AECOM

Public Works and Government Services Canada

Johnson Point
Landfill Monitoring

Prepared by:

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Project Number:

2977-371-00-1100 RPT-035-09

Date:

February 27, 2009

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February 27, 2009

Project Number: 2977-371-00-1100

Brad Thompson
Senior Environmental Engineer
Public Works and Government Services Canada
TELUS Plaza North
5th Floor, 10025 – Jasper Avenue
Edmonton, AB T5J 1S6

Dear Brad:

Re: Johnson Point – Landfill Monitoring Proposal

We are pleased to submit the Johnson Point Landfill Monitoring Proposal. We trust that the information presented in the proposal is consistent with your expectations. Please feel free to contact the undersigned if you have any questions regarding this submission.

Sincerely,
AECOM Canada Ltd.

D. Schmidt

Dara Schmidt, B.Sc.
dara.schmidt@aecom.com

DS:cs
Encl.
cc: File

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	DAS	08/12/17	Draft
2	DAS/CAC	09//02/26	Issued for Final

Signature Page

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1. Introduction

UMA Engineering Ltd. doing business as AECOM, was retained by Public Works and Government Services Canada (PWGSC) on behalf of Indian and Northern Affairs Canada (INAC) Contaminants and Remediation Directorate (CARD) to provide a proposal for a post construction landfill monitoring program at Johnson Point, located on Banks Island, Northwest Territories.

1.1 Background

The Johnson Point site is a deltaic promontory that juts into the Prince of Wales Strait on the eastern shore of Banks Island, Northwest Territories (Latitude 72°45'10" North and Longitude 118°30' West). The site location is identified in Figure A1, Appendix A. The Johnson Point facilities were built in the 1960's as an oil exploration base camp and were used in the 1970's and early 1980's as a staging site for exploration of oil and natural gas. The closest communities to the site are Sachs Harbour and Ulukhaktok.

Previous investigations completed since 2005 have indicated the presence of buried metallic debris in five main areas. The distinct geophysical anomalies identified were assumed to be landfills and were designated Landfills A, B, C, D and Airstrip Landfill. Landfill A is located down gradient of the maintenance shop, south of the tank farm. Landfills B and C are west and northwest of the tank farm respectively, adjacent to the road leading to the upper base. Landfill D is southwest of the upper base. The Airstrip Landfill is situated to the north of the apron area. (Refer to Figure A2, Appendix A)

1.2 Objective

In June 2008, the Northwest Territories Water Board issued a Type B water licence (N74LI-1824) for remediation activities to be completed at Johnson Point. Part G, Condition 2 of the licence requires the licensee (CARD) to submit a landfill monitoring plan to the Board within 12 months of issuance of the license.

The objective of the landfill monitoring program is to collect sufficient information to assess the performance of the landfills from both a geotechnical and environmental perspective. The landfill monitoring plan specifies the specific monitoring requirements for each landfill and monitoring frequency. The monitoring requirements are based on the remedial action plan for each landfill, which was completed by EBA (2007c); the remediation tender package detailed design, completed by UMA/AECOM (October 2007); the Type 2 Material Sources and Earthworks Redesigns, completed by AECOM (November 2008); and the INAC Abandoned Military Site Remediation Protocol, (December 2008).

1.3 Guidelines

The December 2008 INAC Abandoned Military Site Remediation Protocol was available for review for this proposal. The monitoring program recommended for Johnson Point has been written with consideration of the INAC protocol for post construction monitoring.

1.4 Community Consultation / Involvement

CARD has been working closely with the Inuvialuit Regional Corporation (IRC) to identify groups or individuals within the Inuvialuit Settlement Region (ISR) that may be affected by the proposed activities at Johnson Point.

At the recommendation of IRC, CARD has consulted with the Sachs Harbour Hunters and Trappers Committee (HTC) and the Inuvialuit Game Council (IGC) and updated IRC prior to commencing consultation activities with the affected groups within the ISR.

In December 2005, CARD attended the IGC quarterly meeting in Inuvik at the invitation of the IGC. CARD presented information on the Contaminated Sites Program, reviewed the assessment activities that had been completed at Johnson Point during 2005, and summarized the activities that were proposed for 2006.

In April 2006, CARD initiated a Traditional Knowledge/Community survey in Sachs Harbour regarding Johnson Point and the surrounding area. The survey was contracted to the Sachs Harbour HTC and was conducted by Joey Carpenter, an elder from Sachs Harbour. CARD and the Sachs Harbour HTC prepared the survey to collect information about traditional land use of the Johnson Point area by residents of Sachs Harbour (both past and present), historical use of the site by industry, and wildlife occurrences in the area throughout the year. The survey was completed in May 2006.

In addition to the survey, CARD visited Sachs Harbour from April 24-27, 2006. The Sachs Harbour HTC invited CARD to attend an HTC Special Members Meeting on April 25, 2006 to present an update on work progress at Johnson Point. During this presentation, information was provided about the process of evaluation and selection of sites for the Contaminated Sites Program, the tasks completed at Johnson Point in 2005, and a summary of the work proposed to be completed in 2006. Following the presentation, CARD held a question answer/period to gather information about community concerns. Fifteen Sachs Harbour HTC members were in attendance, including three directors on the HTC Board.

CARD conducted a site visit to Johnson Point with elders and some members of the Sachs Harbour HTC on August 13, 2006. Comments from elders and HTC members during the tour of the site were used by CARD to direct further testing to assess potential contamination at Johnson Point and to help avoid sites of cultural importance.

In the spring of 2007, following the 2006 environmental site assessment, CARD and PWGSC visited Sachs Harbour. A Remedial Options Evaluation Meeting, held on April 17, 2007, was attended by delegates of the

Sachs Harbour Hunters and Trappers Committee, Community Corporation, and Elders Committee. The various technically feasible options for each site remedial issue were discussed. Options were selected based on traditional knowledge, anticipated future community use of the area, and the technical benefits and weaknesses of each approach.

CARD also hosted a Community Information Session and dinner (open to the public) in Sachs Harbour on the evening of April 17, 2007, and Ulukhaktok on the evening of April 19, 2007. The remedial selection process and selected options were presented. CARD and PWGSC representatives were in attendance to answer questions about the proposed activities at Johnson Point, and to provide information about CARD activities throughout the Inuvialuit Settlement Region. These Community Information Sessions were well attended with a positive atmosphere; both communities were pleased to learn that the Johnson Point site remediation would soon be proceeding.

