APPENDIX 4

ENNADAI LAKE
REMEDIATION PROJECT

REMEDIAL ACTION PLAN (RAP)

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NUNAVUT

REPORT

NOVEMBER 2012
ISSUED FOR REVIEW
EBA FILE: Y22101286.0012

SOLICITATION NUMBER: EW699-110498/001/NCS
PWGSC PROJECT NUMBER: R.040717.012
SUPPLY ARRANGEMENT NUMBER: EW699-100053/003/NCS

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EXECUTIVE SUMMARY

Foreword

The objective of the remedial action plan is to reduce environmental liability, maximize benefits to the local community and Inuit, and ensure good value to the people of Canada. This is done by identifying environmental liabilities at the site; determining volumes of hazardous and non-hazardous waste and contaminated soils; and identifying and evaluating remediation and disposal options.

The Site is approximately 380 km west of Arviat and covers approximately 58 hectares. It was an operational weather station from 1949 to 1979. It consists of thirteen intact buildings, five large above ground storage tanks (ASTs), pipelines (including one overhead line), an unmaintained airstrip, trails, five drum caches, several upright and laying metal towers, a main debris area, and several small debris areas.

The Site is currently unoccupied with no ongoing land use since previous manned weather station activities ceased in the 1970s; a newer unmanned automated weather station is present at the site. The Site is used as a cache by local hunters, a new boat, motor, fuel, food and clothing were found inside the buildings.

Site access to the Ennadai Lake site is via airplane using the unmaintained airstrip, or beach landing. There is no functional dock at the site.

Remediation of the site will include making the site safe; remediating soil that is either above federal or territorial guidelines; removing hazardous materials from the site; properly disposing of non-hazardous materials; and ensuring the site is aesthetically restored. A summary of the materials found at the sites and recommended remedial actions are provided below.

Waste Stream	Description
Wood Waste: Non-Hazardous	494 m^3 of wood waste can be dealt with by controlled burning on-site.
Other Waste: Non-Hazardous	871 m^3 of Non-hazardous solid waste and 762 drums (20 L and 205 L) will need to be separated, compacted and moved to the on-site landfill.
Asbestos Waste: Hazardous	196 m^3 of asbestos waste will be handled by trained personnel and moved to the on-site landfill.
Liquid Organic Wastes in Drums, Tanks and Pipeline: Hazardous	Approximately 7,476 L of liquid organic wastes in drums, 8,056 L in tanks, and 1,350 L in pipelines will be removed off-site and re-used “as-is” by local personnel, with the exception of the drum content that is in poor condition and will be incinerated on-site. Those not meeting the incineration criteria will be shipped off-site.
Total Lead, Leachable Lead and PCB Paint on Equipment, Metal, Particulate Board, Wood and Metal Towers: Hazardous	Approximately 107 m^3 of equipment, metal, particulate boards and wood and 8 m^3 of metal towers contain total lead and leachable lead paint. Approximately 28 m^3 of equipment and wood are within Building 2 (APEC 15) and contain lead and PCBs. Lead and PCB painted waste will be stripped and handled by trained personnel. The cleaned substrate will be moved to the on-site landfill, with the exception of the softer painted substrates, which will be removed to a Class 1 landfill off-site.

Waste Stream	Description
Total Lead and Leachable Lead Paint on Concrete: Hazardous	Approximately 10 m^3 of lead painted concrete will be stripped and handled by trained personnel, the remaining concrete will stay in place, and the stripped paint will be removed to a Class 1 landfill off-site.
Total Lead and Leachable Lead Paint on Drums: Hazardous	Approximately 339 drums (20 L and 205 L) of lead painted drums will be handled by trained personnel and crushed under proper containment. The crushed drums and any remaining paint chips will be removed to a Class 1 landfill off-site.
Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tile: Hazardous	Approximately 18 m^3 of lead painted asbestos panels and tiles will be handled by trained personnel and removed off-site to a Class 1 landfill.
Compressed Gas Cylinders: Hazardous	Approximately 0.4 m^3 of cylinders are on-site. They will be depressurized, crushed, and landfilled on-site. Known contents that cannot be safely depressurized will be shipped off-site in an approved container, following landfill and shipping company approval.
Fire Extinguishers: Hazardous	Approximately 0.2 m^3 of fire extinguishers are on-site. They will be depressurized, crushed and landfilled on-site. Known contents that cannot be safely depressurized will be shipped off-site in an approved container, following landfill and shipping company approval.
Creosote Treated Wood: Hazardous	Approximately 3 m^3 of creosote treated wood will be wrapped and landfilled on-site or will be removed off-site to an approved facility.
Other Hazardous Waste	Approximately 19 m^3 of miscellaneous solid hazardous waste (batteries, light ballasts, electrical parts, ODS, lead seals, etc.), 755 L of miscellaneous battery electrolyte, chemicals, oil/lubricants/fuels and paint and 720 L of flammable drum content will require disposal in an off-site approved facility.
Contaminated Soil	Approximately 0.5 m^3 of soil contaminated with metal requires off-site/on-site landfill disposal. 2,164 m^3 of soil contaminated with Type B PHCs will require on-site treatment.
Physical Hazards	Each hazard will need to be identified and properly mitigated prior to work commencing. Proper personal protective equipment to be worn at all times.

There are four physical hazards that exist on-site: 1) buildings and metal towers that are dilapidated and present a risk of collapse; 2) steep sandy slopes throughout the site; 3) debris areas that pose a risk and will have to be removed (e.g., nails, broken glass and other sharp objects); and 4) wires, cables and other items that create a tripping hazard are throughout the site. A site-specific safety plan will have to be developed to identify and mitigate all physical hazards.

To remediate the site, a camp may be required. Materials would be brought into Ennadai Lake during the winter prior to remediation; remediation will occur during the summer months and then all materials would be hauled out at the completion of remediation. The current schedule has all site activities, including soil remediation to be completed by March 2016. Verification and monitoring of construction works, environmental clean-up, verification of quantities and quality of work will need to be carried out during the remediation phase of this project. The landfill will require long-term monitoring.

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1.0 INTRODUCTION

EBA Engineering Consultants Ltd. (EBA), operating as EBA, A Tetra Tech Company, was retained by Public Works and Government Services Canada (PWGSC) on behalf of Aboriginal Affairs and Northern Development Canada (AANDC) to complete a Remedial Action Plan (RAP) at a former weather station (the Site) located on the shoreline of Ennadai Lake, southwest of Arviat, Nunavut (NU) (Figure 1). The RAP is a continuation of work that began in 2009 with a Phase I and II Environmental Site Assessments (ESA) (WESA 2010) and continued in August 2012 with a Phase III ESA (EBA 2012). The Phase III ESA also included geotechnical evaluation of the airstrip, landfill and borrow locations as well as an archaeological investigation. An Environmental Screening Report (ESR) and an Archaeological Impact Assessment are also being prepared under a separate document.

EBA understands that, through the Contaminated Sites Program, AANDC is responsible to manage a number of contaminated properties that are no longer maintained by the original occupant.

EBA obtained authorization for undertaking the field component of the work on July 6 and for reporting on October 1, 2012 from PWGSC supply specialist, Mr. Brad Campbell. Mr. Michael Bernardin, B.Env. D. of PWGSC is the Project Manager for this project. The Terms of Reference (TOR) for the Ennadai Lake Former Weather Station are included in Appendix A.

2.0 OBJECTIVE

The objective of the work is to prepare a RAP for the Site that will be used to develop specifications and tender documents for remedial contractors.

The objective of the RAP is to reduce environmental liability, maximize benefits to the local community and Inuit, and ensure good value to the people of Canada.

3.0 SCOPE OF WORK

EBA completed the following scope of work to develop a comprehensive site remediation plan:

- Identified environmental liabilities at the site. This was done during the Phase III ESA;
- Determine volumes of hazardous and non-hazardous wastes and contaminated soils. This was completed during the Phase III ESA;
- Identify and evaluate remediation and disposal options for each waste stream. Options are to be evaluated based on the value to the Crown, the resources available to complete the project, and the reduction in environmental liability;
- Complete a Class D (indicative) estimate for potential remedial options to assist with determination of preferred options;
- Evaluate and integrate the options into a recommended remedial approach for the site. The compilation of the above tasks would constitute the draft RAP;

- Conduct community consultation to present the draft RAP. It is important that the community understands the plans and they are given an opportunity to ask questions and provide input. It is imperative that the final RAP meets the requirements of the community;
- Finalize the RAP after addressing community questions and/or concerns; and
- Inherently included in this scope of work, but not specifically outlined here, is the incorporation of key factors such as AANDC policies and clean-up criteria.

4.0 BACKGROUND

This background section provides a basic understanding of current site conditions, environmental conditions, site history and previous work that has been completed at the Site.

4.1 Site and Area Description

The Site is approximately 380 km west of Arviat and covers approximately 58 hectares. It was an operational weather station from 1949 to 1979. It consists of 13 intact buildings, five large above ground storage tanks (ASTs), pipelines (including one overhead), an unmaintained airstrip, trails, five drum caches, several upright and laying metal towers, a main debris area, and several small debris areas. Photos 1 and 2 provide an overview of the site and surrounding area. Four of the five large ASTs, and the pipeline, contain fuel (Photos 3 and 4). Most of the drums are empty (Photo 4). The main building cluster (Photo 5) and the airstrip (Photo 6) are on Inuit-owned land (IOL), and the remainder of the site is crown land (Figures 1 and 2).

The Site is currently unoccupied with no ongoing land use since previous manned weather station activities ceased in the 1970s; a newer unmanned automated weather station is present at the site (Photo 6). Environment Canada (EC) personnel visit the site occasionally to collect data and maintain equipment.

The Site is also used as a cache by local hunters, a new boat and motor were observed during the EBA Phase III field program. New containers of fuel, clothing, and food were also found inside the buildings. Graffiti was observed on several buildings. There is potential for tourists to visit the site, as a nearby lodge offers wildlife viewing tours.

4.2 Overview of Biophysical Conditions

Ennadai Lake is located in southwestern Nunavut in the Kivalliq Region, approximately 370 km west of Hudson Bay, 120 km north of Manitoba and 50 km east of the Northwest Territories. Ennadai Lake is 84 km long, between 5 and 23 km wide, and is drained to the north by the Kazan River. The region lies in the Kazan River Upland Ecoregion of the Taiga Shield Ecozone. Peatlands and lakes of various sizes are common in the region and are often interconnected. The predominant vegetation consists of black spruce and tamarack, with dwarf birch and willow shrubs, and a ground cover of cottongrass, sedge, moss and lichen. Ennadai Lake lies across the treeline – the gradual transition from boreal forest to tundra. The south end of Ennadai Lake is characterized by open canopy stands of black spruce, while the north end of Ennadai Lake is predominantly tundra vegetation and isolated black spruce colonies are only found in protected poorly drained terrain (Ecological Stratification Working Group 1995).

Climate records for the site are available from 1950 to 1979, and EC has maintained an automated weather station at the site since 1998 (EC 2012). The annual mean air temperature between 1950 and 1979 was -9.4, and ranged from -7.0 to -11.4 °C. Over the last 30 years the climate has warmed, and since 1998 the annual mean air temperature has ranged from -5.4 to -9.0 °C. The mean monthly air temperatures for January and July over the last 15 years have been -24.0 and 14 °C, respectively. The total annual precipitation over the period of record is 280 mm on average, and has ranged from 160 to 450 mm. Snow cover typically extends from October to May.

Ennadai Lake lies in the Churchill Province of the Canadian Shield, and the geology of the region is characterized by Archean age quartzfeldspathic gneiss, mafic metavolcanics, and granodiorite (Peterson 1992). The region was glaciated during the Wisconsin, and the centre of the Laurentide Ice Sheet lay approximately 100 km northeast of Ennadai Lake (Prest 1969). Common indicators of glaciation in the area include: eskers, kettle lakes, Rogen moraines, and till plains (Aylsworth 1989). Following retreat of the ice sheet about 7,900 years ago, the area was covered by a small glacial lake (Prest et al. 1968). Raised beach ridges on the eskers near Ennadai Lake are evidence of the glacial lake. Bedrock outcrops are common but are not a substantial component of the surficial geology.

Ennadai Lake lies at the southern extent of continuous permafrost, and ground temperatures are expected to be between -3 and -5 °C (Heginbottom et al. 1995). The active layer thickness is expected to vary considerably depending on soil and vegetation conditions. The top of permafrost may lie less than 0.5 m below the ground surface in wet organic soils, and more than 3 m in well-drained coarse material. Ice wedge polygons are common north of the treeline in this area, and ground ice is expected to be associated with these features and with fine-grained sediment. Any glacial ice buried in eskers would have melted when the area was covered by the glacial lake, and is therefore not expected (Dredge et al. 1999).

Characteristic mammal species include barren-ground caribou, wolf, wolverine, weasel, Arctic and red fox, Arctic hare, and brown lemming. Additional mammal species, such as muskox, otter and mink, occur at the periphery of their ranges and may be expected to occur irregularly. Many mammal species occur year round. In particular, barren-ground caribou from the Beverly and Qamanirjuaq herds may occupy the area throughout the year, but may be expected in greatest numbers in the summer, fall and early winter. During the spring calving season, a few bulls, juveniles, and non-pregnant females may remain in the area rather than continuing their migration to the calving ground. Bird species in the region include rock and willow ptarmigan, peregrine falcon, short-eared owl, sandhill crane and various waterfowl species. Ennadai Lake supports fish populations, including sport fish such as lake trout, lake whitefish, arctic grayling, burbot, and northern pike (Ecological Stratification Working Group 1995).

4.3 Site History

Construction of the Royal Canadian (RC) Signals Station by the Department of National Defence (DND) began in July 1949. Equipment was brought to the Site from Churchill, MB by air and cat train. Construction was completed in October 1949. It was operated by the DND until the site was handed over to the Department of Transport on September 18, 1954 (Martin 2012).

Other operations in the area included mining exploration camps and prospecting. Transport Canada (TC) operated the site until April 1, 1979, when it was handed over to the Atmospheric Environment Service of Environment Canada (EC). In 1980, EC established a Reserve (Number 1849) at the Site and the surplus buildings were put up for sale. The buildings were eventually sold to 59549 Manitoba Ltd. and EC requested a reduction in reserve for an unmanned weather station. In January 1984, Indian and Northern Affairs Canada (INAC) notified 59549 Manitoba Ltd. that they would have to lease the land below the buildings because the government could not sell or transfer the Reserve to the public. A lease was granted to Tundra Adventures Ltd. (formerly 59549 Manitoba Ltd.) for 10 years, effective May 1, 1984. The lease included the main camp at the Site and adjacent airstrip. At this time, the lands were reportedly removed from the original EC Reserve Number 1849 (WESA 2010). In June 1992, INAC notified Tundra Adventures Ltd. that the leases would be transferred to Nunavut Tunngavik Incorporated (NTI) and the leases would be administered by the Designated Inuit Organization (DIO). In August 1994, Kivalliq Inuit Association (KIA) informed INAC of a fuel spill at the Site. INAC in turn notified EC and Tundra Adventures Ltd. that these lands were not Crown land but are now transferred to NTI (WESA 2010).

4.4 Previous Studies

EBA conducted a records review of historical reports to allow for the completion of a Data Gap Analysis, the development of the Phase III ESA field program and the RAP. The following reports were reviewed/summarized:

- Integrated Phase I and Phase II Environmental Site Assessment, KW007 – Ennadai Lake, WESA, March 2010, File: KB7881-07 (WESA 2010).
- Ennadai Lake Site KW007 – Spill Response, Final Report, Nunami Stantec, August 2011, File: 123510692 (Nunami Stantec 2011).

No other studies were identified during the records review for Ennadai Lake. The EBA Phase III ESA (EBA 2012) is included in this section to provide a summary of that work.

4.4.1 Integrated Phase I and II ESA Report

WESA conducted a Phase I and II ESA at the Site in July 2009. The field activities included identification and quantification of potential environmentally impacted areas, sampling of potential impacted media, identification of hazardous materials at the site and identification of physical hazards. On July 14 and 15, 2009, WESA collected a total of twenty (20) soil samples, three (3) surface water samples, twenty-eight (28) building materials samples, twenty-one (21) paint samples, four (4) concrete samples, nine (9) drum content samples, four (4) AST samples and one (1) pipeline sample. WESA recommended additional sampling was required for delineation and confirmation of previously identified impacts (soils, sediment, water, and hazardous and non-hazardous materials).

4.4.2 Spill Report

Nunami Stantec Ltd. (Nunami) completed a spill response report in August 2011 as follow-up to a reported leak in the fuel system pipeline observed by a conservation officer visiting the site on April 11, 2011. Fuel was reportedly dripping from an overhead pipe between the fuel tanks and the old weather station building at a rate of about two litres per day (NWT/NU spill report #11-106) (WESA 2010).

Nunami conducted a site visit on July 13, 2011 to evaluate the integrity of the petroleum distribution system on-site, investigate the reported leak, and stop it if possible. No dripping was observed from the overhead piping, however, a fuel oil stain approximately 1.5 metres in diameter was observed below a threaded union in the overhead piping. A total of 10 litres of fuel was drained out of the piping system into a drum on-site to prevent further leaking.

An active leak (drip) was also observed at the bottom valve of AST 4; personnel on-site were able to tighten the valve seal and stop the dripping. The soil below the leaking valve at AST 4 was saturated with fuel oil. Personnel checked all other accessible valves on-site and tightened them as required.

Nunami recommended AANDC remove remaining fuel from the storage tanks and piping to prevent additional releases into the environment.

4.4.3 Phase III ESA Report

For the 2012 EBA Phase III ESA field program, the Site was divided into areas of potential environmental concern (APEC) based on the WESA and Nunami reports as well as the spatial distributions of the materials and activities observed at the Site. The term "APEC" was utilized again in the RAP, to remain consistent with the Phase III ESA. An overview of most APECs at the Site is available in Photos 3-6 and in Figure 2. Detailed views of APECs are available in Photos E-1 to E-30 and H-1 to H-65. EBA separated Ennadai Lake into thirty-one (31) APECs:

- APEC 1; Stain 1
- APEC 2; Stain 2
- APEC 3; Stain 3
- APEC 4; Tank 5
- APEC 5; Ennadai Lake
- APEC 6; Medium Cabin
- APEC 7; Small Cabin
- APEC 8; Pipeline
- APECs 9-12; Tanks 1 to 4 (respectively)
- APEC 13; Overhead Pipeline
- APEC 14; Building 1 (Living Quarters and Operations)
- APEC 15; Building 2 (Power House)
- APEC 16; Building 3
- APEC 17; Building 4
- APEC 18; Building 5 (Garage)
- APEC 19; Building 6
- APEC 20; Building 7

- APEC 21; Building 8
- APEC 22; Building 9
- APEC 23-27; Drum Caches 1, 2, 3, 4 and 5 (respectively)
- APEC 28; Main Debris Area
- APEC 29; Shoreline Debris and Pumphouse
- APEC 30; Surface water and Hydrology/Drainage pathway
- APEC 31; Former Fuel Storage area (as identified in old photographs of the site)

Soils impacts were identified at the Site. A summary of the impacted soils at Ennadai Lake is provided in Table 1 below. There were no water or sediment impacts identified during the Phase III ESA.

Table 1: Summary of Contaminated Soil

APEC	Description	Contaminant of Concern	Volume of Impacted Soil
1, 2, 3, 4, 8, 9, 10, 11, 12, 13, 14 15, 20, 21, 22	POL Tanks, Pipeline, Miscellaneous Drums	**PHC:** Type B hydrocarbons (primarily F2, F3)	2,164 m^3
15	Burn Pit	**Metals:** Antimony, Lead	0.5 m^3
		Approximate Volume Impacted Soil	**2,165 m^3**

Note:
Type B hydrocarbons as defined by the *Abandoned Military Site Protocol* (AMSRP) (INAC 2008)

Both hazardous and non-hazardous materials were found throughout the Site. The non-hazardous materials includes wood, metal, asphalt shingles, rubber, concrete, particulate boards, plastic, windows, fibreglass insulation, styrofoam, textiles, porcelain and drums (20 L and 205 L). The hazardous materials includes asbestos containing materials (ACMs), total lead and leachable lead painted materials, organic content in drums, tanks and pipelines and other smaller items, such as: batteries, compressed gas cylinders, creosote treated wood, mercury, polychlorinated biphenyls (PCBs), ozone depleting substances (ODS), miscellaneous chemicals, etc. The volumes of the materials are shown in Tables 2 and 3 below:

Table 2: Inventory of Non-Hazardous Materials of Ennadai Lake

Non-Hazardous	Unpainted Wood	494 m^3
	Metal	372 m^3
	Asphalt shingles	9 m^3
	Rubber	6 m^3
	Concrete (on IOL)	137 m^3
	Concrete (on crown land)	24 m^3
	Insulation and particulate boards	12 m^3
	Plastic	4 m^3

Table 2: Inventory of Non-Hazardous Materials of Ennadai Lake

Non-Hazardous (continued)	Windows	0.4 m^3
	Fibreglass insulation	431 m^3
	Styrofoam	11 m^3
	Textiles	1 m^3
	Porcelain	2 m^3
	Metal drums (205 L and 20 L)	762 drums
Total Non-Hazardous Solid Materials: 1503.4 m^3 Total Non-Hazardous Drums: 762 drums		
Notes: 1. All volumes are uncrushed 2. Volumes have been rounded to the closest whole number unless less than 1		

Table 3: Inventory of Hazardous Materials of Ennadai Lake

Hazardous	Asbestos containing or contaminated materials	196 m^3
	Organic Liquids (Drum/Pipeline/Tanks)	16,882 L
	Total and leachable lead painted materials	155 m^3
	Total and leachable lead painted drums (205 and 20 L)	339 drums
	Other hazardous liquids	1,475 L
	Other hazardous solid materials	23 m^3
Total Hazardous Solid Materials: 392 m^3 Total Hazardous Liquid Materials: 18,357 L Total Hazardous Drums 339 drums		
Notes: 1. All volumes are uncrushed 2. Volumes have been rounded to the closest whole number unless less than 1 3. Volumes of total lead and leachable lead paint include the painted substrate 4. Total and leachable lead painted ACM materials were included in the total and leachable lead paint totals		

The geotechnical investigation at the site concluded approximately 210,400 m^3 of granular material appears to be available. The majority of the granular material identified is sand with minor proportions of silt and gravel. Most of the borrow sources are in close proximity to the site and accessible by ATV and track-mounted equipment. The existing trails to the borrow sites may need to be upgraded for larger earth moving equipment.

Four locations were evaluated for a potential landfill sites. All of the locations are within 240 m of the Site and are easily accessible. Landfill 2 and 3 have a combined area of 6,200 m^2, and no restrictions to their development were identified. Landfill 1 and 4 are larger with respective areas of 4,300 m^2 and 5,000 m^2, but development of these areas might be restricted because Landfill 1 is adjacent to an existing natural spring and Landfill 4 is close to a waterbody.

Two landfarm locations were evaluated. Landfarm 1 is approximately 105 x 105 m, and lies about 450 m southeast of the site within Borrow 7. Landfarm 2 is approximately 60 x 180 m, and lies on Inuit owned land west of the airstrip about 550 m northeast of the site. Access roads may need to be built and/or upgraded to develop these landfarms.

5.0 SITE ACCESS AND INFRASTRUCTURE

The Site is considered to be remote, and was originally accessed by cat train and planes equipped with skis or floats. Hunters visit the Site from Arviat, NU during the winter via snowmobiles, but there are no known documented summer trails between the Site and Arviat, NU. For the August 2012 field program, EBA used a deHavilland Canada DHC-6 Twin Otter on floats to transport equipment to the site, and a DHC-2 Beaver on floats to shuttle the EBA field team to site from a nearby lodge. The float planes were docked on the beach at the site (Photo 7), but there is no functional dock on the beach. The location where the float plane docked is shown on Figure 3.

Two access options were considered for remedial activities: 1) winter road/cat train route; or 2) heavy lift airplane using an ice airstrip. Given the distance to communities that have barge (Arviat, NU) or all season road (Stony Rapids, SK); the river crossings; the variable terrain; the cost of development; and the time required to determine/develop a cat train route; air access using an ice airstrip was considered the preferable option.

There are a number of trails on the esker and adjacent glaciofluvial deposits (Figure 3, Photos 8 and 9). These trails can be used by ATV and track-mounted equipment. There is also a sand and gravel airstrip on the esker deposit located entirely on IOL, about 800 m northeast of the site (Figure 3, Photos 10 and 11). The trails and airstrip are discussed further in Sections 9.1 and 9.2.

All site infrastructures were either built on-site or brought to the Site during its construction and operation likely between 1949 and 1979 to support weather station operations. A newer automated weather station is present at the Site but was not investigated as part of this study. Historical information indicates buildings at the Site were constructed as follows:

- Combined station and quarters 68'x 24';
- Engine house 20'x 20'; warehouse 20'x20'; and
- Ice house 20'x20'.

Communication equipment included:

- One PV 500 low frequency and one TE 176 high frequency transmitters;
- Two Lister diesel power plants;
- Two 150-foot towers for LF transmitting antennae; and
- Three 48-foot towers for SW transmitting and receiving antennae (Martin 2012).

Additional infrastructure was brought to site or built on-site after its initial construction in addition to those listed. These include additional buildings, pipeline, five ASTs, and an airstrip. The infrastructures at the Site have not been maintained and have become dilapidated. Numerous buildings, metal towers, fuel tanks, drums, and pipeline remains are in poor condition.

6.0 REGULATORY CONSIDERATIONS

Based on the TOR for this work, the *Abandoned Military Site Remediation Protocol* (AMSRP) (INAC 2008) was used to compare and interpret the laboratory analytical results for soil, water and sediment samples. For the purpose of the RAP, the primary remedial guidelines are based on the AMSRP as these guidelines have been developed as a protocol document specific to northern contaminated sites. For those contaminants or hazardous materials not included in the AMSRP, the appropriate Federal and Territorial regulations were applied.

6.1 Hazardous/Non-Hazardous Materials

The applicable AMSRP, federal and / or territorial guidelines were reviewed and will be followed during remediation. Table 4 summarizes these guidelines:

Table 4: Summary of Applicable Remedial Guidelines

Publisher	Title	Description	Year
INAC	Abandoned Military Site Remediation Protocol	Drum content guideline	2008
GN	Environmental Guideline for Waste Lead and Lead Paint	Lead paint waste guideline	2011
GN	Environmental Guideline for Waste Paint	Paint waste guideline	2010
GN	Environmental Guideline for Mercury-Containing Products and Waste Mercury	Mercury disposal guideline	2010
GN	Environmental Guideline for the General Management of Hazardous Waste	Reference and waste guidelines	2010
GN	Environmental Guideline for Industrial Waste Discharges	Waste and aqueous content in drum discharges guideline	2002
GN	Environmental Guideline for the Burning and Incineration of Solid Waste	Guidelines for incineration considerations	2012
GN	Environmental Guideline for Waste Asbestos	Guideline required for handling and abatement	2011
GN	Environmental Guideline for Waste Batteries	Guideline and disposal options	2011
GN	Environmental Guideline for Waste Solvent	Waste solvent disposal options	2011
GN	Environmental Guideline for Waste Antifreeze	Waste antifreeze disposal options	2011
CEPA	PCB Regulations	Waste remediation and landfill guideline	2011
EC	Industrial Treated Wood Users Guidance Document	Management of treated wood	2004
GN	Environmental Guideline for Ozone Depleting Substances	Disposal criteria and waste management guideline	2011

Notes:
INAC - Indian and Northern Affairs Canada
GN - Government of Nunavut
CEPA - Canadian Environmental Protection Act
EC - Environment Canada

While all hazardous materials are regulated as indicated in Table 6 above, we discuss three in more detail below, due to the volume of material on-site and/or the human health concerns associated with them, these are organic liquids, asbestos, and lead and/or PCB amended paint.

6.1.1 Drum/Tank/Pipeline Organic Liquids

The drums, tanks and pipelines on the Site were sampled and analysed for parameters to determine their disposal options. The AMRSP was utilized for required analysis, criteria, handling and disposal options for organic content:

"…organic content which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium, 100 ppm lead, and that have a flashpoint between 25°C and 225°C, may be disposed of by incineration."

The AMSRP also states that following incineration, residuals materials will undergo further leachable testing. Leachable materials that are above guidelines shall be disposed of as DCC Tier II contaminated soil and disposed of off-site at a licensed disposal facility.

The tanks and pipelines on the Site were analysed for these previously mentioned parameters, along with parameters to determine whether the content could be re-used by local personnel. The additional analysis was based on the GNWT Petroleum Products Division Quality Control and Fuel Specifications and the GNWT Used Oil and Waste Fuel Management Regulations. The analysis that was conducted on the tanks and pipelines did not inhibit the possibility of this content being re-used. Additional analysis may be conducted at the time of remediation to confirm this.

6.1.2 Asbestos Containing Material (ACM)

There is no definition in the AMSRP that defines Asbestos Containing Material (ACM). The *GN Environmental Guideline for Waste Asbestos* (GN 2011a) provides guidelines of asbestos containing waste storage and handling. It defines an ACM as material that contains 1% or greater by volume of asbestos. Asbestos may be found in the form of the serpentine (Chrysotile) or an amphibole (Crocidolite, Tremolite, Amosite, Anthophyllite or Actinolite).

The Government of Alberta (GA), Employment and Immigration has published the *Alberta Asbestos Abatement Manual* (GA 2011). This manual outlines the best practices and specific abatement risk levels to be followed during asbestos abatement. It also presents basic information on asbestos and asbestos products, health hazards, requirements for worker protection, safe work procedures, inspection criteria, applicable legislation, and competency profiles for those persons involved in abatement activities. This document provides a very detailed guide that clearly lays out the procedures to use. It was utilized to determine what level of asbestos abatement was necessary for each type of asbestos and their associated costs.

6.1.3 Lead/Polychlorinated Biphenyl Amended Paint

The AMSRP provides guidelines for acceptable total lead and leachable lead in paint and their associated disposal requirements. Leachable lead in paint shall be collected and transported off-site, in accordance with the Government of Nunavut's (GN) *Environmental Guidelines for Industrial Waste Discharges* (2002), to a licensed hazardous waste disposal facility.

The AMSRP specifies the guideline for PCBs in paint. Paint containing PCBs in excess of 50 ppm are to be considered hazardous waste and shall be disposed of in a licenced hazardous waste disposal facility.

The manufacture and import of PCBs was banned in North America in 1977. The handling, storage and disposal of PCBs that were in use at the time of the ban, is strictly regulated by the federal government under the *Canadian Environmental Protection Act* (Government of Canada, 2011). The *Chlorobiphenyls Regulations* (1977, revised 1980, 1985, consolidated 1991) (EC 1991) restrict the use and releases of PCBs and prohibit the manufacture, process, import and sale of PCBs and equipment containing a liquid with a PCB concentration greater than 50 mg/kg (50 ppm).

Under the Transportation of Dangerous Goods Act, PCBs are under Class 9; Miscellaneous Products, Substances or Organisms.

As well, the Government of Nunavut does have an advisory against burning wood and other materials that contain PCBs (GN 2012).

6.2 Soil and Sediment

In the event that the AMSRP did not satisfy the remedial requirements, appropriate land use based criteria were applied. For soil, the secondary guideline for identified gaps in the AMSRP is *The Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (PEHH) (CCME 2007). These guidelines provided values for metals not included in the AMSRP, as well as BTEX (benzene, toluene, ethylbenzene, and xylene).

The selection of the applicable soil criteria in the CCME PEHH are in association with land use, soil grain size, and potential contaminant transport pathways and receptors. The generic soil quality guidelines in the CCME PEHH are developed to protect human health and key ecological receptors that sustain normal activities from four land use categories: agricultural, residential/parkland, commercial, and industrial.

Aboriginal Affairs and Northern Development Canada (AANDC) have classified the Site as Agricultural/Wild land. Based upon this land use classification the PEHH (CCME 2007) defines Agricultural/Wild land as:

- The land use category where the primary land use is related to the capability of the land or facility and are agricultural in nature or activities related to the feeding and housing of livestock. Wild lands are grouped with agricultural due to similarities in receptors that would be expected to occur and similar need for a high level of protection to ensure ecological functioning (CCME 2007).

The Government of Nunavut's *Contaminated Site Remediation Guidelines* (2009) defines agricultural land use as:

- The land in which the primary activity is related to the productive capability of the land. This includes lands that provide habitat for transitory wildlife and birds as well as greenhouses (GN 2009).

Because of the nature of the Site and AANDCs classification, the agricultural/wild land criteria will apply in the event that the AMSRP has not established criteria for comparison.

For the assessment of soil, a grain size criterion is also applied. A fine-grained soil is defined as having a median grain size (D50) of 75 micrometres (µm) or less, where as a coarse grained soil has a D50 of 75 µm or greater. Representative soil samples from varying locations across the sites were submitted for particle size analysis (PSA). The majority of the samples were determined to be coarse-grained; therefore coarse-grained criteria were selected.

The AMSRP incorporates the CCME guidelines as appropriate with the consideration of previously conducted quantitative risk assessments within the guidance documents. There are four exposure pathways and they include: 1) human and ecological contact; 2) soil and food ingestion; 3) ground/surface water; and 4) indoor vapour intrusion. All pathways are deemed applicable to the Site, as there is the potential for new shacks or cabins to be built at the site in the future. As part of the data interpretation, the most stringent criteria among the four exposure pathways are used.

Soil depth and soil type are important factors affecting the availability and transport of contaminants. The AMSRP provides specific guidelines for contaminants based upon their depth below ground surface. All soil samples were collected within 2.5 metres below ground level (mbgl). As stated in the AMSRP guidelines, soils below 0.5 mbgl are considered sub-surface and will have a higher guideline threshold applied. Special consideration for the proximity to waterbodies is included in the AMSRP. Table 5 provides the remedial requirements for Type B petroleum hydrocarbons (PHC) (defined as the sum of F1, F2 and F3 PHC) based upon vertical depth below ground level.

Table 5: AMSRP Guidelines for Type B Hydrocarbons

Depth Below Ground Level (mbgl)	30 m to Water (yes or no)	Type B Hydrocarbon AMSRP Guidelines[1] (mg/kg)
0.0 - 0.5	No	2500
0.5 - any depth	No	5000
0.0 -any depth	Yes	330
1. AMSRP Tier 1/2: Abandoned Military Site Remediation Criteria (INAC, 2008)		

For metal contaminated soil only two elements, antimony and lead, were above AMSRP/CCME Guidelines. Table 6 provides the remedial targets for these elements.

Table 6: AMSRP and CCME Guidelines for Metal Impacted Area

Parameter	Guideline	Criteria (mg/kg)
Antimony	CCME[1]	20
Lead	AMSRP[2]	200
1. CCME A/W Tier 1: *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health* (PEHH) by Canadian Council of Ministers of the Environment (CCME), 2007 – Agricultural/Wild land coarse-grained soils 2. AMSRP Tier 1/2: Abandoned Military Site Remediation Criteria (INAC, 2008)		

6.3 Water

The lake water is anticipated to support aquatic life and potentially used as potable water source for hunters and trappers in the area. Surface water analytical results should be compared with the CCME *Canadian Water Quality Guidelines for the Protection of Freshwater Aquatic Life* (PFAL) (CCME 2007) and the *Canadian Drinking Water Guidelines* (DW), (Health Canada 2012). With the absence of federal guidelines for PHC fractions F1 and F2 in water, the *Alberta Tier 1 Guidelines* (AENV 2010) should be used. This is consistent with other federally regulated sites in the Northwest Territories and Nunavut. In the event of a discrepancy between the PFAL and DW guidelines, the lowest value should be applied as the comparison guideline.

The majority of the guidelines are obtained from the Summary Table of the CCME PFAL (CCME 2007); however, various inorganic compounds are pH, temperature or water hardness dependent. These compounds include aluminum, ammonia, cadmium, copper, lead, and nickel. Based on the equations provided in the summary table, specific guideline values were calculated using the average laboratory pH and hardness.

As a note to reader, there was no contaminated water identified during the 2012 Phase III ESA. The discussion above is provided in the event of a spill or the discovery of potentially contaminated surface water during remedial activities.

7.0 REMEDIAL OPTIONS

This section outlines remedial options for each waste stream. We begin by providing a summary of the waste streams and potential options. We also provide details on how the remedial options were assessed using parameters that were deemed to be important (i.e., community acceptance and cost).

7.1 Summary of Potential Remedial Options

Reclamation of the site will include making the site safe; remediating soil that is either above federal or territorial guidelines; removing hazardous materials from the site; properly disposing non-hazardous materials; and reclaiming and ensuring the site is aesthetically restored. A summary of the materials found at the three sites and identified options are provided in Table 7 below. Note that some of the waste streams only had one remedial option identified. This was primarily due to the hazardous nature of the waste stream. Each of these materials is addressed in subsequent sections in more detail.

Table 7: Remedial Options Identified For Materials

Material	Description
Wood Waste: Non-Hazardous	Approximately 494 m^3 of wood, primarily from existing intact buildings on the Site. Wood waste can be dealt with by 1) controlled burning on-site; 2) on-site disposal in a landfill; or 3) off-site disposal to an approved facility.
Other Waste: Non-Hazardous	Approximately 871 m^3 of metal, tanks, shingles, rubber, concrete, plastic, windows, fibreglass insulation, styrofoam, textiles, porcelain, or other inert waste and 762 drums (20 L and 205 L). Can be 1) placed in on-site landfill; or 2) disposed of at an off-site approved facility.

