APPENDIX 6:

HOPE LAKE
REMEDIATION PROJECT

ENVIRONMENTAL SCREENING REPORT

Public Works and Government Services Canada

ISSUED FOR USE

ENVIRONMENTAL SCREENING ASSESSMENT OF THE PROPOSED REMEDIATION OF THE HOPE LAKE SITES UNDER THE NUNAVUT IMPACT REVIEW PROCESS
HOPE LAKE, NUNAVUT

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

EBA Engineering Consultants Ltd. (EBA) was hired by PWGSC to complete a Phase III Environmental Site Assessment (ESA), a Remedial Action Plan (RAP) and an Environmental Screening Assessment Report (ESAR) for the Hope Lake Remediation Project. The project area consists of three mineral exploration sites: Hope Lake, Willow Creek, and Husky Creek. Of the three locations, Hope Lake is the largest site, while the Willow Creek includes three smaller sites, and Husky Creek two separate sites. All three sites are located approximately 75 km south of Kugluktuk, Nunavut. The hazardous waste, non-hazardous debris, and current levels of disturbance at three sites are due to mineral exploration activities that occurred in the late 1960s.

This ESAR has been completed to identify potential impacts of the RAP on the environment and propose actions to mitigate such impacts so that the project can proceed through the licensing, contracting, and remediation phases.

The instigation for the submission of this ESAR is that the proposed RAP for the project is defined as a "project proposal" under the *Nunavut Land Claims Agreement* and therefore must be screened by the Nunavut Impact Review Board.

To complete remediation of the three sites, the RAP proposes that unpainted wood and liquids be treated on-site and all other hazardous and non-hazardous materials be removed off-site to an appropriate landfill. The alternative to shipping the non-hazardous material off-site would be to build a landfill on-site; however, hazardous material would still be removed from all three sites. The recommended remediation option for metal, salt and hydrocarbon contaminated soil is removal off-site. For hydrocarbon-contaminated soil, site-specific remediation criteria (SSRC) are being used. If the SSRC is not accepted by the regulators, a landfarm would be constructed to treat the remaining hydrocarbon-contaminated soil.

Findings and Conclusions

The project area is located in the southern Arctic ecozone that encounters long, cold winters and short, cool summers. Most of the southern Arctic ecozone is underlain by Precambrian granitic and continuous permafrost. Cryosols are the dominant soils in the southern Arctic ecozone, and soils at all three sites were classified as various types of Cryosols. Soils encountered during the field program consisted typically of a few centimetres of LFH horizon followed by a B horizon, usually of friable or loose silty clay texture with abundant cobbles and gravel.

The southern Arctic ecozone represents a transition from the boreal forest plant communities in the south and the Arctic tundra plant communities in the north. The vegetation at the three sites is characteristic of this ecozone where the upland overstory is dominated by the presence of dwarf shrubs and low-lying areas are dominated by wetlands, which primarily consist of sedge-moss vegetation. Wildlife in the area ranges from shrew to ptarmigan and grizzly bear to caribou. Species, or signs, (such as scat or tracks) that were observed during the 2010 project fieldwork included siksik, wolf, fox, grizzly bear, caribou, muskox, and moose. Six species potentially located in the project area require special attention due to their status of "special concern" as designated by

Committee on the Status of Endangered Wildlife in Canada and/or the Government of Nunavut: the short eared owl, tundra peregrine falcon, polar bear, grizzly bear, wolverine and barren-ground caribou (Union and Dolphin herd populations).

During the Archaeological Impact Assessment completed for the project sites, three new heritage resources were located at the Hope Lake site, while no new heritage resources were located at the Willow Creek sites or the Husky Creek sites. The Coppermine River, which ends at Kugluktuk on Coronation Gulf, and surrounding area are still used by local Inuit groups for hunting and trapping. The Kugluktuk Hunters and Trappers Organization own and manage a cabin at the Hope Lake site, which is used by local hunters; this is the only current land use at any of the project sites.

Potential Valued Ecosystem Components (VECs) and Valued Socio-Economic Components (VSECs) were identified in a four stage process. Initially, a review of the regulatory responsibilities of government agencies was completed, and then VECs and VSECs identified in other projects in same area were reviewed. Once these VECs and VSECs were identified, they were confirmed during the community meeting, and finally, based on the RAP, the professional judgement of environmental practitioners and remediation specialists identified any potential gaps in the identified VECs and VSECs. Identified VECs and VSECs included climate, air quality, terrain, soils, hydrology, wildlife, cultural features, and traditional land use.

To determine the potential impacts to the various VECs or VSECs, the environmental baseline information and specific RAP activities were reviewed, and using professional judgement, project activities (site preparation and camp operation, remediation and closure) that would impact/interact with a specific VEC or VSEC were identified.

By far the most common potential impacts to VECs were contamination from spills during refuelling or servicing equipment used in project activities, from remediation activities themselves (such as incinerating waste), or direct physical disturbance to the VEC during project activities (such as sedimentation or camp construction). Important impacts to wildlife range from direct mortality to sensory disturbances. The most important mitigation measures are those that will prevent or limit contamination, such as developing a spill contingency best management practice, or those that prevent or limit physical disturbances, such as using existing disturbances for site access and camp construction.

Residual impacts are defined as impacts that remain after mitigation has been applied. Implementation of the mitigation strategies outlined for the remediation of the Hope Lake sites are predicted to result in no negative residual impacts, and overall, the remediation will have a positive effect on the environment by removing contaminated soil and hazardous material from the sites. Cumulative environmental impacts occur when impacts, in particular residual impacts, from two or more concurrent project activities combine either additively or synergistically to further exacerbate the impact on a VEC or VSEC. Given that the project will have a positive impact on the environment and has no residual impacts, the remediation of the three sites will not add to the cumulative environmental effects of other land use activities in the local area.

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1.0 INTRODUCTION

1.1 GENERAL OVERVIEW

Indian and Northern Affairs Canada (INAC) is the custodian of most federal lands in northern Canada and has responsibility, through the Contaminated Sites Program (CSP), of managing a number of contaminated properties that are no longer maintained by the original occupant. INAC's portfolio of contaminated sites in Nunavut originated from private sector mining, oil and gas activities, and government military activity dating back over half a century, many years before the environmental impacts of such activities were adequately understood. The requirement to remediate three former mineral exploration sites in the Hope Lake area (the Project) in Nunavut is one of these projects.

The INAC Nunavut Regional Office CSP is managing the remediation of the former Hope Lake mineral exploration sites under the Federal Contaminated Sites Action Plan (FCSAP). Since 1999, the Treasury Board of Canada Secretariat (TBS) has approved a management framework of policies and best practices including the *Federal Contaminated Sites Management Policy* (TBS 2002). Under this policy, individual departments, in this case INAC, are responsible for managing the contaminated sites within their jurisdiction. Public Works Government Services Canada (PWGSC) Northern Contaminated Sites Office is managing this project on behalf of INAC.

EBA Engineering Consultants Ltd. (EBA) was hired by PWGSC to complete a Phase III Environmental Site Assessment (ESA) which included a Hazardous and Non-hazardous Materials Audit, an Archaeological Investigation and a Geotechnical Evaluation (EBA 2010), a Remedial Action Plan (RAP) (EBA 2011) and an Environmental Screening Assessment Report (ESAR) for the Project. Before completing the fieldwork, EBA reviewed existing site information, identified information gaps, and developed a detailed assessment plan. The necessary fieldwork was completed in the summer of 2010.

This ESAR has been completed to identify potential impacts of the RAP on the environment and propose actions to mitigate such impacts so that the Project can proceed through the licensing, contracting, and remediation phases in future years.

1.2 ENVIRONMENTAL ASSESSMENT (EA) REGULATORY PROCESS

The instigation for the submission of this ESAR is that the proposed RAP for the Project is defined as a "project proposal" under Article 1 of the *Nunavut Land Claims Agreement* (NCLA) (Nunavut Tunngavik Inc. 1993) and the RAP is not "project proposal" exempt from screening as defined by Schedule 12-1 of the NCLA.

According to Section 12.3.5 of Article 12 of the NCLA, all "project proposals" not located in a part of the Nunavut Settlement Area with an approved land use plan, must be submitted directly to the Nunavut Impact Review Board (NIRB) for screening. Only a "draft" land use plan, the *West Kitikmeot Regional Land Use Plan Draft* (Nunavut Planning Commission [NPC] 2005) exists where the Project is located; therefore, it is expected that this ESAR will be submitted directly to the NIRB.

One of the primary functions of the NIRB is to screen proposals to determine whether the "project proposal" requires a review under Part 5 or Part 6 of Article 12 of the NLCA (Section 12.2.2 of Article 12 of the NLCA) (Nunavut Tunngavik Inc. 1993). A "project proposal" will require a review, according to section 12.4.2 of Article 12 of the NCLA if:

- The Project may have significant adverse effects on the ecosystem, wildlife habitat, or Inuit harvesting activities.
- The Project may have significant adverse socio-economic effects on northerners.
- The Project will cause significant public concern.
- The Project involves technological innovations for which the effects are unknown.

To ensure that the NIRB has the required information to complete the screening process, this ESAR meets the terms of reference (TOR) (PWGSC 2010) provided in the Hope Lake RFP Solicitation EW699-110498/01/NCS and includes:

- Proponent information;
- Description of the existing environment (biophysical and socio-economic);
- Project proposal description including purpose, scope, timing, authorizations, and alternatives;
- Identification of potential environmental, socio-economic, and cumulative effects;
- Identification of mitigation measures and potential residual impacts;
- Description of public participation (informing, consulting, participation);
- Non-technical project summary in English and Inuktitut and/or Inuinnaqtun, depending on the region summarizing the information outlined above (to be completed by INAC); and
- A map of the Project (local and regional scale) in electronic format.

1.3 OBJECTIVES

The specific objective of this ESAR, as outlined in the TOR (PWGSC 2010), is to:

- Assess the environmental, social, economic, and cultural effects of the proposed remediation of the former mineral exploration sites, including identification of potential impacts and development of mitigation measures where necessary.

Specific objectives that will assist in achieving the overall objective include:

- Identifying project components and development activities that may result in potential impacts to the environment and the effect of these on the receiving physical and/or socio-economic environments.
- Identifying existing conditions within the project area, including existing land uses, resources and other activities which have the potential, in combination with proposed remediation activities, to affect the physical and/or socio-economic environment.
- Assess the cumulative effects associated with this project and other past, present, or proposed projects in the area.
- Determine any follow-up requirements.

2.0 PROJECT DESCRIPTION

As part of the ESAR, the report needs to include a description of the project activities. This information is provided so the reader can understand the scope of the Project and integrate the project description information with the baseline data that is provided. This forms the basis for determining the impacts and potential mitigation strategies.

The sections below provide a rationale for the Project, and a scope and description of activities that will be completed during the RAP.

2.1 PURPOSE OF THE HOPE LAKE REMEDIATION PROJECT

The objective of the Project is to reduce environmental liability to the Crown, maximize benefits to the local community and Inuit, and ensure good value to the people of Canada. More specifically, the RAP (EBA 2011) will complete the following:

- Restore the three former exploration sites to an environmentally safe condition;
- Prevent environmental migration of contaminated soil into the Arctic ecosystem;
- Remove physical hazards for the protection of human health and safety; and
- Provide a cost-effective remediation solution.

Implementation of the RAP would primarily create economic and social benefits for the Inuit community of Kugluktuk, and potentially for other communities in Nunavut. The project would provide direct employment (and training) for community members who work on the Project, and spin-off employment and economic benefits the hospitality sector and equipment operations in Kugluktuk or other communities in the north.

2.2 SCOPE OF HOPE LAKE REMEDIATION PROJECT

The implementation of the RAP will require mobilization, camp set up and operation, remediation activities, demobilization of the camp, and then transportation of materials off-site. These activities are discussed in further detail below and provided in the RAP (EBA 2011). The majority of the work will be completed at the Hope Lake site. Materials that are located at both Willow Creek and Husky Creek will be transported to Hope Lake for treatment and/or disposal. Access to Willow Creek and Husky Creek will be from Hope Lake via helicopter.

Please note that the description is limited to the recommended remediation options, and that not all remediation options considered in the RAP have been presented in this section of the report. The initial start-up date for the RAP is unknown, but the mobilization, remediation, and demobilization activities for Hope Lake, Willow Creek and Husky Creek are expected to take one to four years to complete, depending on the remediation option for the hydrocarbon-contaminated soil. A summary of construction equipment, access, camp set-up, remedial activities, and site closure is presented below.

2.2.1 Construction and Remediation Equipment

The RAP anticipates the following equipment needs for this project:

- Excavator(s) to remove contaminated soils for disposal and for use in trail improvements;
- Front end loader(s) to consolidate materials and for trail improvements;
- Haul truck(s) to move materials to staging 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;
- Bull dozer to be used for road improvements;
- Passenger trucks and quads;
- Drum crusher; and
- Cat train consisting of bulldozer(s) or other tracked equipment to remove all materials off-site during the winter.

2.2.2 Mobilization and Site Access

Access to the Hope Lake site is via airplane using an unmaintained airstrip located on-site. A trail/road system exists throughout the Hope Lake site linking infrastructure on-site; however, this system is primarily a quad trail. Summer access to Willow Creek and Husky Creek can be made by helicopter or float plane; however, functional docks are not present at either site.

Mobilization and access activities will consist of the following:

- Mobilizing equipment to site during the winter via cat train on a trail that local residents use for winter access to Hope Lake. This trail may require upgrades or testing (e.g., ice depths) to safely accommodate the equipment and materials that needs to be brought to site;
- Upgrading the Hope Lake airstrip to accommodate heavy lift aircraft (if required);
- Developing a borrow pit(s) to provide construction material for the airstrip upgrade (if required) and for trail upgrades; and
- Upgrading the trail network at the Hope Lake site to accommodate equipment during the summer remedial activities.

After remedial activities are complete, previous and recently disturbed areas (including upgraded roads, borrow pit(s), remediated areas and the camp area) will be recontoured to promote natural revegetation.

Demobilization will involve packing all materials on-site into appropriate containers for cat train removal following remedial activities. The cat train will use the same access for removal of equipment and materials.

2.2.3 Camp Development

For the remedial activities, a base camp will be set up at Hope Lake. The camp will house workers and will meet the specifications laid out by PWGSC. Required facilities include:

- Sleeping quarters;
- Office space (will also contain communications area and equipment);
- Kitchen and dining area;
- Bathroom and shower facilities;
- Laundry facilities;
- First aid facilities (depending 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.

No camp will be set up at either Willow Creek or Husky Creek. Workers will be transported daily to both sites via helicopter. Emergency food and shelter will be stored at both sites while staff are working there in case they cannot be transported back to Hope Lake.

2.2.4 Remedial Activities

The RAP for all three sites proposes that solid materials, except wood, be transported off-site to an appropriate landfill as opposed to a landfill being built on-site, because the cost of landfill construction and long-term monitoring is comparable to removal. Logistical planning associated with shipping and off-site landfill disposal of materials will be the primary issue in determining whether this option will go forward. The alternative to shipping non-hazardous material off-site is to build a landfill on-site. Hazardous material would still be removed from sites. Table 1 provides a summary of recommended remedial options.

TABLE 1: SUMMARY OF RECOMMENDED REMEDIAL OPTIONS

Waste Stream	Recommended Option	Comments
Wood Waste Non-Hazardous (unpainted)	Control burn on-site	Hazardous material must be separated and non-wood waste removed. Wood should be burned in controlled burn. Ashes to be taken off-site.
Aqueous Liquid Waste in Drums Non-Hazardous	Treat on-site	Treatment on-site is the most cost effective option. If the liquid waste cannot be treated to meet discharge criteria, then it will be packaged and shipped off-site.
Other Waste Non-Hazardous	Remove off-site	Hazardous waste will need to be separated and removed off-site.
Asbestos Waste Hazardous	Remove off-site	Asbestos waste will be handled by trained personnel and removed off-site.
Liquid Organic Wastes in Drums Hazardous	Incinerate on-site	Organic liquid waste in drums that meets incineration criteria will be incinerated on-site, except drums that can be identified and returned to owners.
Pressurized Cylinders Hazardous	Remove off-site	Depressurize and remove off-site, following landfill and shipping company approval.
Fire Extinguishers Hazardous	Remove off-site	Remove off-site, following landfill and shipping company approval. Volumes are limited.
Leachable Lead Paint on Tanks and a Caterpillar Hazardous	Remove off-site with paint still on	This will require coordination with another company to receive the tanks and caterpillar.
Leachable Lead Paint on Drums Hazardous	Compact and remove off-site	Remove off-site to a Class 1 landfill. Paint chips that flake off during compaction will be collected, packaged and shipped off-site for disposal.
Other Solid Hazardous Waste	Compact and remove off-site	Remove off-site to a Class 1 landfill. Volumes are limited.

TABLE 1: SUMMARY OF RECOMMENDED REMEDIAL OPTIONS		
Waste Stream	**Recommended Option**	**Comments**
Metal-Contaminated Soils	Remove off-site	Remove off-site to an approved landfill; will require waste characterization.
Hydrocarbon-Contaminated Soils	All soil >2,500 mg/kg TPH to be removed off-site	Will require regulatory approval; limited amount of soil will be need to be removed, that is above 2,500 mg/kg total petroleum hydrocarbon (TPH).
Physical Hazards	Remove all 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.

2.3 DETAILS ON THE REMEDIAL ACTIVITIES

2.3.1 Non-Hazardous Waste

For non-hazardous wood waste, the RAP recommends the following steps be taken:

- Remove all hazardous materials from the buildings on-site. Note that asbestos abatement and handling will be completed by trained abatement workers.
- Remove all non-wood waste and remove off-site.
- Demolish buildings, photograph and document. Remove wood to an area, ideally where ground cover primarily bedrock with little vegetation. Some areas of the Hope Lake camps may be ideal.
- Within an appropriate containment system, conduct a controlled burn under careful supervision at a time of year when moisture conditions are high and there is a low likelihood of causing a tundra fire.
- Fire suppression equipment will be at hand when the controlled burn takes place and air monitoring will be conducted.

For aqueous liquid wastes in drums, the RAP recommends the following steps be taken:

- Treat on-site and then on-site disposal. Organic constituent removed from the aqueous liquid waste would be incinerated.

For other non-hazardous wastes at the site, the RAP recommends the following:

- Clean the inside of the drums that do not have leachable lead paint, and crush.
- Separate all hazardous and non-hazardous materials from buildings.

- Following removal of the hazardous waste, remove all non-hazardous debris off-site.
- From selected areas, where metal impacts were found in soil beneath dump sites, excavate soil beneath dump sites for off-site disposal and collect confirmatory samples for testing.

2.3.2 Hazardous Waste

For asbestos waste at the site, the RAP recommends the following:

- Remove asbestos waste at the sites using trained abatement workers.
- Friable 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.
- Remove bags to an off-site landfill.
- Prior to any demolition being carried out, conduct inspection of workspace where asbestos was formerly contained to ensure removal.

For organic liquid wastes in drums at the site, the RAP recommends the following:

- Incinerate on-site all wastes that cannot be removed off-site by owner.
- Complete air quality monitoring while incineration is occurring.

For pressurized cylinders at the site, the RAP recommends the following:

- Properly vent the known contents on the site(s); a specialist will be needed to vent the unknown contents on-site.
- Remove cylinders to an off-site landfill. Note that once the contents are vented, the cylinders themselves are not hazardous waste.

For fire extinguishers at the site, the RAP recommends the following:

- Arrange pre-approval by the shipping company for extinguishers with content.
- Remove to an off-site landfill.

For leachable lead paint on POL tanks and former exploration construction equipment (one track-type caterpillar tractor) at the site, the RAP recommends the following:

- Clean the inside of the tanks and drain any remaining fuel/fluids from the tractor.
- Ensure this liquid is disposed of properly.
- Remove the tractor and POL tanks (intact) to an off-site facility to remove paint and/or landfill.

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

- Clean the inside and crush the drums.

- Collect any paint chips.
- Remove to an off-site landfill.

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

- Collect solid hazardous waste and remove to an off-site landfill.

2.3.3 Metal and Salt-Contaminated Soils

For remediation of metal-contaminated soils at the site, the RAP recommends the following:

- Excavate all metal and salt-contaminated soil and conduct confirmatory sampling of base and adjacent boundaries to ensure all contaminated soil has been removed.
- Remove to an off-site landfill.

2.3.4 Hydrocarbon-Contaminated Soils

For remediation of hydrocarbon-contaminated soils at the site, the RAP recommends the following:

- Remove soil that is >2,500 mg/kg TPH and dispose of off-site.

If material that is <2,500 mg/kg cannot be left in-situ, a landfarm would be created to treat this material to meet regulatory criteria.

2.4 GEOTECHNICAL CONSIDERATIONS

The on-site network at the Hope Lake site is a trail system with varying degrees of trafficability depending on the integrity of the granular surface course, the stability of the subgrade, the capacity of the culverts, the extent of the vegetative cover, and local grades. These will require upgrading to accommodate construction and remediation equipment and traffic may still be limited during wet conditions. Several culvert crossings along the trail network may require upgrading to accommodate surface water flows and construction traffic. These may need permitting to meet regulatory requirements (i.e., DFO fish habitat).

The Hope Lake airstrip was able to support Skyvan operations during the 2010 field program for the Phase III ESA portion of the Project. If the airstrip will be used for transporting heavy equipment to complete the RAP, it will need extensive levelling with new fill to lengthen it to support heavy lift aircraft. An old borrow area is located nearby and the potential for developing additional borrow areas exists adjacent to the airstrip.

