the former Inuit Pad and the station. No barrel samples were collected, as the barrels were either empty; full and marked with the contents; or they were unable to be opened.

4.4 Demolition Component

The demolition investigation conducted an inventory of all site buildings and other facilities that would require dismantling for disposal. The investigation noted their construction, and any anticipated special disposal requirements, with the collection of samples for applicable analysis to confirm disposal requirements. Samples were collected from painted substrate to identify whether the materials were PCB-containing in excess of CEPA regulations. All locations of asbestos were identified, and it was noted, in particular, where asbestos was covered with PCB-containing paint. Based on paint analytical data, and observations related to asbestos content, the hazardous and non-hazardous component of the demolition materials was determined.

The INAC Protocol has been updated with requirements that incorporate current PCB Regulations (SOR/2008-273) that came into effect on September 17, 2008. Part 1 Section 1(2) in SOR/2008-273 states, "*For the purposes of these Regulations, if a solid or a liquid containing PCBs is composed of several matrices, the concentration of PCBs is based on the mass of the matrix in which the PCBs are located*." This means that for classification of waste painted with PCB amended paint, the mass of the substrate cannot be factored in with the mass of the paint to determine a total PCB concentration for the painted item as a whole, as has been done previously for DEW Line Sites. As a result, compared to previous assessments, there will be more significant volumes of hazardous demolition materials that will require removal from the site. AECOM has based the volume calculations on the new regulations.

There was one facility remaining at the PIN-E site, which was identified for demolition, the powerhouse module from the building train. In addition, the tower and remaining sections of the POL line and communication cables will need to be removed. Three paint samples were collected at PIN-E to assess PCB concentrations; two from the tower and one from the diesel tanks in the powerhouse module. The results showed that the tower paint samples were non-detect for PCB's and leachable lead and the diesel tank paint to be hazardous with a PCB content of 1820 mg/kg.

Two concrete samples were collected, one from the warehouse foundation and one from the garage foundation. The warehouse foundation concrete sample showed a non-detect level of PCB's while the garage sample showed a PCB concentration of 112 mg/kg. Based on this testing, the top 25 mm of the garage slab will have to be removed and packaged as hazardous material for off-site disposal. No asbestos samples were collected as there were no potentially unknown asbestos containing materials identified, based on experience from other DEW Line sites. Table 1 presents a summary of the demolition requirements at PIN-E.

A summary of hazardous materials identified during the demolition inventory is provided in Table 2 of Appendix C. The total volume identified is 14 m^3 and includes asbestos, PCB-amended painted materials and PCB-amended paint over asbestos.

4.5 Estimated Dump Excavation Component

Nominal volumes of hazardous material are typically encountered during dump excavation, including but not limited to battery waste, electrical components, asbestos, and petroleum products. As noted above, based on experience from other DEW Line sites, it is anticipated that a small quantity of hazardous soil will be encountered during excavation of dump sites, generally in the range of 1% of the overall excavation volume.

Based on the volume of dumps where the recommended remedial action is excavation, the estimated volume of hazardous waste to be derived is 7 m^3.

4.6 Remedial Requirements

Generally, all hazardous materials identified at the site will be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act (TDGA) (TC 2002) and Regulations, and the CEPA Inter-provincial Movement of Hazardous Waste Regulations (SOR/2002-301), to a licensed hazardous waste disposal facility.

Particulars are described below:

- Asbestos: Asbestos waste will be collected, double bagged and disposed of in an on-site engineered landfill, in accordance with the appropriate legislation;
- Petroleum Products: Petroleum products, such as gasoline or diesel, which do not contain other hazardous products according to the Barrel Protocol (chlorine, PCB, heavy metals, etc.) will be incinerated on-site under appropriate emissions controls. Heavier petroleum products such as lubricating oil will be disposed of off-site or mixed with lighter petroleum products and incinerated on-site under appropriate emissions controls;
- Compressed Gas Cylinders: Compressed gas cylinders with known contents will be vented. Once empty, the metal cylinder will be disposed on-site in an engineered landfill;
- Creosote Treated Timbers: Timbers will be wrapped in polyethylene sheets and disposed on-site in an engineered landfill;

- PCB Paint on Building Components: PCB paint and PCB painted components, which are regulated under the CEPA, will be collected and transported off-site, in accordance with the Transportation of Dangerous Goods Act and CEPA, to a licensed PCB disposal facility; and
- Lead-Based Paint on Building Components: Lead-based painted components which are classified as hazardous material will be collected and transported off-site, in accordance with the CEPA Inter-provincial Movement of Hazardous Waste Regulations, to a licensed hazardous waste disposal facility.

5. Non-Hazardous Waste Remediation

5.1 Surface Debris Component

The method for completion of the surface debris inventory is described above. Based on the 2009 ESA inventory, the majority of surface debris was identified as non-hazardous, including barrel contents. The estimated volume (crushed) is 60 m^3. A summary of surface debris areas and volumes is provided in Table 1 of Appendix C.

5.2 Demolition Component

The method employed for demolition inventory and characterization of waste is described above. The results of this investigation indicate that the volume of non-hazardous waste materials from demolition is approximately 122 m^3. A summary of demolition quantities is provided in Table 2 of Appendix C.

5.3 Estimated Dump Excavation Component

As note above, the estimated volume of non-hazardous waste from dump excavations has been based on site-specific modification of average values obtained from dump excavations at other DEW Line sites. In certain cases, based on the results of the geophysical survey and ground truthing, this number has been modified. The total volume estimated to arise from dump excavations has been estimated as 127 m^3.

5.4 Remedial Recommendations

The total volume of material identified as non-hazardous waste during the 2009 Phase III ESA is approximately 309 m^3. According to the INAC AMSRP, the assessment of the need for construction of an on-site Non-Hazardous Waste Landfill should consider primarily the availability of suitable locations to build such a facility at the site. Additional considerations include the availability of appropriate granular borrow materials and the volume of non-hazardous waste identified for disposal. At PIN-E, Cape Peel, several locations were identified during the Phase III ESA site investigation that would be suitable for construction of a new facility. Furthermore, no granular borrow material constraints were identified which would preclude any new development. However, based on information from other DEW Line intermediate sites, the volume of demolition and surface debris at this site is not excessive and consideration should be given to transporting non-hazardous waste to the PIN-D, Ross Point Intermediate DEW Line Site for disposal.

6. Contaminated Soil Remediation

6.1 Remedial Criteria and Clean-up Protocols

The investigation and delineation of contaminated soil at Cape Peel was completed for the contaminants of concern identified under the INAC AMSRP: arsenic, cadmium, cobalt, copper, lead, nickel, zinc, and PCBs. The protocol identifies two levels of contamination - Tier I soil which is considered an environmental risk only when located at surface, and Tier II soil which is considered an environmental risk at any depth of impact. Delineation of petroleum hydrocarbon (PHC) impacts was completed using the 2009 INAC Abandoned Military Site Remediation Protocol. TPH soil analyses are typically completed using a methane extraction method, and measure concentrations of carbon chain sizes between C_6 and C_{34}. Type A hydrocarbons are defined as impacts comprised of 70% or more of the heavier fractions (F3 and F4), which corresponds to impacts derived from lubricating (lube) oil or grease spills. Type B hydrocarbons are defined as those impacts comprised primarily of lighter end components (F1-F3), derived from fuel spills. The INAC AMSRP process specifies different numerical cleanup criteria based on the type of hydrocarbon impacts (Type A versus Type B), proximity to significant water bodies, and depth of impacts. Table A below provides a summary of contaminated soil remedial criteria and volumes identified during the Phase III ESA and evaluated based on the 2009 INAC criteria. Volumes estimated to arise from dump excavations have also been noted, as these volumes have also been considered for evaluation of contaminated soil disposal options below. The total volumes noted below combine the volumes from these two sources, with the volume derived from dump excavation estimates noted in parentheses below.

Table A - Summary of Contaminated Soil Remedial Criteria and Quantities

Contaminant Designation	Description	Soil Volume (m^3)
Tier I Contaminated Soil	Soils containing concentrations of any or all contaminants listed as follows: • Lead 200 to 499 ppm • PCBs 1 to <5 ppm	86 (78 from dump excavations)
Tier II Contaminated Soil	Soils containing concentrations equal to or greater than any or all contaminants listed as follows: • Arsenic 30 ppm • Cadmium 5 ppm • Chromium 250 ppm • Cobalt 50 ppm • Copper 100 ppm • Lead 500 ppm • Mercury 2 ppm • Nickel 100 ppm • Zinc 500 ppm • PCBs >5 ppm;<50 ppm	92 (84 from dump excavations)
TPH Type A Soils F3 and F4 fractions	Soils contaminated with hydrocarbons consisting primarily of oil and grease at concentrations equal to or greater than: • TPH, Sum of F3 and F4 fractions 20,000 ppm	-
TPH Type B Soils F1-F3 fractions	Soils contaminated with hydrocarbons consisting primarily of fuel oil, and/or diesel, and/or gasoline, with concentrations equal to or greater than the following concentrations : • Beach POL Area: TPH: F1 fraction 1290 ppm F2 fraction 330 ppm • Station Area: Surface soils to 0.5	1955 (1460 under more stringent near shore criteria)

	m depth 2500 ppm (TPH, sum of F1 through F3 fractions) • Subsurface soils below 0.5 m in depth 5000 ppm (TPH, sum of F1 through F3 fractions)	

The specified remedial requirements under the INAC AMSRP are as follows:

- ***Tier I soil:*** cap in place with a minimum of 0.3 m of granular fill, or dispose in on-site Non-Hazardous Waste Landfill.
- ***Tier II soil:*** dispose in SSDF or transport off-site for disposal in engineered territorial or provincial Non-Hazardous Waste Landfill;
- ***Type A Soils:*** scarify and leave in place if under criteria, or dispose in on-site Non-Hazardous Waste Landfill; and
- ***Type B Soils:*** excavate and treat ex-situ through landfarming, treat in-situ with landfarming, or dispose of in SSDF. Note that disposal in the SSDF is only considered appropriate if concentrations are sufficiently low that there are no concerns for inhibiting freezing of contents and/or with free-product development, which could compromise the liner integrity at the facility.

6.2 Tier I and Type A Soil

The 2009 site investigation identified a small volume of Tier I levels of PCB's at the Beach Huts Area to a depth of 0.3 m in depth. The total volume of Tier I soil identified for remediation is 86 m^3, of which 78 m^3 is the estimated Tier I soil component from dump excavations and 8 m^3 is from delineated contamination areas. A summary of contaminated soil by area is presented in Appendix B.

A detailed breakdown showing area-specific volumes of Tier I soil is provided in Appendix B.

6.3 Type B Soil

Two areas of Type B impacted soil requiring remedial action were identified as part of the 2009 investigation: the POL Storage Pad and the Beach POL. The total volume of PHC Type B soil identified for remediation is 1955 m^3. A summary of contaminated soil volumes by area is presented in Appendix B.

Remedial options applicable to the hydrocarbon impacted soil include:

- In-situ biological treatment or chemical oxidation;
- Ex-situ, on-site biological treatment; and
- Ex-situ, off-site treatment and/or disposal in a Licensed Disposal Facility.

In-situ treatment of the hydrocarbon impacted soil at the beach POL is not considered an option due to its close proximity to the shoreline.

Advantages and disadvantages of each treatment option are described in Table B. Based on the applicability of the various treatment options at the Cape Peel site, the recommended remedial option is on-site ex-situ treatment, i.e. landfarming.

Recent monitoring results from landfarm operations at another former DEW Line site (FOX-C Ekalugad Fjord) have indicated that treated soil criteria are achievable through on-site biological treatment methods; however, more highly contaminated soils may take extended periods of treatment to meet the treatment criteria. Based on the volume of impacted soil and moderate hydrocarbon concentrations observed during the 2009 investigation, it is anticipated that ex-situ biological treatment may be completed within a 1 year period provided site conditions are monitored and optimized where possible (i.e., moisture conditioning, nutrient amendment).

Soils contaminated with Type B fractions should be excavated and treated ex-situ by biological treatment methods in an on-site landfarm facility. Soils concentrations should be reduced, when required, to meet the 2009 INAC Criteria. The Type B soils identified at the Beach POL are subject to a more stringent criteria than Type B soil from other locations, including the proposed landfarm sites, further away from water bodies. The Beach POL soils, however, have TPH concentrations that are typically higher than the far shore criteria of 2,500 mg/kg and ex-situ treatment will be required.

Table B - Summary of Remedial Options - Hydrocarbon Contaminated Soil

Remedial Option	Description Requirements	Applicability	Advantages	Disadvantages/Limitations	Implementation
In-situ Biological Treatment / Chemical Oxidation	• Application of ozone, peroxide or permanganate through instrumentation within the impacted area.	• Amendable to light and medium end hydrocarbons (F1, F2, F3 fractions).	• Under optimal conditions can reduce concentrations below criteria. • Minimize excavation and disturbance of existing vegetation.	• Monitoring required. • Difficult to confirm that target concentrations are met throughout the contaminated area. • Not applicable to metal contaminated soil.	• Not appropriate for hydrocarbon areas located in close proximity to water bodies (Beach POL).
On-Site, Ex-situ Landfarming / Bioremediation	• Hydrocarbon contaminated soils are excavated and placed within bermed treatment area. • Soils are periodically turned and nutrients added to optimize treatment conditions.	• Hydrocarbon contaminated soils, including F1, F2 and F3 fractions.	• Contaminant concentrations reduced. • No environmental risks associated with potential spills during off-site transport.	• More effective on lighter end hydrocarbons. • Generally requires 2-3 treatment seasons for contaminant reduction to criteria. • Restricts use of the site during treatment operations. • Impermeable membrane/low permeable soils required for containment.	• Adequate location and granular materials identified for construction. • Geosynthetic liner required for perimeter containment.
Off-Site Treatment and Disposal	• Contaminated soils are transported off-site for treatment or disposal.	• All contaminated soil types.	• Contaminated soils removed from site eliminating risk of exposure.	• Considerable costs associated with off-site transport. • Project costs are very sensitive to contaminated soil volumes. • Potential environmental risks during transport.	• Shipment and disposal off-site is technically appropriate, but at considerable costs.

6.4 Tier II Soil

The 2009 site investigation identified a small volume of Tier II levels of copper at the Sewage Outfall to a depth of 0.3 m in depth. The total volume of Tier II soil identified for remediation is 92 m^3, of which 84 m^3 is the estimated Tier II soil component from dump excavations and 8 m^3 is from delineated contamination areas. A summary of contaminated soil by area is presented in Appendix B.

The INAC AMSRP indicates that all soils with metal and/or PCB concentrations exceeding the DLCU Tier II Criteria (but not regulated by CEPA) will be disposed of according to the following options:

- On-site disposal within a secure soil disposal facility (SSDF) consisting of double containment within permafrost encapsulation and a geosynthetic liner system in the base and cover of the facility; or
- Off-site disposal at a licensed southern disposal facility.

For an on-site SSDF, the 2009 investigation identified three suitable locations for this facility, including Landfill/Landfarm 1 located southwest of the Station Area, Landfill/Landfarm 2 situated between the Station Area and the Airstrip and Landfill/Landfarm 3, located east of the landfill access road to Lobes R, S and T. Assessment of existing and new potential granular borrow sources was completed during the 2009 investigation. The assessment identified various locations where suitable borrow types (Type 2, 2A, 4, and 5) and quantities are available for construction of a SSDF. Therefore, based on the results of the 2009 assessment, there are no site specific constraints for building an SSDF at PIN-E.

The decision criteria to determine if a Secure Soil Disposal Facility (SSDF) is required at a DEW Line Site is outlined in Table 5.3 of the INAC AMSRP. The site is not landlocked and landfill excavation accounts for almost all of the Tier II soil volume that requires disposal. The estimated Tier II soil volume is 92 m^3, which is less than the decision criteria volume of 300 to 500 m^3 and the risk of overrun is considered to be low to moderate. Based on criteria outlined in Table 5.3 and concerns that INAC has expressed related to long-term liability with constructing such a facility on-site, off-site disposal is considered the preferred remedial option for disposal of Tier II soil at PIN-E. It should be stressed, however, that there is the potential for the volume of Tier II derived from dump excavations to be higher than that estimated. It is therefore recommended that a significant contingency be carried in terms of volume for off-site disposal to ensure that there are sufficient containers on-site for soil containerization during remediation, so as not to delay project completion.

6.5 Summary

Remedial options evaluations for the remediation of contaminated soils were completed as part of the 2009 investigation. Based on the estimated volumes of contaminated soils and technical considerations, for locating and developing suitable disposal and/or treatment facilities, it is recommended that all Tier I and PHC soils at Cape Peel be disposed of or treated on-site. Based on the applicability of the various disposal and treatment options, the following recommendations are made:

- Soils contaminated with Tier I levels of PCBs and inorganic elements should be excavated and placed in the on-site Non-Hazardous Waste Landfill. The total volume of Tier I soil, all from dump excavations, is estimated at 78 m^3. These soils may be utilized as intermediate fill during placement of non-hazardous waste within the landfill.
- There were no soils identified with Type A contamination.
- Soils contaminated with Tier II levels of PCB and/or inorganic elements should be excavated and disposed of off-site. The total volume of Tier II soil, derived almost exclusively from dump excavations, is estimated at 92 m^3.
- Soils contaminated with Type B fractions should be excavated and treated ex-situ by biological treatment methods in an on-site landfarm facility. Soils concentrations should be reduced, when required, to meet the 2009 INAC Criteria. The total volume of hydrocarbon impacted soil requiring treatment is estimated at 1,955 m^3.

7. Implementation

7.1 Schedule

It is expected based on the assumption of barge access that the contractor would mobilize to the site in the fall of Season 1. During this timeframe, it is reasonable to assume that the contractor would be able to set-up their camp, potentially investigate recommended borrow sources, and upgrade roadways as required. It is also recommended that during this season the contractor remove any birds' nest (used by rough-legged hawks or other species) on any of the DEW Line facilities to prevent nesting on the module train early during the main construction period, which would restrict timing of building demolition. It is understood, however, from past DEW Line experience, that when the existing structure still remains, that rough-legged hawks will rebuild the nest. It should be made clear to the contractor; however, that structures which hold nests with young shall not be demolished until the young birds have left the nest.

It is expected, based on the assumption of ice road access, that the contractor would mobilize to the site in the spring of Season 1, leave the site and return in early summer to set-up the camp, upgrade the roadways and initiate the work activities.

Based on the recommended remedial actions outlined above, construction activities will require at least one full season of clean-up activity, following contractor mobilization to site. Specifics related to timing and prioritization of contractor activities is described in the sections below.

7.2 Dump Remediation

Table C below summarizes the recommended remedial requirements for dumps at PIN-E. Where the recommended remediation is excavation, waste segregation during excavation is recommended to separate hazardous and non-hazardous waste. Non-hazardous waste can be disposed of in the Non-Hazardous Waste Landfill on-site. Hazardous waste will require off-site disposal and must be segregated based on PCB-containing waste (for disposal at a licensed PCB disposal facility), or other hazardous waste, which can be disposed of in a licensed Hazardous Waste Landfill. It is recommended that soil be separated from debris during excavation, and stockpiled in such a manner to allow sampling and classification according to the contaminant criteria outlined under the INAC AMSRP. Soil that does not exceed any contaminant criteria may be used as for backfilling excavations, but based on the difficulty with removing small pieces of debris during waste segregation, it is recommended that this backfill be capped with a minimum 0.3 thick layer of clean borrow soil.

In terms of timing for excavation, because of the anticipated contaminated soil and debris components from excavation, the implementation of dump excavations should not proceed until the construction of the Non-Hazardous Waste Landfill (NHWL) is suitable for the initiation of waste storage.

Because no on-site containment facility will be completed, excavation of Tier II soil could commence early during the construction season. Furthermore, because of the uncertainty regarding Tier II contaminated soil volumes from dump excavations, it would be preferred that the contractor commence excavation at the larger dumps (i.e. Lobe X) early in the construction season to ensure that there are ultimately sufficient containers on-site. This would allow for mobilization of additional containers later in the season. If required, the stockpiling of Tier II soils (preferably on a liner or on the surface of an existing Tier II soil contaminated area) beyond the containerization volume could be completed until additional containers are brought to site.

For dumps where the recommended remedial action is regrading, this work can likely commence upon completion of the NHWL construction, when surface debris pickup at the dumps can be completed efficiently.

Table C - Summary of Recommended Dump Remedial Requirements

Dump	Size (m^2) and Depth (m)	Environmental and Geotechnical Investigation	Dump Classification	Recommended Remediation based on Engineering Considerations
Lobe L Dump	66 0.7	• No evidence of contaminant migration. • No potential for surface contaminated soil identified. • No erosion noted. • Moderate vegetation. • 45 m to freshwater habitat	Class B, Upgraded to A	**Excavate, based on small size, which precludes the application of an effective leachate containment system.**
Lobe M Dump	67 1.5	• Some evidence of contaminant migration. • No potential for surface contaminated soil identified. • Moderate vegetation. • No erosion noted.	Class B, Upgraded to A	**Excavate, based on small size, which precludes the application of an effective leachate containment system.**
Lobe N Dump	109 0.7	• No evidence of contaminant migration. • No potential for surface contaminated soil identified. • Moderate vegetation. • No erosion noted.	Class C	**Regrade, based on the stability of this landfill.**
Lobe O Dump	122 0.7	• Evidence of contaminant migration. • No potential for surface contaminated soil identified. • Moderate vegetation cover. • No erosion noted.	Class B, Upgraded to A	**Excavate, based on small size, which precludes the application of an effective leachate containment system**
Lobe P Dump	316 0.7	• No significant contaminant migration. • No surface contaminated soil identified. • No erosion noted.	Class C	**Regrade, based on the stability of this landfill.**
Lobe Q Dump	112 1.0	• Evidence of contaminant migration. • No potential for surface soil contamination identified. • Sparse vegetation cover. • No erosion noted.	Class B, Upgraded to A	**Excavate, based on small size, which precludes the application of an effective leachate containment system.**
Lobe R Dump	502 1.5	• No evidence of contaminant migration. • Surface contaminated soil identified. • Sparse to moderate vegetation cover. • No erosion noted.	Class C	**Excavate contaminated soil and surface debris collection, then regrade based on the stability of this landfill.**
Lobe S Dump	374 0.7	• No evidence of contaminant migration. • No potential for surface soil contamination identified. • High vegetation cover. • No erosion noted.	Class C	**Surface debris collection, then regrade based on the stability of this landfill.**

Dump	Size (m^2) and Depth (m)	Environmental and Geotechnical Investigation	Dump Classification	Recommended Remediation based on Engineering Considerations
Lobe T Dump	1791 0.7	• No evidence of contaminant migration. • No potential for surface soil contamination identified. • High vegetation cover. • No erosion noted.	Class C	**Surface debris collection, then regrade based on the stability of this landfill.**
Lobe V Dump	30 0.5	• Samples not collected from this location because of its immediate proximity to the ocean. • No surface contaminated soil identified. • Erosion potential from wave action and ice scour.	Class A due to proximity to ocean	**Excavate, due to the proximity to ocean.**
Lobe W Dump	13 0.5	• Samples not collected from this location because of its immediate proximity to the ocean. • No surface contaminated soil identified. • Erosion potential from wave action and ice scour.	Class A due to proximity to ocean	**Excavate, due to the proximity to ocean.**
Lobe X Dump	388 0.7	• Evidence of contaminant migration. • No surface contaminated soil identified. • Erosion potential from wave action and ice scour.	Class A due to proximity to ocean	**Excavate, due to the proximity to ocean and evidence of contaminant migration.**
Lobe Y Dump	230 0.7	• No evidence of contaminant migration. • No potential for surface soil contamination identified. • Sparse to moderate vegetation cover. • No erosion noted.	Class C	**Surface debris collection, then regrade based on the stability of this landfill.**
Lobe Z Dump	316 0.7	• No evidence of contaminant migration. • No potential for surface soil contamination identified. • High vegetation cover. • No erosion noted.	Class C	**Surface debris collection, then regrade based on the stability of this landfill.**

7.3 Demolition

The demolition inventory for Cape Peel identified approximately 14 m^3 of hazardous and 122 m^3 of non-hazardous demolition debris. These volumes are based on segregation of hazardous and non-hazardous building components during demolition and do not include bulking factors that may be attributed to off-site packaging volumes or with on-site disposal volumes.

Hazardous building materials and related components, including asbestos containing materials (ACMs) and PCB wastes will be removed prior to demolition of the structures. ACMs generally include mechanical insulation on pipes and chimneys, transite board, and asbestos core fire doors. ACMs that are painted are to be treated as PCB wastes and containerized separately for off-site disposal. Non-painted ACMs will be double bagged and disposed of in an on-site landfill. Vermiculite insulation contained within the inter-module wall cavities is not considered asbestos-containing (<1% asbestos); however, due to its friable nature should be removed in a manner consistent with a moderate risk (Type 2) abatement. Type 2 asbestos removal specifies parameters for removal of minor friable asbestos including loose asbestos on top of false ceilings and within piping or ducting.

Other hazardous materials, including batteries and potential glycol-containing liquids within the building heating systems will be containerized for off-site disposal or recycling in accordance with TDGA requirements. While no PCB-containing equipment or mercury switches were noted during the 2009 investigation, if these materials are identified during clean-up, they will also require containerizing for off-site disposal.

The majority of painted components in the powerhouse module and hazardous concrete in the garage slab are considered PCB wastes and are regulated under the Canadian Environmental Protection Act (CEPA). Loose and flaking paint is to be removed from all painted surfaces and collected for off-site disposal as PCB waste. Similarly, paint on concrete floors in the powerhouse module and garage contains PCBs in excess of 50 mg/kg and will be removed and treated as PCB waste. Consistent with CEPA and INAC's AMSRP, PCB amended painted material will be containerized in accordance with the TDGA and Regulations, and removed from site. These materials will be transported to a licensed facility for PCB destruction and disposal.

Non-hazardous wastes from demolition include unpainted wood and metal construction materials and concrete in foundations following surface paint removal. Painted structural materials with PCB paint concentrations less than 50 mg/kg can be disposed of in an on-site landfill following removal of any loose or flaking paint. If cutting torches will be used to dismantle structural steel components, paint must be removed from the surface in the locations to be cut.

Remaining building foundations at PIN-E consist of concrete slab on grade (garage, warehouse and POL tanks and pumphouse). The warehouse concrete slab is raised above grade and has been cracking, settling and failing at its current location. The warehouse slab should be demolished and disposed of in the Non-Hazardous Waste Landfill. The remaining concrete building foundations, including the concrete anchor blocks used previously to support the radar antenna, can remain in place once all paint and contaminated surface concrete has been removed from the surface of the slab. The preferred remediation option, from a technical perspective, is to place additional fill material and regrade around the foundations to match existing topography.

It is recommended that the segregation and containerization of hazardous waste components be commenced early during Season 2. This will facilitate the completion of full demolition, which can be commenced once construction of the Non-Hazardous Waste Landfill is completed.

7.4 Surface Debris

A total of nine surface debris areas were identified during the 2009 Phase III ESA. The identified limits of these areas cover approximately 495,000 m^2. The volume of hazardous materials identified is 5 m^3, while the volume of non-hazardous waste is 60 m^3. Both of these volumes represent crushed volume estimates and include barrels. A detailed breakdown of surface debris areas and debris volumes is provided in Table 1 of Appendix C. The limits of surface debris areas are shown on Figure 1. Non-hazardous waste can be disposed of in the Non-Hazardous Waste Landfill. Hazardous waste must be packaged in accordance with TDGA regulations for shipping to an off-site licensed hazardous waste disposal facility.

In addition to the identified surface debris areas, it is also typically noted in clean-up specifications that all debris within 50 m of existing pads and roadways is picked up. The surface debris investigation generally covered off all of the areas near roadways, and the existing perimeters were drawn to include debris identified in this vicinity. Nonetheless, it is recommended that a small contingency for additional volume of debris to be collected under the 50 m from roadway criterion be carried for design of the Non-Hazardous Waste Landfill.

Collection of surface debris can proceed upon completion of a suitable starter berm for the Non-Hazardous Waste Landfill construction. This can likely begin early during Season 2.

7.5 Barrel Remediation

The 2009 inventory of barrels at PIN-E indicates there are 233 barrels on-site. Most of the barrels were concentrated within Barrel Storage Areas A and D, the former Station Area and along the POL Line, which were used as markers. Almost all of the barrels identified at PIN-E were empty, including those located at the Barrel Storage Areas. Three full barrels of Avgas, belonging to Diamonds North, were located on the north side of the runway adjacent to the access road to the Station and one full barrel was noted between the former Inuit Pad and the station. It is expected that Diamonds North will be responsible for disposal of their barrels. No barrel samples were collected, as the barrels were either empty; full and marked with the contents; or they were unable to be opened.

Because of the need to classify some barrels that could not be properly assessed during the ESA, it is recommended that collection of barrels, with consolidation of like products, be completed early during season one to allow for sampling of contents in a timely manner, with incineration or additional consolidation for off-site transport completed by the end of the Season 2.

7.6 Proposed New Containment Facilities

7.6.1 Non-Hazardous Waste Landfill (NHWL)

The total volume of non-hazardous waste, from all sources (including Tier I soil), is estimated at approximately 309 m^3. The estimated footprint for a non-hazardous waste landfill (NHWLF) to accommodate this volume is approximately 21 x 21 m. Although landfill/landfarm sites 1, 2 and 4 are each suitable for the placement of the Non-hazardous Waste Landfill, the preferred location is Landfill/Landarm 1. This site has suitable ground conditions and is close to the Station Area where the majority of demolition debris is located and close to borrow sources where Type 2 Granular Fill material is located. Of note, there are no contaminated soil areas for excavation in the near up-gradient area. Therefore, there is no requirement for provision of a sufficient buffer to avoid complication of long-term landfill monitoring data interpretation.