Community Information Sessions and dinners were hosted by CARD at both Sachs Harbour and Ulukhaktok in June 2008 to introduce the site remediation Contractor to the communities. During these sessions, the remedial action plan components were reviewed and the Contractor outlined potential employment opportunities associated with the project.

2. Program Components

2.1 INAC Landfill Monitoring Protocol & Site-Specific Components

A post construction landfill monitoring program was developed by DND, in conjunction with the Inuvialuit in the Western Arctic, and the Inuit for Nunavut. The program included all landfills remediated or constructed during the cleanup of the DEW Line sites under DND's jurisdiction. Since that time, INAC has initiated cleanup of abandoned military sites under their jurisdiction and will also implement a site monitoring program following remedial construction activities. To measure the performance of the landfills, the recommended post-construction landfill monitoring program consists of four main components, (depending on the landfill specific remediation plan): visual, soil, groundwater and/or thermal monitoring. The recommendations for landfill monitoring are laid out in the Environmental Provisions of the Abandoned Military Site Remediation Protocol (Refer to Appendix D) and are summarized in Table 2.1. The site specific monitoring requirements presented here are based on the protocol, but also incorporate issues relating to previous assessment data.

Table 2.1. General Landfill Monitoring Requirements

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

**Soil samples will be limited to locations were seepage or staining has been identified as part of the visual inspection.*

A summary of these requirements, as related to the specific landfills at Johnson Point, is provided in Table 2.2. The rationale for the monitoring requirements is provided in the landfill specific sections.

Based on the results of environmental sampling, the remedial action plan identified all existing landfills at Johnson Point as posing a low environmental risk. Furthermore, no new landfills are being constructed at the site for waste or contaminated soil disposal. Therefore in accordance with the protocol, no groundwater or thermal monitoring are required at the site.

Table 2.2. Johnson Point General Landfill Monitoring Requirements

Landfill Classification	Baseline Soil Monitoring	Visual Inspection	Groundwater Sampling	Soil Sampling	Thermal Monitoring
Landfill A (Low Environmental Risk)	√	√		As required *	
Landfill B (Low Environmental Risk)	√	√		As required *	
Landfill C (Low Environmental Risk)	√	√		As required *	
Landfill D (Low Environmental Risk)	√	√		As required *	
Airstrip Landfill (Low Environmental Risk)	Not required, as this landfill is to be excavated in 2009.				

** Soil samples will be limited to locations were seepage or staining has been identified as part of the visual inspection.*

The requirements for each of the monitoring components are discussed in the following sections.

2.2 Baseline Soil Monitoring

To supplement the long term monitoring requirements, a baseline soil collection program is proposed for completion in 2009. This element is specific to the Johnson Point site. Soil samples collected as part of previous site assessment work were all collected within the existing landfill footprint. There are, therefore, no samples up and downgradient that could be used as a basis for comparison for post construction monitoring soil samples.

We propose to complete baseline sampling by advancing testpits in approximately 50 metre spacing surrounding the landfill perimeter, primarily downgradient. As per the INAC Abandoned Military Site Protocol for landfill assessment, a minimum of five testpits will be taken per landfill. Soil samples will be collected at surface and at 50 cm intervals to the maximum depth of the active layer.

The soil samples will be analyzed 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.

2.3 Visual Monitoring

The physical integrity of the landfills will be inspected and reported using annotated landfill drawings, as applicable. Observations relating to the following issues shall be documented:

- Settlement
- Erosion
- Frost action
- Animal burrows
- Vegetation re-establishment on surface
- Staining
- Vegetation stress
- Seepage points or ponded water
- Debris exposure; and any other features of note.

The visual inspection should note the presence or absence of these items, and the extent, with dimensions as applicable. Photographic records are to be provided to document the general condition of the landfill and to substantiate all recorded observations. Landfill drawings shall be annotated to show the location of each identified feature, the size, and a photographic reference that notes the scale and directional view point.

2.4 Soil Monitoring

Contaminant concentrations observed in baseline soil samples, collected in the 2009 season prior to completion of remediation, will form the basis of comparison for long term monitoring. The results of subsequent landfill monitoring events will be compared to these baseline concentrations to evaluate any potential changes in environmental conditions.

Soil sampling during post construction monitoring will be limited to locations where seepage or staining has been identified as part of the visual inspection. The soil monitoring program has the following requirements:

- Soil samples should be collected over the interval of 0 to 0.15 m, and 0.35 to 0.50 m depth.
- Soil samples are to be analyzed for the following constituents:
  - PCBs (polychlorinated biphenyls – Total Aroclor analysis);
  - Petroleum Hydrocarbon Fractions, F1 to F4; and
  - Inorganic elements: arsenic, cadmium, chromium, cobalt, lead, nickel, and zinc

2.5 Frequency

Conceptually, the landfill monitoring program consists of three phases, as described in detail below.

Phase I: Monitoring of conditions to confirm that physical stability criteria are achieved.

During Phase I, visual inspections of the remediated landfills will be carried out at years 1, 3 and 5 following completion of remediation. It is expected that changes observed after the first three years are more likely attributed to changes in the site conditions (i.e. warmer temperatures, changes in surface water drainage patterns).

An evaluation of the Phase I information would be carried out at the end of five years to confirm that no stability issues had been identified. If required, the Phase I monitoring program may be extended.

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

At the completion of Phase I monitoring and review of the results, requirements for Phase II monitoring will be evaluated. If no significant issues are identified for landfills of low potential environmental risk, monitoring may be discontinued at the conclusion of Phase I.

If additional monitoring is warranted based on the visual observations, 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.

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.

3. Landfill Monitoring Requirements

3.1 Summary of On-site Landfills

The following sections provide a description of existing landfills at Johnson Point in terms of site assessment information and remedial design. A summary table describing the existing environmental and geotechnical conditions, and the remedial design for each landfill has been provided in Appendix B and photographs have been included in Appendix C. There will be no disposal facilities constructed onsite at Johnson Point, therefore only the existing landfills will require monitoring. Because the proposed landfill monitoring requirements are the same for each landfill on site, the monitoring specifics for all landfills are detailed in Section 3.6..