2.5 BORROW PIT DEVELOPMENT

Borrow material will be required for upgrading the trail network and potentially required if a landfarm for the hydrocarbon contaminated soil is built. Borrow may be needed if the airstrip is upgraded. The exact volume of borrow material required is not known at this time, but a number of borrow pit prospects for granular material were identified in the terrain analysis and most were investigated during the 2010 field program. A total of seven borrow pit locations were identified at the Hope Lake site and range in available quantities from 5,000 m^3 to 20,000 m^3. Additional details are provided in the *Phase III Environmental Assessment Report* (EBA 2010).

2.6 SUMMARY OF CONTAMINATED SOIL, NON-HAZARDOUS WASTE AND HAZARDOUS WASTE

A summary of contaminated soil and materials that were inventoried at the Hope Lake, Willow Creek and Husky Creek are provided in Tables 2 to 7 below.

TABLE 2: SUMMARY OF CONTAMINATED SOIL AT THE HOPE LAKE SITE

Description	Contaminant of Concern	Volume of Contaminated Soil
Debris Areas, POL Tanks, Drums and Drum Caches	**PHC**: F1, F2, F3 and F4	1,739 m^3
Debris, Structures, Burn Pits, Calcium chloride, and Tanks	**Metals**: Arsenic, Copper, Chromium, Nickel, Lead, Vanadium, Zinc Salt: EC	97 m^3
Burn Pit, Tank, Drill Platform, Old Drill	**Metals**: Barium, Copper, Lead, Zinc **PHC**: F3 and F4	4 m^3
	Total contaminated soil	**1,840 m^3**

TABLE 3: MATERIAL INVENTORY SUMMARY OF THE HOPE LAKE SITE

TOTALS	Non-Hazardous	Solid Material	803 m^3
		Liquid Material	854 L
		Tanks	123 m^3
		Small Drums	213 drums
		Drums (205L)	227 drums
	Hazardous	Light Ballasts, Fire Extinguishers, Fluorescent Lights, Batteries	2 m^3
		Electrical Insulators, Gaskets, Mastic (Asbestos containing)	5 m^3
		Caterpillar, POL Tanks (Leachable Lead Paint)	622 m^3
		Small Drums (Leachable Lead Paint)	24 drums
		205 L Drums (Leachable Lead Paint)	1,143 drums
		205 L Drums (Organic content)	14,300 L
		Drilling Fluid Containers (Contents)	342 L
		Compressed Air Cylinder (Propane)	11 m^3

TABLE 4: SUMMARY OF CONTAMINATED SOIL AT THE WILLOW CREEK SITES		
Description	**Contaminant of Concern**	**Volume of Contaminated Soil**
Burn Pit	**Metals**: zinc	0.1 m^3
Drum Cache	**PHC:** F2	16.8 m^3
	Total contaminated soil	**16.9 m^3**

TABLE 5: MATERIAL INVENTORY SUMMARY OF THE WILLOW CREEK SITES			
TOTALS	**Non-Hazardous**	Solid Material	127 m^3
		Liquid Material	6,867 L
		Drums (205 L)	132 drums
	Hazardous	Fibreboard and Insulating Materials (Asbestos containing)	1.6 m^3
		Batteries (Content)	0.3 m^3
		Drums (205 L)	355 drums

TABLE 6: SUMMARY OF CONTAMINATED SOIL AT THE HUSKY CREEK SITES		
Description	**Contaminant of Concern**	**Volume of Contaminated Soil**
Drums	**PHC**: F1-F3	6 m^3
	Total contaminated soil	**6 m^3**

TABLE 7: INVENTORY SUMMARY OF THE HUSKY CREEK SITES			
TOTALS	**Non-Hazardous**	Solid Material	38 m^3
		Liquid Material	546 L
		Drums (205 L)	3 drums
	Hazardous	205 L Drums (Leachable lead paint)	13 drums
		Compressed Air Cylinder (Propane)	1

3.0 PROJECT APPROVAL AND PERMIT REQUIREMENTS

The NLCA provides the regulatory context for completing this ESAR for the proposed project for the NIRB. However, both the federal and Nunavut governments have other necessary or potential legislative requirements related to this project. Table 8 provides a list of other Federal and Territorial agencies, associated legislation, and contact information for this proposed project.

TABLE 8: REGULATORY AGENCIES, LEGISLATIVE REQUIREMENTS AND CONTACT INFORMATION

Agency	Legislative Requirements	Contact Information
Federal Agencies		
Indian and Northern Affairs Canada (INAC) and Public Works and Government Services Canada (PWGSC)	*Land Claims Settlement Act* *Federal Real Property Act* and *Regulations* Notes: Permits for land use and potential borrow sources may be required based on the Project as proposed.	Mark Yetman Contaminated Sites Project Manager Indian and Northern Affairs Canada Contaminated Sites Directorate 1104 B - Inuksgait Plaza II Iqaluit, Nunavut X0A 0H0 Telephone: 867.975.4733 Fax: 867.975.4736 Email: Mark.Yetman@inac-ainc.gc.ca Michael Bernardin Environmental Specialist Public Works and Government Services Canada Real Property Services 10025 Jasper Avenue Edmonton, Alberta T5J 1S6 Telephone: 780.497.3853 Email: Michael.Bernardin@pwgsc-tpsgc.gc.ca
Fisheries and Oceans Canada (DFO)	*Fisheries Act* Notes: Authorizations or letter of advice may be required if project impacts fish habitat. Based on the current project, no authorization requirements are expected.	Stefan Romberg Fisheries Management Biologist Fisheries and Oceans Canada Iqaluit District Office PO Box 358 Iqaluit, Nunavut X0A 0H0 Telephone: 867.979.8002 Fax: 867.979.8039
Transport Canada (TC)	*Navigable Waters Protection Act* Notes: Authorization may be required if any structures are built within or on navigable waters. Based on the current project proposal, no authorization requirements are expected.	Allen Cadenhead Navigable Waters Protection Officer Transport Canada 9700 Jasper Avenue NW Edmonton, Alberta T5J 4E6 Telephone: 780.495.7892 E-mail: allen.cadenhead@tc.gc.ca
Environment Canada (EC)	*Species at Risk Act* *Migratory Birds Act* and *Regulations* *Fisheries Act* [Section 36(3)] *Canadian Environmental Protection Act* Notes: Authorizations not anticipated, but a list of species at risk and migratory birds, potential impacts to these species and mitigation strategies has been compiled as part of the ESAR.	Siu-Ling Han Head Environment Canada Eastern Arctic Unit Qimugjuk Building, PO Box 1870 Iqaluit, Nunavut X0A 0H0 Telephone: 867.975.4633 Fax: 867.975.4645 Amy Sparks Contaminated Sites Officer Environment Canada Contaminated Sites 4999 - 98 Avenue

TABLE 8: REGULATORY AGENCIES, LEGISLATIVE REQUIREMENTS AND CONTACT INFORMATION		
Agency	**Legislative Requirements**	**Contact Information**
		Edmonton, Alberta T6B 2X3 Telephone: 780.951.8746
Natural Resources Canada (NRC)	*Explosives Act* and *Regulations* Notes: Permits required if explosives stored, handled or transported. Based on current project description, permits are not required.	William McAuley Regional Manager/Senior Inspector of Explosives Natural Resources Canada 755 Lake Bonavista Drive Southeast, 2nd Floor, Room: 200 Calgary, Alberta T2J 0N3 Telephone: 403.292.4766 Fax: 403.292.4689 Email: William.McAuley@nrcan-rncan.gc.ca
Territorial Agencies		
Nunavut Water Board	*Nunavut Waters Act* *Nunavut Surface Rights Tribunal Act* Notes: Authorizations for water use and deposit of waste into water. Based on the current project description, a water licence will be required.	David Hohnstein Director, Technical Services PO Box 119 Gjoa Haven, Nunavut XOB 1JO Telephone: 867.360.6338
Department of Environment (Government of Nunavut)	*Environmental Protection Act* *Transportation of Dangerous Goods Act* *Wildlife Act* Notes: Based on the current project proposal, spill response plans and waste management guidelines must be followed and waste manifest documents will required for moving hazardous waste. Regulatory requirements related to land use and disturbing wildlife must also be met. Authorizations related to *Wildlife Act* requirement are not anticipated, but a list of wildlife species, potential impacts to these species, and mitigation strategies has been compiled.	Michael Mifflin Manager of Environmental Assessment and Land Use PO Box 1000 Iqaluit Nunavut X0A 0H0 Telephone: 867.975.7733 Email: MMifflin@gov.nu.ca
Department of Culture, Language, Elders and Youth (Government of Nunavut)	*Nunavut Act (Nunavut Archaeological and Palaeontological Sites Regulations)* Notes: All archaeological sites identified in the Archaeological Impact Assessment for this project will be avoided. Excavation of contaminated soils within 1 m of an archaeological site will require a permit; this is not expected for this project as proposed. If any new sites are identified, the Department will be contacted.	Doug Stenton Director of Heritage Department of Culture, Language, Elders and Youth PO Box 1000, Stn 800 Iqaluit, Nunavut X0A 0H0 Telephone: 867.975.5524 Email: DStenton1@gov.nu.ca

TABLE 8: REGULATORY AGENCIES, LEGISLATIVE REQUIREMENTS AND CONTACT INFORMATION		
Agency	**Legislative Requirements**	**Contact Information**
Department of Health and Social Services (Government of Nunavut)	*Public Health Act* and *Regulations* Notes: The criteria outlined in the Act and Regulations for any camps associated with the Project must meet requirement for sanitation, waste disposal, drinking water quality and medical facilities.	Geraldine Osborne Assistant Chief Medical Officer PO Box 1000 Iqaluit Nunavut X0A 0H0 Telephone: 867.975.5743 Email: GOsborne@gov.nu.ca

EBA assumes that INAC and/or PWGSC will contact the agencies with regulations applicable to this project and secure the required permits, including completing *Part 1 Form Project Proposal Information Requirements* (NIRB 2010a) and *Screening Part 2 Form Project Specific Information Requirements* (NIRB 2010b) when submitting the ESAR to the NIRB.

4.0 SITE DESCRIPTION AND LOCATION

The sections below describe the ecological and social conditions of the project site. Included in this section is a description of the location, climate, geology, hydrogeology, hydrology, soils, vegetation, fish and wildlife, land use, cultural features, and aesthetic values.

4.1 LOCATION

The project consists of three locations: Hope Lake, Willow Creek, and Husky Creek (Figure 1). Hope Lake is the largest site, while the Willow Creek includes three smaller sites and Husky Creek includes two separate sites. All three locations are south of Kugluktuk, Nunavut, in the Dismal Lake area of the West Kitikmeot region of Nunavut and are described briefly below.

Hope Lake is located 75 km southwest of Kugluktuk and was a mining exploration site with plans to become an operating mine in 1968 (WK027). It consists of three separate camp sites: Coppermine River Ltd. (CRL) Camp, Hearne Camp, and New Camp. There are numerous discarded metals and building debris, an unmaintained airstrip, trail network, several drum caches, eight petrol, oil and lubricant (POL) tanks, three fuel tanks, 21 horizontal tanks, and several drum caches at Hope Lake (Figure 2). There are both full and empty fuel drums. The site covers approximately 1,500 ha. A southern exploration area, south of the main Hope Lake site, is currently under a mineral lease but is not part of this investigation as it is situated on Inuit-owned lands. Photographs 1 to 4 provide an aerial view of the Hope Lake site.

Willow Creek consists collectively of three small sites: the main site (WK172), south cabins site (WKB01) and a southwest cabins site (WKB02). It is located approximately 65 km south of Kugluktuk (Figure 3). The sites were used for landing float planes. The main site is spread out over 16 ha and consists of seven drum caches, four collapsed structures, one intact structure, two burn pits, and seven main debris areas as well as scattered miscellaneous debris. The south cabins site consists of two debris areas, one collapsed and one dilapidated structure, and two drum caches over an area of 0.45 ha. The southwest cabins site consists of one debris area, one collapsed structure, one drum cache, and one float plane dock. Photographs 5 to 7 provide an aerial view of the Willow Creek sites.

Husky Creek (WK197) is located about 55 km south of Kugluktuk and consists of a south site and north site with site footprints of 0.08 ha and 0.95 ha, respectively (Figure 4). At the south site are a floor platform, wood, a propane cylinder, metal debris, drill core boxes, an old water pump and drill, and nine drums (one full, two partially full, and six empty). At the north site are a bombardier muskeg vehicle, wood and metal debris, and three drums (one full, one partially full, and one empty). Photographs 8 and 9 provide an aerial view of the Husky Creek sites.

Pictures of the three sites are included in the Photographs section at the back of the report.

4.2 PHYSIOGRAPHY

The three sites are located in the southern Arctic ecozone, which stretches from the Richardson Mountains in the Yukon to Ungava Bay in northern Quebec and primarily consists of broadly rolling uplands and lowlands. The Coronation Hills ecoregion is located between the Amundsen and Coronation Gulfs and the northeast shore of Great Bear Lake. The coastal plain extends inland about 30 km and gently reaches an elevation of approximately 160 m above sea level (asl). The landforms consist of large, rounded, rolling, treeless hills; lowland areas; shallow lakes; and rocks debris that was deposited in glacial times with elevations ranging from 200 to 600 m asl (Ecological Stratification Working Group [ESWG] 1995). At Hope Lake, drainage is to the north towards Hope Lake. At Willow Creek, drainage is to the south toward Big Creek. At Husky Creek, drainage is towards the unnamed lake (Natural Resources Canada 2010).

4.3 CLIMATE AND AIR QUALITY

The project area is located in the southern Arctic cozone (ESWG 1995) that encounters long, cold winters and short, cool summers with the mean annual temperature ranging from -11°C to -7°C. Average summer temperatures range from 4°C to 6°C while average winter temperatures are -28°C to -17.5°C. The cool summers have a short growing season but are enhanced by long periods of daylight that average 750 growing degree-days with annual precipitation ranging from 200 mm to 500 mm. The prevailing northwest winds are strongest in fall and winter, and most of the precipitation occurs as rain during the summer, peaking in July and August (NPC 2005).

Within the southern Arctic cozone, the project sites and the Hamlet of Kugluktuk are located in the Coronation Hills ecoregion (ESWG 1995). This ecoregion is located in a cooler and dryer portion (classified as a low arctic ecoclimate) of the southern Arctic ecozone as the mean annual temperature is -11°C with a summer mean of 5°C and a winter mean of -26°C. Precipitation ranges from 200 mm to 300 mm per year (ESWG 1995).

No meteorological stations are located at the project sites. The nearest meteorological data identified are for Kugluktuk and the Jericho mine site (located about 250 km southeast of the Hope Lake site). For Kugluktuk, from 1971 to 2000, the average daily temperature in January (coldest month) is -27.8°C, the average daily temperature in July (warmest month) is 9°C, the annual average snowfall is 1657 mm and average rainfall is 133 mm. A review of meteorological data (1995 to 2000) from the Jericho mine site in the *Baseline Summary Report* and *Environmental Impact Assessment* (Tahera Corporation [Tahera] 2003) confirm that July is the warmest month and January the coldest with the majority of the precipitation occurring as rain in July and August.

No direct measurements or observations of air quality are available for any of the project sites. However, Tahera (2003) reports that PM_{10} (suspended particulate matter <10 µm in diameter) concentrations for the southern Arctic are usually less than <10µg/m^3, while ambient concentrations of CO_2, SO_2 and NO_2 are normally low, which is typical for other undisturbed areas in North America. An AMEC Earth and Environmental study (AMEC 2008) from an area west of Kugluktuk reports that baseline air quality in remote areas is not impacted by local contaminant sources, but is affected by long range transport of contaminants from industrial sources from other parts of the world (including Asia). The Northwest Territories Cumulative Impact Monitoring Program and Audit Working Group (2005) reports that baseline air quality in the Northwest Territories is near pristine or always near background conditions, except near communities, such as Kugluktuk, or industrial developments. A review of National Pollutant Release Inventory (NPRI) data for 2007 between Nunavut and the rest of Canada (Environment Canada 2009) confirms that remote areas in Nunavut have pristine air quality when compared to the rest of Canada (Table 9).

TABLE 9: COMPARISON OF NPRI DATA FOR NUNAVUT AND CANADA

Category	TPM	PM_{10}	$PM_{2.5}$	SO_X	NO_X	VOC	CO	NH_3
Total – Nunavut	8,145	2,523	701	141	11,887	367,177	8,295	7
Total – Canada	18,804,609	6,208,226	1,344,627	1,903,601	2,471,282	26,682,450	11,637,734	503,137

Note: Data includes open sources (such as agriculture and mine tailings) and natural sources (such as forest fires).

4.4 GEOLOGY

Most of the southern Arctic ecozone is underlain by Precambrian granitic bedrock that is predominantly covered by discontinuous morainal deposits with bedrock exposures located throughout. The project sites are located in the western portion of the ecozone, which consists of cretaceous shales covered by thick glacial drifts. Long eskers that can reach lengths up to 100 km are strung throughout the landscape (ESWG 1995). In the

Coronation Hills, the geology consists of Palaeozoic carbonates and stratified, down-faulted, and folded Proterozoic sediments.

In particular, the project sites are located in part of the Bear Geological Province in the northwest part of the Precambrian Canadian Shield. The Bear Geological Province developed when the subsided continental margin accumulated thick sequences of sea sediments. The rocks of the Bear Geological Province contain deposits of uranium, chalcocite, copper, bornite, and chalcopyrite. The surficial geology of the area is predominantly glaciofluvial deposits of sand, gravel, and till with bedrock outcrops. The main glacial landforms found in the area are till plains, drumlins, eskers, scarps, and erratics (Natural Resources Canada 2010).

As part of the field program for the Phase III ESA and RAP, geophysical surveys were completed at all three sites to locate and delineate any buried debris and to assist in the general understanding of the subsurface soils and on-site permafrost conditions. Two instruments were used for this investigation: a Geometric™ G858 magnetic gradiometer and a Ramac™ CUII Ground Penetrating Radar (GPR) with a 500 MHz antenna. Based on the data collected at Hope Lake, Willow Creek, and Husky Creek, depth to interpreted permafrost was between 1.5 and 2.5 m. Test pits were dug for the geotechnical evaluation at all three sites, to a maximum depth of 1 m and no permafrost was encountered.

More details on the methods and interpreting the results of the geophysical survey can be located in the *Phase III Environmental Site Assessment, Hazardous and Non-Hazardous Materials Audit, Geotechnical Evaluation and Archaeological Investigation Hope Lake, Nunavut* (EBA 2010).

4.5 TERRAIN

In the Phase III ESA, a review of available surficial geology maps determined that the surficial materials around the Hope Lake site are primarily glaciofluvial sands and gravels, ranging from 5 m to 50 m deep, along with glaciofluvial-morainal deposits with a large content of boulders, with some till blankets.

A review of the air photos for the Hope Lake Main Site area, completed for the Phase III ESA, indicated that most of the surficial materials are glaciofluvial deposits of predominantly sand and gravel, interspersed by bedrock outcrops of a sedimentary or volcanic successious nature. At the Hope Lake airstrip area, the surficial materials are glaciofluvial deposits of predominantly sand and gravel with cobbles and boulders. There were no stereo air photos available for Willow Creek or Husky Creek.

At Willow Creek main site and South Cabin site, the surficial materials are primarily till blanket. At the Willow Creek Southwest Cabin site, the surficial material primarily consists of bedrock of the middle to late Proterozoic Coppermine Homocline (Geological Survey of Canada 1968).

4.6 SOILS

Cryosols are the dominant soils in the southern Arctic ecozone. Cryosols are underlain by continuous permafrost with active thaw layers that are usually moist throughout the short summers. In the Coronation Hills, the soils are dominated by Turbic and Static Cryosols primarily developed on undulating to ridged glacial tills, but can also be found on fluvioglacial and marine deposits. Organic Cryosols are associated with peat plateaus and high centre polygons and the permafrost has low to medium ice content (ESWG 1996). Soil names follow the *Canadian System of Soil Classification* (Soil Classification Working Group 1998).

Soils were sampled by test pitting at all three sites during the field program for the Phase III ESA, primarily to delineate potential contamination and for geotechnical purposes. Soil horizon depths and soil texture of horizons were logged and classified using the *Canadian System of Soil Classification* (Soil Classification Working Group 1998), allowing for a description of the soils at all three sites. Due to the temperatures and presence of permafrost, soils at all three sites would be classified as Cryosols. Soils encountered during the field program consisted typically of a few centimetres of LFH horizon followed by a B horizon, usually of friable or loose silty clay or silty clay loam texture with abundant cobbles and gravel. Occasionally A, Ah, or Om horizons were present below the LFH horizon.

At the Hope Lake site, the soils generally consisted of a 1 cm to 5 cm thick LFH layer underlain by a B or a B/C horizon that ranged in thickness from 15 cm to over 50 cm. Better developed soils have an Ah horizon below the LFH layer that ranged in thickness from 1 cm to 20 cm, and less developed soils would have a B horizon directly at the surface, with one soil having a C horizon right at the surface.

At the Willow Creek site, the soils with weak development have an LFH layer, ranging in thickness from 1 cm to 3 cm underlain by a B horizon ranging in thickness from 17 cm to 37 cm or a B horizon directly at the surface. Better developed soils have an Ah horizon beneath the LFH layer ranging in thickness from 4 cm to 30 cm thick underlain by a B horizon.

