Final Report: Remedial Action Plan CAM-E (Keith Bay), Nunavut

Prepared for:
Public Works Government Services Canada

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Executive Summary

Stantec Consulting Ltd. (Stantec) was retained by Public Works and Government Services Canada (PWGSC) – Northern Contaminated Sites Group to complete the assessment and prepare this Remedial Action Plan (RAP) for the former Distant Early Warning (DEW) Line Facility CAM-E located at Keith Bay, Nunavut (herein referred to as the Site).

Stantec conducted a Phase III Environmental Site Assessment (ESA) (including a Hazardous and Non-hazardous Materials Audit and a Geotechnical Evaluation) for the Site in 2013. Based on the results and conclusions of the Phase III ESA, this RAP has been developed to evaluate remedial options and recommend a remediation approach.

A wide variety of potential remediation solutions were initially evaluated and from this review, a short list of potentially applicable technologies was compiled. The list was further refined to the recommended remediation approach detailed in the table below.

Category	Sub-Category	Approximate Volume (m^3)	Recommended Option
Contaminated Soil	DCC Tier I Soils	100	Dispose of in on-site Non-Hazardous Waste (NHW) landfill
	DCC Tier II Soils	3,600	Dispose of in on-site Tier II landfill
	Type A Hydrocarbon Soils	1,200	Dispose of in on-site NHW landfill
	Type B Hydrocarbon Soils	1,900	Remediate by on-site treatment
Hazardous Waste	Asbestos	25	Double bag and dispose of in NHW landfill
	Batteries	16 units	Package and dispose of off-site
	PCB and/or lead amended paint	200 m^3 after crushing	Partial abatement onsite of poorly adhered paint and on-site disposal in Tier II landfill after abatement. If lead has leached into substrate at concentrations above the guideline, this material will be disposed of off-site.
Non-Hazardous Waste	Barrels	1,700 m^3 after crushing	To be emptied, cleaned, crushed, and disposed of in the NWH landfill
	Compressed Gas Cylinders		To be vented and disposed of in the NWH landfill
	Building Infrastructure		To be demolished, shredded/incinerated, and disposed of in the NWH landfill
	Other Non-Hazardous Waste		To be collected, shredded, compacted and disposed of in the on-site NWH landfill

Category	Sub-Category	Approximate Volume (m^3)	Recommended Option
Buried Debris Areas	BDA1 through 8	Estimated 3,200 m^3 of material requires excavation	Per location as described in Section 4.2.4

Based on the results of the Phase III ESA sufficient information was gathered to produce the RAP herein. The recommended options are generally to landfill material at the Site and monitor over time rather than ship material off-site for disposal elsewhere. This is primarily based on the cost as well as access issues (particularly for a barge). Disposal options were chosen in accordance with the Abandoned Military Site Remediation Protocol when possible. The information contained in this RAP is considered sufficient to prepare the cost estimate for the remediation, and to proceed with the Environmental Impact Assessment in accordance with Nunavut requirements.

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1.0 Introduction

Stantec Consulting Ltd. (Stantec) was retained by Public Works and Government Services Canada (PWGSC) – Northern Contaminated Sites Group to complete the assessment and prepare this Remedial Action Plan (RAP) for the former Distant Early Warning (DEW) Line Facility CAM-E located at Keith Bay, Nunavut (herein referred to as the Site) (Drawing R1, Appendix A). Aboriginal Affairs and Northern Development Canada (AANDC – formerly Indian and Northern Affairs Canada (INAC)) has responsibility, through the Contaminated Sites Program, to manage a number of the former DEW Line Facilities (including the Site) that are no longer maintained by the original occupant. AANDC has retained PWGSC – Northern Contaminated Sites Group to assist in coordinating the program on its behalf.

PWGSC solicited a proposal from Stantec to complete the scope of work through the existing "As and When Requested" Contract (EW699-121587-001) for Environmental Services within the Western Region. Terms of Reference for this work were provided in April 2013.

2.0 Background

The Site is located on the Simpson Peninsula approximately 75 kilometres (km) east of Kugaaruk (formerly Pelly Bay) (Drawing R1, Appendix A). The Site was historically used as an intermediate DEW Line Facility by Department of National Defense (DND). The Site consists of two separate areas; Area 1 and Area 2. Area 1 includes former infrastructure such as module train debris, warehouse, garage, Inuit house, POL tanks, Quonset huts, storage pads, a small airstrip, multiple drum caches and a dismantled radar tower (Drawing R2, Appendix A). Area 2 is located on a beach plateau approximately 5.6 km away from Area 1 and includes a larger airstrip, two former Quonset huts, a bunker and various debris including scattered and cached drums (Drawing R3, Appendix A).

A Phase III Environmental Site Assessment (including a Hazardous and Non-hazardous Materials Audit and a Geotechnical Evaluation) was conducted for the Site in 2013. The purpose of the Phase III was to delineate previous soil exceedances, determine a total volume of soil requiring management at the Site, record quantities of hazardous and non-hazardous materials present at the Site, determine possible locations of borrow source materials, review potential landfill locations, and evaluate Site access conditions. Based on the results and conclusions of the Phase III ESA, this RAP has been developed to evaluate remedial options and recommend a remediation approach.