It should be noted that, at the Johnson Point site, there is limited availability of the typical granular material types that are specified for use in remediation activities under the INAC Abandoned Military Site Protocol. The remedial designs outlined below have been developed to account for the types of granular materials available at the site.

3.1.1 Landfill A

Landfill A is located within the main pad site southeast of the tank farms, and is comprised of six lobes of buried debris (refer to Figure A5), with a combined area of 4,000 m^2. Lobe A corresponds to buried ferrous debris in five parallel trenches. Lobe B is comprised of a buried pipe , while the Lobe C anomaly is derived from a garage foundation, and surface debris including such items as sled frames, pumps, cables, and incinerator equipment. Lobes D, E and F are comprised primarily of scattered surface debris, with the Lobe E anomaly corresponding to an RF antenna mast.

This landfill is located on the edge of a plateau, adjacent to the tank farm. In previous investigations, testpits were excavated within the boundaries of the landfill. The landfill was found to contain miscellaneous debris that consisted of metal, plastic, electric wires and wood. The depths at which the debris was found ranged from 0.2 m to 0.7 m. As noted above, small amounts of debris were also scattered on surface at different locations within Landfill A. Surface debris will be removed from Lobes C, D, E and F. With the exception of one soil sample containing Tier I lead, no contamination was detected at the landfill. The identified Tier I impacts are located at depth, and therefore, no contaminated soil remediation is required, as per the INAC protocol. Localized erosion was present in the form a drainage channel cutting across the area. There are no nearby aquatic receptors.

Based on an evaluation of the landfill as a contaminant source, potential pathways, and receptors, the landfill was considered a low environmental risk. Remediation includes placement of a 1.0 m thick sand and gravel granular cover over the landfill surface. The southwest, southeast, and northeast slopes of the landfill will be armoured with gravel and cobbles, while the northwest slope will be flattened to blend with the natural

ground. A shallow swale is to be constructed two metres from the toe of the northwest slope to deflect overland water flow around the perimeter of the regraded landfill.

3.1.2 Landfill B

Landfill B is located adjacent to a small pond approximately 400 m west of the tank farms (Refer to Figure A4). The landfill extent is approximately 600 m^2 and is comprised of buried ferrous debris and some visible wood debris. Some surface debris is also present. The buried debris at this location corresponds to a visible mound and is approximately 1.5 m high. Testpits advanced within the landfill identified wood, metal and plastic debris at approximately 0.3 m below grade. No contaminated soil was identified at the landfill, and there are no nearby significant aquatic receptors. While the topography around the landfill itself is relatively flat, the landfill perimeter is considered vulnerable to overland stream flows over the long term.

Based on an evaluation of the landfill as a contaminant source, pathways and receptors, Landfill B is considered a low environmental risk. Remediation includes regrading with the placement of a 0.7 m thick sand and gravel cover. To counter potential water erosion along the regrade perimeter, the slopes will be armoured with erosion resistant gravel and cobbles to a thickness of 0.4 m.

3.1.3 Landfill C

Landfill C is located at the end of the road leading to the upper camp area (Refer to Figure A4). The landfill extent is approximately 1,900 m^2. Previous testpitting investigations within the landfill footprint identified debris consisting of metal, wood, tires/tubes, and vehicle wheels at depths ranging from 0.5 m to 1 m below grade. The buried material at this location is well covered with only a few metal objects protruding along the toe of the slope. The covering material is primarily composed of sand. The landfill has a grade of approximately 10% towards the south. No erosion was noted. Based on the topography and the shape of the gradient anomalies, it would seem that the buried debris was placed in two pits towards the toe of the ridge and then covered using neighbouring material. With the exception of one soil sample (at 1.1 m depth) exceeding the Tier I criterion for lead, no contamination was identified. Because the identified Tier I impacts are at depth, no contaminated soil remediation is required, as per the INAC protocol. The nearest aquatic receptor is approximately 500 m away.

Based on landfill assessment information related to contaminant source potential, pathways and receptors, Landfill C is considered a low environmental risk. Remediation includes regrading with the placement of sand and gravel cover. Because of existing topography prior to regrading, the final cover slope angle of Landfill C will be the steeper than the other landfills, with a higher potential for erosion by surface runoff. To counter the higher erosion potential, the entire regrade area will include a 0.4 m thick surface cap of erosion resistant gravel and cobbles overlying the sand and gravel. On the highest side of the landfill (the northwest), the slope will be flattened from the typical 5H:1V configuration to tie into existing slope geometry. Additionally, a shallow swale will be constructed two metres from the toe in this area to direct surface drainage away from the landfill.

3.1.4 Landfill D

Landfill D is located in a topographic high at the end of the road leading to the upper pad area (refer to Figure A4). The landfill extent is approximately 1,300 m^2. Previous testpits completed in this landfill encountered metallic debris at about 1 m below grade, just above the permafrost in one of five testpits completed. Hydrocarbon odour was noted in two of the test pits at about 1 m below grade. No surface debris is evident at this location. Based on the anomaly configuration, all buried material appears to be contained within one pit that was then covered with surface material consisting of mostly sand. Despite the presence of hydrocarbon odours at depth, no contaminated soil was identified at the landfill. There are no nearby aquatic receptors.

Landfill D was evaluated as a low environmental risk, based on information related to contaminant source, pathways, and receptors. Remediation includes regrading with the placement of 0.7 m of sand and gravel fill. Perimeter slopes will be armoured with the placement of 0.4 m of erosion resistant gravel and cobbles at surface, overlying sand and gravel fill, and the typical 5H:1V slopes will be flattened as required to blend into natural ground.

3.1.5 Airstrip Landfill

This landfill is located adjacent to and north of the former Nodwell camp at the apron area, (refer to Figure A6). This landfill was identified during the gap analysis and was delineated by EBA while conducting geophysical survey as part of 2006 environmental site investigation. Four testpits were excavated within the landfill. Debris encountered in one of the test pits consisted of cans and plastic. Hydrocarbon odours were noted in all four testpits.

This landfill is included within a larger hydrocarbon contaminated area at the apron that is to be remediated. Excavation of landfill debris will be completed in association with contaminated soil excavation. No long term monitoring is therefore required for this landfill.