At the Husky Creek site, the better developed soils have an LFH ranging in thickness from 1 cm to 5 cm underlain by a B horizon ranging in thickness from 10 cm to 60 cm. Weakly developed soils have A and A/B horizons of 10 cm depth at the surface.

The texture of the B, B/C, and C horizons at all the sites was variable and ranged from silty clay loam to sand, with a large gravel, cobble and rock component.

More details on the soil and geotechnical survey can be located in the *Phase III Environmental Site Assessment, Hazardous and Non-Hazardous Materials Audit, Geotechnical Evaluation and Archaeological Investigation Hope Lake, Nunavut* (EBA 2010).

4.7 HYDROLOGY AND HYDROGEOLOGY

4.7.1 Hydrology

Hydrology data for the three project sites is not available. The closest site with limited hydrological data is the Jericho mine site (Tahera 2003). In the region, the low relief and the relative immaturity of the drainage network have resulted in a drainage pattern described as contorted with numerous lakes and many ephemeral streams within the uplands, boulder fields and bedrock outcrops. At the project sites, these lakes and streams eventually flow into the Dismal Lake system, which flows into the Kendall River that joins the Coppermine River.

The lakes within the Jericho watershed are oligotrophic as the pH is slightly acidic, with low concentrations of total dissolved solids (7 to 18 mg/L) and very low concentrations of total suspended solids (<1 to 4 mg/L). All total and dissolved metals concentrations and organic constituent concentrations are below either the analytical detection limits or the CCME freshwater aquatic life and drinking water guidelines (Tahera 2003).

Based on Water Survey Canada data reported in Tahera (2003), the mean annual runoff at the Jericho mine site is highly variable and consistent with the patterns of annual precipitation: late spring runoff (early June) from winter snow and from precipitation falling as rain in July and August. The mean annual rainfall (MAR) is 160 mm/year, which corresponds to an average annual flow in the area of 0.9 m^3/s. Hydrographs are highly variable on streams and rivers with lake storage attenuating runoff from these areas.

In the Canadian Heritage River System designation document for the Coppermine River (Nunavut Parks 2008), only half of the 120 exploration sites in the watershed have been remediated. The non-remediated sites, including the project sites, have a risk of surface and groundwater contamination from garbage deterioration and fuel cache leaks. Surface water samples were collected at Hope Lake, Willow Creek, and Husky Creek. Localized impact was observed in one small pool of surface water adjacent to pile of drill cores.

4.7.2 Hydrogeology

The northern two-thirds of the Bear Geological Province is underlain by continuous permafrost with medium to high ice content in the form of ice wedges, while the southern one-third adjacent to Coronation Gulf is underlain by permafrost with low to medium ice content. The project sites are located in the southern portion of this Province. Boreholes drilled approximately 50 km south of Kugluktuk indicate the permafrost is approximately 160 km thick. Near surface ground temperatures fluctuate between 5ºC in summer to -15ºC in winter and studies indicate the active layer is approximately 1 m thick (NRC 2010).

Permafrost at the Jericho mine site is continuous and extends to a depth of 540 m, except under large lakes and rivers that do not freeze to the bottom. In well-drained mineral soils and exposed rock areas, the active (thaw) permafrost layer is approximately 3 m thick while in organic soils the active layer is approximately 1 m thick (Tahera 2003). Based on data collected during the 2010 field program for the three sites, the active layer is approximate 1.5 m to 2.5 m thick.

Groundwater was not collected in any of the drill holes at the Jericho mine site. An analysis of one sample of the ice infilling the joints of the drilled rock indicates aluminum, chromium, iron, lead, nickel, silver, and zinc concentrations exceed the CCME guidelines for freshwater aquatic life. At the Hope Lake site, one shallow groundwater well was installed down-gradient of hydrocarbon impacts. Groundwater was observed at 0.6 mbgs. The sample collected exceeded CCME criteria for F2 hydrocarbon fraction. Further details are provided in the Phase III ESA (EBA 2010).

4.8 VEGETATION

4.8.1 Terrestrial Environment

The southern Arctic ecozone represents a transition from the boreal forest plant communities in the south and the Arctic tundra plant communities in the north. The upland overstory is characterized by the presence of dwarf shrubs; typical species include dwarf birch (*Betula nana* and *Betula glandulosa*), willow (*Salix* spp.) and heather species (*Cassiope* spp. and *Phyllodoce* spp.). The dwarf shrubs are mixed with a wide variety of grass, herb and lichen species. Low-lying areas are dominated by wetlands that primarily consist of sedge-moss vegetation. Large rivers, such as the Coppermine and Thelon, can support stunted tree species, such as white spruce (*Picea glauca*).

In the Coronation Hills, the nearly continuous cover of shrub vegetation is composed of dwarf birch (*Betula nana* and *Betula glandulosa*), willow (*Salix* spp.), Labrador tea (*Rhododendrum groenlandicum*) with an understory of avens species (*Dryas* spp.) and sedges (*Carex* spp.) tussocks. Alder (*Alnus spp.*) are often located on warmer sites, while wet sites are dominated by willows and sedges.

The ecosystem units within the project sites were classified using the system developed by EBA for the *Tibbit to Contwoyto Winter Road Ecological Land Classification* (EBA 2001). This system includes ecosystem units for the boreal, the tundra, and the transition zones, with the tundra zone classification being used for the Hope Lake sites. The tundra zone has four rock ecosystem units, four scrub birch ecosystem units, two willow ecosystem units, three sedge units, a cottongrass ecosystem unit, and saxifrage ecosystem unit. This classification system closely parallels the systems described by Burt (1999) and Matthews, Epp, and Smith (2001).

The vegetation at all three sites consist of a mosaic of ecosystem units. The ecosystem units at the Hope Lake site include but are not limited to the Sheathed cottongrass – Bog-rosemary Sedge Fen (EA), Round-fruited sedge – Chamisso's cottongrass Fen (CE), Scrub birch - Labrador tea Tundra (BL), boulderfield (BF), Scrub birch – Crowberry Tundra (BE) and Willow – Sedge Low Shrub Fen (SH).

At the Willow Creek sites, the ecosystem units include but are not limited to Scrub Birch – Cloudberry Low Shrub Bog (BR), Sheathed cottongrass – Bog-rosemary Sedge Fen (EA), Scrub birch – Crowberry Tundra (BE) and Scrub birch – Labrador tea Tundra (BL).

At the Husky Creek sites, the ecosystem units include but are not limited to Scrub birch - Labrador tea Tundra (BL), Willow – Sedge Low Shrub Fen (SH) and the Scrub Birch – Cloudberry Low Shrub Bog (BR). Landscape views of the ecosystem units are provided in photographs 10 through 15.

A list of vegetation species identified during the 2010 field program is provided in Appendix A.

4.8.2 Marine Environment

Article 12.12.2 of the NLCA (Nunavut Tunngavik Inc. 1993) indicates that shipping associated with project proposals are subject to review by the NIRB. Since hazardous and non-hazardous material will be shipped from the port located in Kugluktuk, background information on the marine environment and potential impacts from shipping this material is included in this report. To meet this requirement, general information on the biophysical setting for the marine environment at Kugluktuk has been provided.

The marine environment near Kugluktuk is primarily affected by seasonal changes in temperature and sun exposure. Except in August and September, the Coronation Gulf remains frozen. The ecosystem beneath the sea ice is promoted by the primary production of algae, which grow on the underside of the ice sheet itself. Algal production usually commences in early spring (mid-April) and peaks in the middle of spring (late May) when algal blooms expand from the ice into the surrounding waters. Algal production is essential to the Arctic marine food-chain because algae, on average, contribute 57% to the total Arctic marine primary production. The algae are eaten by copepod species and amphipod species (zooplankton), which are preyed upon fish species, such as arctic char (*Salvelinus alpinus*) and arctic cod (*Boreogadus saida*). These and other fish species are an important food source for marine mammal species (Krembs & Deming 2006).

4.9 WILDLIFE

4.9.1 Terrestrial Species

A wide variety of wildlife species can be expected to use the habitats in the vicinity of the Project. Wildlife in the area ranges from shrew (*Sorex* spp.) to ptarmigan (*Lagopus* spp.) and grizzly bear (*Ursus arctos*). Many of the species in the project area are common with high population numbers, but there are species with special conservation status, as well. Species or signs, (such as scat) that were observed during the 2010 Phase III ESA fieldwork included siksik (*Spermophilusp parryii*), wolf (*Canis lupus*), fox (*Alopex lagopus*), grizzly bear, caribou (*Rangifer tarandus*), muskox (*Ovibos moschatus*), muskoxen (*Ovibos moschatus*) and moose (*Alces alces*).

Mammals

Small mammals potentially found in the area of the proposed project include species such as lemming (*Dicrostonyx* spp.), snowshoe hare (*Lepus americanus*), siksik, weasel (*Mustela* spp.), and other species adapted to arctic habitat conditions and related vegetation communities. Weasels are carnivorous species that depend on lemmings as a main staple of their diet. Lemmings live in the subnivean layer during the winter and feed on leaves, grasses, roots, and berries in the spring and summer seasons. The snowshoe hare feeds on vegetation growing in arctic environments and is an important prey species for other carnivorous mammals (Canada Museum of Nature 2004).

A number of medium-sized mammals are likely to be found in the project area. Wolf, arctic fox, and wolverine (*Gulo gulo*) can be found in the project area. Wolverines have very specific habitat requirements, including the availability of a den that provides a safe habitat for females to give birth. Arctic tundra areas provide some of the best denning opportunities for female wolverines (Environment Canada 2001). Wolverines are carnivores and scavengers, and their movements depend on those of wolves and caribou as a reliable source of carrion to feed on (NJWL Limited [NJWL] 2008). Wolves in the Arctic tend to vary their habitat and movements depending on caribou movements. Wolves tend to use the same denning areas to give birth and raise pups year after year, and this can sometimes mean travelling long distances between the den and caribou calving grounds, which are an important hunting ground and food source in the spring (NJWL 2008).

The arctic fox is well adapted to the severe climate because of its tendency towards generalist feeding behavior. The arctic fox will consume a wide variety of foods that allows it to thrive under harsh conditions. Similar to weasel species in the Arctic, arctic fox depend heavily on lemmings as a prey source.

Other large mammals potentially found in the project study area include moose, caribou, barren-ground grizzly bear, and muskoxen. Moose, caribou, and muskoxen are herbivorous ungulates that depend on a variety of habitat types through seasonal changes in the Arctic. Moose browse almost exclusively on woody species (primarily willow) in the winter, compared with a large proportion of aquatic plants in the spring and summer (Environment Canada 1997).

In the winter, a primary food source for caribou is ground lichens, but in the spring and summer, caribou focus on sedges, willow and other shrubs. Caribou are considered migratory and travel long distances between wintering and calving grounds (NJWL 2008). In contrast, muskoxen travel only small distances between summer and winter ranges and occupy much of the territory of Nunavut. In the winter, muskoxen prefer hilltop areas where the wind clears the snow and exposes vegetation, and in the spring and summer, they prefer moist areas such as lake shores and meadows (NJWL 2008).

Grizzly bears are usually solitary animals although small groups may be seen feeding in the same area at particular times of the year. Males tend to roam farther than females. Bear denning occurs in late October and November; their body temperatures drop slightly and they fall into a deep slumber, but they can be awakened by noise or disturbances near the denning area. The breeding season for grizzlies is generally late spring to early summer with cubs being born in mid-winter. Grizzlies have a litter every third year, and the young stay with the mother for two or three years. In Nunavut, female grizzlies usually have their first litter at eight years of age; compared to grizzly populations located in more southern North America, this is quite late and makes barren ground grizzlies more sensitive to over-harvesting. The grizzly bear diet in Nunavut consists mainly of caribou, but is supplemented by vegetation material and small mammals in summer. An increase in the number of encounters between humans and grizzlies is resulting in more "nuisance" bears being killed (NJWL 2008, Government of Nunavut 2011).

Birds

A wide variety of avian species can be expected to occur in the vicinity of the proposed project. Bird species from small, migratory passerines to various species of ptarmigan (*Lagopus* spp.) can be expected to use habitats within the project area. For example, passerines such as savannah sparrow (*Passerculus sandwichensis*), snow bunting (*Plectrophenax nivalis*), common redpoll (*Carduelis flammea*), American tree sparrow (*Passer montanus*) and white-crowned sparrow (*Zonotrichia leucophrys*) can be expected to occur within habitats of the project sites.

Similarly, a variety of waterfowl, shorebirds, and raptors can be expected to use habitats in the vicinity of the proposed project. Examples of waterfowl and shorebirds potentially found in the study area include yellow-billed loon (*Gavia adamsii*), tundra swan (*Cygnus columbianus*), semi-palmated plover (*Charadrius semipalmatus*), northern pintail (*Anas acuta*), green-winged teal (*Anas crecca*), and red-necked phalarope (*Phalaropus lobatus*). Raptors, such as rough-legged hawk (*Buteo lagopus*) and gyrfalcon (*Falco rusticolus*), can also be expected to use the habitats available in the study area (Nunami Jacques Whitford 2008).

Fish

No existing fisheries data is available for the Hope Lake, Husky Creek, or Willow Creek sites. Based on a review of *Jericho Diamond Project Aquatic Studies Program* (Tahera 2000), it can be expected that similar species will occur in the area. Arctic char (*Salvelinus alpinus*), lake trout (*S. namaycush*), round whitefish (*Prosopium cylindraceum*), burbot (*Lota lota*), and slimy sculpin (*Cottus cognatus*) were found during the Jericho Diamond Project study. It is possible for arctic grayling (*Thymallus arcticus*) to be found in tributaries to several lakes in the area.

Historically, these species have been found in the Coppermine River: arctic char, longnose sucker (*Catostomus catostomus*), arctic flounder (*Liopsetta glacialis*), starry flounder (*Platichthys stellatus*), and at least two species of whitefish (not identified) (Ellis 1956). Also found in the Fisheries Research Board of Canada study (Ellis 1956) for the Arctic was lake whitefish (*C. clupeaformis*), broad whitefish (*C. nasus*), northern pike (*Esox lucius*), arctic cod (*Boreogadus saida*), ninespine stickleback (*Pungitius pungitius*), and fourhorn sculpin (*Myoxocephalus quadricornis*).

The anadromous forms of arctic char spend a considerable time of their lives at sea; non-migratory populations remain in lakes and rivers with cold and clear water (Svetovidov 1984). At sea, arctic char live along the coast (Kottelat & Freyhof 2007). As a nerito-pelagic species (Coad & Reist 2004), char populations prey on planktonic crustaceans, amphipods, mollusks, insects, fishes) but favour small pelagic daphnids as a food source (Hulley 1990).

Lake trout, found in shallow and deep waters of northern lakes and streams, is restricted to relatively deep lakes in the southern part of its range (Page & Burr 1991). Lake trout predate on plankton, sponges, fishes, insects, and small mammals (Morrow 1980). Lake trout are highly susceptible to pollution, especially from insecticides, and are a commercially valuable species widely pursued for both sport and food purposes (Morrow 1980).

Round whitefish can be expected to be found in shallow lakes (3-15 m depth) spawning over vegetation or gravels. They feed on benthic larval invertebrates, eggs of lake trout, and other small fish such as scuplins or sticklebacks (Joynt & Sullivan 2003).

Burbot feed on whitefish eggs and other species of fish. Burbot adults are more piscivorous as they mature and prefer to hide among boulders. They can be found in lakes and rivers always near the bottom. (Joynt & Sullivan 2003). Slimy sculpin feed on aquatic insects and small fishes, and they can be found in gravelly tributaries or along rocky bottoms of lakes.

Arctic grayling are inhabitants of well-oxygenated, open, clean, and cold waters of medium to large rivers and lakes. Grayling enter rocky creeks to spawn (Kottelat & Freyhoff 2007, Page & Burr 1991). Schooling in moderate numbers (Frimodt 1995), the young feed on zooplankton with a gradual shift to immature insects; adults feed mainly on surface insects but also take in fishes, fish eggs, lemmings, and planktonic crustaceans (Scott & Crossman 1973). Grayling are known to be extremely susceptible to various forms of pollution (Nelson & Paetz 1992).

Northern pike are primarily a freshwater fish occurring in clear, vegetated lakes, quiet pools, and backwaters of creeks and small to large rivers (Page & Burr 1991), but are known to enter brackish waters. Typically non-migratory (Morrow 1980), this fish is usually solitary and highly territorial. Adults feed on fish, insects, and small birds and mammals; cannibalism is common, especially in arctic lakes, where it may be the only species present in a given waterbody (Coad et al. 2004). Pike are a valuable sport and food fish (Page & Burr 1991) that react poorly to habitat alterations (Kottelat & Freyhoff 2007).

Longnose sucker is found in clear, cold, deep water of lakes and tributary streams and occasionally found in brackish water in the Arctic (Page & Burr 1991). This species moves from lakes into inlet streams or from slow, deep pools into shallow, gravel-bottomed portions of streams to spawn (Morrow 1980). Feeding on benthic invertebrates, young suckers are preyed upon by other fishes and fish-eating birds, while adults in spawning streams are taken by mammals, osprey, and eagles (Page & Burr 1991).

Ninespine stickleback are found in multiple environments from shallow vegetated areas of lakes, ponds and pools of sluggish streams, to open water over sand; marine populations are found near shore and move into fresh water to spawn (Page & Burr 1991). When abundant, it is preyed upon by other fishes (Scott & Crossman 1973), but is also preyed upon by birds (Morrow 1980).

Fourhorn sculpin occurs in cold brackish and moderately saline water near the coast (Morrow 1980). This species enters coastal rivers and may occur as far as 180 km inland (Page & Burr 1991). Landlocked populations do occur but in general are considered to be locally threatened (Kottelat & Freyhoff 2007). Movement into freshwater and long distances up rivers are apparently undertaken by only relatively few individuals at a time (Morrow 1980). This species feeds on small crustaceans, fishes (Quero 1986), and molluscs (Coad & Reist 2004).

4.9.2 Marine Species (Related to Barge Activities)

Mammals

A number of marine mammal species are potentially found in the vicinity of the port facilities that will be used to transport hazardous and non-hazardous material. The species of marine mammal most likely to occur in the project area include ringed seal (*Pusa hispida*), bearded seal (*Erignathus barbatus*), beluga whale (*Delphinapterus leucas*), and polar bear (*Ursus maritimus*). None of the marine mammals expected to occur in the project area are considered at risk in terms of population status.

The ringed seal is the most abundant and widespread seal in the Arctic. One special adaptation of ringed seals that allows them to occupy areas unavailable to other marine mammals is their ability to maintain breathing holes in ice. Ringed seals are an important food source for polar bears. Ringed seals do not depend on land for any part of their life cycle (NJWL 2008).

The bearded seal is not considered to be a species of concern in Nunavut although the data used to determine population status is considered insufficient. Bearded seals are widely spread throughout Nunavut but are much less abundant than ringed seals. Bearded seals are also an important food source for polar bears, as well as a source of nutrition for the Inuit of Nunavut (NJWL 2008).

There are five sub-populations of beluga whales in Nunavut. Habitat requirements of beluga whales vary with the change of seasons. Belugas are important economically in Nunavut as they are hunted by many Inuit communities. Reactions of beluga whales to disturbance have been shown to vary from tolerance to extreme sensitivity (NJWL 2008).

Polar bears are found throughout Nunavut. Polar bears have diverse habitat requirements including ice, open water, coastal areas and inland areas. Polar bear distribution on ice is closely linked to ringed seal distribution. Dens for hibernation and giving birth also represent an important habitat requirement. Generally, only pregnant females den for a significant portion of the winter; other polar bears remain active and only den when the weather is particularly harsh (NJWL 2008).

Birds

As expected, most of the avian species potentially located in the Kugluktuk area are those closely tied to, or those requiring, marine habitat.

Common eiders (*Somateria mollissima*) nest in dense colonies along marine coasts, mostly on islands and islets and occasionally on islands in freshwater. Nests are built on the ground and are lined with a thick layer of down plucked from the female's breast. Breeding and nesting starts in May or June (timing is progressively later proceeding north). During spring migration (March to mid-June), large aggregations may occur immediately south of heavy arctic ice and in open leads (Sea Duck Joint Venture [SDJV] 2011a).

King eiders (*Somateria spectabilis*) are more gregarious than common eiders with flocks often reaching sizes greater than 10,000 individuals. In western Canada and Alaska, including Kugluktuk, they migrate west along a broad front but become concentrated within a few kilometres of shore between Simpson Lagoon and Point Barrow (SDJV 2011b).

In contrast to king eiders, long-tailed ducks (*Clangula hyemalis*) fly in bunched, irregular flocks in constantly changing formations. The birds spend most of the year (approximately nine months) primarily in coastal marine waters, and only during the breeding season do they frequent shallow wetlands of low lying tundra, ranging southward to the northern edge of the boreal forest. Nests are built along the arctic coasts and inland tundra on dry ground close to water, often partly hidden under low growth or among rocks but near lakes or ponds (SDJV 2011c).

In over-wintering sites, Herring gulls (*Larus argentatus*) are most likely to congregate on the beaches and shores of oceans and other large waterbodies. The breeding range for Herring gulls includes every province and territory in Canada, including marine areas around Kugluktuk. On offshore islands, they frequently occupy flat ground, but on the mainland, they tend to nest on cliffs, probably to avoid predatory mammals (Environment Canada 2002).