Table 7: Remedial Options Identified For Materials

Material	Description
Asbestos Waste: Hazardous	Approximately 196 m^3 of asbestos containing insulation, black felt, exterior siding, gaskets, shingles, heat resistant chimney tile, panels, white pipe, window caulking, and fiberglass insulation will require either 1) on-site disposal in a landfill; or 2) off-site disposal to an approved facility.
Liquid Organic Wastes in Drums, Tanks and Pipeline: Hazardous	Approximately 7,476 L of liquid organic wastes in drums, 8,056 L in tanks, and 1,350 L in pipelines. This waste can be 1) incinerated on-site; 2) disposed in an approved off-site facility; and/or 3) re-used by local personnel.
Total Lead, Leachable Lead and PCB Paint: Hazardous	Approximately 107 m^3 of equipment, metal, particulate boards and wood and 8 m^3 of metal towers contain total lead and leachable lead paint. Approximately 28 m^3 of equipment and wood within Building 2 (APEC 15) that contains lead and PCBs. For this waste, the paint can be 1) removed (very labour intensive) and the material landfilled on-site; or 2) material can be removed intact to an off-site landfill. Note if the paint is removed the paint has to be removed off-site.
Total Lead and Leachable Lead Paint on Concrete: Hazardous	Approximately 10 m^3 of concrete; the paint can be 1) removed and the remainder of the concrete is left in place; or 2) the concrete can be removed intact (expensive transporting costs), to an off-site landfill. Note if the paint is removed, the paint has to be removed off-site.
Total Lead and Leachable Lead Paint on Drums: Hazardous	Approximately 339 drums (20 L and 205 L); this waste will be crushed and removed off-site to an approved facility.
Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tile: Hazardous	Approximately 18 m^3 of asbestos panels and asbestos ceiling tiles. For this waste, the paint can be 1) removed (very labour intensive and within an asbestos containment) and landfilled on-site; or 2) the waste can be handled, following asbestos guidelines and removed to an off-site landfill. Note if the paint is removed the paint has to be removed off-site.
Compressed Gas Cylinders: Hazardous	Approximately 0.4 m^3 of compressed gas cylinders and propane tanks are on the Site. This waste can be placed in 1) on-site landfill; or 2) disposed of at an off-site approved facility. A specialist may be required for venting unknown contents if landfilled on-site and for transportation requirements.
Fire Extinguishers: Hazardous	Approximately 0.2 m^3 of fire extinguishers (and potentially content) are at the Site. This waste can be 1) landfilled on-site; or 2) if there is content, removed off-site.
Creosote Treated Wood: Hazardous	Approximately 3 m^3 of creosote treated wood will be 1) wrapped and landfilled on-site; or 2) will be removed off-site to an approved facility.
Other Hazardous Waste	Approximately 19 m^3 of miscellaneous solid hazardous waste (batteries, light ballasts, electrical parts, ODS, lead seals, etc.), 755 L of miscellaneous battery electrolyte, chemicals, oil/lubricants/fuels and paint and 720 L of flammable drum content will require disposal off-site at an approved facility.
Contaminated Soil	Approximately 0.5 m^3 of soil contaminated with metal require off-site/on-site landfill disposal. 2164 m^3 of soil contaminated with Type B PHCs can be disposed of 1) off-site; or 2) remediated on-site using landfarming, thermal desorption or chemical oxidation

7.2 Remedial Options Analysis

Evaluation of the various remedial options was done using a systematic process that identifies parameters with which to rank the various remedial options. For each remedial option identified, the following parameters are considered important for determining which option may be the most preferred:

- Cost of Remediation – Evaluation included all costs associated with implementation of each option as follows:
  - Procurement and transportation of required supplies to site;
  - Costs associated with implementation of the remedial option including but not limited to equipment, transportation, and labour costs;
  - Costs associated with any special handling, health and safety, or environmental protection measures required during implementation;
  - Long-term monitoring costs, and;
  - Opportunities for cost recovery or costs savings (e.g., backhaul of waste materials during winter re-supply), including potential cost efficiencies of scale associated with other remedial options were also considered.
- Effectiveness in Meeting Remedial Goals - This parameter includes an evaluation on whether the option will meet a regulatory target, such as guideline or site specific criteria. Where criteria are not met, an evaluation is made on whether the exposure pathway can be effectively managed (e.g., source reduction) or a receptor can be prevented from being impacted by the contaminant or hazard. Additional consideration is provided for:
  - Residual site liability associated with the remedial option requiring risk management; and
  - Potential for additional environmental harm during implementation of the remedial option;
- Timeframe for Remediation - Is the length of time that an option will take to remediate to applicable criteria. Options involving risk management will rank lower typically due to the timeframe required. This can be an important if there is a specific timeframe in which remediation is required.
- Ease of Implementation - This includes how easily an option can be implemented, with proven solutions. Solutions that can be done easy on remote sites will rank higher than solutions that are problematic, less proven or are more complex. Additional consideration can include:
  - Specialized equipment, training, or procedures required for implementation of the remedial option;
  - Logistical and organizational support requirements;
  - Transportation requirements (e.g., winter access);
  - Additional regulatory requirements (e.g., Fisheries Authorization, additional testing and/or monitoring); or
  - Long-term monitoring requirements.

- Regulatory Acceptance - Is the likelihood that an option would be readily accepted by the various regulators including AANDC, EC, and Territorial regulators.
- Community Acceptance - This is how likely stakeholders from the community and Inuit nearby will accept the remedial option. There is a community meeting being held in Arviat, NU on December 11, 2012. The remedial options will be presented to the community and feedback will be solicited prior to finalizing the RAP.
- Loss of Natural Capital - Natural capital can be defined as the value that natural ecosystems contribute in terms of ecosystem goods (i.e., fish, wildlife, trees) or services (water catchment, erosion control, carbon cycling). The loss of the natural ecosystem through disturbance does have an impact to natural capital. A higher rank corresponds to a smaller chance that there will be a loss of natural capitol.

Each remedial option is ranked with respect to the parameters listed above relative to all the options available. While there are some drawbacks to this process, it is done objectively, so personal biases are not introduced and it provides a means to looking at multiple parameters, not just one.

7.3 Non-Hazardous Waste

7.3.1 General Description

Non-hazardous waste includes materials such as: metal, tanks, shingles, rubber, concrete, plastic, windows, fibreglass insulation, styrofoam, textiles, porcelain, drums (20 L and 205 L) and other inert items. This includes metal pole and tower supports, concrete in Ennadai Lake and Building 9 (APEC 22) floor. The non-hazardous materials have been divided into two waste streams: wood and other non-hazardous waste. Volumes are summarized in Table 8 and details are provided earlier in Tables 2 and 3. Locations for buildings and site infrastructure are shown on Figures 4 to 8. Details of the inventory for each APEC is provided in Appendix B. Photos of the APECs and materials are located in Appendix C, Photos H1-H65.

Table 8: Total Non-Hazardous Materials

Material Description (Waste Stream)	Volume
Wood	494 m^3
Other Non-Hazardous Waste	871 m^3 and 762 drums (20 L and 205 L)

Notes:

1. Volume includes 24 m^3 of unpainted concrete on Crown land that will remain in place assuming that it does not pose a physical hazard.
2. Volume does not include 137 m^3 of unpainted concrete on IOL that will remain in place assuming that it does not pose a physical hazard.

The waste streams listed in Table 8 are discussed separately in the following sections.

7.3.2 Wood Waste

Wood waste is not an environmental concern but may be both an aesthetic and safety concern. Dilapidated and intact buildings have little historic value and can be an extreme hazard to occasional visitors. The buildings should be demolished or dismantled and the wood separated. Approximately 494 m^3 of wood from buildings will need to be adequately disposed of. Some of the wood is painted and this paint contains total lead and leachable lead; this painted wood is discussed in Section 7.4.4 with other hazardous materials.

There are three options for the wood waste: 1) burned and the ashes placed in a landfill on-site or off-site; 2) placed intact in an on-site landfill; or 3) taken intact off-site for landfill disposal. A description of each of the options is provided below.

1. **Burning:** The unpainted wood would be gathered to a central location, following building demolition and separation. Only unpainted wood can be burned. The wood would be burned in a controlled fire at a time of year when the chance for getting out of control would be minimal. To decrease expenses, buildings and wood debris can be burned in place; however, some of the buildings and wood debris may not be in ideal locations. Conceptually, the steps for conducting a controlled burn of the wood at the site are as follows:
   - Conduct separation of hazardous materials from the building and debris areas containing wood.
   - Demolish the intact buildings. Thirteen buildings on-site are intact and will require demolition prior to removal these are: Buildings 1 to 9, in APECs 14-22, the Medium Cabin (APEC 6), the Small Cabin (APEC 7), the Pumphouse (APEC 29) and Building 10 (APEC N/A).
   - Conduct separation of other non-hazardous materials that should not be burnt, such as painted wood, metals, fibreglass, etc., from the wood debris.
   - Haul wood to designated burn location.
   - Conduct controlled burn at appropriate time of year.
   - Test ashes to determine whether they require landfill disposal on or off-site.
2. **Landfill On-Site:** Conceptually, a non-hazardous waste landfill could be built. Details of landfill design and use, as well as information on borrow material is provided in Section 9. The steps are as follows:
   - Demolish the intact buildings.
   - Conduct separation of hazardous materials from the building and debris areas containing wood.
   - Haul wood to on-site landfill, compact and cover.
3. **Remove Off-Site:** The wood would be taken to a staging area and flown off site and transported to another suitable location for landfilling. The steps are as follows:
   - Conduct separation of hazardous materials from the building and debris areas containing wood.
   - Demolish the intact buildings.
   - Haul to staging area.
   - In winter, fly the material for further shipment to an off-site licensed, disposal facility.

The preferred option is burning. Burning is the most cost effective, easiest to implement, has a short time frame, will be accepted by the community (common practice) and can be done during other remedial activities on-site. Landfilling on-site was not preferred as it is not cost effective; has a longer timeframe for remediation and there is a loss of natural capital due to the additional disturbance of the tundra for landfill size and borrow. There is also risk of the landfill slumping as the wood rots within the landfill. Removal off-site was the least preferred due to high costs, hindered ease of implementation (because of logistical difficulties) and loss of natural capital associated with using fuels during transport. There are several potential concerns with burning on-site:

- Wood must be separated from the other non-hazardous waste.
- Burning must be done at time of year when fire risk to the surrounding tundra is low and should be done by someone experienced who could implement a controlled burn management plan and emergency response procedure. If done improperly, a tundra fire could result.
- Burning was meet guidelines for burning and incineration of solid waste (GN 2012).
- Regulatory approval for a controlled burn will need to be obtained and the burn will have to be completed in an approved container.
- Ashes from burned wood will need to be tested for hazardous materials and properly disposed of on or off-site.

7.3.3 Other Solid Non-Hazardous Waste

Other solid non-hazardous waste includes metal, tanks, shingles, rubber, concrete on crown lands, plastic, windows, fibreglass insulation, styrofoam, textiles, porcelain, drums (20 L and 205 L) and other inert items in various locations. The above outlined items are considered an aesthetic concern and a major safety hazard. None of the machinery has historical value or could be put to use, and the majority of this material has little value. The concrete on IOL (137 m^3) is not included in this volume and will remain in place, if it is deemed to not be a safety hazard.

Approximately 871 m^3 of other non-hazardous material and 762 small and large empty drums have been identified within buildings and within debris areas. The five tanks in APECs 4, 9, 10, 11 and 12 will require drainage of contents and demolition due to size constraints for landfilling.

There are two options for the other non-hazardous waste: it can be placed in a landfill on-site or transported off-site for landfill disposal. A description of each of the options follows.

1. **Landfill On-Site:** Conceptually, a landfill could be built as previously described. The steps are as follows:
    - Conduct the separation of non-hazardous materials from buildings and removal from debris areas.
    - Haul to staging area.
    - Clean drums and tanks and remove residual fluids/fuels from machinery.
    - Cut up the tanks; crush the metal debris, drums and machinery.

- Haul materials to an on-site landfill, compact and cover.

2. **Remove Off-Site:** The waste would be taken to a staging area and flown off-site then transported to another suitable location for landfilling. The steps are as above with the exception of:
    - In winter, fly the material to Saskatchewan for further shipment to an off-site licensed, disposal facility.

The preferred option is to landfill the non-hazardous materials on-site. Removal off-site is not preferred due to high costs, hindered ease of implementation (because of logistical difficulties) and loss of natural capital associated with using fuels during transport. The following are potential issues with landfilling the non-hazardous waste on-site:

- Permitting and community acceptance must be obtained for an on-site landfill.
- Long-term monitoring and possible maintenance will be required for an on-site landfill.
- Loss of natural capital due to the additional disturbance of the tundra for landfill and borrow.

7.4 Hazardous Waste

7.4.1 General

Wastes are considered hazardous due to their toxicity, flammability, corrosivity or other properties and fall within the definition of hazardous materials under most federal, provincial or territorial legislation under transportation of dangerous goods regulations. The following is a list of known hazardous waste at the Site (Table 9).

Table 9: Total Hazardous Materials

Material Description (Waste Stream)	Volume
Asbestos Waste	196 m^3
Liquid Organic Waste in Drums, Tanks and Pipeline	16,882 L (7,476 L of liquid organic wastes in drums, 8,056 L in tanks, and 1,350 L in pipelines)
Total Lead, Leachable Lead and PCB Paint on Equipment, Metal, Particulate Board, Wood and Metal Towers	107 m^3 of equipment, metal, particulate boards and wood and 8 m^3 of metal towers that contain total lead and leachable lead paint; 28 m^3 of equipment and wood within Building 2 (APEC 15) that contain lead and PCBs.
Total Lead and Leachable Lead Paint on Concrete	10 m^3
Total Lead and Leachable Lead Paint on Drums	339 drums (20 L and 205 L)
Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tile	18 m^3
Compressed Gas Cylinders	0.4 m^3
Fire Extinguishers	0.2 m^3
Creosote Treated Wood	3 m^3
Other Hazardous Waste	19 m^3 of solid hazardous waste; 755 L of liquid hazardous waste; 720 L of hazardous drum contents

Each of the waste streams listed in Table 9 are discussed separately in the following sections.

7.4.2 Asbestos Wastes

Asbestos is an inhalation hazard and is more of a human health hazard than a hazardous waste, but due to special handling, precautions and disposal, it is similar in nature to hazardous waste and needs to be dealt with adequately. Approximately 196 m^3 of asbestos will need to be removed and appropriately disposed of, according to the applicable guidelines (GA 2011, GN 2011a). Some mould was observed on the basement and main floor materials in Building 1. These materials will already be within containment, due to lead and asbestos abatement, but the proper mould work procedures and PPE shall be adhered to (GA 2009). There are two options for disposal of ACMs: disposal in an on-site landfill or disposal in an off-site landfill, a description of each of the options is provided below.

1. **Landfill On-Site:** Upon removal of the ACMs following applicable safe work procedures, the material is double bagged or containerized in a sound, sealable and not damaged or leaking container, in accordance with the applicable guideline. It is then placed in a known location within the landfill and the location is recorded. The steps are as follows:
   - Conduct removal of asbestos materials from the building or substrate. Asbestos is handled and removed by trained personnel following pre-determined safe work procedures and properly contained. The asbestos will be abated following low, moderate or high risk procedures as listed in the *Alberta Asbestos Abatement Manual* (GA 2011).
   - Haul asbestos to an on-site landfill, record location and cover.
2. **Remove Off-Site:** The asbestos waste would be taken to a staging area and flown off-site then transported to another suitable location for landfilling. The steps are as follows:
   - Conduct removal of asbestos waste from the building or substrate. Asbestos is handled and removed by trained personnel following pre-determined safe work procedures and properly contained. The asbestos will be abated following low, moderate or high risk work procedures as listed in the *Alberta Asbestos Abatement Manual* (GA 2011).
   - Haul contained asbestos waste to staging area. EBA recommends that if ACM waste is to be stored on-site awaiting transport, asbestos waste should be held in sealed containers to reduce the potential for unauthorized access to the asbestos waste. Waste stored in polybags has the potential to rip or degrade if left in the ambient environment causing release of the contents.
   - In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

The preferred option is to landfill the asbestos waste on-site. Removal off-site was not preferred due to high costs, hindered ease of implementation (because of logistical difficulties) and loss of natural capital associated with using fuels during transport. There will be additional logistical planning associated with transporting the asbestos waste off-site and determining landfill acceptance of the asbestos waste at a licensed disposal facility. The following are potential issues with landfilling the asbestos waste on-site:

- Permitting and community acceptance must be obtained for an on-site landfill.
- Long-term monitoring and possible maintenance will be required for an on-site landfill.

- Loss of natural capital due to the additional disturbance of the tundra for landfill and borrow.
- Asbestos can only be handled by personnel with asbestos abatement training and following safe work procedures (required regardless of the remedial option).

7.4.3 Organic Liquid Wastes in Drums, Pipelines and Tanks

Liquid diesel, Jet A, Jet B, heating oil and other organic wastes within drums, tanks and pipelines are a potential contamination of concern, if a leak develops and contents spread to underlying soil. It can also further spread by surface water flow. Previous leaks were identified by WESA and Nunami Stantec related to the pipelines and tanks (WESA Inc. 2010 and Nunami Stantec 2011). The drums can also be a hazard if under pressure and can spray if opened.

Approximately 7,476 L of liquid organic wastes in drums, 8,056 L in tanks, and 1,350 L in pipelines were present throughout and adjacent to the Site, but additional volume could still be found during remediation. There are three options for the disposal of organic liquid waste: incineration on-site, removal off-site (possibly for recycling) or reused “as-is” by local personnel. Descriptions of each option are below.

1. **Incineration On-Site:** An incinerator designed to meet Nunavut draft air quality guidelines (GN 2012) would be brought to the site and the contents of the drums, pipelines and tanks would be run through the incinerator. The steps are as follows:
   - Empty pipeline and tanks into intact, steel drums.
   - Haul drums to incinerator.
   - Run contents of drums through incinerator.
   - Perform air monitoring during the incineration to ensure compliance with applicable air emission standards.
   - Test ash for leachable metals and dispose accordingly.
2. **Remove Off-Site:** The drums, pipeline and tank contents would be placed in overpack drums and then flown off-site for transport to another suitable location for landfilling. The steps are as follows:
   - Empty pipeline and tanks into intact, steel drums.
   - Place drums in overpack containers, sample for Transportation Dangerous Goods (TDG) and waste disposal.
   - Haul to staging area.
   - In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.
3. **Remove Off-Site by/to Local Personnel:** The drums would be collected by the local personnel “as-is” and reused. The steps are as follows:
   - Contact local personnel (may or may not be put for sale).
   - Have the local personnel arrange shipment off-site, or place drum, pipeline and tank contents in overpack drum, and sample for TDG and waste disposal.

- In winter, load on cat train/snowmobile or plane and haul on winter trail to the local personnel. Or in summer, load on a boat and haul to local personnel.

The preferred option is removal of the organic liquid waste off-site by local personnel; however, some organic waste in drums may be incinerated due to the poor quality of this organic waste. Local personnel re-using the organic waste would be very cost effective and will have community acceptance (as burning is a common practice). Removal off-site was not preferred due to high costs, hindered ease of implementation (because of logistical difficulties) and loss of natural capital associated with using fuels during transport. The following are potential issues with removal of the organic waste off-site by local personnel:

- May be challenging determining who is able to use this organic waste.
- Analysis conducted on the organic waste met applicable criteria for fuel consumption (EBA 2012). Local personnel will have to accept the waste "as-is" and will be responsible for additional analysis and proposed reuse of the organic waste.
- This does not provide assurance that all the waste will be removed during remedial activities.

The following are potential issues with incineration of the organic liquid waste on-site:

- Additional logistical planning associated with obtaining the proper incinerator and transporting it to and from site.
- The equipment used is required to meet sufficient air pollution controls, specific air emission standards and will be specifically designed to safely incinerate the organic waste, according to the applicable guideline (GN 2012).
- Any organic liquid waste that does not meet the incineration guidelines will be shipped off-site for disposal at a licensed disposal facility for hazardous waste.

7.4.4 Total Lead, Leachable Lead and PCBs Paint on Equipment, Metal, Particulate Board, Wood and Metal Towers

Lead-based paint (LBP) on equipment, metal, particulate board, wood and metal towers can be a dermal and respiratory hazard and lead can leach into soil. Approximately 107 m^3 of equipment, metal, particulate board, wood and 8 m^3 of metal towers with total lead and leachable lead paint are located at the Site. In addition to that 115 m^3, there is 28 m^3 of equipment and wood with total lead, leachable lead and PCBs in paint at the Site.

There are three options for disposition of the materials with leachable lead and PCBs in paint: 1) remove the paint from the substrate on-site then crush the equipment and metal materials, compact the remaining substrate materials and landfill the substrate on-site (paint chips must be disposed of off-site); 2) remove paint from the substrate on-site, crush and compact, and take both the substrate and the paint off-site for disposal; or 3) remove all the materials, intact, for off-site disposal. Note that the Crown does not want to build an on-site landfill for hazardous waste so disposal of the paint (or other hazardous materials) on-site is not considered an option. The paint removed from the materials would have to be disposed as hazardous waste off-site.

A description of the options follows:

1. **Remove Paint and Landfill On-Site:** The lead and PCB containing paint would be removed from the equipment, metal, particulate board, wood and metal towers, they would then be crushed and compacted and placed in the landfill. The steps are as follows:
   - Separate equipment, metal, particulate board, wood and metal towers from buildings and debris areas and place the materials in one area.
   - Drain any remaining fuel/fluids from the equipment (note liquid from cleaning would need to be treated/tested for disposal).
   - Construct an enclosure over and around the materials that will sufficiently collect the paint chips and prevent them from contaminating adjacent areas.
   - Remove paint by sandblasting or scrapping and collect the sand/paint for disposal off-site in a licensed disposal facility for hazardous waste.
   - Dismantle, cut apart, crush and compact materials.
   - Sample the surrounding soil to determine that the paint did not contaminate the soil.
   - Landfill the substrate and cover. Paint chips are removed off-site to a licensed facility.
2. **Remove Paint and Dispose of Off-Site:** The lead and PCB containing paint would be removed from the equipment, metal, particulate board, wood and metal towers, they would then be crushed and compacted and then hauled off-site for disposal. The steps are as follows:
   - Separate equipment, metal, particulate board, wood and metal towers from buildings and debris areas and place the materials in one area.
   - Drain any remaining fuel/fluids from the equipment (note liquid from cleaning would need to be treated/tested for disposal).
   - Construct an enclosure over and around the materials that will sufficiently collect the paint chips and prevent them from contaminating adjacent areas.
   - Remove paint by sandblasting or scrapping and collect the sand/paint for disposal off-site in a licensed disposal facility for hazardous waste. EBA recommends that if LBP waste is to be stored on-site awaiting transport, LBP waste should be held in sealed containers to reduce the potential for unauthorized access to the LBP.
   - Dismantle, cut apart, crush and compact materials in such a way that they can be transported off-site.
   - In winter, fly the waste material off-site for shipment to an off-site licensed, disposal facility.
3. **Leave Paint On and Dispose of Off-Site:** The equipment, metal, particulate board, wood and metal towers would be taken to a staging area and then hauled off-site for disposal. The steps are as follows:
   - Separate LBP equipment, metal, particulate board, wood and metal towers from buildings and debris areas and place the materials in one area.

- Drain any remaining fuel/fluids from the equipment (note liquid from cleaning would need to be treated/tested for disposal).
- Haul the materials to the staging area.
- In winter, fly the material off-site for shipment to an off-site licensed, disposal facility.

The preferred option is a combination of leaving the paint on select substrates and disposing the paint and substrate in an off-site landfill and removing the paint on other substrates and disposing the substrate in an on-site landfill (paint is removed off-site). This is mostly dependant on the type of materials, as metal waste may act as a stronger substrate while blasting paint off, and wood or particle board may break apart during paint removal. This combination will allow for the most cost effective method within the time constraints that meet the regulatory and community requirements. Removing the paint and disposing of the waste off-site is the least preferred option, due to the high costs and difficulties with coordinating logistics (and therefore ease of implementation). The following are potential issues with the removal of paint on-site and disposing of substrates in an on-site landfill:

- Paint removal on-site may be difficult to safely implement as sand/water blasting would need to be completed in an enclosed environment following safe work procedures.
- Scrapping the paint off all materials would be extremely time consuming and may not possible within the proposed schedule.

The following are potential issues with the disposal of the painted waste off-site:

- The material has to be transported to a location where the paint can be removed and the materials disposed of in an appropriate manner.
- There will be additional logistical planning associated with transporting the large volumes of painted waste off-site.
- With both options the paint that is scraped off would require disposal off-site in a hazardous landfill following the applicable guideline (GN 2011b).
- LBP needs to be handled by personnel with lead abatement training.

7.4.5 Total and Leachable Lead Paint on Concrete

Total and leachable lead paint on concrete can be a dermal and respiratory hazard and lead can leach into soil. Approximately 10 m^3 of concrete with leachable lead paint are at the Site. There are two options for disposal of the concrete with leachable lead paint: 1) strip the paint off the concrete, leave the concrete in place and remove the paint off-site for disposal in a licensed disposal facility for hazardous waste; or 2) remove the painted concrete intact off-site for disposal in a licensed disposal facility for hazardous waste. The unpainted concrete will be left in place if it does not pose a physical hazard and is discussed in Section 7.3.3 Other Non-hazardous Materials. A description of the options follows:

1. **Remove Paint, Leave Concrete in place and Dispose of Paint Off-Site:** The LBP would be removed from the concrete, the remaining concrete would remain in place, and then this stripped paint would be hauled off-site for disposal. The steps are as follows:

- Construct an enclosure over and around the materials that will sufficiently collect the paint chips and prevent them from contaminating adjacent areas. Safe work procedures for removal of LBP must be implemented.
- Remove paint by sandblasting or scrapping and collect the sand/paint for disposal off-site in a licensed disposal facility for hazardous waste. EBA recommends that if LBP waste is to be stored on-site awaiting transport, LBP waste should be held in sealed containers to reduce the potential for unauthorized access to the LBP.
- In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

2. **Leave Paint On and Dispose of Off-Site:** The LBP would remain on the concrete and then this painted concrete would be hauled off-site for disposal. The steps are as follows:
   - Relocate the concrete to the staging area while disturbing the paint as little as possible. This may only be possible with some concrete, such as the overhead piping supports, while not possible with other concrete, such as the Building 1 basement.
   - In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

The preferred option is removing the paint from the concrete and leaving the concrete in place (the paint chips will be removed to a hazardous landfill off-site). This will allow for the most inexpensive method and effectiveness in meeting remedial goals. Leaving the paint on concrete and disposing of the concrete off-site is the least preferred option, due to the high transportation costs associated with heavy items, hindered ease of implementation (because of logistical difficulties) and loss of natural capital associated with using fuels during transport. The following are potential issues with the removal of paint on-site and leaving the concrete in place:

- Paint removal on-site may be difficult to safely implement as sand/water blasting would need to be completed in an enclosed environment following safe work procedures.
- Scrapping the paint off some materials may be time consuming.
- The paint and concrete that is scraped off would require disposal off-site in a hazardous landfill following the applicable guideline (GN 2011b).
- LBP needs to be handled by personnel with lead abatement training.

7.4.6 Leachable Lead Paint on Drums

Leachable lead paint on drums can be a dermal and respiratory hazard and lead can leach into soil. Approximately 337 drums (205 L) and 2 drums (20 L) with leachable lead paint are at the Site. There is only one option for disposal of these drums: crush the drums on-site and remove the drums off-site for disposal in a licensed disposal facility for hazardous waste. Removing the paint and disposal of the drums in the on-site landfill was not considered due to time constraints and the labour intensive nature of the task. A description of the option follows:

1. **Remove Off-site:** The hazardous waste would be taken to a staging area, crushed and then hauled off-site for disposal. The steps are as follows:

- Haul the drums to the staging area.
- Construct an enclosure over and around the materials that will sufficiently collect the paint chips and prevent them from contaminating adjacent areas.
- Clean the inside of the drums and crush.
- In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

The following are potential issues with the disposal of the drums off-site:

- The paint that may fall off during the crushing has to be collected and removed off-site to a licensed disposal facility for hazardous waste following the applicable guideline (GN 2011b).
- LBP needs to be handled by personnel with lead abatement training.

7.4.7 Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tiles

Asbestos is an inhalation hazard and is more of a human health hazard than a hazardous waste, but due to special handling, precautions and disposal, it is considered hazardous waste and needs to be dealt with adequately. Leachable lead paint can be a dermal and respiratory hazard and lead can leach into soil. Approximately 18 m^3 of LBP on asbestos panels and ceiling tiles will need to be removed and appropriately disposed of, according to the applicable guidelines (GN 2011a, GN 2011b). There are two options for disposal of asbestos and LBP containing materials: 1) remove the paint on-site then landfill the asbestos waste on-site; or 2) remove all the materials, intact, off-site. A description of the option follows:

1. **Remove Paint and Landfill On-Site:** The lead paint would be removed from the ceiling tiles and panels within the asbestos containment. They would then be double bagged and placed in the on-site landfill. The steps are as follows:
   - Within the proper containment, remove paint by sandblasting or scrapping and collect the sand/paint for disposal off-site in a licensed disposal facility for hazardous waste.
   - Conduct removal of ACMs from the building or substrate. Asbestos is handled and removed by trained personnel following safe work procedures and properly contained. The asbestos will be abated following low, moderate or high risk work procedures as described in the *Alberta Asbestos Abatement Manual* (GA 2011).
   - Landfill and cover.
2. **Remove Off-Site**: The asbestos would be removed, contained and then hauled to a staging area and fly the material to Saskatchewan for further shipment to an off-site licensed, disposal facility. The steps are as follows:
   - Conduct removal of ACM and lead waste materials from the building or substrate. Asbestos and lead painted waste is handled and removed by trained personnel following safe work procedures and properly contained. The asbestos will be abated following low, moderate or high risk work procedures as described in the *Alberta Asbestos Abatement Manual* (GA 2011). EBA recommends that if ACM/LBP waste is to be stored on-site awaiting transport, ACM/LBP waste should be held in sealed containers to reduce the potential for unauthorized access to the ACM/LBP.

- Haul to staging area.
- In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

The preferred option is leaving the paint on the asbestos panels and tiles and disposing of it off-site. This will allow for the most cost effective method within the time constraints that meets the regulatory and community requirements. Removing the paint and disposing of the waste on-site is the least preferred option, due to the high costs and difficulties with coordinating logistics (and therefore ease of implementation). As well, paint removal by hand may be too time consuming and paint blasting methods would disturb the materials and create elevated levels of asbestos airborne fibres. The following are potential issues with the disposal of the painted waste off-site:

- There will be additional logistical planning associated with transporting the volumes of lead painted, asbestos waste off-site.
- Asbestos and LBP can only be handled by personnel with asbestos and lead abatement training (required regardless of the remedial option).

7.4.8 Compressed Gas Cylinders

Compressed gas cylinders are a hazard due to the potential of a catastrophic leak which can propel the cylinders at a high speed. Depending on the type of gas, the gas itself may be flammable or explosive. Approximately four cylinders (estimated 0.4 m^3 of pressurized gas) are known to be present; others may be found during remediation (Photo H-29). All were intact, one appeared to contain some unknown content (based on weight), one was inaccessible due to unsafe building conditions and the remaining two appeared to be propane (based on the shape of the tank). No attempt was made to open the cylinders, due to the safety concerns associated with unknown pressurized gases. The contents are to be considered hazardous until the contents can be safely identified. There are two options for disposal of compressed gas cylinders: 1) depressurization and then disposal in an on-site landfill; or 2) disposal in an off-site landfill. A description of each of the options follows:

1. **Landfill On-Site**: The cylinder would be depressurized, evacuated, and placed in the landfill. The cylinder would then be covered. The steps are as follows:
    - If the content is known, depressurize, evacuate, landfill and cover.
    - If content is not known, or should not be depressurized (e.g., chlorofluorocarbons [CFCs]), a specialist will depressurize, evacuate and landfill.
    - If the content is known and contents cannot be depressurized on-site, the cylinder will be placed in an approved container and shipped off-site with the content to a licensed landfill.
2. **Remove Off-Site:** The cylinder would be depressurized as above and then hauled off-site for disposal. The steps are as follows:
    - If the content is known, depressurize, and evacuate. If the content is known, and the shipping company approves the conditions of the cylinder, the cylinder can be shipped with the content.

- If the content is known and contents cannot be depressurized on-site, the cylinder will be placed in an approved container and shipped off-site with the content.
- If content is not known, a specialist will depressurize, and evacuate.
- Haul to staging area.
- In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility. The cylinders may or may not be hazardous, depending on if they were depressurized.

The preferred option is to landfill the compressed gas cylinders on-site. Removal off-site was not preferred due to high costs, hindered ease of implementation (because of logistical difficulties) and loss of natural capital associated with using fuels during transport. The following are potential issues with landfilling the waste on-site:

- Permitting and community acceptance must be obtained for an on-site landfill.
- Long-term monitoring and possible maintenance will be required for an on-site landfill.
- Loss of natural capital due to the additional disturbance of the tundra for landfill and borrow.
- Some content is unknown, and some known contents in cylinders may not be safely depressurized on-site. There will be additional logistical planning associated with transporting the waste off-site or evacuating the cylinders in these circumstances following the applicable guidelines (GN 2010a, GN 2011c).

7.4.9 Fire Extinguishers

Fire extinguishers are a hazard due to the hazardous chemicals that are within the extinguisher. This is dependent on the type of fire extinguisher. Eleven fire extinguishers (containing ODS, CO_2 and dry chemical) totalling approximately 0.2 m^3 were inventoried throughout the Site, others (with content) may be buried under debris (Photo H-47). Note: if the extinguishers are empty, they are not considered hazardous waste and can be landfilled on-site. There are two options for disposal of the fire extinguishers: 1) either disposal in an on-site landfill; or 2) disposal in an off-site landfill. A description for each of the options follows:

1. **Landfill On-Site**: The landfill would be built as previously described. The content in the fire extinguishers would be evacuated and the canisters placed in the landfill and covered. The content would be disposed off-site at a licensed disposal facility.
2. **Remove Off-Site:** The fire extinguisher would be hauled off-site for disposal. The steps are as follows:
    - If the content remaining in the extinguisher contains ODS, then the contents cannot be evacuated.
    - If there is content remaining in the extinguisher, and the shipping company approves the conditions of the extinguisher, it can be shipped with the content.
    - Haul to staging area.
    - In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

The preferred option is to landfill the fire extinguishers on-site. Removal off-site was not preferred due to high costs, hindered ease of implementation (because of logistical difficulties) and loss of natural capital associated with using fuels during transport. The following are potential issues with landfilling the waste on-site, similar to other hazardous materials:

- Permitting and community acceptance must be obtained for an on-site landfill.
- Long-term monitoring and possible maintenance will be required for an on-site landfill.
- Loss of natural capital due to the additional disturbance of the tundra for landfill and borrow.
- Some known contents in fire extinguishers may not be safely depressurized on-site (ODS containing), therefore, there will be additional logistical planning associated with transporting the waste off-site or evacuating the fire extinguishers in these circumstances following the applicable guidelines (GN 2010a, GN 2011c).

7.4.10 Creosote Treated Wood

Creosote is primarily composed of polycyclic aromatic hydrocarbons (PAHs) (up to 90%), tar acids, and tar bases which can leach into the surrounding environment. It has been determined that this product is toxic to the environment and is a dermal hazard (EC 2004). Due to this special handling required, precautions and disposal, it is similar in nature to hazardous waste and needs to be dealt with adequately.

Approximately 3 m^3 of creosote treated wood beams and wood pieces were inventoried on the Site (Photo H-31, H-58). There are two disposal options for this creosote treated wood: 1) wrap the wood in polyethylene and dispose of in an on-site landfill; or 2) dispose off-site in a regulated disposal facility.

1. **Landfill On-Site:** Conceptually, a landfill could be built as previously described. The steps are as follows:
   - Conduct the separation of creosote treated wood from buildings and removal from debris areas.
   - Haul to staging area.
   - Wrap the wood securely in polyethylene sheets.
   - Haul materials to an on-site landfill, compact and cover.
2. **Remove Off-Site:** The creosote treated wood would be hauled to a staging area and removed off-site for disposal. The steps are as follows:
   - Conduct the separation of creosote treated wood from buildings and removal from debris areas.
   - Haul to staging area.
   - Wrap the wood securely in polyethylene sheets.
   - In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

The preferred option is to landfill on-site. It has the highest acceptance for cost, effectiveness, community and regulatory acceptance and natural capital. The following are potential issues with landfilling the creosote treated wood on-site:

- Permitting and community acceptance must be obtained for an on-site landfill.
- Long-term monitoring and possible maintenance will be required for an on-site landfill.
- Loss of natural capital due to the additional disturbance of the tundra for landfill and borrow.

7.4.11 Other Solid and Liquid Hazardous Waste

Various solid hazardous waste represent different kinds of hazards. ODS are hazardous to the atmosphere and ozone layer. The remaining types of hazardous waste generally present an environmental hazard by leaching into the surrounding soil or water and ingestion, inhalation or dermal hazards to wildlife and humans. Other solid hazardous wastes inventoried on the Site include: batteries and battery electrolyte (Photo H-26), which contain acids and lead; mercury vapour in fluorescent lights and elemental mercury in thermostats; PCBs in light ballasts (Photo H-19); PCB, tantalum, lead and mercury solder in electrical parts (Photo H-21, H-22); lead solder on copper pipes; leachable lead in cast iron pipe seals (Photo H-17) and lead cables; leachable lead paint cans; ODS within a freezer; oil absorbent; and an unknown crystallized, white material (Photo H-15). As well, there are various containers of miscellaneous oils/fuels/lubricants, and chemicals which we have classified as hazardous as detailed chemical analysis has not been completed. Approximately 19 m^3 of other solid hazardous waste exists in the materials listed above.

Approximately 1,475 L of liquid hazardous waste exists and includes: 755 L as battery electrolyte; miscellaneous chemicals, miscellaneous oil/lubricants/fuels and paint; and 720 L as flammable, clear liquid and green liquid drum content. There is only one option for disposal of this other solid and liquid hazardous waste: Disposal off-site in a licensed disposal facility for hazardous waste, according to the applicable guideline (GN 2010b, GN 2010c, GN 2011c, GN 2011d, GN 2011e, GN 2011f). A description of the option follows:

1. **Remove Off-Site:** The hazardous waste would be taken to a staging area and then hauled off-site for disposal. The steps are as follows:
   - Separate the materials from the buildings and debris areas.
   - Haul hazardous materials to staging area.
   - Contain the materials for transport.
   - In winter, fly the material off-site for further shipment to an off-site licensed, disposal facility.

The following are potential issues with removal of other hazardous waste off-site:

- The amount of solid hazardous waste should be taken out by aircraft and following TDG by air regulations, if required.

The following are potential issues with the disposal of the hazardous waste off-site:

- The hazardous waste will be handled properly, following GN and other federal guidelines (regardless of remedial option).
- The various hazardous wastes have to be labeled and packaged properly for transport, following TDG Regulations.

- There will be additional logistical planning associated with transporting a variety of hazardous wastes off-site.