3.2 Monitoring Requirements

As noted above, all existing landfill that will remain in place at Johnson Point are classified as having a low potential environmental risk. The long term monitoring plan for these landfills consists of visual inspection, and the periodic collection of soil samples (as required). As noted above, baseline soil samples will be collected in 2009 to document existing contaminant concentrations at the landfill perimeter. While it is expected, based on information to date, that no contaminant issues will be identified, there is the possibility that some requirements for specific soil monitoring will be recommended, following an analysis of this information. The site-specific requirements for soil sampling frequency and monitoring parameters will be finalized following a review of the sampling completed in 2009. The monitoring requirements for the existing landfills are provided in Table 3.1.

Table 3.1. Monitoring Requirements for Landfills A, B, C & D

Sample Type	Frequency	Parametres
Visual	Once per year in years 1, 3 and 5 following the completion of remediation construction.	N/A
Soil	As required. To be determined following the 2009 monitoring results.	PCBs
		F1 (C_6-C_{10})
		F2 (C_{10}-C_{16})
		F3 (C_{16}-C_{34})
		Arsenic
		Cadmium
		Chromium
		Cobalt
		Lead
		Nickel
		Zinc

[*] *Soil samples will be limited to locations were seepage or staining has been identified as part of the visual inspection.*

4. Remedial Requirements Summary

The remedial requirement for Landfills A, B, C, and D are capping, with the placement of sand and gravel fill in lifts. Each lift is to be compacted to minimize the potential for surface water infiltration and erosion. The typical slope configuration for regrade perimeters is 5H:1V, however, as noted above in the landfill-specific sections, this slope will be flattened out in specific areas to blend in with surrounding terrain to minimize erosion potential along the slopes and toes by surface drainage.

For landfill regrading, the typical requirements for surface cover are well-graded sand and gravel. However, the majority of granular deposits at this site do not meet the gradation requirements that are typically specified under the INAC Abandoned Military Site Protocol (too much sand). To account for this, a surface capping of more erosion resistant gravel and cobbles has been specified at all landfills along the slopes, but as noted above, also over the entire surface at Landfill C. Furthermore, to minimize the potential for erosion by surface drainage following regrading, drainage swales will be constructed as required, to redirect drainage away from the landfills.

Narrow, steep-sided channels are present at locations throughout the site. The accumulation of fines downgradient of these channels indicates they are areas of active erosion. Furthermore, based on the configuration of these channels, it appears that erosion is occurring not only as a result of surface water runoff, but also permafrost degradation. As a consequence, the channels are expected to continue to advance upgradient as permafrost is exposed and melted. Where these channels occur within 50 m of existing landfills being regraded, the channels will be backfilled with erosion resistant gravel and cobbles to prevent further erosion and permafrost degradation.

5. Recommendations

Based on the requirements of the draft INAC Abandoned Military Site Remediation Protocol, the existing landfills on site have all been identified as posing a low potential for environmental risk. The present recommendations for post-construction monitoring are to monitor the site in years 1, 3 and 5 following the completion or remediation. The monitoring program is recommended to comprise visual inspection three times over the first 5 years following completion of remediation. At the conclusion of the 5th year, it is recommended that the inspection records be reviewed. If the landfill appears to be meeting performance measures, consideration should be given to a reduction of long term monitoring.

Because all the previous environmental data for the landfills was collected within the landfill footprint, it is recommended that baseline sampling to assess the contaminant concentrations up and downgradient the landfills be completed in 2009 to form a record of existing contaminant concentrations for long term monitoring. While it is expected, based on information to date from previous assessment information, that no specific soil monitoring requirements will be identified, it is recommended that some contingency be carried to complete soil monitoring at the landfills above that which is specified under the generic INAC protocol. Following a review of baseline soil contaminant concentrations, in conjunction with previous site assessment data, a recommendation related to soil sampling requirements in terms of parameters and frequency will be developed.

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Johnson Point Type 2 Material Sources and Earthworks Redesigns

Appendix A

Figures

Public Works and Government Services Canada
Johnson Point Remediation Project
Landfill Monitoring Proposal

Site Location

Figure A1

AECOM

ISS/REV: A
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BANKS ISLAND

449 000 | 449 500 | 450 000 | 450 500 | 451 000 | 451 500 | 452 000

8 076 500 N
8 076 000 N
8 075 500 N
8 075 000 N

DIAMONDS NORTH CAMP SITE
EXISTING LANDFILL C
FIGURE A4
FIGURE A3
FIGURE A5
FIGURE A6
UNNAMED RIVER
POTENTIAL BORROW AREA 1
EXISTING LANDFILL D
EXISTING LANDFILL B
EXISTING LANDFILL A
EXISTING AIRSTRIP LANDFILL
POTENTIAL BORROW AREA 2
POTENTIAL BORROW AREA 5
FORMER WASHED OUT PORTION (REPAIRED)
AIRSTRIP
PRINCE OF WALES STRAIT
2008 BORROW PIT LOCATION
WASHED OUT PORTION
POTENTIAL BORROW AREA 3
NAVAID

449 000 E | 449 500 E | 450 000 E | 450 500 E | 451 000 E | 451 500 E | 452 000 E

LEGEND

2008 REMEDIATION CAMP AND GREYWATER TREATMENT SYSTEM LOCATION

2008 BORROW PIT LOCATION

0 100 200 300 m

SCALE 1:10000

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Public Works and Government Services Canada
Johnson Point Remediation Project
Landfill Monitoring Proposal

Site Location Plan

Figure A2

449 750 E | 449 800 E | 449 850 E | 449 900 E | 449 950 E | 450 000 E | 450 050 E | 450 100 E | 450 150 E

8 075 950 N | 8 075 900 N | 8 075 850 N | 8 075 800 N | 8 075 750 N | 8 075 700 N

FORMER EXTENT OF UPPER CAMP AREA (NODWELL CAMP GENERATOR UNIT AND 5 NODWELL CAMP UNITS), REMOVED

POTENTIAL BORROW AREA 4

N

EXISTING ROAD

APPROXIMATE EXTENT OF MATERIAL PLACED IN 2008

EXISTING LANDFILL D

LEGEND

SPECIFIED EXTENT OF LANDFILLS

STREAM CHANNELS

ROAD

0 15 30 45 m

SCALE 1:1500

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Public Works and Government Services Canada
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Landfill Monitoring Proposal

Existing Landfill D Area

Figure A3

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8 076 100 N
8 076 050 N
8 076 000 N
8 075 950 N
8 075 900 N
8 075 850 N
8 075 800 N
450 150 E
450 200 E
450 250 E
450 300 E
450 350 E
450 400 E
450 450 E
450 500 E

POTENTIAL BORROW AREA 4

FORMER EXTENT OF UPPER CAMP AREA (NODWELL CAMP GENERATOR UNIT AND 5 NODWELL CAMP UNITS), REMOVED.