Glaucous gulls (*Larus hyperboreus*) breed along marine and freshwater coasts, tundra, offshore islands, cliffs, shorelines, and ice edges, including in the Kugluktuk area, but are rarely found breeding very far inland. They winter along maritime coasts, freshwater lakes, and agricultural fields in the more southern portions of North America. Nests are placed on islands, edges of ponds on open tundra, cliff ledges, grassy slopes above cliffs, and rock scree found at the foot of cliffs (Cornell University 2011a).

The arctic tern (*Sterna paradisaea*) is well known for its long yearly migration of about 40,000 km, as it travels from its Arctic breeding grounds to its wintering grounds near Antarctica. Most arctic terns return to the area where they were hatched, often to the same colony with breeding colonies being located in open tundra, in boreal forest, or on rocky islands and beaches. Nests are placed on the open ground and consist of scrapes in the gravel or grass, or platforms of vegetation or debris (Cornell University 2011b).

Fish

The Kugluktuk marine region has a well-established history of sustenance fishing traditions (Ellis 1956) and more recently a reliable commercial harvest of arctic char (Yaremchuck *et al.*, 1989). The Coppermine delta and Bloody Falls provide a wide variety of freshwater, brackish and marine conditions, and a mixed sea floor around Kugluktuk (varying from bedrock, stone and gravel bars to mud) supports a wide variety of benthic fish species (Mecklenburg & Mecklenburg 2009). Specimens of whitefish, char, cod, sculpin, and flounder were collected in the Coppermine River delta and surrounding area in the late 1950s (Ellis 1956). In particular, lake whitefish inhabits fresh, brackish, and marine environments. Specimens collected at Coppermine delta contained small marine fish and fish eggs (Ellis 1956).

Shorthorn sculpin (*Myoxocephalus scorpius*) is a semi-sedentary ambush predator. It inhabits shoal waters feeding on fishes, crustaceans, amphipods, and polychaetes. (Ellis 1956). Arctic staghorn sculpin (*Gymnocanthus tricuspis*) is widely abundant, and this benthic species inhabits shallow shoreline waters on multiple sea-floor substrates, such as mud, gravel, and rock. This sculpin is a common prey species for cods, flounder, and eelpouts (Mecklenburg & Mecklenburg 2009). Hamecon (*Artediellus scaber*) is a sculpin and is common catch in arctic trawling nets. It inhabits rock, gravel, sand and mud substrates in depths of 10 m to 290 m but is commonly located in depths less than 55 m (Mecklenburg & Mecklenburg 2009). Spatulate sculpin (*Icelus spatula*) is an abundant and wide ranging benthic sculpin, found at depths of 12 m to 859 m in the subarctic, but more commonly inhabits less than 365 m depths in arctic seas. It inhabits mud, sand, and pebble substrates and typically feeds on shrimp, amphipods, polychaetes and small mollusks (Mecklenburg & Mecklenburg 2009).

Arctic flounder is a coastal species not found far offshore. This species occurs at shallow depths on mud bottoms, often in brackish water and frequently enters freshwaters. A benthic zone inhabitant, it feeds on small fishes and bottom invertebrates (Coad & Reist 2004).

Bering flounder (*Hippoglossoides robustus*) is an abundant flounder in the Arctic and Kugluktuk is near the eastern border of its range. As a benthic species, it is most abundantly found on mud at intertidal depths to 532 m, but usually less than 150 m deep. It preys on pricklebacks, eelpouts, poachers, sculpins, cod, amphipods, shrimps, crabs, and other small bottom invertebrates and is eaten by cod species (e.g., *Gadus ogac*), halibut species, seals, and beluga whales (Mecklenburg & Mecklenburg 2009).

Saffron cod (*Eleginus gracilis*) is a locally abundant cod found in the western Arctic. This species inhabits the demersal zone in brackish waters and river mouths to the continental shelf edge (Mecklenburg & Mecklenburg 2009).

Other species that are likely present in the waters off Kugluktuk include halfbarred pout (*Gymnelus hemifasciatus*), polar eelpout (*Lycodes polaris*), slender eelblenny (*Lumpenus fabricii*), stout eelblenny (*Anisarchus medius*), fish doctor (*Gymnelus viridis*), and banded gunnel (*Pholis fasciata*).

4.9.3 Species of Concern

Five species potentially located in the project area require special attention due to their status of "special concern" as designated by Committee on the Status of Endangered Wildlife in Canada (COSEWIC): the short eared owl (*Asio falmmeus*), tundra peregrine falcon (*Falco peregrinus tundrius*), polar bear, wolverine and barren-ground caribou (Union and Dolphin herd populations). The short-eared owl primarily uses marshlands and open grasslands as habitat, but is susceptible to disturbance due to its ground nesting habit (NJWL 2008). The distribution of short-eared owls depends greatly on the abundance of small mammal prey species (AMEC 2008). The tundra peregrine falcon breeds across the arctic, however, suitable nesting sites (cliff ledges and crevices) are not located at the project sites. Therefore it is unlikely that falcons would even forage in the vicinity of the site, except during migration. However, falcons are known to make use of man-made structures for nesting (AEMC 2008), but none were observed during the field program in 2010. Polar bears, wolverines and barren ground caribou have previously been discussed in this report.

Of the large mammals found in the vicinity of the proposed project, the grizzly bear has been designated a status of "special concern" by COSEWIC (2011) and "sensitive" by the Government of Nunavut (2011); however, the grizzly bear population in Nunavut is considered to be growing (NJWL 2008). In Nunavut, the grizzly can be found throughout the Kivalliq region and in large portions of the Kitikmeot and Baffin regions, including all three sites. Grizzlies are omnivorous and an increase in the number of encounters between humans and grizzlies is resulting in more 'nuisance' bears being killed. A change in conservation status of the tundra peregrine falcon, polar bear, wolverine and barren-ground caribou (Union and Dolphin herd populations) under the Government of Nunavut is pending.

4.10 LAND USE HISTORY, CULTURAL FEATURES, AND SPECIAL PLACES

Reviews of the Archaeological Impact Assessment (AIA) (Golder 2010) and of the Phase III ESA (EBA 2010) were completed and used in developing a land use history of the area and for identifying any cultural features and/or special places in the project area.

4.10.1 Land Use History

Any historical resources located in project area are representative of human activity after the ice sheet, which covered most of North America, receded approximately 8,000 years ago. This early period (8,000 Before Present [BP] to 4,000 BP) is referred to as the Early Shield Culture or Paleo-Arctic Tradition and developed out of northern and eastern predecessors. The early Shield Culture was replaced by the Arctic Small Tool Tradition (ASTt) (4,200 BP to 2,800 BP) culture, which was located across the Canadian Arctic as well as parts of Alaska and Greenland. Current thought is that the ASTt culture relates to separate migration of peoples from Siberia rather than being related to the Paleo-Arctic Tradition. The Canadian Tundra Tradition (3,300 BP to 2,600 BP) is a local variant of the ASTt that exploited caribou in areas ranging from the Great Slave and Great Bear Lakes eastward to North Henrik Lake near Hudson Bay (Golder 2010).

The Dorset Culture replaced the ASTt and occupied the Canadian Arctic from 2,500 BP to 1,000 BP. The Dorset Culture was more successful than the ASTt given the large area it occupied, and Dorset groups became skilled at hunting during the winter on sea ice, which led to the development of permanent winter villages. With an expansion of sea ice during this time, hunting shifted from terrestrial hunting of caribou and hunting sea mammals on open water to hunting sea mammals from sea ice or coastlines. The Thule Culture replaced the Dorset Culture approximately 1,000 BP, but by that time, the Dorset Culture had disappeared from the Canadian Arctic. The Thule cultural tradition dated until 400 BP and is a derivation of the Norton Tradition in Alaska. The Thule Culture relied on hunting large sea mammals in open water using drag floats and large skim boats. The use of dogs to pull sleds was another Thule innovation, and the use of terrestrial mammals as a food source became more common closer to present day (Golder 2010).

Use of the project area is identified with the "Copper Inuit," whose traditional lands extend from the Coppermine River in the west to the Perry River in the east, and from the south coast of Banks Island in the north to Great Bear Lake in the south. The life of the Copper Inuit was affected by the change of seasons; inland terrestrial hunting and fishing was completed by small groups during the spring and summer, and caribou hunting dominated the fall. Winter was spent in semi-permanent villages of larger population groups along the coast and dominated by breathing-hole sealing. The Copper Inuit were different from other Arctic Groups due to their extensive use of copper and distinct clothing and familial organization. The Coppermine River and environs is the most important river in the project area from a historical resource perspective. The Copper Inuit used the river and surrounding area as a source of copper and wood, for hunting caribou, and for fishing arctic char. This area was also used by other Inuit and Dene groups for thousands of years (Golder 2010).

Samuel Hearne was the first explorer in the region when he travelled over land from Hudson Bay to investigate the source of copper discovered by locals in 1771. Float equipped aircraft allowed active exploration to commence in 1929. From 1929 to 1966, numerous exploration companies actively prospected and drilled in the area; however, no deposits of significant size were located. In 1966, PCE Explorations Ltd. undertook a large mineral staking program. Several other companies were attracted to the area by the news of a major exploration venture. In 1968, Coppermine River Limited prepared a feasibility study to conduct copper mining and build a town site at Hope Lake; however, these plans were not carried out. No reported exploration activities have occurred near any of the project area sites since the 1970s (Golder 2010).

The Coppermine River and surrounding area are still used by local Inuit groups for hunting and trapping. The Kugluktuk Hunters and Trappers Organization (HTO) own and manage a cabin at the Hope Lake site, which is used by local hunters; this is the only current land use at any of the project sites. The three sites are unoccupied with no other ongoing land use since previous exploration activities ceased in the 1970s. Newer barrels of fuel were observed at the Hope Lake airstrip indicating the airstrip may have been recently used as a fuel cache site. Other than this, the only other known uses of the site have been during the 1960s and 1970s as exploration camps. There are no nearby adjacent land uses, but historically, exploration has been conducted on surrounding land (Golder 2010).

4.10.2 Cultural Features and Special Places

Several heritage sites have been previously located near the project area at Dismal Lake, in the community of Kugluktuk, at Bloody Falls along the Coppermine River, and along the coast of Coronation Gulf (Golder 2010).

During the AIA completed for the project sites, three new heritage resources were located at the Hope Lake sites, while no new heritage resources were located at the Willow Creek sites or the Husky Lake sites (Golder 2010). The first archaeological site is a stone feature of four food caches in a boulder field along the southwest shore of Hope Lake. The four caches were dug out of the boulders and are 2 m to 2.5 m deep, range in depth from 0.40 m to 0.70 m, and are open. The second site is a single inukshuk located on a ridge overlooking the Hope Lake sites and comprises ten stones on top of a large rock. The final site is another inukshuk located on a high ridge overlooking the Hope Lake sites and comprises five flat stones located on a boulder. These archaeological sites, along with the cabin belonging to the Kugluktuk HTO, were the only cultural features or special places located in any of the project areas.

4.11 SOCIO-ECONOMIC

The Hamlet of Kugluktuk is the nearest community to the project sites and is located on the Coronation Gulf at the mouth of the Coppermine River approximately 600 km north of Yellowknife. In 2001, the population of Kugluktuk was 1,212, but as of 2006, the population of Kugluktuk was 1,302 (with a total of 355 housing units located in the community (Robert Hornal and Associates [RHA] 2002, Wikipedia 2010).

4.11.1 Employment

According to RHA (2002), the economy of Kugluktuk is a typical northern mixed economy with government transfer payments, traditional activities, and wages from employment inside and outside the community supporting the economy. The wage economy is dominated by employment with the government, with 49% of the workforce employed by the government or by government-related agencies such as education, healthcare, and municipal services.

Most non-government employment is with companies operating outside the community, with many inhabitants travelling to work at the EKATI Diamond Mine, the Diavik Diamond Mine, the Snap Lake Diamond Mine, and the Hope Bay Mine. In 1999, 28% of the workforce in the Hamlet of Kugluktuk was unemployed, with 1,614 cases of income support (income support in a community can be greater than the total number of residents as income support is often granted more than once per year). In 1998, 2% of the workforce had a high school diploma; 32% had a trade or certificate; and 7% had a university degree (RHA 2002).

4.11.2 Community Services

The Hamlet of Kugluktuk has a wide variety of community services and organizations. The community has two schools that provide education from kindergarten to Grade 12 which are busy since 35% of the population of Kugluktuk is 14 years of age or younger. RHA (2002) also reports that Nunavut Arctic College in Kugluktuk offers high school upgrading, as well as university and other special courses and programs. Outside agencies and employers have also provided training in the areas of geological sciences, construction trades, heavy equipment mechanics, kimberlite processing, and Inuit culture and language (Inuinnaqtun is the most common aboriginal language in Kugluktuk), especially since 89% of the inhabitants of Kugluktuk are of aboriginal descent. The hamlet also has a community health centre, elder's centre, youth centre, recreation centre, and wellness centre. Municipal services include electrical power generation, an airport, two retail stores, a hotel, a RCMP detachment, water and sewage collection, and a volunteer fire department (RHA 2002).

4.11.3 Traditional Land Uses

In 1998, RHA (2002) reported that 58% of the workforce hunted and fished and 10% trapped. The dollar value of the caribou hunted by the community in that year was $1,078,185, which comprised approximately 4,000 caribou. Community members also harvested 120,000 lbs. of arctic char, along with wolves, grizzly bears and wolverines. RHA (2002) reports that 31% of the workforce in the community is involved in the traditional craft industry, which includes carving and making traditional clothing. The Coppermine River and surrounding area are still used by local Inuit groups for hunting and trapping. The Kugluktuk HTO owns and manages a cabin at the Hope Lake site, which is used by local hunters; this is the only current land use at any of the project sites.

4.12 AESTHETIC VALUES

Natural landscapes, encompassing the land, water, and sky, changing from season to season, especially those undisturbed by human activities, are highly valued by most members of society. Natural landscapes disturbed by anthropogenic activities are often much less valued by societies. The natural landscapes at the three project sites have been disturbed by anthropogenic activities, which primarily occurred during the exploration activities of the 1960s. Disturbances include damaged terrain, such as the trail networks and burn pits, waste (hazardous and non-hazardous), such as tanks, drums and structures, and soil contamination.

5.0 PROJECT/ENVIRONMENT INTERACTIONS

This ESAR has been prepared in a manner that is consistent with NIRB requirements as outlined in the Article 12 of the NCLA and the *Guide 3: Guide to Filing Project Proposals and the Screening Process* (NIRB 2007a). In order to determine project and environment interactions, it is necessary to identify relevant ecosystem components (biological and anthropogenic), determine potential impacts to those components based on the scope of work, and the possible mitigation strategies available to reduce or eliminate those impacts. The sections below outline the process to identify and determine the interactions.

5.1 IDENTIFICATION OF VALUED ENVIRONMENTAL AND SOCIO-ECONOMIC COMPONENTS

The NIRB (NIRB 2007b) defines valued ecosystem components (VECs) as "those aspects of the environment considered to be of vital importance to a particular region or community, including:

- Resources that are either legally, politically, publicly or professionally recognized as important, such as parks, land selections, and historical sites;
- Resources that have ecological importance; and
- Resources that have social importance."

Valued Socio-Economic Components (VSECs) are defined by the NIRB (NIRB 2007b) as "those aspects of the socio-economic environment considered to be of vital importance to a particular region or community, including components relating to the local economy, health, demographics, traditional way of life, cultural well-being, social life, archaeological resources, existing services and infrastructure, and community and local government organizations."

Potential VECs and VSECs were identified in a four-stage process. Initially, a review of the regulatory responsibilities of applicable Nunavut and other government agencies was completed, including the NIRB. Also, VECs and VSECs identified in other projects in same area were reviewed, such as the *Jericho Diamond Mine Environmental Impact Statement* (Tahera 2003), the *Environmental Screening of the Proposed Investigation and Remediation of PIN-B Clifton Point DEW Line Site* (AMEC 2008), and the *Environmental Assessment Report for the Canadian Coast Guard Inuvik MCTS Tower Replacement Project* (EBA 2002). Once these VECs and VSECs are identified, they are confirmed during the public consultation process and in discussions with local government; in this case the Kitikmeot Inuit Association (KIA). Finally, based on the activities in the proposed RAP, professional judgement of environmental practitioners and remediation specialists identified any potential gaps in the VECs and VSECs previously identified.

As a result of this selection process, a comprehensive list and selection rationale was developed and is outlined below in Table 10.

TABLE 10: LIST OF VECS AND VSECS AND SELECTION RATIONALE

VEC or VSEC	VEC Selection Process			
	Regulatory Requirement	Identified in other Environmental Screening Reports	Public/Inuit Input	Professional Judgement
Climate and Air Quality	✓	✓		✓
Terrain and Geology		✓		
Soils	✓	✓		✓
Hydrology and Hydrogeology	✓	✓		✓
Vegetation	✓	✓		✓
Wildlife (Terrestrial Species)	✓	✓		✓
Wildlife (Aquatic Species)	✓	✓		✓
Cultural Features and Special Places	✓	✓		✓
Job Opportunities	✓	✓	✓	✓
Current Employers	✓		✓	✓
Traditional Land Use	✓	✓	✓	✓
Community Services	✓			✓
Aesthetics	✓	✓		✓

5.2 IDENTIFICATION OF PROJECT IMPACTS AND MITIGATION

To determine the potential impacts to the various VECs or VSECs, the baseline information along with specific project activities outlined in the RAP were reviewed, and using professional judgement, project activities that would impact/interact with a specific VEC or VSEC were identified. As recommended by the NIRB (2010b) in *Screening Part 2 Form Project Specific Information Requirements (PSIR)* this process was completed using a matrix of project activities versus VECs and VSECs. This matrix and the results of the process are included in Table 11.

TABLE 11: IDENTIFICAITON OF PROJECT IMPACTS ON VECS AND VSECS

VEC or VSEC	Project Activities												
	Site Preparation and Camp Operations			Remediation								Closure	
	Mobilization and Transportation of Personnel and Equipment to Sites	Trail and Camp Construction; Potential Development of Borrow Pit(s) and Upgrading of Airstrip	Camp Equipment Setup and Operation – Waste Treatment Systems and Maintenance	Structure Demolition and Debris Removal	On-Site Burning of Non-Hazardous Wood Waste	On-Site Incineration of Liquid Organic Waste	On-Site Compaction of Hazardous Solid Waste	On-site Treatment of Aqueous Liquid Waste	Removal of Contaminated Soil	Potential Construction and Operation of Landfarm[1]	Off-Site Transportation of Waste to Kugluktuk and then to a Disposal Facility[2]	Site Recontouring and Natural Revegetation of Disturbances	Demobilization and Transportation of Personnel and Equipment Off-Site
Climate and Air Quality	√	√	√	√	√	√	√	√	√	√	√	√	√
Terrain and Geology		√		√					√	√	√	√	
Soils	√	√	√	√	√	√	√	√	√	√	√	√	√
Hydrology and Hydrogeology	√	√	√	√		√		√	√	√	√	√	√
Vegetation	√	√	√	√				√	√	√	√	√	√
Wildlife (Terrestrial Species)	√	√	√	√			√	√	√	√	√	√	√
Wildlife(Marine Species)		√									√		
Cultural Features and Special Places		√		√					√	√	√	√	
Job Opportunities	√	√	√	√	√	√	√	√	√	√	√	√	√
Current Employers	√	√	√	√	√	√	√	√	√	√	√	√	√
Traditional Land Use		√	√	√	√	√	√	√	√	√	√	√	
Community Impacts	√	√	√								√	√	√
Aesthetics		√	√						√	√		√	

Notes:

[1] – If SSRC are not accepted by regulators then in situ treatment not possible

[2] – Materials to be shipped: drums and tanks with leachable lead paint; hazardous waste such as asbestos, pressurized cylinders, fire extinguishers and non-hazardous waste such as metal, plastic and glass.

In NIRB (2007c) *Guide 4: Guide to Project Proposals Exempt from Screening* significance is defined as "…a consideration of the context of the project and the intensity of adverse effects, by giving particular regard to the following:

- The environmental sensitivity of the geographic area likely to be affected by the project;
- The historical, cultural and archaeological significance of the geographic area likely to be affected by the project;
- The extent of the effects of the project, including the geographical area that will be affected, the size of the affected human populations, and the size of the affected wildlife populations and related habitat;
- The extent of the effects of the project on other regional human populations and wildlife populations, including the extent of the effects on Inuit harvesting activities;
- The magnitude and complexity of adverse effects;
- The probability of adverse effects occurring;
- The frequency and duration of adverse effects;
- The reversibility or irreversibility of adverse effects; and
- The potential for cumulative adverse effects given past, present and future relevant events."

Environmental effects are defined as "any positive or negative change in the biophysical and/or socio-economic environment caused by, or directly related to, a former, ongoing or proposed activity (NIRB 2007b). There are two types of effects:

- Direct effects - refer to changes in the environmental components that result from direct cause-effect consequences of interactions between the project activities and the environment.
- Indirect effects - result from cause-effect consequences of interactions between the environment and direct impacts. For example, the effect of pollution may not only be seen directly in the loss of local vegetation, but indirectly as a degradation of the health, culture and social structure of the local people."

Socio-economic effects are defined as "…any of a variety of social and economic effects, including impacts upon the local economy, health, demographics, traditional way of life, cultural well-being, social life, archaeological resources, existing services and infrastructure, and local and regional government organizations" (NIRB 2007b).

Once an impact to a particular VEC or VSEC was identified, the impact was rated using the system outlined in Table 12. This system is based on Smardon et al. (1976) and Leopold et al. (1971). This system was used by AMEC (2008) for a similar screening report and has been advocated by Canadian Environmental Assessment Agency (CEAA 2010).