In terms of contractor priorities for construction of new facilities during clean-up, construction of the NHWL is considered the second priority, behind the landfarm (see below). It is expected that construction of the facility can be completed during the construction season with disposal of waste also commencing this same season.

Because of the relatively small volume of non-hazardous waste requiring on-site disposal, consideration should be given to transporting the non-hazardous waste from PIN-E to the PIN-D for disposal.

7.6.2 Landfarm

The total volume of Type B soil identified for remediation is approximately 1,955 m^3. The majority of this soil is at the Beach Area and it would be preferable to locate the landfarm facility as close as possible to the Beach Area. Landfill/Landfarm 3 has been identified as a suitable and the preferred site for a landfarm. This site is in close proximity to the Beach and far enough away to be outside of the "Near Shore" zone relative to soil with hydrocarbon contamination. Landfill/Landfarm 3 also meets siting requirements for a landfarm and is close to borrow sources where Type 2 Granular Fill material is located.

The construction of the landfarm is a priority as the treatment of soil could potentially delay contractor's demobilization from site.

7.7 Contaminated Soil Excavation

- Tier I soil: Excavation of this soil may commence as soon as the NHWL is constructed.
- Type A soil: None identified at the PIN-E Site.
- Tier II soil: Because of the uncertainty regarding ultimate Tier II soil volumes that will be derived from dump excavations, it is recommended that excavation and containerization of Tier II soils commence early during Season 2. This will allow a better assessment of the ultimate number of containers that will be required for shipping off-site, and will allow the contractor opportunity to bring in additional containers later in the season.
- Type B soil: Excavation of this soil should be completed immediately upon landfarm construction, which should be the number one priority for the contractor, as noted above.

7.8 Borrow Sources

To confirm that sufficient sources of the various granular material types were identified during the Phase III ESA, an estimate of the required granular material volumes was completed for the recommended remedial options discussed above. The following summarizes the estimated volumes for each granular material type:

- ***Type 1:*** no requirements for Type 1 Granular Fill
- ***Type 2:*** the estimated volume required is approximately 10,000 m^3, which includes construction of the Non-Hazardous Waste Landfill, and the Landfarm. Volumes required for regrading of dumps have also been included in this consideration.
- ***Type 3:*** the estimated volume required is in the order of 2,500 m^3, which includes backfilling of dump and contaminated soil excavations. It should be noted here, that, based on our estimate of clean fill that will be derived from dump excavations, the majority of the dump backfilling requirements will likely be met by using this soil. However, as noted above, the clean soil derived from dump excavations will likely contain small pieces of debris, so this material is only recommended for intermediate backfill.
- ***Type 4:*** no requirement since no SSDF or leachate containment of existing dumps will be constructed.
- ***Type 5:*** again, no requirement, similar to Type 4.
- ***Type 6:*** the intermediate fill requirements for the construction of the NHWL are estimated as 200 m^3. Some of the requirements for intermediate fill may be met by using Tier I/Type A soil.

Based on these estimates, it is anticipated that sufficient granular material sources were identified during the Phase III ESA. The following summarizes the estimated available borrow materials at PIN-E:

Table D – Borrow Area Summary

Borrow Area	Available Granular Fill Type	Area (m^2)	Depth (m)	Volume (m^3)	Comments
1	Type 2,3,6	47,000	0.7	33,000	Undisturbed Area
2	Type 4,3	31,000	1.0	31,000	Undisturbed Area
3	Type 4,3	13,000	1.0	13,000	Undisturbed Area
4	Type 4,3	50,000	1.0	50,000	Undisturbed Area
5	Type 2A	140,000	0.4	56,000	Undisturbed Area
	Type 2, 3	140,000	0.3	42,000	
6	Type 2A,4,3	30,000	1.0	30,000	Undisturbed Area
7	Type 2A,2, 3, 6	57,000	1.0	57,000	Undisturbed Area
8	Type 2,3,6	35,000	1.0	35,000	Disturbed Area
9	Type 2,3	42,000	0.8	34,000	Disturbed Area
10	Type 2,3	40,000	1.0	40,000	Partially Disturbed Area
11	Type 4,3	60,000	1.0	60,000	Undisturbed Area

7.9 Contract Efficiencies by Combining PIN-E and PIN-D Projects

The site assessment and provision of a Remedial Action Plan for PIN-D, Ross Point is being undertaken coincidently with PIN-E. There may be certain efficiencies and cost savings if the PIN-E and PIN-D remediation projects were combined into one contract. Under one contract, the sites could be done consecutively with the mobilization of one camp and equipment fleet. Certain critical path work activities could be scheduled to allow for efficient overall completion of both projects. The volume of non-hazardous waste and contaminated soil requiring disposal in the Non-Hazardous Waste Landfill at PIN-E is relatively small and there could be cost savings by shipping the PIN-E waste for disposal at the PIN-D Non-Hazardous Waste Landfill.

Based on these factors and a cost comparison (provided separately), AECOM recommends that a combined contract be implemented for PIN-E and PIN-D.

7.10 Summary

The following summarizes the site access and remediation implementation developed for PIN-E, Cape Peel:

- The remediation activities at PIN-E are anticipated to be completed in one summer construction season with mobilization by barge in the summer/fall of the previous year.
- A total of fourteen existing dump lobes have been identified for remediation at PIN-E, representing a total area of about 4,440 m^2. Lobes L, M, O, Q, R, V, W and X are designated for excavation while Lobes N, P, S, T, Y and Z will be regraded.
- The demolition of buildings and structures at PIN-D represents a crushed volume of 122 m^3 of non-hazardous debris requiring on-site disposal and 14 m^3 of hazardous debris requiring off-site disposal.
- A total of 21 debris areas were identified on-site with an estimated crushed volume of 60 m^3 of non-hazardous debris requiring on-site disposal and 5 m^3 of hazardous debris requiring off-site disposal.
- A total of 233 barrels were identified for processing and an additional three full barrels were identified as belonging to Diamonds North. The 233 barrels were mostly empty and processing is not expected to require a significant effort.

- A non-hazardous waste landfill is proposed for the disposal of 309 m^3 of crushed demolition, debris and contaminated soil. Consideration should be given to transporting the PIN-E non-hazardous waste to PIN-D for disposal.
- A landfarm is proposed for the treatment/storage of 1,955 m^3 of Type B hydrocarbon contaminated soil.
- The priority for contaminated soil excavation is dependent on the disposal or treatment requirements. The priority from high to low is as follows: 1. Type B (requires sufficient time for treatment), 2. Tier II and Hazardous Soil (requires suitable container volume) and 3. Tier I/Type A (requires disposal in Non-Hazardous Waste Landfill).
- A total of 11 borrow sources were identified at PIN-E. The estimated total volume of granular material required for PIN-D remediation construction is 6,700 m^3 while the total volume of borrow material identified is in excess of 480,000 m^3.
- To allow for work efficiencies and cost savings, AECOM recommends that a combined contract be implemented for PIN-E and PIN-D.

8. References

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Appendix A

Figures

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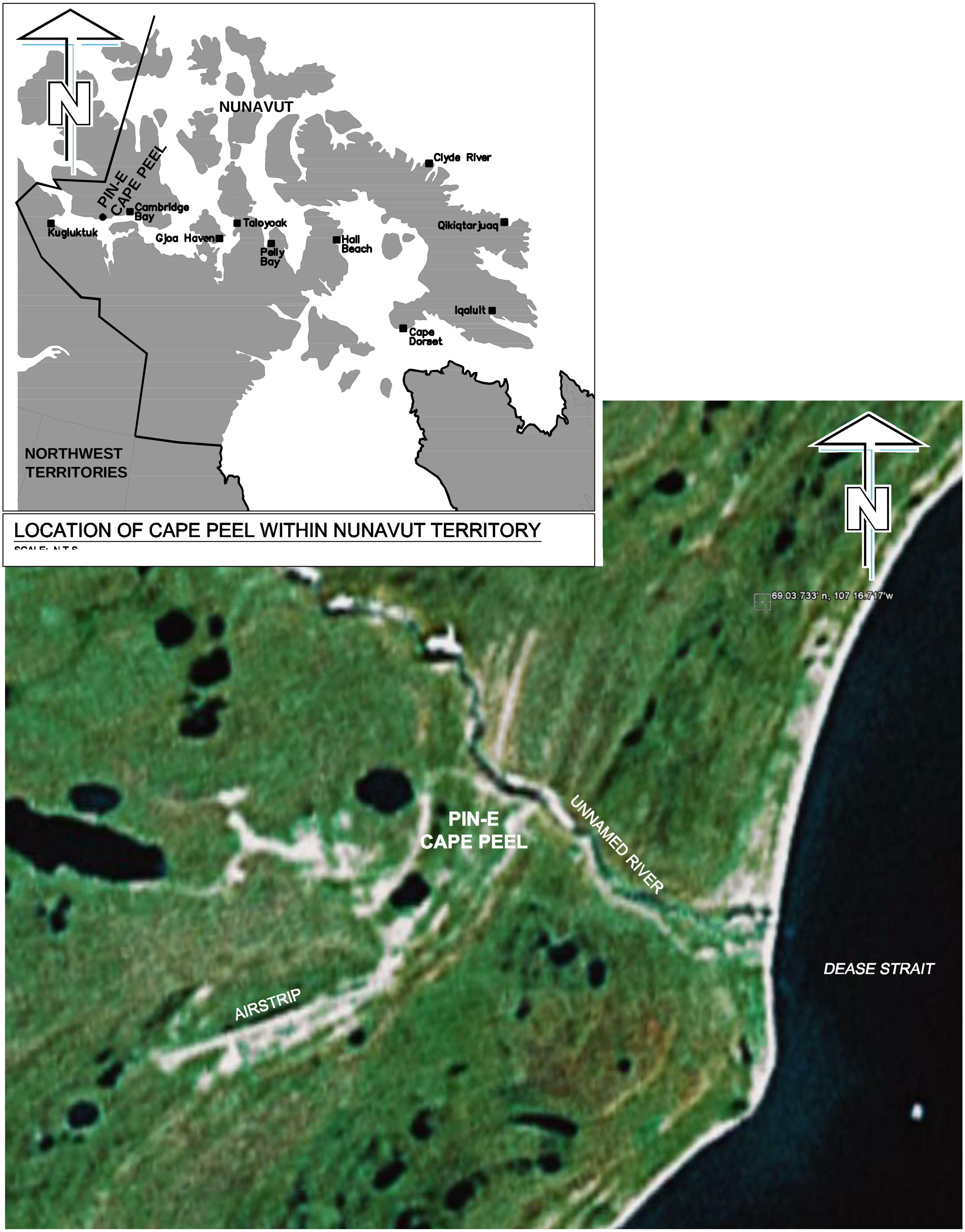

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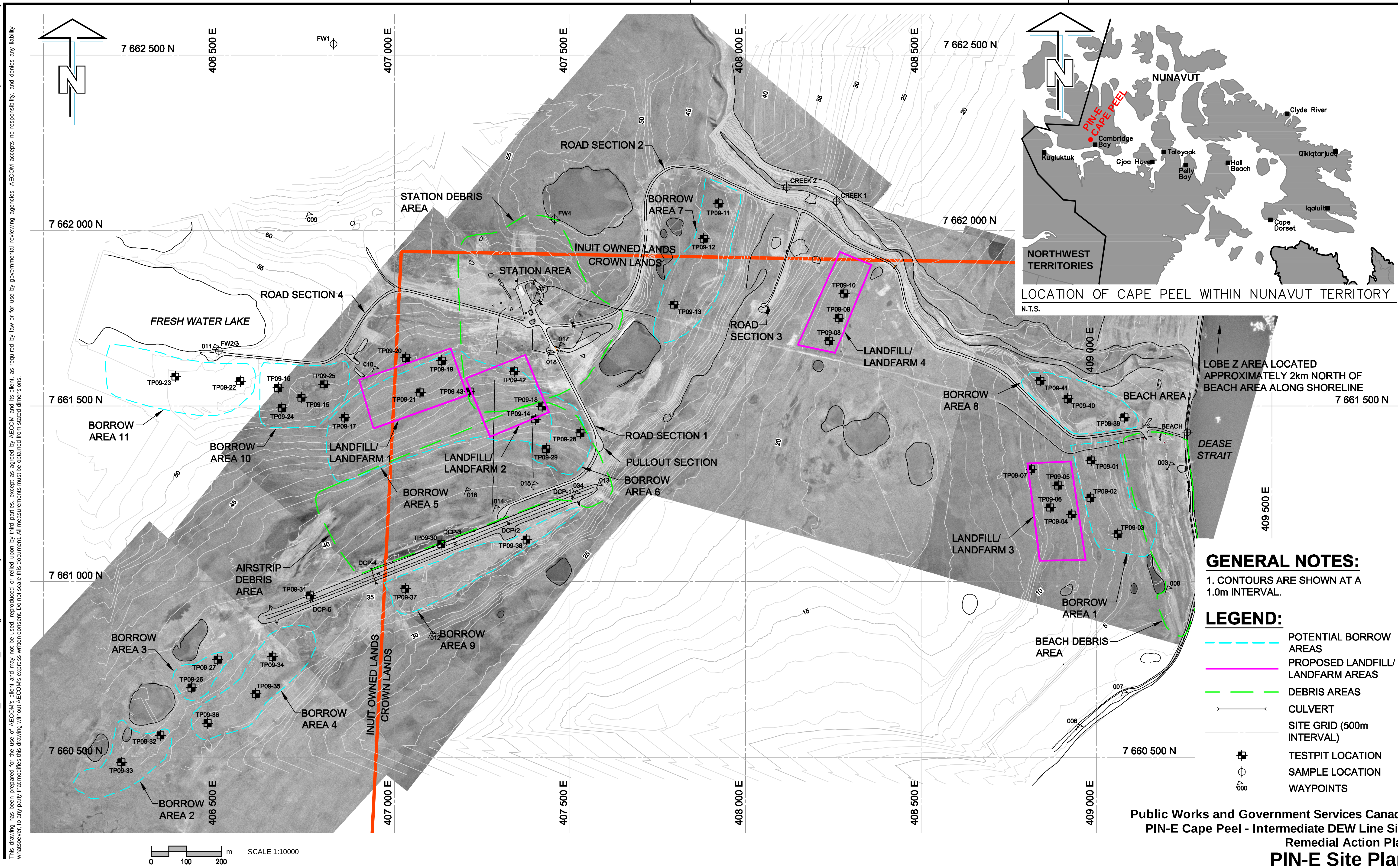
Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

Site Location

AECOM

Figure 1.0



Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

PIN-E Site Plan

Figure 2.0

AECOM

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GENERAL NOTES:

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LEGEND:

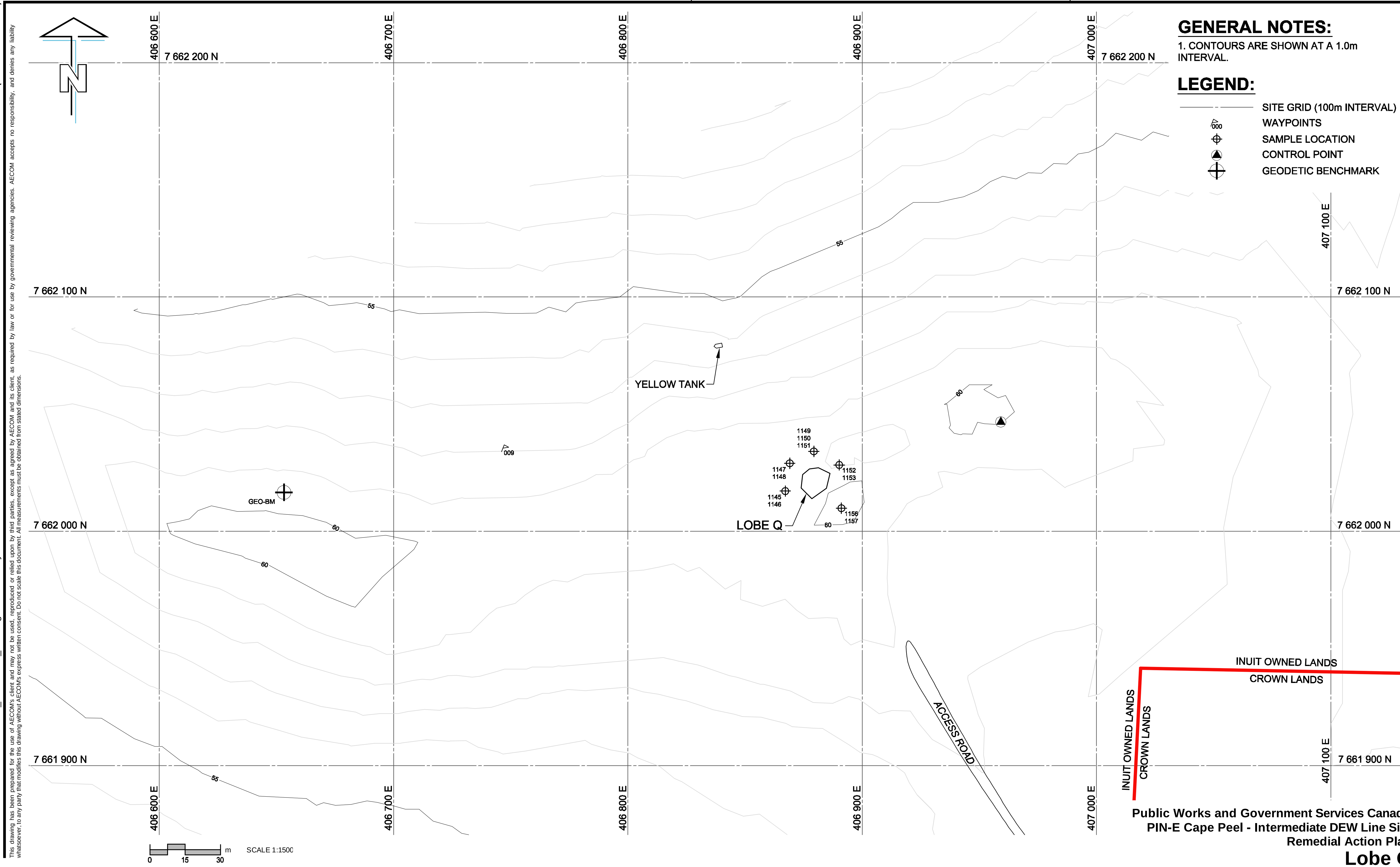
- SITE GRID (100m INTERVAL)
- POTENTIAL BORROW AREAS
- PROPOSED LANDFILL/ LANDFARM AREAS
- DEBRIS AREAS
- CULVERT
- WAYPOINTS
- SAMPLE LOCATION
- TIER II
- TYPE B
- CONTROL POINT
- GEODETIC BENCHMARK
- TIER II ESTIMATED AREA OF CONTAMINATION
- TYPE B ESTIMATED AREA OF CONTAMINATION

Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

Station Area

AECOM

Figure 3.0



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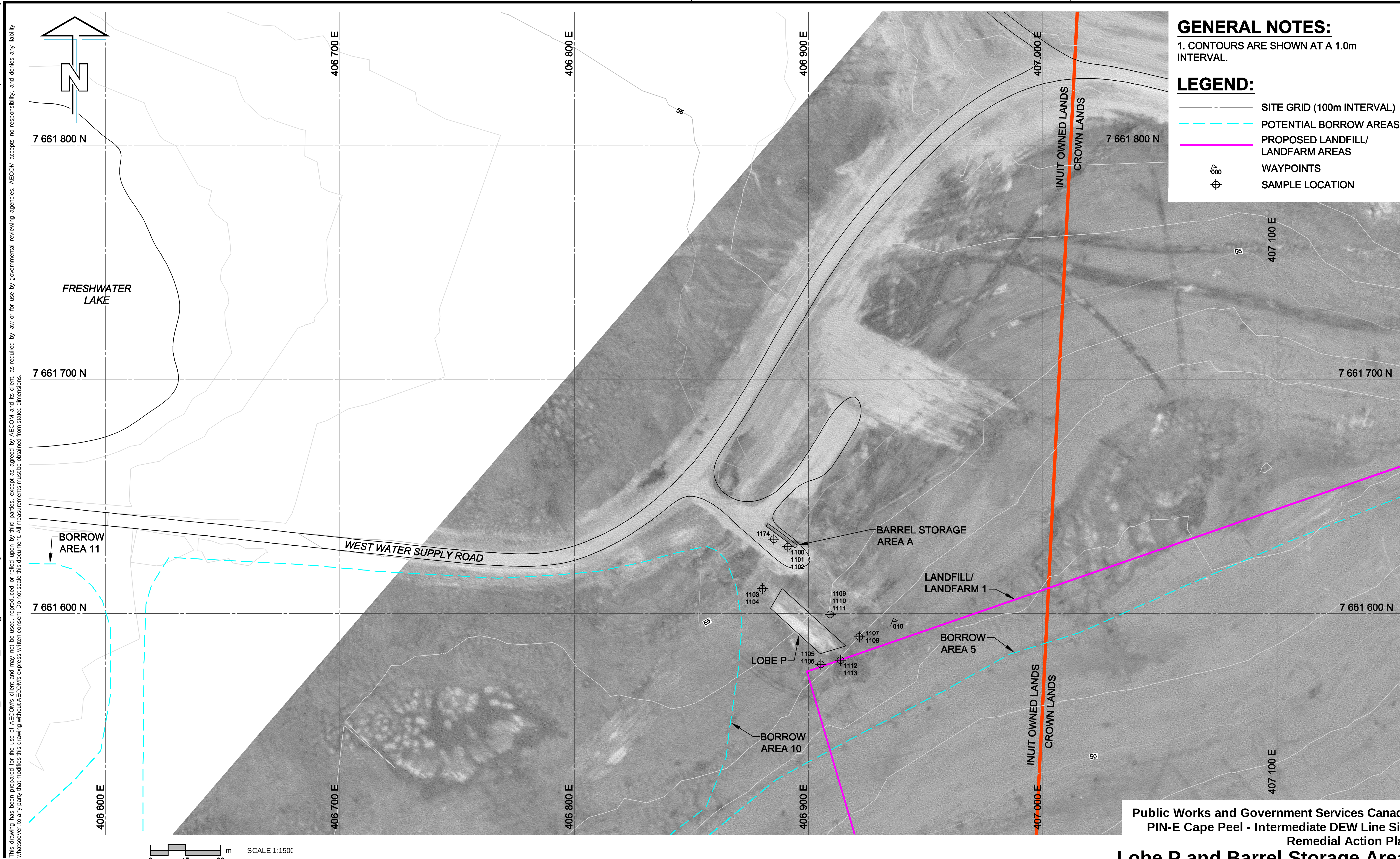
Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

Lobe Q

Figure 4.0



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Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

Lobe P and Barrel Storage Area

Figure 5.0

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Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

Landfill Road Area

Figure 6.0

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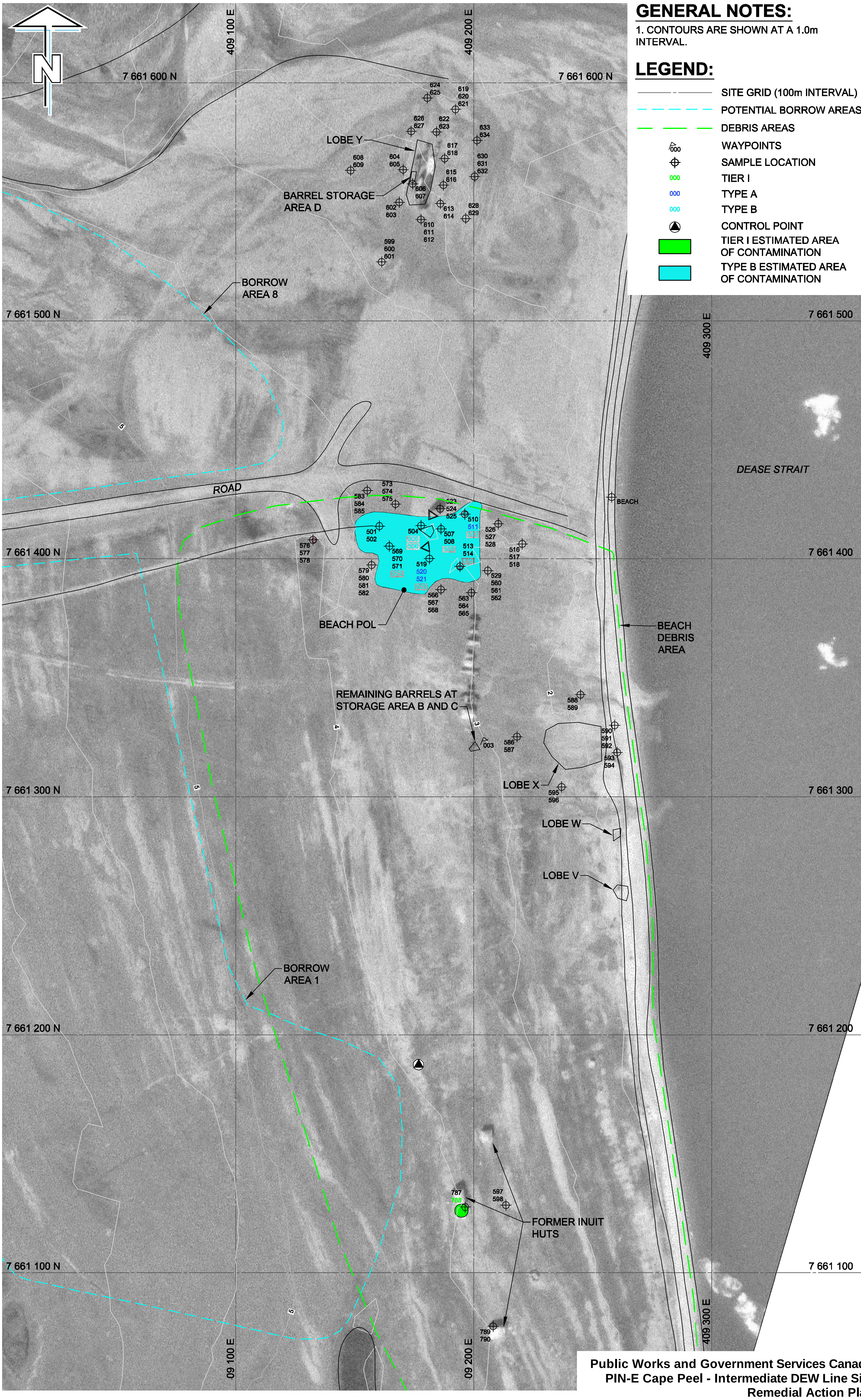

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Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

East Beach Area

AECOM

Figure 7.0

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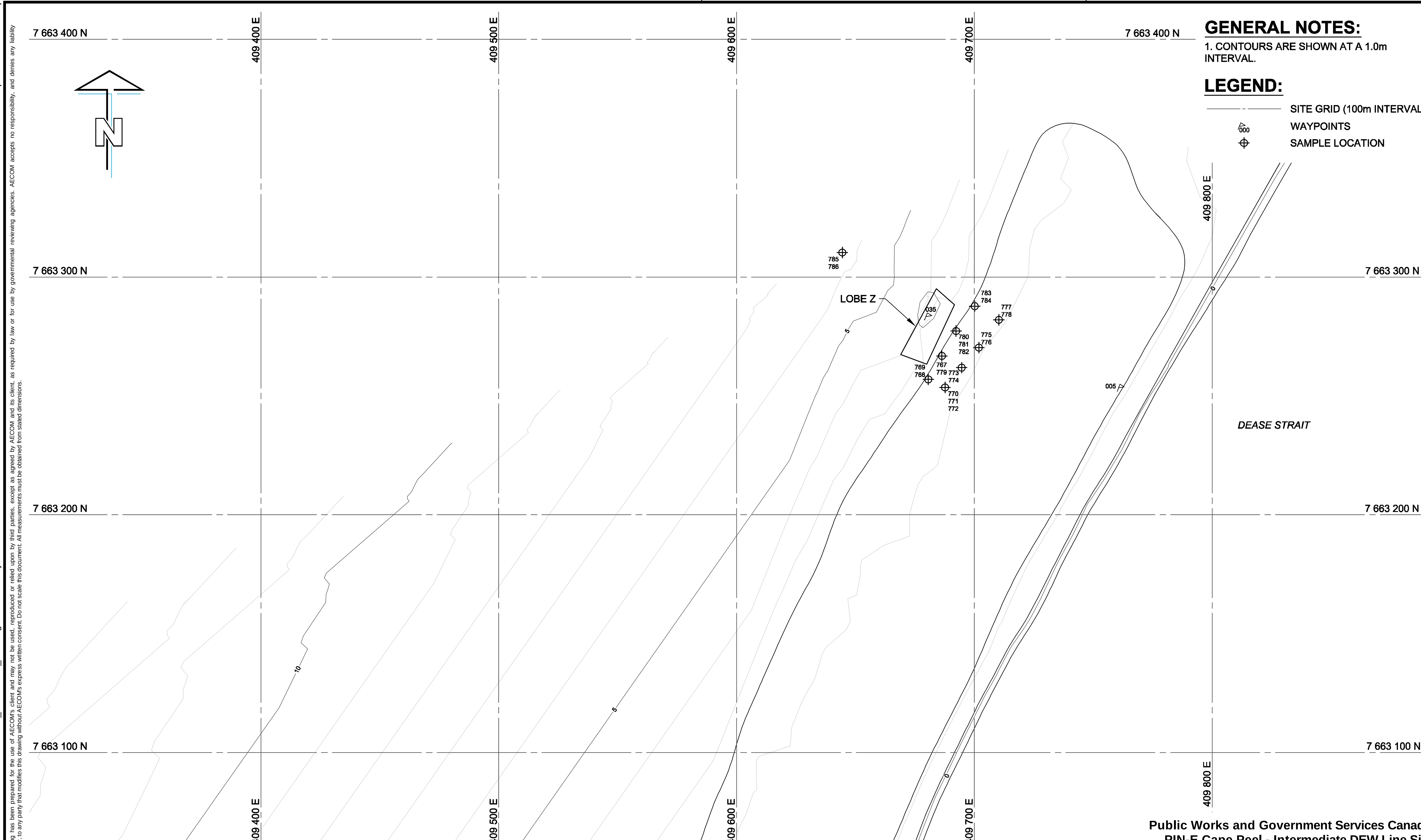