EXISTING ROAD

EXISTING LANDFILL C

APPROXIMATE EXTENT OF MATERIAL PLACED IN 2008

EXISTING LANDFILL B

APPROXIMATE EXTENT OF MATERIAL PLACED IN 2008

FORMER APPROXIMATE EXTENT OF AREA WITH 7 "ATCO" TYPE TRAILERS AND MISCELLANEOUS DEBRIS

LEGEND

SPECIFIED EXTENT OF LANDFILLS

STREAM CHANNELS

ROAD

MW–72 MONITORING WELL

NOTE: PRE-PLACEMENT CONTOURS PROVIDED BY EGT SURVEYOR

0 15 30 45 m SCALE 1:1500

AECOM

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Johnson Point Remediation Project
Landfill Monitoring Proposal

Existing Landfill B and Landfill C Areas

Figure A4

8 076 000 N
8 075 950 N
8 075 900 N
8 075 850 N
8 075 800 N
8 075 750 N
450 450 E
450 500 E
450 550 E
450 600 E
450 650 E
450 700 E
450 750 E
450 800 E
450 850 E
450 900 E
450 950 E

CULVERT
ACCESS ROAD
POTENTIAL BORROW AREA 7
FORMER TANK FARM CONTAINMENT BERM (RESHAPED IN 2008)
TANKS 7-13 REMOVED FROM SITE INTACT DURING 2008
MAIN STATION HYDROCARBON CONTAMINATED SOIL (NOT EXCAVATED IN 2008)
TANKS 14-19 NOT DEMOLISHED DURING 2008
CULVERT
TANKS 1-6 DEMOLISHED DURING 2008
TEMPORARY HAZMAT STORAGE AREA
MAINTENANCE SHED AREA
FORMER AREA OF EXISTING LANDFILL A LOBE B SURFACE DEBRIS
CONTAINMENT BERM (RESHAPED IN 2008)
APPROXIMATE AREA OF EXISTING LANDFILL A LOBE C SURFACE DEBRIS (NOT COLLECTED DURING 2008)
EXISTING LANDFILL A LOBE A
FORMER AREA OF RECON 1 LOBE O SURFACE DEBRIS
APPROXIMATE AREA OF RECON 1 LOBE M EXCAVATION (NOT EXCAVATED IN 2008)
APPROXIMATE AREA OF RECON 1 LOBE N EXCAVATION (NOT EXCAVATED IN 2008)
POTENTIAL BORROW AREA 8
FORMER AREA OF EXISTING LANDFILL A LOBE F SURFACE DEBRIS
FORMER AREA OF EXISTING LANDFILL A LOBE D SURFACE DEBRIS
FORMER AREA OF EXISTING LANDFILL A LOBE E SURFACE DEBRIS
FORMER EXTENT OF MISCELLANEOUS STRUCTURES
PONDED EXCAVATIONS
POTENTIAL BORROW AREA 5

MW-145, MW-14, MW-13, MW-16, MW-28, MW-15, MW-29, MW-18, MW-06, MW-04, MW-26, MW-140, MW-142, MW-143

LEGEND

- SPECIFIED EXTENT OF HYDROCARBON CONTAMINATED SOIL EXCAVATIONS
- SPECIFIED EXTENT OF BURIED DEBRIS EXCAVATIONS
- SPECIFIED EXTENT OF LANDFILLS
- MW-72 MONITORING WELL
- STREAM CHANNELS
- ROAD/AIRSTRIP BOUNDARIES

0 15 30 45 m
SCALE 1:1500

AECOM

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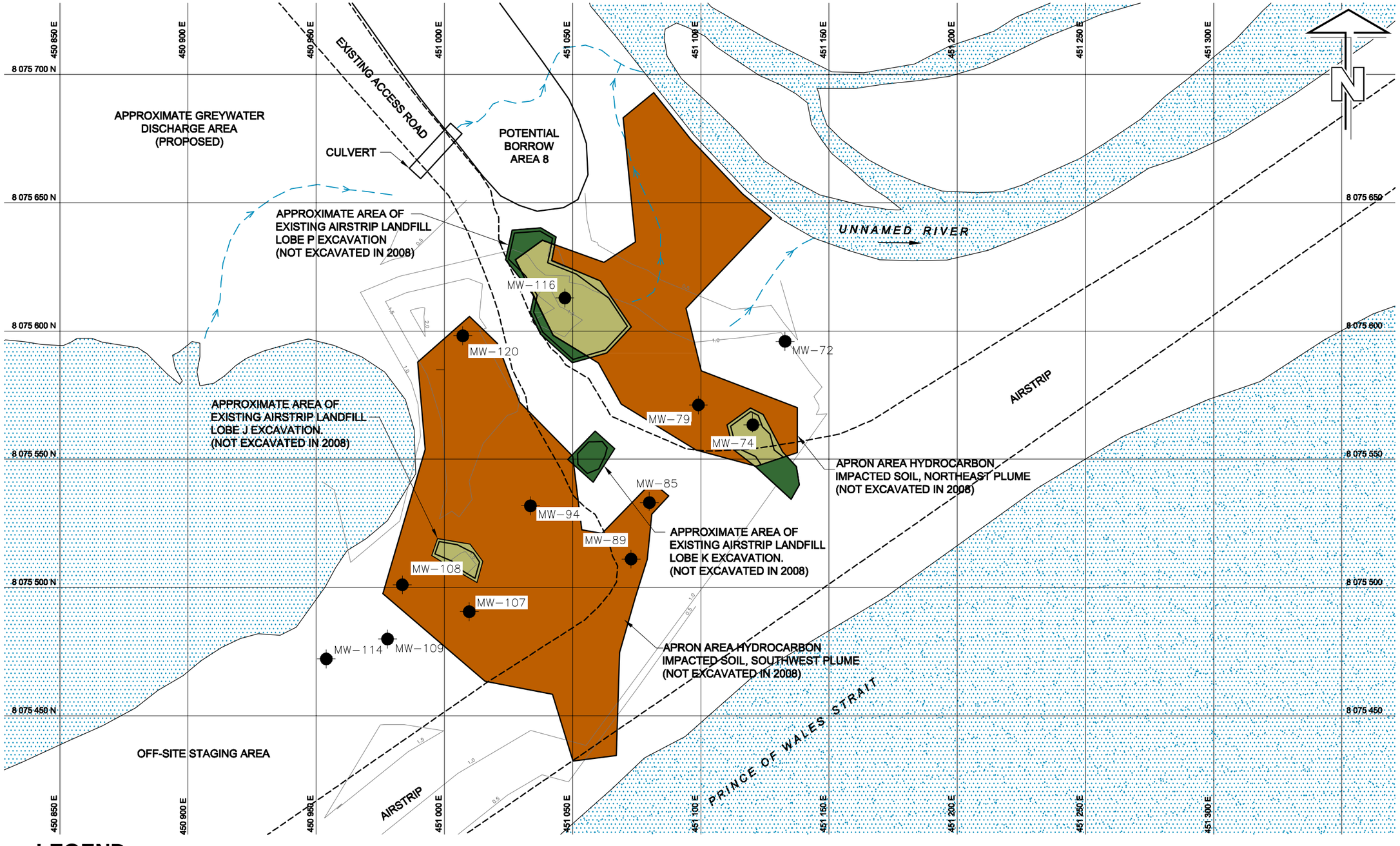
Johnson Point Remediation Project
Landfill Monitoring Proposal