This rating system has been modified so that the definitions provided by NIRB have been considered and to make it suitable for this project.

TABLE 12: IMPACT RATING CRITERIA

Attribute	Options	Definition
Direction	Positive	Beneficial impact to population or resource
	Neutral	No change to population or resource
	Negative	Adverse impact to population or resource
Scope	Local	Impact restricted to area within 1 km of the Project site
	Regional	Impact extends up to several kilometers from the Project site
	Territorial	Impact extends throughout Nunavut
Duration	Short-Term	Impacts are significant for less than a year before population or resource returns to its previous state; or for a species, less than one generation
	Medium-Term	Impacts are significant for 1 to 10 years; or for a species, for one generation
	Long-Term	Impacts are significant for greater than 10 years; or for a species, significant for than one generation
Frequency	Once	Occurs only once
	Intermittent	Occurs occasionally at irregular intervals
	Continuous	Occurs on a regular basis and regular intervals
Magnitude	Negligible	No measurable change from background in the population or resource; or in the case of air, soil or water quality, if the parameter remains less than the standard, guideline or objective
	Low	Impact causes <1% change in the population or resource (where possible the population or resource base is defined in quantitative terms)
	Moderate	Impact causes 1 to 10% change in the population or resource
	High	Impact causes >10% in population in resource
Probability	Low	The impact is unlikely to occur
	Medium	The impact is fairly likely to occur
	High	There is a high probability of the impact occurring
Significance	Insignificant	Minimal or no measurable change from background conditions that may last over a long-term period
	Significant	Measurable change from background conditions that may last over a long-term period
	Unknown	Insufficient data available to make a professional judgement, more study required.

Different project activities have similar impacts and impact ratings and consequently similar mitigation strategies; therefore, in the following sections, project activities with analogous impacts, impact ratings, and mitigation have been grouped together for each of VECs and VSECs. The following tables provide an assessment of project interactions, potential impacts and ratings, and mitigation strategies. A brief summary for each VEC is also included. A discussion, rather than a table format, is provided for VSECs and project interactions later in the report. Only residual impacts, those impacts that cannot be mitigated and that are also considered significant, are discussed later in the ESAR.

5.3 PROJECT IMPACTS AND MITIGATION

5.3.1 Climate and Air Quality Impacts and Mitigation

TABLE 13: ASSESSMENT OF IMPACTS ON CLIMATE

Project Activity	Potential Impact	Impact Rating	Mitigation
Site Preparation and Camp Operations		Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Negligible Probability: High Significance: Insignificant	Greenhouse gas emissions from this project are insignificant so mitigation is not required
Mobilization and transportation of personnel and equipment to sites	Greenhouse gas emissions from equipment operation and camp waste incineration		
Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip			
Camp equipment setup and operation – waste treatment systems and maintenance			
Remediation			
On-site burning of non-hazardous wood waste On-site incineration of liquid organic waste Structure demolition and debris removal On-site compaction of hazardous solid waste Removal of contaminated soil Off-site transportation of waste to Kugluktuk and then to a disposal facility	Greenhouse gas emissions from wood waste, from incineration equipment and incinerating liquid organic waste, and from equipment operation		
Closure			
Site recontouring and natural revegetation of disturbances Demobilization and transportation of personnel and equipment off-site	Greenhouse gas emissions from equipment operation		

Summary:

Adverse potential impacts to air quality with respect to climate are associated with all phases at all project areas, including mobilization, remediation and demobilization. As a result emissions of greenhouse gases, nitrogen oxides (NO_x), sulphur dioxide (SO_2) particulate matter, and carbon monoxide (CO) due to combustion of aviation fuel, diesel fuel and gasoline; incineration of liquid hazardous waste and burning of non-hazardous wood waste will increase. Emissions from construction equipment, however, will be short term and intermittent and will not have a significant residual effect on the climate within the local study area, regionally, or nationally.

TABLE 14: ASSESSMENT OF IMPACTS ON AIR QUALITY

Project Activity	Potential Impact	Impact Rating	Mitigation
Site Preparation and Camp Operations			
Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip	Dust from development of borrow pit(s), upgrading of airstrip and trails, and camp construction Exhaust emissions from equipment operation	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Negligible Probability: High Significance: Insignificant	Development and implementation of a Dust Control Best Management Practices (BMP), such as using water for controlling dust and limiting remediation activities during high wind periods Exhaust emissions for project are insignificant so mitigation is not required
Remediation			
On-site burning of non-hazardous wood waste	Potentially hazardous air emissions if hazardous material is burned with wood Potentially increased emissions of particulate matter	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Negligible Probability: Low (hazardous emissions) High (particulate matter) Significance: Insignificant	Proper segregation of wood from other material so only wood is burned Proper training of burning operators to ensure high temperatures to limit particulate emissions
On-site incineration of liquid organic waste	Potentially hazardous air emission s from moving and incinerating hazardous material (e.g., dioxins and furans); Potentially increased emissions of particulate matter Exhaust emissions from equipment operation	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Negligible Probability: Low Significance: Insignificant	Incineration equipment only operated by trained contractor and equipment is properly maintained to ensure the liquid organic waste is completely incinerated and particulate emissions are controlled Exhaust emissions for project are insignificant so mitigation is not required
Structure demolition and debris removal On-site compaction of hazardous solid waste Removal of contaminated soil Potential construction and operation of landfarm Off-site transportation of waste to Kugluktuk and then to a disposal facility	Potential emissions of hazardous waste particles and dust while completing remediation activities and the potential construction and operation of landfarm Exhaust emissions will result from equipment operation	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Negligible Probability: Medium Significance: Insignificant	Development and implementation of a Dust Control BMP, such as using water for controlling dust and limiting remediation activities during high wind periods Careful segregation and transportation of hazardous waste Exhaust emissions for project are insignificant so mitigation is not required
Closure			
Site recontouring and natural revegetation of disturbances Demobilization of camp and construction equipment	Potential dust emissions while recontouring disturbed areas Exhaust emissions from equipment operation	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Negligible Probability: High Significance: Insignificant	Development and implementation of a Dust Control BMP, such as using water for controlling dust and limiting remediation activities during high wind periods Exhaust emissions for project are insignificant so mitigation is not required

Summary:

Adverse potential impacts to air quality are associated with all phases at all project areas, including mobilization, remediation and demobilization In order to complete the proposed remediation, heavy equipment, liquid waste treatment, and incineration equipment will be used and wood and camp waste will be burned. As a result emissions will increase due to combustion of aviation fuel, diesel fuel and gasoline, incineration of liquid organic waste and burning of wood waste. Emissions from vehicles and construction equipment however will be short term and intermittent and will not have a significant residual effect on air quality within the local study area, regionally or nationally. Dust generation is expected to also be low in volume and infrequent.

A number of measures will be implemented to mitigate the potential adverse effects associated with project activities. These will include, though not be limited to: dust suppression/control measures, implementation of good practice measures and avoidance of work during extreme wind events. There is potential for emissions of dioxins and furans through the incineration of liquid organic wastes and the inadvertent burning of hazardous wastes, but these will be managed by ensuring on-site diversion and segregation of waste, thus ensuring only appropriate waste streams are burned and / or incinerated. Additionally, the amount of soil exposed and disturbed will be limited to the areas requiring remediation and the movement of soils will be minimized whenever possible. Exposed soil piles will be covered, except for the landfarm. A BMP for Dust Control will be developed and implemented and will contain these and other measures. Following implementation of mitigation measures, adverse impacts associated with project activities to air quality will be local, short term and insignificant. Additionally, these impacts are not expected to contribute to any adverse cumulative effects.

5.3.2 Terrain and Geological Impacts and Mitigation

TABLE 15: ASSESSMENT OF IMPACTS ON TERRAIN AND GEOLOGY

Project Activity	Potential Impact	Impact Rating	Mitigation
Site Preparation and Camp Operations		Direction: Negative Scope: Local Duration: Short-Term Frequency: Once Magnitude: Low Probability: High Significance: Insignificant	
Mobilization and transportation of personnel and equipment to sites Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip	Site preparation and construction activities could disturb the terrain and potentially damage permafrost		Use existing roads, pathways and previously disturbed areas to the fullest extent possible Limit creation of new disturbed areas Disturbed areas will be recontoured to match pre-disturbance conditions to the fullest extent possible
Remediation			
Potential construction and operation of landfarm	Disruption of surficial geology may provide a potential pathway for impact into the bedrock Permafrost may be damaged		The landfarm must be constructed with a proper liner (which must not be breached) and leachate collection system Proper operation of the landfarm to ensure impact is contained within the landfarm Limit exposure time of the permafrost
Structure demolition and debris removal On-site burning of non-hazardous wood waste Removal of contaminated soil Off-site transportation of waste to Kugluktuk and then to a disposal facility	Remediation activities could disturb the terrain and potentially damage permafrost		Minimize disturbance to the terrain Ensure incineration areas are properly constructed to avoid impact to permafrost Recontour disturbed area quickly to match pre-disturbance conditions Use of low pressure equipment while transporting untreated waste to Kugluktuk
Closure		Direction: Negative Scope: Local Duration: Short-term Frequency: Once Magnitude: Low Probability: Moderate Significance: Insignificant	Land surface will be recontoured to match pre-disturbance conditions to the fullest extent possible Surface area and time of permafrost exposure will be minimized
Site recontouring and natural revegetation of disturbances	Activities could disturb the terrain and potentially damage permafrost		
Summary: Adverse potential impacts to geology are associated with the construction of a landfarm and the potential for impact of the underlying geology. However, if proper construction and maintenance techniques are followed no impacts are expected and the construction of a landfarm is not expected to contribute to any adverse cumulative effects. It is expected that the Project will have long-term beneficial effects on the geology at the sites due to the removal or treatment of hazardous waste and removal and treatment contaminated soil as these sources of impact will have been removed. No residual or cumulative impacts to geologic resources are expected.			

5.3.3 Soil Impacts and Mitigation

TABLE 16: ASSESSMENT OF IMPACTS ON SOIL

Project Activity	Potential Impact	Impact Rating	Mitigation
Site Preparation and Camp Operations			
Mobilization and transportation of personnel and equipment to sites Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip Camp equipment setup and operation – waste treatment systems and maintenance	Potential impact of soil from spills when refuelling and servicing equipment Degradation (erosion, compaction, admixing) of soil during site preparation activities	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available to all workers on-site Fuel and hazardous material will be stored in easily accessible and bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Hazardous waste and fuel storage areas (including drums) will be inspected daily Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992) Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies
Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip	Degradation (erosion, compaction, admixing) of soil during site preparation activities	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Low Probability: Moderate Significance: Insignificant	A Soil Management BMP will be developed and implemented Use existing roads, pathways and previously disturbed areas to the fullest extent possible Topsoil and subsoil will be handled and stored separately Soil will not be disturbed or handled during wet and / or windy conditions
Remediation			
Structure demolition and debris removal On-site burning of non-hazardous wood waste On-site incineration of liquid organic waste On-site compaction of hazardous solid waste On-site treatment of aqueous liquid waste Removal of contaminated soil Potential construction and operation of landfarm Off-site transportation of waste to Kugluktuk and then to a disposal facility	Potential impact of soil from spills when refuelling and servicing equipment Potential soil impact while removing, transporting, burning or incinerating remediation materials, and potential landfarm construction	Direction: Negative (beneficial once non-hazardous and hazardous materials and contaminated soil have been treated or removed from the sites) Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available to all workers on-site Fuel and hazardous material will be stored in easily accessible and bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Hazardous waste and fuel storage areas (including drums) will be inspected daily Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies All workers will be trained in proper handling of non-hazardous and hazardous materials and contaminated soil Hazardous materials and contaminated soil will be exposed for as short time as possible
Structure demolition and debris removal Removal of contaminated soil Potential landfarm construction and operation Off-site transportation of waste to Kugluktuk and then to a disposal facility	Degradation (erosion, compaction, admixing) of soil during remediation activities such as removing waste, contaminated soil or potential landfarm construction	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Low Probability: Moderate Significance: Insignificant	A Soil Management BMP will be developed and implemented Use existing roads, pathways and previously disturbed areas to the fullest extent possible Topsoil and subsoil will be handled and stored separately Soil will not be disturbed or handled during wet and / or windy conditions
Closure			
Site recontouring and natural revegetation of disturbances Demobilization and transportation of personnel and equipment off-site	Potential impact of soil from spills when refuelling and servicing equipment	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low	A Spill Contingency BMP will be developed and implemented, and be available to all workers on-site Fuel and hazardous material will be stored in easily accessible and bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Hazardous waste and fuel storage areas (including drums) will be inspected daily Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and

TABLE 16: ASSESSMENT OF IMPACTS ON SOIL

Project Activity	Potential Impact	Impact Rating	Mitigation
		Significance: Insignificant	*Regulations* (Government of Canada 1992)
Site recontouring and natural revegetation of disturbances	Degradation of soil (erosion, compaction, admixing) during recontouring	Direction: Negative Scope: Local Duration: Short-term Frequency: Once Magnitude: Low Probability: Moderate Significance: Insignificant	A Soil Management BMP will be developed and implemented Topsoil and subsoil will be handled and stored separately Soil will not be disturbed or handled during wet and / or windy conditions

Summary:

Adverse potential impacts to soils are associated with all phases of the Project, including mobilization, remediation and demobilization, especially in the event of extreme precipitation. Adverse effects may include degradation of soil through compaction and/or admixing of topsoil and subsoil. Potential soil impact can occur from improper storage, transportation and use of fuel and hazardous waste.

Adverse effects associated with extreme precipitation events include erosion, slumping or sliding of surficial materials (especially during landfarm construction and operation, if required). A number of measures will be implemented to mitigate the potential adverse effects associated with project activities. These will include, though not be limited to, locating access routes and storage areas on previously disturbed areas, limiting the area and time that permafrost is exposed, re-contouring and grading to ensure that landforms match pre-disturbance conditions as much as possible. Other measures include avoiding working with equipment during extreme precipitation events, and if required separating topsoil and subsoil during construction activities. A soil handling protocol will be developed prior to construction activities.

To mitigate the impacts of potential soil impact, fuel and hazardous material will be stored in an easily accessible bermed area, hazardous waste and fuel storage areas (including drums) will be inspected daily. Fuel and hazardous material containers will be stored in a manner that allows easy removal in case of a leak or spill. A Spill Contingency BMP will be developed and implemented, and along with spill containment equipment, be available to all workers on-site.

Overall, the removal of abandoned site infrastructure and debris, removal or treatment of hazardous and non-hazardous waste, and removal or treatment of contaminated soil will be beneficial to soil resources as sources of impact will be removed. Following implementation of mitigation measures, adverse effects associated with project activities to landforms and soils will be local, short term and insignificant. Additionally, these impacts are not expected to contribute to any adverse cumulative effects.

5.3.4 Hydrology and Hydrogeology Impacts and Mitigation

TABLE 17: ASSESSMENT OF IMPACTS ON HYDROLOGY AND HYDROGEOLOGY

Project Activity	Potential Impact	Impact Rating	Mitigation
Site Preparation and Camp Operations			
Mobilization and transportation of personnel and equipment to sites Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip Camp equipment setup and operation – waste treatment systems and maintenance	Potential impact of surface water and groundwater from spills when refuelling and servicing equipment	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available on-site for all workers Contain spill as close to release point as possible Proper containment and removal of fuels from any waterbodies Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Hazardous waste and fuel storage areas (including drums) will be inspected daily Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992)
Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip	Sedimentation or damage to riparian areas can occur during site preparation activities	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	Development and implementation of a Sediment Control BMP. Placement of temporary (during remediation) and permanent (e.g., for the barrier or landfarm) erosion control measures (i.e., berms, silt fences) Limit disturbance of any new areas Disturbed areas near adjacent to water bodies will be stabilized Environmental monitoring will occur during construction activities to ensure erosion control measures are implemented and adequate
Camp equipment setup and operation – waste treatment systems and maintenance	The operation of the work camp will include disposal of camp sewage, grey water, garbage and other non-hazardous wastes which could impact water quality	Direction: Negative Scope: Local Duration: Short-term Frequency: Intermittent Magnitude: Negligible Probability: High Significance: Insignificant	Camp sewage and grey water will be diverted to sumps that are located a minimum of 100 m from a watercourse or a waterbody Sumps will be closed off at the end of remediation activities All other camp waste will be disposed of off-site on completion of the remediation activities
Remediation			
Structure demolition and debris removal On-site burning of non-hazardous wood waste On-site incineration of liquid organic waste On-site compaction of hazardous solid waste On-site treatment of aqueous liquid waste Removal of contaminated soil Potential landfarm construction and operation Off-site transportation of waste to Kugluktuk and then to a disposal facility	Potential impact of surface water and groundwater from spills when refuelling and servicing equipment Potential surface water and groundwater impact while removing, transporting, burning or incinerating waste materials, and potential landfarm construction	Direction: Negative (beneficial once non-hazardous, but especially hazardous materials and contaminated soil have been treated or removed from the sites) Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available on-site for all workers Contain spill as close to release point as possible Proper containment and removal of fuels from any waterbodies Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Hazardous waste and fuel storage areas (including drums) will be inspected daily Hazardous materials and contaminated soil will be exposed for as short time as possible All workers will be trained in proper handling of non-hazardous and hazardous materials and contaminated soil Landfarm will be constructed to ensure leachate will not impact the surrounding environment

TABLE 17: ASSESSMENT OF IMPACTS ON HYDROLOGY AND HYDROGEOLOGY

Project Activity	Potential Impact	Impact Rating	Mitigation
Structure demolition and debris removal Removal of contaminated soil Potential construction and operation of landfarm	Sedimentation or damage to riparian areas can occur during remediation activities that disturb the land surface	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Moderate Significance: Insignificant	Development and implementation of a Sediment Control BMP. Placement of temporary (during remediation or landfarm construction) erosion control measures (i.e., berms, silt fences) Limit disturbance of any new areas Disturbed areas near adjacent to water bodies will be stabilized Remedial excavations or landfarm design should provide for proper drainage and soil stability Environmental monitoring will occur during remediation activities to ensure erosion control measures are implemented and adequate
Closure		Direction: Negative (beneficial once non-hazardous, but especially hazardous materials and contaminated soil have been treated or removed from the sites) Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available on-site for all workers Contain spill as close to release point as possible Proper containment and removal of fuels from any waterbodies Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Hazardous waste and fuel storage areas (including drums) will be inspected daily Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992)
Demobilization and transportation of personnel and equipment off-site Site recontouring and natural revegetation of disturbances	Potential impact of surface water and groundwater from spills when refuelling and servicing equipment		
Site recontouring and natural revegetation of disturbances	Sedimentation or damage to riparian areas can occur during site recontouring	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Moderate Significance: Insignificant	Development and implementation of a Sediment Control BMP. Disturbed areas near adjacent to water bodies will be stabilized Recontouring site to match natural terrain after infrastructure, hazardous and non-hazardous waste, and contaminated soil removal

Summary:

Adverse potential impacts to aquatic resources and water quality at all three sites are possible during all phases of the Project due to potential spills and sedimentation events (especially during extreme rainfall events). Silt generated by the use and movement of heavy equipment and remediation equipment across the site, the excavation of contaminated soil, the potential construction of the landfarm, the operation of the landfarm, along with fugitive dust emissions may have an effect on surface water quality and could impact local aquatic environments. Surface and groundwater impacts could occur from improperly storing and transporting fuel and hazardous waste, refuelling equipment, incinerating and / or burning of hazardous and non-hazardous waste, and from potential landfarm leachate.

A number of environmental protection measures will be incorporated to reduce the likelihood of surface and groundwater impacts such as developing and implementing a Spill Contingency BMP which will include measures such as having containment equipment available, storing fuel and hazardous material and refuelling of equipment at least 100 m from any waterbodies and proper treatment of waste water. Construction design of the landfarm must ensure that leaching to surrounding surface water or groundwater will not occur. Erosion and sediment release can occur at any time but especially at the beginning of construction (therefore sedimentation control barriers should be placed as soon as possible), and during precipitation events or during snowmelt. The highest potential for sedimentation occurs during clearing, grading and during activities in or near wetlands and watercourses. Specific mitigation measures for the protection of the topsoil resource and water quality from sedimentation will be in the Sedimentation Control BMP and will include limiting the disturbance of any new areas and placing temporary sedimentation control barriers.

Overall the remediation activities are expected to have positive impact on the hydrology and hydrogeology of the three sites with removal of hazardous and non-hazardous materials, and contaminated soil. Following implementation of mitigation measures, adverse effects associated with project activities to the hydrology and hydrogeology of the project areas will be local, short-term and insignificant. These impacts are not expected to contribute to any adverse cumulative effects.