GENERAL NOTES:

1. CONTOURS ARE SHOWN AT A 1.0m INTERVAL.

LEGEND:

SITE GRID (100m INTERVAL)
WAYPOINTS
SAMPLE LOCATION

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Public Works and Government Services Canada
PIN-E Cape Peel - Intermediate DEW Line Site
Remedial Action Plan

Lobe Z

Figure 8.0

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Appendix B

Summary of Contaminated Soil Areas

Remedial Action Plan for PIN-E, Cape Peel
Table B1: Summary of Contaminated Soil Areas

Location	Area (Ref. by Tag Number)	Contaminants	Tier I		Tier II		PHC Type A		PHC Type B		Tier I Volume m^3	Tier II Volume m^3	PHC Type A Volume m^3	PHC Type B Volume m^3
			Area m^2	Depth m	Area m^2	Depth m	Area m^2	Depth m	Area m^2	Depth m				
Sewage Outfall	1132	Cu			25	0.3					0	7.5	0	0
Station POL	1037, 1047	PHC B							550	0.9	0	0	0	495
Beach POL	503, 505, 506, 509; 511, 512, 515, 520, 521, 522 and 572	PHC B							1460	1	0	0	0	1460
Beach Huts	788	PCB's	25	0.3							7.5	0	0	0
CONTAMINATED SOIL AREAS											**7.5**	**7.5**	**0**	**1955**
DUMP EXCAVATION											**?**	**?**		
TOTAL											**8**	**8**	**0**	**1955**

Appendix C

Tables

Remedial Action Plan for PIN-E, Cape Peel
Table C1: Summary of Surface Debris Areas

AECOM

Debris Area	Description	Location	Estimated Areal Extent (m^2)	Estimated Uncrushed Volume (m^3)	Estimated Crushed Volume (m^3)	Hazardous Volume Component (m^3)	Comments
1	Debris: 9 empty barrels (remainder of Barrel Storage Area B &C)	East Beach Debris Area	225	9	1.8	n/a	Barrels are located together and consist of the remainder of Barrel Areas B and C. Good access to area.
	Debris: 10 rusty barrels, wood, empty gas can, washing machine, stove, strapping, metal bedframes, canvas		79,700	15	10	n/a	This debris area is very spread out with scattered debris everywhere. This area was formerly called Landfill 5, although there is very little buried debris in the area, which is captured in Lobes V, W and X. Good access to area.
2	Debris: culvert, runway lights, piece of scrap metal, barrel	West end of Airstrip	100	2	1	n/a	Access is off the end of the runway.
3	Debris: yellow tank, pile of rebar	Lobe Q	1,000	5	2	n/a	Access is through Lobe Q, which is located in what was likely a former borrow area. The yellow tank and pile of rebar are located approximately 100 m apart.
4	Debris: 1 empty barrel, 3 pieces of wood, 1 piece of strapping	Lobe P	100	2	1.2	n/a	Located just east of Lobe P. Access from Lobe P, may require an ATV for access.
5	Debris: 1 piece of 2 inch x 15 ft. copper pipe, 1 piece of wood	Freshwater Lake	25	1.5	1.5	n/a	Located just off the shoreline of the Freshwater Lake at the access point.
6	Debris: culvert made of 6 barrels, empty gas can	South of Airstrip	25	6	1.5	n/a	Located south of airstrip, access with an ATV will be required.
7	Debris: 1 piece of corrugated metal, cable	Airstrip Debris Area	215,500	2.0	0.5	n/a	Located on the south side of the airstrip. Access off the end of the Airstrip.
	Debris: 15 marker barrels, 2 x 4 wood, 1 piece of structural steel, communication cable			16	5	n/a	Very scattered debris throughout this area. The area was soft and wet at the time of the investigation.
8	Debris: 5 sheets of plywood, scrap metal, steel pipe, hot water tank, glass, wood, concrete block, corrugated metal, 2 structural steel beams, 25 empty barrels, rebar	between Inuit Pad and Station	188,800	29	10	n/a	Very scattered debris around the entire station area. Access on the station pad is good; however, much of the surrounding area is soft and wet. The hazardous materials identified consist of asbestos.
	Debris: 4 barrels, 1 sheet of corrugated metal, plywood, 2 x 4s	across road from Inuit Pad		5	1.5	n/a	
	Debris: 4 barrels, wood, water tank, foam insulation, metal door, rebar, scrap metal	Warehouse and Garage		7	3	n/a	
	Debris: pipe, structural steel, 3 asbestos core doors, wood, 3 barrels, vermiculite chips	Module Train		8	4	2.0	
	Debris: asbestos pipe wrap, 4 furnace vents, 4 compressed gas cylinders, 6 barrels, rebar	Powerhouse Module		10	2.5	2.0	
	Debris: 7 empty barrels, 1 asbestos core door, wood, POL line	Station POL		10	3.5	1.0	
	Debris: 5 empty barrels, structural steel	North of Station Pad		7	3	n/a	
	Debris: 3 empty barrels, cable	West of Station Pad		3	0.6	n/a	
9	Debris: barrels, cans, strapping, wood, cable	Lobe U	10,000	12	3.0	n/a	Steep slope. Partly buried barrels and near the top of slope.
10	Debris: approximately 100 barrels at Barrel Storage Area A	West of Landfill/Landfarm 1	n/a	20	4	n/a	Excellent access along West Water Supply Road
TOTALS			**495,475**	**170**	**60**	**5**	

AECOM

Remedial Action Plan for PIN-E, Cape Peel

Table C2: Demolition Debris Inventory

Structure	Description of Components	Hazardous Material	Estimated Hazmat (m^3) - crushed	Estimated Non-Haz (m^3) - crushed	Comments
Radar Tower	Steel pipe and beam construction. Triangular cross-section. 65 m L x 5 m W x 5 m H	none	n/a	80	Paint samples were below non-detect for PCBs and leachable lead.
Powerhouse Module	2.5 m L x 4.5 m W x 4.6 m H, metal frame remaining, furnace fans, 2 x diesel tanks.	PCB paint, both adhered and flaked on the floor and structures such as tanks and the asbestos pipe wrap; asbestos. Most of the asbestos has fallen off of the pipes due to exposure.	15	40	Extensive asbestos debris around the remains of this module. There are also four CO2 cylinders and 6 x empty barrels. There is a large raven nest in this structure.
Garage Foundation	12.5 m L x 10.2 m W concrete floor with grating in half the floor and grating within the access ramps.	none	3	n/a	Remove top 25 mm of concrete and package as hazardous material. Provide confirmatory testing of remaining concrete and, if clean, cover with granular material.
Warehouse Foundation	Concrete Floor elevated on concrete base. There are four 0.6 m x 0.6 m x 0.2 m footings and fifteen 0.4 m x 0.4 m x 1 m footings.	none	n/a	n/a	Demolish remaining concrete slab and substructure and dispose of in the Non-Hazardous Waste Disposal Facility.
Windcone	Steel windcone and marker barrel	none	n/a	1.5	Only the concrete footing remains intact, which will be covered with granular materials.

Appendix D

INAC Protocols

Affaires indiennes et du Nord Canada
Indian and Northern Affairs Canada

Abandoned Military Site Remediation Protocol

Volume I – Main Report

Indian and Northern Affairs Canada
Northern Affairs Organization
Contaminated Sites Program

Final
March 2009

Canada

Indian and Northern Affairs Canada | Affaires indiennes et du Nord Canada

Abandoned Military Site Remediation Protocol

Volume I – Main Report

March 2009

Indian and Northern Affairs Canada

ACKNOWLEDGMENTS

This Protocol is an update on the previous Indian and Northern Affairs Canada (INAC) Abandoned Military Site Remediation Protocol, which was produced in 2005. Considerable intellectual effort has gone into the revisions and updates contained in this new Protocol and INAC wishes to recognize and thank the organizations involved in its development.

This document, which is comprised of Volume I (Main Report) and Volume II (Supporting Technical Documentation) is a product of the collaborative efforts by the following organizations:

- Environmental Sciences Group, Royal Military College of Canada
- Golder Associates Ltd.
- EBA Engineering Consultants Ltd.
- UMA Engineering Ltd. (now AECOM)
- Qikiqtaaluk Environmental Inc.
- Jacques Whitford Ltd.
- Dept. of Geological Sciences and Geological Engineering, Queen’s University

INAC also wishes to recognize and thank the members of the Technical Advisory Working Group who provided invaluable input to development of this Protocol.

TABLE OF CONTENTS PAGE NO.

List of Tables **Page No.**

List of Figures **Page No.**

1 INTRODUCTION

In the 1950s, at the height of the Cold War, a number of facilities were constructed in the Canadian Arctic to provide surveillance of northern approaches to the continent. The largest installation was the Distant Early Warning (DEW) Line, a series of radar stations spanning the northern coastline from Alaska to Greenland. In total, 63 stations were constructed, 42 of which were located in Canada. In 1963, due to advances in technology, installations at 21 of the sites were considered redundant and these sites were abandoned. All buildings, vehicles, Petroleum Oil Lubricant (POL) storage tanks and miscellaneous debris were left in place. Administration of these sites was transferred to Indian and Northern Affairs Canada (INAC) (Fletcher 1989; INAC 2002). Other abandoned military sites include those associated with the Pole Vault line in the eastern Arctic. Locations of INAC military sites in the Canadian Arctic are indicated on Figure 1. The remainder of the installations on the DEW Line continued to operate until the early 1990s, at which point most of them were converted to the North Warning System (NWS). Decommissioning and cleanup of these 21 sites, excluding facilities that are required for the operation of the NWS, is the responsibility of the Department of National Defence (DND).

Several environmental issues were at these abandoned military sites based on previous preliminary and detailed assessments at the INAC and DND sites (ESG 1991, 1993). These issues include physical hazards related to unconsolidated debris and aged structures, and environmental impacts associated with soil contamination. In 1996, DND initiated remediation of the DEW Line sites under its jurisdiction and cleanup of these sites is on going. The cleanup follows the conditions of the DEW Line Cleanup Protocol (ESG, 1993 and ESG/UMA, 1995) and the co-operation agreements between DND and Nunavut Tunngavik Inc. (NTI) (DGE 1998) and DND and the Inuvialuit Regional Corporation (IRC) (DGE 1996).

INAC has completed the remediation of a number of sites across the Canadian Arctic namely Iqaluit Upper Base, Resolution Island (BAF-5), Horton River (BAR-E), Sarcpa Lake (CAM-F), and Pearce Point (PIN-A). The approach adopted for remediation of these sites has generally been consistent with the methodology applied at the DND DEW sites (PWGSC 2001 to 2003). Due to the commitment of the Federal Government to future funding of contaminated site clean up, INAC recognizes the need for a consistent protocol for abandoned military site cleanup (INAC 2002).

A number of factors must be considered when determining the most suitable approach to site remediation for remote sites in the Arctic environment. The Abandoned Military Site Remediation Protocol (AMSRP) is based on an approach that addresses legal requirements, INAC's Contaminated Sites Policy (including risk management requirements), and standard environmental management practices (INAC 2002).

This Protocol also takes into consideration financially prudent methodologies that address environmental issues while striking a balance with remedial cost. An over-arching principle has been to balance the environmental benefits of remediation activities with potential negative physical impacts to the Arctic environment.

The primary objectives of this document are to provide sufficient background information to understand the environmental issues present at these sites, and to describe the guiding principles for their assessment and remediation. AMSRP, Volume 2 (INAC 2009) provides additional supporting technical information.

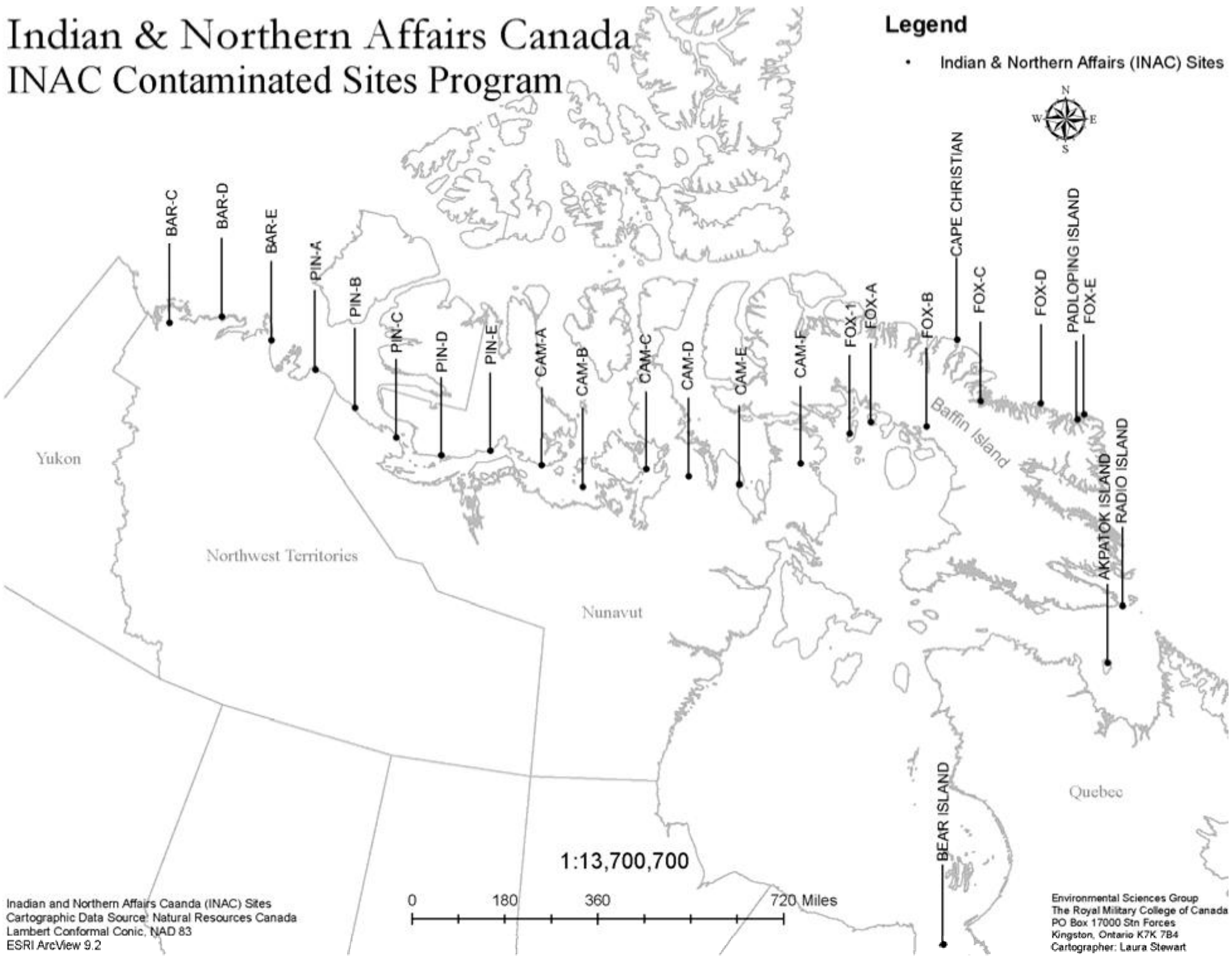

Figure 1 **Location of INAC Military Sites**

1.1 Scope of Document

This document is structured in a manner generally consistent with the steps outlined in the Federal Contaminated Sites Action Plan (CSM 2000) as shown in Figure 2. As previously indicated, issues of environmental concern have been identified at the INAC DEW Lines (Step 1). Extensive historical data (Steps 2 and 3) from initial environmental assessments, as well as detailed information collected through assessment of DEW sites under the jurisdiction of DND, has been used to develop the requirements for the detailed assessment of the INAC sites (Step 5), as described in Section 4. Guidelines for development of a remediation strategy (Step 7) are provided in Section 5. Implementation related issues, such as confirmatory sampling, waste manifesting, construction quality assurance/quality control measures (Step 9) are described in Section 6. Post-implementation monitoring requirements are described in Section 7 (Step 10).

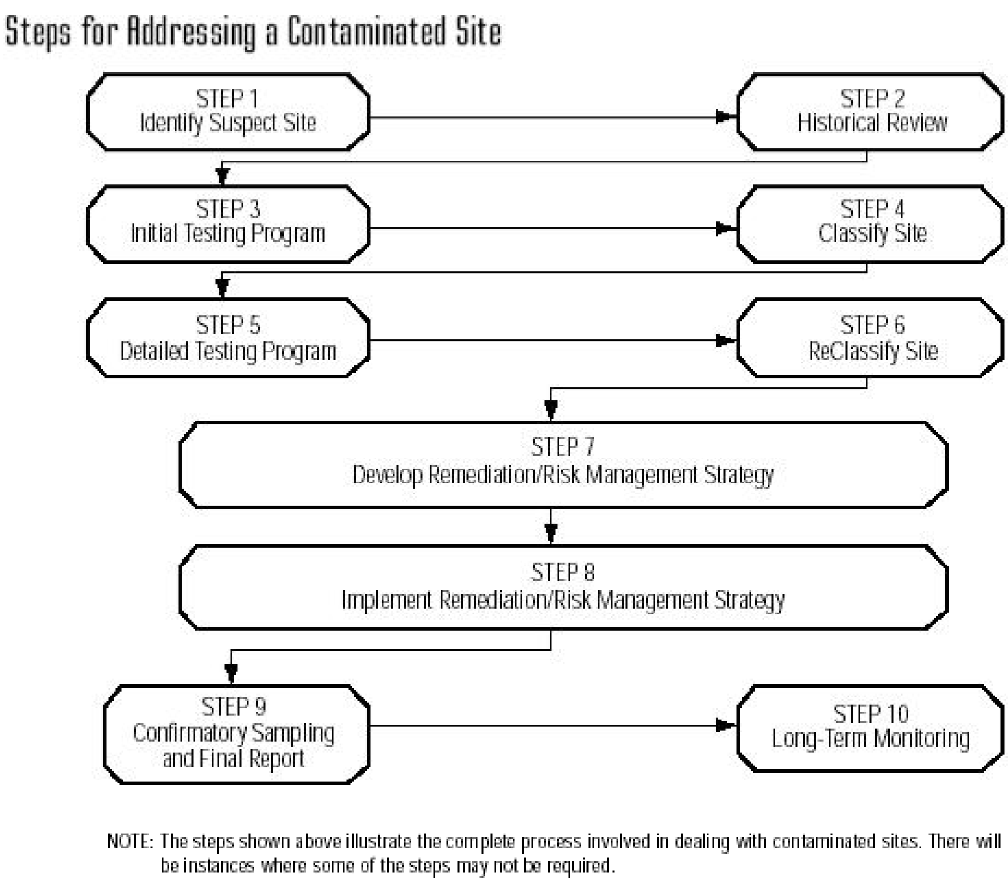

Figure 2	Steps for Addressing a Contaminated Site

2 BACKGROUND

2.1 CCME Environmental Quality Guidelines

Where remediation of federal real property is carried out, departments and agencies are to set remediation objectives in accordance with the most applicable of the three methods developed by the Canadian Council of Ministers of the Environment (CCME) (CCME 1997):

CCME Tier 1: Follow CCME Environmental Quality Guidelines (CCME 1997, 1999), as amended from time to time, and, where applicable, the *Canada-wide Standard for Petroleum Hydrocarbons in Soil* (CCME 2008), as amended from time to time. To the extent that guidelines do not exist for a particular type of contamination, or are technically or economically inappropriate for a particular situation, departments and agencies may follow equivalent guidelines or standards (e.g. provincial);

CCME Tier 2: Follow modified CCME Environmental Quality Guidelines where site conditions, land use, receptors, or exposure pathways differ only slightly from the protocols used in the development of the guidelines; and

CCME Tier 3: Develop site-specific remediation objectives based on a site-specific risk assessment, as outlined by the CCME, or equivalent, where site conditions are unique or particularly sensitive.

Although the CCME Environmental Quality Guidelines are broad in application and address a wide variety of land uses and potential contaminants from diverse sources, they do not specifically address the environmental conditions representative of the Arctic, as discussed in AMSRP Volume 2 (INAC 2009).

2.2 Department of National Defence (DND) DEW Line Cleanup (DLCU) Protocol

The initial environmental assessment of DEW Line sites under the jurisdiction of DND was one of the first major contaminant investigations in the Arctic related to point source contaminants. Following these assessments in the early 1990s, DND developed a remedial protocol in consultation with other government agencies and stakeholders (ESG 1991, 1993), and referred to it as the DEW Line Cleanup (DLCU) Protocol. This Protocol was developed at a time when no remediation standards and criteria specific to the Canadian Arctic existed. The remedial criteria were developed using a contaminant source and pathway targeted approach, consistent with CCME's Tier 3 method. A broad suite of chemicals was investigated and contaminants of concern at DEW Line sites were identified as those contaminants that were consistently elevated relative to the site background levels and the available Canadian federal or provincial guidelines (CCME 1991). The rationale for selection of contaminants of concern is provided in AMSRP Volume 2 (INAC 2009). Engineering input with respect to remediation strategies was used to refine the cleanup protocol (ESG/UMA 1995) prior to its implementation at the first DND sites in 1996.

Cleanup of Arctic sites presents a number of unique challenges, including but not limited to:

- Remote site location, with access limited to sea-lift and small aircraft during the summer months, and over-land during winter;
- Short construction season, typically from July to September, which may limit the technical feasibility of remedial options;
- Lack of centralized waste disposal facilities;
- High costs associated with mobilization of equipment and personnel to the sites, both during the site assessment and remedial phases; and
- Sensitivity of the Arctic ecosystem to changes in physical habitat.

Experience gained since 1996 at the DND sites has been reviewed annually to evaluate lessons learned and to incorporate new information and methodologies as they become available. The DLCU protocol therefore is the culmination of scientific and engineering expertise that has been applied across the Arctic at the DND sites.

Although there are many similarities between INAC and DND DEW sites, the INAC sites were in operation for a significantly shorter period of time, and environmental issues tend to differ in scale. In addition, there may have been other land use subsequent to the DEW Line activities. INAC sites and the associated known land uses are summarized in Table 2.1

Table 2.1 Summary of INAC Military Sites and Historic Land Use

Site Designation/Name	Location	Other Historic Land Use/ or Issues
BAR-C Tununuk Camp	NWT	Imperial Oil as Lessee
BAR-D, Atkinson Point	NWT	Canadian Marine Drilling (CANMAR) Canadian Reindeer Ltd. (note: cleanup on-going)
BAR-E Horton River	NWT	SRR, (note: cleanup completed, monitoring on-going)
PIN-A Pearce Point	NWT	Biological Research Station (note: cleanup completed, monitoring ongoing)
PIN-B Clifton Point	Nunavut/Kitikmeot	
PIN-C Bernard Harbour	Nunavut/Kitikmeot	
PIN-D Ross Point	Nunavut/Kitikmeot	
PIN-E Cape Peel	Nunavut/Kitikmeot	
CAM-A Sturt Point	Nunavut/Kitikmeot	
CAM-B Hat Island	Nunavut/Kitikmeot	Short Range Radar (SRR) as part of North Warning System
CAM-C Matheson Point	Nunavut/Kitikmeot	
CAM-D Simpson Lake	Nunavut/Kitikmeot	SRR (module train dismantled and buried on site)
CAM-E Keith Bay	Nunavut/Qikiqtaaluk	Module train gone/some evidence of burning
CAM-F Sarcpa Lake	Nunavut/ Qikiqtaaluk	Research Station (note: cleanup completed, monitoring ongoing)
FOX-1 Rowley Island	Nunavut/Qikiqtaaluk	SRR (large burn area, module train gone)
FOX-A Bray Island	Nunavut/Qikiqtaaluk	SRR (module train gone)
FOX-B Nudluardjuk Lake	Nunavut/Qikiqtaaluk	SRR (module train gone)
FOX-C Ekalugad Fiord	Nunavut/Qikiqtaaluk	
FOX-D Kivitoo	Nunavut/Qikiqtaaluk	Fire destroyed main building train in 1963
FOX-E Durban Island	Nunavut/Qikiqtaaluk	Partially burned building

Site Designation/Name	Location	Other Historic Land Use/ or Issues
Cape Christian	Nunavut/Qikiqtaaluk	LORAN Site
Padloping Island	Nunavut/Qikiqtaaluk	Navigational aid and weather station
Radio Island	Nunavut/Qikiqtaaluk	Navigational aid and weather station (note: cleanup completed, no monitoring required)
Bear Island	Nunavut/Qikiqtaaluk	Mid-Canada site
BAF-5 Resolution Island	Nunavut/Qikiqtaaluk	Pole-Vault site (note: cleanup completed, monitoring ongoing)
Iqaluit, Upper Base	Nunavut/Qikiqtaaluk	Pole-Vault site (note: cleanup completed, monitoring ongoing)

Cleanup objectives were set for the INAC sites, and the INAC AMSRP was developed as outlined in the following sections.

3 CLEANUP OBJECTIVES

Cleanup objectives, which are consistent with the Federal Contaminated Sites Management Working Group (CSMWG) objective to “integrate sustainable development and pollution prevention principles while meeting environmental regulations and protecting public health” (CSM 2000, TB 1998, 2000, 2002), are as follows:

- To restore sites to meet the environmental objectives established for northern sites;
- To prevent migration of contaminants into the Arctic ecosystem;
- To remove physical hazards for the protection of human health and safety; and
- To implement a cost effective remediation solution.

These objectives are consistent with those applied in the remediation of DEW Line sites under the jurisdiction of DND (DGE 1996, 1998). The following considerations need to be taken into account when developing and implementing a Remedial Action Plan (RAP) for INAC sites:

- Respect all historical agreements and obligations in a fair and reasonable manner;
- Ensure consistency with federal guidelines for management of contaminated sites;
- Apply the Canadian Council of Ministers of the Environment (CCME) environmental protection and management approaches (CCME 1996, 1997, 1999, 2001, 2008) as applicable;
- Apply simple, practical remedial solutions wherever possible, with flexibility as necessary to adjust to site-specific conditions when they are identified;
- Establish cost effective solutions through use of best practices to ensure appropriate levels of environmental protection for all sites;
- Recognize the concerns of climate change in an Arctic setting; and
- Ensure long-term effectiveness of the environmental remedial measures.

It is Canadian government policy that all federal departments and agencies ensure sound environmental stewardship with respect to property in their care by avoiding contamination and managing contaminated sites in a consistent and systematic manner that recognizes the principle of risk management and results in the best value for the Canadian taxpayer (TB 1998, 2000, 2002). The following section identifies the primary factors that have been considered in developing a remediation approach.

3.1 Biophysical Environment

The INAC abandoned military sites are located across the Arctic in the Southern Arctic Ecozone in the western Arctic, in the Northern Arctic Ecozone in the central and eastern Arctic, and the Arctic Cordillera along the east coast of Baffin Island. The majority of the sites are located along the coastline. (Agriculture and Agri-Food Canada, 1996).

Mean annual temperatures are in the range of -11^{0}C in the western Arctic and tend to be colder in the central and eastern Arctic. Accordingly, all sites are located within the zone of continuous permafrost. Much of the Arctic region is classified as polar desert as annual precipitation, predominantly as snow, is generally within the range of 100 to 300 mm. One exception is the eastern coastline of Baffin Island near Cumberland Peninsula, where precipitation can be in the order of 400 to 600 mm annually.

As indicated, the Arctic ecosystem is characterized by extreme environmental conditions, including cold temperatures, large seasonal fluctuations in incoming solar radiation, extensive snow and ice cover, and short growing seasons. These conditions affect the productivity, species diversity, wildlife behaviour (e.g., migration), and food chain characteristics of Arctic ecozones. For example, productivity in terrestrial, freshwater, and marine environments is reduced due to limited nutrient availability, low light, low temperatures, ice cover, and short growing seasons. Compared to most other ecosystems, the Arctic is characterized by relatively low reproduction, organisms that are slower to reach sexual maturity and are generally longer lived, lower species diversity, and distinctive sub-ice biological communities. Relatively short food chains, which are characteristically known for their dominance of marine mammals and birds, are associated with simple predator-prey relationships (e.g. phytoplankton-zooplankton-fish-seal-polar bear or phytoplankton-zooplankton-whale). The combination of all these physical factors affect the sparse distribution and number of Arctic biological communities and makes them very sensitive to physical disturbances such as habitat destruction (AMAP 1998, CACAR 2003).