7.5 Hydrocarbon-Impacted Soils

Based on the findings of the Phase III ESA (EBA 2012) there is an estimated volume of 2,146 m^3 of Type B hydrocarbon contaminated soil requiring remediation. These volumes are based upon the AMSRP guidelines and defined in the Phase III ESA (EBA 2012). For remediation, the AMSRP guidelines are defined based on vertical depth below ground surface and proximity to water as discussed in Section 6.1, and presented in Table 4. Figures 4 to 8 show the areas of contamination. Photos of the contaminated areas can be found in Appendix C, Photos E1 to E30.

Based upon the Phase III ESA, there are 13 APECs identified areas requiring remedial action. Table 10 summarizes the volume of impacted material by APEC.

Table 10: Type B Hydrocarbon Contamination Volumes

APEC	Vertical Depth of Contamination (mbgl)	Within 30 m of waterbody (Y/N)	Type B Hydrocarbon Volume (m^3)
1	2.5	N	33
2	1	N	12
3	1.8	N	156
4	2.5	N	76
8.1	1.35	N	17
8.2	2.5	N	121
12	2.5	N	1039
13.1	1	N	38
13.2	2.5	N	60
15	1.5	N	11
20.1	2.5	Y	479
20.2	2.5	Y	103
22	0.5	N	0.5
		Total	**2,146**

7.5.1 Potential Remedial Options

As part of remedial option analysis for PHC contaminated soils, six options were evaluated: 1) remove from site; 2) landfarm on-site; 3) chemical oxidation; 4) thermal desorption; 5) alluing; or 6) natural attenuation with monitoring. The current project schedule has remedial activities to be complete by March 2016. This is an aggressive schedule for soil remediation so multiple options were considered; discussion on the options is provided to assist contractors in determining the most appropriate means to meet the remedial objectives of the project.

These options are described in further detail below.

1. **Remove Off-Site:** The PHC contaminated soils (>AMSPR guidelines) would be consolidated for transport from the site to a licensed disposal facility. The contaminated soils would be placed into bulk transport containers following excavation so that they are able to be handled when it is time for shipping. The steps are as follows:
   - Excavate impacted material from specified areas and package for transport according to TC TDG regulations. The excavation work would be completed during the summer.
   - Haul impacted material to staging area.
   - Materials would be loaded onto a plane and moved off-site in the winter. The soil would then be transported to a licensed disposal facility with appropriate waste manifests and landfill approvals.
   - Re-contouring and re-vegetation would be completed as required in areas of excavation.

This option requires the completion of an on-ice runway with significant air traffic to meet the remedial objectives. Heavy equipment to move contaminated soil from the site would be needed for movement of soil. An estimated 200 flights with heavy aircraft are required to remove the entire amount of contaminated material. Significant costs are anticipated with this remedial option.

2. **Landfarming On-Site**: This option involves construction of a land treatment area (LTA). Nutrients would be added and the soil tilled and aerated on a regular basis volatize light end PHCs, to introduce oxygen and promote biodegradation. Bioremediation as a treatment option for PHCs in the arctic is appealing due to remoteness and site restrictions to other treatment technologies. Concerns for this option include low soil temperature, moisture content, nutrient limitation, alkalinity and accumulation of acidic metabolites such as aliphatic acids produced during alkane degradation (Aislabie et al. 2006, SAIC 2006).

   The average optimum soil temperature for biodegradation of PHC is usually between 15°C and 30°C; it may be impractical to reach temperatures above 10°C in the Arctic (Thomassin-Lacroix et al. 2002). Thus, a focus is usually on optimizing nutrient availability and moisture content of the soil for optimum microbial degradation. The optimum levels of soil water for hydrocarbon ranges between 30% and 80% field capacity (Walworth et al. 1997). The remedial objectives can be achieved within three to five seasons. Due to the timelines required by PWGSC and AANDC, a combination treatment may be required to achieve the remedial objectives, and special permission beyond March 2016 may be needed if remedial targets are not met.

   Landfarming would require that the contractor construct one or more treatment facilities to store and treat the PHC contaminated soils. Given the limited warm season at the site, chemical oxidation, alluing, disc aeration and/or nutrient optimization should be considered in conjunction with the landfarm remedial option. Alluing and chemical oxidation are also discussed as potential options, further in this section.

The steps for landfarming are as follows:

- Construction of a LTA with an impermeable liner and perimeter berms. Groundwater monitoring wells should be included to ensure the integrity of the impermeable liner. Construction of the LTA is discussed in detail in Section 9.5.
- Excavation and hauling of PHC contaminated soils to the LTA during the summer.
- Treatment and tillage of contaminated soils; to be most effective soils should be no greater than 0.3 m thick. Demarcation of the impermeable liner is needed to ensure that it is not damaged during treatment. Treatment including chemical oxidants, nutrients and aerating should be considered to meet the remedial targets within the defined remedial period.
- Collection and submission of analytical samples from the LTA to quantify the level of contamination, nutrient and microbial levels, and determine need for additional treatment.
- Once the soils are successfully remediated, LTA reclamation activities may include grading to promote natural drainage of water, seeding and if required, fertilization. The artificial liner will be removed prior to reclamation. Due to the timeline required for remediation, soil will be regraded to a natural grade in place as remedial activities will be complete on-site. If landfarmed on IOL, soil will be removed and regraded to natural surroundings off IOL land.

This remediation has been proven to be effective in northern climates; however, the time line for completion is weather dependent. Specialized equipment for seaming of the liner may be required. Also large machinery will be required for landfarm construction. All excavations will need to be filled in and/or contoured to be safe for Hunters and Trappers Organization (HTO) and other visitors to the Site. This option requires additional disturbance to the natural surrounding areas.

3. **Chemical Oxidation:** A specialized product such as sodium permanganate, potassium permanganate or hydrogen peroxide would be added to the impacted soil and mixed. The chemical product would react with the hydrocarbons producing carbon dioxide (CO2) and water (H2O) as well as smaller hydrocarbon chains, which would be more amenable to biodegradation and volatilization. Sometimes chemical oxidants are mixed with a slow-release oxygen product (available commercially, such as Regenesis ORC®), which promotes biodegradation by maintaining an aerobic environment. The steps are as follows:

   - Set up treatment area; this may consist of a soil or geosynthetic liner.
   - Excavate soil and treat on-site; treatment rates would be determined by manufacturer of the chemical oxidant.
   - Allu soil and chemical oxidant and sample after a suitable length of time to determine hydrocarbon levels.
   - Collection and submission of analytical samples to quantify the level of contamination and determine need for additional treatment.

Chemical oxidation is a proven technology for the remediation of hydrocarbons in southern climates. The technology will work in cold climates but reactions are somewhat related to temperature, provided the soil is not frozen. It also requires intensive management in order for it to be effective. Note that no effective treatment can be obtained with frozen soils. The remediation can be nearly immediate with hydrogen peroxide, but is dependent on soil chemical contact. The chemicals are highly reactive and dangerous to handle and transport. There may be other chemical adverse effects, such as changes to soil salinity which can be detrimental to plant growth or soil organisms. Impact of residual chemicals on permafrost is unknown. Chemical oxidation in cold regions has been shown to have a drastic effect on subsurface micro-biota and an increase in subsurface soil temperature (due to the exothermic breakdown of hydrocarbons) (Fergusson 2004). Short-term post-remediation may show a reduced likelihood of recovery due to the subsurface impacts associated with chemical oxidation.

Reagents can be costly, and may require specialized equipment to implement. Due to the project timelines established by PWGSC and AANDC, this option was not included in the scoring but should be considered as part of a landfarm treatment method to expedite remediation. If using chemical oxidation in conjunction with other methods it is import to note that this treatment will kill natural occurring bacteria, limiting the effectiveness of bioremediation. Without further study, chemical oxidation timelines cannot be established. It is recommended that bench scale tests be completed if using this option.

4. **Thermal Desorption**: Low temperature thermal desorption technology is an innovative soil remediation process which involves an ex-situ means of physically separating volatile and semi-volatile organic contaminants from soils. During the first stage, contaminated soil is placed in the primary chamber of the mobile thermal treatment unit, and heated to volatilize the associated hydrocarbons, removing the toxins from soil as a gas stream. At the second stage, the clean soil exits the primary chamber. The gas stream containing the volatilized petroleum hydrocarbons and dust and fine particulates is then passed through a high-surface area filtration unit, where dust and particulates are removed. In the final stage, these gases travel to a secondary chamber (oxidation chamber) where the hydrocarbon molecules are turned into carbon dioxide and water. The treated soil is then returned to the original excavation-site after it is re-hydrated and cooled. The steps are as follows:

   - Mobilization/Set up of equipment on-site. The equipment required generally includes; a skid mounted thermal plant with a portable system and feed bin, screening unit, counter flow dryer, oxidizer and baghouse, heat exchanger, soil conditioner, scrubber, discharge belt, control house, controls, starters, and generator.
   - Excavation of contaminated material to a staging area.
   - Thermal desorption using the unit.
   - Testing to ensure soil has been remediated and can be re-distributed.
   - Replacement of soil into excavation following hydration.

This remediation technique is effective but requires specialized knowledge of operation. Large machinery will be required for the movement of soil. Excavations will need to be filled in and/or contoured to be safe for people that use the area. Thermal desorption is not weather dependent, but requires emissions monitoring and a fuel cache for operation.

5. **Alluing:** Alluing is the mechanical process of mixing the soil and volatilizing light end hydrocarbons to reduce soil PHC concentrations contamination from soil. This method of remediation has been adopted

for several federally owned contaminated sites in the Northwest Territories and Nunavut. The process is temperature dependent and requires additional time for multiple aerations. This process has been excluded as an individual option for remediation due to the unknown time required for remediation. This option should be considered as a combination to landfarming to increase the remedial efficiency. The steps for alluing soil are as follows:

- Mobilization of an allu-bucket or fixed allu screen to site for set up;
- Excavation of contaminated soil in staging area;
- Screening of soil through the allu-bucket/fixed screener to mix and volatilize hydrocarbons;
- Testing to ensure soil meets guidelines; and
- Replacement of soil into excavations post-remediation or into landfarm treatment unit.

This remediation technique is effective in reducing hydrocarbons but due to temperature dependence is not effective as a primary remedial technique. Alluing is also not effective with large chain hydrocarbons as they do not volatilize. Alluing can be considered as a remedial counterpart for increasing landfarm efficiency, but was excluded as a stand-alone remedial technique due to the levels of F3 PHCs in the soil.

6. **Natural Attenuation with monitoring:** Due to the long timeline required for remediation, natural attenuation and long-term monitoring was not included on the option analysis for soil remediation.

7.5.2 Remedial Option Analysis

For the purposes of assessing options, removal off-site, landfarming and thermal desorption have been chosen as these methods can meet the remedial goals of the project and are remedial strategies for northern contaminated sites. Chemical oxidation and alluing are anticipated to be secondary options to primary treatment. They were determined to be incapable of meeting the remedial targets as stand-alone remedial options and were not assessed independently during the option analysis.

Cost of Remediation

Landfarming is anticipated to be the most cost effective remedial option. Additional costs regarding secondary treatment (alluing/chemical oxidation/off-site removal of highly contaminated soils) and an extension beyond 2016 may be required to achieve the remedial targets. The cost for removing soil off-site is high due to the flight costs and the construction of an extended season ice-runway. An expanded fuel cache to meet the demands of flights for this option would be required, further increasing the cost. Thermal desorption will require significant costs associated with logistics and the establishment of a fuel cache for the operation of the unit. Specialized training is required for the operation of a thermal desorption unit. Thermal desorption will have significant costs associated with the operation and maintenance of the unit.

Effectiveness in Meeting Remedial Goals

The most effective option to meet the remedial goals is to excavate the contaminated soil and remove it off-site for disposal in an appropriate landfill facility. This option results in the complete removal of the source and associated environmental liabilities. Thermal desorption is considered the second most appropriate method as contaminants will be broken down and completely remove contamination. The efficiency of the process is unknown as it is dependent on soil type, operating conditions and manufacturer type but all contamination is removed from the soil. Landfarming is considered the third most appropriate option as hydrocarbons will biodegrade and be chemically broken down, depending on the strategy utilized.

Timeframe for Remediation

Excavating and removing hydrocarbon contaminated soils for off-site disposal is considered the most time effective, as it is anticipated that this option will require one year to complete including off-site transport via airplane on the winter ice strip. Thermal desorption is anticipated to take two years to complete based upon the average unit specifications, but is dependent on the type of equipment and soil conditions encountered. As landfarming is anticipated to require two to five years from set-up and implementation until residual concentrations meet site-specific remedial goals, the on-site landfarm option is considered least effective. PWGSC have stated a remedial target date of March 2016, special consideration and approval beyond this date would need required. All efforts to meet the remedial date should be made. Landfarming in combination with alluing, nutrient enrichment and chemical oxidation will reduce the amount of time required for remediation.

Ease of Implementation

Landfarming is considered to have the greatest ease of implementation as soils do not have to be removed from site and there is limited specialized knowledge post construction required. Thermal desorption is anticipated to rank second in ease of implementation as specialized training and set up is required to operate the unit. The equipment is also required to be mobilized to and from site. Removal off-site is anticipated to be the most difficult to implement as a winter ice-strip is required to move an estimated 200 loads of impacted soil to achieve the remedial goals.

Regulatory Acceptance

The most regulatory acceptable option is considered to be the landfarming option, as this option has been successfully implemented at other northern remediation-sites (e.g., Colomac and DEW lines) to treat hydrocarbon impacted soils. This option can also be submitted for regulatory approval using well-developed regulatory processes within the land use permitting approval process. Off-site removal of contaminated soils will have the same level of regulatory acceptance, as all risks associated with soil contamination are removed from the Site. Specialized Transport Canada regulations may be required for intensified on-ice landings during the remediation. Thermal desorption is anticipated to have moderate acceptance from regulators, as incineration will require special permits and/or air monitoring requirements.

Community Support

Removal off-site is anticipated to have the highest level of community acceptance. It is anticipated that the community would support the landfarming option as this has been successfully implemented, with community support, at other northern remediation-sites. Thermal desorption is expected to have some community support, however, this may be perceived as a new technique by the community, and not widely used in northern remediation.

Loss of Natural Capital

All three remedial options will result in a loss of natural capital. Thermal desorption will have the least amount of disturbance as soil that is remediated through this method can be replaced back into the excavation after analytical testing. Removal off site will require borrow sources to replace the removed soil and landfarming will cause the greatest disturbance as an area will need to be developed for the LTA. The amount of new disturbance during landfarming will depend on the ability to utilize previously disturbed sites as well as using the treated soil for backfill, so that undisturbed areas do not need to be used for borrow/backfill purposes.

7.5.3 Preferred Remedial Option

The preferred remedial option is landfarming, the overall cost is less than thermal desorption and removing soil off-site. Landfarming is effective in meeting remedial targets and has a greater ease of implementation. Landfarming has historically been used in northern climates and is anticipated to be met with regulatory acceptance and community support.

Thermal desorption has a series of unknown variables, as it is equipment dependent and has logistical and cost challenges regarding mobilization and the establishment of a fuel cache. Removal off-site can meet all of the goals of the project within the required timelines but will have significant costs due to transport and licensed landfill fees. Cost was the primary driver in the selection of landfarming as the preferred option.

Landfarming Considerations

One item that needs to be considered using landfarming as the preferred option is the level of F3 PHCs in some of the impacted areas. F3 contaminated soils take more time to treat than F1 or F2 impacted soils. Homogenization of this soil with other less impacted soil may lead increase treatment times and time to reach remedial goals. Areas that have high levels of F3s that may be difficult to treat using only landfarming are provided in Table 11.

Table 11: Areas of Concern That May Not Be Landfarm Treatable Based on F3 Concentrations

APEC	Maximum Level of F3 Hydrocarbons (mg/kg)	Potential Volume of Impacted Soil (m^3)
2	11,300	12
13.2	22,000	60
15	10,800	10
20.1	34,600 (50,900 F2)	389
	Total	**471**

Based upon the levels of F3 contamination there are 471 m^3 of soil which may not be land treatable within project timelines. These levels of F3 contamination can be treated more aggressively within a separate LTA or disposed of alternately (removal off-site). If these soils are homogenized with the other soil streams, the resulting homogenization may cause all soil to have a prolonged remedial timeline extending beyond the project timeline. Emphasis is to meet the remedial targets for March 2016. Special consideration and approval is required by PWGSC and AANDC to extend the remedial targets for the LTA beyond 2016.

A combination of alluing, nutrient optimization (determined by bench scale testing), and chemical oxidation should be considered to meet the remedial completion date of this heavily contaminated material. Removal off-site of the heavily contaminated soils in Table 11 or a secondary LTA with an aggressive treatment frequency will increase the ability to meet remedial objectives. A combination of the following additional treatment options should be considered to optimize the LTA efficiency.

Additional Treatments

- Alluing:

  Alluing should be conducted continually to homogenize soil and provide aeration to increase the efficiency of the LTA. This method has been adopted on northern contaminated sites and has shown success in the reduction of volatile organic carbons and light chained fuels. Alluing is only efficient during the summer period when temperatures are above 10°C. A designated allu-bucket or free standing allu unit with a dedicated front-end loader would be used to continually aerate the soil from a stock pile into the LTA. The addition of nutrients or chemical oxidants to optimize the aeration and dispersion could be included with this process.

- Nutrient Optimization:

  Nutrient optimization should be considered to obtain the maximum levels of bio-degradation as part of the landfarming. Nutrient availability can be increased through the use of inorganic fertilizers such as slow release urea (46-0-0) and monoammonium phosphate (11-52-0). Studies have shown that fertilizing with both N (nitrogen) and P (phosphorus) have the greatest stimulation for microbial degradation of PHC (Braddock et al. 1997; Thomassin-Lacroix et al. 2002). However, there are concerns when using fertilizers, particularly for this site where the soils are sand to loamy sand. Sand and loamy sand have lower water holding capacities and are more sensitive to over-fertilization with inorganic N. In sandy soils, fertilization concentrations should not exceed 100 mg N/kg soil and 50 mg P/kg soil (McCarthy et al. 2004; Walworth et al. 1997). Too high of fertilization rates can reduce the water potential and create toxic conditions for microorganisms. In addition, too high of soil moisture can reduce oxygen available for microbes to degrade contaminants (McCarthy et al. 2004). Over-fertilization can cause changes in soil pH, particularly in coarse textured soils, as they have a lower buffering capacity. To counter this change in soil pH, limestone can be added to neutralize the changes in soil pH, maintaining optimum conditions for microbial populations (Brady and Weil 1999; Pierzynski, et al. 2005). Lower soil pH can also cause dissolution of metals, increasing the availability of metals such as iron, magnesium and zinc into the soil (Brady and Weil 1999). It is recommended that bench scale tests be conducted prior to remediation to determine nutrient optimization.

- Chemical Oxidation:

  Chemical oxidants can be considered an option to increase the efficiency of the landfarm; however it is important to ensure that secondary CCME/AMSRP criteria for SAR and electrical conductivity are not exceeded. The primary method of chemical oxidation is the use of hydrogen peroxide (H_2O_2). Hydrogen peroxide is an oxidizing agent that would liberate PHC in the soil by electro-oxidation. The efficiency of PHC reduction is a function of temperature and oxidizing agent/surfactant concentration (Filler et al. 2009). The concerns with using H_2O_2, include an initial reduction in soil pH and potential effect on the microbial community. A study in Antarctica found the total microbial population to drop below detection levels for one year but over three years returned to over 1,400% of the pre-treatment level. The pH change was just slight (from 9.2 to 8.4) on fluvial modified glacial deposits (Ferguson et al. 2004). An additional consideration with using chemical oxidation is the potentially high cost of the product and amount of product used to remediate to a guideline level of 2,500 ppm. We currently estimate over 400 m^3 of Type B hydrocarbons (with concentrations up to 51,000 ppm for F2 and 30,000 ppm for F3) that will be difficult to landfarm (Table 11). If these levels were present throughout all the soil, an approximate up-scaled cost for chemical oxidation is $2M. The unit cost substantially decreases with lower PHC concentrations, due to less oxidizing agent for remediation. For example to remediate 2,200 m^3 of soil from 4,000 ppm to 2,500 ppm would cost approximately $400,000. It is recommended that bench scale tests be conducted prior to remediation to determine appropriate application of chemical oxidants. Also, chemical oxidations should be considered as a final treatment in landfarming, as the oxidants will kill microbes that are within the soil.

In loamy sand to sandy soils, organic carbon tends to be lower than finer textured soils. For chemical oxidation this does not impede the oxidizing agent instead it may increase its effectiveness, since there is less organic carbon for the oxidizing agent to bind to. As for the organic carbon for fertilization there is no census on the optimum carbon (C) to N ratio for enhancing biodegradation of hydrocarbons. The optimal C:N ratio range is from 200:1 to 9:1.

- Nutrient and Chemical Oxidation Combination Approach

  There is a potential to use both fertilization and oxidation to remediate this site. To optimize the use from both oxidizers and fertilizers, two or more landfarms (or areas with the landfarm) could be used to segregate the lower contaminated soils from the higher contaminated soils. Because fertilizers are generally less expensive, but slower acting than oxidizers, it is more cost effective to start with fertilization of the landfarm to lower the contamination levels and degrades the most readily available carbon. The oxidizing agent can be applied at the end of the process to remediate the remainder of PHCs. However, the concerns outlined above (changes in soil moisture, pH and microbial populations) are still a concern that need to be addressed before, during and after remediation.

Other Considerations

There is a significant amount of clean overburden within APEC 12 and APEC 20 that will need to be stockpiled on-site. In addition to the clean overburden, clean soil will need to be excavated to ensure safe access into the excavations (estimated to be 2.5 m deep). Demarcation of the overburden amounts, as well as the area needed for ingress and egress are shown on Figure 9. Estimated volumes of clean material are provided in Table 12 below.

Table 12: Volumes of Clean Soil to be Stockpiled

APEC	Soil Amounts
12	Overburden: 304 m^3
	Egress: 660 m^3
20.1	Overburden: 97 m^3
	Egress: 448 m^3
Total	**1509 m^3**

7.6 Metal Impacted Soils

The Phase III ESA identified a single area of metal impacted soil (antimony and lead) in APEC 15, Figure 7 that is a result of battery disposal. The APEC is shown in Photos E16 to E18. The total volume of impacted material is 0.5 m^3. This volume was identified in the Phase III ESA (EBA 2012).

Metals may migrate in soils and they pose a risk to ecological receptors. Based upon the volumes identified in the ESA there are two remedial options for metal contaminated soils: 1) disposal in a lined landfill on-site; or 2) disposal off-site. A description of each of the options follows:

1. **Landfill On-Site:** Conceptually, an inert landfill could be constructed on-site as described in Section 9.4. For landfilling on-site, laboratory analysis is required to ensure that the metals identified are not leachable. In the event that leachable results are above the Government of Nunavut's environmental guideline for Industrial Waste Discharges into Municipal Solid Waste and Sewage Treatment Facilities (GN 2011g), all impacted metal soil will have to be disposed of off-site.

   The steps are as follows:

   - Excavate impacted soil.
   - The total excavation would generate a volume of 0.5 m^3 of impacted soil. Send sample for leachable analysis to determine if acceptable for on-site landfill.
   - Landfill and cover impacted soil.

2. **Remove Off-Site:** The metal contaminated soils could be consolidated for transport from the site to a licensed disposal facility. The contaminated soils would need to be placed into bulk transport containers following excavation so that they are able to be handled when it is time for shipping. The steps are as follows:

   - Excavate impacted material from specified areas and package for transport.
   - Haul impacted material to staging area.
   - Materials would be loaded onto a plane via the winter ice strip or transferred to Ennadai Lake Lodge in the winter for transport via the camps runway. The type and number of loads required for hauling contaminated soils from the site would be dependent on the method of bulk storage and transport that was selected by the contractor.

Removal off-site is the preferred remedial option. It was the highest ranked for effectiveness, regulatory and community acceptance, and timeframe. However, if the metal contaminated soil meets landfill criteria for leachable metals, if could easily be added to the landfill, with minimal work. The following are potential issues with removing the hydrocarbon soil off-site:

- Volumes of soils are estimated at just over 0.5 m^3. If this volume increases, the economics of removing soil off-site will change resulting in a re-analysis of the remedial stream. The costs are exponential per flight for disposal of soil.
- All of the soil should be acceptable for disposal in a licensed disposal facility subject to landfill characterization. Waste manifests, and off-site landfill approval is required before removing the contaminated soil from the property, as per the Government of Nunavut waste transfer guidelines defined in the Contaminated Site Remediation Guidelines (GN 2009).

7.7 Physical Hazards

Physical hazards are considered to be man-made structures; openings and other features that could constitute a risk to humans. There are four physical hazards that exist: 1) buildings and metal towers that are on-site that are dilapidated and present a risk of collapse (Buildings 3 and 4 are structurally unsound) and other buildings have weathered floors and ceilings; 2) steep sand slopes throughout the site; 3) debris areas (most notably at APEC 28) that contain debris that will have to be removed (e.g., nails, broken glass and other sharp objects); and 4) wires, cables and other items that create a tripping hazard are throughout the site (but concentrated around the building cluster).

Demolishing metal towers and buildings will remove this hazard. Two metal towers are intact (adjacent to Building 2 and Building 9). They will require careful demolition to prevent the disturbance and removal of lead paint. Thirteen buildings on-site are intact, and will require demolition prior to disposal on-site, these are: Buildings 1 to 9, in APECs 14-22, the Medium Cabin (APEC 6), the Small Cabin (APEC 7), the Pumphouse (APEC 29) and Building 10 (APEC N/A). However, hazardous wastes should be removed in Buildings 3 and 4 before demolition can occur. These two buildings shall be reinforced and safe for personnel to conduct asbestos abatement and hazardous waste removal prior to demolition. The concrete basement (Building 1) and concrete floors (Buildings 2, 5 and 9) may present a physical hazard following building demolition. Where approved, this concrete can be broken apart or perforated to create a free draining condition to allow vegetation to be established and then covered with materials conductive to vegetation growth. This may also occur on other concrete debris throughout the site.

A specific safety plan will have to be completed for handling hazardous materials, re-enforcing buildings, removal of debris that is located on steep slopes, sorting of material in the debris areas and avoiding slips, trips and falls due to unearthed cables. This will include, but not be limited to type and placement of equipment and proper safety gear for people working in these areas.

8.0 RECOMMENDED REMEDIAL OPTIONS

8.1 Summary

EBA proposes that all solid non-hazardous waste (with the exception of burnable wood), lead painted substrates following paint removal, asbestos waste, empty compressed gas cylinders, empty fire extinguishers, and creosote treated wood be landfilled on-site, as opposed to being transported off-site. The option of air transporting this waste off-site, then ground transporting to an appropriate landfill will be more costly than landfilling the waste on-site. Landfill construction and long-term monitoring will be the primary issue with this option.

Organic liquids will be incinerated on-site or removed by local personnel off-site. Other hazardous materials would be removed from site.

Metal contaminated soil would be removed from site. Hydrocarbon impacted soil above AMSRP guidelines will be landfarmed on-site with special considerations to soil in Table 11. A summary of proposed recommended options for this site is provided in Table 13.

Table 13: Summary of Recommended Remedial Options

Issue	Recommended Option	Description
Wood Waste: Non-Hazardous	Control burn on-site	Wood waste can be dealt with by controlled burning on-site, on-site disposal in a landfill or off-site disposal to an approved facility.
Other Waste: Non-Hazardous	Landfill on-site	Non-hazardous solid waste will need to be separated, compacted and moved to the on-site landfill.
Asbestos Waste: Hazardous	Landfill on-site	Asbestos waste will be handled by trained personnel and moved to the on-site landfill.
Liquid Organic Wastes in Drums, Tanks and Pipeline: Hazardous	Remove off-site and incinerate on-site	Organic liquid waste will be removed off-site and re-used "as-is" by local personnel, with the exception of the drum content that is in poor condition and will be incinerated on-site. Those not meeting the incineration criteria will be shipped off-site.
Total Lead, Leachable Lead and PCB Paint on Equipment, Metal, Particulate Board, Wood and Metal Towers: Hazardous	Combination of remove off-site and landfill on-site	Lead and PCB painted waste will be stripped and handled by trained personnel. The cleaned substrate will be moved to the on-site landfill, with the exception of the softer painted substrates, which will be removed to a Class 1 landfill off-site.
Total Lead and Leachable Lead Paint on Concrete: Hazardous	Remove paint and remain in place	Lead painted concrete will be stripped and handled by trained personnel, the remaining concrete will stay in place, and the stripped paint will be removed to a Class 1 landfill off-site.
Total Lead and Leachable Lead Paint on Drums: Hazardous	Remove off-site	Lead painted drums will be handled by trained personnel and crushed under proper containment. The crushed drums and any remaining paint chips will be removed to a Class 1 landfill off-site.

Table 13: Summary of Recommended Remedial Options

Issue	Recommended Option	Description
Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tile: Hazardous	Remove off-site	Lead painted and asbestos panels and tiles will be handled by trained personnel and removed off-site to a Class 1 landfill.
Compressed Gas Cylinders: Hazardous	Evacuate and landfill on-site	Depressurize, crush and landfill on-site. Known contents that cannot be safely depressurized will be shipped offsite in an approved container, following landfill and shipping company approval.
Fire Extinguishers: Hazardous	Evacuate and landfill on-site	Depressurize, crush and landfill on-site. Known contents that cannot be safely depressurized will be shipped offsite in an approved container, following landfill and shipping company approval.
Creosote Treated Wood: Hazardous	Landfill on-site	Creosote treated wood will be wrapped and landfilled on-site.
Other Hazardous Waste	Remove off-site	Miscellaneous solid hazardous waste (batteries, light ballasts, electrical parts, ODS, lead seals, etc.) and miscellaneous hazardous liquid waste (battery electrolyte, chemicals, oil/lubricants/fuels and paint and flammable drum content) will be removed off-site to a Class 1 landfill.
Metal-Impacted Soil	Remove off-site	Remove off-site to an approved landfill, will require waste characterization.
Hydrocarbon- Impacted Soil	Landfarm	Landfarming of impacted soil will be conducted with special consideration to soil in Table X. May require special permission if remediation required beyond March 2016.
Physical Hazards	Remove all metal towers and buildings and develop site-specific safety plans	Each hazard will need to be identified and properly mitigated prior to work commencing. Proper personal protective equipment to be worn at all times.

Recommendations for each of these waste streams are discussed further in the subsequent sections.

8.2 Non-Hazardous Waste

For **non-hazardous wood waste** at the site, EBA recommends the following steps be taken:

- Remove all hazardous materials from the buildings on-site. Asbestos and lead abatement and handling should be conducted by trained professionals following safe work procedures.
- Remove all non-wood waste and move to the on-site landfill.
- Demolish buildings, photograph and document.
- Remove wood to an area, ideally where there is little vegetation.

- Conduct a controlled burn within an approved container, under careful supervision, and at a time of year when moisture conditions are higher and there is a low likelihood of causing a tundra fire. Fire suppression equipment should be at hand when the controlled burn takes place and air monitoring should be conducted. Conduct the burn according to the applicable guideline (GN 2012).

For **other solid non-hazardous waste** at the site, EBA recommends the following:

- Conduct the separation of non-hazardous materials from buildings and removal from debris areas.
- Clean drums and tanks and remove residual fluids/fuels from machinery.
- Cut up the tanks; crush the metal debris, drums and machinery.
- Haul materials to an on-site landfill, compact and cover.

8.3 Hazardous Waste

For **asbestos waste** at the site, EBA recommends the following:

- Follow appropriate work procedures as outlined in *Alberta Asbestos Abatement Manual* (GA 2011) when the risk level has been identified, i.e., low risk, moderate risk or high risk.
- Some mould was observed on the basement and main floor materials in Building 1. These materials will already be within containment, due to lead and asbestos abatement, but the proper mould work procedures and PPE shall be adhered to (GA 2009).
- Abate ACM at the sites using trained abatement workers utilizing the appropriate risk level, according asbestos guidelines.
- Asbestos must be wetted and double bagged in approved asbestos disposal bags and sealed with duct tape. The exterior of the bags must be cleaned with a damp cloth or HEPA vacuum prior to removing from work area.
- Haul materials to an on-site landfill and cover, according to the applicable guideline (GN 2011a).
- Conduct the required inspections and air monitoring during and post abatement. Ensure asbestos removal, prior to any demolition being carried out.

For **organic liquid wastes** in drums, tanks and pipeline at the site, EBA recommends the following:

- Incineration on-site following approved procedures for all wastes that cannot be removed off-site and re-used by local personnel.
- Complete air quality monitoring while this process is occurring, for predetermined parameters according to the applicable guideline (GN 2012).

For **total and leachable lead paint** on equipment, metal, particulate board, wood and metal towers at the site, EBA recommends the following:

- Separate equipment, metal, particulate board, wood and metal towers from buildings and debris areas and place the materials in one area.

- Drain any remaining fuel/fluids from the equipment (note liquid from cleaning would need to be treated/tested for disposal).
- Construct an enclosure over and around the harder painted waste, that will sufficiently collect the paint chips and prevent them from contaminating adjacent areas, following appropriate work procedures (GN 2011b, SSPC 2012).
- Remove paint by sandblasting or scrapping and collect the sand/paint for disposal off-site in a licensed disposal facility for hazardous waste.
- Dismantle, cut apart, crush and compact materials.
- Sample the surrounding soil to determine that the paint did not contaminate the soil.
- Compact, landfill and cover.
- Wrap the softer painted substrates intact with 6 mil polyethylene sheets and remove them, along with the lead paint chips generated from the abatement to an off-site facility to landfill (following TDG 1992, GC 2006).

For **total and leachable lead paint on concrete** at the site, EBA recommends the following:

- Construct an enclosure over and around the materials that will sufficiently collect the paint chips and prevent them from contaminating adjacent areas, following appropriate work procedures (GN 2011b, SSPC 2012).
- Remove paint by sandblasting or scrapping and collect the sand/paint for disposal off-site in a licensed disposal facility for hazardous waste.
- The remaining stripped concrete stay in its current location.

For **leachable lead paint on drums** at the site, EBA recommends the following:

- Clean the inside and crush the drums.
- Remove to an off-site licensed disposal facility for hazardous waste (following TDG 1992, GC 2006).

For **total and leachable lead paint on asbestos** panels and ceiling tiles, EBA recommends the following:

- Conduct removal of asbestos and lead waste materials from the building or substrate following safe work procedures as per applicable regulations. Asbestos and lead-painted waste is handled and removed by trained personnel and properly bagged.
- Haul to staging area for removal to an off-site landfill (following TDG 1992, GC 2006).

For **compressed gas cylinders and fire extinguishers** at the site, EBA recommends the following:

- A specialist will vent the known or unknown contents on-site.
- Displace to the on-site landfill.

- Known contents that cannot be safely vented on-site (containing ODS) will be removed in an approved container as per TDG by air regulations to an off-site licensed disposal facility for hazardous waste (following TDG 1992, GC 2006).

For **creosote treated wood** at the Site, EBA recommends the following:

- Conduct the separation of creosote treated wood from buildings and removal from debris areas.
- Wrap the wood securely in 6 mil polyethylene sheets.
- Haul materials to an on-site landfill, compact and cover.

For **other solid and liquid hazardous waste** at the site, EBA recommends the following:

- Collect solid and liquid hazardous waste and remove to an off-site licensed disposal facility for hazardous waste (following TDG 1992, GC 2006).

8.4 Metal Impacted Soil

For remediation of metal-impacted soils at the site, EBA recommends the following:

- Excavate all metal impacted soil and conduct confirmatory sampling of base and adjacent soil boundaries to ensure all impacted soil has been removed.
- Metal impacted soil is removed off-site to a licensed disposal facility.

8.5 Hydrocarbon-Impacted Soil

For remediation of hydrocarbon-impacted soils at the site, EBA recommends the following:

- Excavate all hydrocarbon impacted soils and conduct confirmatory sampling of base and adjacent soil boundaries to ensure all impacted soil has been removed.
- Landfarm to meet remedial targets. Special consideration to heavily contaminated soil is required to meet remedial objectives. Permission is required (if needed) to extend landfarm remediation beyond March 2016.

9.0 GEOTECHNICAL CONSIDERATIONS

9.1 Ennadai Lake Trail Network

There are a number of trails on the esker complex and adjacent glaciofluvial deposits at the Ennadai Lake site. The trail system is shown in Figure 3. The existing trails are poorly defined, mostly unvegetated, and composed of loose, well-drained sand (Photos G1 to G5). Some of the trails are on steep slopes. At the time of EBA's field program in August 2012, the trails were trafficable by ATVs.

A trail network connects the main site to all of the proposed landfill locations, Landfarm 1, and Borrow Sources B1, B2, B5, and B7. All APECs can be accessed through this trail network except for APEC 22 – a small metal building (Building 9) with upright tower – which is located northwest of the main site, approximately 60 m east of Ennadai Lake. The terrain surrounding APEC 22 is organic and not easily trafficable, so access to this APEC must be considered. There is no well-utilized trail between the main camp site and the airstrip; however, a trail network at the airstrip connects Landfarm 2, and Borrow Sources B4, B6, and B8. The selected contractor should evaluate the existing trails to determine if upgrading is required to support larger equipment.

New haul roads would likely need to be constructed to access borrow sources, and the landfill and landfarm areas, and might also be needed to avoid using existing trails which are on steep and unsafe slopes. A new road connecting the main site to the airstrip could be routed from the east side of Borrow B1 to the west side of Landfarm 2. A new road could be routed along the southern edge of Borrow B2 to access Landfarm 1, Borrow B2 and B7 without traversing the steep slopes on the esker complex. A road across the drainage channel between the main site and Landfill 1 could be developed to avoid steep slopes, but would require a culvert across the channel. General routes of the potential new roads are presented in Figure 3.

Any new roads should consider waterbodies, springs, restricted areas, and steep slopes that are susceptible to erosion and potentially unsafe. Roads should also avoid organic terrain where permafrost and poorly-drained conditions were observed. Organic terrain is identified on Figure 3. In general, road development should be kept to a minimum to minimize site disturbances. Vegetation on the existing trails is distressed and has not recovered even after 33 years since site-abandonment.