5.3.5 Vegetation Impacts and Mitigation

TABLE 18: ASSESSMENT OF IMPACTS ON VEGETATION

Project Activity	Potential Impact	Impact Rating	Mitigation
Site Preparation and Camp Operations			
Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip	Dust from development of borrow pit(s), upgrading of airstrip and trails, and camp construction could impact vegetation	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Negligible Probability: High Significance: Insignificant	Development and implementation of a Dust Control BMP, such as using water for controlling dust and limiting remediation activities during high wind periods
Mobilization and transportation of personnel and equipment to sites Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip Camp equipment setup and operation – waste treatment systems and maintenance	Potential impact to vegetation from spills when refuelling and servicing equipment	Direction: Negative Scope: Local Duration: Medium-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available on-site for all workers Contain spill as close to release point as possible Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Hazardous waste and fuel storage areas (including drums) will be inspected daily Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992)
Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip	Loss or alteration of vegetative cover can occur when completing site preparation and camp construction	Direction: Negative Scope: Local Duration: Long-Term Frequency: Intermittent Magnitude: Low Probability: High Significance: Insignificant	Use existing roads, pathways and previously disturbed areas to the fullest extent possible Ensure natural drainages are recreated to limit water ponding and foster revegetation Use equipment with low pressure tires Storage of non-contaminated surface soil for use in revegetation
Remediation			
Structure demolition and debris removal Removal of contaminated soil Potential construction and operation of landfarm Off-site transportation of waste to Kugluktuk and then to a disposal facility	Dust from remediation activities, such as removing debris and burning waste, and the potential construction and operation of landfarm could impact vegetation	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Negligible Probability: High Significance: Insignificant	Development and implementation of a Dust Control BMP, such as using water for controlling dust and limiting remediation activities during high wind periods
Structure demolition and debris removal On-site burning of non-hazardous wood waste (On-site incineration of liquid organic waste On-site compaction of hazardous solid waste On-site treatment of aqueous liquid waste Removal of contaminated soil Potential landfarm construction and operation Off-site transportation of waste to Kugluktuk and then to a disposal facility	Potential impact to vegetation from spills when refuelling and servicing equipment Potential vegetation impact from wastes while removing, transporting, burning or incinerating waste materials, and potential landfarm construction	Direction: Negative (beneficial once non-hazardous, but especially hazardous materials and contaminated soil have been treated or removed from the sites) Scope: Local Duration: Medium-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available on-site for all workers Contain spill as close to release point as possible Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Hazardous waste and fuel storage areas (including drums) will be inspected daily All workers will be trained in proper handling of non-hazardous and hazardous materials and contaminated soil Hazardous materials and contaminated soil will be exposed for as short time as possible Landfarm will be constructed to ensure leachate will not impact the surrounding environment

TABLE 18: ASSESSMENT OF IMPACTS ON VEGETATION

Project Activity	Potential Impact	Impact Rating	Mitigation
Structure demolition and debris removal Removal of contaminated soil Potential construction and operation of landfarm Off-site transportation of untreated waste to Kugluktuk and then to a disposal facility	Physical disturbance, loss or alteration of vegetative cover can occur when completing remediation activities such as removing debris or hazardous soil and the potential construction and operation of the landfarm	Direction: Negative Scope: Local Duration: Long-Term Frequency: Intermittent Magnitude: Low Probability: High Significance: Insignificant	Use existing roads, pathways and previously disturbed areas to the fullest extent possible Ensure natural drainages are recreated to limit water ponding and foster revegetation Limit creation of new disturbed areas while completing remediation Use equipment with low pressure tires
Closure			
Site recontouring and natural revegetation of disturbances	Dust from recontouring could impact vegetation	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Negligible Probability: High Significance: Insignificant	Development and implementation of a Dust Control BMP, such as using water for controlling dust and limiting remediation activities during high wind periods
Site recontouring and natural revegetation of disturbances Demobilization and transportation of personnel and equipment off-site	Potential impact to vegetation from spills when refuelling and servicing equipment	Direction: Negative Scope: Local Duration: Medium-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available on-site for all workers Contain spill as close to release point as possible Proper containment and removal of fuels from any waterbodies Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Hazardous waste and fuel storage areas (including drums) will be inspected daily Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992) Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies
Site recontouring and natural revegetation of disturbances	Loss or alteration of vegetative cover can occur when completing recontouring activities	Direction: Negative Scope: Local Duration: Long-term Frequency: Intermittent Magnitude: Low Probability: High Significance: Insignificant	Use existing roads, pathways and previously disturbed areas to the fullest extent possible Ensure natural drainages are recreated to limit water ponding and foster revegetation Land surface will be recontoured in to match pre-disturbance conditions to the fullest extent possible but with the minimal equipment use to foster natural revegetation Utilize stockpiled surface soil for revegetation Use equipment with low pressure tires

Summary:

Adverse potential impacts to vegetation are associated with all phases of the Project. The movement of heavy equipment, transportation equipment and remediation equipment across the site, potential construction and operation of the landfarm removing waste and debris, upgrading trails and airstrip, camp construction, borrow pit development and recontouring the sites will result in fugitive dust emissions. Dust suppression and control measures will be implemented, thus dust is not expected to have a significant effect on adjacent vegetation. Remediation at all three sites will significantly remove contaminants in local soils and remove the long-term potential for vegetation damage. Longer term impacts on vegetation are expected from disturbance during infrastructure and debris removal; hazardous and non-hazardous waste removal, storage and transport; and potential landfarm construction (including stockpiles); upgrading trails and the airstrip; potential borrow pit development; and camp construction. To minimize the potential for direct loss and / or alteration of vegetation, remediation activities will be limited to the footprint of previously disturbed areas as much as possible. Extreme windy conditions may exacerbate fugitive dust, extreme rainfall may exacerbate erosion, and accidental hydrocarbon spills have the potential to adversely affect vegetation, with appropriate mitigation, such as proper fuel storage, erosion control and dust control measures the probability of significant adverse effects is anticipated to be low. Residual effects on vegetation may result from some site preparation and remedial activities until natural revegetation occurs. These impacts are not expected to contribute to any adverse cumulative effects. Overall, remediation of the three sites will have a positive impact on vegetation communities.

5.3.6 Wildlife Impacts and Mitigation

TABLE 19: ASSESSMENT OF IMPACTS ON TERRESTRIAL WILDLIFE

Project Activity	Potential Impact	Impact Rating	Mitigation
Site Preparation and Camp Operations			
Mobilization and transportation of personnel and equipment to sites Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip Camp equipment setup and operation – waste treatment systems and maintenance	Direct mortality, sensory impairment, disruption of movement patterns and indirect mortality produced by wildlife/human interactions potentially caused during transportation of materials and site preparation, such as upgrading trails, and camp operations	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: High Significance: Insignificant	Implement Wildlife BMP that includes noise abatement measures Conduct pre-disturbance nest surveys; avoid active nesting structures when present; if habituated by a bird species of special concern remove structure when nesting complete Inspect all structures and debris to for wildlife use prior to remediation Suspend activities during the caribou calving season(May-July) if caribou cows are present Suspend activities if large numbers (>100) caribou are migrating through or within 5 km of the sites Operations will avoid caribou water crossings if any are identified Restrict wildlife access to disturbed areas Aircraft flights will maintain a minimum altitude of 610 m above ground level except for takeoff and landing (AMEC, 2008) Containers for domestic waste will be located in enclosed bear-proof structures Garbage will be removed or incinerated from sites daily Bear safety awareness training will be provided as will information on other wildlife encounters All personnel will be familiar with current 'Safety in Bear/Polar Bear Country' literature produced by Nunavut Department of Environment Bear deterrents will be kept at all sites The use of electric fencing will be considered for the camp
Mobilization and transportation of personnel and equipment to sites Trail and camp construction; potential development of borrow pit(s) and upgrading of airstrip Camp equipment setup and operation – waste treatment systems and maintenance	Potential impact to wildlife habitat from spills when refuelling and servicing camp, construction, and transportation equipment	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available to all workers on-site Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Hazardous waste and fuel storage areas (including drums) will be inspected daily Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992)
Remediation			
Structure demolition and debris removal On-site burning of non-hazardous wood waste On-site incineration of liquid organic waste On-site compaction of hazardous solid waste On-site treatment of aqueous liquid waste Removal of contaminated soil Potential construction and operation of landfarm Off-site transportation of waste to Kugluktuk and then to a disposal facility	Direct mortality, sensory impairment, disruption of movement patterns and indirect mortality produced by wildlife/human interactions potentially caused by remediation activities like removing debris and demolishing infrastructure using heavy equipment	Direction: Negative (beneficial once non-hazardous, but especially hazardous materials and contaminated soil have been treated or removed from the sites) Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: High Significance: Insignificant	Implement Wildlife BMP that includes noise abatement measures Conduct pre-disturbance nest surveys; avoid active nesting structures if habituated by a bird species of special concern, remove structure when nesting completed Inspect all structures and debris for wildlife use prior to remediation Suspend activities during the caribou calving season(May-July) if caribou cows are present Suspend activities if large numbers (>100) caribou are migrating through or within 5 km of the sites Operations will avoid caribou water crossings if any are identified Restrict wildlife access to disturbed areas Aircraft flights will maintain a minimum altitude of 610 m above ground level except for takeoff and landing (AMEC, 2008) Bear safety awareness training will be provided as will information on other wildlife encounters All personnel will be familiar with current 'Safety in Bear/Polar Bear Country' literature produced by Nunavut Department of Environment Bear deterrents will be kept at all sites

TABLE 19: ASSESSMENT OF IMPACTS ON TERRESTRIAL WILDLIFE

Project Activity	Potential Impact	Impact Rating	Mitigation
Structure demolition and debris removal On-site burning of non-hazardous wood waste On-site incineration of liquid organic waste On-site compaction of hazardous solid waste On-site treatment of aqueous liquid waste Removal of contaminated soil Potential landfarm construction and operation Off-site transportation of waste to Kugluktuk and then to a disposal facility	Potential impact of wildlife from spills when refuelling and servicing remediation equipment	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available to all workers on-site Fuel and hazardous material will be stored in and easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Hazardous waste and fuel storage areas (including drums) will be inspected daily All workers will be trained in proper handling of non-hazardous and hazardous materials and contaminated soil Hazardous materials and contaminated soil will be exposed for as short time as possible
Closure		Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: High Significance: Insignificant	Implement Wildlife BMP that includes noise abatement measures Suspend activities if large numbers (>100) caribou are migrating through or within 5 km of the sites Operations will avoid caribou water crossings if any are identified Restrict wildlife access to disturbed areas Aircraft flights will maintain a minimum altitude of 610 m above ground level except for takeoff and landing (AMEC, 2008) Bear safety awareness training will be provided as will information on other wildlife encounters All personnel will be familiar with current 'Safety in Bear/Polar Bear Country' literature produced by Nunavut Department of Environment Bear deterrents will be kept at all sites
Site recontouring and natural revegetation of disturbances Demobilization and transportation of personnel and equipment off-site	Direct mortality, sensory impairment, disruption of movement patterns and indirect mortality produced by wildlife/human interactions potentially caused during transportation of materials by aircraft and construction equipment		
Site recontouring and natural revegetation of disturbances Demobilization and transportation of personnel and equipment off-site	Potential impact of wildlife habitat from spills from when refuelling and servicing construction and transportation equipment	Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Low Probability: Low Significance: Insignificant	A Spill Contingency BMP will be developed and implemented, and be available to all workers on-site Fuel and hazardous material will be stored in an easily accessible bermed area, which will act as a spill barrier and allow for easy removal in case of a leak or spill Fuel storage, hazardous material storage and refueling of equipment will occur at least 100 m from any waterbodies Hazardous waste and fuel storage areas (including drums) will be inspected daily Transportation procedures on-site and off-site will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992)

TABLE 19: ASSESSMENT OF IMPACTS ON TERRESTRIAL WILDLIFE			
Project Activity	Potential Impact	Impact Rating	Mitigation
Summary: Potential adverse impacts to terrestrial wildlife are associated with all phases of the Project at all three sites. Adverse effects may include sensory disturbance, disruption of wildlife movement, direct and indirect wildlife mortality as a result of project activities and wildlife/human interactions. Noise from transportation equipment, heavy equipment and remediation equipment and human activity will likely result in the temporary avoidance of the area by most wildlife, and may result in changes in local movement patterns of wildlife. The impacts from noise are considered to be of negligible-low magnitude based on the potential species present and number of individuals recorded in the area during fieldwork for this project at all three sites. Maintaining equipment in good working condition, turning equipment off when not in use, and use of mufflers will reduce the effects of noise on wildlife. Nest sites and / or burrows maybe disturbed during the demolishment of infrastructure and the removal of non-hazardous waste, hazardous waste (including containers) and debris. Infrastructure should be checked for all wildlife species but especially species of concern. In the event that remediation activities cannot be completed without disturbing/destroying nests or burrows associated with migratory birds or species of special concern a wildlife officer from the Government of Nunavut should be contacted for additional guidance and/or to obtain a permit authorizing the removal of nests or disruption of habitat. Small mammals with ground colonies should also be avoided, where possible. The potential for wildlife and human interactions during the Project is possible, especially at the campsite; however, it is expected that such encounters will be infrequent and insignificant. Longer term contact is possible if the landfarm is constructed. Grizzly bear, wolverine, foxes, wolves, and ravens may also be attracted to the three sites. Proper containment and disposal of wastes/garbage, such as removal or incineration at the end of every day, and training of workers in wildlife interactions and bear safety will reduce the probability of adverse wildlife encounters. Leaks or spills of stored hazardous waste or fuel are possible and could impact wildlife. Previous measures outlined for preventing or dealing with spills and leak will be implemented. The development and implementation of a Wildlife Management BMP will assist in minimizing project impacts on wildlife and could include measures such as aircraft maintaining minimum altitudes and providing bear proof structures for containers for domestic waste. Overall, the removal of abandoned site infrastructure and remediation of contaminated soils will improve habitat quality and thus, have long-term benefits for wildlife. Following implementation of mitigation measures, adverse effects associated with project activities to wildlife will be local, short-term, and insignificant. These impacts are not expected to contribute to any adverse cumulative effects.			

TABLE 20: ASSESSMENT OF IMPACTS ON MARINE WILDLIFE

Project Activity	Potential Impact	Impact Rating	Mitigation
Remediation		Direction: Negative Scope: Local Duration: Short-Term Frequency: Intermittent Magnitude: Negligible Probability: Low Significance: Insignificant	If possible schedule barging activities during times when marine mammals are not to be in the area If necessary use barge monitors to watch for beluga pods Barges should maintain straight courses and low speeds Shipping scheduled during the normal open water season thus avoiding sensitive seal denning season (March-June) Make information available to personnel regarding marine habitat/fauna
Off-site transportation of waste to Kugluktuk and then disposal facility	Barging of hazardous material from Kugluktuk could cause noise issues for marine mammals Barging could impact seal pupping activities and seal behaviour (i.e., use of offshore areas and beaches) Barging could result in potential collisions with marine mammals (belugas)		
	While refueling or transporting material on the barge a fuel spill or leak could occur Hazardous material being transported could spill or leak	Direction: Negative Scope: Local Duration: Short-Term Frequency: Once Magnitude: Negligible Probability: Low Significance: Insignificant	Develop and implement a Spill Contingency BMP and ensure personnel are appropriately trained Have Spill Contingency BMP available to all workers A Spill Contingency BMP will be developed and implemented, and be available on-site for all workers Contain spill as close to release point as possible Proper containment and removal of fuels from any waterbodies Transportation procedures will be in accordance with the *Transportation of Dangerous Goods Act* and *Regulations* (Government of Canada 1992)
Summary: Potential impacts to marine mammals are generally limited to barging operations during the limited open water season. The sensitivity of marine mammals to shipping operations is not fully understood (Finley et al. 1990) but is thought to be influenced by timing, location, as well as the size, speed and number of the vessels involved. The barge(s) used to ship hazardous material and contaminated soil from Kugluktuk will be small, slow moving and limited in number. If possible shipping will only occur in August and September to avoid seal denning/pupping times so that impacts to seal populations are low. The greatest risk to marine wildlife and marine resources is the accidental release of shipped hazardous materials and/or a spill of fuel during refuelling, which could directly impact marine wildlife or marine wildlife habitat. A Spill Contingency BMP will include measures for dealing with a spill on marine waters. The Spill Contingency BMP will minimize the potential of an accidental release of contaminants into the marine environment. Generally, the impact on marine resources is expected to be neutral with no adverse cumulative effects.			

5.4 CULTURAL FEATURES AND SPECIAL PLACES IMPACTS AND MITIGATION

Several heritage sites have been previously located in the vicinity of the Project at Dismal Lake. Dismal Lake is located southwest of the project area, and three archaeological sites have been located near the lake, along with nine stone ring sites located along the shore of the lake.

During the AIA completed for the Hope Lake Exploration Remediation Project, three new heritage resources were located near Hope Lake, while no new heritage resources were located at the Willow Creek or the Husky Creek (Golder 2010). The first archaeological site is a stone feature site of four food caches in a boulder field along the southwest shore of Hope Lake. The second site is a single inukshuk located on a ridge overlooking Hope Lake. The final site is another inukshuk located on a high ridge overlooking Hope Lake. These archaeological sites, along with the cabin belonging to the Kugluktuk HTO were the only cultural features or special places located during the AIA field program.

Current mobilization, remediation, and demobilization activities planned for the project areas will not impact any cultural features or special places identified in the AIA. To protect the cultural features at Hope Lake, their locations will be identified and their boundaries, with a buffer, will be visibly marked while remediation activities are taking place to ensure they are not affected. Location and boundary markers will be removed once remediation activities are completed. If any new cultural features are discovered, especially in areas slated for remediation, their location and boundary, including a buffer, will be marked and the area avoided. The discovery will be reported to the Archaeology Division of the Department of Culture, Language Elders and Youth of the Government of Nunavut. If a cultural feature or features need to be impacted to complete the remediation, no disturbance of the feature will occur until advice from the Archaeology Division is received. This may require hiring an outside consultant to complete an AIA and make recommendations for the treatment of the cultural feature or features. Impacts to the current cultural features/special places or any discovery of any cultural features/special places can be mitigated, and no adverse cumulative effects are expected.

5.5 SOCIO-ECONOMIC IMPACTS AND MITIGATION

5.5.1 Traditional Land Use

In 1998, RHA (2002) reported that 58% of the workforce hunted and fished and 10% trapped. The Coppermine River and surrounding area are still used by local Inuit groups for hunting and trapping. The Kugluktuk HTO own and manage a cabin at Hope Lake, which is used by local hunters; this is the only current land use at any of the project sites.

The mobilization, remediation, and demobilization activities will only affect traditional land use in the project areas as well as along the winter access route while activities are being completed. A schedule of activities is not currently known but will be provided to the HTO and the KIA. If a landfarm is constructed to remediate hydrocarbon-contaminated soil, it will require regular operation and maintenance; the operation and maintenance schedule will be provided to both organizations. Impacts to the traditional land uses in the project areas can be mitigated and positive residual impacts are expected. Positive residual impacts are expected with the removal of non-hazardous and hazardous waste and clean-up of contaminated soil at the sites, which will improve wildlife habitat and therefore potentially increase traditional land use activities.

5.5.2 Job Opportunities and Current Employers

The Project will result in positive socio-economic benefits to the community of Kugluktuk. The NCLA (Nunavut Tunngavik Inc. 1993) serves as a guide for the mitigation of socio-economic impacts, for example, it provides for the creation of procurement policies by federal and territorial governments for Inuit-owned firms. An Aboriginal Opportunities Considerations (AOC) section will be included in the contract for the work. The AOC will guarantee minimum levels of Inuit employment and Inuit sub-contracting. Project procurement proposals will be evaluated based on criteria such as socio-economic benefit, technical content and cost. Individuals and businesses will be able to benefit through employment and procurement opportunities and related economic benefits. Employment opportunities could provide positive economic benefit through skills acquisition and work experience. Some of the possible employment opportunities could include:

- Camp staff;
- Equipment operators;
- Mechanics;
- Surveyors;
- Trades;
- Labourers;
- Wildlife monitors;
- Interpreters;
- Health and safety officer; and
- Sampling scientist.

Potential business opportunities that may arise from the project will exist primarily in the areas of accommodation, logistical support, heavy equipment and supply. A range of Inuit-owned businesses located in Kugluktuk provide goods and services in the areas of accommodation and food services, expediting, contracting and equipment supply, and transportation and shipping (RHA 2002). During the community meeting on February 22, 2011, a number of individuals indicated that they had hazardous material handling training, which will be needed for the remedial activities at Hope Lake. No negative impacts to job opportunities and current employers are expected, and therefore, no residual impacts are expected.

5.5.3 Community Impacts

The Hamlet of Kugluktuk has a wide variety of community services and organizations. An impact to community services would be the use of the community health centre in the case of an accident during the project activities. This impact would be of short duration but could be significant depending on the accident. It would not have residual impacts on the community.

Hazardous and non-hazardous materials will be packaged and transported to Kugluktuk for storage and eventual barge transport to approved landfills. The storage of these materials will be in accordance with all territory and federal regulations. As such, potential impacts, such as exposure of hazardous material to the community, are considered unlikely and insignificant. There are no expected residual impacts.

While many of the staff required to complete the remedial activities at Hope Lake may be from Kugluktuk, a number of individuals from outside the community will likely be needed for the duration of the remedial activities. This influx of people is expected to be small and is not expected to impact the community as most staff will be staying at the camp that will be set up at Hope Lake.

5.6 AESTHETIC IMPACTS

Exploration of the area for mining in the 1960s caused many anthropogenic disturbances at the three sites. The remediation activities will be beneficial to the aesthetics of areas as buildings will be demolished and all debris will be removed. The only short-term aesthetic impact will be the potential construction of the landfarm, but once soil in the landfarm meets regulatory criteria this area will be revegetated. All aesthetic impacts can be mitigated, and no residual impacts are expected.

5.7 RESIDUAL IMPACTS

Residual impacts are defined as impacts that remain after mitigation has been applied (CEAA 1999). The remediation of the three Hope Lake sites is not expected to result in any negative residual impacts, and the remediation of the sites will have a positive effect on the environment.