The assessment and remedial protocols developed are cognizant of striking a balance between the physical disturbances of existing impacted areas versus the physical disturbances of developing new areas required to support remediation activities.

4 ASSESSMENT PROTOCOL

The elements of the assessment protocol have been developed through the review of previous work at related sites (eg. PWGSC 2001a-c, 2002a-f, IEG 2001, EWG 1998, 1999, UMA 1994) and take into consideration information of particular relevance to the unique character of the INAC sites. Typical environmental issues at abandoned military sites include:

- Contaminated soils;
- Existing solid waste disposal areas;
- Debris on surface and in waters near the sites;
- Debris associated with the demolition of structures/facilities; and
- Hazardous waste.

The objective of the environmental assessment of these sites is to collect sufficient information to allow development of a Remedial Action Plan (RAP).

Issues related to implementation, including but not limited to: environmental screening, permitting, and construction, also require information to be collected at the assessment stage. These information requirements can include:

- Geotechnical site information relating to potential development areas for landfills and/or hydrocarbon contaminated soil treatment area, and available borrow sources;
- Site access, such as condition of roadways, the airstrip, barge landing areas, requirements for winter roads or CAT train routes;
- Potable water supply and seasonal fluctuations of potable water supply;
- Siting of camp facilities and temporary storage areas;
- Natural Environment Assessment;
- Traditional Knowledge Surveys/Assessment; and
- Archaeological Assessment.

This section of the protocol provides guidance related to conducting an environmental site assessment that meets the requirements of the INAC cleanup objectives.

4.1 Background Geo-Chemical Assessment

Application of remedial criteria must take into account background concentrations of inorganic elements, as naturally elevated concentrations of a select number of inorganic elements may impact assessment and subsequent remedial activities. High natural variability in concentrations of inorganic elements on a local scale has been observed at several DND DEW Line sites (PIN-1, DYE-M, FOX-2, FOX-3). Based on a desk-top study of the geochemistry and surficial and bedrock geology, a detailed investigation of background concentrations is required in conjunction with the environmental site assessment of the following sites:

- Ross Point (PIN-D)
- Nadluarjuk Lake (FOX-B),
- Kivitoo (FOX-D),
- Durban Island (FOX-E) and
- Padloping Island.

A statistically valid approach must be used to design a sampling program for the collection of representative samples from background areas. Guidance for the background geochemistry investigation is provided in AMSRP Volume 2 (INAC 2009).

4.2 Contaminated Soils

4.2.1 Inorganic Elements and PCBs – DCC Criteria

The contaminants of concern for INAC abandoned military sites, where historic land use is limited to former DEW Line operations, is based on a detailed review of data collected to date from DND and INAC site assessment and delineation programs. The DEW Line Cleanup (DLCU) Protocol, which includes criteria for a specific, limited set of contaminants, is considered appropriate for INAC sites. Supporting documentation for selection of these criteria is provided in AMSRP Volume 2 (INAC 2009).

This provides a consistent approach across all sites, and is generally considered protective of the Arctic ecosystem as described in AMSRP Volume 2 (INAC 2009). Table 4.1 identifies the parameters and criteria.

Table 4.1 DEW Line Cleanup Criteria (DCC) for Soil[a]

Parameter in Soil	**CRITERIA[b]** mg/kg	
Inorganic Elements	*DCC Tier I [c]*	*DCC Tier II[d]*
Arsenic (As)		30
Cadmium		5.0
Chromium		250
Cobalt		50
Copper		100
Lead	200	500
Mercury		2.0
Nickel		100
Zinc		500
Polychlorinated biphenyls		
PCBs	*1.0*	*5.0*

a. These criteria were adopted specifically for the cleanup of Arctic DEW Line Sites from the 1991 versions of the Quebec Soil Contamination Indicators and the Canadian Council of Ministers of the Environment Interim Canadian Environmental Criteria for Contaminated Sites. They were validated by an assessment of the soil concentration at which the substance was taken up by vascular plants and thereby constituted an input to the Arctic ecosystem.

b. Soil criteria are given in parts per million, ppm.

c. Soils containing lead and/or PCBs at concentrations in excess of DCC Tier I, but less than DCC Tier II, may be landfilled in a Non-Hazardous Waste Landfill,

d. Soils containing one or more substrates in excess of DCC Tier II are to be treated/disposed of in a manner that precludes contact with the Arctic ecosystem.

A review of data collected on INAC sites with land use other than DEW Line activities indicated that the likelihood of other parameters occurring systematically at concentrations exceeding applicable criteria in the absence of other contaminants of concern is low (AMSRP Volume 2 (INAC 2009)).

Based on historic patterns of waste disposal and contamination observed at other abandoned military sites, soils contaminated in excess of the DCC criteria are typically found in the following locations:

- In the vicinity of buildings;
- Former sewage discharge areas;
- Former open storage areas;
- Where surface debris is present;
- Solid waste disposal areas; and
- Petroleum, Oil, Lubricant (POL) bulk storage areas and along fuel lines and transfer locations.

Delineation of the lateral extent and depth of contamination is required to determine quantities of sufficient accuracy to develop a RAP and the subsequent Contractual Drawings and Specifications. A detailed sampling plan shall be developed for each potential area of concern identified as part of historic review, and shall include the following information:

- Description of the objective for each potential area of concern;
- Sampling locations;
- Sampling methodology;
- Proposed number of samples and media;
- Parameters for analyses; and
- Analytical requirements and Quality Assurance/Quality Control measures.

Delineation shall be achieved by sampling in a grid pattern over the affected area. The estimated size of the area determines the grid spacing: the larger the estimated area, the larger the grid spacing. Test pits shall be excavated to determine the depth of contamination. Test pits shall also be excavated outside the area of surface contamination to evaluate whether sub-surface migration of contaminants has occurred. Greater sample density may be warranted based on site specific conditions, particularly in areas where soils contaminated with PCB concentrations in excess of 50 ppm are suspected; such as near buildings where electrical transformers were housed, vehicle maintenance structures, and near exit doors of facilities. It is recommended that a reasonable degree of over-sampling and an iterative approach to analyses be employed to provide greater confidence that closure is achieved during the assessment phase, recognizing that the cost of analyses is only a fraction of disposal costs.

Additional samples shall be collected and analysed to determine transport and disposal requirements should off-site disposal of contaminated soils be required.

4.2.2 Hydrocarbon Contaminated Soils

Where free product is encountered, the free phase liquid will be addressed prior to the application of a qualitative risk assessment method for establishing remediation requirements.

A review of the assumptions used for the derivation of the CCME CWS for Petroleum Hydrocarbons (PHC) as well as the need to minimize physical disturbance suggests that direct application of criteria for the protection of all receptors may not be appropriate at the INAC sites AMSRP Volume 2 (INAC 2009). A revised set of criteria are provided in Table 4.2. These criteria incorporate the CWS PHC as appropriate, as well as previous quantitative risk assessment results. Two classes of hydrocarbons were identified, Type A – non-mobile, and Type B – mobile. Type A refers to heavy end products, such as lubricating oils, and are easily differentiated by dark staining. Relative to the CWS PHC, Type A consists of the sum of F3 and F4 constituents. Type B includes lighter end or more volatile hydrocarbon products such as MoGas, jet fuel and diesel, and is approximately equal to the sum of the F1 through F3 fractions. When all four fractions are present, the dominant hydrocarbon type is defined by the percentage of the sum of F3 and F4, relative to the sum of F1 to F4 (total TPH). For Type A contaminated soil, the sum of F3 plus F4 must be greater than 70% of the total TPH concentration **and** the F2 concentration must be less than the F4 concentration.

Table 4.2 Remedial Objectives – Hydrocarbon Contaminated Soil – INAC Abandoned Military Sites

Exposure Pathway	F1	F2	F3	F4	Type B Hydrocarbon Contamination	Type A Hydrocarbon Concentration
Protection of Freshwater Aquatic Life(a)	1290(a)	330(a)	NA	NA	330(a)	NA
Direct Soil Eco-Contact	Not utilized – See AMSRP Volume 2 (INAC 2009)					
Protection of Terrestrial Wildlife					2500(b)	
Human Health		11000	20000			20,000
Management Limit					5000(c)	

Notes:
(a) Within 30 m of a water body
(b) For surface soils to 0.5 metres depth.
(c) Below 0.5 m depth, a value of 5000 mg/kg may be applied based on professional judgement.

Based on historic patterns of contamination observed at other abandoned military sites, soils contaminated with hydrocarbons are typically found in the following locations:

- In the vicinity of buildings near fuel distribution lines, fuel dispensing tanks;
- Former open storage areas and/or debris areas where barrels may be present;
- Petroleum, Oil, Lubricant (POL) bulk storage areas; and
- Solid waste disposal areas.

Delineation of the lateral extent and depth of contamination is required to determine quantities of sufficient accuracy to develop a RAP and the subsequent Contractual Drawings and Specifications. A detailed sampling plan shall be developed for each potential area of concern identified as part of historic review, and must include the following information:

- Description of the objective for each potential area of concern;
- Sampling locations;
- Proposed sampling methods for shallow and depth samples, where the depth sampling should achieve a depth consistent with the estimated active layer thickness;
- Proposed number of samples and media;
- Parameters for analyses in accordance with Table 4.2;
- Sampling methodology, analytical requirements, Quality Assurance/Quality Control measures.

At minimum, the information requirements as outlined in Table 4.2 shall be incorporated into the Sampling Plan.

Table 4.3 Hydrocarbon Contaminated Soil Information Requirements

Item	Comments
Hydrocarbon Contaminated Soils – Stained Soils (F3/F4 fraction) – Type A	
Areal Extent -Visible surface staining	Topographic survey and location/coordinates of stained areas and sample locations Provide sketches with measurements
Topography	Examine for evidence of erosion (drainage channels)
Soil Description	Include description of grain size distribution, well graded or poorly graded. Fine grained, coarse grained, maximum particle size
Sampling	Collect soil samples for analyses of F1 to F4 fractions to characterize contamination, analyses for presence of co-contaminants such as PCBs.
Confirm Depth of Staining	Testpit to extent of stain, collect soil sample for PHC analyses at 0.5 m depth.
In areas of multiple staining	Identify and survey extent of stains Collect individual samples from most visibly stained areas to represent “worst” case. Focus on stained areas larger than 4 m^2
Evidence of residual or free product	
Hydrocarbon Contaminated Soils – Near Fuel Storage, Distribution or Dispensing Areas (F1-F3 fraction) Type B	
Within 30 m of water body supporting aquatic life	
Describe surrounding environment	Consulting locals and elders who use the area may prove to be useful.
Sampling – Hydrocarbons	Delineate **laterally and at depth** to 330 mg/kg as per on-site analytical capabilities Collect sufficient samples for laboratory analyses of hydrocarbon fractions to confirm correlation with on-site analytical results. Over-sampling (within reason) and iterative analyses may be required where there is poor correlation with test-kits (organic materials)
Sample groundwater in testpit excavation in source zone.	Collect groundwater samples and analyze for dissolved hydrocarbons (F1, F2) and wastewater discharge criteria (Section 6). Measure water levels, and presence of free product, if applicable

Item	Comments
Greater than 30 m distant of water body supporting aquatic life	
Sampling – Hydrocarbons	Delineate **laterally and at depth** to 2500 mg/kg as per on-site analytical capabilities. Collect sufficient samples for laboratory analyses of hydrocarbon fractions to confirm correlation with on-site analytical results For the purposes of comparison, use the summation of F1 to F3 concentrations.
Collect soil samples for grain size distribution	Representative samples should be taken of soils within and downgradient of the source zone for determination of grain size distribution, and water content.
All Hydrocarbon Contaminated Soil Areas	
Topography	Survey sample locations and topography of source zone and surrounding area. Include min. 25 m buffer zone around contaminated areas. Document seepage zones (toe of embankments), if applicable. Evidence of erosion
Evidence of impacted vegetation	Note presence and extent of vegetation; identify areas of stressed vegetation if applicable.
Wildlife	Note presence or evidence of wildlife (nests, burrows, etc.) within impacted and surrounding area. Review in context with overall Natural Environment Survey (Section 4.9)

Additional representative samples shall be collected and analysed to assist in the determination of treatment requirements. Samples should be collected from areas representing the largest contributions to the PHC contaminated soil volumes (such as bulk fuel storage areas). These analyses include, but are not limited to:

- Water content
- Total Available Nutrients; Total Organic Carbon
- Treatability tests to assess bioremediation potential (bacterial counts, hydrocarbon degraders).

4.3 Solid Waste Disposal Areas

Solid Waste Disposal Areas (WDA) on INAC abandoned military sites are generally smaller in extent than those located on DND DEW Line sites, and may be more appropriately referred to as buried debris areas or dump sites. As part of the historic review, areas of ground disturbance/landfill activity will be identified for further investigation. A detailed investigation/sampling plan shall be developed for each area, and must include the following information:

- Description of the objective for each potential area of concern
- Methodology for determining extent of buried debris using non-intrusive geophysical surveys, such as Electro-Magnetic Surveys (EM) or Ground Penetrating Radar (GPR), and associated ground-truthing. The consultant is to indicate the type of geophysical survey to be used based on anticipated ground conditions. In general, a grid-survey pattern shall be used that provides adequate coverage of the area. Identification of areas of surface debris within the geophysical survey area is required to allow correlation with geophysical survey results. All geophysical surveys must be referenced to a UTM coordinate system.
- Identification of sampling locations both up- and down-gradient of the landfill, debris area or dump site.
- Proposed sampling methods for shallow and depth samples, where depth sampling should achieve a depth consistent with the estimated active layer thickness.
- Proposed number of samples and media.
- Parameters for analyses.
- Sampling methodology, analytical requirements, and Quality Assurance/Quality Control measures.

In addition, general site information shall be collected as outlined in Section 4.9 and 4.10, as well as specific information for each WDA as described below to support the evaluation of the potential environmental risk associated with the WDA (Annex A).

Physical Characteristics:

Areal Extent of WDA Extent

Depth of Buried Debris, as applicable

Contaminant Characterization (concentrations/extent)

Volume and extent of exposed debris, where exposed debris is defined as surface and/or partially buried debris within 0.5 meters of the surface.

Pathway/Transport Mechanisms

Surface expressions of contaminated soil and/or leachate.

Grades/Topography

Surface cover materials type and depth

Evidence of erosion

Precipitation

Distance to downgradient perennial surface water bodies

Receptor Characteristics

Distance to freshwater/marine habitat and habitat usage.

Terrestrial Habitat

Traditional Land Use

Minor modifications to the evaluation matrix prepared by the DND/NTI Environmental Working Group (EWG 1998) will be used for the assessment of potential environmental risk (Annex A). These modifications included:

- Addressing remedial requirements for dump sites and debris areas (generally smaller in size than landfills)
- Modifying contaminant characterization to include leachate migration and the presence of contaminants as one category.
- Including consideration of snow pack as well as annual precipitation.

Additional detail regarding the evaluation of WDAs is provided in Annex A.

4.4 Surface Debris

Surface debris is present on many of the sites, and may consist of a variety of waste materials including:

- Scrap metal and wood wastes (painted/unpainted);
- Barrels, potentially containing product; and
- Asbestos, batteries, and electrical equipment.

All areas of debris shall be inventoried to the extent possible to provide volume estimates and characterization of waste materials. Site debris shall be classified as inert, non-hazardous wastes or hazardous wastes in accordance with the following Acts and Regulations.

- Federal Transportation of Dangerous Goods Act and Regulations
- The Canadian Environmental Protection Act
- The Nunavut or Northwest Territories Environmental Protection Act

The number of barrels containing product shall be inventoried where it is safe to do so. However, it is impractical to sample and analyse contents of all barrels on site during the assessment phase. To provide information required for the Remedial Action Plan, a statistically relevant number of barrels shall be sampled and analysed. The actual number of barrels sampled will depend on the total number of barrels at the site, and should be determined using professional judgement. Samples will be analysed for parameters in accordance with the barrel protocol, and as summarized below:

Organic Phase: Total Chlorine, PCBs, Cadmium, Chromium, Lead

Aqueous Phase: % Alcohols and Glycols, Total Chlorine, Cadmium, Chromium, Lead

If the aqueous phase is less than 2% alcohols or glycols, water shall be analysed in accordance with waste water discharge criteria. Annex B provides further information on the Barrel Protocol.

4.5 Submerged Debris

Debris may be present in the near shore marine environment and/or lakes that are present on the site. Observations of debris in water shall be recorded to the extent possible and supplemented with local and anecdotal knowledge. Previous studies have confirmed that such debris is primarily a risk to navigation in shallow waters (AMSRP Volume 2 (INAC 2009)).

4.6 Buildings/Structure Inventory

Existing buildings and infrastructure at a site will be demolished down to their foundations as part of the cleanup. To assist in the development of the RAP, an inventory of building contents, foundation construction materials and details, and building/structure construction materials and dimensions are required. Building contents, where present, shall be inventoried and classified as non-hazardous or hazardous wastes. Hazardous building materials may include, but not be limited to: PCB and lead-amended paint, asbestos containing materials (ACMs), fluorescent lights, and mercury containing switches.

Painted building materials shall be tested for total lead and PCBs, and leachable lead and PCBs in order to determine disposal requirements. The thickness and density of the paint and substrate material shall be recorded as it may be required to calculate total PCB concentrations. Samples of concrete, excluding paint, shall be collected and analysed for PCBs. The locations and number of samples are to be determined in the field. Samples should be collected from both stained and non-stained areas on concrete on surface and at depth. Over-sampling and iterative analyses is recommended. As part of the assessment, a detailed waste inventory shall be prepared that includes: dimensions, building materials, foundation materials (concrete slab, timber piles, timber crib), estimated volume and mass of wastes, and the basis of any assumptions used in the estimate. Painted materials must be specifically identified and the extent of paint coverage and adherence quantified.

4.7 Geotechnical Requirements

4.7.1 Potential Development Areas

New engineered landfills and hydrocarbon treatment areas may be required during cleanup. Potential locations shall be identified and surveyed during the site assessment phase. Guidelines for the siting of potential development areas include:

- Avoidance of permafrost sensitive areas, vegetated areas and archaeological features.
- Avoidance of contaminated areas.
- Maintain a distance of 300 m or more from downgradient permanent water features.
- Locate at elevations greater than 2 metres above sea level or storm surge level
- Ground surface topography with grades of 6% or less.
- Proximity to borrow sources, waste materials.

The INAC sites are all located within the zone of continuous permafrost. The sensitivity of permafrost to climate warming consists of two components, the thermal response to warming and the impact of thaw (physical response) (Smith, Burgess, 2004) as cited in AMSRP Volume 2 (INAC 2009). The physical response of the terrain to permafrost degradation is mainly dependent on the ice content of the frozen material (Dyke et al., 1997). Warming of ice-rich perennially frozen ground would eventually lead to its thawing and the resultant thaw settlement, slope instability, thaw slumping, thermokarst, and other permafrost degradation-related processes. Excess ground ice can be identified by landforms at surface, such as patterned ground. An evaluation of the potential for impacts due to climate change is provided in AMSRP Volume 2 (INAC 2009).

Potential development areas shall be surveyed to provide detailed topographic information to allow generation of ground contours. A buffer zone of a minimum of 50 m should be surveyed around all proposed development areas. In previously disturbed areas, soil sampling and analyses shall be carried out to confirm or disprove the presence of any historic contamination using a targeted approach. Additional sampling should be carried out over a grid with spacing of approximately 50 m x 50 m.

4.7.2 Borrow Sources

During cleanup, borrow material is required for construction of new landfills, development of treatment areas, backfilling of contaminated soil excavation, closure of existing landfills, general regrading and for road construction/maintenance.

Available existing sources of borrow material should be exhausted before exploiting new areas. Areas of excess ground ice or of biophysical significance (denning/nesting areas) are to be avoided. Use of abandoned gravel pads and road infrastructure as granular source material is preferable, wherever possible. Existing gravel pads shall be screened for the presence of contaminants during the assessment phase.

Borrow sources shall be identified and characterized and estimated quantities developed. Test-pits shall be excavated to confirm subsurface stratigraphy, seepage, depth to permafrost table or bedrock, and ground ice conditions. Select soil samples shall be retained for geotechnical laboratory testing to assist in the development of Specifications. Testing shall include, but not be limited to: water content, grain size distribution, and moisture density relationships. At sites where background inorganic element concentrations are elevated, additional samples shall be collected for geo-chemical characterization of the borrow material.

4.7.3 Site Access

Access to the sites is typically by barge/ship and aircraft and on site by existing access roads. A limited number of sites are land-locked. Use of the airstrip is essential to mobilize materials and equipment required for site activities. An inspection and sampling of the airstrip fill materials shall be completed during the assessment phase to determine the load capacity to support a variety of aircraft. Drainage and erosion features shall be documented in order to assess the useable length, and/or upgrading requirements.

Investigation of potential CAT Train and/or other equipment mobilization options shall be investigated for the mobilization of heavy equipment. Construction records for Short Range Radar (SRR) sites located in the vicinity may be available as reference. Suitability of the beach for barge landing/sea lift access shall also be assessed. Local knowledge and Traditional Knowledge (TK) may prove useful in evaluating potential CAT train routes as well as suitable barge landing sites.

Helicopter landing pads, associated with Short Range Radar sites, are within the DND reserve. Only a non-intrusive visual inspection should be carried out to document the physical status of these areas.

4.7.4 Siting of Camp Facilities and Temporary Storage areas.

Laydown areas are required for temporary camp structures, equipment and storage during the cleanup. Potential locations shall be identified during the site assessment phase. Where possible, these will be located in previously disturbed areas such as borrow or storage areas, to minimize any new disturbances.

4.8 Potable Water Supply

A suitable drinking water supply shall be identified during the site assessment phase. A qualitative assessment of the flow rates (as applicable) shall be made at the time of the site assessment, as flow will vary throughout the season, with higher flows typically in spring run-off. Identifying the high water mark, and estimating depth of the stream/lake, as applicable, will aid in this evaluation. The Contractor will be advised that water withdrawal rates may not exceed 10% of the flow volume or 10% of the water volume in a lake, and to modify consumption as appropriate. Water samples shall be collected and analysed for criteria in accordance with the latest edition of the CCME Guidelines for Drinking Water Quality.

4.9 Natural Environment Assessment

A thorough assessment of the natural environment of the site and surrounding area shall be conducted as part of the detailed environmental site assessment. This assessment shall be carried out mainly by a biologist with input from a local community representative, where appropriate. This study shall consist of describing the regional and local setting, local ecosystems, species assemblage as well as potential impacts to vegetation and wildlife from cleanup activities and proposed mitigation measures. Additional information requirements are outlined in the following subsections.

4.9.1 Regional and Local Setting

The report should address the following information requirements.

- Location (site coordinates, main natural and man-made features present);
- Ecosetting (ecozones and ecoregions);
- Climate (mean temperature and precipitation data);
- Vegetation;
- Landforms and soils (main land features, soil types, general topography); and
- Human usage and disturbance (TK input will be valuable to assess human usage of the area).

4.9.2 Local Ecosystems

This subsection should describe 1) the various inland ecosystems; 2) the ecosystems present in the former operational areas (*i.e.*, disturbed areas and areas with infrastructure); as well as, if applicable, 3) the shore/coastline ecosystem; and the 4) open ocean ecosystem.

Each identified ecosystem should be described in terms of the various terrestrial and freshwater habitats, the vegetation and wildlife species present in those habitats, as well as past and current impacts and disturbances to habitats. Local and traditional knowledge from people who use these areas for hunting and fishing may provide useful information on plant and wildlife species present as well as ecosystem health.

4.9.3 Species Assemblage

This subsection should describe the various species at risk (*i.e.*, extirpated, endangered, threatened, or special concern) according to the Species at Risk Act (SARA) that occur in the general vicinity of the site, as well as any migratory species that known to breed or nest in the area (Migratory Birds Convention Act).

All species (*i.e.*, birds, mammals, fish, and plants) observed or known to use the site and surrounding areas should be documented. Observations should be described in terms of numbers and behaviour during sighting (*e.g.*, migrating, nesting/breeding, feeding, etc.). Species not observed on site but known to use the area may be documented by consulting local community representatives as well as various studies and reports.

4.9.4 Impacts and Mitigation

Potential impacts to vegetation and wildlife from site investigation and remediation activities should be clearly identified. Proposed constraints and other recommendations should also be presented as part of the Natural Environment Assessment, in order to incorporate these requirements into the Environmental Protection Plan.

4.10 Traditional Knowledge Surveys/Assessment

Traditional Knowledge (TK) forms an integral part of the development of the RAP. Incorporating TK during the assessment phase can provide guidance on targeting specific areas of concern to local residents. Qualitative knowledge provided by local residents can be used to complement and enhance the largely quantitative information provided by the physical studies completed.

TK can be efficiently obtained through a local community representative (*i.e.*, local TK consultant) who can liaise between the Consultant and various TK holders in the community. The local TK consultant may either be an Elder or someone else who knows the site well (*e.g.*, hunter, ranger). The ideal local TK consultant possesses some TK, but more importantly knows who to consult in the community to obtain relevant site information and TK.

4.10.1 Typical TK and Local Knowledge

TK may be grouped into four main categories:

1. Historical and Archaeological Features
2. Wildlife Use
3. Land Use
4. Site Specific Information

Historical and archaeological features provide information on traditional land use of the area. These features, often hidden from the untrained eye, will be identified by local TK holders as to their use and relative age, and can complement the work of the archaeological assessment.

Wildlife use of the land in and around the site includes migration routes, mating and calving grounds, as well as summer and winter-feeding areas of large land mammals. Nesting, moulting, and summer feeding grounds of migratory birds such as geese and ducks, as well as migration routes and feeding areas of sea mammals must also be identified.

Land use relates to traditional usage of the land and sea for hunting, fishing, camping, and harvesting products on land (*e.g.*, berries, eggs, medicine, tea, drinking water), and harvesting of sea products (*e.g.*, clams, kelp).

Site-specific information about the military site while it was under construction or in operation, including events (spills, accidents), waste management practices (storage, dumping), as well as natural occurrences, should also be documented.

4.11 Archaeological Assessment

The overall purpose of the archaeological assessment is to obtain the necessary archaeological regulatory approval at the assessment stage as required to implement the remediation program. The scope of the archaeological assessment shall include:

- Preparation and submission of permit applications to the Department of Culture, Language, Elders and Youth (Nunavut) or the Prince of Wales Northern Heritage Centre (NWT).
- Completion of an Overview for each site, which would include file searches to determine the number, nature and terrain associations of previously recorded sites.
- Completion of a field inventory and assessment of each site;
- Completion of a heritage features or structures evaluation for consideration of heritage value;
- Provision of a heritage resource impact assessment for each site
- Implementation of more detailed investigations at key sites and appropriate mitigation at significant sites affected by proposed projects (if required); and
- Preparation of a final permit report for each site and, if required, provides a summary of these results suitable for inclusion in a screening document.

Areas of high and moderate archaeological potential for containing cultural material will require detailed examination during the assessment phase, to ensure the protection and if required, development of mitigation measures to be implemented prior to or during cleanup.

5 REMEDIATION PROTOCOL

The elements of the remediation protocol have been developed through the review of previous work at related sites by DND and INAC, and take into consideration information of particular relevance to the unique character of the INAC sites.

The primary components of cleanup on the INAC abandoned military sites include:

- Treatment/Disposal of Contaminated Soil
- Disposal of Debris/Demolition Waste
- Closure of Existing Solid Waste Disposal Areas
- Construction of New Landfills
- Development of Borrow Sources and Site Grading Activities

The goals of a RAP are to provide the foundation for development of a cleanup design that will reduce the environmental liabilities present at the site, maximize benefits to local communities and provide good value to the Crown. More specifically, the RAP is to identify and evaluate options applicable to the treatment and/or disposal of waste materials present at a site. These waste materials typically include:

- Soil contaminated with inorganic elements, PCBs and/or petroleum hydrocarbons;
- Non-hazardous and hazardous wastes associated with building/facility demolition;
- Visible/accessible debris including barrel contents; and
- Buried debris/landfills as identified by geophysical surveys

The estimated volume of waste materials in each stream shall be determined and options evaluated on the basis of effectiveness to reduce and/or mitigate environmental risks in the short and long term, long term liability or residual risks, relative costs, monitoring costs and community acceptance. The costs associated with implementing remedial solutions include, but are not limited to: resources, such as materials, equipment, and personnel, and site logistics. Mobilization and site access constitute a significant cost for remote site cleanups, and can have significant impact on selection of the preferred remedial option. The evaluations shall be summarized and preferred remedial options identified for each waste stream. Options shall be integrated to finalize the recommended approach for site remediation.

During remediation planning public community consultations are conducted in surrounding communities to obtain feedback on the draft RAP.

5.1 Contaminated Soils

Contaminated soils are considered in three primary categories: soils that are regulated; soils classified as hazardous; and, soils classified as contaminated but not hazardous waste. Contaminated soils that are regulated shall be remediated and/or disposed of in compliance with the applicable regulations. Hazardous contaminated soils are defined as those that exceed criteria as provided in the Transportation of Dangerous Goods Act and Regulations. Contaminated soils that are not regulated or hazardous shall be excavated to the depth and extent to meet the DCC (see section 4.2.1) or PHC remedial targets (Section 4.2.2).

Three primary contaminated soil types have been identified; inorganic element contaminated soil, PCB contaminated soil and hydrocarbon contaminated soil. Where multiple contaminants are present in the soils, the most conservative remedial option that addresses all contaminant types shall be applied. A summary of remedial options for contaminated soils is presented in Table 5.1.