Based on the activities conducted during the Phase III ESA, the following conclusions were reached:

- Coliforms were identified in excess of the Health Canada Drinking Water Quality Guidelines in the Freshwater Lake.
- Metals concentrations above applicable guidelines were present in the water body at the Main Station Landfill.
- Elevated aluminum concentrations were present in one sample collected from Area 2. However, given the composition of local till and bedrock, this may be reflecting background concentrations. This area should be resampled prior to conducting remedial activities. Additional surface water samples should also be collected during the remediation program to establish baseline metal ranges.
- Contaminated soils at the Site included approximately 100 m^3 of soil greater than DCC Tier I criteria, 3,600 m^3 of soil greater than DCC Tier II criteria, 1,200 m^3 of soil greater than Type A hydrocarbon AMSRP criteria, and 1,900 m^3 of soil greater than Type B hydrocarbon AMSRP criteria.
- Eight buried debris areas were identified and reviewed in accordance with the AMSRP requirements. Two of the buried debris areas were determined to be Class B (moderate potential environmental risk), while the remaining six were Class C (low potential environmental risk).
- Approximately 25 m^3 of asbestos containing waste, 200 m^3 of other hazardous materials (crushed PCB and lead paint amended material), and 1,700 m^3 of crushed non-hazardous waste materials were present at the Site.

3.0 Regulatory Framework

The Site is managed by AANDC and is a former military facility. INAC (now AANDC) published the Abandoned Military Site Remediation Protocol (AMSRP) for use at AANDC sites. The AMSRP takes into account the realities of remediation in the north, including financially prudent methods.

The AMSRP has been developed through the review of previous work at related sites by DND and AANDC, and takes into consideration information of particular relevance to the unique character of the AANDC sites. Remedial criteria for waste materials typically encountered on AANDC sites (contaminated soil, non-hazardous and hazardous wastes, visible/accessible debris, and buried debris/landfills) have been identified within the AMSRP.

Three primary contaminated soil types are identified in the AMSRP; inorganic element contaminated soil, PCB contaminated soil, and hydrocarbon contaminated soil. Where multiple contaminants are present in the soil, the most conservative remedial option that addresses all contaminant types shall be applied.

A summary of default remedial options for contaminated soil, hazardous and non-hazardous waste from the AMSRP are as follows:

Table A AMSRP Summary of Remedial Options

Contaminated Soil	Remedial Options
DCC Tier I	Excavate and place in an on-site engineered landfill or cap in place under o.3 m of clean fill in a stable location.
DCC Tier II	Excavate and dispose of in an on-site Tier II facility or containerize for off-site disposal.
Type A TPH (Non-Mobile Hydrocarbon Contaminated Soil)	Excavate and place in an on-site engineered landfill or scarify surficial stains that are less than criteria
Type B TPH (Mobile Hydrocarbon Contaminated Soil)	*In-situ* or *ex-situ* treatment to reduce environmental risk to meet guidelines
Non-hazardous Wastes	Minimize volume through crushing, shredding, or incineration and place in approved engineered landfill or dispose of off-site
Hazardous Wastes – PCB Paint on Building Components	Collect and transport PCB paint and PCB painted components that are regulated under the CEPA (PCB concentrations greater than 50 ppm) off-site in accordance with the Transportation of Dangerous Goods Act and CEPA, to a licensed waste disposal facility.
Hazardous Wastes – Lead-Based Paint on Building	Collect and transport lead-based painted components that are classified as hazardous material (lead leachate concentrations

Contaminated Soil	Remedial Options
Components	exceeding 5 mg/L) off-site in accordance with the Transportation of Dangerous Goods Act, to a licensed waste disposal facility.
Asbestos	Collect, double bag, and disposed of asbestos material in an on-site engineered landfill, in accordance with the appropriate legislation or ship off-site for disposal. Where asbestos materials are painted, disposal requirements are based on paint analysis.
Petroleum Products	Petroleum products, such as gasoline or diesel, which do not contain other hazardous products (chlorine, PCBs, 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 AMSRP's Barrel Protocol.
Compressed Gas Cylinders	Compressed gas cylinders with known contents will be vented and once empty, will be disposed of in an on-site engineered landfill or shipped off-site for disposal, depending on landfill availability.
Barrels	Empty Barrels: Empty barrels will be crushed and disposed of on-site in an engineering landfill. Filled or Partially Filled Barrels: Barrel contents will be inspected, tested if necessary, and disposed of appropriately (off-site or incinerated). The empty barrel will be rinsed, and disposed of as described above. The rinse liquid will be tested and disposed of appropriately. Absorbent materials used as part of this process shall be incinerated or disposed of as a hazardous material, depending on test results. Buried Empty Barrels: Areas containing buried empty barrels shall be inspected to determine if any of the barrels contain material and characterize through a geophysical study. If the barrels are 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 will be placed over the area and compacted.
Buildings and Infrastructure	Existing buildings and infrastructure will be demolished to concrete foundations and above-grade timber foundations will 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 will be removed to a minimum of 0.3 m to below ground surface.

Although the AMSRP outlines default remedial options, if other site-specific options were considered appropriate, they were evaluated further in Section 4.2.

4.0 Remedial Action Plan

4.1 REMEDIAL OBJECTIVES

As described in the AMSRP, the remedial objectives for the cleanup of DEW line sites in the Canadian arctic include:

- Remediate and reclaim sites to meet the environmental objectives established for northern sites
- Prevent further migration of contaminants into the arctic ecosystem
- Remove physical hazards to protect human health and safety
- Implement a cost effective remediation solution

Each of the potential remedial options described in the sections below will be assessed with consideration of these objectives to identify the most viable options for the Site.

4.2 REMEDIAL OPTIONS EVALUATION AND PROPOSED APPROACH

A wide variety of potential remediation solutions were initially evaluated that considered the environmental effectiveness relative to the specific site conditions. Each technology was reviewed considering factors such as physico-chemical compatibility, technical practicability/impracticability, previous effectiveness, permanence, and protectiveness. From this review, a short list of potentially applicable technologies was compiled.