9.2 Airstrip

There is a sand and gravel airstrip on the esker about 800 m northeast of the site (Photos G6 to G10). The airstrip lies entirely on IOL, and is approximately 40 m (130 feet) wide, 375 m (1,230 feet) long and slopes gently (2%) to the east (Figure 3). The airstrip is not apparent on the 1957 air photos. Dean Carter and Brandon Kotulak, pilots with Arctic Sunwest Charters, visually assessed the airstrip. Both thought the airstrip would be suitable for Twin Otter or Beaver landings, provided the plane had proper tires and that a site reconnaissance (preferably by foot access from a float plane) was done prior to a landing attempt.

The airstrip alignment extends to the west approximately 360 m. This area is about 30 to 40 m wide and slopes gently to the west, and consists of exposed sand with some gravel, occasional cobbles and boulders at the surface. Some areas have been colonized by grasses and there are several debris items in the area as well. This area also lies on IOL and is not suitable for aircraft landings in its current condition. This is the site proposed for Landfarm 2. Construction of Landfarm 2 in this area would prevent the extension of the airstrip to the west, and the presence of heavy equipment in this area might restrict use of the airstrip. The airstrip would require upgrading to support larger planes.

9.3 Borrow Sources

Eight potential borrow sources (B1 to B8) were investigated during the field program. A detailed description of the eight borrow sources is presented in the Phase ESA III (EBA 2012). For the RAP, Borrow B3 was eliminated and the extent of Borrow B4 was reduced because of nearby archaeologically restricted areas. Only the available borrow sources are presented in the RAP, and these are shown on Figure 10.

The thickness of the borrow sources is unknown, but a thickness of 2.0 m was assumed for calculating the estimated volume of available granular material for most of the sources, except B7 and B8. The estimated volumes and characteristics of the granular material are summarized in Table G-1 in Appendix D. The lab test results are also presented in Appendix D, along with Table G3 summarizing the testpits, collected samples and geotechnical lab test results. Three types of material are proposed for construction of the landfill and landfarm – oversize material (cobbles and boulders) for erosion control on the landfill side slopes, well-graded sand and gravel for construction of the berms for the landfill and landfarm, and bedding sand for the landfarm to protect the liner system. The specifications for these materials is provided in Section 9.4.3

An existing trail network connects the main site, the proposed landfill locations, Landfarm 1, and Borrow Sources B1, B2, B5, and B7. A separate trail network at the airstrip connects Landfarm 2, and Borrow Sources B4, B6, and B8.

Borrow 1 (B1) – B1 is a rounded hill located approximately 200 m northeast of the site (Photos G11 to G13). This source contains approximately 21,500 m^3 of material and the testpits encountered sandy gravel and silty sand material. The sandy gravel material is appropriate for the construction of the berms for the landfill and landfarm, but some of the material is too fine (silty) to meet the material requirements (Appendix D). The material in B1 could be used to backfill areas where contaminated soil has been extracted. The quantity and accessibility of the material in B1 as well as its proximity to proposed landfill locations make it a favourable material source. However, development of this source might be limited because it is close to the spring and it is partially situated on IOL. Development of B1 requires further delineation of appropriate materials within this source, and consideration of IOL and proximity of the spring.

Borrow 2 (B2) – B2 is a long east-west trending ridge approximately 230 m south of the site (Photos G14 to G16). B2 contains approximately 26,100 m^3 of sand and gravel appropriate for the construction of the berms for the landfill and landfarm (Appendix D). Development of B2 is restricted by the presence of waterbodies to the north. To avoid disturbance of the waterbodies, granular material should only be extracted from the south side of B2. This would require a haul road to be built through undisturbed terrain.

Borrow 4 (B4) – B4 is a flat-topped ridge of glaciofluvial material that lies approximately 1,200 m east-northeast of the site (Photos G17 and G18). B4 contains approximately 11,400 m^3 of gravel and sand to gravelly sand appropriate for the construction of the berms for the landfill and landfarm (Appendix D). This borrow source lies close to waterbodies, a spring, and a restricted area. B4 is also furthest from any of the potential landfill or landfarm locations, and development of this source would require extraction equipment to use the airstrip. For these reasons, B4 may not be developed.

Borrow 5 (B5) – B5 is the main ridge of the esker deposit and is located approximately 100 m south of the site (Photos G19 to G22). The eastern extent of this borrow source intersects the Environment Canada Weather Station-site. B5 contains at least 40,000 m^3 of sand, ranging from gravelly to silty sand (Appendix D). The surface of B5 is unvegetated and already disturbed, but the steep side-slopes are vegetated and might be susceptible to erosion if disturbed. Bedding sand could be extracted from the disturbed surface of B5 but disturbance of the side slopes is not recommended.

Borrow 6 (B6) – B6 is a rounded hill located approximately 650 m east of the site (Photos G23 to G26). B6 is assumed to contain approximately 9,000 m^3 of sand and gravel appropriate for the construction of the berms for the landfill and landfarm (Appendix D). This source is accessible, well-defined, and has minimal vegetation cover. Although B6 lies near a restricted area, the restricted area is about 3 to 5 m higher in elevation and probably would not be disturbed by development of B6. Area B6 appears to contain additional volumes of granular material if enlarged to the east, but this should be confirmed prior to construction. Development of B6 is recommended.

Borrow 7 (B7) – B7 is an undisturbed, low-lying till deposit located approximately 420 m southeast of the site (Photos G27 and G28). B7 is believed to contain approximately 27,900 m^3 of gravelly sand with some silt, appropriate for the construction of the berms for the landfill and landfarm (Appendix D). This potential borrow source covers a large area so development should target a specific area of the source to minimize overall terrain disturbance. Also, B7 is 30 % covered with boulders generally between 0.3 and 1.5 m diameter, and the majority of this material is partially embedded in the gravelly sand matrix. This oversize material is appropriate to use for erosion control on the side slopes of the landfill. However, harvesting of the oversize material will be labour intensive and will cause terrain disturbance, as boulders exposed at the surface would need to be individually extracted with the backhoe. Development of B7 should only proceed with further delineation of appropriate material for erosion protection and extraction should be targeted in locations where ground disturbance would be minimized.

Borrow 8 (B8) – B8 is a low-lying till deposit located approximately 750 m northeast of the site (Photos G29 to G30). B8 contains approximately 6,300 m^3 of sand and gravel with some cobbles and silt, appropriate for the construction of the berms for the landfill and landfarm (Appendix D). The surface of B8 is vegetated and undisturbed, and is about 30% covered with boulders typically between 0.3 and 1.5 m diameter. The majority of this material is partially embedded in the sand and gravel matrix. The oversize material is appropriate to use for erosion control on the side slopes of the landfill. However, harvesting of the oversize material will cause terrain disturbance and will be labour intensive, as boulders exposed at the surface would need to be individually extracted with the backhoe. Development of B8 should only proceed with further delineation of appropriate material for erosion protection and extraction should be targeted in locations where ground disturbance and disturbance to the nearby waterbodies would be minimized.

9.3.1 Summary

An estimated total of 142,200 m^3 of granular material appears to be available within seven borrow sources. Approximately 82,000 m^3 of sand and gravel appropriate for the construction of the landfill and landfarm berms appears to be available in Borrow Sources B2, B4, B6, B7, and B8, and approximately 40,000 m^3 of bedding sand appears to be available in Borrow B5. Riprap for erosion control is not readily available at the site, but some boulders can be harvested from areas B7 and B8.

It is prudent to note that the materials at depth in these sources may differ from that observed in the shallow hand dug testpits, and the sources investigated may extend deeper than the depths assumed in this report, consequently additional material volumes may be available.

9.4 Non-Hazardous Landfill

As part of the planning process, it was necessary to identify disposal options including on-site disposal of non-hazardous material. A non-hazardous landfill could be constructed for the disposal of non-hazardous waste collected from the site during clean-up and building demolition waste.

9.4.1 General

Non-hazardous landfills are above ground facilities constructed of a granular fill perimeter berm with a minimum 1.0 m thick granular fill cover. The landfill is not designed to freezeback the waste materials. Granular fill is mixed between subsequent layers of waste to fill voids and minimize settlement.

The solid waste to be contained within the non-hazardous landfill would consist of inert, non-leachable wastes including: asphalt shingles, rubber, concrete, insulation and particulate boards, plastic, windows, fibreglass insulation, styrofoam, textiles, porcelain, and empty crushed drums of varying sizes. All drums will have residue removed and crushed to minimize volume in the landfill.

9.4.2 Location

Four locations were evaluated for the non-hazardous landfill as shown in Figure 10, and summarized in Table G-2 in Appendix D. Photos G31 to G39 show the potential landfill locations. A detailed description of each potential landfill site is presented in the Phase ESA III (EBA 2012). The locations were evaluated based on their dimensions, foundation conditions, topography, proximity to waterbodies and restricted areas, proximity to work areas, level of disturbance and accessibility. Landfill 1 is not recommended because of its proximity to the spring, and the presence of poorly-drained organic terrain overlying permafrost at this site. Landfills 3 and 4 are not large enough areas to accommodate the required landfill and their size is restricted by steep-sides slopes that are not easily modified. Landfill 4 is also close to waterbodies.

Landfill 2 is preferred for the non-hazardous landfill. Landfill 2 is located approximately 240 m east of the site (Figure 10). The area identified is approximately 3,600 m^2; 70 x 50 m. This potential landfill area is well-drained, and slopes gently to the east (Photos G33 to G35). Borrow B1 lies to the northwest of Landfill 2, and the north side of the area is partially vegetated. The surface consists of exposed sand and gravel with patches of vegetation. At the eastern extent of Landfill 2 there is an accumulation of metal, glass, and wood debris. There are small stockpiles of granular material and disturbed areas which suggests that this area might have been used as a borrow source when the site was active. The site consists of well-drained silty sand with a trace of gravel, and permafrost was not encountered to depths of 1.0 m. The footprint for the landfill design is presented in Figure 11. Landfill 2 is judged to be an acceptable site because of its location and site conditions.

9.4.3 Granular Fill Types

One type of granular fill (Type 1) is required for the construction of the non-hazardous landfill. Granular fill Type 1: Well-Graded Sand and Gravel would be used for construction of the landfill berms, cover, and the intermediate fill between the layers of waste. Type 1 granular fill can be obtained from Borrow Sources B2, B6, B7, and B8. The gradation limits for Granular Fill Type 1 are listed in Table 14.

Table 14: Recommended Particle Size Distribution Limits for Granular Fill Type 1: Well-graded Sand and Gravel

Particle Size (mm)	Percent Passing
200	100
50	60 to 100
5	40 to 75
0.425	10 to 40
0.08	5 to 15

9.4.4 Construction

The conceptual steps to construct a non-hazardous landfill for the site are as follows:

- Survey landfill footprint and elevations.
- To maintain the landfill base elevation, the landfill area (i.e., 11.4 m by 11.4 m) will require cut and fill earthwork and will be constructed on Elevation 335.45 m.
- Excavate suitable landfill construction material and haul to site.
- Construct landfill perimeter berms to design elevations (Type 1), while leaving an access corridor.
- Install up-gradient and down-gradient groundwater/leachate monitoring wells and conduct baseline soil and water sampling.
- Place waste in 0.5 m lifts separated by 0.15 m intermediate cover (Type 1) and compact; place lifts to design height.
- Cover with a minimum 1 m of Type 2 granular fill.

9.4.5 Landfill Design Options

EBA evaluated two design options for the non-hazardous landfill based on anticipated non-hazardous waste quantities. The first consisting of approximately 850 m^3 of waste including wood debris and the second consisting of approximately 350 m^3 of waste excluding wood debris. These volumes are based on crushed volumes provided in the EBA Phase III ESA (EBA 2012). Note that the volumes presented Sections 7.3 and 7.4 are uncrushed volumes. Based on the November 13, 2012 email from Mr. Michael Bernardin, EBA understands that untreated/unpainted wood will be incinerated on-site in a controlled manner. Upon completion of wood incineration, ash will be landfilled. Therefore, the landfill design is based on approximately 350 m^3 of waste excluding wood debris. The proposed non-hazardous waste landfill conceptual design and the landfill model are shown in Figure 12.

Design and Granular Fill Quantities

Since wood debris will likely be burnt on-site, the crushed volume of reject materials is approximately 350 m^3. A conceptual design of the landfill will consists of three layers of waste. The waste is to be placed in 0.5 m lifts with a 0.15 m intermediate lift of fill between the two layers of waste for a total thickness of 1.8 m. The following table summarizes the landfarm dimensions and the granular fill quantities.

Footprint (inside toe of berms)	11.4 x11.4 m
Footprint (outside toe of berms)	Approximately 30.6 x 32.5 m
Height of berms	Ranging from 1 to 2.5 m
Type 1 – Well-graded Sand and Gravel Quantity including 1 m cover	$\approx$ 1,800 m^3 (in place)

9.5 Landfarm for Hydrocarbon Contaminated Soil

Soils containing hydrocarbon contamination in excess of AMSRP standards will be treated within an on-site landfarm facility. Landfarming is an effective and simple method for remediating PHC contaminated soil and is a practical option for many remote locations.

9.5.1 General

Landfarms are above ground facilities constructed for remediating contaminated soils through aeration and biological processes. Contaminated soil is spread in a thin layer (approximately 0.3 m thick), and is then periodically tilled, together with other factors, to stimulate aerobic microbial activity.

The waste to be contained in a landfarm at Ennadai Lake would include petroleum hydrocarbon (PHC) contaminated soil fractions F1 to F3 as defined in the Canada-Wide Standard (CWS) for Petroleum Hydrocarbons in Soil (CCME 2008).

The landfarm would need to slightly sloped so that there is drainage into one area, and designed so that leachate could be collected.

9.5.2 Location

Two sites were assessed for potential landfarm locations as shown in Figure 10, and summarized in Table G-2 in Appendix D. A detailed description of the potential landfarm locations is presented in the Phase III ESA (EBA 2012). The areas identified are approximately 11,000 m^2 (105 x 105 m) for Landfarm 1 and 10,700 m^2 (60 x 180 m) for Landfarm 2 (Photos G40 to G44). Landfarms 1 and 2 are 450 and 550 m from the site respectively. Landfarm 1 is vegetated and mostly undisturbed, and is 30% covered with boulders typically between 0.3 and 1.5 m diameter. Landfarm 2 lies on IOL, and is relatively level, well-drained and slopes gently to the west with exposed sand and some gravel, occasional cobbles and small boulders at the surface. Roads will need to be constructed for both sites to allow access for heavy equipment.

The locations were evaluated based on their dimensions, foundation conditions, topography, proximity to waterbodies and restricted areas, level of disturbance and accessibility. Although both sites are acceptable locations for a landfarm, Landfarm 1 is on undisturbed terrain and has considerable boulder coverage on the surface that would have to be cleared prior to constructing the landfarm. Landfarm 2 is the preferred location and is presented on Figure 11. Landfarm 2 is on disturbed sandy terrain that could be easily graded.

9.5.3 Granular Fill and Liner Material Quantities

As discussed in Section 9.4.3, Type 1 granular fill material consisting of well-graded sand and gravel with trace to some silt can be used for the construction of landfarm berms. The Landfarm will be a lined facility using a 60 mil HDPE geomembrane protected on either side with a non-woven geotextile, as presented on Figure 13. After the 60 mil HDPE and non-woven geotextile is installed within, then Type 2 granular fill material (bedding sand) should be placed overtop to protect the liner system from tilling or turning events during nutrient application. It is recommended that a layer of burlap or equivalent material be placed over the sand bedding to provide demarcation between the contaminated soil and bedding material.

The landfarm dimensions are based on approximately 2,860 m^3 of PHC contaminated soil including a 30% bulking factor. The following table summarizes the landfarm dimensions and the granular fill quantities.

Footprint (inside toe of berms)	9,600 m^2 (i.e., approximately 98 by 98 m or 50 by 192 m)
Footprint (outside toe of berms)	12,000 m^2 (i.e., approximately 110 by 110 m or 60 by 200 m)
Footprint of berms	2,400 m^2
Height of berms	1 m
Type 1– Well-graded Sand and Gravel	$\approx$1,700 m^3
Type 2 – Bedding Sand	$\approx$2,900 m^3

The required Type 1 well-graded sand and gravel could be sourced from Borrow Areas 2, 4, 5 and 7. The quantity of 60 mil HDPE geomembrane liner is approximately 13,600 m^2, and approximately 27,200 m^2 of non-woven geotextile fabric will be required to protect the liner.

10.0 SITE REQUIREMENTS FOR REMEDIATION

A camp and other facilities will need to be constructed as part of this remediation plan and equipment will need to be brought to site.

10.1 Camp

For the remediation at Ennadai Lake, a camp will need to be set up sufficient distance away from the site to ensure workers are not affected by hazards and contamination. Two sites were identified as potential locations for construction camps (Figure 3). Camp 1 is located northwest of the airstrip, and west of a small lake. This site could be used if the airstrip was used to access the site. Camp 2 is located south of the western point of the esker on the shore of Ennadai Lake. This site could be used if the site was access primarily by boat or float plane. The camp will need to house workers and will need to meet the specifications laid out by PWGSC and Workers Safety and Compensation Committee. Facilities that will be required include the following:

- Sleeping quarters;
- Office (also contains communications area);
- Kitchen and dining area;
- Bathroom and showers;
- Laundry facilities;
- First aid facilities (may depend on the number of workers);
- Sewage lagoon or water treatment system;
- Incinerator;
- Mechanics and equipment area that would also have a petroleum and lube containment area, tanks and drums;
- Water supply and pumps;
- Diesel powered generator and back-up; and
- Emergency shelter.

10.2 Expected Contracting Equipment Necessary for Site

Anticipated equipment needs for this project are:

- Excavator(s) to remove contaminated soils for treatment and for use in trail and/or road improvements;
- Front end loader(s) to consolidate materials and for trail and or road improvements;
- Haul truck(s) to move materials to staging and treatment areas;
- Waste incinerator(s) (both for the camp waste and for incineration of certain materials currently located on-site);
- Aqueous liquid waste treatment system to treat aqueous liquids for on-site disposal;
- Dozer (s) to be used for landfill/landfarm construction and road improvements;
- Smooth drum compactor for landfill/landfarm construction;
- Water truck to haul water to camp if required or for dust suppression;
- Waste compactor;
- Drum crusher;
- All-terrain vehicle (s) with trailers;

- Packer to ensure compaction is appropriate with the natural terrain;
- Ice runway (flooding equipment);
- Generators (for remedial equipment); and
- Other miscellaneous equipment determined by contractor.

11.0 VERIFICATION AND POST REMEDIATION LONG-TERM MONITORING PROGRAM

11.1 Verification and Monitoring During Remediation Activities

Verification and monitoring of construction works, environmental clean-up, verification of quantities and quality of work will need to be carried out during the remediation phase of this project (INAC 2008). Skill sets needed include residential engineering experience, hazardous materials testing and abatement, environmental health and safety monitoring, soil sampling, and geotechnical and materials testing. The following work tasks will need to be performed:

Disposition of Non-Hazardous Waste

- Ensuring removal of all hazardous materials from dump sites and buildings prior to removal or demolition of buildings.
- Removal of all non-wood materials that is not hazardous from buildings and verification of hauling to on-site landfill.
- Verification of clean-up of all debris areas and hauling to on-site landfill.
- Verification of building demolition, wood collection from buildings and debris areas and removal to burn area. Supervision of controlled burn with air monitoring. Sampling and testing of ashes if necessary. Removal of ashes either off-site or to on-site landfill.
- Photo documentation and surveying of above activities where applicable.

Hazardous Materials Testing and Abatement

- Supervision and air monitoring of asbestos and lead paint abatement and verification of contractor activities against applicable regulations for such work.
- Testing of liquid in drums or other containers for TDG and disposal options.
- Supervision and verification of depressurization and evacuation of cylinders and fire extinguishers.
- Testing of solid suspected hazardous materials to determine appropriate disposition.
- Verification of appropriate storage of hazardous waste in temporary storage area until shipment.
- Verification of shipments including waste manifests and quantities of materials off-site.

Remediation of Impacted Areas

- Sampling beneath and adjacent to metal/hydrocarbon impacted soil areas to ensure complete removal.
- Baseline soil sampling of temporary storage area, camp area, sewage lagoon, incinerator areas, fuel and lube oil storage facilities, camp area, and mechanics area.
- Baseline groundwater sampling and documentation of well installation and stratigraphy of boreholes for areas around landfarm.
- Verification of manifests for impacted soil that goes off-site.
- Photo documentation and surveying of above activities where applicable.
- Monitoring of construction of landfill/landfarm, materials testing and borrow development.
- Conduct grain size distribution testing and moisture density relationship tests of borrow material proposed for any site construction.
- Verification of quantities taken from borrow area.
- Compaction monitoring.

11.2 Post-Remediation Long-Term Monitoring Program

If the preferred remedial options for all the waste streams are implemented, long-term monitoring will only be required for the landfill.

In the event that a landfarm is constructed as proposed as the preferred option to remediate the hydrocarbon impacted soils, minimum bi-annual monitoring will be required during landfarm operations. It is anticipated that the landfarm would be in operation for two to three years. Once the soils were remediated to applicable criteria, the liner will be removed and the soil re-contoured requiring no further monitoring. Special permission for remediation beyond March 2016 is required.

12.0 CLOSURE

We trust this report meets your present requirements. Should you have any questions or comments, please contact the undersigned at your convenience.

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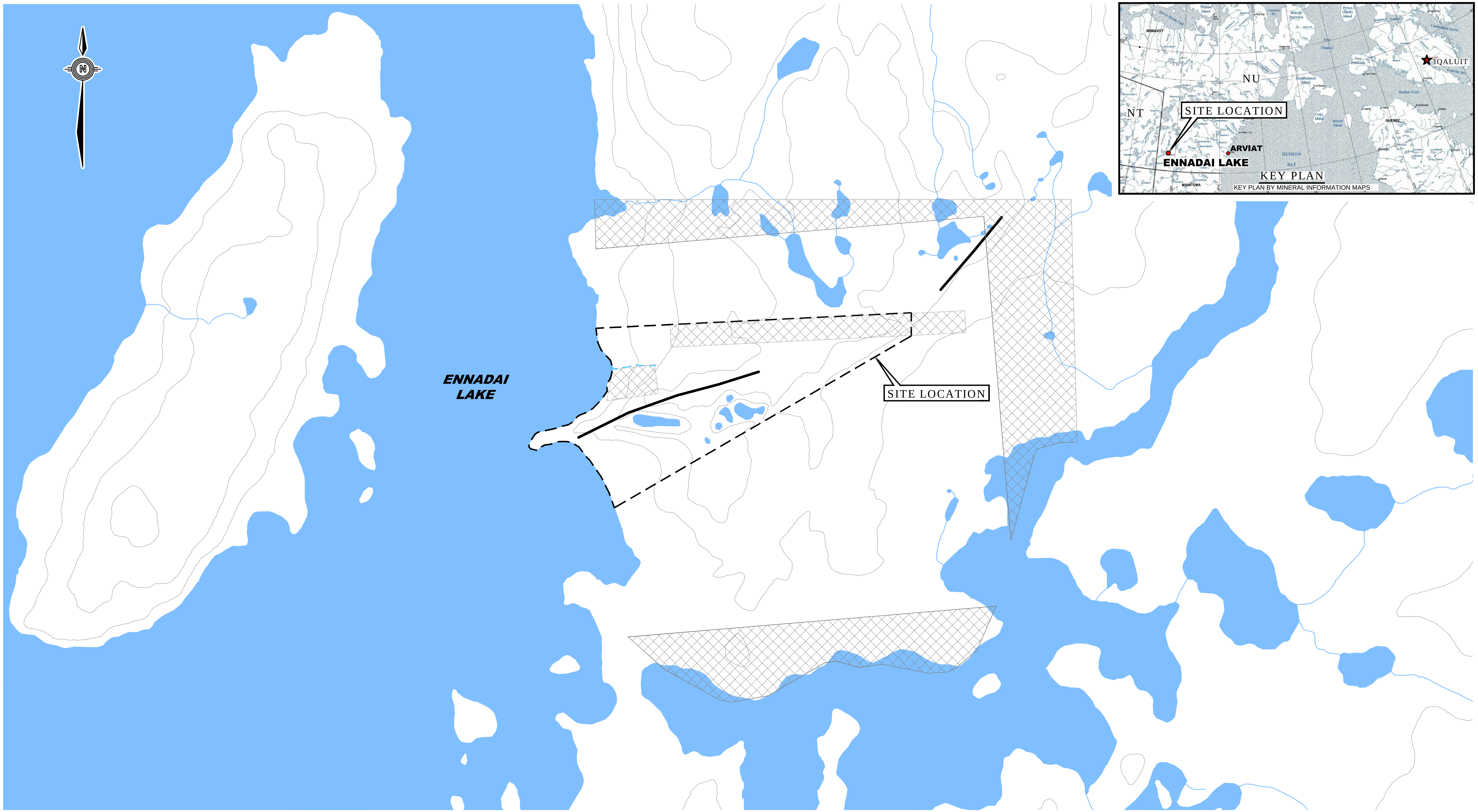
FIGURES



LEGEND:

- INUIT OWNED LAND
- ESKER

NOTE:

LOCATION OF INUIT OWNED LAND WAS PROVIDED BY AANDC AND MAY EXTEND BEYOND BOUNDARY SHOWN

0 500 m

Scale: 1: 15 000

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REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

SITE LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
Y22101286	MM/EL	KO	0

OFFICE	DATE
EDM	November 2012

Figure 1

Q:\Edmonton\Drafting\PROJECTS\Y221\Y22101286 Ennadai\Autocad\RAP\Y22101286_Figure 1 RAP.dwg [FIGURE 1] November 25, 2012 - 12:16:58 pm (BY: MARSH, MAUREEN)

LEGEND:

- INUIT OWNED LAND
- APEC - AREA OF POTENTIAL ENVIRONMENTAL CONCERN
- APPROXIMATE LOCATION OF DRAINAGE CHANNEL
- BUILDINGS
- DEBRIS
- WATER

0 100 m

Scale: 1: 2 000

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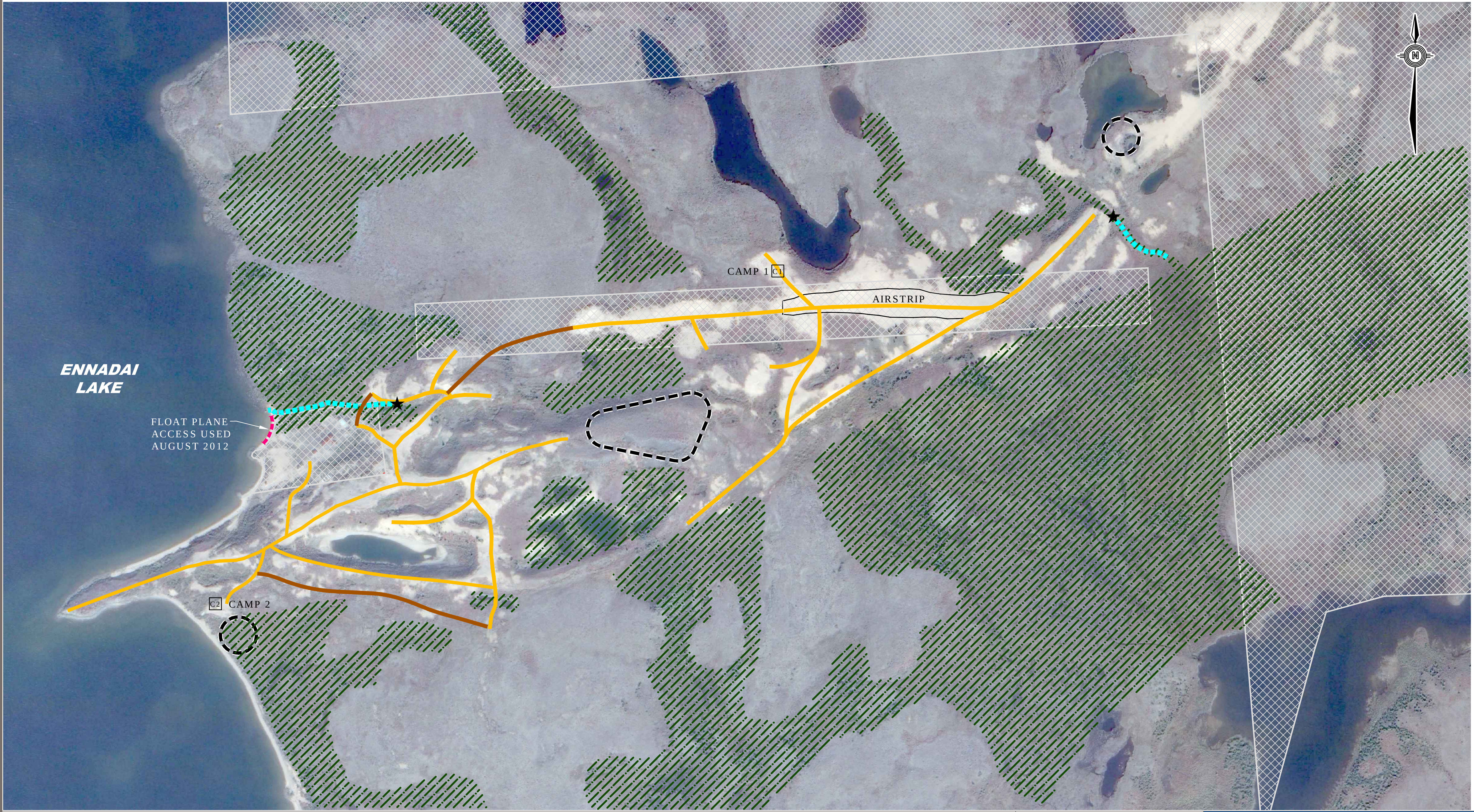
REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

GENERAL SITE PLAN

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	KO	0
OFFICE	DATE		
EDM	November 2012		

Figure 2

Q:\Edmonton\Drafting\PROJECTS\Y221\Y22101286 Ennadai\Autocad\RAP\Y22101286_Figure 2 RAP.dwg [FIGURE 2] November 25, 2012 - 12:17:54 pm (BY: MARSH, MAUREEN)



LEGEND:

- INUIT OWNED LAND
- ORGANIC TERRAIN - AVOID DISTURBANCE
- POTENTIAL CONSTRUCTION CAMP LOCATION
- SPRING
- ATV TRAIL
- POTENTIAL NEW ROAD ROUTE
- FLOAT PLANE ACCESS
- RESTRICTED AREA
- DRAINAGE CHANNEL

0 200 m
Approximate Scale 1: 6 000

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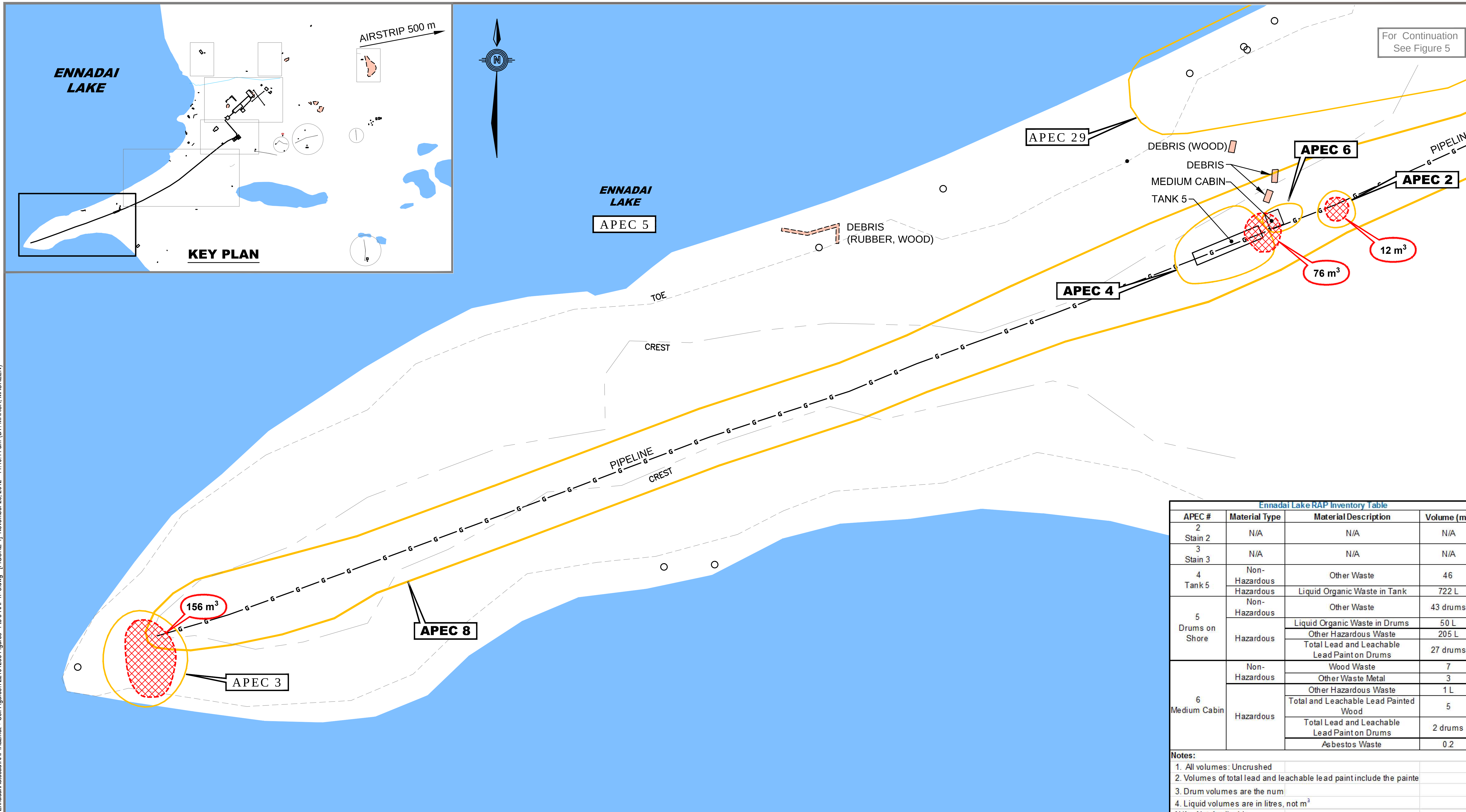
REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

SITE PLAN SHOWING
SITE ACCESS

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	KK	0

OFFICE	DATE
EDM	November 2012

Figure 3



APEC #	Material Type	Material Description	Volume (m³)
Ennadai Lake RAP Inventory Table			
2 Stain 2	N/A	N/A	N/A
3 Stain 3	N/A	N/A	N/A
4 Tank 5	Non-Hazardous	Other Waste	46
	Hazardous	Liquid Organic Waste in Tank	722 L
5 Drums on Shore	Non-Hazardous	Other Waste	43 drums
	Hazardous	Liquid Organic Waste in Drums	50 L
		Other Hazardous Waste	205 L
		Total Lead and Leachable Lead Paint on Drums	27 drums
6 Medium Cabin	Non-Hazardous	Wood Waste	7
		Other Waste Metal	3
	Hazardous	Other Hazardous Waste	1 L
		Total and Leachable Lead Painted Wood	5
		Total Lead and Leachable Lead Paint on Drums	2 drums
		Asbestos Waste	0.2

Notes:

1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painte
3. Drum volumes are the num
4. Liquid volumes are in litres, not m³

N/A = Not Applicable

LEGEND

- DRUM(S) (205 L)
- DRUM(S) (20 L)
- APEC - AREA OF POTENTIAL ENVIRONMENTAL CONCERN
- BUILDINGS
- DEBRIS
- WATER
- METALS IMPACTED SOIL
- PHC IMPACTED SOIL
- 156 m³ - VOLUME OF SOIL IMPACTED

0 — 20 m
Scale: 1: 600

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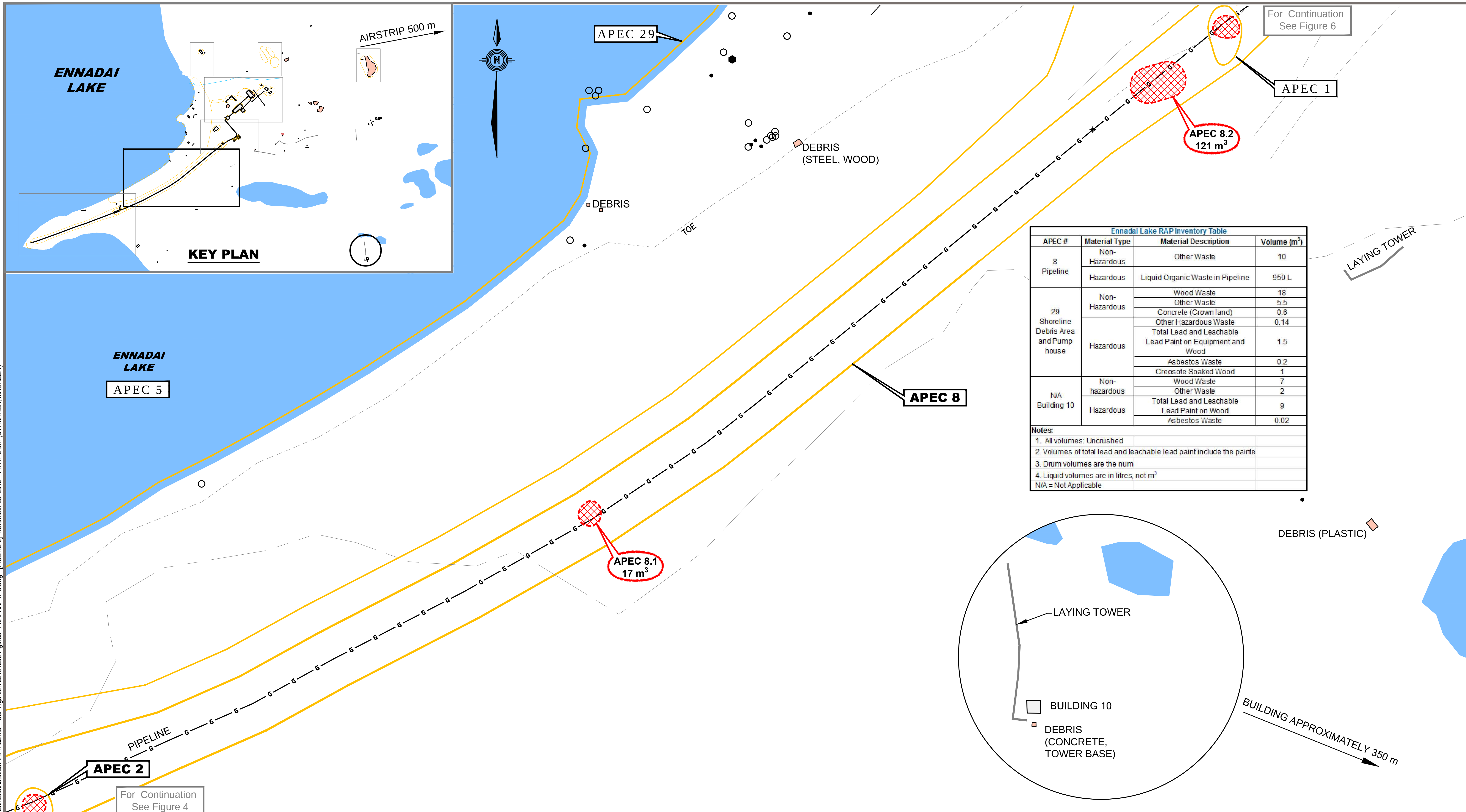
REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