Table 5.1 Summary of Remedial Options – Contaminated Soil

Contaminated Soil	Remedial Options
DCC Tier I	▪ Excavate and place in an on-site engineered landfill or ▪ Cap in place under 0.3 m of clean fill if in a stable location
DCC Tier II	• Excavate and dispose of in an on-site Tier II facility or • Containerize for off-site disposal[1]
Inorganic Elements Leaching	• Transport in accordance with the TDGA for disposal at an off-site facility
PCB Contaminated Soil in excess of CEPA	• Store in accordance with PCB Regulations pending a decision regarding disposal
Type A TPH (Non-Mobile Hydrocarbon Contaminated Soil)	• Excavate and place in an on-site engineered landfill or • Scarify surficial stains that meet PHC criteria.
DCC Tier I -Type A TPH	• Excavate and place in an on-site engineered landfill or • Cap in place under 0.3 m of clean fill if in a stable location
DCC Tier II -Type A TPH	• Excavate and place in an on-site Tier II disposal facility or • Containerize for off-site disposal[1]
Type B TPH (Mobile Hydrocarbon Contaminated Soil)	• *In-situ* or *ex-situ* treatment to reduce environmental risk to meet guidelines
DCC Tier I -Type B TPH	• Ex-situ treatment to meet guidelines and place in an on-site engineered landfill or cap under 0.3 m of clean fill in a stable location after treatment. • Small areas of contamination may be excavated and disposed of in a Tier II disposal facility
DCC Tier II -Type B TPH	• Excavate and place in an on-site Tier II Facility or • Containerize for off-site disposal[1]
Hazardous Soil	• Dispose in compliance with applicable regulations

[1] Decision of whether to dispose of on or off-site is based on cost –benefit analyses (see Section 5.4.2).

5.2 Debris – Site Debris and Demolition Wastes

Site debris shall be collected and segregated into hazardous and non-hazardous waste streams for disposal:

Non hazardous waste: The volume of the non-hazardous materials shall be minimized through crushing, shredding, or incineration, prior to placement in an on-site engineered landfill. If there is no existing landfill on-site, and no suitable location for a new engineered landfill, non-hazardous materials shall be disposed of off-site; and

Hazardous waste: These materials shall be disposed of off-site, in accordance with the current regulations governing the handling and disposal of hazardous materials.

Hazardous materials referred to in this section are defined as any materials, which are, designated "hazardous" or "dangerous goods" under Territorial or Federal legislation. Generally, all hazardous materials identified at the site shall be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act (TC 2002), to a licensed hazardous waste disposal facility.

Hazardous materials that are typical of abandoned military sites and require special consideration include the following:

PCB Contaminated Concrete: Concrete (excluding paint) with PCB concentrations in excess of 50 ppm is regulated under the CEPA, and shall be collected and transported off-site, in accordance with the Transportation of Dangerous Goods Act and CEPA to a licensed hazardous waste disposal facility.

PCB Paint on Building Components: PCB paint and PCB painted components that are regulated under the CEPA, shall be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act and CEPA, to a licensed hazardous waste disposal facility. The thickness and density of the paint and substrate material shall be recorded as it may be required to calculate total PCB concentrations. Loose paint materials/paint chips are regulated under CEPA when PCB concentrations in the paint are greater than 50 ppm.

Lead-Based Paint on Building Components: Lead-based painted components that are classified as hazardous material shall be collected and transported off site, in accordance with the Transportation of Dangerous Goods Act to a licensed hazardous waste disposal facility. Painted components that exceed the relevant federal or Territorial criteria but are not considered hazardous shall be collected and disposed in an on-site engineered landfill. Lead-based painted materials are considered hazardous when the lead leachate concentrations from a test of the component (paint and substrate) exceed 5 mg/L or the concentration as provided in the latest schedule of the TDGA. Additional discussion related to the classification of painted material is provided in AMSRP Volume 2, (INAC 2009).

There are also a few exceptions, which are described below:

Asbestos: Asbestos waste shall be collected, double bagged and disposed of in an on-site engineered landfill, in accordance with the appropriate legislation. Where no on-site facility is available, asbestos waste shall be shipped off-site for disposal. Where asbestos materials are painted, disposal requirements are based on paint analyses.

Petroleum Products: Petroleum products, such as gasoline or diesel, which do not contain other hazardous products (chlorine, PCB, metals, etc.) will be incinerated on-site under appropriate emissions controls. Heavier petroleum products such as lubricating oil will be disposed of off-site or mixed with lighter petroleum products and incinerated on-site under appropriate emissions controls in accordance with the Barrel Protocol provided in Annex B.

Compressed Gas Cylinders: Compressed gas cylinders with known contents shall be vented. Once empty, the metal cylinder shall be disposed on-site in an engineered landfill. Where no on-site facility is available, compressed gas cylinders shall be shipped off-site for disposal.

Creosote Treated Timbers: Timbers shall be wrapped in polyethylene sheets and disposed on-site in an engineered landfill. Where no on-site facility is available, creosote treated timbers shall be shipped off-site for disposal.

5.2.1 Submerged Debris

Submerged debris shall be removed from the near-shore environment to a depth of 2 metres or 30 metres off-shore, whichever is encountered first. Work in marine and freshwater environments shall be in accordance with all stipulations as provided by the Department of Fisheries and Oceans. Debris, once removed, shall be classified as hazardous or non-hazardous and disposed of as indicated in the previous sub-section.

5.2.2 Barrels

Barrels shall be handled according to the Barrel Protocol (Annex B) and as outlined below:

Empty Barrels: Empty barrels shall be crushed and disposed in an on-site engineered landfill;

Filled or Partially Filled Barrels: Barrel contents shall be inspected and tested if necessary and disposed of appropriately (off-site or incinerated). The empty barrel shall be rinsed, crushed and disposed on-site in an engineered landfill. The spent rinse liquid shall be tested and disposed of appropriately. Absorbent materials used as part of this process shall be incinerated if incineration criteria are met, or disposed of as hazardous material, as required; and

Buried Empty Barrels: Areas containing buried empty barrels will be inspected to determine if any of the barrels contain material and characterized through a geophysical survey. If the barrels are found to be empty, the area will be stabilized through compaction to crush any corroded barrels, if the area is deemed suitable from a geotechnical perspective. A cover of borrow material shall be placed over the area and compacted.

The criteria used to determine the acceptability of product for on-site incineration are summarized in Table 5.2 as follows:

Table 5.2 Barrel Protocol Criteria and Disposal Summary

Phase	% Alcohol or Glycols	PCBs	Chlorine ppm	Cadmium ppm	Chromium ppm	Lead ppm	Disposal
Organic		<2	<1000	<2	<10	<100	On-Site Incineration
Organic		>2	>1000	>2	>10	>100	Ship South
Aqueous	>2		>1000	>2	>10	>100	Ship South
Aqueous	>2		<1000	<2	<10	<100	On-Site Incineration
Aqueous	<2						Discard in accordance with wastewater discharge criteria

Wastewater generated during barrel cleaning shall be treated to meet discharge criteria in accordance with permits and licences issued for cleanup activities.

5.2.3 Buildings and Infrastructure

Existing buildings and infrastructure shall be demolished to concrete foundations. Above-grade timber foundations shall be removed. Where concrete foundations are above grade, the area will be re-graded with the placement of additional granular fill to match surrounding topography. Exposed timber piles shall be removed to a minimum of 0.3 m below ground surface. All hazardous materials shall be segregated prior to or during demolition. Non-hazardous demolition materials and asbestos shall be collected and disposed in an on-site engineered landfill. If there is no existing landfill on site and no suitable location for a new engineered landfill, the non-hazardous materials shall be disposed of off-site. Hazardous demolition materials shall be disposed off-site.

PCB amended painted material shall be containerized in accordance with the Transportation of Dangerous Goods Act, and transported off-site to a licensed treatment disposal facility.

Only in exceptional circumstances will existing buildings remain intact on site following the remediation program. These structures may remain as emergency shelters only once clear transfer of ownership has been established.

5.3 Solid Waste Disposal Area (WDA) Closure

The following section applies to landfills, dumps and debris areas, collectively referred to as WDA.Using the WDA evaluation matrix (Annex A), WDA can be classified into one of three broad categories. Actions associated with each category of WDA have been identified. Where a WDA exists on INAC abandoned military sites, the condition of the WDA shall be evaluated to determine the most appropriate action;

Class A: If the WDA is located in an unstable, high erosion location, it shall be relocated to a properly engineered landfill. A WDA located at an elevation of less than two metres above mean sea level will be removed. During the relocation process, any identified hazardous materials shall be segregated for off-site disposal.

Class B: If the WDA is located in a suitable, stable location, but there is evidence of contaminant migration, potential remedial solutions include excavation or provision of a suitably engineered containment system. Permafrost containment shall be designed in accordance with the geothermal requirements outlined in Section 5.4.2. The remedial solution selected shall be based on a cost-benefit analyses that includes consideration of construction costs and long-term monitoring costs.

Class C: If the WDA is located in a suitable, stable location, with no evidence of contaminant migration, it may be left in place. If required, additional granular fill shall be placed to ensure erosion protection and proper drainage. Consideration must be given to surrounding topography (to blend into existing terrain) and long term monitoring costs.

Additional information related to landfill design and closure is provided in AMSRP Volume 2, (INAC 2009).

5.4 Landfill Development

New engineered landfills may be required for the disposal of non-regulated contaminated soils and non-hazardous debris collected or generated during cleanup. Two classes of landfills are provided:

- Non-Hazardous Waste (NHW) Landfill
- Tier II Contaminated Soil Landfill

5.4.1 Non-Hazardous Waste Landfill

A NHW Landfill is a new landfill constructed for the disposal of non-hazardous debris and building demolition waste. Tier I contaminated soils and Type A PHC soil may also be disposed of in these landfills. Landfills constructed to date at DND DEW sites are predominately above ground facilities. These landfills do not rely on permafrost for containment nor do they include a geosynthetic liner.

The general design parameters include a perimeter berm and landfill cover constructed of a well graded sand and gravel. Clay is generally not available at the abandoned military sites. The sand and gravel should have a minimum of 8% fines (<0.08 mm) and be compacted to a minimum of 95% maximum dry density (ASTM D698). The landfill should have a maximum debris thickness of 3 m and minimum cover thickness of 1.0 m.

To reduce settlement and ground subsidence, debris should be placed in maximum 0.5 m thick lifts with granular fill placed over each lift of debris to fill the voids (intermediate fill). Intermediate fill should be a minimum of 0.15 m thick and worked into the underlying debris. The final landfill surface must be graded such that water ponding does not occur. Ponding and infiltration could increase the seasonal thaw depth or contribute to leachate generation. The landfill surface must not be so steep that it promotes erosion of the cover materials, which could expose debris.

Fill material for the landfill cap should be a well-graded material that is relatively erosion resistant and will have moderate water infiltration. Alternative designs or surface treatments, such as imported coarser gravels and cobbles, vegetation covers at sites where it is possible to vegetate the sites, roller compacted concrete or other synthetic surfaces, are required if erosion resistant materials are not present on site.

Final landfill design parameters including granular fill specifications, side slopes, cover thickness, and maximum height of landfill are dependent on site specific ground conditions and borrow availability. Designs must be reviewed by a geotechnical engineer with permafrost experience.

5.4.2 Tier II Contaminated Soil Landfill

The decision as to whether to construct a Tier II Contaminated Soil Landfill on site is based on a number of factors, including but not limited to those summarized in Table 5.3. These criteria were based on generic designs and relative cost estimates and may not accurately reflect site-specific conditions. These are provided as a guideline only.

Table 5.3 Decision Criteria Tier II Contaminated Soil Landfill

Is the site landlocked?	For landlocked sites, off-site transport costs increase significantly. Consideration should be given to on-site disposal facility.
Is landfill excavation required.	Landfill excavations pose contracting risks due to unknown quantities of waste material. To mitigate risks, an on-site Tier II disposal facility should be considered.
Are known contaminated soil volumes less than 300 to 500 m^3.	If yes, evaluate contingency factors and potential over-runs. If significant risk of quantity overrun is present, construct landfill on-site. If volume of contaminated soil estimated to be below these values, ship off-site for disposal.
Are known volumes of contaminated soil between 500 and 1000 m^3	Evaluate site specific conditions, and develop preliminary design and cost estimate for an on-site disposal facility using site specific information. Confirm availability and quality of borrow material.
Are known volumes of contaminated soil greater than 1000 m^3.	If yes, confirm availability and quality of granular borrow. If granular borrow sufficient, develop preliminary design and cost estimate for an on-site disposal facility, using site specific conditions. Re-evaluate on-site disposal costs versus off-site disposal and confirm cost-benefit.

The Tier II Contaminated Soil Landfill design is based on the containment of contaminated soil in a landfill provided with a geo-synthetic liner and a granular fill cover of sufficient thickness to maintain the contaminated soil in a frozen condition. The required fill thickness is a function of the climatic conditions selected as the design criteria.

Geothermal analyses are required to substantiate the use of permafrost as a means of containment for the landfills. Analyses are carried out to predict the short-term and long-term ground temperatures for the Tier II Contaminated Soil Landfill to determine:

- Length of time for landfill freezeback;
- Short-term and long-term thermal regime in the landfill; and
- Depth of annual thaw (active layer) in the cover material.

Geothermal analyses should be carried out for the landfills using two-dimensional finite element computer models. The models simulate transient, two-dimensional heat conduction with a change of phase for a variety of boundary conditions. Heat exchange at the ground surface should be modeled with an energy balance equation that considers air temperatures, wind velocity, snow depth, and solar radiation. The models should include the temperature phase change relationships for saline soils, such that freezing depression and unfrozen water content variations can be explicitly modeled.

Soil thermal properties required to carry out geothermal analyses include: porewater composition, latent heat, specific heat (frozen and unfrozen), and thermal conductivity (frozen and unfrozen). These properties are determined indirectly from well-established correlations with soil index properties, moisture content, grain size distribution, bulk density, salinity, etc. (Farouki, 1986; Johnston, 1981). Soil index properties are based on information collected during the site investigations.

Climatic data required for the thermal model include monthly mean air temperature, wind speed, solar radiation, and snow cover. The thermal analysis should be calibrated to measured temperatures and/or observed active layers thicknesses. The landfill designs include analyses for mean temperature conditions, warm conditions and long-term climate change. Statistical analyses are carried out to determine mean monthly temperatures representative of a 1 in 100 warm year. The freezing index and thawing index for each year are calculated from the recorded air temperature data. The index for each year is ranked in ascending order and plotted. A “best-fit” line is drawn through the set of points to estimate the 1 in 100 warm year index. Mean monthly air temperatures are increased by the ratio of the 1 in 100 warm year freezing or thawing index to the mean year freezing or thawing index to estimate the mean monthly temperatures of a 1 in 100 warm year. The influence of climate change should be evaluated by similar methods presented in ACIA (2005). This includes the average estimated seasonal temperature changes by various Global Circulation Models (GCMs).

Given the uncertainties in climate change and the cost of returning to a site at a future date, it is recommended that the Soil Disposal Facility be designed for 100 years of long-term climate warming (average of four GCMs) as a minimum. With this design condition, the active layer could penetrate the contaminated soil if a warm year occurred. Containment during this condition would be provided by the thick soil cover and the geomembrane liner. Additional factors of safety can also be applied to account for uncertainties in the geothermal model, soil input parameters, and climate input parameters, or the facilities can be designed for climate change plus one 1 in 100 warm year.

5.5 Borrow Source Development

Granular borrow material will be required for the development of new landfills and general site grading purposes.

5.5.1 Site Grading

Grading operations generally consist of the shaping and regrading of disturbed areas to blend in with the natural contours, in accordance with all applicable licenses. Disturbed areas may include:

- contaminated soil excavation areas,
- existing and new landfill areas,
- debris areas,
- areas disturbed during demolition activities,
- granular borrow areas, and
- any area disturbed during establishment and operation of the camp, equipment storage and maintenance activities.

5.6 Contractor Support Activities

For implementation of remedial activities, a Contractor will establish a camp and storage areas on-site, where required. Where possible, these will be located in previously disturbed areas such as borrow or storage areas, to minimize any new disturbances in accordance with all applicable licenses.

Domestic refuse generated by the camp shall be incinerated and disposed of on-site in an engineered landfill. Sewage shall be handled by an appropriately sized sewage treatment system, in accordance with applicable legislation and all applicable licenses.

Wastewater generated by the Contractor, shall be treated to meet discharge criteria as stipulated in permits and licenses issued for the project.

Potable water supplies at the site will be tested and used, only if they meet the Canadian Drinking Water Quality Standards (CCME 2002) or the latest edition thereof, in accordance with all applicable licenses.

Fuel required for the operation of the camp will be stored on-site in accordance with applicable legislation and licenses.

All hazardous materials shall be segregated prior to or during demolition. Non-hazardous demolition materials and asbestos shall be collected and disposed in an on-site engineered landfill. Hazardous demolition materials shall be disposed off-site.

Only in exceptional circumstances shall existing buildings remain intact on site following the remediation program. These structures may remain as emergency shelters once clear transfer of ownership has been established.

6 CONSTRUCTION RELATED IMPLEMENTATION REQUIREMENTS

Consistent with Step 9 of the Federal Contaminated Sites Action Plan, confirmation that the objectives of the RAP have been met is required. Based on the issues typically associated with the remediation of INAC sites, confirmatory testing encompasses a wider range of activities. These include, but are not necessarily limited to:

- Confirmatory testing of contaminated soils;
- Quality Assurance testing of earthworks associated with the remediation and construction of landfills;
- Testing as required for waste manifesting to allow for shipment and disposal of materials off-site; and
- Testing as required to meet the requirements of Land Use Permits, and/or other Licences/Permits issued for the cleanup program.

The requirements and/or guidelines for these testing programs are outlined in the following sub-sections.

6.1 Confirmatory Testing Contaminated Soils

Following excavation of contaminated material confirmatory samples shall be collected and analyzed to ensure that cleanup objectives have been met. Sampling will be conducted by a third party qualified to carry out such work. A detailed sampling plan shall be developed for each area of concern identified for excavation in the RAP, and must include the following information:

- Description of the objective for each potential area of concern
- Sampling locations
- Sampling methodology
- Proposed number of samples and media
- Parameters for analyses
- Analytical requirements, and Quality Assurance/Quality Control measures.

6.1.1 Tier I contaminated soils

Tier I criteria were developed to address aerial transport of contaminants; excavation and backfilling precludes this pathway. If, during the site assessment, sufficient evidence has been collected to demonstrate that soils at depths of greater than 0.3 m below surface do not exceed Tier II levels for inorganic elements or PCBs, confirmatory sampling will not be required.

6.1.2 Tier II contaminated soils

Confirmatory sampling shall be carried out using a systematic grid sampling design following the DND DLCU Confirmatory Sampling Protocol as summarized in Table 6.1. This design provides a practical and simple method for designating sample locations and ensures uniform coverage of a site. Discrete samples should be collected at every point on the grid. For small areas, all samples shall be analyzed, whereas for larger areas only a fraction of the interior grid samples shall be analyzed. When choosing sample locations for analysis, consideration shall be given to areas of previously high concentrations. No single sample result or the mean of a duplicate/replicate sample shall exceed the cleanup objectives. In cases where field analytical methodology is used, 10-20% of the samples analyzed in the field should also be analyzed in the laboratory for quality control purposes.

Table 6.1 Confirmatory Testing Grid Sizes

Size of area	Grid size	# Perimeter samples analyzed	# Interior grid samples analyzed
<100 m^2	3x3 m	all	all
>100 m^2, <2500 m^2	6x6 m	50%	40%
>2500 m^2	12x12 m	50%	40%

6.1.3 Hazardous Soils

Confirmatory sampling following excavation of soils considered hazardous according to CEPA (PCBs >50 ppm) or the TDGA may require a more closely spaced grid than outlined in Table 6.1 to minimize the overall volume of materials requiring off-site disposal.

6.1.4 Type B TPH (Fractions F1 to F3)

Confirmatory sampling following excavation of petroleum hydrocarbon impacted soils within 30 m of a water body supporting aquatic life will follow the confirmatory sampling protocol outlined in section 6.1.2. The remedial solution for petroleum hydrocarbon impacted soils further removed from surface water bodies involves excavation of source areas. In cases where field analytical methodology is used, 10-20% of the samples analyzed in the field should also be analyzed in the laboratory for quality control purposes. For comparison purposes, total petroleum hydrocarbons (TPH) data obtained by hexane extraction can be compared to data generated using the CCME analytical procedure for PHC in soils by summing fractions F1 to F3. The presence of residual petroleum hydrocarbon contamination is expected following excavation to design limits as outlined in the RAP. Representative samples from the base of the excavation will be collected and analyzed for record keeping purposes using the CCME analytical procedure for PHC in soils.

6.1.5 Ex-situ Confirmatory Sampling

Soils excavated from landfills and dumps will be classified ex-situ. Excavated soils will be placed in windrows or stockpiles with a maximum stockpile size of 20 m^3 (B.C. Environment, 1995). Debris is separated from the soil and sorted as potentially hazardous and non-hazardous under the supervision of the Hazardous Materials Specialist. Stained soil and soil associated with potentially contaminated debris such as battery waste or barrels must be stockpiled separately from other soil to prevent dilution and facilitate disposal.

As part of the sampling protocol, two types of soil samples shall be collected from stockpiles: discrete and composite. Sample locations are selected at various surface and depth locations in each stockpile to obtain samples that are representative of the entire pile. Five discrete samples are collected and analyzed for the first 20 stockpiles and every 20th stockpile thereafter. Composite samples shall be collected and analyzed at all stockpiles. Composite samples consist of approximately equal volumes of soil collected from five discrete sample locations.

The standard deviation for each stockpile shall be calculated based on discrete sample results. These standard deviations are then used to calculate the average standard error for all stockpiles (Equation 1). Twice the average standard error is added to the analytical result for the composite sample to provide a 95% upper confidence limit (Equation 2).

$$SE_{avg} = \frac{\sum_{1}^{m}\left(\frac{SD}{\sqrt{n}}\right)}{m} \qquad \textbf{(Equation 1)}$$

$$UCL = [Composite_x] + 2(SE_{avg}) \qquad \textbf{(Equation 2)}$$

n = number of sample values,

SE_{avg} = average standard error,

SD = standard deviation of the sample values,

m = number of stockpiles,

UCL = upper confidence limit and

x = the stockpile number.

Classification of stockpiles for disposal is based on a comparison of the 95% upper confidence limit values and the relevant clean up objectives. The first 20 stockpiles shall be analyzed for the eight inorganic elements for which the DCC criteria are applicable and PCBs. Selection of samples for analysis for petroleum hydrocarbon will be based on visual and/or olfactory evidence. This process shall be repeated for every 20th stockpile thereafter. All the remaining stockpiles will be tested for copper, lead and zinc and any other analyte that exceeded the DCC criterion previously until it is no longer present (Table 6.2). Field analysis can provide adequate detection limits for statistical classification of certain contaminants (PCBs and PHC), while others (inorganic elements) must be analyzed in CAEAL accredited laboratories for more precise results.

Table 6.2 Analytical Requirements for Stockpile Sampling

Stockpile No.	Samples Collected	Analytical Suite	Samples for Analyses
1 through 20	**5 discrete** 1 composite	**PCBs, Cu, Ni, Co, Cd, Pb, Zn, Cr, As** PHC and Hg where evident	All discrete and all composite samples are analyzed for first 20 stockpiles
Every 20th thereafter	**5 discrete** 1 composite	**PCBs, Cu, Ni, Co, Cd, Pb, Zn, Cr, As** PHC and Hg where evident	All discrete and all composite samples are analyzed
Remaining stockpiles	**1 composite**	**PCBs, Cu, Pb, Zn** PHC, Hg and other inorganic elements where evident	Every composite sample is analysed.

Once the excavation is complete, the base of the landfill excavation must be sampled in accordance with confirmatory sampling protocol for Tier II soils.

6.1.6 Confirmatory Sampling of Material Processing Areas

Residual contamination may be present at barrel processing areas, hazardous materials processing areas, and stockpile lay down areas after clean up activities are complete. Once an area is no longer in use, a detailed inspection for evidence of staining and other indicators of contamination such as visible debris or paint flakes shall be carried out. Samples must be collected in these areas in a grid pattern based on the size of the area (see Table 6.1). In cases where field analytical methodology is used, 10-20% of the samples analyzed in the field should also be analyzed in the laboratory for quality control purposes.

6.2 Quality Assurance Testing of Earthworks

At most sites, earthworks will be carried out as part of the construction of new landfills, remediation of existing landfills, and/or development of hydrocarbon contaminated soil treatment areas. Contract Specifications developed for the project will identify specific requirements for fill gradation and compaction standards. As part of the testing to be carried out during cleanup, quality assurance (QA) testing is required to confirm that the earthworks are in conformance with the Specifications. The number and type of testing will be dependent on the volume of fill to be placed and the number of different material types employed in the cleanup. A QA program shall be developed in conjunction with the design engineer to determine the optimal number of tests required.

6.3 Testing Related to Permits/Regulatory Requirements

The Owner representative and the Contractor will be required to carry out testing to confirm that the requirements of the Land Use Permits and Water Licenses issued for the project are met.

This testing typically includes:

- Effluent testing for waste water generated from camp operations.
- Testing to confirm potability of drinking water supplies
- Testing of waste water generated from cleanup operations.

7 POST-CONSTRUCTION MONITORING

7.1 Introduction

A post-construction landfill monitoring program was developed by DND in conjunction with the Inuvialuit in the Western Arctic and the Inuit in Nunavut for landfills remediated and/or constructed during the cleanup of DEW Line sites. DND initiated cleanup of their DEW Line sites in 1996 and have collected a significant volume of landfill monitoring data since that time. Indian and Northern Affairs Canada, INAC, have initiated cleanup of abandoned military sites under their jurisdiction, and will implement a site monitoring program following remedial construction activities.

This section describes the recommended monitoring plan. It has been based on the DND landfill monitoring program and on landfill monitoring data collected at DND and INAC DEW Line sites to date. Additional monitoring requirements related to the natural environment and traditional knowledge have been added to the program.

A detailed description of the post-construction monitoring program is provided in AMSRP Volume 2 (INAC 2009).

7.2 Monitoring Program

The recommended monitoring program for abandoned military sites consists of:

- Baseline Geo-chemical Monitoring.
- Natural Environment Monitoring.
- Landfill Monitoring.

These are briefly described in the following subsections.

7.2.1 Baseline Geo-Chemical Monitoring

Geochemical Characterization of Soil Conditions

In all proposed development areas, and existing landfill areas (with the exception of existing landfills to be excavated), it is recommended that geochemical characterization of soil conditions be carried out during the assessment or remediation phase. For proposed development areas, sampling should be carried out on a grid spacing of approximately 50 m by 50 m. For existing landfills, testpits should be excavated at a minimum spacing of 50 m of landfill perimeter with a minimum of five testpits per area. Soil stratigraphy is to be logged in accordance with the Unified Soil Classification System, and evidence of seepage and or soil staining recorded. Soil samples should be collected at surface and at 50 cm intervals to the maximum depth of the active layer, and analysed for the following parameters:

- PCBs (polychlorinated biphenyls);
- Hydrocarbon Fractions, F1, F2, F3 and F4; and
- Inorganic elements: arsenic, cadmium, chromium, cobalt, copper, lead, nickel, and zinc.

These data supplement information collected during the assessment phase of a site.

Geochemical Characterization of Groundwater Quality

In proposed landfill development areas or at landfills requiring leachate containment, it is recommended that a detailed characterization of groundwater quality be carried out. A minimum of three wells per area is recommended; however, this may be increased if the size of the landfill warrants increased coverage. The locations of monitoring wells should be selected based on the potential for groundwater (based on the testpit program for soil characterization), and to be representative of both up and downgradient areas. The depth of the monitoring well will be based on anticipated maximum depth of thaw. The monitoring wells should be located no further than 10 m beyond the final construction perimeter as defined by the design.

For baseline water quality, water samples should be collected at minimum monthly for one full season to allow assessment of changes in water quality as the active layer deepens. The wells for baseline sampling are typically installed in the final construction season. This minimizes the potential for damage during construction.

Recommended analytical requirements are outlined below:

- Petroleum Hydrocarbon Fractions, F1 and F2
- Total and dissolved metals.
- Major ions, hardness, total dissolved solids, total suspended solids.
- pH and conductivity.

Given the low solubility of PCBs, analyses of PCBs may be limited to once over the season, near the time of maximum thaw.

For each monitoring event, water level, pH, conductivity, and turbidity should be measured.

If significant variability is observed in groundwater monitoring data, a second season of baseline monitoring should be carried out following remedial activities.

Typically, only dissolved metals are measured in groundwater monitoring programs; however, previous concerns existed with respect to transport of contaminants with colloidal material. The requirement for total metal analyses should be reviewed at the completion of baseline monitoring, and eliminated if concentrations can be correlated with Total Suspended Solids (TSS) concentrations.

7.2.2 Natural Environment Monitoring

A natural environment assessment (NEA) conducted during the ESA phase of site remediation will serve as a reference for post-construction site monitoring. Local and traditional knowledge will be obtained from a local community representative familiar with the site (ideally the same person who assisted with the NEA). Natural environment data will be collected during the site visit as well as during community meetings with people who use or visit the site/area frequently (*i.e.*, year-round). The purpose of collecting this new data is not to find correlations with landfill monitoring data but rather to provide anecdotal data related to the presence of wildlife and changes over time.