Main Station Area

Figure A5



LEGEND

- SPECIFIED EXTENT OF HYDROCARBON CONTAMINATED SOIL EXCAVATIONS
- SPECIFIED EXTENT OF BURIED DEBRIS EXCAVATIONS
- SPECIFIED EXTENT OF BURIED DEBRIS AND HYDROCARBON CONTAMINATED SOIL OVERLAP EXCAVATION AREAS
- MW-72 MONITORING WELL
- STREAM CHANNELS
- ROAD/AIRSTRIP BOUNDARIES

0 15 30 45 m SCALE 1:1500

AECOM

Public Works and Government Services Canada
Johnson Point Remediation Project
Landfill Monitoring Proposal

Airstrip Apron Area

Figure A6

Appendix B

Existing Landfill Summaries

Table B1: Existing Dump Assessment Summary

	Existing Dumps				
	Landfill A	**Landfill B**	**Landfill C**	**Landfill D**	**Airstrip Landfill**
Reference Drawing (Refer to Appendix A)	A2, A5	A2, A4	A2, A4	A2, A3	A2, A5
Location	Landfill A is located within the main pad site southeast of the tank farms. (300 m NW of the airstrip)	Landfill B is located adjacent to a small pond approximately 400 m west of the tank farms.	Landfill C is located at the end of the road leading to the upper camp area. (NE of the Upper Camp Area)	Landfill D is located in topographic high at the end of the road leading to the upper pad area. (500 m SW of the Upper Camp Area)	This landfill is located adjacent to and north of the former Nodwell camp at the apron area.
Photo Reference (Refer to Appendix C)	AECOM (2008) Photo 9, EBA (Oct. 2006) Photos 15 to 20, EBA (Mar. 2007) Photos 1,2	AECOM (2008) Photos 10-14, 25,26, EBA (Oct. 2006) Photos 21, 22, EBA (Mar. 2007) Photos 3,4	AECOM (2008) Photos 27 to 32, EBA (Oct. 2006) Photos 23, 24, EBA (Mar. 2007) Photos 5, 6	AECOM (2008) Photos 33 to 38, EBA (Mar. 2007) Photo 7	AECOM (2008) Photos 39, 40, EBA (Mar. 2007) Photo 8
Estimated Landfill Extent	4,000 m²	600 m²	1,900 m²	1,300 m²	Within the hydrocarbon impacted soil at the apron area.
Estimated Depth	Maximum burial depth is expected to be 1.5 to 2.0 metres.	The buried debris at this location corresponds to a visible mound and is in the order of 1.5 metres high.	Maximum burial depth is not expected to exceed 2 to 2.5 metres.	Uncertain what the maximum burial depth of material could be at this location.	Maximum burial depth is not expected to exceed 1.0 to 1.5 metres.
Estimated Volume of Hazardous Material	n/a	n/a	n/a	n/a	n/a
Contents	Miscellaneous debris including; metal, plastic, electric wires and wood.	Ferrous, wood and plastic debris.	Miscellaneous debris containing metal, wood, tires/tubes, vehicle wheels.	Not defined; metal found within one pit, no other debris found during the investigations.	Cans, plastics, fuel bladder.
Estimated Volume of Tier II Contaminated Soils	No Samples exceed criteria.	No Samples exceed criteria.	No Samples exceed criteria.	No Samples exceed criteria.	No Samples exceed criteria.
Estimated Volume of Tier I Contaminated Soils	Testpit A8 (1.0 m), lead exceeding (434 ppm) likely less than 100 m³ of soil.	No Samples exceed criteria.	Testpit CAN3 (1.1 m), lead exceedance (434 ppm) likely less than 100 m³ of soil.	No Samples exceed criteria.	No Samples exceed criteria. This area is a part of the hydrocarbon impacted apron area that is to be excavated in 2009.
Presence of Contaminants	None of the soil samples taken from buried debris and landfill areas across the site returned levels of metals or PCBs that exceeded the Tier II criteria.				
Presence of Hydrocarbons	No Samples exceed criteria.	No Samples exceed criteria.	No Samples exceed criteria.	No Samples exceed criteria.	Soils exceed the Abandoned Military Site Protocol for Hydrocarbons (Protection of Aquatic Life)
Presence of Exposed Debris	Yes	Yes	Yes	No.	Yes, very minimal
Topography/Drainage	Surface water flows southward across the area during storm events and there is a small drainage channel through the center of the area. There is also a drainage channel just west of the landfill area.	Relatively flat	The landfill has a grade of approximately 10 percent towards the south.	Located in topographic high at the end of the road leading to the upper pad area.	Relatively flat.