SITE PLAN SHOWING
NON-HAZARDOUS AND HAZARDOUS WASTE
AND SOIL EXCEEDANCES

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	MC	0
OFFICE	DATE		
EDM	November 2012		

Figure 4



Ennadai Lake RAP Inventory Table

APEC #	Material Type	Material Description	Volume (m^3)
8 Pipeline	Non-Hazardous	Other Waste	10
	Hazardous	Liquid Organic Waste in Pipeline	950 L
29 Shoreline Debris Area and Pump house	Non-Hazardous	Wood Waste	18
		Other Waste	5.5
		Concrete (Crown land)	0.6
	Hazardous	Other Hazardous Waste	0.14
		Total Lead and Leachable Lead Paint on Equipment and Wood	1.5
		Asbestos Waste	0.2
		Creosote Soaked Wood	1
N/A Building 10	Non-hazardous	Wood Waste	7
		Other Waste	2
	Hazardous	Total Lead and Leachable Lead Paint on Wood	9
		Asbestos Waste	0.02

Notes:
1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painte
3. Drum volumes are the num
4. Liquid volumes are in litres, not m^3
N/A = Not Applicable

LEGEND
- DRUM(S) (205 L)
- DRUM(S) (20 L)
- APEC - AREA OF POTENTIAL ENVIRONMENTAL CONCERN
- BUILDINGS
- DEBRIS
- WATER
- METALS IMPACTED SOIL
- PHC IMPACTED SOIL
- 156 m^3 - VOLUME OF SOIL IMPACTED

0 20 m
Scale: 1: 600

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REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

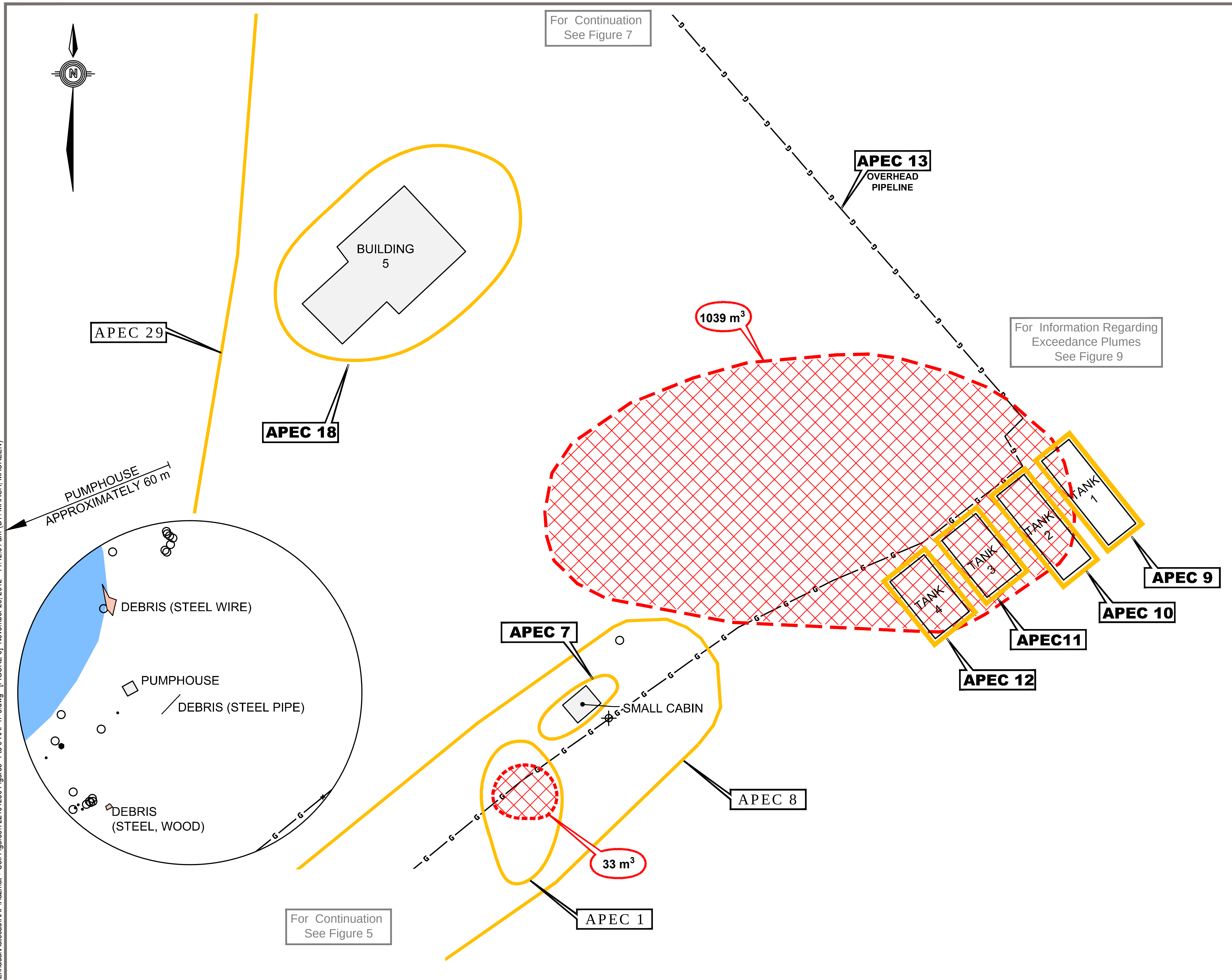
SITE PLAN SHOWING NON-HAZARDOUS AND HAZARDOUS WASTE AND SOIL EXCEEDANCES

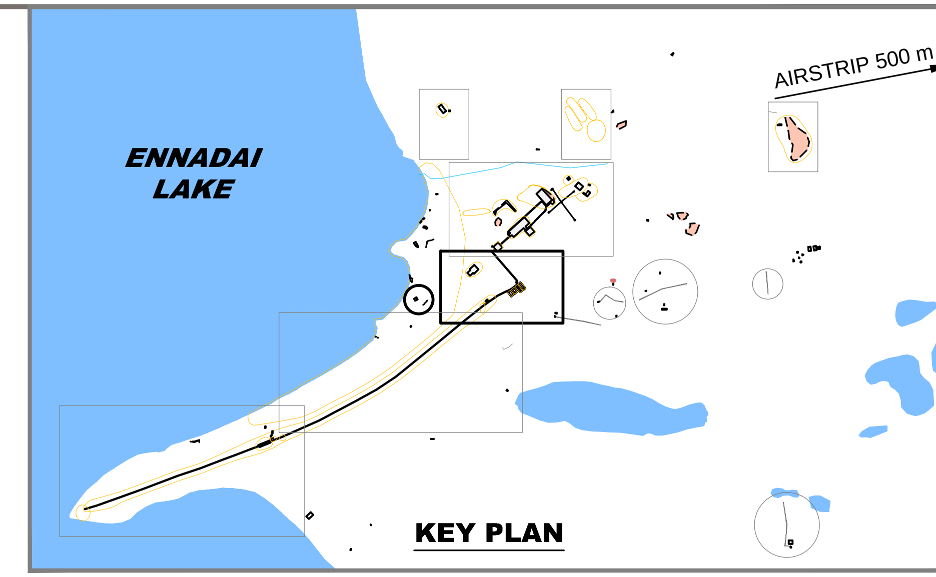
PROJECT NO.	DWN	CKD	REV
Y22101286	MM	MC	0

OFFICE	DATE
EDM	November 2012

Figure 5

Q:\Edmonton\Drafting\PROJECTS\Y221\Y22101286 Ennadai\Autocad\RAP\Hazmat + Soil Figures\Y22101286 Figures 4 to 9 RAP h+e.dwg [FIGURE 5] November 26, 2012 - 11:41:42 am (BY: MARSH, MAUREEN)





Ennadai Lake RAP Inventory Table			
APEC #	Material Type	Material Description	Volume (m^3)
1 Stain 1	N/A	N/A	N/A
7 Small Cabin	Non-Hazardous	Wood Waste	2
		Other Waste	1.1
	Hazardous	Asbestos Waste	1.1
		Total and Leachable Lead Painted Wood	5
9 Tank 1	Non-Hazardous	Other Waste	36
		Concrete (IOL)	1.5
	Hazardous	Liquid Organic Waste in Tank	1935 L
		Asbestos Waste	0.02
10 Tank 2	Non-Hazardous	Other Waste	36
		Concrete (IOL)	1.5
	Hazardous	Liquid Organic Waste in Tank	1868 L
		Asbestos Waste	0.02
11 Tank 3	Non-Hazardous	Wood Waste	1.5
		Other Waste	37
	Hazardous	Liquid Organic Waste in Tank	0 L
		Asbestos Waste	0.02
12 Tank 4	Non-Hazardous	Wood Waste	1.5
		Other Waste	37
	Hazardous	Liquid Organic Waste in Tank	3531 L
		Asbestos Waste	0.02
13 Overhead Piping	Non-Hazardous	Other Waste	20
		Concrete (IOL)	3
	Hazardous	Total Lead and Leachable Lead Paint on Concrete	1
		Liquid Organic Waste in Pipeline	400 L
18 Building 5	Non-Hazardous	Wood Waste	115
		Concrete (IOL)	15
		Other Waste	13.6
	Hazardous	Asbestos Waste	4.03
		Total Lead and Leachable Lead Paint on Wood	1
		Total lead, Leachable Lead and PCB Paint on Equipment	21
		Other Hazardous Waste	0.7, 180 L
		Liquid Organic Waste in Drums/ASTs	591 L

Notes:
1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painte
3. Drum volumes are the num
4. Liquid volumes are in litres, not m^3
N/A = Not Applicable

LEGEND
- DRUM(S) (205 L)
- DRUM(S) (20 L)
- APEC - AREA OF POTENTIAL ENVIRONMENTAL CONCERN
- BUILDINGS
- DEBRIS
- METALS IMPACTED SOIL
- PHC IMPACTED SOIL
- 156 m^3 - VOLUME OF SOIL IMPACTED

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REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

SITE PLAN SHOWING
NON-HAZARDOUS AND HAZARDOUS WASTE
AND SOIL EXCEEDANCES

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	MC	0

OFFICE	DATE
EDM	November 2012

Figure 6

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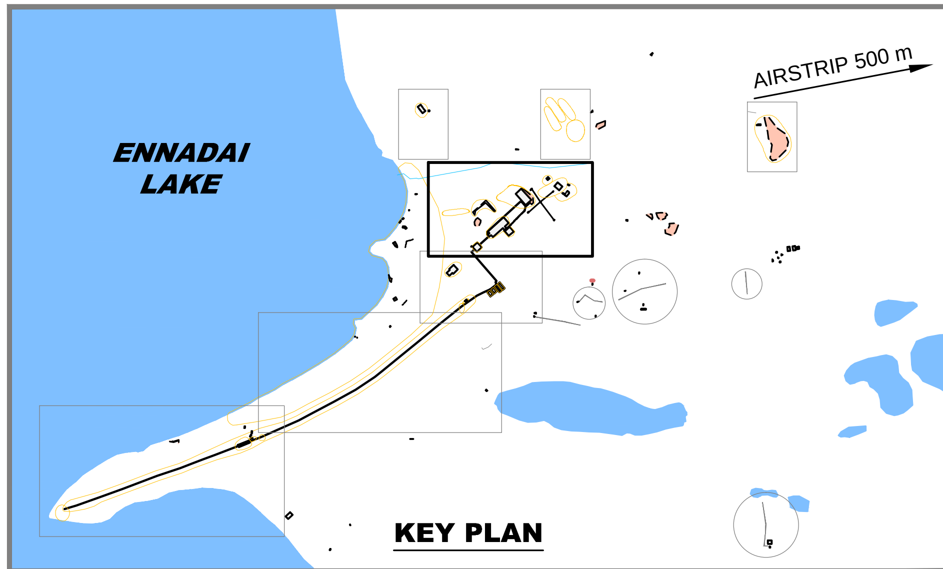

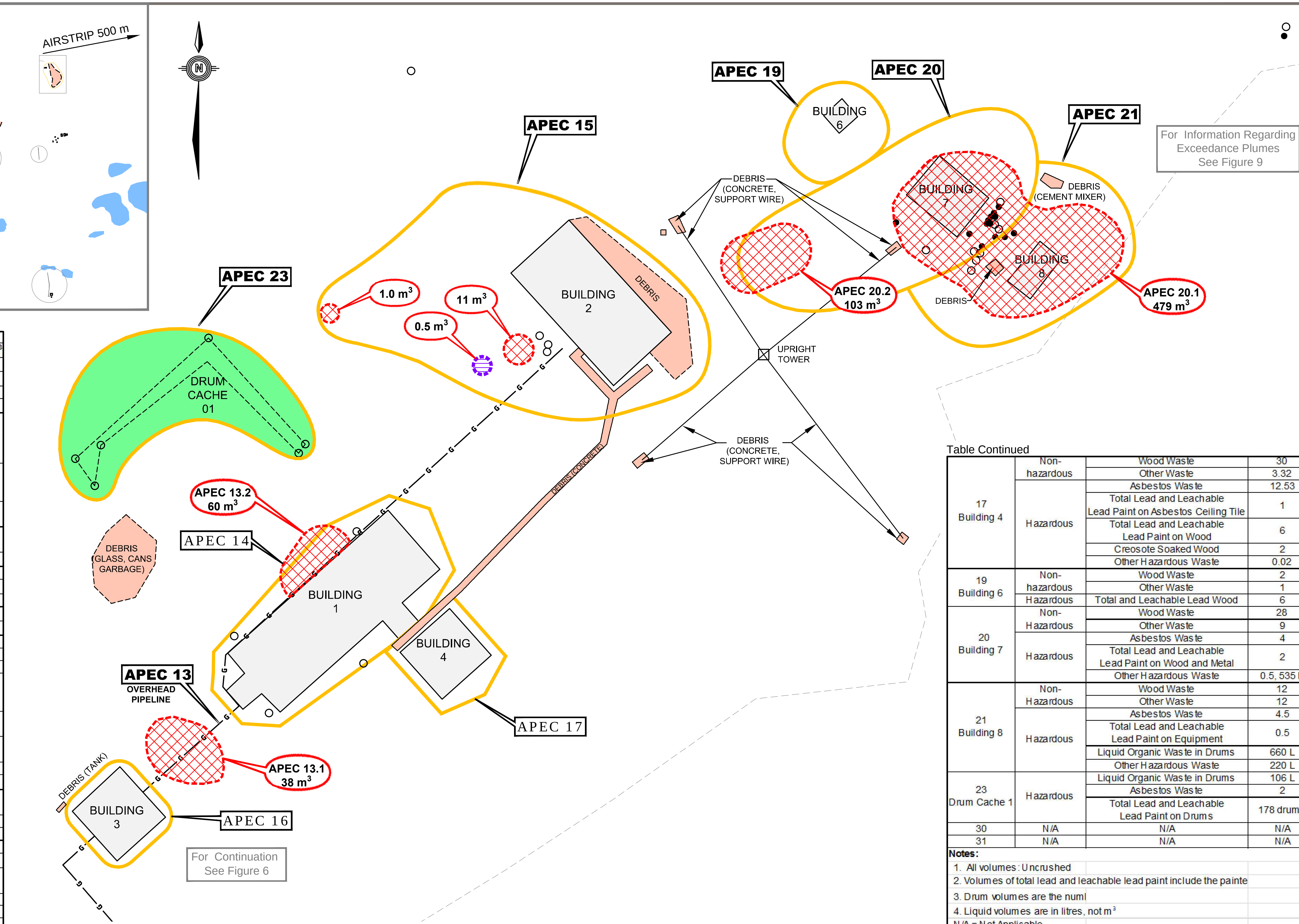

Ennadai Lake RAP Inventory Table

APEC #	Material Type	Material Description	Volume (m^3)
14 Building 1	Non-Hazardous	Wood Waste	240
		Other Waste	29.2
		Concrete (IOL)	74
	Hazardous	Asbestos Waste	153.1
		Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tile	17
		Total Lead and Leachable Lead Paint on Wood, Particulate Board	15
		Total Lead and Leachable Lead Paint on Drums	1 drum
		Total and Leachable Lead Paint on Concrete	5
		Other Hazardous Waste	3.83, 27 L
		Fire Extinguisher	0.06
		Compressed Gas Cylinders	0.1
		Liquid Organic Waste in Drums	410 L
15 Building 2	Non-hazardous	Wood Waste	1
		Other Waste	432.02
		Concrete (IOL)	42
	Hazardous	Asbestos Waste	0.02
		Other Hazardous Waste	29 L
		Total Lead, Leachable Lead and PCB Paint on Wood and Equipment	7
		Total and Leachable Lead Paint on Concrete	4
		Total and Leachable Lead Painted Metal	45
		Fire Extinguishers	0.1
		Other Hazardous Waste	2.22
		Liquid Organic Waste in Drums/ASTs	2264 L
		Other Hazardous Waste	261 L
16 Building 3	Non-hazardous	Wood Waste	10
		Other Waste	3.25
	Hazardous	Asbestos Waste	10.52
		Total Lead and Leachable Lead Paint on Wood	5
		Compressed Gas Cylinders	0.3
		Fire Extinguisher	0.04
		Other Hazardous Waste	0.1, 17 L

Table Continued

17 Building 4	Non-hazardous	Wood Waste	30
		Other Waste	3.32
	Hazardous	Asbestos Waste	12.53
		Total Lead and Leachable Lead Paint on Asbestos Ceiling Tile	1
		Total Lead and Leachable Lead Paint on Wood	6
		Creosote Soaked Wood	2
		Other Hazardous Waste	0.02
19 Building 6	Non-hazardous	Wood Waste	2
		Other Waste	1
	Hazardous	Total and Leachable Lead Wood	6
20 Building 7	Non-Hazardous	Wood Waste	28
		Other Waste	9
	Hazardous	Asbestos Waste	4
		Total Lead and Leachable Lead Paint on Wood and Metal	2
		Other Hazardous Waste	0.5, 535 L
21 Building 8	Non-Hazardous	Wood Waste	12
		Other Waste	12
	Hazardous	Asbestos Waste	4.5
		Total Lead and Leachable Lead Paint on Equipment	0.5
		Liquid Organic Waste in Drums	660 L
		Other Hazardous Waste	220 L
23 Drum Cache 1	Hazardous	Liquid Organic Waste in Drums	106 L
		Asbestos Waste	2
		Total Lead and Leachable Lead Paint on Drums	178 drums
30	N/A	N/A	N/A
31	N/A	N/A	N/A

Notes:

1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painte
3. Drum volumes are the numl
4. Liquid volumes are in litres, not m^3

N/A = Not Applicable

LEGEND

- ○ - DRUM(S) (205 L)
- ● - DRUM(S) (20 L)
- APEC - AREA OF POTENTIAL ENVIRONMENTAL CONCERN
- BUILDINGS
- DEBRIS
- DRUM CACHE
- METALS IMPACTED SOIL
- PHC IMPACTED SOIL
- 156 m^3 - VOLUME OF SOIL IMPACTED

0 — 20 m

Scale: 1: 400

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REMEDIAL ACTION PLAN FORMER WEATHER STATION ENNADAI LAKE, NU

SITE PLAN SHOWING NON-HAZARDOUS AND HAZARDOUS WASTE AND SOIL EXCEEDANCES

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	MC	0

OFFICE	DATE
EDM	November 2012

Figure 7

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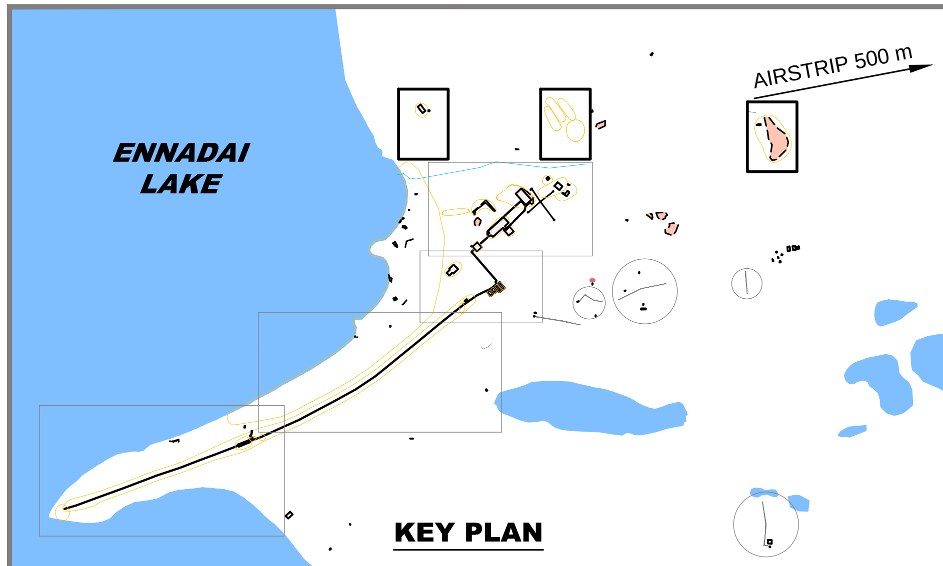

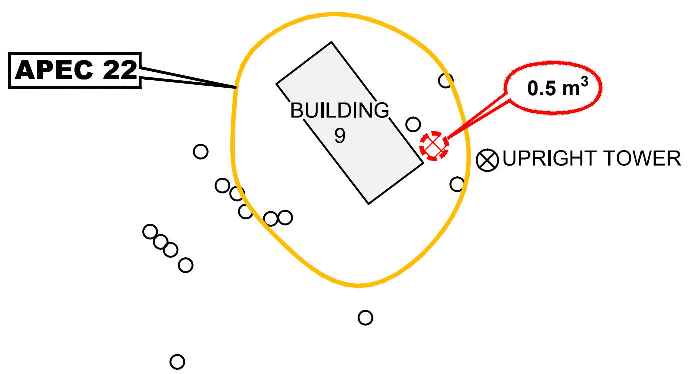

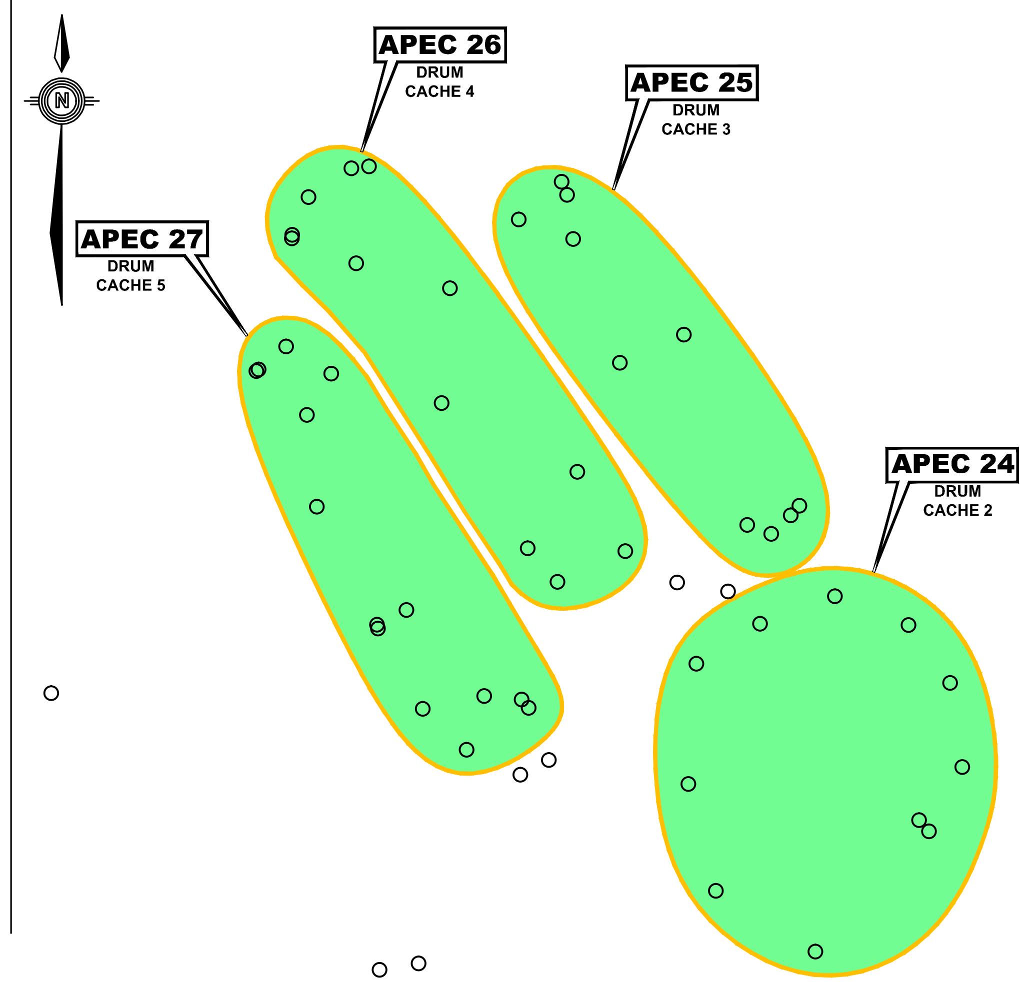

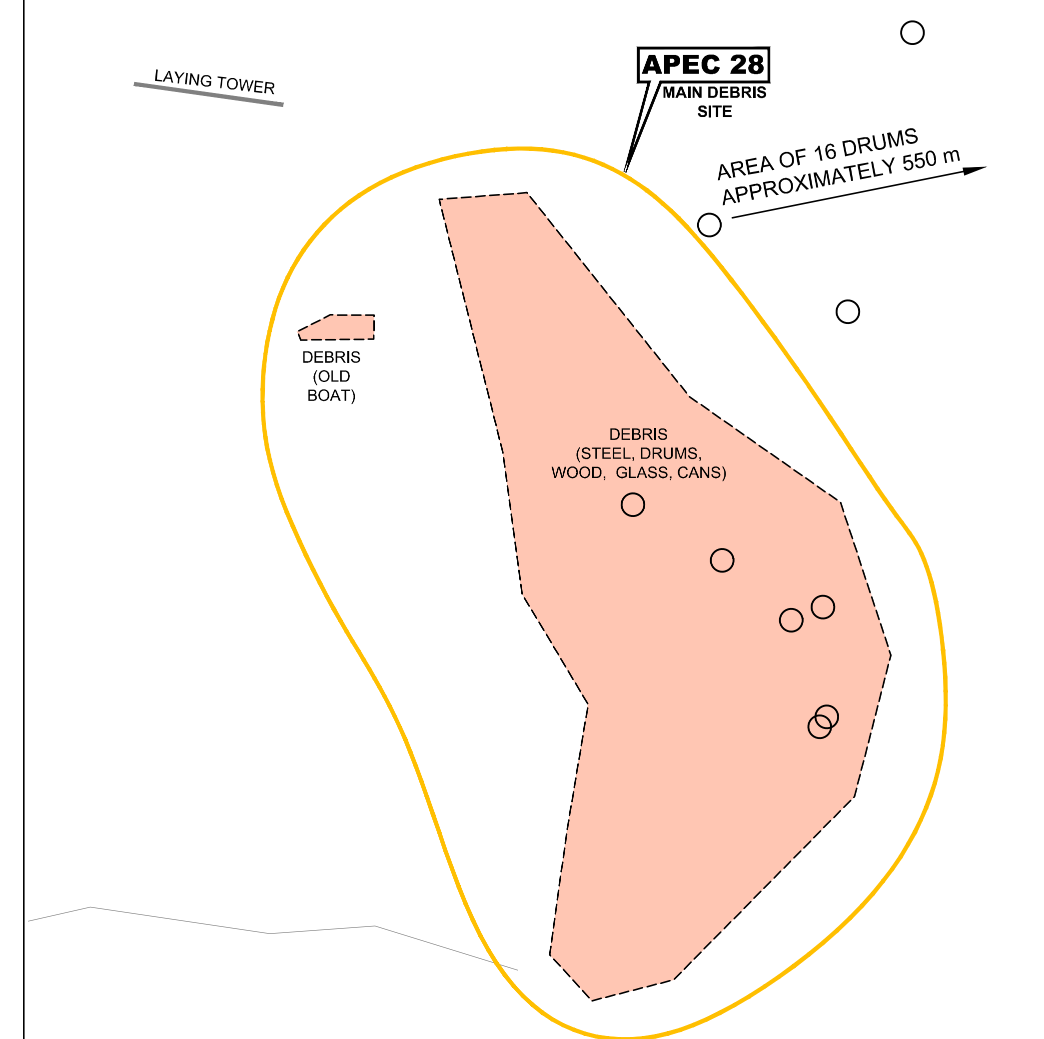

Ennadai Lake RAP Inventory Table			
APEC #	**Material Type**	**Material Description**	**Volume (m^3)**
22 Building 9	Non-hazardous	Wood Waste	15
		Concrete (Crown land)	12
		Other Waste	71
	Hazardous	Other Hazardous Waste	0.1
		Asbestos Waste	3
		Total Lead and Leachable Lead Paint on Drums	11 drums
		Liquid Organic Waste in Drums	220 L
		Fire Extinguisher	0.02
24 Drum Cache 2	Non-Hazardous	Liquid Organic Waste in Drums	50 L
		Other Waste	30 drums
	Hazardous	Total Lead and Leachable Lead Paint on Drums	75 drums
25 Drum Cache 3	Non-Hazardous	Other Waste	317 drums
	Hazardous	Liquid Organic Waste in Drums	50 L
		Total Lead and Leachable Lead Paint on Drums	3 drums
26 Drum Cache 4	Non-Hazardous	Other Waste	130 drums
	Hazardous	Total Lead and Leachable Lead Paint on Drums	5 drums
27 Drum Cache 5	Non-Hazardous	Other Waste	225 drums
	Hazardous	Total Lead and Leachable Lead Paint on Drums	5 drums

Table Continued

28 Main Debris Area	Non-Hazardous	Wood Waste	2
		Other Waste	8, 17 drums
	Hazardous	Total Lead and Leachable Lead Paint on Wood and Metal	4
		Total Lead and Leachable Lead Paint on Drums	1 drum
		Other Hazardous Waste	1
N/A Scattered Debris throughout and adjacent to the Site	Non-Hazardous	Wood Waste	2
		Other Waste	31
		Concrete (Crown land)	11
	Hazardous	Asbestos Waste	1.1
		Total Lead and Leachable Lead Paint on Metal, Wood and Metal Towers	10
		Total Lead and Leachable Lead Paint on Drums	31 drums
		Other Hazardous Waste	10.6
		Liquid Organic Waste in Drums	3075 L

Notes:
1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painte
3. Drum volumes are the num
4. Liquid volumes are in litres, not m^3

N/A = Not Applicable

LEGEND

- DRUM(S) (205 L)
- DRUM(S) (20 L)
- APEC - AREA OF POTENTIAL ENVIRONMENTAL CONCERN
- BUILDINGS
- DEBRIS
- DRUM CACHE
- METALS IMPACTED SOIL
- PHC IMPACTED SOIL

0 — 20 m
Scale: 1: 400

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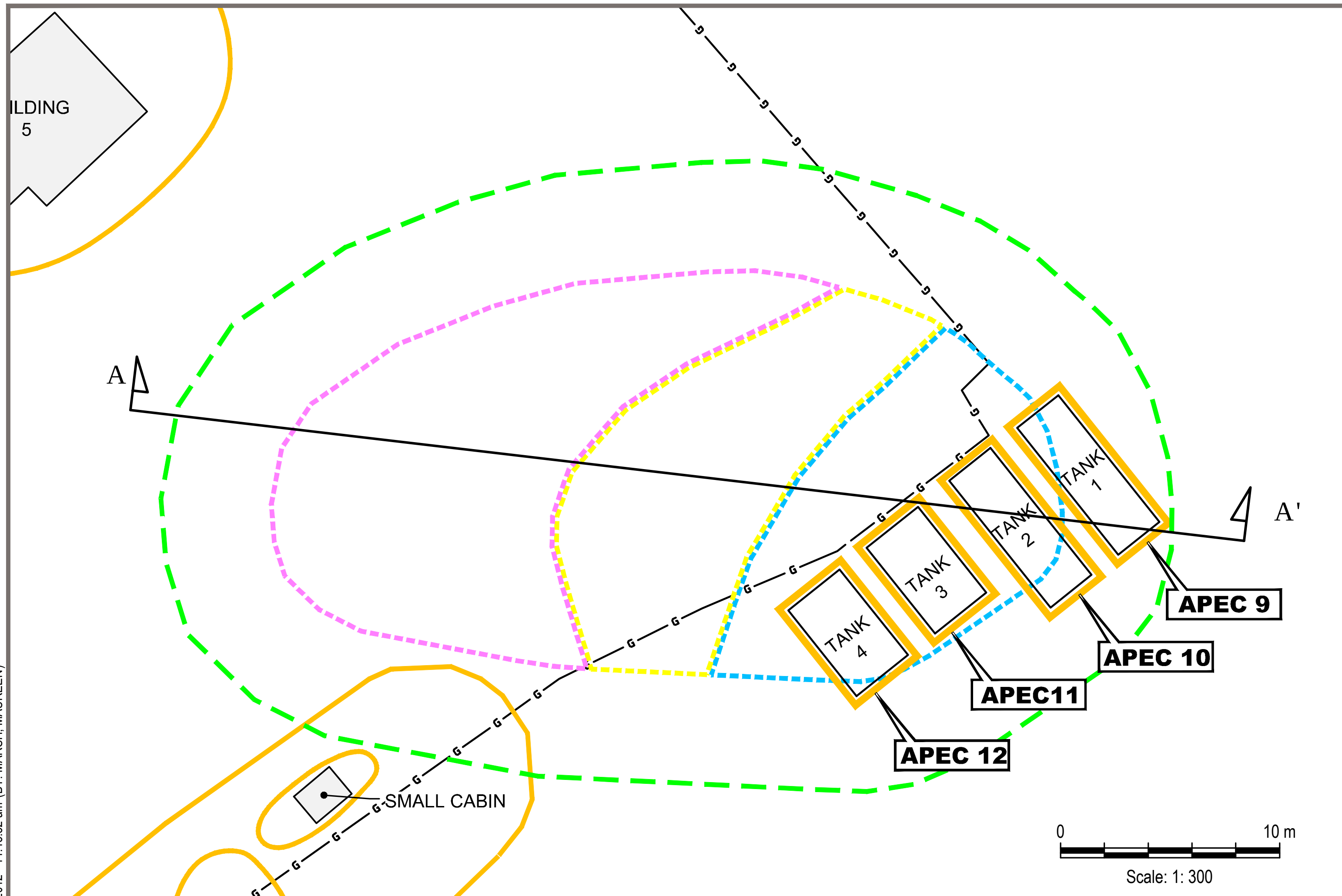
REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