Site specific data to be collected during the site visit should try to include as many of the following items:

- Wildlife sightings (species, number, gender, juveniles)
- Other evidence of recent presence of wildlife (droppings, tracks, feathers/fur, carcass remains, etc.)
- Wildlife activity (summering/nesting/denning, migratory/passing through)
- Qualitative assessment of relative numbers versus previous years (more, same, less)
- Revegetation of disturbed areas versus previous years (more, same, less)

Regional information to be collected during visits to the area throughout the year should include as many of the following items as possible:

- Use by people for traditional activities
- Season(s)
- Activities (hunting, fishing, trapping, camping, other harvesting)
- Relative frequency versus previous years (more, same, less)
- Wildlife species present (sightings or evidence)
- Wildlife presence versus previous years (more, same, less)
- Health of wildlife observed or harvested (good, average, poor)

- Relative health of wildlife versus previous years (better, same, worse)

7.2.3 Landfill Monitoring

In general, there are four types of landfills that require monitoring:

- New landfills for non-hazardous materials and Tier I soil;
- Landfills to be closed by the addition of granular fill and regraded;
- Landfills to be closed with leachate containment; and
- Tier II soil disposal facilities.

Based on site conditions at INAC's abandoned military sites, it is considered unlikely that leachate containment would be considered; however, it is included for consistency with previous monitoring plans at military sites. A summary of requirements is provided in Table 7.1.

Table 7.1 Summary of Landfill Monitoring Requirements

	Monitoring Requirements				
Landfill Type	**Baseline Monitoring** S- Soil GW - groundwater	**Visual Inspection**	**Soil Sampling**	**GW Sampling**	**Thermal Monitoring**
New Non-Hazardous Waste (NHW) Landfill (LF)	S, GW	✓	as required[a]	✓	
Regraded LF (low potential risk)	S	✓	as required[a]		
Leachate Contained LF (moderate potential risk)	S, GW	✓	as required[a]	✓	✓
New Tier II Soil Facility	S, GW	✓	as required[a]	✓	✓

[a] Refer to Section 7.3.4 for details.

Baseline monitoring requirements were described in Section 7.2.1. The details of the other four landfill monitoring elements are described in the following subsections.

7.3 Specific Monitoring Requirements

7.3.1 Visual Inspection

The physical integrity of the landfill should be inspected and reported using photographs (from the air, when possible, as well as ground level) and hand drawn sketches. Documented observations should at minimum include the items identified in Table 7.2. It is recommended that Table 7.2 be adapted for use as a field checklist to facilitate this data collection.

Table 7.2 Visual Inspection Requirements - Landfills

Item	**Presence/ Absence**	**Extent**	**Description** **Photographic Reference**
Settlement Erosion Frost Action Animal Burrows Vegetation Staining Vegetation Stress Seepage Points Exposed Debris Condition of Monitoring Instruments Other features of note	Yes or No	Provide dimensions, as applicable of: Length Width Depth	Features of note, photographic reference with scale, view point and direction

7.3.2 Groundwater Sampling

Results of analyses of groundwater samples from landfills should be compared to the baseline and background samples as this is indicative of changing environmental conditions at the site. In general, a minimum of three to four groundwater monitoring wells will be associated with Non-Hazardous Waste Landfills, Tier II landfills and Existing Landfills – Leachate Containment.

Consistent with the baseline analyses, groundwater samples should be tested for:

- Petroleum Hydrocarbon Fractions, F1 and F2
- Total and dissolved metals.
- Major ions, hardness, total dissolved solids, total suspended solids.
- pH and conductivity.
- PCBs

For each monitoring event, water level, pH, conductivity, and turbidity should be measured in-situ. The evaluation of whether both total and dissolved metals are required will be evaluated after baseline monitoring.

Given the low solubility of PCBs in water, analyses of PCBs may be discontinued if not detected in the first five years of monitoring.

7.3.3 Thermal Monitoring

One component of the leachate containment system incorporates aggradation of the permafrost through the landfill contents such that the active layer does not penetrate the waste materials. Geothermal analyses were carried out to predict the length of time for freezeback of the landfill; long-term and short-term thermal regime in the ground; and the depth of the active layer in the cover material. The analyses have shown that it takes several years for the landfill temperatures to equilibrate and stabilize.

A thermal monitoring system provides measurement of sub-surface ground temperatures, which allows comparison to and verification of the predicted ground temperatures. The thermal monitoring system consists of installation of thermistor strings, with “thermistor beads” at select intervals to provide ground temperature profiles at various locations within the landfill. The thermistor strings are attached to automated data-loggers which allow for remote data collection. In general, a minimum of three thermistors is placed; this is evaluated on a landfill-specific basis. Thermistor installation follows standard engineering practice.

7.3.4 Soil Sampling

As previously indicated, soil sampling and analyses provide limited information with respect to the performance of a landfill. Soil sampling will be limited to locations where seepage or staining has been identified as part of the visual inspection. Analytical requirements include:

- Petroleum Hydrocarbon Fractions, F1 to F4
- Arsenic, Cadmium, Cobalt, Copper, Chromium, Lead, Nickel, and Zinc
- PCBs
- Soil samples should be collected over the interval of 0 to 0.15 m, and 0.35 to 0.50 m depth.

7.4 Monitoring Frequency

Conceptually, three phases have been identified for landfill monitoring as described in the following sub-sections. Natural environment monitoring may be conducted according to the same schedule.

Phase I: Monitoring of conditions to confirm that thermal equilibrium and physical stability criterion are achieved.

During Phase I, monitoring would take place in years 1, 3, 5. The five-year term was selected on the basis that ground-temperature thermal regimes at these specific landfills would require three to five years to reach equilibrium.

Visual and thermal monitoring should be carried out on Tier II soil facilities and leachate contained landfills.

Visual inspections of the constructed and remediated landfills would also be carried out. It is anticipated that, if there is settlement or erosion within the initial years following remediation, it is likely attributable to construction quality. Changes after the first three years are more likely attributable to changes in the site conditions (i.e. warmer temperatures, changes in surface water drainage patterns).

It is recommended that groundwater monitoring take place in Years 3 and 5. The timing of the groundwater sampling event should consider the variability of water quality measured during the baseline monitoring.

An evaluation of the Phase I data would be carried out at the end of five years to confirm that thermal equilibrium has been achieved, and that no stability issues had been identified. The Phase I monitoring program may be extended, if required.

Phase II: Verification of equilibrium conditions established during Phase I.

At the completion of Phase I monitoring and review of the results, the Phase II monitoring frequency may be modified or downgraded. If no significant issues are identified for landfills of low potential environmental risk (as defined by the landfill evaluation matrix), monitoring may be discontinued at the conclusion of Phase I. If additional monitoring is warranted based on the thermal, groundwater or physical inspection, it is recommended that the monitoring frequency in Phase II be carried out according to the following schedule: Year 7, Year 10, Year 15, and Year 25. Year 25 would mark the end of Phase II monitoring.

Physical inspections of all landfills would be carried out at each monitoring event. The requirement for continued thermal monitoring would be based on Phase I results, or if significant climate changes had been recorded in the region.

Groundwater monitoring would be carried out at each monitoring event. The optimal time period for sampling would be based on the results obtained during baseline and Phase I monitoring.

Phase III: Monitoring for long term issues such as liner integrity, permafrost stability, and significant storm events.

At the end of Phase II, 25 years after implementation of the remedial actions for a given landfill, a re-evaluation of the monitoring program should be carried out prior to initiating Phase III. It is difficult to predict beyond 25 years how world events and improvements in technology may impact monitoring requirements.

7.5 Interpreting Monitoring Results

Landfill monitoring results (thermal, chemical and visual) have to be interpreted in concert with one another as described in AMSRP Volume 2 (INAC 2009).

7.6 Reporting Format

To provide a basis for comparison between monitoring events, it is recommended that a consistent format be used in reporting.

An outline is provided as follows:

1 Introduction. The introduction should provide an outline of the work elements, the timing of and weather conditions during field work, and describe the scope of the document.

For each individual landfill, the following information is to be provided.

2a. Landfill Summary: For each landfill, a summary should be prepared that describes the monitoring carried out, any notable groundwater analytical results, and any associated staining, seepage, exposed debris, and/or evidence of vandalism. In addition, visual inspection issues identified as significant or unacceptable should be identified. The overall performance rating of the landfill should be provided.

2b. Completed Visual Inspection Report.

2c. A preliminary stability assessment, as described in Section 4.

2d. Annotated drawings on a tabloid paper, indicating all visual inspection features.

2e. Completed thermistor inspection reports, where appropriate.

2f. Photographic records.

2g. Thermal monitoring data, where appropriate.

2h Groundwater analytical data.

2i. Monitoring well sampling logs.

In Annexes to the report, the following information is to be provided.

- Formal laboratory results.
- QA/QC evaluation of the analytical results.
- Handwritten field notes.

Example field note templates are provided in AMSRP Volume 2 (INAC 2009).

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Annex A – Dump site, landfill and debris area (waste disposal area – WDA) evaluation

SUMMARY

In 1997, the DEW Line Cleanup Environmental Working Group (EWG), comprised of members representing Nunavut Tungaavik Inc. (NTI) and the Department of National Defence (DND) / Defence Construction Canada (DCC), was formed to address environmental issues associated with the DEW Line sites under the jurisdiction of DND. One of their tasks was the development of a matrix to assess potential environmental risk associated with existing landfills at the DEW Line sites. The evaluation matrix considered three primary categories, contaminant source, exposure pathways and potential receptors. In the development of the matrix, landfills typical of the DND DEW Line sites were considered. The DND DEW Line sites were in operation for nearly 40 years, and landfill activity was generally extensive.

By comparison, most INAC Abandoned Military Sites were generally only operational for a much shorter period of time, approximately five to six years. Accordingly, waste disposal practices were different. At many sites, waste materials were not consolidated in a single area, and dump sites and/or isolated areas of partially buried debris are common. These areas are collectively referred to as Waste Disposal Areas (WDA).

This current document presents an Evaluation Matrix for WDAs that considers conditions more specific to INAC Abandoned Military sites.

1 INTRODUCTION

To address the varied nature of landfills at abandoned military sites, a consistent method for the assessment of their potential risk to the arctic environment, in the form of a risk evaluation matrix, was developed by the DND/NTI EWG in 1997 (EWG 1998). Since that time, the matrix has been utilized to develop recommendations for landfill remediation at DND DEW Line sites. This document provides a modified evaluation matrix to address the dump sites, landfills and buried debris areas more typical of the abandoned military sites under the jurisdiction of INAC. As a whole, these are referred to as Waste Disposal Areas (WDAs).

The DND/NTI evaluation matrix was based on the CCME National Classification System for Contaminated Sites, and adapted to address the particular concerns of the Arctic environment. This revised version also references the Federal Contaminated Site Action Plan (FCSAP) Contaminated Site Classification Guidance Document. The matrix is divided into three categories of equal weight: contaminated source, pathways, and receptors. The interaction of these three elements results in environmental risk. Each category is assigned 50 points, which are distributed among several factors. Each of these factors has been made as specific as possible in order to reduce the subjectivity of the matrix to a minimum. In addition, each of the three main categories is assigned a highly subjective "special considerations" factor according to the method described in the CCME Classification System. As it is unlikely that any classification system could address all possible factors, a special considerations factor allows the user to increase or decrease the score "to emphasize important concerns about a site and should be used as an exception rather than as a rule" (CCME 1992, p.6-7).

The intended purpose of the matrix is to evaluate the potential environmental risk posed by WDAs in their current condition.

Two conservative assumptions are made during the evaluation of all WDAs

- The contents of WDAs are generally unknown and all potential contaminants may be present.
- If contaminants come into contact with receptors, they could have adverse effects on the receptors.

2 Matrix Factors

2.1 Contaminant Source – Category A

Four factors were considered under Contaminant Source to describe specific disposal areas as follows:

A.1 Areal extent of waste disposal.

A.2 Estimated depth of buried debris

A.3 Contaminant Characteristics – combined presence of leachate and surface contaminated soil.

A.4 Presence of Surface Debris

Contaminant characteristics were assigned the greatest weighting in this category as it is a strong indicator of potential environmental risk associated with the WDAs. The volume of a WDA is considered to be related to its potential to be contaminated – the greater the volume, the greater the risk that contaminants are present. The volume of the waste disposal area is divided into two parameters, area and depth. The area is relatively easy to measure; the estimated depth of the buried waste is given less weight in the matrix as it is difficult to measure using non-intrusive techniques.

A.1 Areal Extent of Waste Disposal

The larger the area impacted by waste disposal, the greater the potential for contaminants to be present exists. The areal extent of dump sites can be easily surveyed based on the presence of surface wastes. Landfill or buried debris areas are based on the results of geotechnical/geophysical site surveys and visual observations. A value of 10 000 m^2 is used as the basis for comparison. All WDAs greater than 10 000 m^2 are awarded the maximum points for this category. Scoring for all other WDAs is prorated relative to 10 000 m^2. WDAs less than 1000 m^2 are referred to as debris areas.

Scores are provided for all WDAs following the detailed field investigations that are carried out prior to cleanup/construction. The objectives of these investigations are to delineate the extent of known contamination, and confirm existing site and WDA conditions.

A.2 Estimated Depth

The depth of landfills and debris areas can be estimated by visual inspection of surrounding topographic features. The average depth of the active layer is used as a qualifier for the description of landfill depth, as this is generally the maximum depth of investigation. The depth of the active layer may range from one to two meters at these sites, depending on material type; therefore an average depth of 1.5 meters was used in the rating. Landfills and buried debris with estimated depths of greater than 1.5 meters were scored higher than those with estimated depths of less than 1.5 meters. For the majority sites, it is anticipated that the depth of buried waste is 1.5 metres or less. Exceptions to this may include dumping within ravine areas or other natural depressions. A minimum score of 2 is allotted to all WDAs in the absence of specific data.

A.3 Contaminant Characteristics

Contamination associated with WDAs may be elevated with respect to background concentrations, but less than applicable criteria. In this case, elevated concentrations may be indicative of chronic low levels of contaminants leaching from the WDA, as a result of infiltration and percolation of surface water, or flow of active layer groundwater through areas of buried debris. In some cases, contamination on the surface may exceed applicable criteria as a result of direct spills or leaking containers.

With consideration of the FSCAP Hazard Ranking of contaminants and the DCC Criteria, all contaminants included in the DCC are considered high concern, with the exception of Petroleum Hydrocarbon Fractions F3 and F4. The F3 and F4 fractions are considered essentially insoluble and are therefore immobile. In the scoring of this category, four categories are provided:

- Concentrations not elevated with respect to background; however, the potential for contamination is considered possible.
- Concentrations elevated with respect to background; but less than DCC criteria. Elevated with respect to background refers to a concentration in excess of the three times the mean background concentration. With respect to organic contaminants, such as hydrocarbons and PCBs, the method detection limit is assumed to represent background concentrations.
- Concentrations in excess of DCC Tier I guidelines.
- Concentrations in excess of DCC Tier II guidelines.

A.4 Presence of surface debris

At some WDAs, in particular dump sites, surface debris is very extensive, while at others there is almost no debris. Scoring needs to be quantitative; therefore the percentage of the surface area of the landfill that is covered with debris is used as the basis for scoring. A WDA that has surface debris covering more than 50% of its surface receives a full score. Debris areas, and dump sites as implied by the designation, generally receive full score for this category.

2.2 Pathways – Category B

The primary transport mechanisms for contaminants at these sites are considered to be:

B.1 Aerial transport of fine particles; and

B.2 Dissolved phase and/or colloidal transport in water, both as surface water run-off or subsurface water flow.

B.1 Aerial Transport of Contaminants

All contaminants can be transported as particles. Windblown debris is not considered in this category, as debris pickup is inherent in any cleanup. Surface contamination or surface expressions of leachate impacted soils imply the potential for aerial transport. This factor is given a low weight because the quantity of contaminated soil on the surface is generally low relative to the quantity of contaminated soil at the site as a whole. In addition, it is anticipated that relative to the effect of water movement, aerial transport contributes less to the transport of contaminants away from a landfill.

B.2 Water Movement

Dissolved phase and/or colloidal transport in water includes movement of surface water and subsurface water within the active layer. "Groundwater" is not addressed as an issue separate from surface water, as the movement of water within the active layer is generally subject to the same driving forces or gradients as surface water. The intent of this sub-category is to examine factors that affect migration away from the WDA – slope, runoff, extent and type of cover on below grade disposal areas, annual precipitation and distance to surface water. Among these factors, topography, runoff potential and proximity to surface water are given the greatest weight.

B.2.1 Topography

The degree of the slope on which the WDA is located is one of the major factors contributing to transport of contaminants. Scoring is carried out on a progressive scale. In cases where there are different slopes in the area, a weighted average is used.

B.2.2 Cover Material – Depth

The extent to which contaminants are available for transport is also dependent on the depth and type of cover material, where present. The potential for leachate generation and correspondingly, leachate migration, is related to infiltration of water. Cover over the WDA helps mitigate infiltration of water into the landfill contents. As the thickness of the cover increases, the likelihood that potential contaminants will be released decreases. If the active layer is contained in the cover material above the debris, then the potential for surface water infiltration into the WDA is small; this circumstance is assigned the lowest score.

B.2.3 Cover Material – Type

The erosion potential of a WDA is partly based on the type of cover material. Erosion can eventually lead to the exposure of the waste. Some cover materials are more susceptible to erosion than others; well graded gravels are the least susceptible, and silty materials are the most susceptible. In cases where there is no cover, this factor is assigned the highest score. Where the cover materials consist of a combination of soil types, the scoring should reflect the more conservative or higher score.

B.2.4 Surface Water/Run-Off Potential

This factor aims to describe the destructive potential of water action on the WDA, which could take the form of waves; streams, rivers or lakes; or seasonal drainage. Where there is significant seasonal drainage, the run-off potential is high. "Significant seasonal drainage" is defined as run-off that has the potential to transport large quantities and concentrations of contaminants to surface water courses over a short period of time (CCME 1992, p.23). Significant seasonal drainage also includes consideration of major snow drifting in the area.

B.2.5 Precipitation

The amount of precipitation received, either as rain or snow fall, affects the amount of surface water infiltration or run-off, and potentially erosion. The majority of the abandoned military sites receive less than 500 mm of precipitation annually, with the exception of sites on the lower east coast of Baffin Island. Typically, the amount of precipitation at any site is relatively low. Any given rainfall event is unlikely to generate major run-off; however, spring thaw and corresponding run-off may be significant at some sites. Detailed precipitation data is not available for the INAC sites; therefore data was interpolated from the Hydrological Atlas of Canada Maps [accessed on line: http://atlas.nrcan.gc.ca/site/english/maps/archives/5thedition] as summarized below for various areas. For sites not listed below, the aforementioned maps should be consulted.

Sites	Annual Precipitation (mm)	Annual Snowfall (cm)	Average Maximum Snow Pack depth (cm)
Clifton Point	100-200	100	30
Bernard Harbour east to Matheson Point	100-200	80	30
Simpson Lake to Sarcpa Lake	150-200	100	50
Bray Island, Rowley Island	150-200	100	60
Nadlaurdjuk Lake	200-300	100	60
Ekalugad Fiord	200-300	200	70
Kivitoo	350	240	100
Durban Island	+400	240	100

As spring run-off likely represents the maximum precipitation event, scoring is provided relative to the maximum snow pack depth, with a score of 4 allotted to snow pack depth of 100 cm. If site specific factors, such as drifting in the WDA are present, the score may be increased to 5, the maximum allotted to this category.

B.2.6 Distance to Down-gradient Perennial Surface Water/Seasonal Drainage Channel

The distance to surface water will affect the probability of contaminants reaching the watercourse. This factor can include streams, seasonal or perennial, running directly through the WDA, or streams and lakes downgradient from the WDA, but it is intended to exclude small ponds with no outflow. On very steep slopes, this distance should consider the horizontal distance to the water body rather than the elevation difference. The impact of drainage with respect to contaminant exposure is not considered in this category (it is considered under Receptors); this factor determines whether there is a drainage pathway away from the WDA.

2.3 Receptors – Category C

This section addresses the potential for impact on receptors, specifically, aquatic and terrestrial habitats, as well as human exposure. Impact on humans is the primary consideration; however, it should be recognized that impact on humans is implicit in the scoring of factors addressing ecosystem impact. The scoring within each category is to be based on recorded data, as well as local knowledge of the land use in the area, and therefore requires local input.

C.1 Potential Impact on Receiving Freshwater/Marine Habitat

Selection of the water body in this category is based on potential effects on the receiving habitat. Consideration must be given to the regional drainage patterns. For example, where the drainage from a WDA is overland (i.e. there is no direct connection between the WDA and the downgradient water body), water bodies beyond two kilometers should not be used in the evaluation. This is based on the premise that natural attenuation of any potential contamination will occur with overland flow. Where a direct connection between a WDA and a downgradient water body exists, via a stream or interconnected ponds, the two-kilometre limit should not be used.

C.1.1 Proximity to Receiving Freshwater/Marine Habitat

"Receiving habitat" is considered to be a significant body of water near the limit of the WDA where contaminants are likely to have an impact. The water body may support freshwater or marine life and/or may be used by avifauna and/or terrestrial mammals as a water source. It is not necessarily the seasonal drainage course or perennial water body closest to the limit of the WDA toe. The objective is to select a habitat that supports receptors rather than identify the closest body of water. It is assumed that only habitat downgradient from the WDA is to be considered (given that aerial transport of contaminants to habitat upgradient from the WDA will be addressed by the remediation of contaminated soil).

C.1.2 Estimated Habitat Usage – Freshwater/Marine

The score within this category is based on the frequency of usage within the selected receiving environment and considers the level of biodiversity and the occurrence of calving/spawning grounds. Freshwater and/or marine wildlife are potentially more at risk compared with terrestrial wildlife or avifauna, the latter of which are exposed through water ingestion. Thus, when terrestrial wildlife or avifauna are the primary receptor, the score for this factor should fall into the moderate or low category based on the potential frequency of usage. Otherwise, when the selected water body sustains freshwater and/or marine wildlife, the level of biodiversity should be used to evaluate the score. It should be noted that the most conservative approach - in the selection of the receiving water body - must be used when scores from section C.1.1 and C.1.2 are combined. Finally, "biologically sensitive" areas such as bird sanctuaries and/or endangered, threatened or vulnerable populations should be considered as "special considerations".

C.2 Potential Impact on Receiving Terrestrial Habitat

C.2.1 Extent of Vegetation

The extent of vegetation considers the area within 300 metres downgradient of the WDA. Within this distance, vegetation is expected to be most susceptible to uptake of contaminants if they are leaching from the WDA. However, topography and the potential for run-off must be considered and a greater or lesser distance could be considered.

C.2.2 Estimated Habitat Usage – Terrestrial/Avifauna

The same criteria as for usage of aquatic habitat are to be applied.

C.3 Potential Human Exposure Through Land Use

C.3.1 Presence/Occupation

This factor addresses strictly dermal exposure and inhalation; consumption of food and water from the area are dealt with in subsequent factors. The risk of dermal exposure or inhalation is much lower when soil is frozen; therefore winter occupation of the site is assigned a low risk. "Summer" in this factor is intended to include the spring, summer and fall periods when the ground surface is not frozen. Within this factor, the scoring takes into account the likelihood and the duration of contact. Using this method, proximity to a community is considered (high likelihood of contact), although proximity to a community does not necessarily trigger a high score if visits are infrequent (low duration of contact).

The likelihood of contact considers proximity to community or to a camp, as well as proximity to "travel routes". The duration of contact considers full time residences (i.e. permanent community for high, summer camp for moderate, winter camp or travel routes as low). Scores may be interpolated between the allocated points, according to Table 1 below. Unmanned Short Range Radar (SRR) sites, part of the North Warning System, are co-located at some of the former abandoned military sites, and periodic maintenance of these facilities is carried out. As a conservative approach, it may be considered that maintenance workers may have a low likelihood of contact and low duration of contact.

Table 1: Scoring Guide for Section C.3.1

	High Likelihood of Contact	Moderate Likelihood of Contact	Low Likelihood of Contact
High Duration of Contact	8	6	4
Moderate Duration of Contact	6	4	2
Low Duration of Contact	4	2	1

Different areas on a site may need to be considered individually.

C.3.2 Proximity to Drinking Water Source

Regardless of whether the source is seasonal or perennial, an established community or a summer camp water source located downgradient of the WDA is to be considered in this factor.

C.3.3 Food Consumption

This factor is divided into two sub-sections, and the score is the sum of the score for each of the two sub-sections.

Sedentary organisms are more susceptible to local inputs as their exposure is greater if they are downgradient from the WDA. These organisms can include bottom-dwellers such as sculpins, mussels, sea urchins etc., as well as terrestrial vegetation, which can be used for medicinal purposes. This kind of contamination “is quite localized when considered on a broad regional scale” (DIAND 1997, pg. 5).

Migratory marine animals may have body burdens of contaminants; these are not directly attributable to local contaminant sources, as the vast majority of organochlorines, for instance, arrive in the Arctic via long range transport. Caribou living in the general area of DEW sites do not have elevated levels of contaminants, as they feed over a very wide area. The Canadian Arctic Contaminant Assessment Report (DIAND, 1997) describes these results in more detail.

It is recognized, however, that sources such as abandoned military sites do contribute contaminants to the Arctic ecosystem. For the purpose of scoring the matrix, therefore, a high consumption of animals from the area surrounding the site has the potential to pose a higher risk than a low consumption, although in general the risk remains low.

2.4 Special Considerations

As indicated in the introduction to the matrix, each of the three main categories includes a "*special considerations*" factor. The proposed value of the special considerations factor is a maximum of ten percent of the overall score for each category. It is intended that no circumstance will allow a user to assign a special considerations score that will cause the score for that category to exceed the maximum allotted. To avoid undue bias, it is also suggested that the user should complete the entire evaluation form and score a site before addressing special considerations in the total score.

The Environmental Working Group (EWG) based their landfill risk evaluation matrix on the CCME model which defines three categories: contaminant source, pathways and receptors. Within those three categories, the EWG tried to address all of the possible factors contributing to risk. Recognizing that even a thorough matrix could never address all possible risk factors, special considerations were included to address specific risk factors that are not general to all of the abandoned military sites.

As noted in the CCME document, the special considerations factor is not intended to be applied on a regular basis, as it addresses very site-specific risk factors. In fact, if the special consideration factor was being consistently applied in the scoring of a WDA, it would indicate that the matrix itself was incomplete. Special considerations should be site-specific characteristics that can be documented.

Three examples of how special considerations could be applied are provided to clarify the use of such a classification:

Example 1. Wildlife on site

It may be that "special considerations" points would be assigned to the Receptors category when endangered, threatened and/or vulnerable species (COSEWIC, 1997) are known to visit the WDA.

Example 2. Proximity to a community

In the WDA risk evaluation matrix, human exposure to a WDA is measured in the following way: people can spend time at the WDA (potential dermal exposure), they can drink water from an area near the WDA (potential ingestion), they could live very close to the WDA (potential exposure through aerial transport) or they could eat animals that feed near the WDA (potential ingestion). These considerations form section C.3 of the risk evaluation matrix. If a WDA is located near a community, there is a greater likelihood that people will spend time at the site than there is for areas far from a community. It is not necessarily the case, however, that WDAs near communities receive frequent visits; therefore, instead of creating a special section addressing proximity to a community, the risk of human exposure (see Table 1-1) is more accurately evaluated by measuring time spent at a WDA. In these cases, however, "special considerations" points may be added to the receptors category to address a community's specific concerns, such as the physical hazards associated with an exposed dump site.

2.5 Traditional Knowledge

The matrix for the evaluation of potential environmental risk was developed recognizing that local input would be relied upon in the scoring of WDAs. Additional guidance on the collection of Traditional Knowledge is provided in Section 4.10 of the protocol.

3 INTERPRETATION OF SCORES

The score obtained through the application of the matrix is intended to represent the potential environmental risk posed by a given WDA in its current state. The objective of remediation is to mitigate the risk associated with a WDA by preventing the migration of contaminants that may be present in the landfill, and by removing physical hazards.

During the development of the matrix by the EWG, WDAs at four different sites were evaluated by environmental scientists and engineers to assess the applicability of the matrix and to determine cut-off values between categories. WDA scoring 105 points or more is classified as potentially high risk (Class A) and require excavation. The high score accorded to these WDAs is generally a result of the ecological sensitivity of the area and the geometry and surrounding topography of the landfill, which precludes the development of a cost-effective and long-term design solution such as pathway intervention and/or stabilization of the landfill. WDAs with a score of 100-104 points must be considered on a case by case basis – some may require complete excavation while others may be considered Class B landfills. WDAs that score less than 105 require excavation/removal if one or more of the following conditions are met:

- The WDA is located at an elevation of less than 2 m higher than an ocean.
- The WDA consists of unconsolidated wastes at surface. Debris should be removed, classified, and sorted, and non-hazardous contents placed in an engineered landfill.
- WDA, with areal extent of less than 1000 m^2 and scoring a total of 89 points or more are classified as potentially high risk and require excavation to the full extent/depth of the debris. In addition, if these WDAs score greater than 23 points in the contaminant source category, complete excavation of the area is recommended.

A WDA with a score in the range 75 to 99 points is classified as moderate potential environmental risk (Class B). An engineered leachate containment system will be provided for these WDAs to mitigate against potential environmental risks. In specific cases where an engineered leachate containment system cannot be constructed, an evaluation of excavation will be carried out with the objective of determining whether complete excavation or partial excavation with a leachate containment system is required.