The short list of technologies was then further assessed against other factors including:

- Physical conditions at the Site such as
    - the distance between the Site and Kugaaruk
    - the remoteness of the Site in terms of lack of on-site facilities (camp, potable water, power)
    - unique northern climate
    - unknown (and likely variable) degree of ice coverage in Sea of Boothia
- The short construction timeframe for northern Sites (generally from June to September)
- Ability to mitigate risks to human and environmental health
- Stakeholder expectations/requirements
- Reaching closure in a timely manner
- Costs

Based on the factors listed above, specific consideration was given to those technologies which would mitigate risk to human and environmental health, while maintaining cost control. Below is a summary of options evaluated for each category and the proposed approach.

4.2.1 Contaminated Soils

Drawings R4 through R16, Appendix A shows contaminated soil locations.

4.2.1.1 DCC Tier I Soils

Approximately 100 m^3 of DCC Tier I soil were identified in Area 1, including near the Warehouse, the Station Dump, and the Main Station Landfill. The following remedial options were considered:

Excavate and Place in an On-Site Non-Hazardous Landfill - Contaminated soils would be excavated and placed into an on-site non-hazardous waste (NHW) landfill and used as intermediate fill. Three potential NHW landfill locations (Potential Landfill/Landfarm Site 3, 4, and 5) were identified in the Phase III and are located within one km of Area 1.

Cap in Place - In accordance with the AMSRP, Tier I soil can be capped in place under 0.3 m of fill in a stable location. The cap would eliminate the potential for humans and/or wildlife to come in contact with the contaminated soil, as well as reduce the amount of precipitation coming in contact with the soil, thus preventing further dispersion of the contaminant.

4.2.1.1.1 Proposed Remediation Approach

In accordance with the AMSRP, and to protect human and ecological health, these soils will be excavated from their current locations and placed in an on-site engineered landfill for non-hazardous wastes rather than cap in place. Capping was considered, however, by placing these soils in a central area (i.e., landfill), access to these soils can be better controlled and monitored, and costs associated with monitoring will be reduced. In addition, the bulk of Tier I soil is present in the Main Station Landfill which will be excavated as part of other remediation work.

4.2.1.2 DCC Tier II Soils

Approximately 3,600 m^3 of DCC Tier II soil was identified, with the largest quantities located at the Main Station Landfill and Northwest Drum Cache in Area 1 and at the Airplane Wreckage in Area 2. It should be noted that approximately 2,000 m^3 was assumed to be Tier II soil and testing will be conducted at the outset of remediation to confirm the soil quality. The following remedial options were considered:

Excavate and Place in an On-Site Tier II Landfill - DCC Tier II soil would be excavated and disposed of in an on-site Tier II landfill. In accordance with the AMSRP, the Tier II landfill would be constructed using a geomembrane liner and sufficient granular fill cover to maintain the landfill security (i.e., permafrost base). Potential Landfill/Landfarm Site 1 has been identified as the optimal location due to its relatively flat grades (low erosion potential) and permafrost expected to be widely found (greater than 43,000 m^2) and at a relatively shallow depth (0.4 – 0.6). This is the recommended location for the Tier II landfill. In addition, a long term monitoring program would be established to monitor for landfill and permafrost stability. This would include the use of thermistors to monitor groundwater temperature.

Excavate and Containerize for Off-Site Disposal - DCC Tier II soil would be excavated, containerized (in soil bags and seacans), and transported off-site for disposal at a facility that is licensed to accept metals and PCB contaminated soils. Based on preliminary research this would include moving soils via cat train to either Kugaaruk (where it would be removed by sealift to a barge) or having the coast guard access the site with the sealift, and transporting the soil to Montreal, QC for disposal. A number of other potential routes are possible. It is not clear if a barge was ever at Site, however, based on the fact that barges do not

access Kugaaruk (supplies are brought by the smaller Coast Guard sealift) it is unlikely that barges were used to access the Site.

4.2.1.2.1 Proposed Remediation Approach

The process and cost of disposing of the Tier II material off-site was evaluated against construction of an on-site Tier II landfill and the cost of monitoring for 25 years. For off-site disposal, there is an estimated 1,200 m^3 - 3,600 m^3 of Tier II material and assuming a density of 2 tonnes per m^3 (for estimating purposes), there are 2,400 tonnes – 7,200 tonnes of soil requiring management. Assuming the only access is via coast guard sealift, the disposal cost to ship the soil to Montreal for disposal would be approximately $2,500 per tonne, for a total disposal cost ranging from $6 million (M) to $18 M depending on the final volume.

If an on-site Tier II landfill is constructed, monitoring in accordance with the AMSRP would be required (over a 25 year period). The approximate cost to complete the monitoring would be less than $1 M. The material to construct the landfill (liner, thermistors, etc), the mobilization of these materials, and the actual construction are not expected to be greater than $1 M (and likely significantly less considering the equipment will already be on-site).

In addition to the costs, off-site disposal would occur over multiple years due to the capacity of the coast guard. This would add additional costs to keep the equipment on-site to support shipping.

Based on the cost of transporting this large quantity of soil off-site for disposal it is recommended that the material be excavated and placed in an on-site Tier II Landfill and monitoring be conducted in accordance with the AMSRP.

4.2.1.3 Type A Hydrocarbon Soil

Approximately 1,200 m^3 of Type A hydrocarbon soils were identified in Area 1 near the Quonset Hut #1, Station Airstrip Dump, Main Station Landfill, and the Pallet Line. In accordance with the AMSRP, Type A hydrocarbons are not considered mobile and are suitable for disposal in a NHW Landfill.