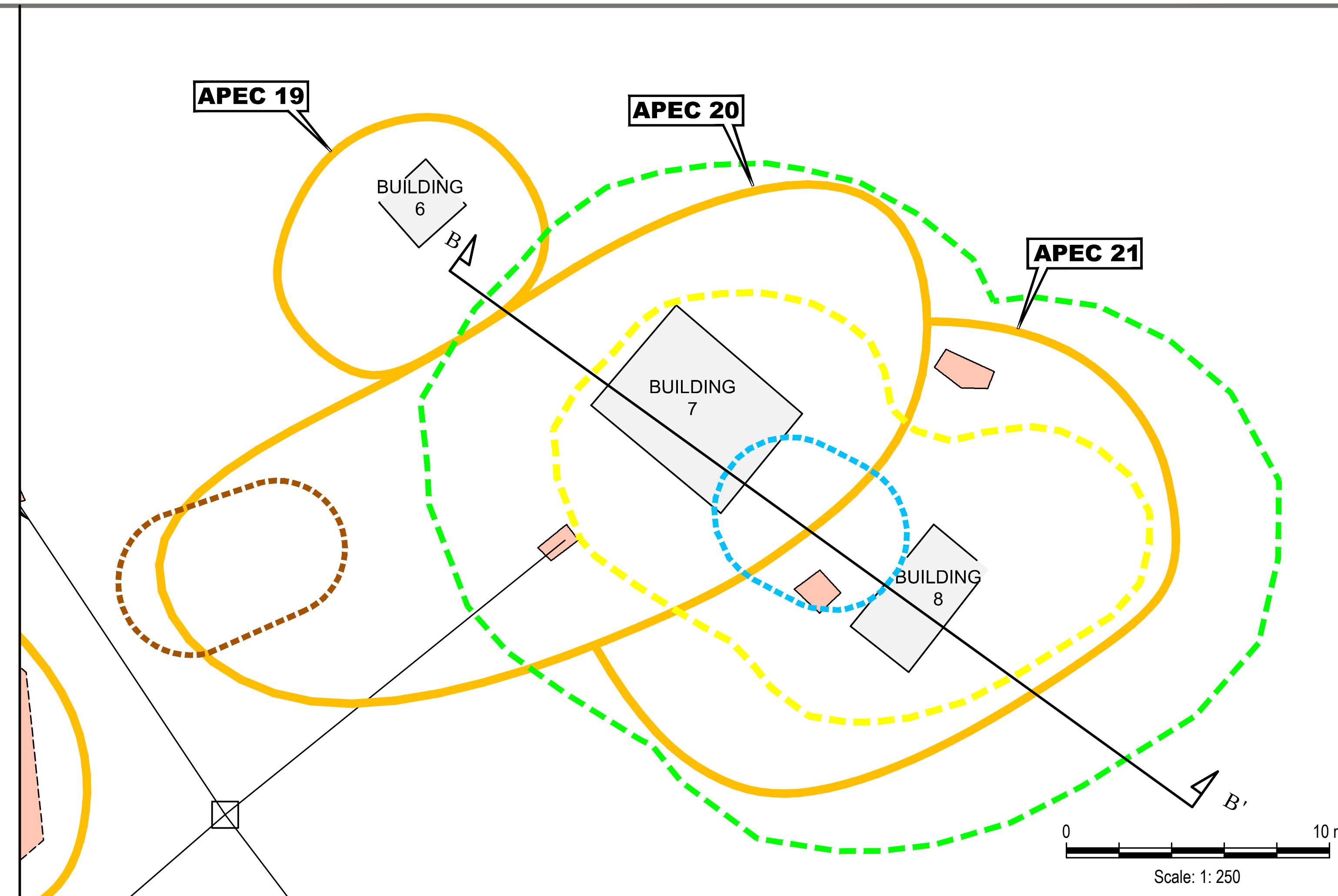
SITE PLAN SHOWING
NON-HAZARDOUS AND HAZARDOUS WASTE
AND SOIL EXCEEDANCES

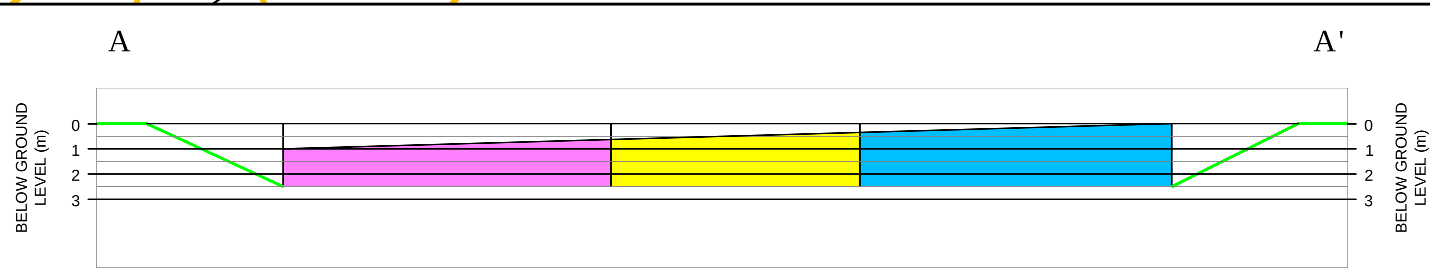
PROJECT NO.	DWN	CKD	REV
Y22101286	MM	MC	0

OFFICE	DATE
EDM	November 2012

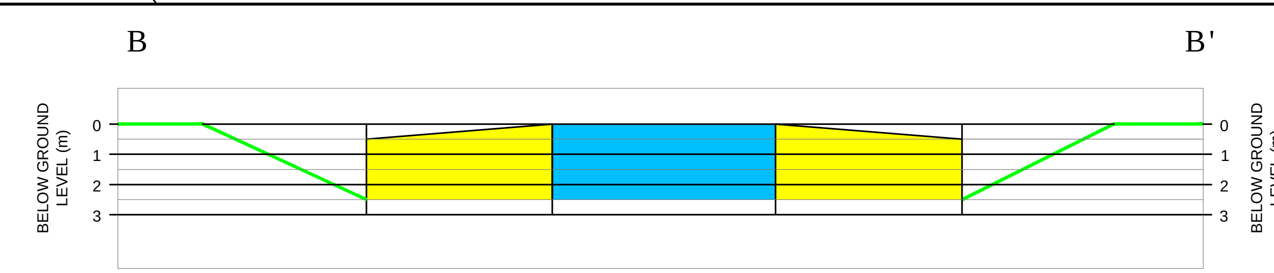
Figure 8







SCHEMATIC PROFILE OF IMPACTED SOIL



SCHEMATIC PROFILE OF IMPACTED SOIL

AREA 1
-CONTAMINATED SOIL 0 - 2.5 m bgl

AREA 2
-CONTAMINATED SOIL 0.5 - 2.5 m bgl

AREA 3
-CONTAMINATED SOIL 1.0 - 2.5 m bgl

AREA 4
-EXCAVATION REQUIRED FOR SLOPE STABILITY AND EGRESS

AREA 1
-CONTAMINATED SOIL 0 - 2.5 m bgl

AREA 2
-CONTAMINATED SOIL 0.5 - 2.5 m bgl

AREA 3
-REQUIRED FOR SLOPE STABILITY AND EGRESS OF EXCAVATION AREA

AREA 4
-SECONDARY IMPACT AREA

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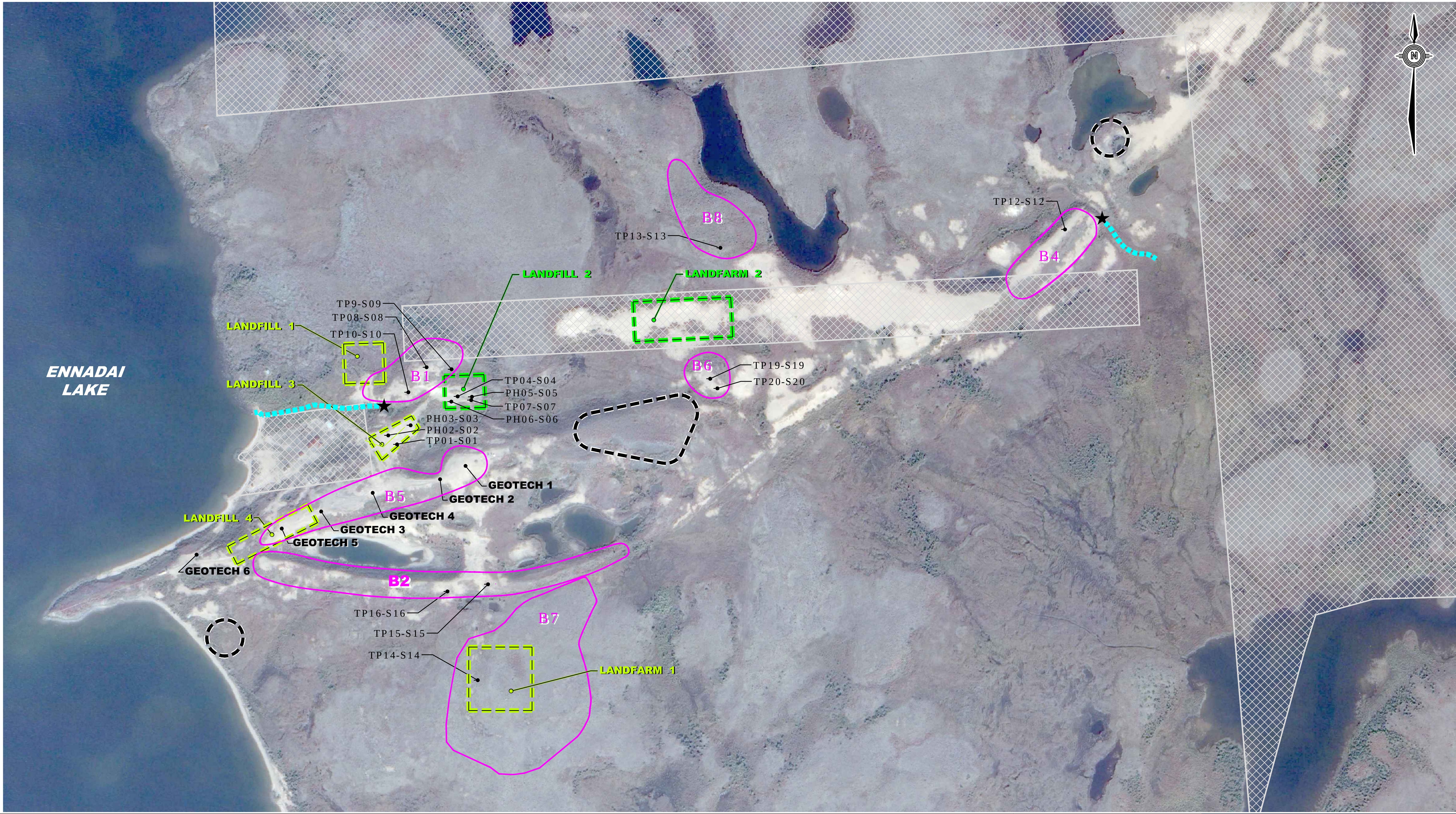
REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

PLAN AND SCHEMATIC PROFILE OF IMPACTED SOIL AREAS

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	MC	0
OFFICE	DATE		
EDM	November 2012		

Figure 9

Q:\Edmonton\Drafting\PROJECTS\Y221\Y22101286 Ennadai\Autocad\RAP\Hazmat + Soil Figures\Y22101286 Figures 4 to 9 RAP h+e.dwg [FIGURE 9] November 26, 2012 - 11:45:52 am (BY: MARSH, MAUREEN)



LEGEND:

- INUIT OWNED LAND
- DRAINAGE CHANNEL
- BORROW SOURCE
- SAMPLING LOCATION
- SPRING
- RESTRICTED AREA
- POTENTIAL LOCATION OF LANDFILL AND LANDFARM
- PROPOPSED LOCATION FOR LANDFILL AND LANDFARM

0 200 m

Approximate Scale 1: 6 000

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REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

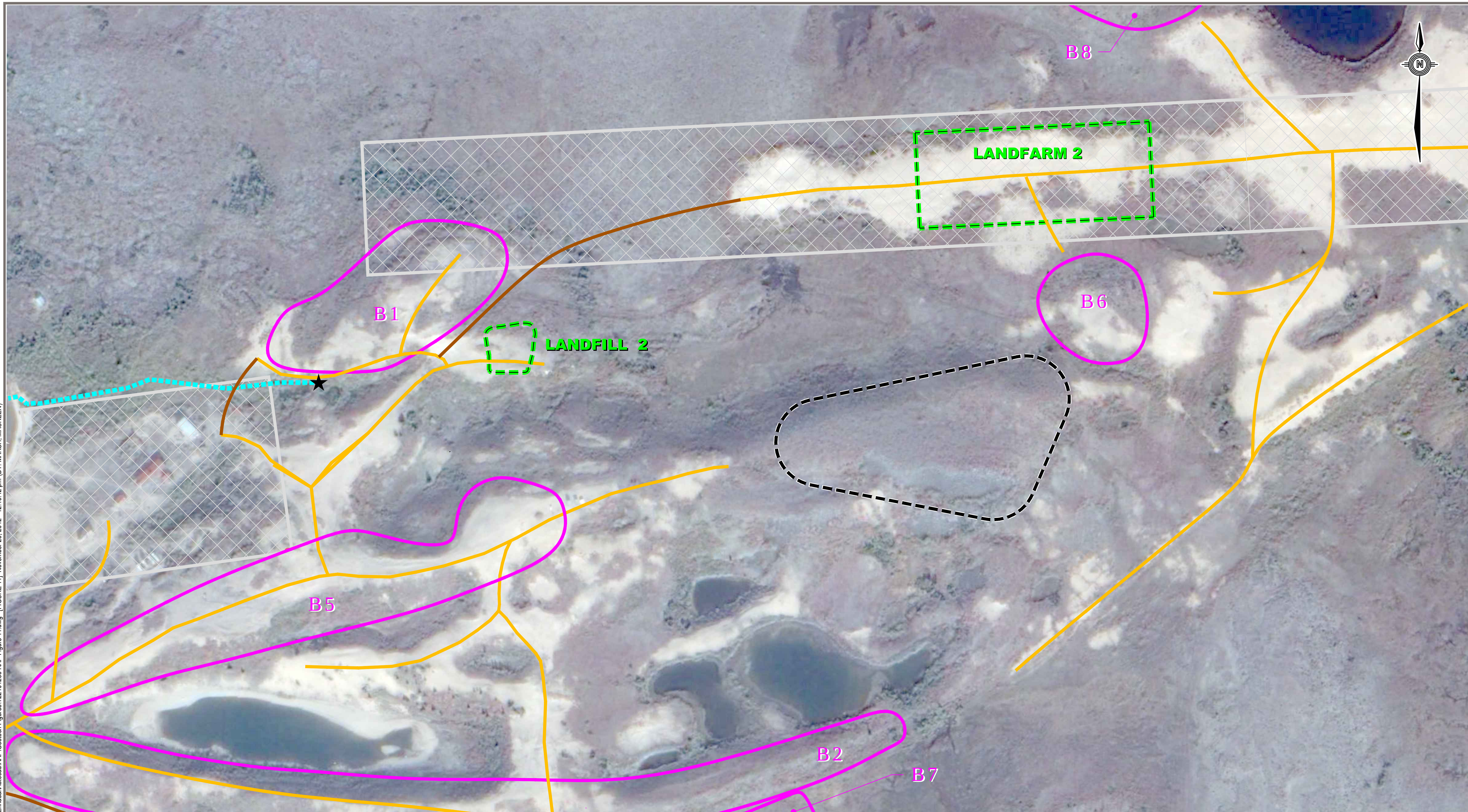
SITE PLAN SHOWING
LANDFILL, LANDFARM, BORROW AREAS
AND SAMPLE LOCATIONS

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	KK	0

OFFICE	DATE
EDM	November 2012

Figure 10

Q:\Edmonton\Drafting\PROJECTS\Y221\Y22101286 Ennadai\Autocad\RAP\Geotech Figures 3,10,11,12,13\Y22101286 RAP Figure 10,13.dwg [FIGURE 10] November 26, 2012 - 12:32:21 pm (BY: MARSH, MAUREEN)



LEGEND:

- INUIT OWNED LAND
- SPRING
- DRAINAGE CHANNEL
- BORROW SOURCE
- ATV TRAIL
- POTENTIAL NEW ROAD ROUTE
- RESTRICTED AREA
- FOOTPRINT OF DESIGNED LANDFILL AND PREFERRED LOCATION FOR LANDFARM

0 100
Scale: 1: 2 500 (metres)

CLIENT

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

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A TETRA TECH COMPANY

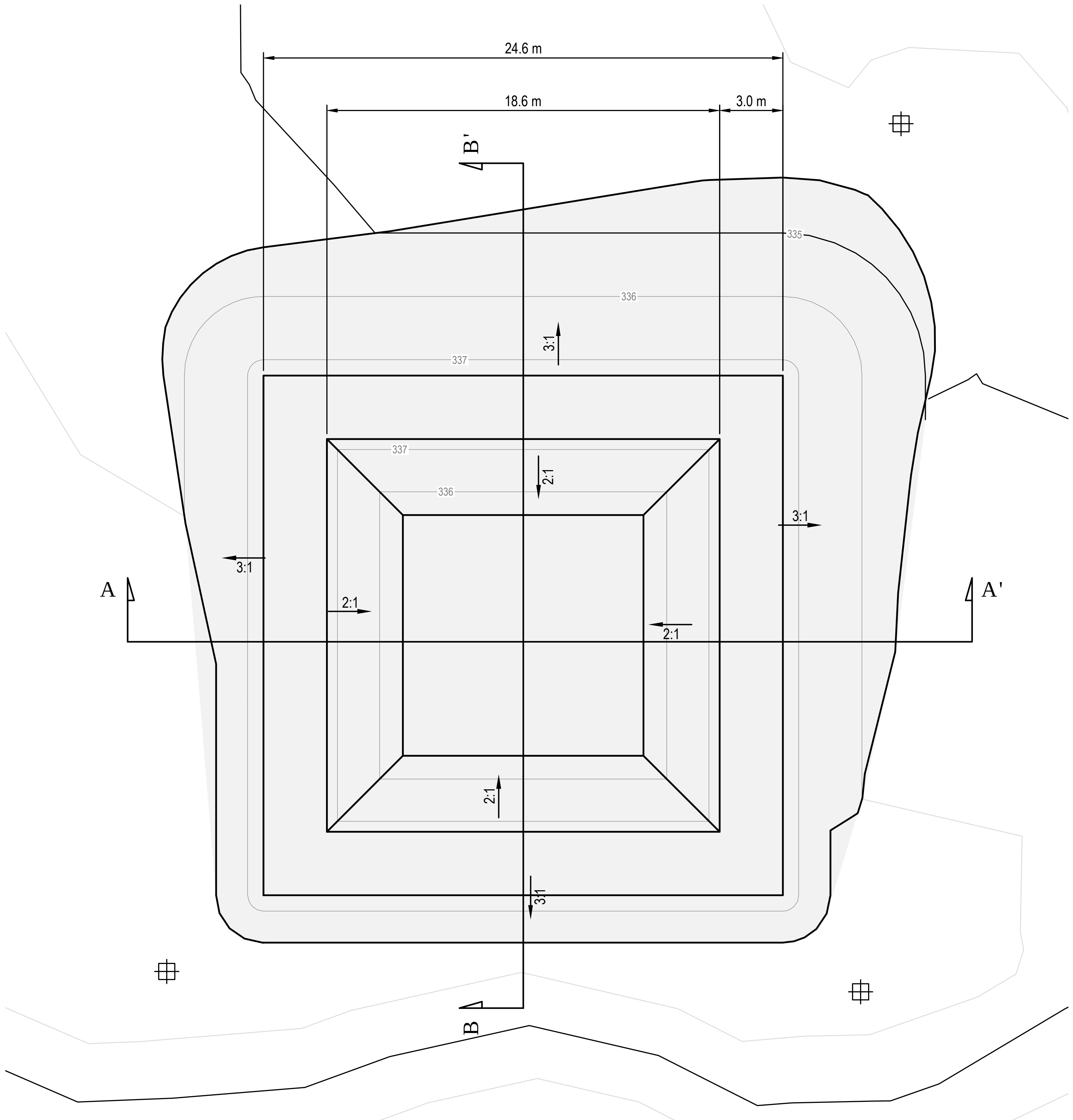
REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

SITE PLAN SHOWING
FOOTPRINT OF DESIGNED LANDFILL AND
PREFERRED LOCATION FOR LANDFARM

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	KK	0
OFFICE	DATE		
EDM	November 2012		

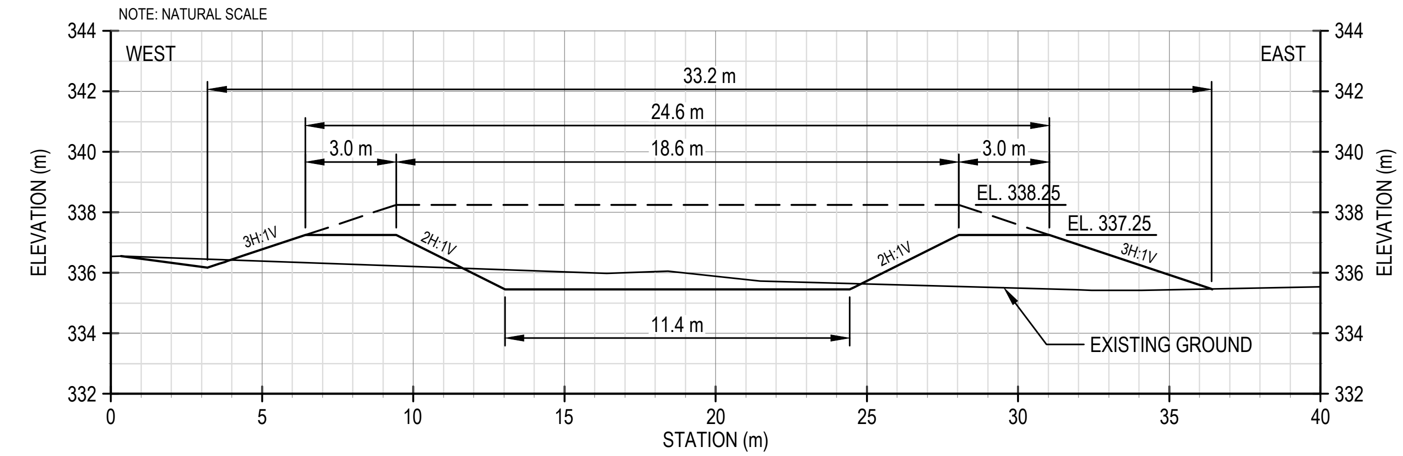
Figure 11

Q:\Edmonton\Drafting\PROJECTS\Y221\Y22101286 Ennadai\Autocad\RAP\Geotech Figures\Y22101286 RAP Figure 11.dwg [FIGURE 11] November 26, 2012 - 12:10:42 pm (BY: MARSH, MAUREEN)

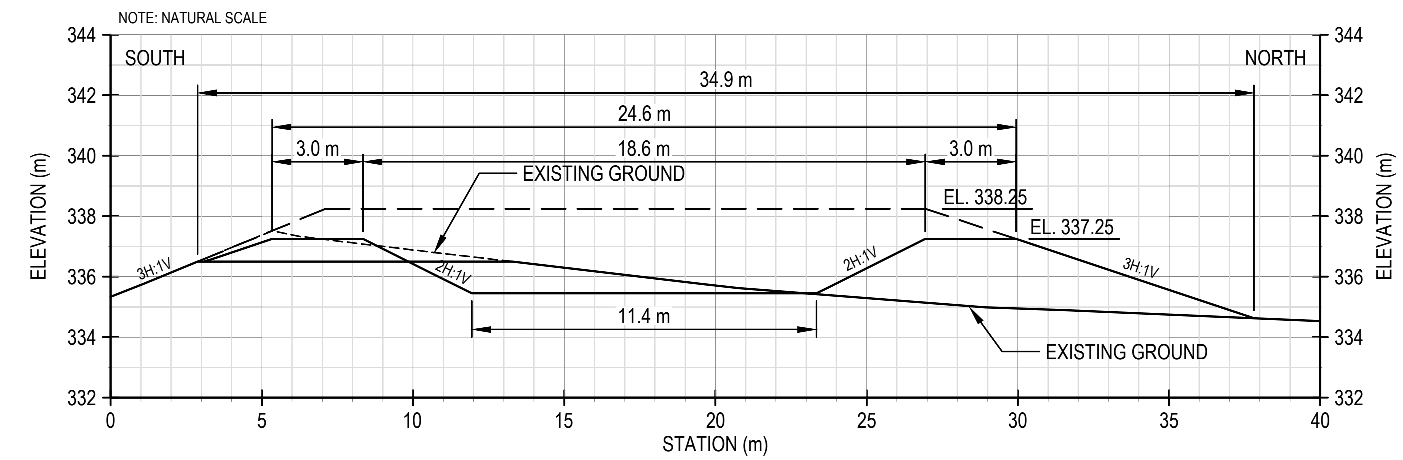


PLAN OF LANDFILL

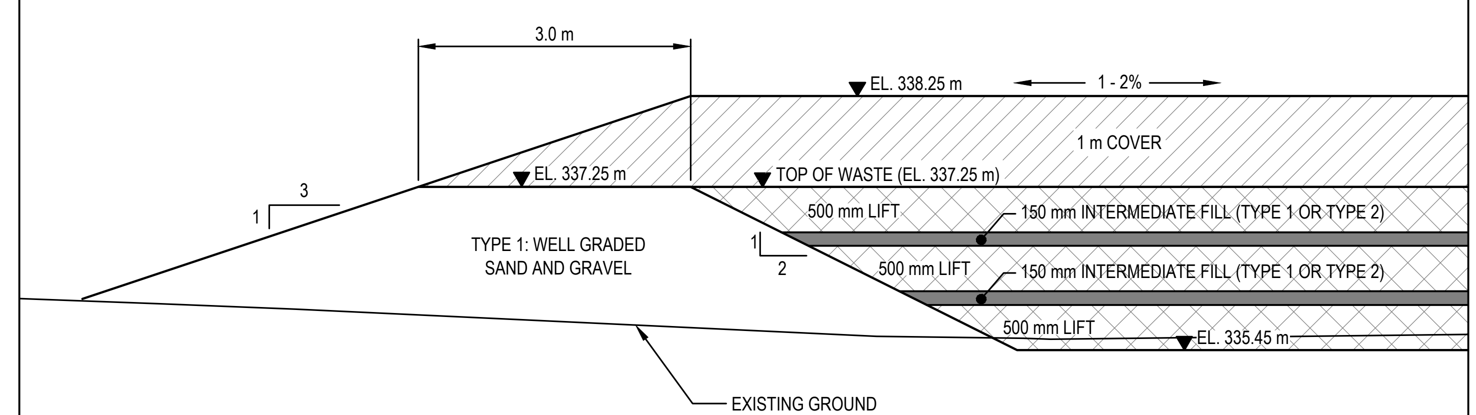
1:250



CROSS-SECTION A-A'



CROSS-SECTION B-B'



TYPICAL CROSS-SECTION

NTS

LEGEND:

⌗ - PROPOSED GROUNDWATER MONITORING WELL

NOTES:

1. HEIGHT OF PERIMETER BERMS MAY VARY DEPENDING ON SURROUNDING TOPOGRAPHY AND FINAL DESIGN GRADES AND ELEVATIONS.
2. ALL DIMENSIONS SHOWN ARE DESIGN MINIMUMS UNLESS OTHERWISE NOTED.

CLIENT

REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

LANDFILL CONCEPTUAL DESIGN PLAN

PROJECT NO.	DWN	CKD	REV
Y22101286	EL	KK	0

OFFICE	DATE
EDM	November 2012

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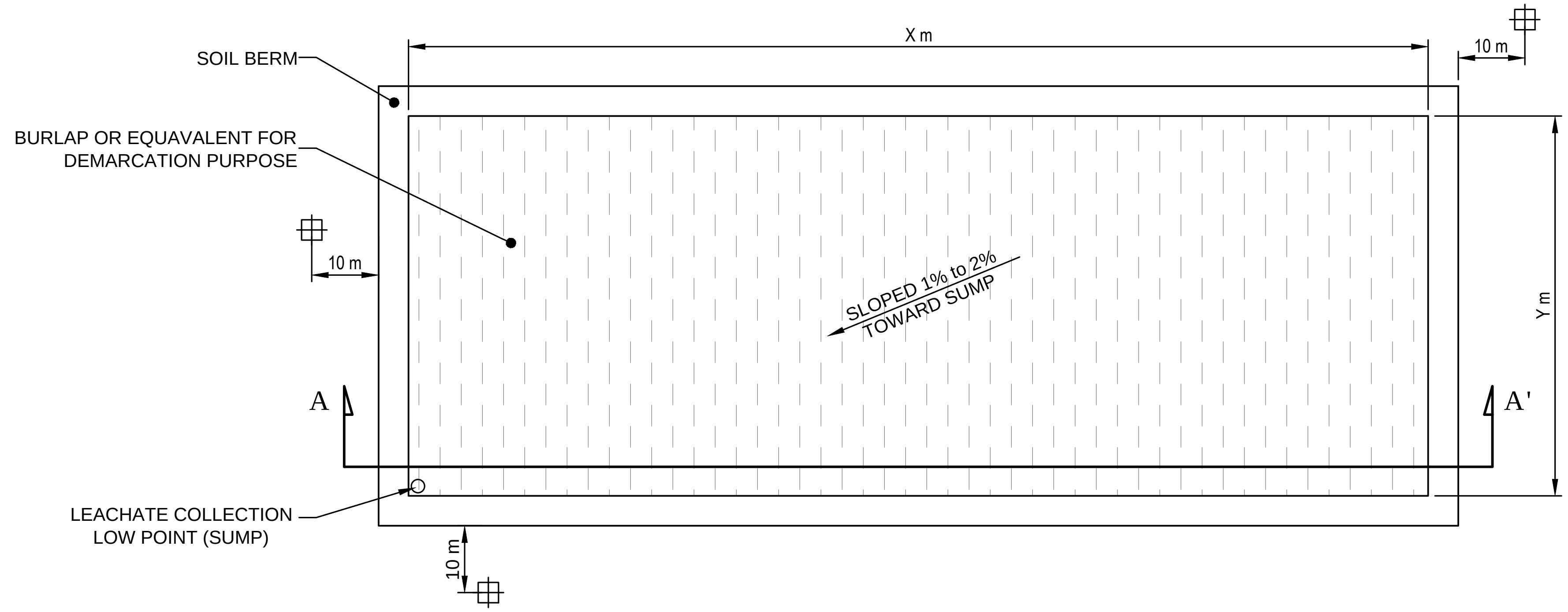
Figure 12

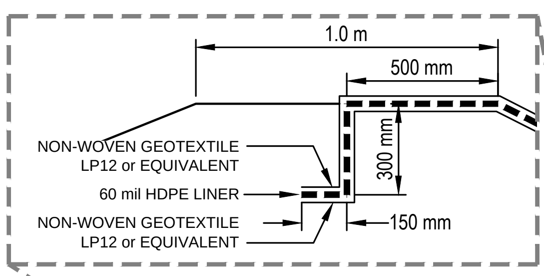


LEGEND:

⊞ - PROPOSED GROUNDWATER MONITORING WELL

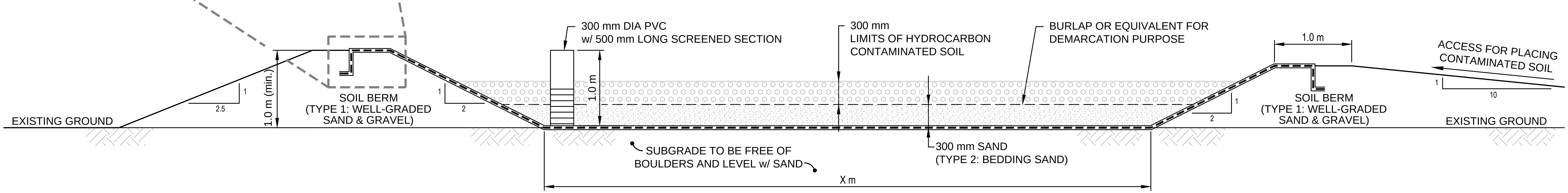
PLAN OF LANDFARM

NTS



ANCHOR TRENCH DETAIL

NTS



TYPICAL CROSS-SECTION A - A'

NTS

NOTE:

ALL DIMENSIONS SHOWN ARE DESIGN MINIMUMS UNLESS OTHERWISE NOTED

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REMEDIAL ACTION PLAN
FORMER WEATHER STATION
ENNADAI LAKE, NU

LANDFARM CONCEPTUAL DESIGN
PLAN AND SECTION

PROJECT NO.	DWN	CKD	REV
Y22101286	MM	CC/EG	0
OFFICE	DATE		
EDM	November 2012		

Figure 13

APPENDIX B
MATERIALS INVENTORY

Appendix B: Ennadai Lake RAP Inventory Table

APEC #	Material Type	Material Description	Volume (m^3)
1 Stain 1	N/A	N/A	N/A
2 Stain 2	N/A	N/A	N/A
3 Stain 3	N/A	N/A	N/A
4 Tank 5	Non-Hazardous	Other Waste	46
	Hazardous	Liquid Organic Waste in Tank	722 L
5 Drums on Shore	Non-Hazardous	Other Waste	43 drums
	Hazardous	Liquid Organic Waste in Drums	50 L
		Other Hazardous Waste	205 L
		Total Lead and Leachable Lead Paint on Drums	27 drums
6 Medium Cabin	Non-Hazardous	Wood Waste	7
		Other Waste Metal	3
	Hazardous	Other Hazardous Waste	1 L
		Total and Leachable Lead Painted Wood	5
		Total Lead and Leachable Lead Paint on Drums	2 drums
		Asbestos Waste	0.2
7 Small Cabin	Non-Hazardous	Wood Waste	2
		Other Waste	1.1
	Hazardous	Asbestos Waste	1.1
		Total and Leachable Lead Painted Wood	5
8 Pipeline	Non-Hazardous	Other Waste	10
	Hazardous	Liquid Organic Waste in Pipeline	950 L
9 Tank 1	Non-Hazardous	Other Waste	36
		Concrete (IOL)	1.5
	Hazardous	Liquid Organic Waste in Tank	1935 L
		Asbestos Waste	0.02
10 Tank 2	Non-Hazardous	Other Waste	36
		Concrete (IOL)	1.5
	Hazardous	Liquid Organic Waste in Tank	1868 L
		Asbestos Waste	0.02
11 Tank 3	Non-Hazardous	Wood Waste	1.5
		Other Waste	37
	Hazardous	Liquid Organic Waste in Tank	0 L
		Asbestos Waste	0.02
12 Tank 4	Non-Hazardous	Wood Waste	1.5
		Other Waste	37
	Hazardous	Liquid Organic Waste in Tank	3531 L
		Asbestos Waste	0.02
13 Overhead Piping	Non-Hazardous	Other Waste	20
		Concrete (IOL)	3
	Hazardous	Total Lead and Leachable Lead Paint on Concrete	1
		Liquid Organic Waste in Pipeline	400 L

Notes:

1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painted substrate, except concrete
3. Drum volumes are the number of drums, not m^3
4. Liquid volumes are in litres, not m^3

N/A = Not Applicable

Appendix B: Ennadai Lake RAP Inventory Table

APEC #	Material Type	Material Description	Volume (m^3)
14 Building 1	Non-Hazardous	Wood Waste	240
		Other Waste	29.2
		Concrete (IOL)	74
	Hazardous	Asbestos Waste	153.1
		Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tile	17
		Total Lead and Leachable Lead Paint on Wood, Particulate Board	15
		Total Lead and Leachable Lead Paint on Drums	1 drum
		Total and Leachable Lead Paint on Concrete	5
		Other Hazardous Waste	3.83, 27 L
		Fire Extinguisher	0.06
		Compressed Gas Cylinders	0.1
		Liquid Organic Waste in Drums	410 L
15 Building 2	Non-hazardous	Wood Waste	1
		Other Waste	432.02
		Concrete (IOL)	42
	Hazardous	Asbestos Waste	0.02
		Other Hazardous Waste	29 L
		Total Lead, Leachable Lead and PCB Paint on Wood and Equipment	7
		Total and Leachable Lead Paint on Concrete	4
		Total and Leachable Lead Painted Metal	45
		Fire Extinguishers	0.1
		Other Hazardous Waste	2.22
		Liquid Organic Waste in Drums/ASTs	2264 L
		Other Hazardous Waste	261 L
16 Building 3	Non-hazardous	Wood Waste	10
		Other Waste	3.25
	Hazardous	Asbestos Waste	10.52
		Total Lead and Leachable Lead Paint on Wood	5
		Compressed Gas Cylinders	0.3
		Fire Extinguisher	0.04
		Other Hazardous Waste	0.1, 17 L
17 Building 4	Non-hazardous	Wood Waste	30
		Other Waste	3.32
	Hazardous	Asbestos Waste	12.53
		Total Lead and Leachable Lead Paint on Asbestos Ceiling Tile	1
		Total Lead and Leachable Lead Paint on Wood	6
		Creosote Soaked Wood	2
		Other Hazardous Waste	0.02

Notes:

1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painted substrate, except concrete
3. Drum volumes are the number of drums, not m^3
4. Liquid volumes are in litres, not m^3

N/A = Not Applicable

Appendix B: Ennadai Lake RAP Inventory Table

APEC #	Material Type	Material Description	Volume (m^3)
18 Building 5	Non-Hazardous	Wood Waste	115
		Concrete (IOL)	15
		Other Waste	13.6
	Hazardous	Asbestos Waste	4.03
		Total Lead and Leachable Lead Paint on Wood	1
		Total lead, Leachable Lead and PCB Paint on Equipment	21
		Other Hazardous Waste	0.7, 180 L
		Liquid Organic Waste in Drums/ASTs	591 L
19 Building 6	Non-hazardous	Wood Waste	2
		Other Waste	1
	Hazardous	Total and Leachable Lead Wood	6
20 Building 7	Non-Hazardous	Wood Waste	28
		Other Waste	9
	Hazardous	Asbestos Waste	4
		Total Lead and Leachable Lead Paint on Wood and Metal	2
		Other Hazardous Waste	0.5, 535 L
21 Building 8	Non-Hazardous	Wood Waste	12
		Other Waste	12
	Hazardous	Asbestos Waste	4.5
		Total Lead and Leachable Lead Paint on Equipment	0.5
		Liquid Organic Waste in Drums	660 L
		Other Hazardous Waste	220 L
22 Building 9	Non-hazardous	Wood Waste	15
		Concrete (Crown land)	12
		Other Waste	71
	Hazardous	Other Hazardous Waste	0.1
		Asbestos Waste	3
		Total Lead and Leachable Lead Paint on Drums	11 drums
		Liquid Organic Waste in Drums	220 L
		Fire Extinguisher	0.02

Notes:

1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painted substrate, except concrete
3. Drum volumes are the number of drums, not m^3
4. Liquid volumes are in litres, not m^3

N/A = Not Applicable

Appendix B: Ennadai Lake RAP Inventory Table

APEC #	Material Type	Material Description	Volume (m^3)
23 Drum Cache 1	Hazardous	Liquid Organic Waste in Drums	106 L
		Asbestos Waste	2
		Total Lead and Leachable Lead Paint on Drums	178 drums
24 Drum Cache 2	Non-Hazardous	Liquid Organic Waste in Drums	50 L
		Other Waste	30 drums
	Hazardous	Total Lead and Leachable Lead Paint on Drums	75 drums
25 Drum Cache 3	Non-Hazardous	Other Waste	317 drums
	Hazardous	Liquid Organic Waste in Drums	50 L
		Total Lead and Leachable Lead Paint on Drums	3 drums
26 Drum Cache 4	Non-Hazardous	Other Waste	130 drums
	Hazardous	Total Lead and Leachable Lead Paint on Drums	5 drums
27 Drum Cache 5	Non-Hazardous	Other Waste	225 drums
	Hazardous	Total Lead and Leachable Lead Paint on Drums	5 drums
28 Main Debris Area	Non-Hazardous	Wood Waste	2
		Other Waste	8, 17 drums
	Hazardous	Total Lead and Leachable Lead Paint on Wood and Metal	4
		Total Lead and Leachable Lead Paint on Drums	1 drum
		Other Hazardous Waste	1
29 Shoreline Debris Area and Pump house	Non-Hazardous	Wood Waste	18
		Other Waste	5.5
		Concrete (Crown land)	0.6
	Hazardous	Other Hazardous Waste	0.14
		Total Lead and Leachable Lead Paint on Equipment and Wood	1.5
		Asbestos Waste	0.2
		Creosote Soaked Wood	1
30	N/A	N/A	N/A
31	N/A	N/A	N/A
N/A Building 10	Non-hazardous	Wood Waste	7
		Other Waste	2
	Hazardous	Total Lead and Leachable Lead Paint on Wood	9
		Asbestos Waste	0.02
N/A Scattered Debris throughout and adjacent to the Site	Non-Hazardous	Wood Waste	2
		Other Waste	31
		Concrete (Crown land)	11
	Hazardous	Asbestos Waste	1.1
		Total Lead and Leachable Lead Paint on Metal, Wood and Metal Towers	10
		Total Lead and Leachable Lead Paint on Drums	31 drums
		Other Hazardous Waste	10.6
		Liquid Organic Waste in Drums	3075 L