6.0 CUMULATIVE ENVIRONMENTAL IMPACTS

Cumulative environmental impacts occur when impacts, in particular residual impacts, from two or more concurrent project activities combine either additively or synergistically to further exacerbate the impact on a VEC or VSEC. CEAA (1999) defines cumulative impacts as "…changes to the environment that are caused by an action in combination with other past, present, and future human actions." While the NIRB (2007b) defines cumulative impacts as "…the accumulation of changes to the environment caused by human activities (e.g., past, existing and proposed activities, including activities associated with the Project under assessment). These changes occur over space and time and can be brought about by environmental effects that are additive or interactive. For example, hunting, oil spills, loss of habitat, and commercial fishing pressure on prey species, can affect marine mammals in the Arctic".

A cumulative effects assessment includes activities that have already taken place, or are likely to take place, in the foreseeable future. The foreseeable future usually describes projects that are under regulatory review or are proposed for regulatory review (CEAA 1999). CEAA defines the reasonably foreseeable as "The [project] may proceed, but there is some uncertainty about this conclusion."

The amount of mining and exploration activity in the Kitikmeot region of Nunavut has been quite high according to *Nunavut Overview 2007: Mineral Exploration, Mining and Geoscience* (INAC et al. 2007), but no mining activity is currently scheduled within 50 km of the three sites. However, several diamond mining operations are located southwest of the project area, with potential diamond mining to resume at the Jericho site and the development of the Hope Bay mine.

Also, within the region, a number of other former exploration, mining, and military sites are currently being remediated or have remediation schedules that may overlap with the Hope Lake Remediation Program.

The remediation program at the three Hope Lake sites will initially disturb the existing terrain and environmental conditions of the study area. However, given the limited environmental footprint of the sites and the removal, containment and/or disposal of contaminated soil and hazardous and non-hazardous waste, it is expected that the overall impact of the remediation project will be positive. In the long term, the remediation project will facilitates the return of soil, water, and vegetation and wildlife habitat to natural conditions.

Given that the Project will have a positive impact on the environment and has no residual impacts, the remediation of the three sites will not add to the cumulative environmental effects of other land use activities in the local area.

7.0 MONITORING PROGRAM

Project monitoring has two objectives:

- Monitor implementation of the Project to confirm compliance with the remediation objectives and accuracy of impact predictions; and
- Monitor the long-term success of the Project if required; measuring environmental conditions against triggers and thresholds that would initiate adaptive management and contingency plans.

The NIRB (2007b) defines monitoring as the systematic observation or tracking of an activity to determine whether it is proceeding or functioning as expected. Through monitoring, the accuracy of environmental impact predictions is assessed. Two different monitoring activities that will be incorporated into this Project are identified below:

- Effects monitoring is the process of measuring and interpreting changes to environmental and socio-economic parameters to identify relevant project effects, and may involve assessing the accuracy of impact predictions contained in the Project impact statements.
- Compliance monitoring is the process of determining whether and to what extent the activity is carried out according to regulatory requirements, including terms and conditions contained in NIRB project certificates.

Based on the NIRB definition and the monitoring objectives, compliance monitoring will be completed for the duration of the remedial activities. This will include such actions as adherence to safety standards, sampling protocols, and reporting schedules. An environmental management plan (EMP) will be completed prior to the work being conducted that will outline requirements of compliance monitoring based on regulatory and industry standards. If a landfarm is created on-site for remediation of the hydrocarbon-contaminated soil, the monitoring of this facility would be identified within the EMP.

Based on the recommended remedial options, no long-term monitoring will be required. All impacts will be removed to regulatory criteria with the exception of minor groundwater located within one area of Hope Lake that had hydrocarbon impacts. Once soil remediation has been completed, impacts to groundwater should be mitigated. We recommend monitoring at the time of remediation and again one year later to confirm that impacts have been mitigated.

8.0 KNOWLEDGE DEFICIENCIES

Information on the environmental conditions at the site was collected during previous field studies. While this information is adequate for the scope of this work, there are some knowledge deficiencies with respect to remediation work in the arctic that are not specific to this project.

The International Panel on Climate Change (IPCC) reports that average global temperatures could increase by up to 6°C by the end of the century (IPCC 2007), and this increase could result in an increased frequency of extreme weather events including increased precipitation. Much uncertainty remains regarding climate change predictions and how these changes will affect Arctic regions. However, likely alterations include changes in the range and depth of permafrost occurrences, all of which have a bearing on impact predictions related to soil stability, erosion control, and drainage. These should not have a bearing on the Project as we are not creating a landfill on-site and no impacted materials are remaining on-site at the end of the remediation process.

9.0 PUBLIC INPUT AND CONCERNS

To collect public input and to receive public concerns regarding the Project, a community meeting was held in Kugluktuk on February 22, 2011, to discuss the draft RAP. Approximately 30 members of the local community attended the meeting. RAP information was also provided to members of the Kugluktuk Hunters and Trappers Organization and the Kitikmeot Inuit Association. The primary concerns of the community were impacts of the Project on traditional land use and employment opportunities directly working on the Project, or for other employers in Kugluktuk.

10.0 CONCLUSION

The mitigation strategies outlined for the remediation of the Hope Lake sites are predicted to result in no negative residual impacts, and overall, the remediation of sites will have a positive effect on the environment by removing contaminated soil and hazardous material from the sites. Cumulative environmental impacts occur when impacts, in particular residual impacts, from two or more concurrent project activities combine either additively or synergistically to further exacerbate the impact on a VEC or VSEC. Given that the project will have a positive impact on the environment and has no residual impacts, the remediation of the three sites will not add to the cumulative environmental effects of other land use activities in the local area.

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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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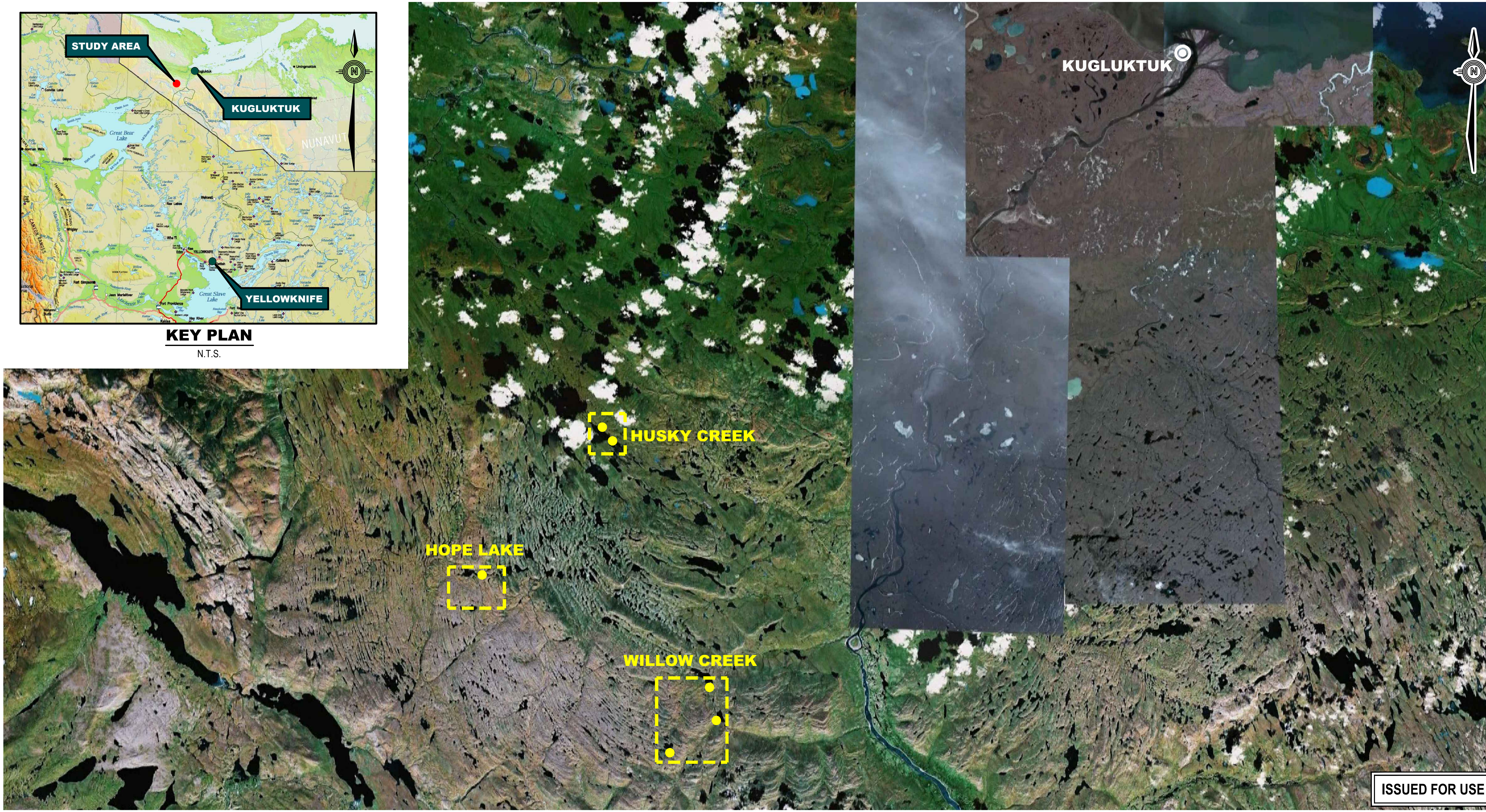
FIGURES



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CLIENT
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ENVIRONMENTAL SCREENING ASSESSMENT OF THE PROPOSED REMEDIATION OF THE HOPE LAKE SITES HOPE LAKE, NUNAVUT

OVERALL SITE PLAN

PROJECT NO.	DWN	CKD	REV
Y22101167.700	DBD	QB	0

OFFICE	DATE
EBA-EDM	March 21, 2011

Figure 1

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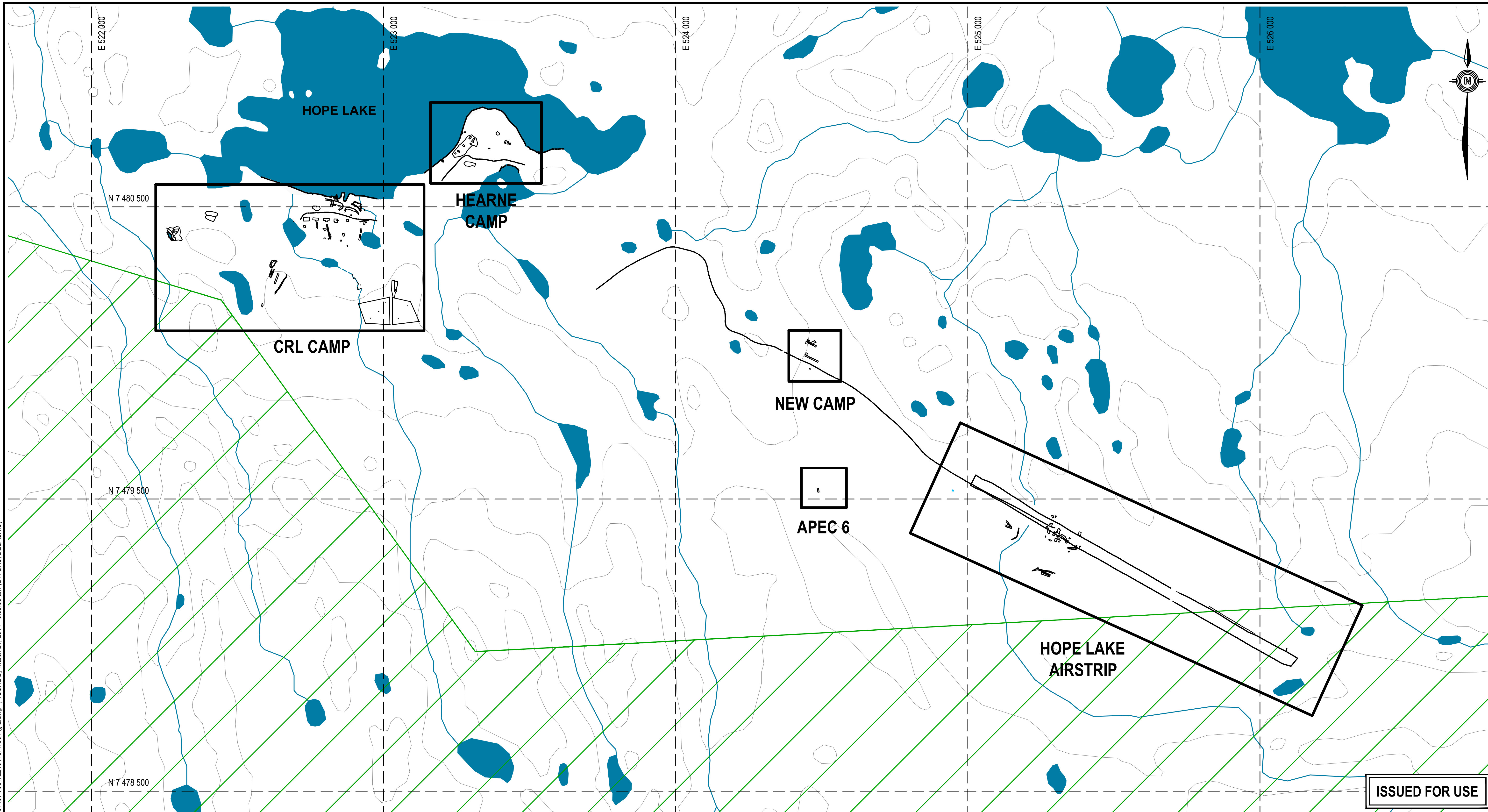

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0 500
Scale (m)

LEGEND:

- APPROXIMATE LOCATION OF INUIT OWNED LAND

CLIENT

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

ENVIRONMENTAL SCREENING ASSESSMENT OF THE PROPOSED REMEDIATION OF THE HOPE LAKE SITES HOPE LAKE, NUNAVUT

HOPE LAKE SITE PLAN (WK027)

EBA Engineering Consultants Ltd.

PROJECT NO.	DWN	CKD	REV
Y22101167.700	DBD	QB	0
OFFICE	DATE		
EBA-EDM	March 21, 2011		

Figure 2

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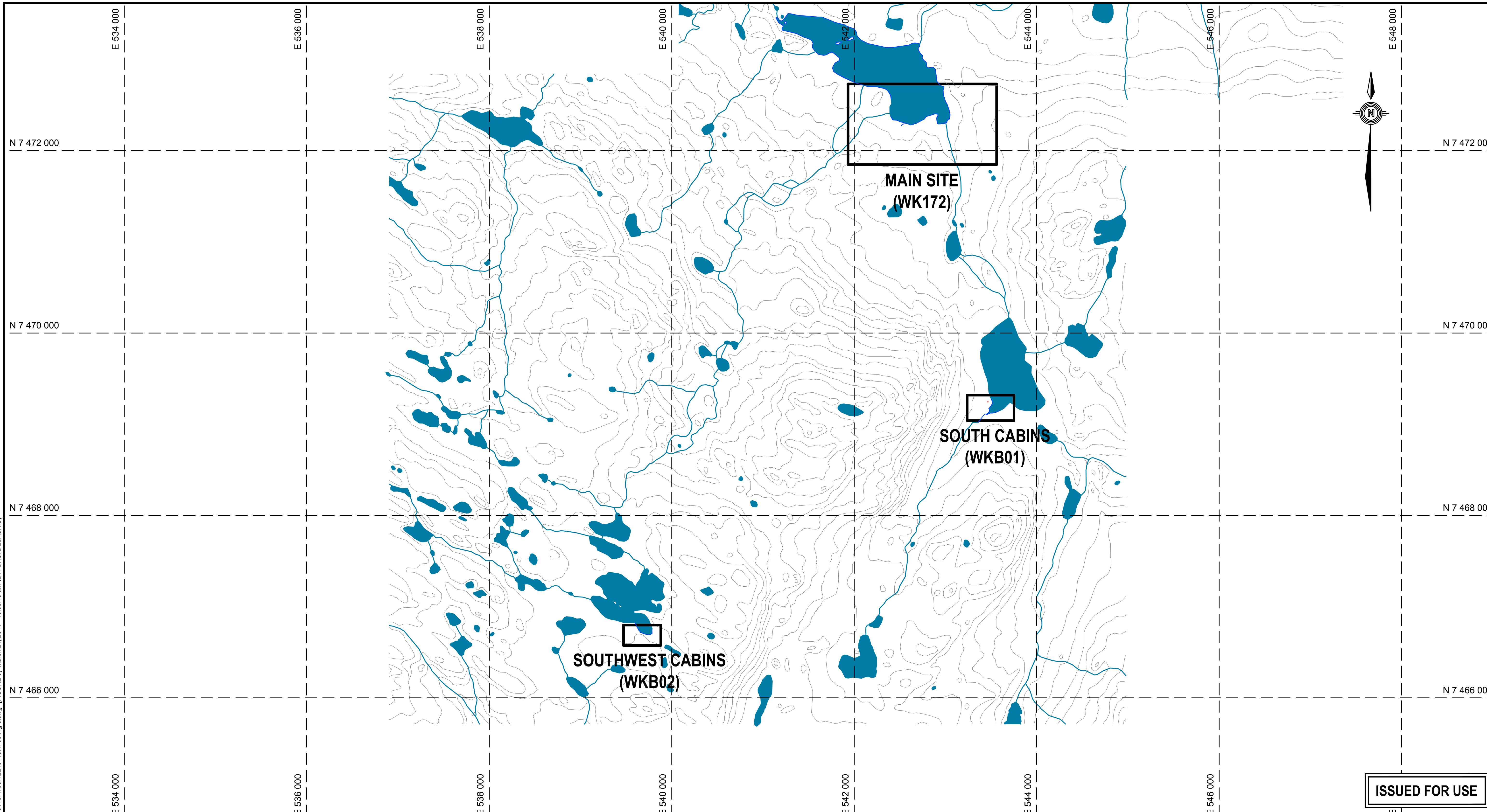

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0 2 000 m

Scale (m)

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ENVIRONMENTAL SCREENING ASSESSMENT OF THE PROPOSED REMEDIATION OF THE HOPE LAKE SITES
HOPE LAKE, NUNAVUT

WILLOW CREEK SITE PLAN

PROJECT NO.	DWN	CKD	REV
Y22101167.700	DBD	QB	0

OFFICE	DATE
EBA-EDM	March 21, 2011

Figure 3

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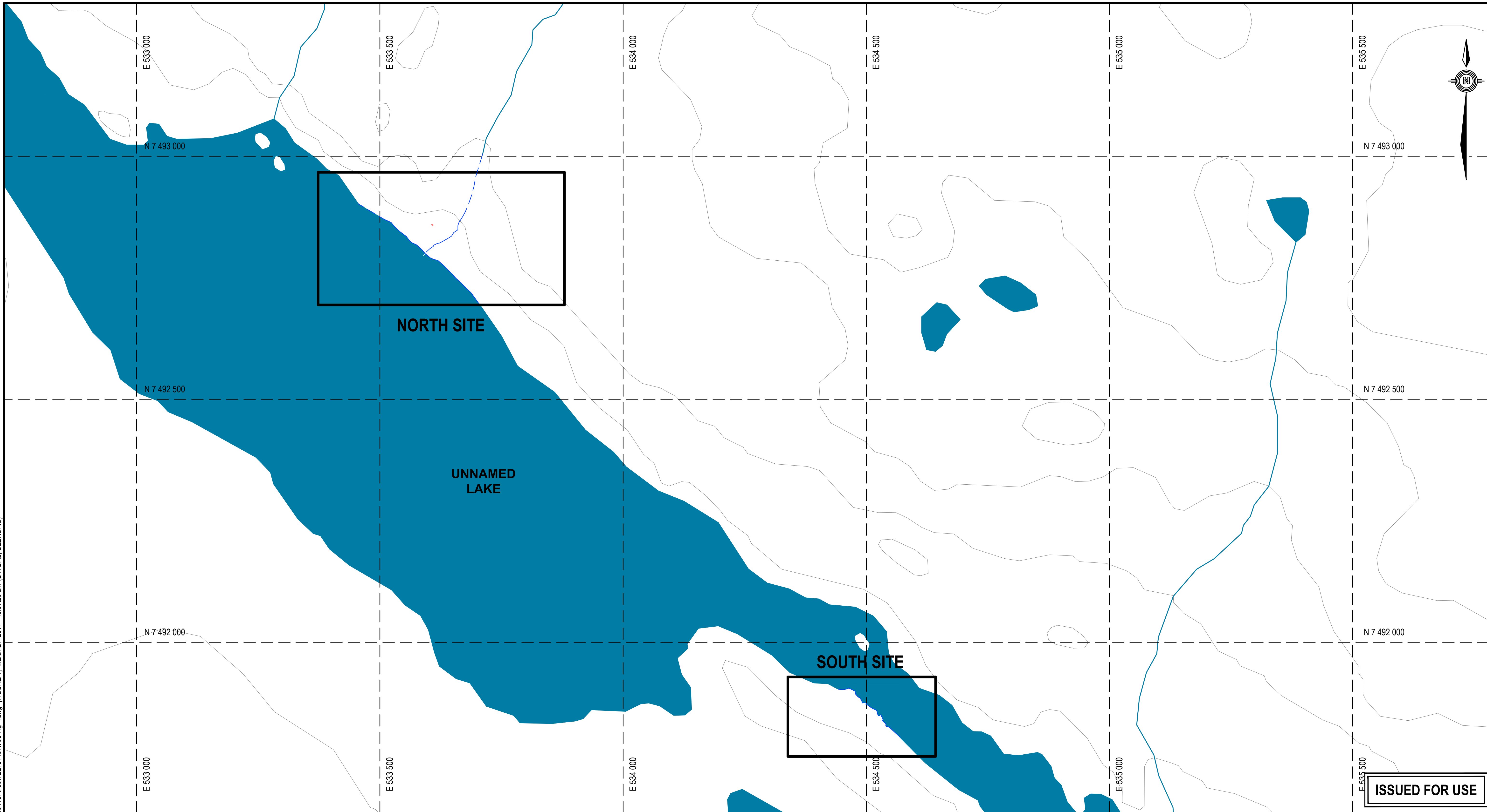

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0 250 m

Scale (m)

CLIENT

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

EBA Engineering Consultants Ltd.