As a NHW landfill will be constructed for the disposal of Tier I soils, Type A Hydrocarbon soils will also be placed in the NHW landfill. Three potential NHW landfill locations (Potential Landfill/Landfarm Site 3, 4, and 5) were identified in the Phase III and are located within 1 km of Area 1.

4.2.1.4 Type B Hydrocarbon Soil

Approximately 1,900 m^3 of Type B hydrocarbon soils were identified in both Area 1 and 2, located around the Garage, the POL Foundations, the Southeast Drum Cache, the Main Station Landfill, the Pallet Line, the Beach Drum Cache, the Bunker and the Beach Landfill. The following remedial options were considered:

Excavation and Off-Site Disposal - Type B hydrocarbon soils at the Site would be excavated and shipped off-site to a licensed facility similar to the process described for Tier II soils.

On-Site Landfill – Based on the Phase III ESA, up to five locations are suitable for the construction of on-site landfills. The landfill would have an engineered liner to reduce the potential of contaminants mobilizing. This would also require a long term monitoring program be implemented similar to the program for the Tier II Landfill.

On-site Treatment – There are a few options for treating the soil on-site. These include landfarming, biopiling, allu bucket and chemical oxidation which are discussed below.

- Landfarming - Landfarming is a process in which hydrocarbon contaminated soils is spread in a 0.3 – 1.0 m layer and nutrients added. The soils are mixed for aeration to promote microbial activity, volatilization, and bioremediation/biodegradation. Additional measures, such as the adding bulking agents to increase aeration, lime to adjust pH, or the addition of substrates, can be taken to decrease the time required to degrade the contaminants. After soil contaminant levels decrease below the applicable criteria the soil would be spread and contoured to match the surrounding environment and no further monitoring would be conducted.
- Biopiles - A biopile is a remediation technique where soil is aerated to enhance the microbial activity that degrades the contaminants. Aeration can be completed mechanically (with an excavator), actively (using blowers) or a passive system (perforated pipes placed throughout the biopile connected to vertical pipes and a fan system). Compared to landfarming, biopiles require less surface area to treat a comparable volume of soil and will not freeze as quickly as soil spread out for landfarming. As with landfarming, bacteria or fertilizers may be added to the biopiles (depending on the design) to increase the hydrocarbon removal rate. In Stantec's northern experience, hydrocarbons have been shown to decrease below the criteria within 5 years and in some cases sooner than landfarms. Given the time requirements to treat soil using biopiles, they would need to be constructed and operated within the first year of construction to minimize maintenance/monitoring trips after the bulk of site remediation is complete.
- Allu Bucket – An allu bucket can be attached to a loader or excavator and operates by breaking up and aerating the soil to promote the volatilization of volatile components.
- Chemical Oxidation (ChemOx) - ChemOx is an active treatment method that uses specific oxidizing chemicals to convert organic contaminants (i.e. PHC) to inert compounds (water, carbon dioxide). The chemicals are typically transported to the site in concentrate form where they are diluted to suit the specific site treatment needs. The diluted liquid ChemOx mixture is applied to a stockpile and mixed using conventional earth moving equipment (i.e. excavators/backhoes) to promote the chemical reaction. This method is beneficial when the schedule is very compressed and treatment must be completed within a tight timeframe. However, the method requires more intense sampling to determine if additional ChemOx doses are needed to achieve remedial objectives. This method also requires the transport of bulk concentrate chemical oxidizer containers to the site as well as a designated on-site mixing and storage tank area. The per-tonne treatment cost for this option is more expensive than passive solutions such as landfarming and biopiles, but can reduce the construction schedule (specifically with respect to soil treatment).

4.2.1.4.1 Proposed Remediation Approach

The recommended approach for Type B hydrocarbon soils is on-site treatment using one (or a possible combination) of the above discussed methods. The chosen method will be dependent on client-required

schedule milestones (to complete the remediation), the access to equipment, and community feedback. This will be determined during the design of the remediation program.

4.2.2 Hazardous Site Materials

4.2.2.1 Asbestos

Approximately 25 m^3 asbestos-containing materials (ACMs) were observed at the Site including insulation, boiler materials, vinyl floor tiles, concrete board, gasket materials, etc. ACMs will be abated in accordance with applicable Federal and Territorial Asbestos regulations. The abatement will be conducted on-site using experienced contractors prior to demolition activities. The removal of ACMs will be confirmed with on-site inspection. The following remedial options were considered:

On-Site Engineered Landfill Disposal - ACMs would be collected, double bagged, and disposed of in a NHW landfill, in accordance with the appropriate legislation. The location of the asbestos materials located within the landfill would be noted for future reference.

Off-Site Disposal - If a NHM landfill is not constructed, or there is insufficient capacity for ACMs, they would instead be collected and shipped off-site for disposal, by aircraft, barge, or CAT Train.

4.2.2.1.1 Proposed Remediation Approach

It is recommended that ACMs be abated and disposed of in the on-site NHW landfill in accordance with the AMSRP.

4.2.2.2 Batteries

In accordance with the AMSRP, batteries will be contained in seacans, labeled in accordance with the Transportation of Dangerous Goods Act and disposed of off-site at a licensed facility. Approximately sixteen batteries were observed during the Phase III ESA however additional batteries may be uncovered during the Main Station Landfill work.

4.2.2.3 Paint

Based on the results in the Phase III ESA, approximately 200 m^3 of material containing PCB and/or lead amended paint is present at the Site at the Garage, Warehouse, Quonset Huts 3, 4, and 5, Module Train Area, Inuit House, Airplane Wreckage, and former radar antennae. As part of the Phase III ESA only paint samples were collected. PCBs are relatively stable and are not known to leach into a metal substrate. However, it is possible for lead to leach into a metal substrate. As such, prior to, or immediately at the outset of remedial activities, samples of lead paint with the substrate will be collected to determine if lead has leached into the substrate. For the purposes of this RAP, it is assumed that lead has not leached significantly into any metal substrates. If sample results show that concentration of lead in paint and substrate are greater than 5 mg/L in the leachate testing, these materials will be disposed of off-site.