Notes:

1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painted substrate, except concrete
3. Drum volumes are the number of drums, not m^3
4. Liquid volumes are in litres, not m^3

N/A = Not Applicable

Appendix B: Ennadai Lake RAP Inventory Table

APEC #	Material Type	Material Description	Volume (m^3)
Totals: (m^3)	Non-Hazardous	Wood Waste	494
		Other Waste and Concrete (crown land)	871, 762 drums
		Concrete (IOL)	137
	Hazardous	Asbestos Waste	196.4
		Liquid Organic Waste in Tanks	8056 L
		Compressed Gas Cylinders	0.4
		Fire Extinguishers	0.22
		Creosote Soaked Wood	3
		Liquid Organic Waste in Drums	7476 L
		Liquid Organic Waste in Pipeline	1350 L
		Total Lead, Leachable Lead and PCB Paint on Equipment, Metal, Particulate Board, Wood and Metal Towers	127
		Total Lead and Leachable Lead Paint on Drums	339 drums
		Total Lead and Leachable Lead Paint on Concrete	10
		Total Lead and Leachable Lead Paint on Asbestos Panels and Ceiling Tiles	18
		Other Hazardous Waste	19.21, 1475 L

Notes:

1. All volumes: Uncrushed
2. Volumes of total lead and leachable lead paint include the painted substrate, except concrete
3. Drum volumes are the number of drums, not m^3
4. Liquid volumes are in litres, not m^3

N/A = Not Applicable

APPENDIX C
PHOTO LOG

Photographs Index

General Site Photographs and Aerial Photographs

Photo 1: View of the Site from above

Photo 2: View of the main building cluster, looking southeast

Photo 3: View of the Site, looking east

Photo 4: View of the drum caches and buildings, looking southeast

Photo 5: View of the main building cluster, looking north

Photo 6: View of the Site, looking northeast

Photo 7: Floatplane docked at the beach at the Ennadai Lake Former Weather Station site

Photo 8: Typical trail system on esker

Photo 9: Trail through main esker complex looking south toward Landfarm 1

Photo 10: Airstrip at Ennadai Lake, Former Weather Station, looking north from above

Photo 11: Airstrip looking east

Environmental Photographs

Photo E-1: APEC 1 - Stain 1 - Flag markers depicting soil delineation samples APEC 1-SS001, SS002 and SS003

Photo E-2: APEC 1 - Stain 1 - Flag locations for delineation soil samples APEC 1-SS004 and SS005 in a low lying depressional area

Photo E-3: APEC 2 - Stain 2 - Flag locations for delineation soil samples APEC 2-SS001, SS002 and SS003; coarse-grained sand and cobbles were prevalent throughout the esker

Photo E-4: APEC 3 Stain 3 - Delineating terminal extent of the pipeline

Photo E-5: APEC 3 - Stain 3 - Terminal extent of pipeline facing up-gradient from the shoreline

Photo E-6: APEC 4b - Tank 5 - Delineation of tanks; staining can be seen at the valve

Photo E-7: APEC 4a - Tank 5 - Flag locations for delineation soil samples facing up-gradient toward the tank

Photo E-8: APEC 4a - Tank 5 - Flag locations for soil samples APEC 4a- SS001, staining was noted at the valve of the AST

Photo E-9: APEC 8 - Pipeline - Flag locations for delineation soil samples APEC 8- SS004, SS005 and SS006; staining was noted along the pipeline at a junction

Photo E-10: APEC 8 - Pipeline - Sample location taken down-gradient of APEC1; delineation soil sample APEC 8-SS011 is shown; both samples taken in a low-lying depressional area, hydrocarbon odour was noted

Photo E-11: APEC 9 - 12 - Delineation soil sample APEC 9-SS004 and Tanks 1 - 4 are shown; the picture was taken looking east up-gradient toward the tank farm; sand fill was present on the slope

Photo E-12: APEC 9 - Tank 1- Soil sample location APEC 9-SS001; the soil sample was taken down-gradient of the fuel distribution lines; significant hydrocarbon odour and staining around the valves was noted

Photo E-13: APEC 12 - Tank 4 - Delineation soil sample APEC 12-SS007 is shown looking north toward the tank farm; in the background soil samples APEC 12- SS001 to SS005 can be seen delineating the hydrocarbon plume

Photo E-14: APEC 13-Overhead Pipeline- Delineation soil samples APEC 13 SS002 to SS009 are seen between Building 3 (APEC 16) and Building 5 (APEC 18). An active leak was present at the time of the Site investigation

Photo E-15: APEC 13/APEC 14 - Overhead Pipeline/Building 1 - Delineation soil sample locations APEC 13-SS010 to SS017 are shown; hydrocarbon odour was noted at the base of the foundation

Photo E-16: APEC 15 - Building 2 - Delineation soil sample locations APEC 15 SS001 to SS003 are shown; the picture was taken facing northwest

Photo E-17: APEC 15 - Building 2 - Delineation soil sample locations APEC 15-SS002 to SS005 shown; the picture was taken facing north

Photo E-18: APEC 15 - Building 2 - Delineation soil sample locations APEC 15-SS005, SS006 and SS008; the picture was taken facing northeast

Photo E-19: APEC 18 - Building 5 - Delineation soil sampling locations APEC 18-SS001 to SS006; a concrete pad and excavator were present in the building

Photo E-20: APEC 18 - Building 5 - Delineation soil sampling locations APEC 18-SS001 to SS006; the photo was taken facing south toward the building

Photo E-21: APEC 19 and APEC 20 - Buildings 7 and 8 - Delineation soil samples APEC 20-SS001 and SS002 are seen in the photo and represent the eastern edge of the contamination plume

Photo E-22: APEC 19 and 20 - Buildings 7 and 8 - Delineation of contaminated area

Photo E-23: APEC 19 - Building 7 - A drainage/seepage pathway was located behind the APECs running toward Ennadai Lake; sediment and surface water samples APEC 20-SW001 and APEC 20-SD-01 are shown

Photo E-24: APEC 20 - Building 8 - Soil sample APEC 20-SS017 is shown; water was encountered upon the completion of the test pit

Photo E-25: APEC 23 - Drum Cache 1/Wind Break- Delineation soil samples APEC 23-SS001, SS003 and SS005 are shown; a historic fuel cache was formerly located south of APEC 23 toward Ennadai Lake

Photo E-26: APEC 28 - Debris Area, organic soil/matter was encountered overlaying sand, multiple layers of waste were discovered during test pitting

Photo E-27: APEC 29 - Shoreline - Various empty barrels were found around the Site; there was no staining or odour noted

Photo E-28: General Soil Condition taken at APEC 12 - Sand with an estimated 5 – 10 % cobbles, located at the toe of APEC 12

Photo E-29: General Soil Condition at APEC 3 - Sand with an estimated 10 - 20 % cobbles and gravel at terminal extent of pipeline near Stain 3

Photo E-30: General Soil Condition at APEC 13 (Central Buildings) - Well sorted sand with some gravel

Geotechnical Photographs

Photo G-1: Trail from main camp site to Landfill 3

Photo G-2: Trail from Landfill 3 to Landfill 2

Photo G-3: Trail through main esker complex looking south towards Borrow 7 and Landfarm 1

Photo G-4: Trail on top of main esker complex near Environment Canada Weather Station

Photo G-5: Trail from main camp site towards Landfill 4, looking northeast

Photo G-6: Airstrip at Ennadai Lake, Former Weather Station, looking north from above

Photo G-7: Airstrip at Ennadai Lake Former Weather Station, looking northeast

Photo G-8: Airstrip at Ennadai Lake Former Weather Station, looking southwest

Photo G-9: End of airstrip at Ennadai Lake Former Weather Station, looking east

Photo G-10: Western end of airstrip at Ennadai Lake Former Weather Station, looking northeast

Photo G-11: Borrow 1 in the foreground, Landfill 3 in the mid-ground, and Borrow 5 in the background, looking southwest

Photo G-12: Borrow 1 in the background, with debris in Landfill 2 in the foreground, looking north northwest

Photo G-13: Borrow 1, with organic deposit in the foreground, looking southwest

Photo G-14: Borrow 2 ridge with water body on the right, and Landfill 4 in the background on the right, looking west

Photo G-15: Borrow 2 ridge in background, looking south

Photo G-16: Borrow 2 - Testpit (TP15)

Photo G-17: Borrow 4, with airstrip in foreground, looking east northeast

Photo G-18: Borrow 4, with airstrip in foreground, looking northeast

Photo G-19: Borrow 5, looking west

Photo G-20: Borrow 5, north side, looking west

Photo G-21: Borrow 5, north side with Borrow 2 in the background on the left, looking west southwest

Photo G-22: Borrow 5, top, looking west

Photo G-23: Borrow 6, looking east

Photo G-24: Borrow 6, airstrip in the background, looking northeast

Photo G-25: Borrow 6, Borrow 1 in the background, looking west

Photo G-26: Borrow 6 - Testpit (TP20)

Photo G-27: Borrow 7, looking south

Photo G-28: Borrow 7, southern extent, showing gentle side slopes and adjacent organic deposits, looking southeast

Photo G-29: Borrow 8, looking north

Photo G-30: Borrow 8 – Testpit (TP13)

Photo G-31: Potential Landfill 1, looking northeast

Photo G-32: Potential Landfill 1, looking northwest

Photo G-33: Potential Landfill 2, looking east

Photo G-34: Potential Landfill 2, looking southeast

Photo G-35: Potential Landfill 2 - Testpit (TP04), showing subrounded gravel removed from testpit

Photo G-36: Potential Landfill 3, looking southwest

Photo G-37: Potential Landfill 3 – Testpit (TP01)

Photo G-38: Potential Landfill 4, looking north

Photo G-39: Potential Landfill 4, looking east northeast towards Borrow 5

Photo G-40: Potential Landfarm 1, looking south

Photo G-41: Potential Landfarm 1, looking west

Photo G-42: Potential Landfarm 2, looking northwest

Photo G-43: Landfarm 2, looking southeast

Photo G-44: Landfarm 2, looking west

Hazardous and Non-Hazardous Materials Photos

Photo H-1: APEC 3 – Stain 3 – Organic content remaining in the pipeline

Photo H-2: APEC 4 – Tank 5 (42000L) – Organic content remaining in Tank 5

Photo H-3: APEC 5 – Drums (Located on the shore of Ennadai Lake) - Total and leachable lead painted drums

Photo H-4 APEC 6 – Medium Cabin – Asbestos black felt, total lead and leachable lead painted wood exterior and drums and lubricants

Photo H-5: APEC 7 – Small Cabin – Asbestos black felt and panels, and total and leachable painted wood

Photo H-6: APEC 8 – Pipeline – View from Tanks 1-4, looking toward the Medium Cabin and esker

Photo H-7: APEC 8 – Pipeline – View from end of the pipeline and the esker, looking northeast

Photo H-8: APEC 9 – 12 – Tanks 1-4 – View looking west, Tank 1 on the far right and Tank 4 is on the far left; asbestos gaskets on all tanks and organic content in all tanks, except for Tank 3

Photo H-9: APEC 9 – Tank 1 - Close-up of asbestos gasket

Photo H-10: APEC 13 – Overhead piping from tanks to Buildings – View of overhead piping towards Building 3 Total and leachable lead painted concrete and organic content in pipeline

Photo H-11: APEC 13 – Overhead piping from tanks to Building – View of overhead piping towards Building 2; total and leachable lead painted concrete and organic content in pipeline

Photo H-12: APEC 14 – Building 1 – Asbestos black felt, asbestos window caulking, total and leachable lead painted wood

Photo H-13: APEC 14 – Building 1 – Basement total lead and leachable lead painted concrete walls, miscellaneous chemicals, ODS in freezer, mould on wood beams and concrete

Photo H-14: APEC 14 – Building 1 – Basement northwest wall

Photo H-15: APEC 14 – Building 1 – Basement unknown crystallized white material (possibly a cleaning product)

Photo H-16: APEC 14 – Building 1 – Basement two drums and jerry cans, assumed to be full of diesel, new, Labeled: Paul Anowtalik and Tony V's property

Photo H-17: APEC 14 – Building 1 – Leachable lead seals on cast iron piping and tanks behind

Photo H-18: APEC 14 – Building 1 – Main floor hallway, viewing northeast; asbestos flooring wall panels and ceiling, total lead and leachable lead painted asbestos panels on walls and second layer of ceiling particulate board

Photo H-19: APEC 14 – Building 1 – Main floor kitchen; asbestos flooring, wall panels and ceiling, total lead and leachable lead painted wood shelves, mercury vapor in lights and PCBs in light ballasts

Photo H-20: APEC 14 – Building 1 – Main floor living room and bedrooms; asbestos flooring, wall panels and ceiling

Photo H-21: APEC 14 – Building 1 – Main floor control desk; asbestos walls and ceiling, PCBs, mercury and lead solder in electrical parts

Photo H-22: APEC 14 – Building 1 – Main floor electrical box. Asbestos walls and ceiling, PCBs, mercury and lead solder in electrical parts

Photo H-23: APEC 14 – Building 1 – Asbestos attic insulation

Photo H-24: APEC 15 – Building 2 - Asbestos black felt, asbestos window caulking, total and leachable lead painted wood, organic content in the AST and drum

Photo H-25: APEC 15 – Building 2 – Northwest half of building; total lead and leachable lead painted metal walls, ceiling and concrete floor, mercury in lights and PCBs in light ballasts

Photo H-26: APEC 15 - Building 2 - Total lead, leachable lead and PCBs painted generators, total lead, leachable lead and PCBs painted plastic over fibreglass insulation, ceiling and concrete floor miscellaneous fluids in generators and lead acid batteries

Photo H-27: APEC 15 – Building 2 – Miscellaneous chemicals, total lead and leachable lead painted metal walls, ceiling and concrete floor

Photo H-28: APEC 16 – Building 3 – Asbestos black felt, attic insulation, window caulking and total lead and leachable lead painted wood

Photo H-29: APEC 16 – Building 3 – Total lead and leachable lead painted wood and compressed gas cylinder

Photo H-30: APEC 16 – Building 3 – Total lead and leachable lead painted wood and miscellaneous containers of oil/lubricants/fuel

Photo H-31: APEC 17 – Building 4 – Asbestos black felt, attic insulation, window caulking, walls panels and total lead and leachable lead painted wood

Photo H-32: APEC 17 – Building 4 – Asbestos chimney tile and ceiling tile, and total lead and leachable lead painted wood

Photo H-33: APEC 17 – Building 4 – Asbestos insulation, and total lead and leachable lead painted wood

Photo H-34: APEC 18 – Building 5 - Asbestos exterior panels, black felt, attic insulation, window caulking, and total lead and leachable lead painted wood

Photo H-35: APEC 18 – Building 5 - Total lead and leachable lead painted wood and equipment, lead acid batteries and miscellaneous containers of oil/lubricants

Photo H-36: APEC 18 – Building 5 - Total lead and leachable lead painted wood, AST organic contents and miscellaneous containers of oil/lubricants

Photo H-37: APEC 18 – Building 5 - Total lead and leachable lead painted caterpillar

Photo H-38: APEC 18 – Building 5 – Fibre glass insulation (not containing asbestos)

Photo H-39: APEC 19 – Building 6 – Total lead and leachable lead painted wood

Photo H-40: APEC 20 – Building 7 – Asbestos exterior asphalt shingles and total lead and leachable lead painted wood

Photo H-41: APEC 20 - Building 7 - Asbestos flooring, asbestos white piping, asbestos black felt, total and leachable lead painted wood and metal, miscellaneous containers of oil/lubricants, drum content (clear, flammable) and PCBs in light ballasts and electrical equipment

Photo H-42: APEC 21 – Building 8 - Asbestos exterior asphalt shingles and black felt

Photo H-43: APEC 21 – Building 8 - Miscellaneous containers of oil/lubricants

Photo H-44: APEC 21 – Cement mixer, painted with total lead and leachable lead paint

Photo H-45: APEC 21 - Organic content in 205L and 20L drums between Building 7 and Building 8

Photo H-46: APEC 22 – Building 9 – Metal exterior and total lead and leachable lead painted metal tower and drums, and drum content (organic)

Photo H-47: APEC 22 – Building 9 – Interior asbestos panels and fire extinguisher

Photo H-48: APEC 23 – Drum Cache 1 – Total lead and leachable lead painted drums welded together and drum content (organic)

Photo H-49: APEC 24 – Drum Cache 2 - Total lead and leachable lead painted drums and drum content (organic)

Photo H-50: APEC 24 – Drum Cache 2 - Total lead and leachable lead painted drum and some organic drum content

Photo H-51: APEC 25 – Drum Cache 3 - Total lead and leachable lead painted drums and drum content (organic)

Photo H-52: APEC 26 – Drum Cache 4 - Total lead and leachable lead painted drums

Photo H-53: APEC 27 – Drum Cache 5 - Total lead and leachable lead painted drums

Photo H-54: APEC 25-27 – Drum Cache 3 on the right, Drum Cache 4 in the center and Drum Cache 5 on the left - Total lead and leachable lead painted drum and drum content (organic)

Photo H-55: APEC 28 – Main Debris Area – Metal debris

Photo H-56: APEC 28 – Main Debris Area – Partially buried total and leachable lead paint wood, metal and drums, electrical parts and lead acid batteries

Photo H-57: APEC 29 – Shoreline Debris Area and Pump house (in background) – Various metal and wood debris

Photo H-58: APEC 29 – Pump house – Asbestos black felt, total lead and leachable lead painted equipment and wood

Photo H-59: APEC 29 – Total lead and leachable lead painted drum with blue, flammable content

Photo H-60: APEC N/A – Building 10 – Total and leachable lead painted metal tower and Building 10 in background

Photo H-61: APEC N/A – Building 10 - Antenna Tuning Unit Shelter, Total lead and leachable lead painted wood and asbestos panel

Photo H-62: APEC N/A – Building 10 - Antenna Tuning Unit Shelter interior

Photo H-63: APEC N/A – Scattered Debris throughout and adjacent to the site – metal cans debris west of the main building cluster on the hill

Photo H-64: APEC N/A – Scattered Debris throughout and adjacent to the site – Two total lead and leachable lead painted metal towers west of the main building cluster, on the top of the hill

Photo H-65: APEC N/A – Scattered Debris throughout and adjacent to the site – New drums and organic drum content by the airstrip

Photo 1: View of the Site from above

Photo 2: View of the main building cluster, looking southeast

Photo 3: View of the Site, looking east

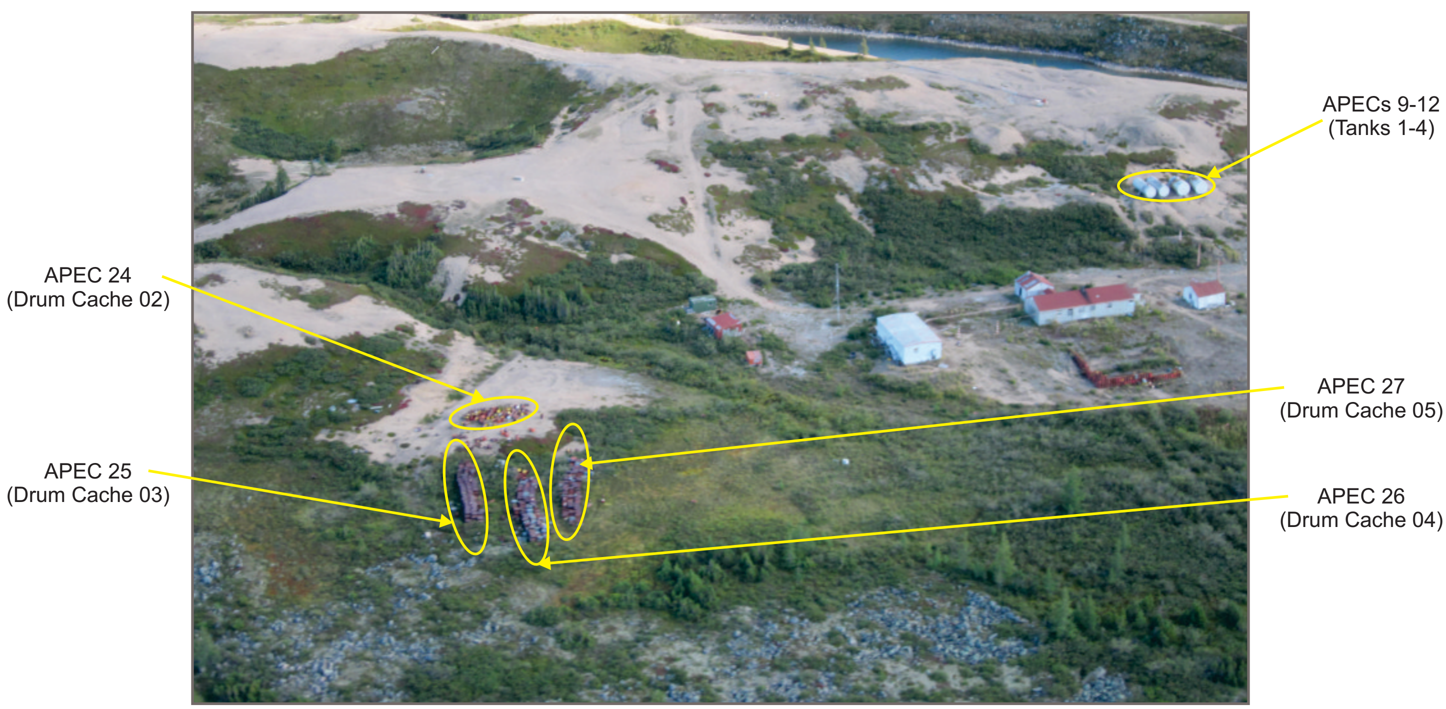

Photo 4: View of the drum caches and buildings, looking southeast

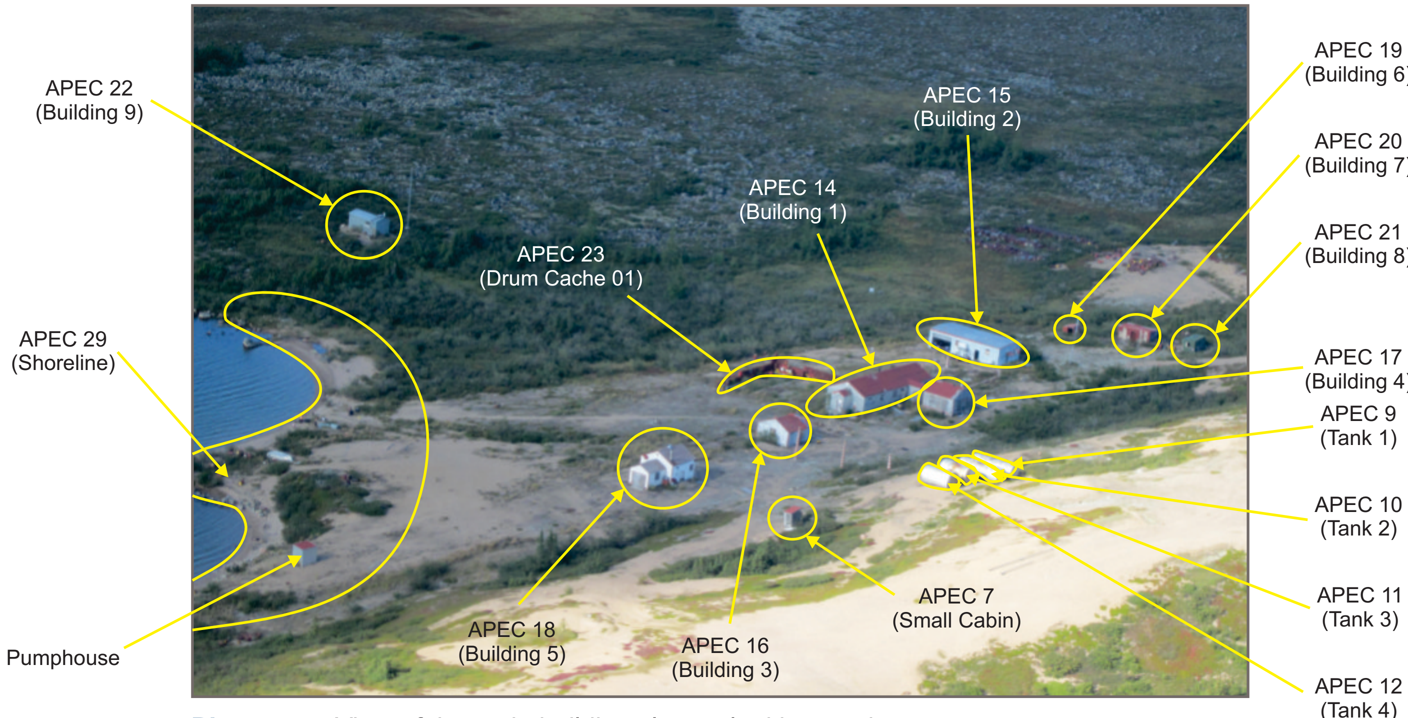

Photo 5: View of the main building cluster, looking north

Photo 6: View of the Site, looking northeast

Photo 7: Floatplane docked at the beach at the Ennadai Lake Former Weather Station site

Photo 8: Typical trail system on esker

Photo 9: Trail through main esker complex looking south toward Landfarm 1

Photo 10: Airstrip at Ennadai Lake, Former Weather Station, looking north from above

Photo 11: Airstrip looking east

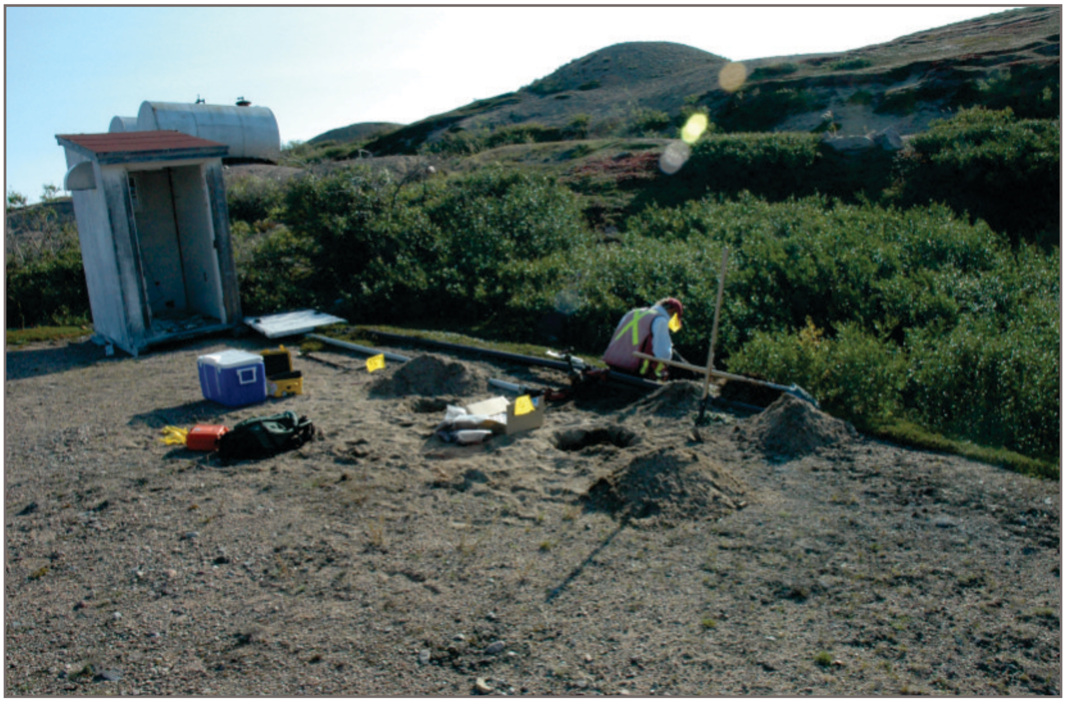

Photo E-1: APEC 1 - Stain 1 - Flag markers depicting soil delineation samples APEC 1-SS001, SS002 and SS003

Photo E-2: APEC 1 - Stain 1 - Flag locations for delineation soil samples APEC 1-SS004 and SS005 in a low lying depressional area

Photo E-3: APEC 2 - Stain 2 - Flag locations for delineation soil samples APEC 2-SS001, SS002 and SS003; coarse-grained sand and cobbles were prevalent throughout the esker

Photo E-4: APEC 3 Stain 3 - Delineating terminal extent of the pipeline

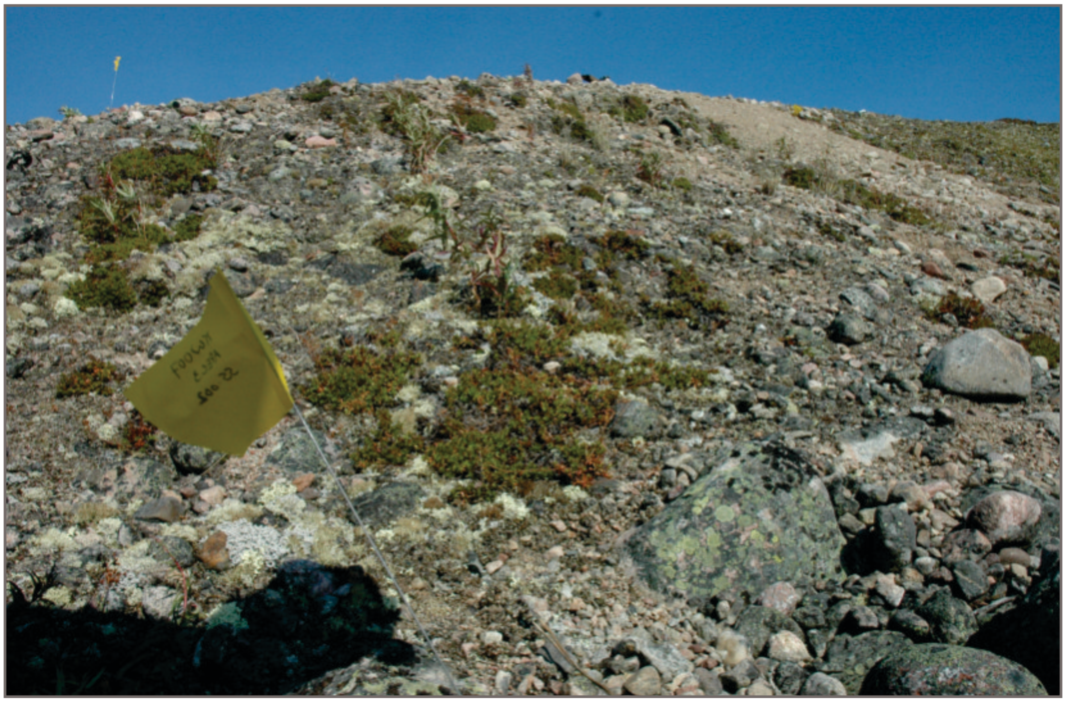

Photo E-5: APEC 3 - Stain 3 - Terminal extent of pipeline facing up-gradient from the shoreline

Photo E-6: APEC 4b - Tank 5 - Delineation of tanks; staining can be seen at the valve

Photo E-7: APEC 4a - Tank 5 - Flag locations for delineation soil samples facing up-gradient toward the tank

Photo E-8: APEC 4a - Tank 5 - Flag locations for soil samples APEC 4a- SS001, staining was noted at the valve of the AST

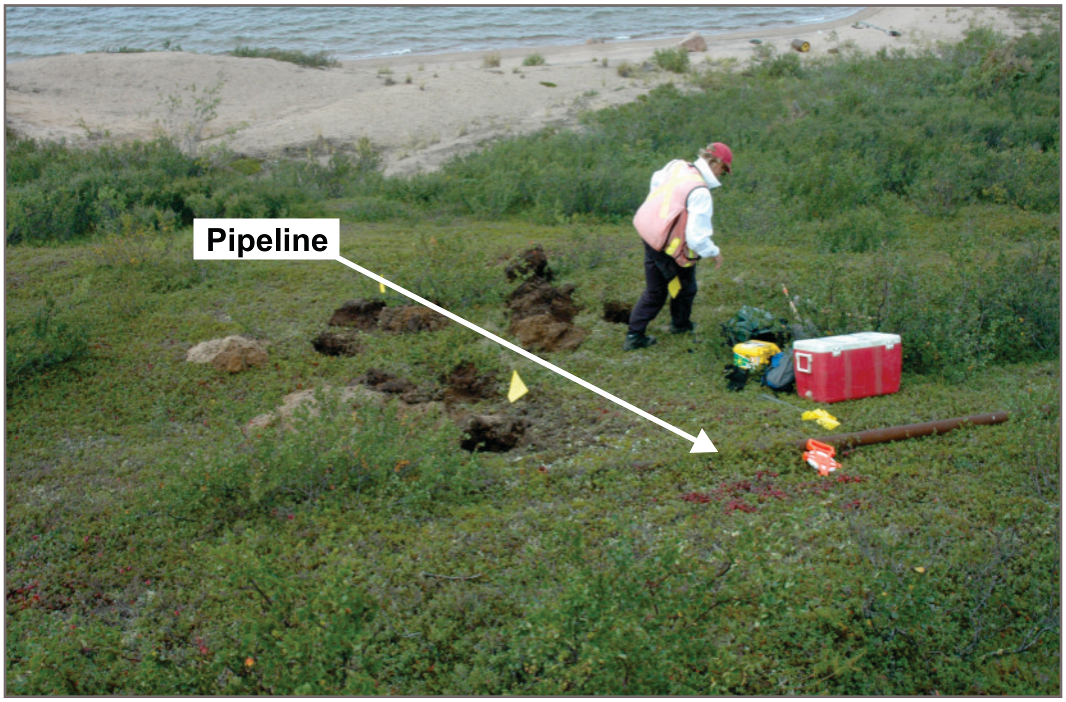

Photo E-9: APEC 8 - Pipeline - Flag locations for delineation soil samples APEC 8-SS004, SS005 and SS006; staining was noted along the pipeline at a junction

Photo E-10: APEC 8 - Pipeline - Sample location taken down-gradient of APEC1; delineation soil sample APEC 8-SS011 is shown; both samples taken in a low lying depressional area, hydrocarbon odour was noted

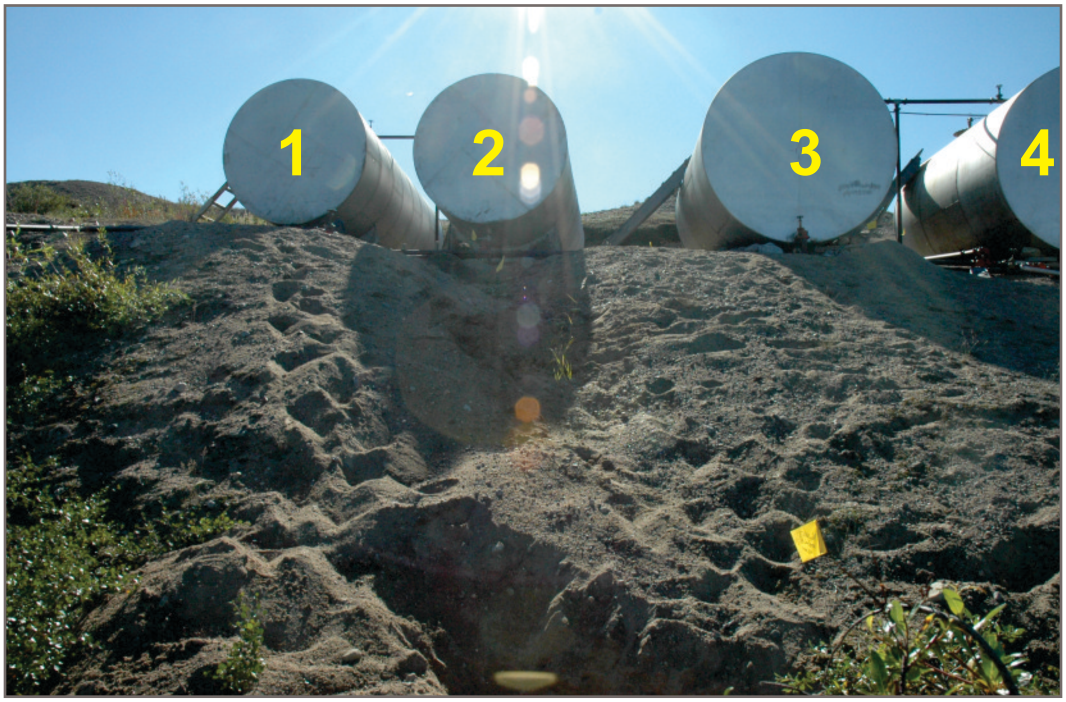

Photo E-11: APEC 9 - 12 - Delineation soil sample APEC 9-SS004 and Tanks 1 - 4 are shown; the picture was taken looking east up-gradient toward the tank farm; sand fill was present on the slope

Photo E-12: APEC 9 - Tank 1- Soil sample location APEC 9- SS001; the soil sample was taken down-gradient of the fuel distribution lines; significant hydrocarbon odour and staining around the valves was noted

Photo E-13: APEC 12 - Tank 4 - Delineation soil sample APEC 12-SS007 is shown looking north toward the tank farm; in the background soil samples APEC 12-SS001 to SS005 can be seen delineating the hydrocarbon plume

Photo E-14: APEC 13-Overhead Pipeline- Delineation soil samples APEC 13 SS002 to SS009 are seen between Building 3 (APEC 16) and Building 5 (APEC 18). An active leak was present at the time of the Site investigation.