Table B1: Existing Dump Assessment Summary

	Existing Dumps				
	Landfill A	**Landfill B**	**Landfill C**	**Landfill D**	**Airstrip Landfill**
Cover Material	Sand; some surface debris visible	Sand; surface debris is visible	Sand; very little surface debris evident	Sand; no surface debris evident	Sand
Evidence of Erosion	None noted in the investigations.	Site observations during 2008 indicate this landfill regrade to be vulnerable to overland stream flows coming from the ridge to the northwest, scouring the perimeter of the regrade. At least two existing erosion channels funnel concentrated water flows (from rain, melting snow and/or melting permafrost) towards Existing Landfill regrade B.	Narrow, steep-sided erosion channels occur in several locations along the southeast flank of the ridge, including down slope of Existing Landfills C and D. Fans of silt and sand accumulating where these channels meet the flat ground at the base of the ridge flank show these channels are actively eroding material from the ridge flank. Inspection completed in 2008 indicates these channels are likely the product of melting permafrost.		None noted in the investigations.
	Where permafrost melt channels occur within 50 m of Existing Landfill regrades, the channels are to be backfilled with Type 1 material to reduce, and potentially prevent, further upslope migration of the channels.				
Annual Precipitation*	150 mm	150 mm	150 mm	150 mm	150 mm
Distance to Downgradient Waterbodies	~ 500 m from the ocean,	~ 750 m from the ocean	~ 900 m from the ocean	~ 1000 m from the ocean	~ 45 m from the ocean
Groundwater Flow	Based on the groundwater elevations, groundwater flow appears to be going to the northwest.	Groundwater is shallow and is found within 0.3 to 1.0 m below ground elevation. Groundwater flow is expected to be influenced by surface and permafrost topography and move south.	Not available	Not available	In the area of the airstrip landfill, flow direction appears to be to the east.
Distance to freshwater	~ 200 m from the unnamed river	~ 430 m from the unnamed river	~ 500 from the unnamed river	n/a	~ 65 m from the unnamed river
Material Type	Based on EBA's site investigation, soils were coarse-grained materials, primarily sands with some finer grained silts and very fine grained sands.				

Table B1: Existing Dump Assessment Summary

	Existing Dumps				
	Landfill A	**Landfill B**	**Landfill C**	**Landfill D**	**Airstrip Landfill**
Planned Remedial Activity	Remediation includes placement of a 1.0 m thick sand and gravel granular cover over the landfill surface. The southwest, southeast, and northeast slopes of the landfill will be armoured with gravel and cobbles, while the northwest slope will be flattened to blend with the natural ground. A shallow swale is to be constructed two metres from the toe of the northwest slope to deflect overland water flow around the perimeter of the regraded landfill.	Remediation includes regrading with the placement of a 0.7 m thick sand and gravel cover. To counter potential water erosion along the regrade perimeter, the slopes will be armoured with erosion resistant gravel and cobbles to a thickness of 0.4 m.	Remediation includes regrading with the placement of sand and gravel cover. Because of existing topography prior to regrading, the final cover slope angle of Landfill C will be the steeper than the other landfills, with a higher potential for erosion by surface runoff. To counter the higher erosion potential, the entire regrade area will include a 0.4 m thick surface cap of erosion resistant gravel and cobbles overlying the sand and gravel. On the highest side of the landfill (the northwest), the slope will be flattened from the typical 5H:1V configuration to tie into existing slope geometry. Additionally, a shallow swale will be constructed two metres from the toe in this area to direct surface drainage away from the landfill.	Remediation includes regrading with the placement of 0.7 m of sand and gravel fill. Perimeter slopes will be armoured with the placement of 0.4 m of erosion resistant gravel and cobbles at surface, overlying sand and gravel fill, and the typical 5H:1V slopes will be flattened as required to blend into natural ground.	Excavation of landfill debris will be completed in association with contaminated soil excavation.
Monitoring Recommendation	Baseline sampling to be completed around the perimeter in 2009. Visual monitoring to be completed in years 1, 3 and 5 following completion of remediation construction.	Baseline sampling to be completed around the perimeter in 2009. Visual monitoring to be completed in years 1, 3 and 5 following completion of remediation construction.	Baseline sampling to be completed around the perimeter in 2009. Visual monitoring to be completed in years 1, 3 and 5 following completion of remediation construction.	Baseline sampling to be completed around the perimeter in 2009. Visual monitoring to be completed in years 1, 3 and 5 following completion of remediation construction.	Landfill excavated, no monitoring required.

n/a - not applicable

Sources:

Phase III Environmental Site Investigation, Johnson Point Staging Facility, Banks Island NWT, May 2007, EBA Engineering Consultants Ltd.

* Environment Canada, Climate Normals 1971-2000, Sachs Harbour, NWT

Appendix C

Photographs

Notes: Previous EBA photos referenced as Area A, B, C & D, correspond with Photos referenced as Landfill A, B, C, D etc.

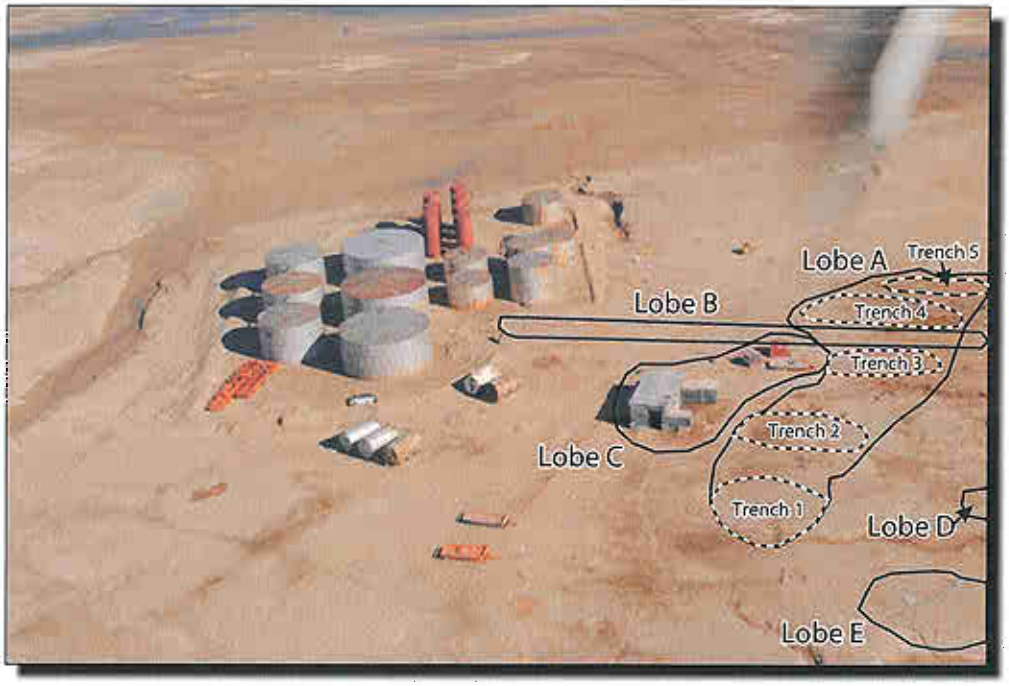


Photo 1
Area A, overview.