The following remedial options were considered:

Full On-Site Abatement – For this option, a paint abatement area will be constructed at the Site which would include a negative air chamber in an airtight system. The abatement will be conducted by physically removing the PCB and/or lead containing paint (scraping, chemical stripping, or sand blasting) from the associated substrate. This option will also require water collection and treatment which would be a costly option. After abatement, the equipment will be disposed of in the NHW landfill being constructed for other materials at the Site.

Partial On-Site Abatement – For this option, abatement will be conducted manually in a closed area (such as inside a seacan) and will focus on removal of poorly adhered paint. Removed paint will be collected and disposed of off-site. The substrate will then contain only well adhered paint. In this case, the mass of the substrate would be incorporated into the calculation to determine the PCB concentrations and preliminary calculations show the PCB concentrations would be below the applicable regulations. The substrate will then be disposed of on-site in the Tier II landfill.

Off-Site Disposal of Painted Materials - For this option, the equipment will be dismantled and disposed of as hazardous materials by transporting them off-site in accordance with the Transportation of Dangerous Goods Act to a licensed waste disposal facility.

4.2.2.3.1 Proposed Remediation Approach

A partial abatement is recommended based on the cost to conduct a full abatement, and the fact that a Tier II landfill is required for other hazardous waste material. The partial abatement will focus on removal of poorly adhered paint. The removed paint will be collected and disposed of off-site at a licensed facility. Following the abatement, the equipment with remaining with well-adhered paint will be disposed of in the Tier II landfill.

4.2.3 Non-Hazardous Site Materials

Non-hazardous site materials included wood, metal, glass, electrical equipment, vehicle debris, etc. The approximate crushed volume of non-hazardous materials is 1,700 m^3. These materials will be placed in a NHW landfill with the Tier I soils.

Barrels - Approximately 5, 900 barrels were observed at the Site. The assessment of accessible barrels found approximately 30 contained liquid. Of these 30, 10 were tested and were considered suitable for on-site incineration. The other barrels were not able to be sampled, and prior to incineration, the contents of the barrels should be combined and tested in accordance with the AMSRP Barrel Protocol. Any remaining solid residue will be analyzed for leachate. Materials identified as non-leachable will be disposed of as DCC Tier II contaminated soil, while leachable material shall be treated as hazardous waste and disposed of at a licensed off-site disposal facility. After the barrels are emptied, they will be washed on-site, crushed and placed in the NHW landfill. Wash water will be captured and either treated on-site or disposed of off-site at a licensed facility.

Compressed Gas Cylinders – A total of six compressed gas cylinders were observed during the Phase III ESA. Cylinders will be vented until empty and disposed of in the NHM landfill.

Existing Building and Infrastructure – The garage is the only remaining building at the Site and it will be demolished to the concrete foundation. The garage is constructed on a concrete pad, and the concrete pad for the former warehouse is still present at the Site. The area around these concrete pads will be re-graded with the placement of additional granular fill to match surrounding topography. All hazardous materials will be segregated prior to or during demolition.

It should be noted that at the time of the Phase III ESA, a raven was nested in the frame of the garage. The process for demolishing the garage structure will be assessed in the Environmental Impact Assessment and this document should be referenced prior to any demolition.

Other non-hazardous Waste –All remaining non-hazardous site materials will be minimized through crushing, shredding, or incineration and placed in the NHW landfill. This includes all remaining non-hazardous debris (such as old vehicles and scrap metal) as well as demolition materials from dismantled Site infrastructure.

4.2.4 Buried Debris

During the Phase III ESA, eight buried debris areas (BDA) were identified in accordance with the AMSRP requirements. Two of the buried debris areas were determined to be Class B (moderate potential environmental risk), while the remaining six were Class C (low potential environmental risk). The locations of the BDAs are shown on Drawings 17 and 18, Appendix A. Below is a summary of remedial activities recommended to stabilize the landfills.

Table B Remediation Options

Buried Debris Identifier and Class	Location	Description	Recommended Option
BDA1 – Class C	Near the Main Station	Approximately 86 m^2 slightly raised area (<1.5 m) with minimal surface debris observed.	Recontour slopes to decrease potential for slope failure and add additional gravel cover.
BDA2 – Class C	Near the Main Station	Approximately 61 m^2 slightly raised area (<1.5 m) with minimal surface debris observed.	Recontour slopes to decrease potential for slope failure and add additional gravel cover.
BDA 3 – Class A/B	Main Station Landfill Area	Approximately 3000 m^3 (area of 1200 m^2 and assumed depth of 2.5 m) with exposed barrels and other various debris near a surface water body. Exceedances of DCC Tier I, DCC Tier II, Type A Hydrocarbon, and Type B Hydrocarbon criteria	Landfill will be excavated and debris will be landfilled as described above depending on type of debris found. Testing will be conducted on materials with unknown composition. Soils will be disposed of as described within this RAP depending on additional characterization samples collected during remediation. The area will be recontoured after remediation to restore drainage pathways.