Photo E-15: APEC 13/APEC 14 - Overhead Pipeline/Building 1 - Delineation soil sample locations APEC 13-SS010 to SS017 are shown; hydrocarbon odour was noted at the base of the foundation

Photo E-16: APEC 15 - Building 2 - Delineation soil sample locations APEC 15 SS001 to SS003 are shown; the picture was taken facing northwest

Photo E-17: APEC 15 - Building 2 - Delineation soil sample locations APEC 15-SS002 to SS005 shown; the picture was taken facing north

Photo E-18: APEC 15 - Building 2 - Delineation soil sample locations APEC 15-SS005, SS006 and SS008; the picture was taken facing northeast

Photo E-19: APEC 18 - Building 5 - Delineation soil sampling locations APEC 18-SS001 to SS006; a concrete pad and excavator were present in the building

Photo E-20: APEC 18 - Building 5 - Delineation soil sampling locations APEC 18-SS001 to SS006; the photo was taken facing south toward the building

Photo E-21: APEC 19 and APEC 20 - Buildings 7 and 8 - Hydrocarbon contamination was identified between the buildings

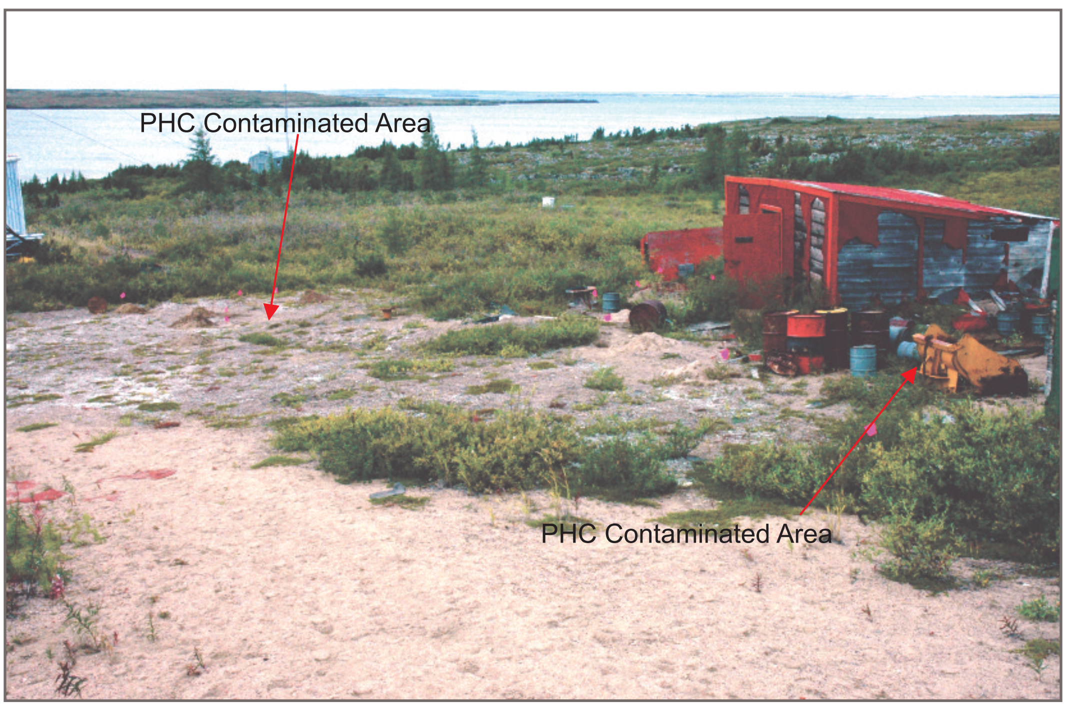

Photo E-22: APEC 19 and 20 - Buildings 7 and 8 - Two areas of hydrocarbon contamination were identified. The approximate locations of the areas are shown.

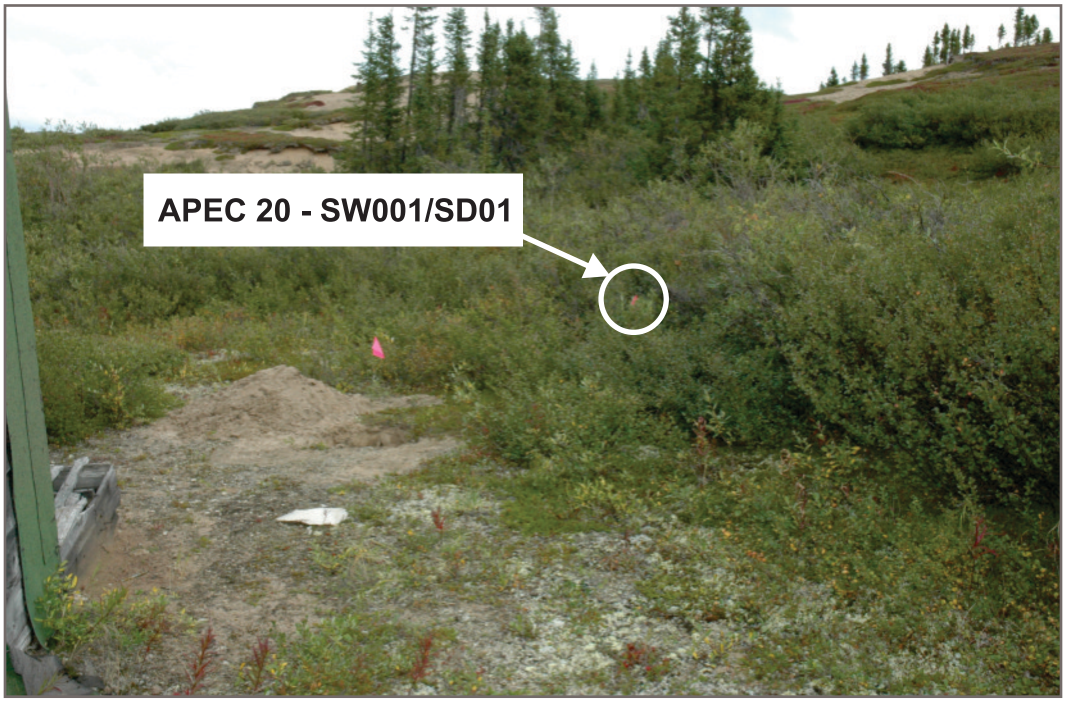

Photo E-23: APEC 19 - Building 7 - A drainage/seepage pathway was located behind the APECs running toward Ennadai Lake; sediment and surface water samples APEC 20-SW001 and APEC 20-SD-01 are shown

Photo E-24: APEC 20 - Building 8 - Soil sample APEC 20-SS017 is shown; water was encountered upon the completion of the test pit

Photo E-25: APEC 23 - Drum Cache 1/Wind Break- Delineation soil samples APEC 23-SS001, SS003 and SS005 are shown; a historic fuel cache was formerly located south of APEC 23 toward Ennadai Lake

Photo E-26: APEC 28 - Debris Area, organic soil/matter was encountered overlaying sand, multiple layers of waste were discovered during test pitting

Photo E-27: APEC 29 - Shoreline - Various empty barrels were found around the Site; there was no staining or odour noted

Photo E-28: General Soil Condition taken at APEC 12 - Sand with an estimated 5 - 10% cobbles, located at the toe of APEC 12

Photo E-29: General Soil Condition at APEC 3 - Sand with an estimated 10 - 20 % cobbles and gravel at terminal extent of pipeline near Stain 3

Photo E-30: General Soil Condition at APEC 13 (Central Buildings) - Well sorted sand with some gravel

Photo G1: Trail from main camp site to Landfill 3.

Photo G2: Trail from Landfill 3 to Landfill 2.

Photo G3: Trail through main esker complex looking south towards Borrow 7 and Landfarm 1.

Photo G4: Trail on top of main esker complex near Environment Canada Weather Station.

Photo G5: Trail from main camp site towards Landfill 4, looking northeast.

Photo G6: Airstrip at Ennadai Lake, Former Weather Station, looking north from above.

Photo G7: Airstrip at Ennadai Lake Former Weather Station, looking northeast.

Photo G8: Airstrip at Ennadai Lake Former Weather Station, looking southwest.

Photo G9: End of airstrip at Ennadai Lake Former Weather Station, looking east.

Photo G10: Western end of airstrip at Ennadai Lake Former Weather Station, looking northeast.

Photo G11: Borrow 1 in the foreground, Landfill 3 in the mid-ground, and Borrow 5 in the background, looking southwest.

Photo G12: Borrow 1 in the background, with debris in Landfill 2 in the foreground, looking north northwest.

Photo G13: Borrow 1, with organic deposit in the foreground, looking southwest.

Photo G14: Borrow 2 ridge with water body on the right, and Landfill 4 in the background on the right, looking west.

Photo G15: Borrow 2 ridge in background, looking south.

Photo G16: Borrow 2 - Testpit (TP15).

Photo G17: Borrow 4, with airstrip in foreground, looking east northeast.

Photo G18: Borrow 4, with airstrip in foreground, looking northeast.

Photo G19: Borrow 5, looking west.

Photo G20: Borrow 5, north side, looking west.

Photo G21: Borrow 5, north side with Borrow 2 in the background on the left, looking west southwest.

Photo G22: Borrow 5, top, looking west.

Photo G23: Borrow 6, looking east.

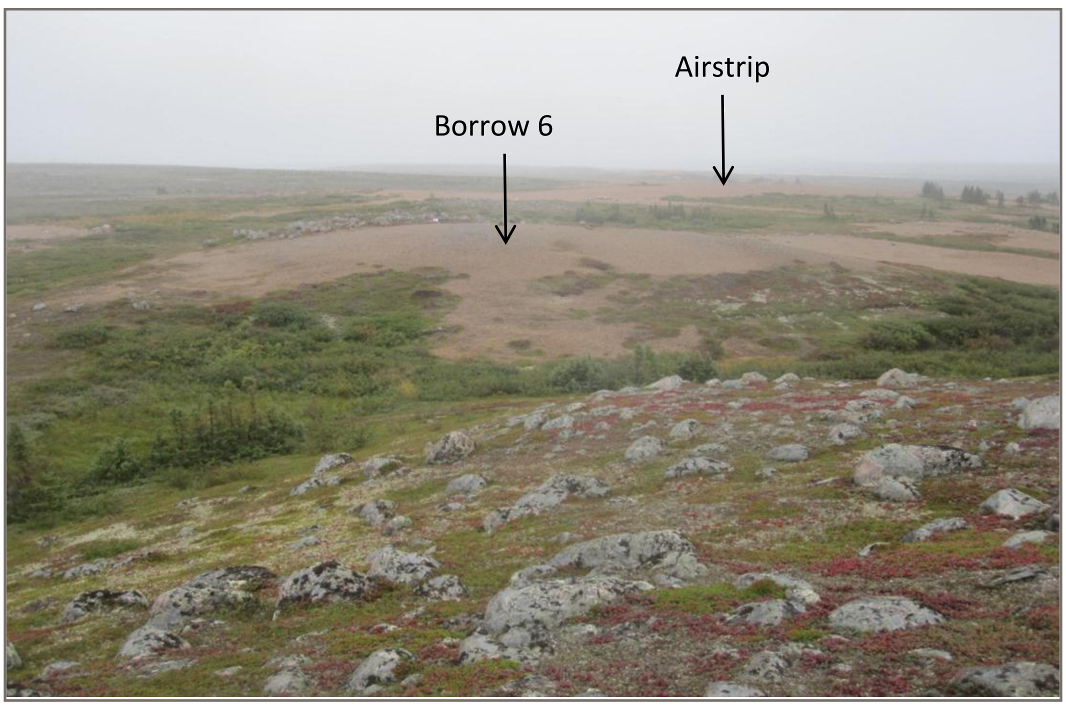

Photo G24: Borrow 6, airstrip in the background, looking northeast.

Photo G25: Borrow 6, Borrow 1 in the background, looking west.

Photo G26: Borrow 6 - Testpit (TP20).

Photo G27: Borrow 7, looking south.

Photo G28: Borrow 7, southern extent, showing gentle side slopes and adjacent organic deposits, looking southeast.

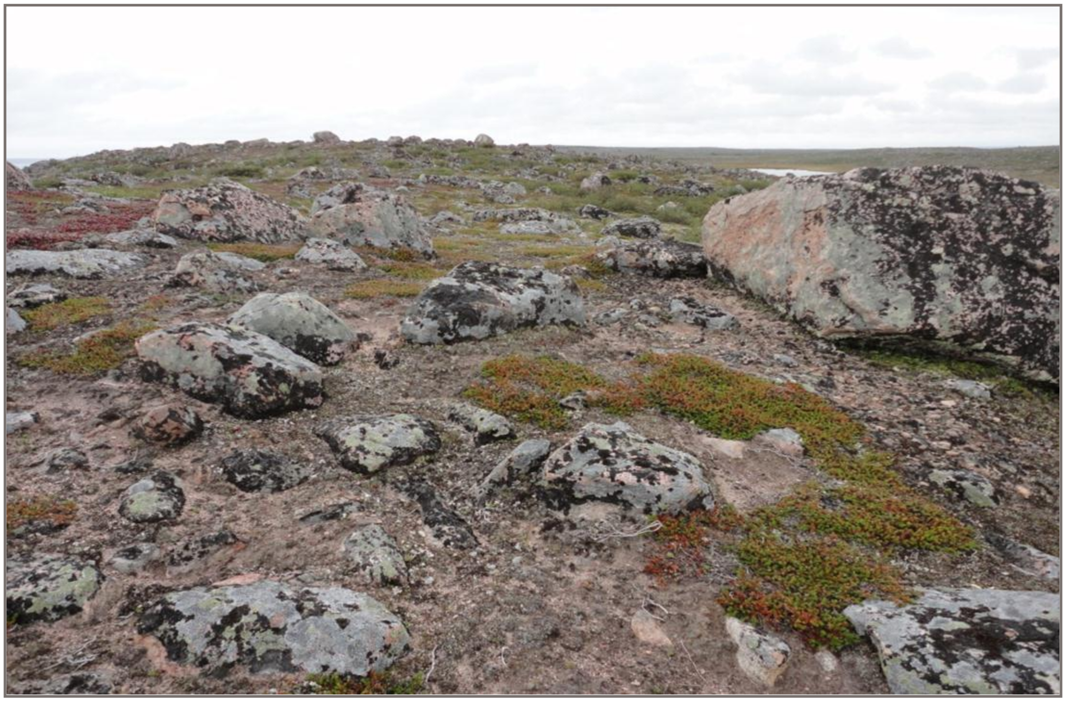

Photo G29: Borrow 8, looking north.

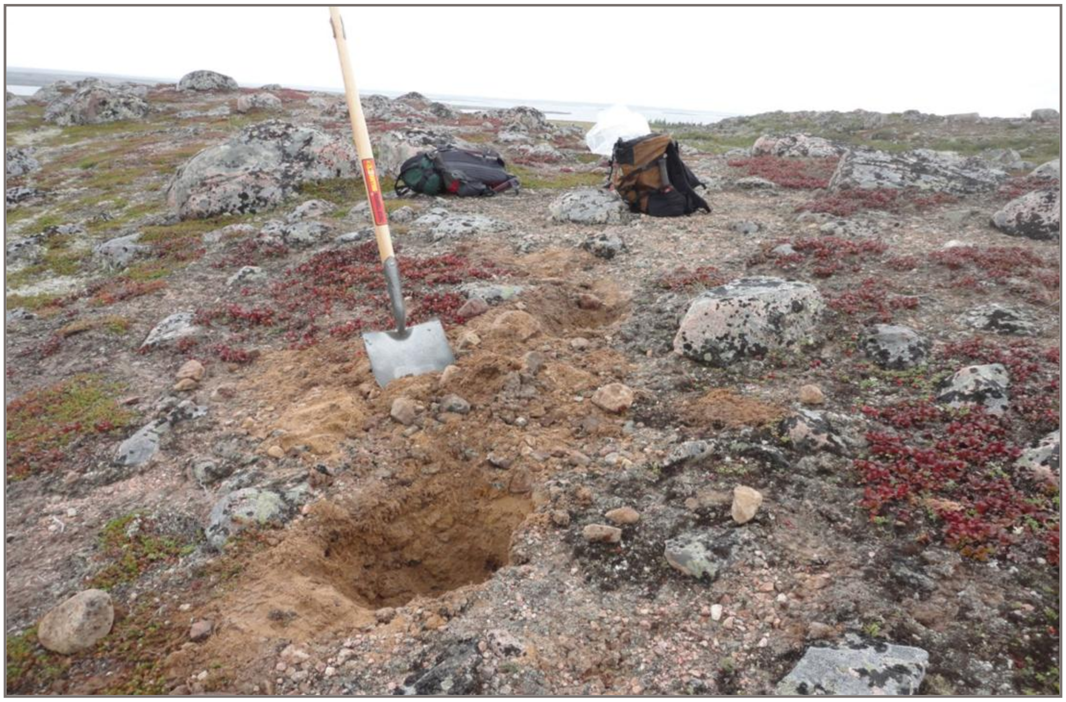

Photo G30: Borrow 8 – Testpit (TP13).

Photo G31: Potential Landfill 1, looking northeast.

Photo G32: Potential Landfill 1, looking northwest.

Photo G33: Potential Landfill 2, looking east.

Photo G34: Potential Landfill 2, looking southeast.

Photo G35: Potential Landfill 2 - Testpit (TP04), showing subrounded gravel removed from testpit.

Photo G36: Potential Landfill 3, looking southwest.

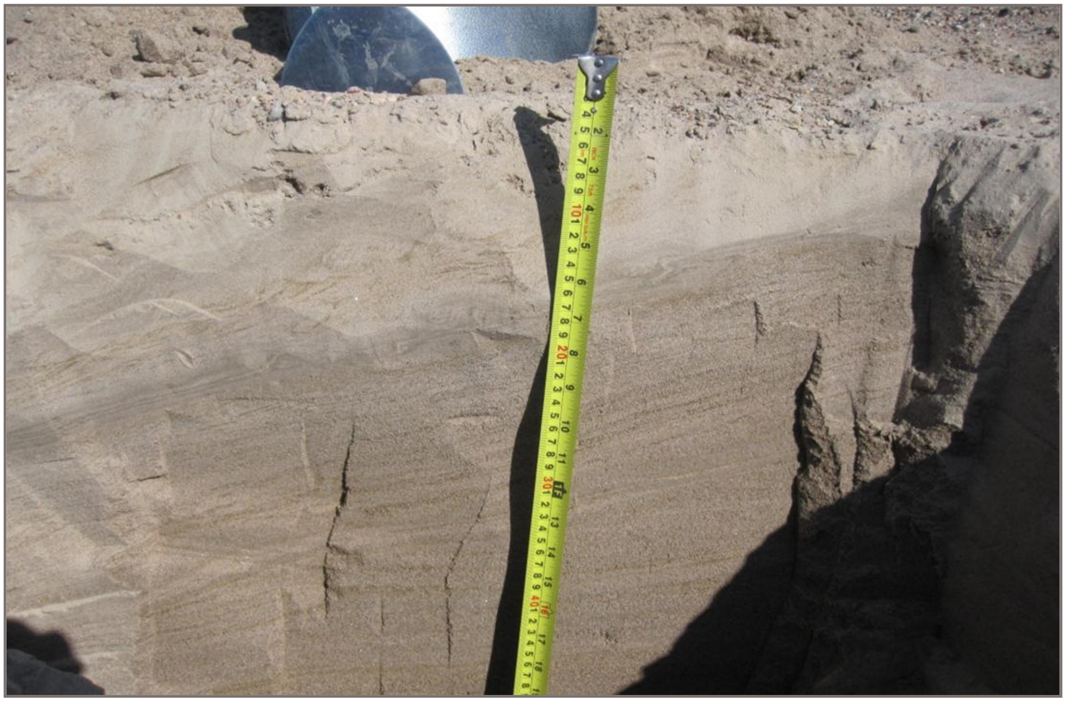

Photo G37: Potential Landfill 3 – Testpit (TP01).

Photo G38: Potential Landfill 4, looking north.

Photo G39: Potential Landfill 4, looking east northeast towards Borrow 5.

Photo G40: Potential Landfarm 1, looking south.

Photo G41: Potential Landfarm 1, looking west.

Photo G42: Potential Landfarm 2, looking northwest.

Photo G43: Landfarm 2, looking southeast.

Photo G44: Landfarm 2, looking west.

Photo H-1: APEC 3 – Stain 3 – Organic content remaining in the pipeline

Photo H-2: APEC 4 - Tank 5 (42000L) - Organic content remaining in Tank 5

Photo H-3: APEC 5 - Drums (Located on the shore of Ennadai Lake) - Total and leachable lead painted drums

Photo H-4: APEC 6 - Medium Cabin - Asbestos black felt, total lead and leachable lead painted wood exterior and drums and lubricants

Photo H-5: APEC 7 - Small Cabin - Asbestos black felt and panels, and total and leachable painted wood

Photo H-6: APEC 8 - Pipeline - View from Tanks 1-4, looking toward the Small Cabin and esker

Photo H-7: APEC 9 - 12 - Close up of Tanks 1-4, Tank 1 on the far right and Tank 4 is on the far left

Photo H-8: APEC 9 - 12 - Tanks 1-4 - View looking west, Tank 1 on the far right and Tank 4 is on the far left; asbestos gaskets on all tanks and organic content in all tanks, except for Tank 3

Photo H-9: APEC 9 - Tank 1 - Close-up of asbestos gasket

Photo H-10: APEC 13 - Overhead piping from tanks to Buildings - View of overhead piping towards Building 3; total and leachable lead painted concrete and organic content in pipeline

Photo H-11: APEC 13 - Overhead piping from tanks to Building - View of overhead piping towards Building 2; total and leachable lead painted concrete and organic content in pipeline

Photo H-12: APEC 14 - Building 1 - Asbestos black felt, asbestos window caulking, total and leachable lead painted wood

Photo H-13: APEC 14 - Building 1 - Basement total lead and leachable lead painted concrete walls, miscellaneous chemicals, ODS in freezer, mould on wood beams and concrete

Photo H-14: APEC 14 - Building 1 - Basement northwest wall

Photo H-15: APEC 14 - Building 1 - Basement unknown crystallized white material (possibly a cleaning product)

Photo H-16: APEC 14 - Building 1 - Basement two drums and jerry cans, assumed to be full of diesel, new, labelled: Paul Anowtalik and Tony V's property

Photo H-17: APEC 14 - Building 1 - Leachable lead seals on cast iron piping and tanks behind

Photo H-18: APEC 14 - Building 1 - Main floor hallway, viewing northeast; asbestos flooring wall panels and ceiling, total lead and leachable lead painted asbestos panels on walls and second layer of ceiling particulate board

Photo H-19: APEC 14 - Building 1 - Main floor kitchen; asbestos flooring, wall panels and ceiling, total lead and leachable lead painted wood shelves, mercury vapor in lights and PCBs in light ballasts

Photo H-20: APEC 14 - Building 1 - Main floor living room and bedrooms; asbestos flooring, wall panels and ceiling

Photo H-21: APEC 14 - Building 1 - Main floor control desk; asbestos walls and ceiling, PCBs, mercury and lead solder in electrical parts

Photo H-22: APEC 14 - Building 1 - Main floor electrical box. Asbestos walls and ceiling, PCBs, mercury and lead solder in electrical parts.

Photo H-23: APEC 14 - Building 1 - Asbestos attic insulation

Photo H-24: APEC 15 - Building 2 - Asbestos black felt, asbestos window caulking, total and leachable lead painted wood, organic content in the AST and drum

Photo H-25: APEC 15 - Building 2 - Northwest half of building; total lead and leachable lead painted metal walls, ceiling and concrete floor, mercury in lights and PCBs in light ballasts

Photo H-26: APEC 15 - Building 2 - Total lead, leachable lead and PCBs painted generators, total lead, leachable lead and PCBs painted plastic over fibreglass insulation, ceiling and concrete floor miscellaneous fluids in generators and lead acid batteries

Photo H-27: APEC 15 - Building 2 - Miscellaneous chemicals, total lead and leachable lead painted metal walls, ceiling and concrete floor

Photo H-28: APEC 16 - Building 3 - Asbestos black felt, attic insulation, window caulking and total lead and leachable lead painted wood

Photo H-29: APEC 16 - Building 3 - Total lead and leachable lead painted wood and compressed gas cylinder

Photo H-30: APEC 16 - Building 3 - Total lead and leachable lead painted wood and miscellaneous containers of oil/lubricants/fuel

Photo H-31: APEC 17 - Building 4 - Asbestos black felt, attic insulation, window caulking, walls panels and total lead and leachable lead painted wood

Photo H-32: APEC 17 - Building 4 - Asbestos chimney tile and ceiling tile, and total lead and leachable lead painted wood

Photo H-33: APEC 17 - Building 4 - Asbestos insulation, and total lead and leachable lead painted wood

Photo H-34: APEC 18 - Building 5 - Asbestos exterior panels, black felt, attic insulation, window caulking, and total lead and leachable lead painted wood

Photo H-35: APEC 18 - Building 5 - Total lead and leachable lead painted wood and equipment, lead acid batteries and miscellaneous containers of oil/lubricants

Photo H-36: APEC 18 - Building 5 - Total lead and leachable lead painted wood, AST organic contents and miscellaneous containers of oil/lubricants

Photo H-37: APEC 18 - Building 5 - Total lead and leachable lead painted caterpillar

Photo H-38: APEC 18 - Building 5 - Fibre glass insulation (not containing asbestos)

Photo H-39: APEC 19 - Building 6 - Total lead and leachable lead painted wood

Photo H-40: APEC 20 - Building 7 - Asbestos exterior asphalt shingles and total lead and leachable lead painted wood

Photo H-41: APEC 20 - Building 7 - Asbestos flooring, asbestos white piping, asbestos black felt, total and leachable lead painted wood and metal, miscellaneous containers of oil/lubricants, drum content (clear, flammable) and PCBs in light ballasts and electrical equipment

Photo H-42: APEC 21 - Building 8 - Asbestos exterior asphalt shingles and black felt

Photo H-43: APEC 21 - Building 8 - Miscellaneous containers of oil/lubricants

Photo H-44: APEC 21 - Cement mixer, painted with total lead and leachable lead paint

Photo H-45: APEC 21 - Organic content in 205L and 20L drums between Building 7 and Building 8

Photo H-46: APEC 22 - Building 9 - Metal exterior and total lead and leachable lead painted metal tower and drums, and drum content (organic)

Photo H-47: APEC 22 - Building 9 - Interior asbestos panels and fire extinguisher

Photo H-48: APEC 23 - Drum Cache 1 - Total lead and leachable lead painted drums welded together and drum content (organic)

Photo H-49: APEC 24 – Drum Cache 2 - Total lead and leachable lead painted drums and drum content (organic)

Photo H-50: APEC 24 – Drum Cache 2 - Total lead and leachable lead painted drum and some organic drum content

Photo H-51: APEC 25 - Drum Cache 3 - Total lead and leachable lead painted drums and drum content (organic)

Photo H-52: APEC 26 - Drum Cache 4 - Total lead and leachable lead painted drums

Photo H-53: APEC 27 - Drum Cache 5 - Total lead and leachable lead painted drums

Photo H-54: APEC 25-27 - Drum Cache 3 on the right, Drum Cache 4 in the center and Drum Cache 5 on the left - Total lead and leachable lead painted drum and drum content (organic)

Photo H-55: APEC 28 - Main Debris Area - Metal debris

Photo H-56: APEC 28 - Main Debris Area - Partially buried total and leachable lead paint wood, metal and drums, electrical parts and lead acid batteries

Photo H-57: APEC 29 - Shoreline Debris Area and Pumphouse (in background) - Various metal and wood debris

Photo H-58: APEC 29 - Pumphouse - Asbestos black felt, total lead and leachable lead painted equipment and wood

Photo H-59: APEC 29 - Total lead and leachable lead painted drum with blue, flammable content

Photo H-60: APEC N/A - Building 10 - Total and leachable lead painted metal tower and Building 10 in background

Photo H-61: APEC N/A - Building 10 - Antenna Tuning Unit Shelter, Total lead and leachable lead painted wood and asbestos panel

Photo H-62: APEC N/A - Building 10 - Antenna Tuning Unit Shelter interior

Photo H-63: APEC N/A - Scattered debris throughout and adjacent to the site - metal cans and debris west of the main building cluster on the hill

Photo H-64: APEC N/A - Scattered debris throughout and adjacent to the site - Two total lead and leachable lead painted metal towers west of the main building cluster, on the top of the hill

Photo H-65: APEC N/A - Scattered debris throughout and adjacent to the site; new drums and organic drum content by the airstrip

APPENDIX D
GEOTECHNICAL INFORMATION

Table G1: Summary of Borrow Sources Identified for Remedial Action Plan - Former Weather Station, Ennadai Lake, NU

Borrow Source	Assumed Thickness (m^3)	Estimated Volume (m^3)	Testpits	Material Description	Notes
B1	2	21,500	TP08 TP09 TP10	Gravelly Sand & Silt and Sand	- Previously disturbed -Close to spring - Partially on IOL - Accessible and close to site
B2	2	26,100*	TP15 TP16	Gravel and Sand	- Steep side slopes - Close to water bodies - Accessible and close to site - Requires construction of haul road
B4	2	22,800	TP12	Gravelly Sand & Gravel and Sand	- Close to spring - Partially on IOL - Accessible to airstrip
B5	2	40,000	Geotech-1 Geotech-2 Geotech-3 Geotech-4 Geotech-5	Sand & Gravelly Sand to Silty Sand	- Previously disturbed - Steep side slopes - Close to water bodies - Accessible
B6	2	9,000	TP19 TP20	Sand and Gravel	- Accessible to airstrip
B7	0.5	27,900	TP14	Gravelly Sand	- Vegetated and undisturbed - 30% boulders exposed on surface - Accessible and close to site - Requires construction of haul road
B8	0.5	6,300	TP13	Sand and Gravel	- Vegetated and undisturbed - 30% boulders exposed on surface

*Accounting for steep side slopes

Table G2: Summary of Landfill/Landfarm areas Identified for Remedial Action Plan - Former Weather Station, Ennadai Lake, NU

Potential Landfill/Landfarm Area	Area (m^2)	Testpits/ Probeholes (Depth)	Material Description	Surface Condition	Notes
Landfill 1	4,300	N/A	Sand	- Exposed Sand - Patches of Vegetation - Cache of empty fuel drums	- Overlaps western portion of Borrow 1 - Close to site - Accessible - Close to spring
Landfill 2	3,600	TP04 PH05 PH06 TP07	Sand & Silty Sand	- Exposed Sand - Patches of Vegetation - Previously disturbed area	- Debris pile at eastern extent - Close to site - Accessible
Landfill 3	2,600	TP01 PH02 PH03	Silty Sand	- Exposed Sand - Unvegetated	- Restricted size - Close to site - Accessible
Landfill 4	5,000	Geotech-5	Sand	- Exposed Sand - Unvegetated	- Overlaps western portion of Borrow 5 - Close to site - Accessible - Close to water body
Landfarm 1	11,000	TP14	Gravelly Sand	- Vegetated and undisturbed - Gentle side slopes - 30% boulders exposed on surface	- Overlaps Borrow 7 - Requires construction of haul road
Landfarm 2	10,700	N/A	Sand	- Exposed Sand - Patches of grass	- Overlaps IOL - Requires construction of haul road

Table G3: Summary of Testpits, Samples Collected, and Lab Test Results for Remedial Action Plan - Former Weather Station, Ennadai Lake, NU

Testpit ID	Testpit Depth (m)	Location	Sample ID	Sample Depth (m)	Gravel (%)	Sand (%)	Fines (%)	Moisture (%)	Material Description	Comment
TP01	1.1	Landfill 3	TP01-S01	0.0 - 1.1	0	66	34 (1% Clay)	5.3	SAND (Glaciofluvial) silty, trace clay, uniformly graded fine sand, dry at surface and damp at depth, light brown/grey, cross-bedding	Blended composite sample was taken from side wall of testpit. Material was uniform with depth.
PH02	1.3	Landfill 3	PH02-S02	0.0 - 1.3	1	71	28	7.8	SAND (Glaciofluvial) silty, trace gravel, poorly-graded fine to medium sand, dry at surface and damp at depth, light brown/grey	Blended composite sample was taken using a soil auger. Material was uniform with depth.
PH03	1.3	Landfill 3	PH03-S03	0.0 - 1.3	3	93	4	1.7	SAND (Glaciofluvial) trace gravel, trace fines, poorly-graded fine to medium sand, dry, light brown/grey	Blended composite sample was taken using a soil auger. Material was uniform with depth.
TP04	1.0	Landfill 2	TP04-S04	0.25 - 1.0	7	76	17	4.9	SAND (Glaciofluvial) some silt, fine to coarse sand, trace subrounded fine to coarse gravel, occasional subrounded cobble, dry at surface and damp at depth, light grey	Blended composite sample was taken from side wall of testpit. Gravel increased gradually with depth.
PH05	0.9	Landfill 2	PH05-S05	0.0 - 0.9	2	72	26	5.4	SAND (Glaciofluvial) silty, fine to medium sand, trace fine gravel, dry at surface and damp at depth, light grey	Blended composite sample was taken using a soil auger. Material was uniform with depth. Refusal at 0.9 m
PH06	1.0	Landfill 2	PH06-S06	0.0 - 1.0	5	73	22	6.5	SAND (Glaciofluvial) silty, fine to medium sand, trace gravel, dry at surface and damp at depth, light grey	Blended composite sample was taken using a soil auger. Material was uniform with depth. Refusal at 1.0 m
TP07	0.5	Landfill 2	TP07-S07	0.0 - 0.5	7	92	1	1.8	SAND (Glaciofluvial) trace gravel, trace fines, well graded fine to coarse sand, dry, light brown/grey	Blended composite sample was taken from side wall of testpit. Material was uniform with depth.
TP08	0.5	Borrow 1	TP08-S08	0.0 - 0.5	23	74	3	2	SAND (Glaciofluvial) gravelly, trace fines, fine to coarse sand, fine subrounded gravel, well-graded, dry, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michael Bernardin (PWGSC). No description of testpit recorded.
TP09	0.5	Borrow 1	TP09-S09	0.0 - 0.5	25	74	1	2.7	SAND (Glaciofluvial) gravelly, trace fines, fine to coarse sand, fine to coarse subrounded gravel, well-graded, dry, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michael Bernardin (PWGSC). No description of testpit recorded.
TP10	0.5	Borrow 1	TP10-S10	0.0 - 0.5	0	46	54	8.4	SILT & SAND (Glaciofluvial) fine sand, poorly-graded, moist, light grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michael Bernardin (PWGSC). No description of testpit recorded.
TP12	0.5	Borrow 4	TP12-S12	0.0 - 0.5	16	83	1	1.5	SAND (Glaciofluvial) some subrounded gravel, trace fines, medium to coarse sand, poorly-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Material was uniform with depth.
TP13	0.5	Borrow 8	TP13-S13	0.0 - 0.5	57	37	6	2.2	GRAVEL & SAND (Till) trace fines, some cobbles, fine to coarse subrounded gravel, fine to coarse sand, well-graded, damp, brown	Blended composite sample was taken from side wall of testpit. Material was uniform with depth. Surface was 60-70% covered with boulders 0.5 to 1.5 m in size.
TP14	0.5	Landfarm 1 & Borrow 7	TP14-S14	0.0 - 0.5	29	57	14	4.3	SAND (Till) gravelly, some fines, fine subrounded gravel, fine to coarse sand, occasional cobble, well-graded, damp, brown	Blended composite sample was taken from side wall of testpit. Material was uniform with depth. Surface was 40-50% covered with boulders 0.5 to 1.0 m in size.
TP15	0.5	Borrow 2	TP15-S15	0.0 - 0.5	50	47	3	2.3	GRAVEL & SAND (Glaciofluvial) trace fines, fine to coarse subrounded gravel, fine to coarse sand, well-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Material was uniform with depth.

Table G3: Summary of Testpits, Samples Collected, and Lab Test Results for Remedial Action Plan - Former Weather Station, Ennadai Lake, NU

Testpit ID	Testpit Depth (m)	Location	Sample ID	Sample Depth (m)	Gravel (%)	Sand (%)	Fines (%)	Moisture (%)	Material Description	Comment
TP16	0.5	Borrow 2	TP16-S16	0.0 - 0.5	38	58	4	2.6	SAND & GRAVEL (Glaciofluvial) trace fines, fine to coarse subrounded gravel, fine to coarse sand, well-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Material was uniform with depth.
TP19	0.5	Borrow 6	TP19-S19	0.0 - 0.5	41	56	3	2.3	SAND & GRAVEL (Glaciofluvial) trace fines, fine to coarse subrounded gravel, medium to coarse sand, well-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Material was uniform with depth.
TP20	0.5	Borrow 6	TP20-S20	0.0 - 0.5	36	62	2	1.7	SAND & GRAVEL (Glaciofluvial) trace fines, fine to coarse subrounded gravel, medium to coarse sand, well-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Material was uniform with depth.
Geotech - 1	0.5	Borrow 5	Geotech - 1	0.0 - 0.5	0	99	1	2.5	SAND (Glaciofluvial) fine sand, trace fines, poorly-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michele Crawford (EBA). No description of testpit recorded.
Geotech - 2	0.5	Borrow 5	Geotech - 2	0.0 - 0.5	27	71	2	2	SAND (Glaciofluvial) gravelly, trace fines, fine to coarse sand, fine to coarse subrounded gravel, well-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michele Crawford (EBA). No description of testpit recorded.
Geotech - 3	0.5	Borrow 5	Geotech - 3	0.0 - 0.5	0	73	27	6.6	SAND (Glaciofluvial) silty, fine sand, poorly-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michele Crawford (EBA). No description of testpit recorded.
Geotech - 4	0.5	Borrow 5	Geotech - 4	0.0 - 0.5	2	97	1	2.5	SAND (Glaciofluvial) trace gravel, trace fines, fine to medium sand, poorly-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michele Crawford (EBA). No description of testpit recorded.
Geotech - 5	0.5	Landfill 4 & Borrow 5	Geotech - 5	0.0 - 0.5	1	98	1	2.5	SAND (Glaciofluvial) trace gravel, trace fines, fine to medium sand, poorly-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michele Crawford (EBA). No description of testpit recorded.
Geotech - 6	0.5	West of Borrow 5	Geotech - 6	0.0 - 0.5	25	72	3	2.9	SAND (Glaciofluvial) gravelly, trace fines, fine to coarse sand, fine to coarse subrounded gravel, well-graded, damp, light brown/grey	Blended composite sample was taken from side wall of testpit. Sample collected by Michele Crawford (EBA). No description of testpit recorded.