For WDAs of less than 1000 m^2, it is considered unlikely that leachate containment will be cost-effective when compared to excavation and removal of debris. Consideration must therefore be given to the level of contamination present. If contaminants are present in excess of criteria, it is recommended that the debris area be excavated to its full extent. If contamination does not exceed criteria, debris should be cut-off and removed within the upper 0.5 metres of the ground surface. The area should then be regraded to match surrounding topography.

A WDA with a score of 75 or less is classified as low potential environmental risk (Class C). In general, the remediation approach for these areas includes placement of an engineered cover, following collection, sorting, and appropriate disposal of debris from the surface, and excavation and disposal of any surface contaminated soils from the area. Some of the factors to be considered in the design of the cover include: thickness and type of the existing cover materials; slopes on the landfill; surrounding topography and available granular fill. The cover is designed to promote surface water run-off (i.e. no areas of standing water), prevent erosion, and mitigate against settlement. Where required, the slope of the WDA may be modified and/or geotextiles may be incorporated into the granular cover to provide a long-term solution. Generally, the final thickness of cover material is approximately 0.75 metres, and may be greater, dependent on site specific conditions. The granular cover material is to be placed in layers and compacted before the placement of the next layer of granular fill, until the design thickness is reached.

Overall, it is to be stressed that the matrix is to be used in the assessment of potential environmental risks associated with a specific WDA. It is not intended to be used as the sole criterion in determining the remediation solution for a WDA. The results of the matrix, both total score and the score from each major category, are to be considered in conjunction with the engineering evaluation of site conditions, to determine appropriate design solutions. Review of the individual category scores relative to the total score will highlight particular areas of concern that are to be addressed during the design process.

The potential impacts of climate change are also to be considered in evaluating remedial solutions.

It should be emphasized that the total score has an error associated with it of approximately 5 points; there is inevitable subjectivity in the scoring process and scores that fall near decision points should be considered on a case by case basis.

4 REFERENCES

BC Environment. June 1996. Guideline #1 Contaminated Sites: Site Characterization and Confirmation Testing. Draft.

CCME. 1992 National Classification System for Contaminated Sites.

COSEWIC, 1997, Categories of the Committee on the Status of Endangered Wildlife in Canada, Canadian Wildlife Service, Environment Canada.

DIAND, 1997. Canadian Arctic Contaminants Assessment Report.

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ATTACHMENT 1

WASTE DISPOSAL AREA

EVALUATION MATRIX

	ENVIRONMENTAL RISK EVALUATION MATRIX **WASTE DISPOSAL AREAS - ABANDONED MILITARY SITES**	Maximum Score
A. **A.1**	**CONTAMINANT SOURCE** **AREAL EXTENT OF WASTE DISPOSAL AREA**	
	>10,000 m2	10
	For areas less than 10,000 = Area of Waste Disposal Area X 10 / 10 000	2-9
	Minimum Score	1
A.2	**ESTIMATED DEPTH OF BURIED WASTES**	
	greater than 1.5 m	5
	less than 1.5 m	2-4
A.3	**CONTAMINANT CHARACTERIZATION**	
	Concentrations in excess of DCC Tier II Criteria	25
	Concentrations in excess of DCC Tier I Criteria	20
	Concentrations elevated relative to background	10
	Potential Contamination	5
A.5	**PRESENCE OF SURFACE DEBRIS**	
	>50% of surface area	10
	<50% of surface area, pro-rated	1-9
	No debris observed	0
	SPECIAL CONSIDERATIONS	+/- 5
	TOTAL SCORE - CONTAMINANT SOURCE	

	ENVIRONMENTAL RISK EVALUATION MATRIX WASTE DISPOSAL AREAS - ABANDONED MILITARY SITES	Maximum Score
B.	**PATHWAY/TRANSPORT MECHANISMS**	
B.1	**AERIAL TRANSPORT OF CONTAMINANTS**	
	All Waste Disposal Areas Scored as 2, if surface sol contamination (A.4) or leachate (A.3) has been identified.	
B.2	**WATER MOVEMENT**	
B.2.1	**TOPOGRAPHY**	
	Steeply Slope (>40 % Grade)	12
	Sloping (10% to 40% Grade)	4-11
	Subdued to 10% Slope	2-3
	Flat (< 3%)	1
B.2.2	**COVER MATERIALS –DEPTH**	
	No to little existing cover	4
	Greater than 50% exposed/surface debris	3
	Occasional exposed/surface debris	2
	Existing cover, minimal debris,	1
	Cover thickness > average active layer thickness	0
B.2.3	**COVER MATERIAL – TYPE**	
	No cover	5
	Silty/Sandy Material	4
	Sandy/Gravel Material	3
	Gravel Material	1-2

B.	**PATHWAY/TRANSPORT MECHANISMS continued**	
B.2.4	**SURFACE WATER/RUN-OFF POTENTIAL**	
	Very High - evidence of erosion, continuing run-off, or wave action	12
	High - evidence of erosion, seasonal, widespread, storm waves	10
	Moderate - % area affected by erosion	3-9
	Low - no evidence of erosion, slight slopes	1-2
B.2.5	**PRECIPITATION**	
	> 100 cm snow pack	4
	< 100 cm snowpack (pro-rated)	1-4
	Snow Drifting	1
B.2.6	**DISTANCE TO DOWNGRADIENT PERENNIAL SURFACE WATER/SEASONAL DRAINAGE CHANNEL**	
	0 to 100 m	10
	100 to 300 m	7-9
	300 to 1 km	2-6
	greater than 1 km	1
	SPECIAL CONSIDERATIONS	+/- 5
	TOTAL SCORE – PATHWAYS	

	ENVIRONMENTAL RISK EVALUATION MATRIX WASTE DISPOSAL AREAS - ABANDONED MILITARY SITES	Maximum Score
C.	**RECEPTORS**	
C.1	**POTENTIAL IMPACT ON RECEIVING FRESHWATER/MARINE HABITAT**	
C.1.1	**PROXIMITY TO RECEIVING FRESHWATER/MARINE HABITAT**	
	0 to 100 m	6
	100 to 300 m	4-5
	300 to 1 km	2-3
	greater than 1 km	1
C.1.2	**ESTIMATED HABITAT USAGE - FRESHWATER/MARINE**	
	High; High Biodiversity/ High Occurrence/Calving or Spawning Area	5-6
	Moderate: Moderate Biodiversity, Migratory	3-4
	Low: Low biodiversity; rare sightings	1-2
C.2	**POTENTIAL IMPACT ON RECEIVING TERRESTRIAL HABITAT**	
C.2.1	**Extent of Vegetation**	
	Extensive vegetation growth, (80 to 100 % ground cover)	6
	Moderate vegetation growth (40 to 80% ground cover)	4-5
	Low vegetation growth (20 to 40% ground cover)	2-3
	Sparse vegetation (<20% ground cover)	1
C.2.2	**ESTIMATED HABITAT USAGE - TERRESTRIAL/AVIFAUNA**	
	High; High Biodiversity/ High Occurrence/Calving, Denning or Nesting Area	5-6
	Moderate: Moderate Biodiversity, Migratory	3-4
	Low: Low biodiversity; rare sightings	1-2

C.	**RECEPTORS continued.**	
C.3	**POTENTIAL HUMAN EXPOSURE THROUGH LAND USE**	
C.3.1	**Presence/Occupation** Duration of Contact /Likelihood of Contact	7-8
	see chart and provide rationale for scoring	4-6
		1-3
C.3.2	**Proximity to Drinking Water Source**	
	0 to 100 m	8
	100 to 300 m	5-7
	300 to 1 km	2-4
	greater than 1 km	1
C.3.3	**Food Consumption**	
	High quantity of sedentary organisms - marine & plant life	8
	Moderate quantity of sedentary organisms - marine & plant life	6
	Low quantity of sedentary organisms - marine & plant life	4
	No consumption	0
	High quantity of migratory organisms	2
	Moderate quantity of migratory organisms	1
	Low quantity of migratory organisms	0.5
	No consumption	0
	SPECIAL CONSIDERATIONS ***TOTAL SCORE – RECEPTORS***	+/-5
	TOTAL SCORE	

Annex B – Barrel Protocol

1 Introduction

In order to determine the correct disposal method for barrels and their contents, the contents must first be identified. All barrel contents should be sampled and analyzed according to DND DEW Line Cleanup standard procedures, as described in this section.

Analytical data obtained for the samples collected from barrels located at the site should be compared to the criteria included in Table 1, below. Barrel contents are identified as organic or aqueous and the concentrations of glycols, alcohols, PCBs, chlorine, cadmium, chromium and lead are determined. The flash point of organic waste and aqueous waste (> 2% glycols/alcohols) must also be determined. Uncontaminated aqueous phases can be disposed of on the land according to the discharge criteria; uncontaminated organic phases can be incinerated; contaminated aqueous material should be scrubbed free of organic material; and contaminated organic material should be disposed of as hazardous material.

During the delineation phase of the site investigation, an inventory of the number and locations of barrels at the site is to be compiled. This inventory should include buried or partially buried barrels that will be taken out of the landfills during excavation. Where significant numbers of barrels are present on a site, and if safe to do so, representative samples shall be collected to provide a preliminary indication of whether on-site incineration is a viable alternative. Otherwise, barrels are only sampled during the cleanup phase and as such, the handling, transportation and opening of barrels is the responsibility of the site Contractor.

Other waste fuels and oils are also sampled according to this protocol. These may come from a variety of sources including, but not necessarily limited to, old generators, fuel tanks and pipelines, and transformers.

2 Inspection

All barrels are to be inspected to address the following items which shall be recorded and used as a guide prior to opening barrels.

- Symbols, words, or other marks on the barrel that identify its contents, and/or that its contents are hazardous: e.g. radioactive, explosive, corrosive, toxic, flammable.

- Symbols, words, or other marks on the barrel that indicate that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume containers.

- Signs of deterioration or damage such as corrosion, rust, or leaks at seams, rims, and V grooves, or signs that the barrel is under pressure such as bulging and swelling.

- Spillage or discoloration on the top and sides of the barrel.

3 SAMPLING

Barrels shall not be transported until it has been determined that they are not under pressure, do not leak, and are sufficiently sound for transport.

Barrels to be sampled should be set in an upright position, provided that this does not cause them to leak and that it is physically possible.

Barrels should only be opened according to accepted procedures and under qualified supervision, preferably using remotely operated, non-sparking equipment.

Once open, barrels will be sampled by personnel wearing proper personal protective equipment as described below. Samples of the contents of all barrels shall be extracted using a drum thief and placed into a pre-labelled glass vial. The number and type of liquid phases, and their respective thickness, and the size of each barrel are to be recorded.

In instances where there are a large number of barrels with obviously similar contents, these can be grouped together and 30 to 40% of the barrels in the group sampled. Barrels containing less than 50 mm of liquid may be combined with compatible material prior to sampling; samples inferred to contain only water on a visual examination shall be tested prior to this consolidation. Barrel contents, which consist of black oil, shall not be consolidated.

All barrels shall be clearly numbered using spray paint or other suitable paint marker. The number on this label should be the only sample coding provided to the laboratory.

The barrel locations and barrel sample descriptions should be recorded.

Samples should be kept at ambient temperatures and shipped by guaranteed freight to laboratories where they should be kept cold pending analysis.

4 TESTING

Liquid samples shall be inspected and classified as either containing water or organic materials. Samples thought to contain water shall be analyzed to confirm that they are indeed water, and contain less than 2% glycols or alcohols.

The contents of barrels containing organic materials, including aqueous samples which contain more than 2% glycols or alcohols, shall be tested for flash point, PCBs, total chlorine, cadmium, chromium and lead following the targeted barrel testing approach presented in Figure 1. Analyses will be conducted on a rush basis where indicated. In addition, major organic components should be identified e.g. fuel oil, lubricating oil.

If on site incineration of waste is not planned, waste samples need only be tested for flash point, PCB, and pH (at regular turnaround time) in order to classify the waste for transport and disposal options.

Contents of barrels which contain two or more phases shall have all phases analyzed; the organic phases as described above and the aqueous phase to ascertain whether it contains less than 2% organic substances. In addition, the aqueous phase shall be tested for any components found in the organic phases above the criteria provided in the protocol.

5 DISPOSAL OF BARREL CONTENTS

Barrels containing only rust and sediment shall be treated as empty barrels.

Barrel contents comprising water only (less than 2% glycols or alcohols) shall be transferred to an open vessel such as a utility tub or half-barrel and any organic material removed by agitation with a pillow or segment of oil absorbent material. The water shall be tested prior to discharge in accordance with wastewater discharge criteria. Where water meets criteria, it may be discharged to the ground a minimum of 30 meters distance from natural drainage courses. Used oil absorbent material shall be treated as described in the following subsection.

Barrel contents which are composed of water with glycols and/or alcohols or organic phases, and which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium, 100 ppm lead, and that have a flash point between 25°C and 225°C, may be disposed of by incineration. Alternatively these contents may be disposed of off-site at a licensed disposal facility. The solid residual material resulting from incineration shall be subjected to a leachate extraction test. Material found to not be leachable shall be disposed of as DCC Tier II contaminated soil. Leachable material shall be treated as hazardous waste and disposed of off-site at a licensed disposal facility.

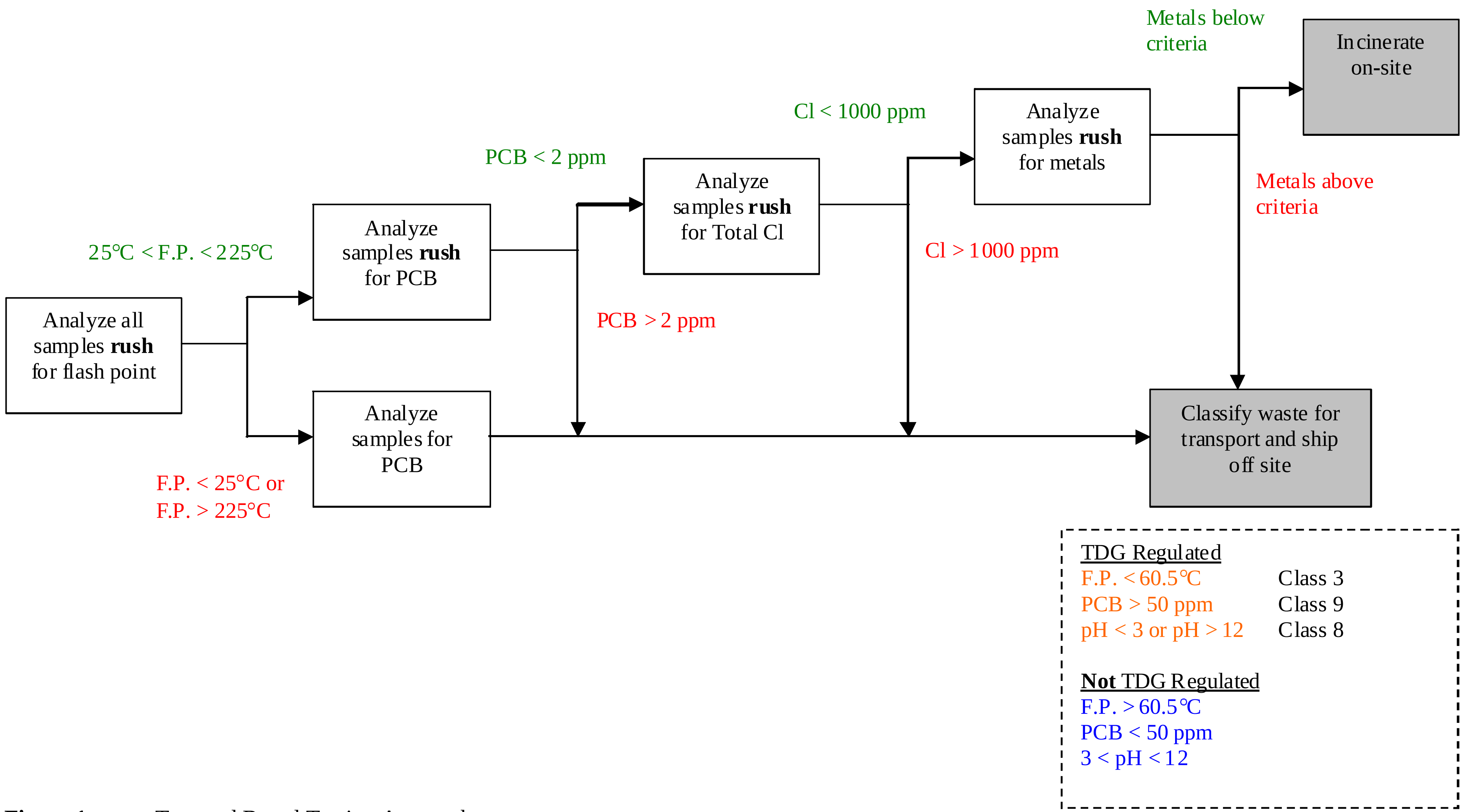

Figure 1 Targeted Barrel Testing Approach

Barrel contents, which contain greater than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium or 100 ppm lead, or that have a flash point below 25°C or greater than 225°C shall be disposed of off-site at a licensed disposal facility. Contents may be combined with compatible materials for shipping purposes.

Used oil absorbent material should be treated as hazardous waste and disposed of off-site at a licensed disposal facility. If it is shown to be uncontaminated with PCBs (< 2 ppm), chlorine (< 1000 ppm), cadmium (< 2 ppm), chromium (< 10 ppm) and lead (< 100 ppm), it may be incinerated on-site.

6 DISPOSAL OF BARRELS

Empty barrels may be crushed or shredded and landfilled on-site as non-hazardous waste after they have been cleaned in an appropriate manner. The barrels shall be crushed in such a manner so as to reduce their volume by a minimum of 75%. Shredded barrels may be disposed of off-site as recycled metals.

7 PERSONNEL PROTECTIVE EQUIPMENT

Safety equipment required includes a respirator with organic vapour cartridges, safety glasses, a hard hat, rubber safety boots, double gloves (chemically resistant on the outside, and latex or vinyl on the inside) and disposable Syranex-coated coveralls.

A decontamination procedure should be established at the barrel sampling area(s) to prevent tracking potentially contaminated liquids outside of the sampling area(s).

It is advisable to have one person outside of the sampling area to observe the sampler(s) in case of unexpected hazards, and also to record the samplers' observations.

Appendix E

Golder Archaeological Impact Assessment Report

FINAL REPORT

ARCHAEOLOGICAL IMPACT ASSESSMENT (AIA) OF THE PIN-E INTERMEDIATE DEW LINE SITE, CAPE PEEL, NUNAVUT

Submitted to:

The Department of Culture, Language, Elders and Youth (CLEY), Nunavut
Nunavut Permit No. 2009-023A

DISTRIBUTION:

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EXECUTIVE SUMMARY

During August of 2009, Golder Associates Ltd. conducted an Archaeological Impact Assessment (AIA) of the PIN-E Intermediate DEW Line Site in Cape Peel on behalf of Public Works and Government Services Canada (PWGSC). This AIA was carried out in conjunction with the Phase III Environmental Site Assessment, Hazardous and Non-Hazardous Materials Audit, Geotechnical Evaluation and Remedial Action Plan. All required fieldwork was completed under an Archaeological Permit (2009-023A) issued by the Department of Culture, Language, Elders and Youth (CLEY), Nunavut to Brent Murphy of Golder.

The Intermediate DEW Line Site is located at Cape Peel, approximately 80 km west of Cambridge Bay Nunavut. Low-level aerial reconnaissance of the site area was conducted in order to assess the locations of all structures and debris requiring further investigation and to identify areas of archaeological potential. Lack of vegetation and sedimentation enabled surface examination of the facility areas to adequately assess for the presence of cultural materials. As requested, areas which will not be impacted during remediation were not examined. During the study two sites were identified and documented as per the *Nunavut Archaeological and Palaeontological Sites Regulations*.

PWGSC has fulfilled the requirements to indentify the potential for impact to heritage resources during the proposed remediation/reclamation of the PIN-E DEW Line site at Cape Peel. The AIA included the participation of Richard Angivrana and Gary Avalak from the local community of Cambridge Bay, who acted as bear monitors and participated in the identification and recordation of the heritage resource sites.

During the investigations two heritage resource sites, NgNj 1 and NgNj 2 were newly recorded. It is recommended that avoidance of NgNj 1 be required during the remediation process; however NgNj 2 is considered to be of limited significance and no further work is recommended. There were also several sites that, while not meeting the technical requirements to be classified as heritage resources, are cultural markers of a recent occupation as described in this report.

It is recommended that PWGSC have met their obligations to assess the potential for impact to heritage resources during the proposed Remedial Action Plan. It is also recommended that the newly identified site NgNj 1 be avoided during reclamation activities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

1. INTRODUCTION

During August of 2009, Golder Associates Ltd. (Golder) conducted an Archaeological Impact Assessment (AIA) of the PIN-E Intermediate DEW Line Site, Cape Peel in conjunction with the Phase III Environmental Site Assessment, Hazardous and Non-Hazardous Materials Audit, Geotechnical Evaluation, Remedial Action Plan on behalf of Public Works and Government Services Canada (PWGSC). All required fieldwork was completed under an Archaeological Permit (2009-023A) issued by the Department of Culture, Language, Elders and Youth (CLEY), Nunavut to Brent Murphy of Golder.

Low-level aerial reconnaissance of the site area was initially flown in order to assess the locations of all structures and debris requiring further investigation and to identify areas of archaeological potential. The AIA was intended to identify any artifacts or heritage resource areas that might be impacted by a remediation program and, as such, only those areas of previous and potential disturbance were assessed. Artifacts collected under Archaeological Permit (2009-023A) will be submitted to the collections repository at the Prince of Wales Northern Heritage Centre located in Yellowknife, Northwest Territories. The intent of this program was not to conduct a full AIA of the entire Cape Peel area. However, during traverses of the former DEW Line station some lands outside of proposed impacts were surveyed (Figure 1).

The amount of previous disturbance associated with the DEW Line site and lack of vegetation facilitated assessment of the facility areas and increased visual assessment for the presence and/or absence of cultural materials. As requested, areas that will not be impacted during remediation were not fully examined. Two previously unrecorded heritage resource sites were identified by the archaeologist during the program, which were documented as per the *Nunavut Archaeological and Palaeontological Sites Regulations*.

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5 0 5
SCALE KM

LEGEND
PROJECT AREA

REFERENCE
TOPOGRAPHIC MAP O77D AND 077A OBTAINED FROM SoftMap. © 2002 HER MAJESTY THE QUEEN IN RIGHT OF CANADA, DEPARTMENT OF NATURAL RESOURCES. ALL RIGHTS RESERVED. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD83 COORDINATE SYSTEM: UTM ZONE 13.

PROJECT
PIN-E DEW LINE SITE
CAPE PEEL

TITLE
PIN-E LOCATION

Golder Associates
Calgary, Alberta

PROJECT	09.1333.0018.8430		FILE No. 09133300188430A001	
DESIGN	BM	11/05/09	SCALE AS SHOWN	REV. 1
CADD	RML	11/01/10	**FIGURE: 1**	
CHECK	BM	10/02/10		
REVIEW	DB	10/02/10		

2. LOCATION, POTENTIAL IMPACTS, AND OBJECTIVES

2.1 Location

The PIN-E Intermediate DEW Line site is located at Cape Peel, Victoria Island 80 km west of Cambridge Bay, on Victoria Island, Nunavut. Cape Peel is the western entrance to Wellington Bay from the Dease Strait. The site area is characterized as being relatively flat with the abandoned site area being the highest point of land at about 60 m above sea level (Plates 1 and 2). The PIN-E site was constructed in 1959 and included a module train, warehouse, garage, fuel tanks, Inuit house and a Doppler antenna. In addition to the main site a beach landing area, gravel road linking various facilities and two airstrips, one earlier abandoned, were constructed. The site was deactivated in 1963 and has remained this way since.

Plate 1 Aerial photo of the PIN-E Intermediate DEW Line site facilities.

Plate 2 Aerial photo of the beach landing area showing roads, barrels and former location of POL tanks.

2.2 Potential Impacts

The potential impacts to heritage resources around the PIN-E site at Cape Peel are dependent upon the proximity of those resources to the remediation activities that will be conducted to remove the remnants of the former PIN-E site. Heritage resource sites are non-renewable resources that may be located at or near ground level or may be deeply buried. Prehistoric or precontact archaeological sites are those sites which contain features, artifacts or ecofacts reflecting the use of a given land base by people prior to European influences and technologies. Features are non-portable articles that indicate a human modification of the local environment such as hearths, pits, tent rings, stone cairns and Inuksuit. Artifacts are portable items that have been modified by people at some time in the past. These include such items as projectile points, stone flaking debris, and cut and modified bone. Ecofacts are naturally occurring items such as preserved plant remains or pollen that can aid in the interpretation of archaeological sites. Historic archaeological sites include the features, artifacts and ecofacts relating to the past few hundred years of human occupation. These sites are typically identified by the presence of buildings or structural remains, but may include any site that has evidence of historic use of the landscape.

Alteration of the landscape can result in the damage or complete destruction of all or portions of historic resource sites. These alterations often involve the displacement of artifacts resulting in the loss of valuable contextual information or may involve the destruction of the artifacts and features themselves resulting in complete information loss. These losses are permanent and irreversible. Primary, secondary and tertiary impacts are possible with any new development. Remediation can be considered a new development in this context if it impacts previously undisturbed areas during operation.

Primary impacts include those disturbances resulting immediately from a project. The primary impact zone is the area within the remediation footprint including access roads, temporary work zones, borrow pits and dumps. Individual sites are likely to be affected to varying degrees if they are located within the development area. Artifact context is fundamental to interpretation of archaeological sites. By disturbing the context in which artifacts and features are recovered, interpretations of heritage resources sites and, ultimately, past lifeways are affected negatively.

Secondary impacts can occur when the support services or additional access required by development adversely affects heritage resources outside the primary target areas. The remediation project should have no secondary effect on heritage resources.

Tertiary impacts are the results of project induced changes in demography and land use patterns. Increased rates of intentional and unintentional impacts can be expected as a result of increased visitation to an area if the project were large enough to affect regional population bases. Tertiary impacts are anticipated to be very low for this project, especially because changes to the site through remediation will probably not affect the visitation rates.

The study detailed in this report is intended to identify areas of possible impact and to determine whether the current proposed project will disturb those heritage resources located in proximity to the development.

2.3 Project Objectives

The objective of the 2009 study at the PIN-E Intermediate DEW Line site located at Cape Peel is to ensure that heritage resources are not inadvertently impacted by the proposed clean-up and remediation project. The purpose of this AIA is to:

- conduct a pre-impact assessment of the proposed remediation areas;
- identify any archaeological sites within those areas (if present);
- make recommendations to CLEY and PWGSC to mitigate or avoid those sites;
- make recommendations on surveillance and monitoring;
- provide a cost estimate on implementing the recommendations during the construction phase; and
- prepare a draft Final Report to be reviewed by PWGSC, followed by a Final Report for distribution as required and submission to CLEY.

3. PHYSICAL AND CULTURAL SETTING

3.1 Environmental Context

An understanding of past environmental conditions and the environmental factors that shape human approaches to subsistence and settlement patterns enable archaeologists to not only locate sites, but also to provide more accurate interpretations of individual sites. The physical aspects of the environs (topography, drainage, climate and soils) as well as resource availability (flora, fauna, lithic materials and water) are prime criteria for the identification of site location and function. Assessments of the universal cultural activities of site location, travel within and through the area, and resource exploitation are key components of any archaeological site analysis.

The anthropological theory of environmental determinism suggests that, to a great extent, environmental factors condition human behavioural and cultural adaptations, or patterns of behaviour. The environment has likely influenced many of the activities that contribute to the character of the regional prehistoric record. All available environmental variables must be considered as indicators of prehistoric use of the landscape.

The regional environment influences where specific activities and occupation are located in a pattern of seasonal movements according to the availability of resources: a seasonal round. The variables of archaeological site distribution can be identified and combined into useful criteria for suggesting the potential of an environment to hold heritage resources that includes a wide variety of landforms frequently associated with coastlines and lake shores, river banks, eskers and kames, and bedrock knolls in Arctic environs. Distribution patterns partially reflect environmental opportunities presented to human groups as well as cultural preferences demonstrated by site location. Topography influences much human activity including travel, communication, resource catchments, dwelling locations and eventually constrains human activity areas to defined localities. Based on existing heritage resources, the environment is a key factor in human settlement patterns.

3.2 Regional Environment

Prior to contact with Europeans, the environment in which the people of North America lived strongly influenced their culture and economy. The people who inhabited the North took advantage of the seasons and all the resources that were available.

Victoria Island is mainly moraine covered low-lands and drumlin fields, with many raised beaches (Collignon 2005). The vegetation is typical of a tundra environment and consists of arctic willows, marshy lowlands and lichen on rocky outcrops. Inland small herds of musk-oxen and caribou as well as white foxes, wolves, ptarmigans and Arctic owls are found on the island; while seals and polar bears inhabit the coastal areas.

The PIN-E site area is characterized by hummocks, rolling hills and raised beaches compost of coarse grained gravel. The station facilities were constructed on a raised beach (Plate 3) sloping toward Dease Strait. During the study the only wildlife that was observed were a small heard of musk-oxen, very little vegetation was observed at this location.