Buried Debris Identifier and Class	Location	Description	Recommended Option
BDA 4 – Class C	Main Station Landfill Area	Approximately 144 m^2 area with a depth less than 1.5 m and occasional exposed debris.	Recontour slopes to decrease potential for slope failure and add additional gravel cover.
BDA5 – Class C	South of Main Station Landfill	Approximately 435 m^2 area with an assumed depth greater than 1.5 m and mounded with sloped sides.	Remove exposed debris and recontour slopes to reduce erosion potential. Add additional gravel cover.
BDA6 – Class C	Near bunker and beach landfill	Approximately 80 m^2 area with an unknown depth – area is generally flat.	Remove exposed debris. No evidence of erosion and area is generally flat.
BDA7 – Class C	Near bunker and beach landfill	Approximately 260 m^2 area with an assumed depth greater than 1.5 m and sharply sloped to the north.	Remove exposed surface debris and recontour northern extent to reduce erosion potential.
BDA8 – Class B	South of bunker and beach landfill	Approximately 160 m^3 (area of 105 m^2 and assumed depth of 1.5 m) and mounded with sloped sides.	Excavate and dispose of debris appropriately. Testing will be completed if material composition is unknown.

4.3 PROPOSED REMEDIAL APPROACH SUMMARY

Table B below summarizes the recommended remedial approach for each component.

Table C Remediation Options

Category	Sub-Category	Approximate Volume (m^3)	Recommended Option
Contaminated Soil	DCC Tier I Soils	100	Dispose of in on-site NHW landfill
	DCC Tier II Soils	3,600	Dispose of in on-site Tier II landfill
	Type A Hydrocarbon Soils	1,200	Dispose of in on-site NHW landfill
	Type B Hydrocarbon Soils	1,900	Remediate by on-site treatment
Hazardous Waste	Asbestos	25	Double bag and dispose of in NHW landfill
	Batteries	16 units	Package and dispose of off-site
	PCB and/or lead amended paint	200 m^3 after crushing	Partial abatement onsite of poorly adhered paint and on-site disposal in Tier II landfill after abatement. If lead has leached into substrate at concentrations above the guideline, this material will be disposed of off-site.
Non-Hazardous Waste	Barrels	1,700 m^3 after crushing	To be emptied, cleaned, crushed, and disposed of in the NWH landfill
	Compressed Gas Cylinders		To be vented and disposed of in the NWH landfill
	Building Infrastructure		To be demolished, shredded/incinerated, and disposed of in the NWH landfill
	Other Non-Hazardous Waste		To be collected, shredded, compacted and disposed of in the on-site NWH landfill
Buried Debris Areas	BDA1 through 8	Estimated 3,200 m^3 of material requires excavation	Per location as described in Section 4.2.4

5.0 Stakeholder Consultation

On January 8, 2014 a consultation was held with residents of Kugaaruk at the community hall in Kugaaruk, NU. The purpose was to present the RAP and to allow an opportunity for feedback from the community. The consultation was advertised by the Hamlet Office prior to the meeting and began at 7 pm. In attendance were over 60 people from the community, Mr. Dele Morakinyo from AANDC, Mr. Jessie Hoyt of PWGSC, and Mr. Michael Doucet of Stantec.

The general plan for remediation as outlined in this RAP was presented in full by Mr. Dele Morakinyo. After the presentation was completed an opportunity for feedback was provided to the attendees. Comments included, questions about the schedule and if it was appropriate (reference was made to CAM-4 which was scheduled for 2 years and ended up taking 10 years), questions about the material remaining at the Site and if it could be salvaged, and a reference to a grave site that was known to be in the area that may not have been observed during the Archaeological Impact Assessment (AIA).

With respect to the schedule, Mr. Dele Morakinyo described how the level of assessment detail between the two sites prior to remediation was very different, and the detailed information about the Site allows for more certainty with the schedule. For material that remains at the Site, if it is deemed to be non-hazardous or contaminated, AANDC has a release process whereby a community member may take the material if they sign for the liability associated with it. Finally, the location of the grave site was indicated roughly on a map. The AIA document was reviewed and it is not clear if this location was observed or not. As such, prior to remediation commencing, this location should be clearly identified to the Site archaeologist so that it can be marked and avoided during remediation.

6.0 Logistics and Remediation Development

6.1 SCHEDULE

A possible schedule for the remediation is offered below. It is noted that Type B Hydrocarbon soil treatment is assumed to be completed using passive treatment. Although most of the site remediation, landfill construction, and decommissioning can be completed by 2018, some equipment may need to remain to complete on-site Type B Hydrocarbon soil treatment.

Table D Proposed Schedule

Activity	Timing
Design Remediation and Request for Proposal (RFP) Documents	April 1, 2014 - August 1, 2014
Apply for Permits	April, 2014 to April, 2015
Post RFP in Buy and Sell	August 15, 2014
RFP Submission Closure	September 30, 2014
Mobilize Equipment (likely to Repulse Bay or Taloyoak)	August/September 2015
Mobilize Equipment to Site via CAT Train	March 2016
Conduct Active Remediation	April 2016 – September 2018
Demobilize from Site	September 2021 (See Note 1)
Landfill Monitoring	2019 – 2044
Final Site Closure	2044

Note1: Overall equipment demobilization will occur by Sept 2018. Final demobilization will occur after passive soil treatment is complete (assumes 5 years from start of remediation work).

6.2 SITE DEVELOPMENT

6.2.1 Camp

Based on the distance from Kugaaruk to the Site, a camp will be constructed at the Site to facilitate timely remediation. The camp should have a capacity for a minimum of 30 on-site workers and associated camp staff. Water samples were collected from the Freshwater Lake, however concentrations of coliform exceeded Health Canada guidelines and a sufficient water treatment system will be required. The camp will be constructed with suitable infrastructure to meet Nunavut guidelines for this type of temporary camp (such as sewage collection) and will be constructed and prepared for weather and/or emergency situations.