ENVIRONMENTAL SCREENING ASSESSMENT OF THE PROPOSED REMEDIATION OF THE HOPE LAKE SITES HOPE LAKE, NUNAVUT

HUSKY CREEK SITE PLAN (WK197)

PROJECT NO.	DWN	CKD	REV
Y22101167.700	DBD	QB	0
OFFICE	DATE		
EBA-EDM	March 21, 2011		

Figure 4

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PHOTOGRAPHS

Photo 1
Hope Lake: aerial view of airstrip

Photo 2
Hope Lake: aerial view of CRL Camp

Photo 3
Hope Lake: aerial view of New Camp

Photo 4
Hope Lake: looking south upslope to APEC 6

Photo 5
Willow Creek: aerial view of Main Site looking south

Photo 6
Willow Creek: aerial view of South Cabins Site

Photo 7
Willow Creek: aerial view of Southwest Cabins Site looking south

Photo 8
Husky Creek: aerial view of South Site looking south

Photo 9
Husky Creek: aerial view of North Site looking north

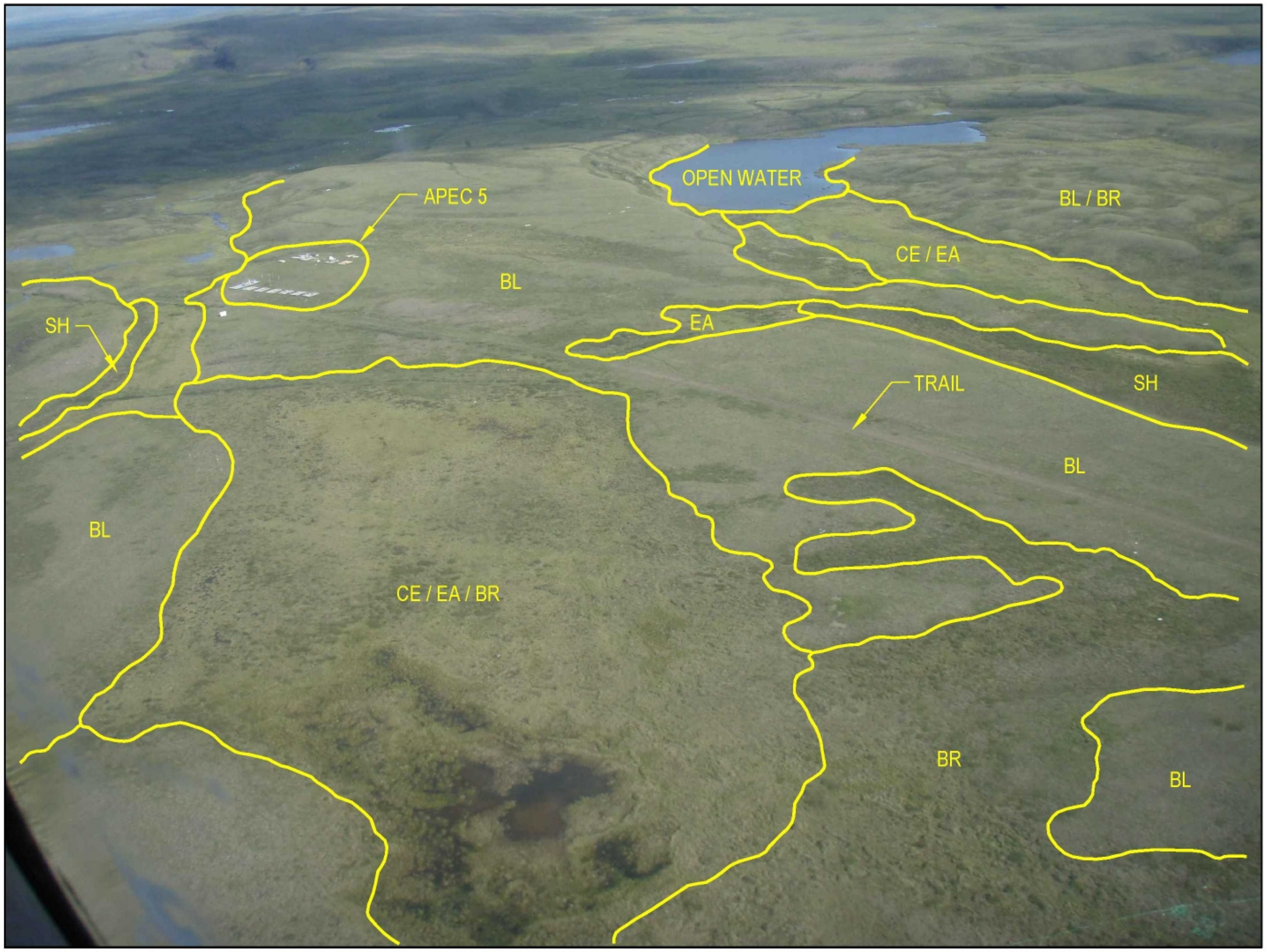

Photo 10 Hope Lake ecosystem units, aerial view between airstrip and APEC 5

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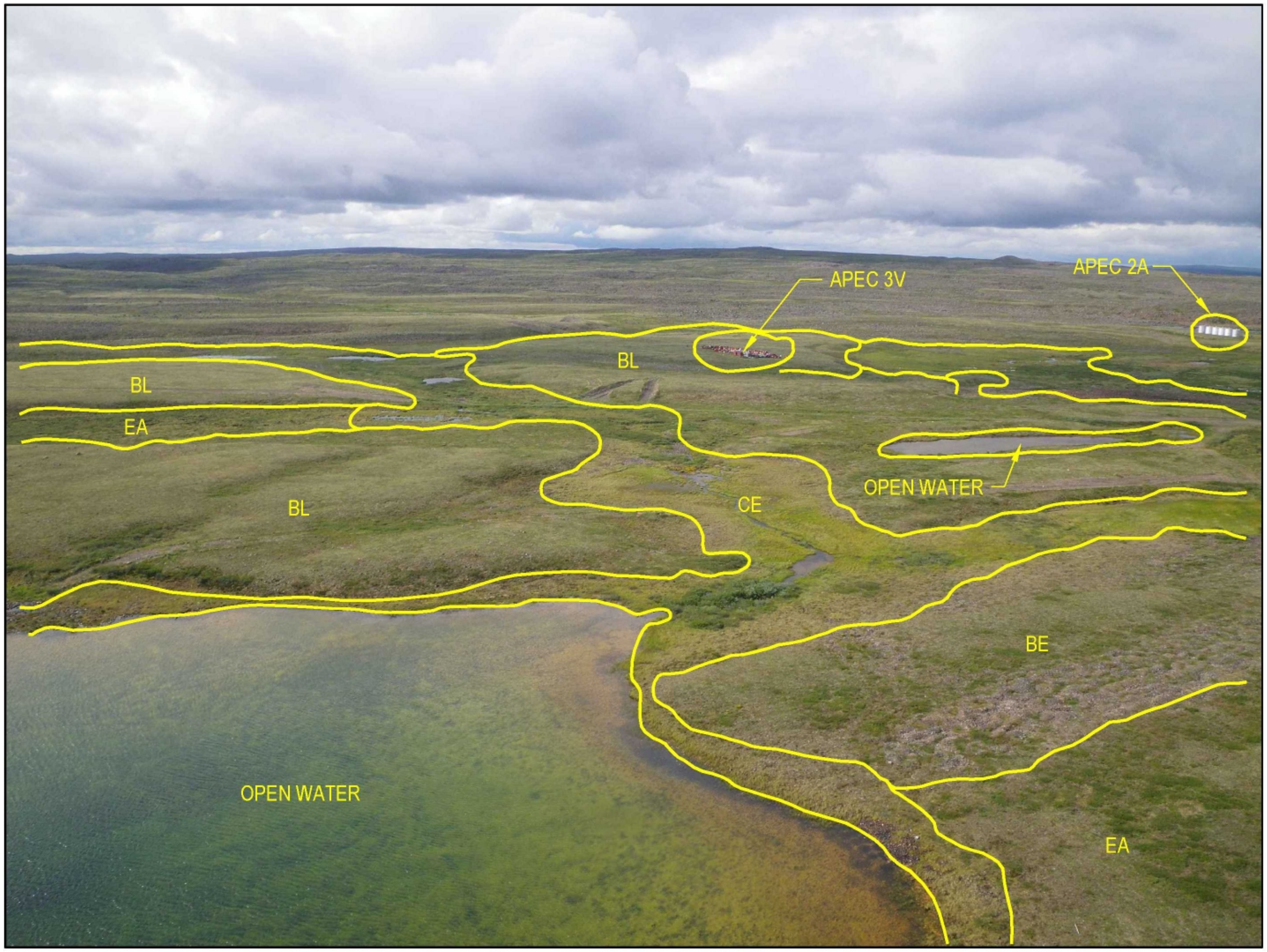

Photo 11 Hope Lake ecosystem units, aerial view looking south to APEC 2A and 3V

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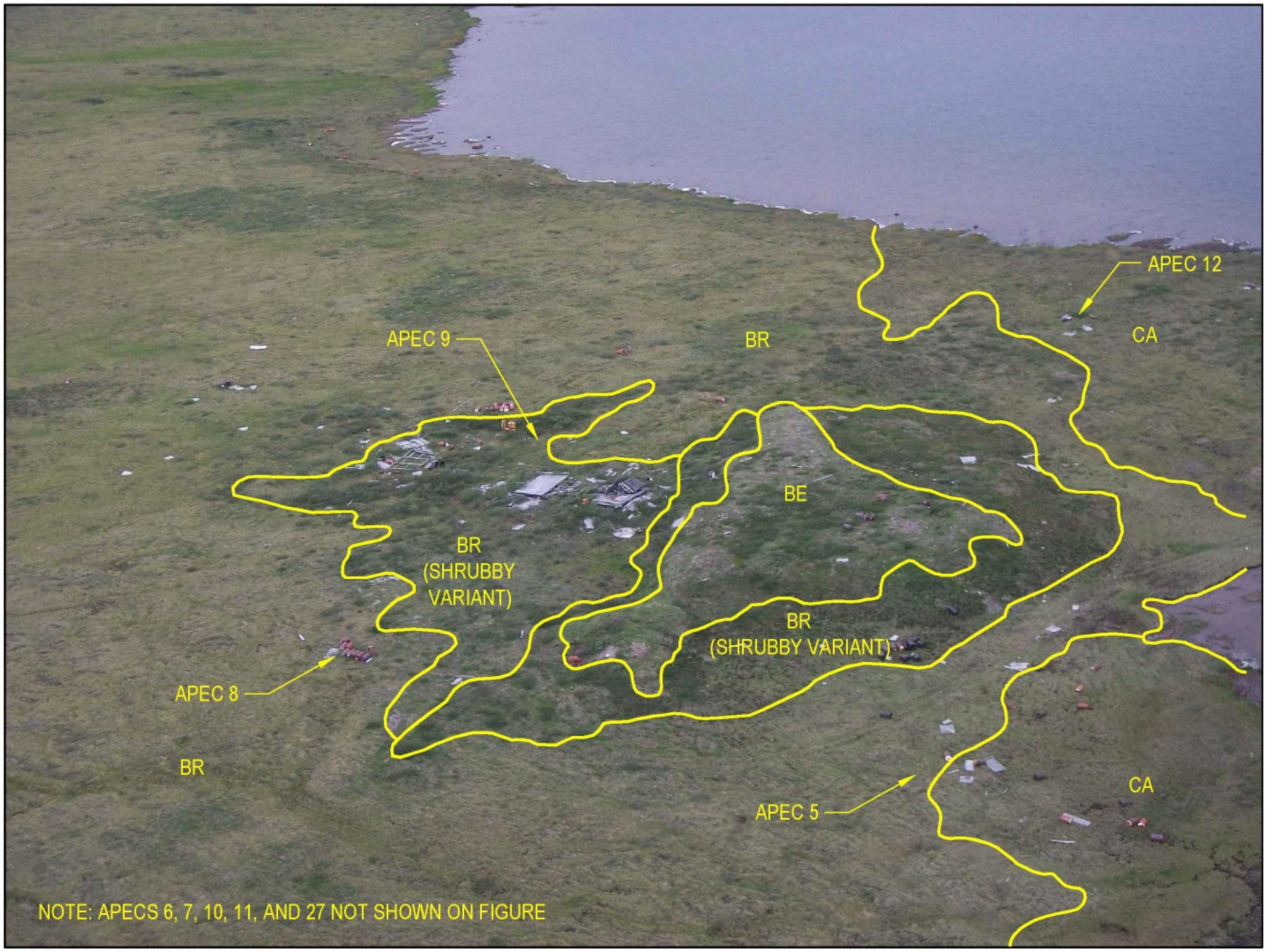

Photo 12 Willow Creek main site ecosystem units, aerial view

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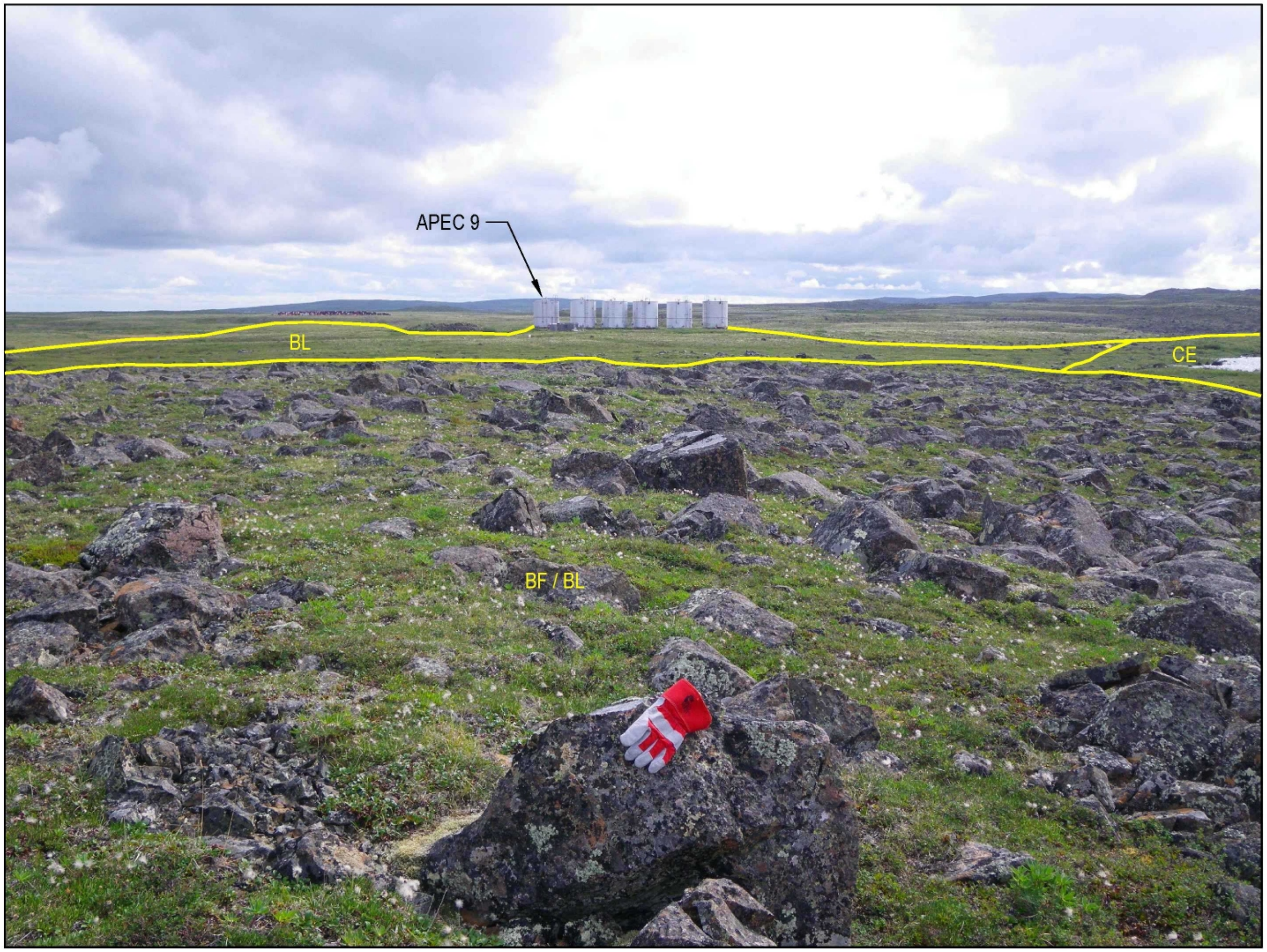

Photo 13 Hope Lake, close up of BF and BL ecosystem units

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Photo 14 Hope Lake, close up of BL ecosystem unit

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Photo 15 Hope Lake, close up of SH ecosystem unit

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APPENDIX A

APPENDIX A LIST OF VEGETATION SPECIES

APPENDIX A: VEGETATION SPECIES LIST FOR THE HOPE LAKE REMEDIATION PROJECT SITES

Common Name	Species (Latin) name
Shrubs	
northern bog rosemary	*Andromeda polifolia var. polifolia*
red bearberry	*Arctous rubra*
bog birch	*Betula glandulosa*
arctic white heather	*Cassiope tetragona subsp. tetragona*
crowberry	*Empetrum nigrum*
heather	*Phyllodoce spp.*
shrubby cinquefoil	*Potentilla fruticosa*
cinquefoil species	*Potentilla spp.*
stipulated cinquefoil	*Potentilla stipularis*
Labrador tea	*Rhododendron groenlandicum*
arctic willow	*Salix arctica*
northern willow	*Salix arctiphilo*
gray willow	*Salix glauca*
bog bilberry	*Vaccinium uliginosum*
lingonberry	*Vaccinium vitis-idaea*
Forbs	
pygmy pussytoes	*Antennaria monocephala*
arnica species	*Arnica spp.*
Tilesius' wormwood	*Artemisia tilesii*
alpine milk-vetch	*Astragulus alpinus*
milk-vetch species	*Astragulus spp.*
common moonwort	*Botrychium lunaria*
mustard species	*Brassicaceae spp.*
Indian paintbrush species	*Castilleja spp.*
mums species	*Chrysanthemum spp.*
mountain avens	*Dryas integrifolia*
fireweed species	*Epilobium spp.*
dwarf scouring rush	*Equisetum scirpoides*
horsetail species	*Equisetum spp.*
dwarf mountain fleabane	*Erigerion compositus*
swamp fleabane	*Erigeron elatus*
fleabane species	*Erigeron spp.*
subalpine aster	*Eurybia merita*
strawberry	*Fragaria vesca*
four-parted gentain	*Gentianella propinqua ssp.arctophila*
gentain species	*Gentianella spp.*
alpine sweet-vetch	*Hedysarum alpinum*
blazing star	*Liatris spp.*
arctic lupine	*Lupinus arcticus*
lupine species	*Lupinus spp.*

Common Name	Species (Latin) name
Forbs (continued)	
club-moss species	*Lycopodium spp.*
naked mitrewort	*Mitella nuda*
alpine mountain-sorrel	*Oxyria digyna*
marsh grass-of-parnassus	*Parnassia paulustris*
lousewort species	*Pedicularis spp.*
hairy butterwort	*Pingicula villosa*
butterwort species	*Pinguicula spp.*
common butterwort	*Pinguicula vulgaris*
wintergreen species	*Pyrola spp.*
buttercup species	*Ranunculus spp.*
dock species	*Rumex spp.*
prickly saxifrage	*Saxifraga tricuspidata*
arctic groundsel	*Senecio atropurpureus subsp. frigidus*
moss campion	*Silene acaulis*
northern bog aster	*Symphyotrichum boreale*
Scotch false asphodel	*Tofieldia pusilla*
northern starflower	*Trientalis borealis*
smooth cliff fern	*Woodsia glabella*
Grasses	
blue-joint grass	*Calamagrostis canadensis*
water sedge	*Carex aquatilus*
Bigelow' sedge	*Carex bigelowii subsp. bigelowii*
northern bog sedge	*Carex gynocrates*
black sedge	*Carex magellanica subsp. irrigua*
rock sedge	*Carex saxatilis*
sedge species	*Carex spp.*
spike-rush species	*Eleocharis spp.*
northern-leaved cottongrass	*Eriophorum angustifolium subsp. angustifolium*
cotton-grass species	*Eriophorum spp.*
arctic sweetgrass	*Heirochloe pauciflora*
fowl bluegrass	*Poa palustris*
bluegrass species	*Poa spp.*
Lichens	
cetraria species	*Cetraria spp.*
reindeer lichen species	*Cladina spp.*
Mosses	
glow moss	*Aulacomnium palustre*
midway peat moss	*Sphagnum magellanicum*
golden moss	*Tomothypnum nitens*

Notes:

All flowering plants, where applicable or possible, are refereneced from Flora of North America Editorial Committee (1993). Other flowering plants, mosses and lichens referenced from Johnson et al. (1995).