3.3 Heritage Resources

Archaeology is the study of human history through the material remains of culture, now known as heritage resources. The ultimate goal in archaeology is to describe the cultures and events responsible for the creation and deposition of the remains at a given archaeological site. As such, archaeologists use material remains to determine the nature and age of cultural occupations at a site. Artifacts, ecofacts and features deposited into the natural environment, along with their inter-relationships, are the integral parts that make up an archaeological site. The Nunavut Archaeological and Palaeontological Sites Regulations (2003) define heritage resources as: “but not limited to, archaeological and historical sites, burial grounds, palaeontological sites, historical buildings and cairns.”

Plate 3 View north of PIN-E sites, in the background, from an intermediate beach ridge showing typical topography of the study area.

Predating the arrival of Europeans, precontact archaeological sites are comprised of artifacts, features and residues of native origin typically characterized by modified bone and stone, and stone structures. Historic sites are those structures, features, and objects of European influence that date back to contact with the Europeans but can also represent more recent activity of more than 50 years. Depending on the context, sites less than 50 years old may be considered to represent traditional land use and are identified to document continued use and occupation of an area to the present time. A key component of the historic period record are the sites, artifacts and affiliated resources relating to post-contact Aboriginal people's use of the landscape. These include both archaeological sites and objects such as standing and collapsed cabins, campsites, graves, and traditional sites and resources, such as special places, hunting and plant collecting areas, traplines and their associated remains, oral traditions and various documents. These latter resources are usually identified through consultation procedures such as Traditional Use Studies (TUS) or community consultations.

Additionally, heritage resources include, as well as the sites where events took place in the past, all of the objects that they contain and any of the contextual information that may be associated with them and will aid in their interpretation, including natural specimens and documents or verbal accounts.

Heritage resources are non-renewable and are susceptible to alteration, damage, and destruction by construction and development activities. The value of heritage resources cannot be measured in terms of individual artifacts or biological specimens, rather the value of these resources lies in the integrated information which is derived from the relationship of the individual artifacts and fossil specimens, associated features, spatial relationships (distribution), and contextual situations. Interpretation of heritage resource materials, and the ability to interpret the significance of particular sites in a landscape, is based on an understanding of the nature of the relationship between individual archaeological and palaeontological materials as well as the sediments and strata within which they are contained. As such, removal or mixing of cultural or fossil bearing sediments results in the permanent loss of information basic to the understanding of these resources. As a result, heritage resources are increasingly susceptible to destruction and depletion through disturbance.

Similarly, tundra areas north of the tree line are characterized by extremely slow rates of soil development and sediment accumulation. Accordingly, at repeatedly occupied sites, there is little chance of distinguishing occupations relating to different periods within the 10,000-year record of human occupation in the region without recovering a diagnostic indicator. Some areas of high sediment deposition rates are present within the study area, but these are not the typical scenario.

The lack of temporally diagnostic artifacts, the absence of materials suitable for radiocarbon dating, and the natural mixing of shallow archaeological deposits serve to limit the definition of the recognized prehistory for the region. In contrast, extant documents, records, and oral testimony provide a firmer basis for understanding the historic period of the region.

3.3.1 Cultural Chronology

Many of the archaeological materials in the project area represent human activity after the ice sheet receded about 8,000 years ago. Most heritage resources sites have been located on eskers in this regional environment (Noble 1981: 97) and Wright (1995: 121) refers to this early period, 8,000 to 4,000 B.C., as the Early Shield culture and suggests a direct development out of eastern and northern predecessors based on technological characteristics and trends.

Between approximately 6,000 and 3,000 B.P. lanceolate projectile points are seen as horizon markers. The Shield Archaic is replaced by the Arctic Small Tool tradition (ASTt) components, attributable to *Palaeo-Eskimo* peoples.

3.3.1.1 Arctic Small Tool tradition (4200 B.P. to 2800 B.P.)

There is presently little evidence to link Palaeo-Arctic tradition occupations to the Arctic Small Tool tradition (ASTt) occupations that succeed them. The ASTt represents a widespread cultural manifestation that covers all of the Canadian Arctic as well as parts of Alaska and Greenland. The ASTt is typically thought to date between approximately 4,200 and 2,800 B.P. (McGhee 1990). It includes the Denbigh Flint complex in northern Alaska, the Independence I culture of the Canadian High Arctic, the Inuvik Phase and the Pre-Dorset culture in Arctic Canada, and the Sarqaq culture in Greenland. It is thought that the ASTt relates to a separate migration of peoples from Siberia and does not appear to be related to the preceding Palaeo-Arctic tradition. As the name implies, the toolkit of the ASTt is comprised of lithic artifacts that are finely made and smaller than tools of similar function and age from elsewhere in North America. These include microblades and microcores, burins, gravers, small side and end scrapers, side and end blades, and bipointed (arrow) and triangular (harpoon) projectile points (Wright 1995). In Alaska it appears to have developed into the cultures of the Norton tradition while in Canada it developed into the Dorset culture.

The Canadian Tundra Tradition (3,300 – 2,600 B.P.) has been described as a local variant of the ASTt which focused on caribou exploitation (Noble 1981). Sites of this cultural tradition are widespread, being represented in sites on Great Slave and Great Bear Lakes eastward to North Henik Lake near Hudson Bay. Characterized by large lenticular and oval bifaces, small triangular and side notched points, side blades, burin and microblade technology, these assemblages are most commonly associated with orange/pink and white quartzites. Native copper appears in some sites toward the end of this period.

Following the ASTt is the Taltheilei Shale Tradition (2,500 B.P. to 100 B.P.), seen as ancestral to development of the Athapaskan people (Noble 1981). Artifacts of siliceous shale originating on the eastern arm of Great Slave Lake are characteristic; although Taltheilei artifacts have also been identified in the Barrens south of Kugluktuk at Itchen Lake (Blower 2003). Lanceolate projectile points continue to be important in the tool assemblage but small corner and side notched points occur in the latter half of the tradition. The prominent biface and burin and microblade technologies of the preceding phase are notably absent.

3.3.1.2 Dorset Culture (2,500 B.P. to 1,000 B.P.)

The Dorset culture occupied the Canadian Arctic from 2,500 BP until at least 1,000 BP. (McGhee 1990). Best known for miniature carvings, Dorset appears to have been a more successful adaptation to the conditions of the north than the preceding ASTt cultures from which it developed. This is demonstrated by the huge area occupied by Dorset groups and by evidence that they had perfected winter hunting on the sea ice. Cooler conditions in the northern hemisphere around 3,000 years ago resulted in expansion of the sea ice and a shift away from terrestrial hunting of caribou and hunting of sea mammals from boats in open water to a procurement of sea mammals from coastal edges and sea ice. This is evidenced in the archaeological record with a shift away from bow hunting to harpoon and spear hunting (McGhee 1990). Artifacts recovered from sites representing this period are more diverse and “reflect a richer and more secure way of life than that of earlier Palaeo-Eskimos.” including the establishment of permanent winter villages (McGhee 1990).

However, when the people of the Thule culture arrived in the Canadian Arctic approximately 1,000 years ago, the Dorset culture had largely or entirely disappeared for reasons that are not well understood (McGhee 2001; Wright 1999).

3.3.1.3 Thule (1,000 B.P. to 400 B.P.)

The Thule tradition dates from approximately 1,000 to 400 B.P. and is derived from the Norton tradition in northern Alaska. More specifically, Thule grows out of the Old Bering Sea and Punuk traditions, which have numerous similarities to Thule cultural assemblages. These assemblages suggest subsistence based on maritime resources such as seals and whales that were hunted from kayaks or umiaks as identified by harpoon floats. Thule represented a new kind of adaptation to the Arctic environment, based on the hunting of large sea mammals in open water through the use of drag floats attached to the harpoon line. Large skin boats and the use of dogs to pull large sleds were other Thule innovations. Winters were spent in sometimes large communities of semi-subterranean houses, subsisting on a stored surplus obtained most typically by hunting bowhead whales. The introduction of Thule into the Canadian Arctic is noted by a distinct change in a number of cultural markers from the Dorset culture. The earliest Thule occupations currently recognized are on islands in the Bering Strait and exhibit an almost complete reliance on maritime resources; however, later sites demonstrate that both maritime and terrestrial resources were utilized (McGhee 1990). Climatic changes following the thirteenth century likely caused the Thule to modify their way of life into that of the various historic Inuit groups.

3.3.2 Historic Inhabitants

Historic use of the project area is identified with the ‘Copper Inuit’. The traditional territory of the Copper Inuit extends from the Coppermine River east to the Perry River and the south coast of Banks Island south to Great Bear Lake (Damas 1984). The subsistence, economy and settlement pattern of the Copper Inuit was greatly influenced by seasonal fluctuations. In the spring they would leave their more sedentary villages along the coast to hunt and fish inland. Subsistence from late May until November was reliant on caribou, fish, fowl and small game common on the interior tundra. In the fall during the caribou migration hunting caribou was often the most dominant form of subsistence. The Copper Inuit would return to the coast in the fall to build villages for the winter; breathing-hole sealing was the most prevalent activity during the winter months. This method involved specialty trained dogs to locate the seals’ breathing holes; each hunter would station themselves at a hole and quietly wait for a seal to come up to breathe (Damas 1984). Other resources that were occasionally used include polar bears in the winter and musk-oxen in the summer.

The largest grouping of Copper Inuit was during the winter months when they would gather in villages along the coast (more people was beneficial for breathing-hole sealing). Over the summer they split up into smaller groups and even individual nuclear families when subsistence was based on fishing, hunting small animals and foraging. In the late autumn many of these groups would reunite for the sewing period, when sewing their winter garments was the most important task (Damas 1984).

Although many of the characteristics described are similar with other Inuit groups there are some distinguishing characteristics that the Copper Inuit have. According to Damas (1984) aside form the territory that they inhabited, the Copper Inuit were also known for their wide use of copper; their distinctively tailored clothing; and their social and familial organization.

3.3.3 Heritage Studies

Prior to the current study of the PIN-E Intermediate DEW Line site at Cape Peel, no heritage resources sites were recorded in the Nunavut or Canadian Museum of Civilization database for this location. However, exploration of the region has been taking place throughout the past century and even prior to this with early explorers trying to find the Northwest Passage.

In the early 1900s researchers were travelling around the southern coast of Victoria Island learning about the geography of the land and studying the people who inhabited it. Two of the more well known researchers/explorers were Diamond Jenness and Vilhjalmur Stefansson who created a basis for further archaeological research in the region. The first organized archaeological survey was in the early 1960s. In 1963 the National Museum of Canada sent William E. Taylor out to identify any heritage resources in the vicinity of the DEW Line sites between Lady Franklin Point and Cambridge Bay, N.W.T. (Taylor 1972).

Across Wellington Bay, 50 km east from the study area, Iqaluktuuq is one of the most studied regions on Victoria Island. The Iqaluktuuq area (a place of many fish) is located along a short stretch of the Ekalluk River between Ferguson Lake and Wellington Bay, 50 km northwest of Cambridge Bay. Iqaluktuuq is a traditional hunting and fishing ground that is well known for the migrating caribou that pass through this area as well as its annual run of arctic char (Friesen 2002). Both sides of the river contain dense archaeological remains that reflect the continuous occupation of this region beginning with the Pre-Dorset tradition (1800 to 500 B.C.). William E. Taylor conducted three seasons of extensive fieldwork in this area and recorded 28 heritage resources (Friesen 2002). Jack Brink is also known for the work he did in this area, specifically regarding lithic reduction at the Cadfael site (Brink 1992). More recently Max Friesen has led a multi-year archaeological project of the Iqaluktuuq region (Kitikmeot Heritage Society).

To the west of the PIN-E DEW Line site a single archaeological site was recorded and mitigated in advance of the construction of the Cape Peel West Short Range Radar Station (Helmer 1989). The site, NgNl 1, consisted of a tight cluster of nine stone tent rings on an esker. NgNl 1 is approximately 20 km from the current study area.

4. METHODOLOGY

4.1 Field Inventory and Assessment

All field work was conducted under a valid Class II Archaeological Permit issued by CLEY. The field program focused on assessment of all areas of high and moderate archaeological potential within the disturbed DEW Line site, and the proposed borrow source locations. The purpose of the field investigation was to identify archaeological materials, document location and content and provide data to be used in the development of recommendations for future remediation programs. Inventory and assessment techniques followed established practices and consisted of the following:

- visual examination of the identified areas to determine the presence of such surficial features such as standing or collapsed buildings, dumps, cache pits, cabin foundations, etc. and exposed precontact cultural materials such as stone tool making debris and tools;
- visual examination of the identified areas to determine the presence of items of historical military interest;
- excavation of shovel tests (ca. 40 x 40 cm) to varying depths to determine the potential for subsurface precontact cultural remains if deposition is present;
- visual examination of bedrock exposures (if any) or gravels for precontact quarrying activity;
- excavation of either additional shovel tests or 1 x 1 m units for the purpose of identifying the distribution, density, and nature of cultural remains associated with sites identified through inventory procedures;
- documentation of the location (GPS coordinates), nature, size, and complexity of each identified site; and
- documentation of individual site features to record content, context, potential identity, and to provide information required to develop a mitigation program.

These results, along with updates and recommendations will be included in written submissions to CLEY as required by the Permit to conduct the AIA, and discussed with the Chief Archaeologist of Nunavut.

4.2 Heritage Feature / Structure Evaluation

Evaluations of heritage features and standing structures were to be completed for features/structures that are observed during the investigations. These evaluations would consider perceived heritage resource value and community cultural value as well as the predicted impact from the proposed program. In general, disturbed sites with limited cultural remains would be assigned lower archaeological resource values than undisturbed sites, large sites with large amounts of cultural material, complex sites, and multicomponent sites. Undisturbed multicomponent sites would generally be assigned the highest heritage resource value.

Community input will play a role in the evaluation of site value, and the inclusion of members of the local community on the field crew aided in the in-field discussions regarding site significance.

4.3 Detailed Archaeological Site Investigations / Mitigation

If required, mitigation of significant heritage resources sites may include a number of different options. Prior to evaluation of these mitigative options, the perceived value of the identified archaeological sites will be discussed with the PWGSC Project team to determine the feasibility of avoiding important sites. Only if site avoidance is not possible, will other mitigative measures such as collection and documentation, and controlled mapping/excavation be considered. In areas of no sediment deposition surface collection and mapping of artifacts and features may satisfy regulatory requirements for mitigation. Recommendations for excavation may include a controlled excavation mitigative plan and will specify the number of square metres and suggest locations for excavation units/blocks.

Overall mitigative options may be summarized by:

- collection and documentation undertaken at the time of the field assessment at all sites with low archaeological resource value;
- avoidance if feasible at all sites assigned high archaeological resource value;
- mitigative excavations which will be recommended at those sites assigned high archaeological resource value that could not be avoided by borrow source relocation; and
- a management plan for required mitigation relative to the proposed construction schedule will be discussed with the site project team.

4.4 Reporting

Analysis of collected artifacts includes cleaning, cataloguing, identification, inventory, and description of each individual piece for inclusion in the final report. GPS site information is provided for mapping relative to the former site structures at the site and to CLEY, but not included in the final versions of this report. Archaeological site maps, photographs, and artifact scans are prepared as digital files.

Upon completion of the field component and the artifact curation, a draft report was prepared. This final permit report on the archaeological studies will be forwarded to PWGSC for their review, and then on CLEY for their review. This report includes a project description, the environmental setting, the historical and archaeological context for the project area, field methodology, and the results of the field reconnaissance. The report includes both descriptive, as well as mapped data on the sites, artifacts, and features identified, as well as detailed information on the nature, content, and significance of the artifacts and features identified. Cultural material recovered has been inventoried, described, and discussed within the report text to aid in evaluation of scientific and interpretive value. All identified sites have been documented on appropriate site inventory forms.

If required, a summary of the findings will be prepared for inclusion in a screening document.

In general, the following workplan is followed:

- avoidance has been recommended if feasible at all sites assigned high archaeological resource value (this to include all constructed features: burials, tent rings, caches, hunting blinds, hearths);
- collection and documentation has been undertaken as a mitigative option of sites with low archaeological resource value as a method of protecting the heritage resource from future undocumented impacts due to increased personnel activity in the vicinity; and
- acceptable methods of mitigation are discussed with CLEY and the Territorial Archaeologist, and may lead to a recommendation for detailed mapping, collection and/or test excavations at those sites assigned high archaeological resource value that cannot be avoided by reclamation project.

A management plan for required mitigation, monitoring or surveillance relative to the proposed remediation will be developed as part of the contracted services deliverable to PWGSC. This includes site mitigation, additional survey of any project re-locates required due to site avoidance, and verification of those heritage sites located outside the proposed development activity area that should remain outside re-located areas.

4.5 Community Consultation

Consultation regarding the PIN-E Intermediate DEW Line site Phase III Environmental Site Assessment, Hazardous and Non-Hazardous Materials Audit, Geotechnical Evaluation, Remedial Action Plan is ongoing. Community meetings were held in regard to the Project in Cambridge Bay in January of 2010. The presentation included the results of this study, sites identified, and recommendation.

5. RESULTS

A search of the Canadian Museum of Civilization database yielded no information on previously recorded heritage resources sites at Cape Peel prior to conducting the AIA. As such, no revisits or information updates to existing sites was required.

The AIA assessment included all of the areas of moderate to high archaeological potential that has been disturbed by the PIN-E DEW Line site as well as areas identified as having potential for future borrow sources or dumps. The disturbed areas that were surveyed included the Station Area (Plate 4), airstrip, beach (Plate 5), barrel dumps, landfills (Plate 6) and all the existing roads and anywhere there was evidence of a bull dozer push or any other disturbance. Previously undisturbed areas that were examined included the periphery of all the impacted areas as well as several areas that were identified as potential borrow areas, landfills and landfarms for remediation activities (Plates 7 and 8).

During the survey two heritage sites were identified and recorded. The sites include a stone cairn, NgNj 1, and an isolated find, NgNj 2 which are described in more detail below. In addition to the heritage sites, a land use site consisting of the remains of three Inuit houses and a grave as well as two modern stone tent rings were observed. Although the structures have been removed from the beach, material culture left behind indicates that at least three Inuit houses were present on the beach approximately 300 m south of the former location of the POL tanks and beach landing area (Plate 9 and 10). Material culture observed includes domestic artifacts such as children’s toys, flat glass, clothing, rubber garden hose, ceramic and plastic plate fragments, bed frame, container glass, an ulu (Plate 11), seal and bird bone as well as electrical wire, metal strapping, electrical switches and other unidentified artifacts from the DEW Line site.

Plate 4 View northeast of antenna, PIN-E DEW Line Site.

Plate 5 View north of barrels on the beach.

Plate 6 View east of Landfill 1 location.

Plate 7 View north of PIN-E site with potential borrow area in the foreground.

Plate 8 View east of potential borrow area off the west end of the runway.

Plate 9 View east of former house location and general site area.

Plate 10 View west of former house location and general site area.

Plate 11 Ulu identified amongst cultural material.

The grave is located approximately 450 m southwest of the Inuit house remains on a beach ridge (Plate 12). The grave is marked with a wooden cross made of dimensional lumber and the coffin is partially exposed as the lid has collapsed and is only shallowly buried. The coffin is small, approximately 2 feet by 4 feet, and is made of plywood. Remains can be seen under the collapsed lid that appears to be immature rib bones. After recording the grave site Gary Avalak, who assisted in recording the grave, asked his mother Mary Avalak about the grave and she thought it might have been the grave of Alice Kaotalok who had lived in the area with her husband David and her parents. According to Mary, Alice has died of cancer and was buried around the same time as the operation of the DEW Line Site. Although this is a possibility, the grave appears quite small for an adult and may possibly contain the remains of a child.

Plate 12 View northwest of grave and surrounding terrain.

The two modern stone tent rings were located on the beach beside the river along the northeastern edge of the study area. The two tent rings are 3 and 5 m in diameter and are made of seven and eight large stones respectively (Plate 13). Material culture around the two stone rings includes shotgun shells, plastic oil containers and food cans.

Plate 13 View east of modern tent ring.

5.1 Newly Identified Heritage Resource Site

5.1.1 NgNj 1

NgNj 1 is a stone feature site that is made up of a single stone cairn that was recorded on an intermediate ridge line (Plate 14). The cairn was recorded on the fourth beach ridge just below the location of the PIN-E DEW Line site. The cairn is made up of at least 14 flat stones with a diameter of 1 m (Plate 15). There was no additional cultural material observed around the stone feature. Although the area just north of the site has been previously disturbed by a bulldozer the site area has not. The stones also exhibit a lichen patterning that would indicate prolonged exposure and therefore is thought to predate the DEW Line Site. NgNj 1 is considered to be of moderate potential and it is

Plate 14 View north of NgNj 1 with PIN-E Site in the background.

Plate 15 Detail of stone cairn, NgNj 1.

recommended that any impacts to the site be avoided. At this time there are no plans to disturb NgNj 1 during the remediation activities.

5.1.2 NgNj 2

NgNj 2 is an isolated find site consisting of a single modified flake. The flake was surface collected on the second beach ridge approximately 230 m from the water (Plate 16). The flake is made of red quartzite and is relatively large (55 x 68 x 16 mm) with three flake scars on the dorsal side. The flake appears to be broken, missing the platform, and has been bifacially modified along both lateral edges and distal edge. The distal edge also appears to show signs of having been utilized. No additional cultural material was observed around the site area and four shovel tests were negative for cultural material. Due to the limited cultural assemblage, NgNj 2 is thought to be of limited significance and no further work is recommended.

Plate 16 View northeast of NgNj 2 site area.

6. SUMMARY AND RECOMMENDATIONS

The AIA of the PIN-E Intermediate DEW Line site conducted under Nunavut Permit 2009-023A produced the results discussed in Section 5 and outlined in Table 1. The disturbed nature of the site and lack of vegetation and sedimentation enabled a high visibility surface examination of the facility areas to adequately assess for the presence of cultural materials. As requested, areas which will not be impacted during remediation were not fully examined. During the study two heritage resource sites, NgNj 1 and NgNj 2, were identified and are documented as per the *Guidelines for Applicants and Holders of Nunavut Territory Archaeology and Palaeontology Permits* (Government of Nunavut 2003).

Table 1 Heritage Site Recommendations

Site	Type	Significance	Recommendations
NgNj 1	Stone cairn	moderate	Avoidance is recommended
NgNj 2	Isolated find	low	No further work is recommended

PWGSC has fulfilled the requirements to indentify the potential for impact to heritage resources during the proposed remediation/reclamation of the PIN-E DEW Line site at Cape Peel. The AIA of the PIN-E Site included the participation of Richard Angivrana and Gary Avalak from the local community of Cambridge Bay, who acted as bear monitors and participated in the identification and recording of the heritage resource sites.

The AIA identified two heritage resource sites, NgNj 1 and NgNj 2. The site NgNj 1 is considered to be of moderate significance and it is recommended that this site be avoided during remediation activities. NgNj 2, however, is considered to be of limited significance and no further work is recommended.

7. CLOSURE

We trust the above meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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APPENDIX I

PHOTOGRAPH LOG

PIN-E AIA Photo Log

Number	Comment
09-023A photo 1	Aerial view of the northwest end of runway
09-023A photo 2	Photo of building foundation - DEW Line Site
09-023A photo 3	Photo of building foundation - DEW Line Site
09-023A photo 4	Photo of DEW Line building
09-023A photo 5	Photo of tower
09-023A photo 6	Photo of tower
09-023A photo 7	Photo of tower
09-023A photo 8	Photo of tower support
09-023A photo 9	Photo of tower - top
09-023A photo 10	Photo of tower - top
09-023A photo 11	Photo of tower
09-023A photo 12	View northeast from DEW Line site of Musk ox
09-023A photo 13	View northeast from DEW Line site of Musk ox
09-023A photo 14	Photo of can dump east of the DEW Line site on hill
09-023A photo 15	Photo of can dump east of the DEW Line site on hill
09-023A photo 16	Photo of can dump east of the DEW Line site on hill
09-023A photo 17	Detail of can dump
09-023A photo 18	Detail of can dump
09-023A photo 19	Photo of Musk ox skull
09-023A photo 20	View west of Landfill 4
09-023A photo 21	View south of tower from Landfill 4
09-023A photo 22	View south of tower from Landfill 4
09-023A photo 23	Control photo of shovel
09-023A photo 24	View north along Landfill 4 area
09-023A photo 25	View south along Landfill 4 area
09-023A photo 26	View south along road to Landfill 4
09-023A photo 27	View north along road to Landfill 4
09-023A photo 28	View south from Barrel Area A from freshwater Lake
09-023A photo 29	View south from Barrel Area A from freshwater Lake
09-023A photo 30	View east of Barrel Area A
09-023A photo 31	Photo of tower - bottom end
09-023A photo 32	Photo of bird's nest in DEW Line site building
09-023A photo 33	View south along fuel line from beach to site area
09-023A photo 34	View south along fuel line from beach to site area
09-023A photo 35	View north along fuel line from beach to site area - site can be seen in the background

PIN-E AIA Photo Log (continued)

Number	Comment
09-023A photo 36	View southeast of east end of runway with plane
09-023A photo 37	View south along river that is east of the site area
09-023A photo 38	View south along river that is east of the site area
09-023A photo 39	View south along river closer to the beach
09-023A photo 40	View north along river close to the beach
09-023A photo 41	Photo of "Toc" for breaking holes in ice
09-023A photo 42	Photo of grave
09-023A photo 43	Photo of grave and surrounding area
09-023A photo 44	View southwest of grave and surrounding area
09-023A photo 45	View northeast of grave and surrounding area
09-023A photo 46	Detail of grave
09-023A photo 47	Detail of grave
09-023A photo 48	Detail of grave
09-023A photo 49	Detail of grave
09-023A photo 50	View north of grave and surrounding area
09-023A photo 51	View north of grave and surrounding area
09-023A photo 52	Detail of grave
09-023A photo 53	View southwest of survey marker
09-023A photo 54	View southwest of survey marker
09-023A photo 55	View northeast along beach
09-023A photo 56	View northeast along beach area - along the second beach ridge
09-023A photo 57	View north of NgNj 1 showing site area
09-023A photo 58	View north of NgNj 1 showing site area
09-023A photo 59	View west of site area, NgNj 1
09-023A photo 60	View east of site area, NgNj 1
09-023A photo 61	View southeast of site area, NgNj 1
09-023A photo 62	Detail of stone cairn, NgNj 1
09-023A photo 63	Detail of stone cairn, NgNj 1
09-023A photo 64	Photo of bull dozer push close to NgNj 1
09-023A photo 65	Photo of bull dozer push close to NgNj 1
09-023A photo 66	View east towards Landfill 1 and Landfill 2
09-023A photo 67	View south east with barrel marking runway
09-023A photo 68	View northeast of two modern tent rings
09-023A photo 69	View southeast of modern tent rings with barrel dump in the background
09-023A photo 70	View southeast of modern tent rings with barrel dump in the background

PIN-E AIA Photo Log (continued)

Number	Comment
09-023A photo 71	Photo of a can associated with the modern tent rings
09-023A photo 72	View south east of modern tent ring area with barrels in the background
09-023A photo 73	View west of barrels from beach area
09-023A photo 74	View south along beach
09-023A photo 75	Photo of concrete foundation for POL tank
09-023A photo 76	View southwest of NgNj 2 site area
09-023A photo 77	View northeast of site area NgNj 2 - with barrel dump in the background
09-023A photo 78	Inuit house remains - first of three
09-023A photo 79	Detail showing shovel and flat glass etc
09-023A photo 80	Inuit house remains - first of three also showing surrounding area
09-023A photo 81	Ulu blade
09-023A photo 82	Inuit house remains - first of three also showing surrounding area
09-023A photo 83	Front forks of a trike
09-023A photo 84	Inuit house remains - two of three showing material culture
09-023A photo 85	Inuit house remains - two of three showing material culture
09-023A photo 86	Inuit house remains - two of three showing material culture
09-023A photo 87	Photo of toilet seat and flat glass
09-023A photo 88	Photo of oil barrels among domestic artifacts
09-023A photo 89	Inuit house remains, three of three
09-023A photo 90	Inuit house remains, three of three
09-023A photo 91	Washing machine left close to the beach
09-023A photo 92	Washing machine left close to the beach
09-023A photo 93	Washing machine left close to the beach
09-023A photo 94	Two oil barrels
09-023A photo 95	Misc piece of electronics
09-023A photo 96	Surrounding area of Inuit huts
09-023A photo 97	View east along the north side of the runway
09-023A photo 98	View east along the north side of the runway
09-023A photo 99	View east on west end of runway of potential borrow sources areas
09-023A photo 100	View east on west end of runway of potential borrow sources areas
09-023A photo 101	View south of proposed borrow pit west of the runway
09-023A photo 102	View northeast from just north of the runway, potential borrow area
09-023A photo 103	View northeast from just north of the runway, potential borrow area
09-023A photo 104	View north towards PIN-E Site of potential borrow source
09-023A photo 105	View southeast from north of the runway with plane in the background

PIN-E AIA Photo Log (continued)

Number	Comment
09-023A photo 106	View west of potential borrow sources north of runway
09-023A photo 107	Aerial view of freshwater lake and access road
09-023A photo 108	Aerial view of road, Barrel Area A and Landfill 4, north end of the site area
09-023A photo 109	Aerial view of PIN-E Site
09-023A photo 110	Aerial view of PIN-E Site
09-023A photo 111	Aerial view of beach area, PIN-E Site
09-023A photo 112	Aerial view of western end of beach area