6.2.2 General Improvements

Prior to remediation, some Site improvements are required. Equipment mobilization to implement improvements is assumed to be via CAT Train. However, the selected contractor may elect use of barges if shoreline bathymetry and equipment availability is found to be more cost effective. General improvements are described in detail below, and will also include access roadway improvements between Area 1 and Area 2 and a culvert installation to address a washout approximately 0.8 km north of Area 2.

6.2.3 Airstrips

During the Phase III ESA a twin otter was successfully landed on both airstrips at the Site. However, it was determined that under repeated loadings, wheel path rutting would be likely. Therefore, the airstrips will require regular re-grading assuming regular use during remediation. It was also recommended that an additional 200 mm of new crushed gravel be scarified into the existing surface.

It should be noted that during interviews with elders in Kugaaruk, it was found that aircraft accessed the Site by landing on the sea ice. This is a possibility which should also be considered for appropriate aircraft.

6.2.4 Barge Landing Areas

It is unclear from interviews with elders in Kugaaruk if barges have ever accessed the Site. There were three potential locations identified in the Phase III ESA, however additional information such as bathymetry would be required to determine for certain a possible landing location. This would also be conducted with the barge captain. It should be noted that barges do not access Kugaaruk. Supplies are brought to Kugaaruk by the Coast Guard. Although this vessel might be able to reach the Site, this vessel is much smaller than a barge and is tasked with other projects throughout the year which would limit its ability to service the Site remediation.

6.2.5 CAT Train

CAT train access is possible to the Site from Kugaaruk, and from Repulse Bay, and/or Taloyoak. As barges can access Repulse Bay, this is the most likely location to mobilize equipment onto a CAT Train to reach the Site. However, the selected contractor may propose another route. During interviews with Kugaaruk elders it was not clear if a CAT train was used during construction of the Site, however it was likely.

6.3 LANDFILLS

As discussed in Section 4.0, the construction of two landfills (a NHW landfill and a Tier II landfill) and one area for on-site treatment are recommended. Below are the general requirements for construction. The locations of the Potential Borrow Sources and Potential Landfills/Landfarms are shown on Drawing 19, Appendix A. These will be further detailed and refined in the design stage of the project.

6.3.1 NHW Landfill

Three potential NHW landfill locations (Potential Landfill/Landfarm Site 3, 4, and 5) were identified in the Phase III and are located within 1 km of Area 1. This landfill will contain Tier I soils (100 m^3), Type A Hydrocarbon soil (1,200 m^3), NHW material (1,700 m^3), and asbestos material (25 m^3). This results in an approximate volume of 3,025 m^3. Potential Landfill/Landfarm Site 5 is the recommended location as it is adjacent to the existing roadway and in close proximity to both Potential Borrow Source 6 (estimated 11,850 m^3 of borrow material) and Potential Borrow Source 7 (estimated 7,620 m^3 of borrow material). This location was estimated to have sufficient capacity for this volume of material. The NHW landfill will be constructed in accordance with the AMSRP and will include a perimeter berm and cover and the design should be reviewed by a geotechnical engineer prior to implementation.

6.3.2 Tier II Landfill

A Tier II Landfill is required for Tier II soils (approximately 3,600 m^3) and material with well adhered PCB and/or lead amended paint (approximately 200 m^3). There is also an estimated 3200 m^3 of buried debris requiring excavation that has not been classified and may require disposal in this landfill. Potential Landfill/Landfarm Site 1 is located adjacent to existing roadways in Area 2 and is coincident with Potential Borrow Source 1. This location was estimated to have sufficient capacity for this volume of material. The Tier II landfill will be constructed in accordance with the AMSRP and will include a geosynthetic liner base perimeter berms and sufficient cover to maintain the landfill in frozen conditions. The design should be reviewed by a geotechnical engineer prior to implementation and will include a thermistor monitoring system so freeze back can be monitored.

6.3.3 On-site Treatment

On-site treatment is the recommended option for Type B hydrocarbons (approximately 1,900 m^3). The recommended location for the on-site treatment is Potential Landfill/Landfarm Site 3 or 5. Both locations are adjacent to roadways and near borrow sources. The on-site treatment area will be constructed on a geosynthetic liner with containment berms and surface runoff will be captured and contained for either off-site disposal or on-site treatment.

6.4 ARCHAEOLOGICAL SITES

During the Phase III ESA, an AIA was conducted concurrently[1]. Although no archeologically sensitive sites were found in the immediate vicinity of the Site, there were some heritage sites identified in areas where debris collection would likely occur. As such, prior to remediation these locations should be marked in the field by an archaeologist so they are avoided. In addition, debris removal should be conducted manually using all-terrain vehicles and trailers. In addition, as discussed in Section 5.0, the grave site mentioned during the community consultation should be identified and marked prior to commencing remediation.

[1] Former CAM-E DEW Line Site, Keith Bay, prepared by Golder Associates for Stantec Consulting Ltd, December 13, 2013

7.0 Additional Activities

7.1 PRE-REMEDIAL ACTIVITIES

The following data gaps require action prior to, or during the early stages of remediation.

- Resample the surface water in one location in Area 2 that contained concentrations of aluminum greater than the applicable guidelines.
- Collect surface water samples from across the Site, and from outside the Site area to establish baseline ranges of metals concentrations.
- Painted materials previously identified as being lead-leachate toxic paint above the 5 mg/L guideline will be resampled along with the associated substrate prior to remediation to determine the material leachate content for disposal.
- Sample soil under barrel caches after barrels are removed to assess for contaminants.
- Identify and mark grave location identified during the community consultation.