Photo 2
Area A looking southwest.

Photo 3
Area B looking southeast.

Photo 4
Area B, Lobe E, note surface debris.

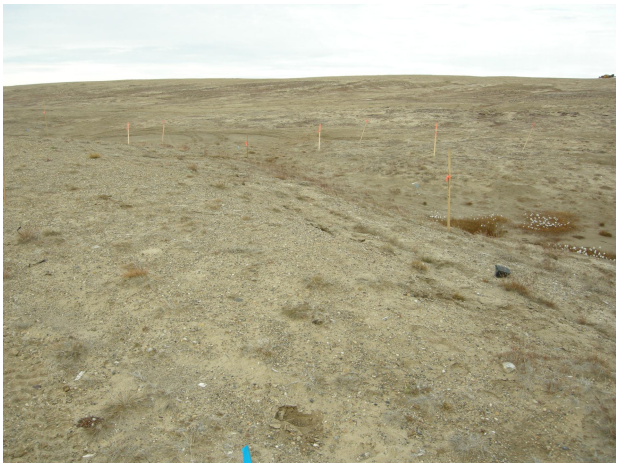
Photo 5
Area C, looking north from toe of slope to Lobe H.

Photo 6
Area C looking south from crest of ridge to Lobe H.

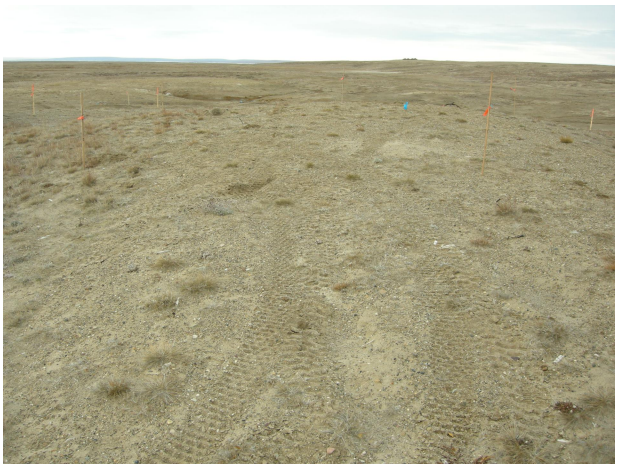
Photo 7
Looking west towards Area D (Lobe I).

Photo 8
Airstrip area, overview.

Photograph 9 ↑
Approximate location of Landfill A



Photograph 10 ↑
Landfill B



Photograph 11 ↑
Landfill B

Photograph 12 ↑
Landfill B

Photograph 13 ↑
Landfill B

Photograph 14 ↑
Landfill B

Photo 15
Existing Landfill A

Photo 16
Existing Landfill A – surface debris

Photo 17
Existing Landfill A – surface debris

Photo 18
Existing Landfill A – surface debris

Photo 19
Existing Landfill A – metal debris from landfill

Photo 20
Existing Landfill A – wooden debris

Photo 21
Existing Landfill B

Photo 22
Existing Landfill B – wood and metal at about 0.3 m below grade

Photo 23
Existing Landfill C – wood and metal at the bottom of testpit

Photo 24
Existing Landfill C – debris encountered at about 1 m below grade

Photograph 25 ↑
Landfill B

Photograph 26 ↑
Landfill B

Photograph 27 ↑
Landfill C

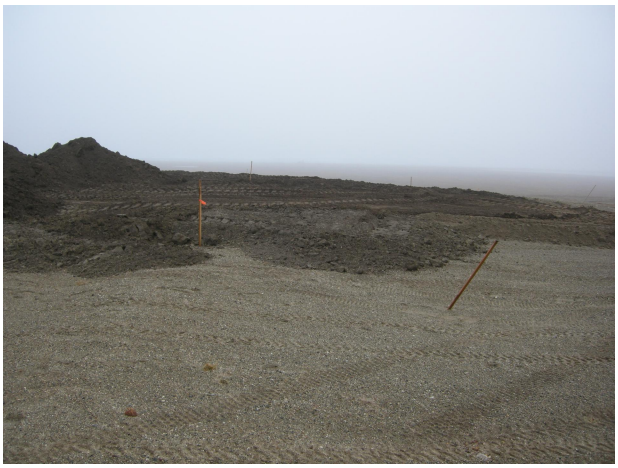
Photograph 28 ↑
Landfill C

Photograph 29 ↑
Landfill C

Photograph 30 ↑
Landfill C

Photograph 31 ↑
Landfill C

Photograph 32 ↑
Landfill C



Photograph 33 ↑
Landfill D

Photograph 34 ↑
Landfill D

Photograph 35 ↑
Landfill D

Photograph 36 ↑
Landfill D

Photograph 37 ↑
Landfill D

Photograph 38 ↑
Landfill D

Photograph 39 ↑
Airstrip Landfill Area

Photograph 40 ↑
Airstrip Landfill Area

Sources:
Photos 9-14, 25-40 AECOM, 2008 Field Season
Photos 15-24, EBA Engineering Consultants Ltd. 2007c. Geotechnical Evaluation Johnson Point Staging Facility, Banks Island, Northwest Territories. October 2006
Photos 1-8, EBA Engineering Consultants Ltd. 2007b. Phase III Environmental Site Investigation, Johnson Point Staging Facility, Banks Island, Northwest Territories. Report for Indian and Northern Affairs Canada Contaminants and Remediation Directorate. March 2007

Appendix D

INAC Abandoned Military Site Remediation Protocol

See Attached CD or File