7.2 DURING REMEDIATION ACTIVITIES

During remediation, confirmatory soil samples will be collected after contaminated soil is removed to assess if residual concentrations are less than criteria. Samples will also be collected of waste to characterize contaminants levels prior to placement in the on-site landfills. Sampling frequency will be conducted in accordance with the AMSRP.

In addition to confirming soil concentrations, quality testing will be conducted to confirm earthworks such as testing for fill quality prior to landfill construction. The testing will be conducted to determine if the construction is in accordance with the specifications for the remediation.

Finally, during remediation, testing will be required as part of the Land Use Permits and Water Licenses.

Note this is not an extensive list of activities to be conducted during remediation. These will be specified in the detailed design of the remediation program.

7.3 POST REMEDIAL ACTIVITIES

Residual contamination may be present at barrel processing areas, hazardous materials processing areas, lead/PCB abatement areas, and stockpile lay down areas following the completion of the remedial activities. In accordance with the AMSRP, these areas will be visually assessed for contamination indicators such as staining, debris, or paint chips and sampled if required.

In accordance with the AMSRP the NHW landfill and Tier II landfill will require post-remedial monitoring. Each of the two types of landfill will require various types of monitoring, as outlined below:

- Visual monitoring to observe the physical integrity of the landfill including observations for possible settling, erosion, frost action, vegetation, leachate, staining, etc.

- Groundwater monitoring through the installation of three to four post remedial groundwater monitor wells within each landfill.

Post remedial monitoring activities may be required for the on-site treatment area depending on the method chosen during the design phase of work. When the on-site treatment area is no longer in use. the treated soil will be contoured to match the surrounding areas and the geosynthetic liner and support equipment will be removed and disposed off-site.

In addition to the above noted monitoring requirements, the Tier II landfill will also undergo thermal monitoring, which will consist of obtaining measurements of the sub-surface ground temperature within the landfill for comparison to and verification of the predicted ground temperatures.

Areas that are disturbed during the remedial activities will be re-graded to match existing surface grades. After building frames and structures are removed, concrete foundations and slabs will be left in place. Borrow material will be placed in these areas to match top-of-concrete to final surface grades.

8.0 Conclusions

Based on the results of the Phase III ESA sufficient information was gathered to produce the RAP herein. The recommended options are generally to landfill material at the Site and monitor over time rather than ship material off-site for disposal elsewhere. This is primarily based on the cost as well as access issues (particularly for a barge). Disposal options were chosen in accordance with the AMSRP when possible. The information contained in this RAP is considered sufficient to prepare the cost estimate for the remediation, and to proceed with the Environmental Impact Assessment in accordance with Nunavut requirements.

9.0 Closure

This report documents work that was performed in accordance with generally accepted professional standards at the time and location in which the services were provided. No other representations, warranties or guarantees are made concerning the accuracy or completeness of the data or conclusions contained within this report, including no assurance that this work has uncovered all potential liabilities associated with the identified property.

This report provides an evaluation of selected environmental conditions associated with the identified portion of the property that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Stantec at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Stantec to be correct. Stantec assumes no responsibility for any deficiency or inaccuracy in information received from others.

The opinions in this report can only be relied upon as they relate to the condition of the portion of the identified property that was assessed at the time the work was conducted. Activities at the property subsequent to Stantec's assessment may have significantly altered the property's condition. Stantec cannot comment on other areas of the property that were not assessed.

Conclusions made within this report consist of Stantec's professional opinion as of the time of the writing of this report, and are based solely on the scope of work described in the report, the limited data available and the results of the work. They are not a certification of the property's environmental condition. This report should not be construed as legal advice.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Stantec assumes no responsibility for losses, damages, liabilities or claims, howsoever arising, from third party use of this report.

This report is limited by the information contained in the Phase III ESA.

The locations of any utilities, buildings and structures, and property boundaries illustrated in or described within this report, if any, including pole lines, conduits, water mains, sewers and other surface or sub-surface utilities and structures are not guaranteed. Before starting work, the exact location of all such utilities and structures should be confirmed and Stantec assumes no liability for damage to them.

The conclusions are based on the site conditions encountered by Stantec at the time the work was performed at the specific testing and/or sampling locations, and conditions may vary among sampling locations. Factors such as areas of potential concern identified in previous studies, site conditions (e.g., utilities) and cost may have constrained the sampling locations used in this assessment. In addition, analysis has been carried out for only a limited number of chemical parameters, and it should not be inferred that other chemical species are not present. Due to the nature of the investigation and the limited data available, Stantec does not warrant against undiscovered environmental liabilities nor that

the sampling results are indicative of the condition of the entire site. As the purpose of this report is to identify site conditions which may pose an environmental risk; the identification of non-environmental risks to structures or people on the site is beyond the scope of this assessment.

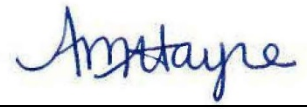
Development or design plans and specifications should be reviewed by Stantec sufficiently ahead of initiating the next project stage to confirm that this report completely addresses the elaborated project specifics and that the contents of this report have been properly interpreted. Specialty quality assurance services (field observations and testing) during construction are a necessary part of the evaluation of sub-subsurface conditions and Site preparation works. Site work relating to the Geotechnical Assessment recommendations included in this report should only be carried out in the presence of a qualified geotechnical engineer; Stantec cannot be responsible for Site work carried out without being present.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, Stantec specifically disclaims any responsibility to update the conclusions in this report.

10.0 Stantec Quality Management

This document entitled Final Report: Remedial Action Plan CAM-E (Keith Bay), Nunavut was prepared by Stantec Consulting Ltd. for the account of Public Works Government Services Canada.

This report has been prepared by:



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APPENDIX A
Drawings