PHASE 2
DRAFT ENVIRONMENTAL IMPACT STATEMENT

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Glossary and Abbreviations

Terminology used in this document is defined where it is first used. The following list will assist readers who may choose to review only portions of the document.

Alluvial	Pertaining to the loose, unconsolidated sediments that have been eroded, deposited, and reshaped by water in some form in a non-marine setting. Generally, not applied to deposits when the particular mode of deposition via water is identifiable.
Attribute	Any feature of a vegetation association that is not represented by the site series/vegetation association, site modifier or structural stage. Attributes may either be recorded from fieldwork or inferred by extrapolating features from similar vegetation associations.
CCME	Canadian Council of Ministers of the Environment. CCME is comprised of the environment ministers from the federal, provincial, and territorial governments. These 14 ministers normally meet at least once a year to discuss national environmental priorities and determine work to be carried out under the auspices of CCME. The CCME seeks to achieve positive environmental results, focusing on issues that are national in scope and that require collective attention by a number of governments.
COSEWIC (Committee on the Status of Endangered Wildlife in Canada)	A committee of experts that assesses and designates which species are in some danger of disappearing from Canada.
EA	Environmental Assessment
Ecological amplitude	The limits of environmental conditions within which an organism can live and function.
Ecosystem (terrestrial)	A volume of earth-space that is composed of non-living parts (climate, geologic materials, groundwater, and soils) and living or biotic parts, which are all constantly in a state of motion, transformation, and development. No size or scale is inferred.
Edaphic	Pertaining to soil characteristics, and specifically how these affect living organisms.
EIS	Environmental Impact Statement
ELC	Ecosystem Land Classification
FCIR	False-Colour Infrared
Floodplain	Area of unconsolidated, river-borne sediment in a river valley; subject to periodic flooding.
Fen	Peatlands where groundwater inflow maintains relatively high mineral content within the rooting zone. They are dominated by non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses.

Fibric	Poorly decomposed peat with large amounts of well-preserved fiber readily identifiable as to botanical origin.
Forb	Non-graminoid herbaceous plants.
Habitat	Land and water surface used by wildlife. This may include biotic and abiotic aspects such as vegetation, exposed bedrock, water and topography.
HBML	Hope Bay Mining Limited
Hectare	10,000 m^2 or 0.01 km^2 or 2.47 acres.
Herb	A plant - annual, biennial or perennial - with stems that die back to the ground at the end of the growing season.
Hydric	A qualitative measure of soil moisture that indicates water being removed so slowly that a water table is at or above soil surface during the entire growing season. Organic and gleyed mineral soils are present.
Hydrophilic	Substances that have an affinity for water often because of the formation of hydrogen bonds.
Hygric	A qualitative measure of soil moisture regime that indicates wetter than mesic conditions. Saturation of the soil is limited so that anaerobic soil conditions are transient in the rooting zone.
Hydrodynamic index	And index measuring the magnitude of water vertical fluctuation and lateral flow.
ISSG	Invasive Species Specialist Group
LSA	Local Study Area
Marsh	A shallowly flooded mineral wetland dominated by emergent grass-like vegetation.
Mesic	1. Organic material in an intermediate stage of decomposition where some fibers can be identified as to botanical origin. 2. Medium soil moisture regime where a site has neither excess soil moisture nor a moisture deficit.
Moisture regime	Indicates the available moisture for plant growth in terms of the soil's ability to hold, lose, or receive water. Described as moisture classes from Very Xeric (0) to Hydric (8) (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998).
NGSWG	National General Status Working Group
NIRB	Nunavut Impact Review Board
NTDB	National Topographic Database

Nutrient regime	Indicates the available nutrient supply for plant growth. Nutrient regime is based on a number of environmental and biotic factors, and is described as classes from Oligotrophic (A) to Hypereutrophic (F) (BC Ministry of Environment Lands and Parks and BC Ministry of Forests Research Branch 1998).
NWT GSRP	Northwest Territories General Status Ranking Program. The program that integrates knowledge from relevant agencies regarding statue of species within the NWT.
Palsa	Palsas are low, often oval, frost heaves occurring in polar and subpolar climates, which contain permanently frozen ice lenses.
PDA	Project Development Area
Peatland	Organic wetlands containing at least 40 cm of peat accumulation on which organic soils (excluding folisols) develop (Warner and Rubec 1997).
Periglacial process	Freezing and thawing processes that drastically modify the ground surface.
Physiognomy	General appearance of an object without reference to its implied characteristics.
Polygon	Delineations that represent discrete areas on a map, bounded by a line on all sides.
Presence/absence surveys	Surveys which rely on visual observations to confirm the presence of the target. These cannot be used in isolation from other statistical techniques to determine the size or absence of a population. They can only be used to confirm the presence of a target species.
Rescan	Rescan Environmental Services Ltd.
Riparian ecosystem	Ecosystems whose structure and species composition is strongly influenced by regular flooding.
RSA	Regional Study Area
SARA	*Species at Risk Act*
Structural stage	Describes the existing dominant stand appearance or physiognomy for a land area. Structural stages range from non-vegetated to old forest.
Submesic	A qualitative measure of soil moisture regime that indicates soil conditions drier than mesic. Water is removed from the soil at a faster rate than supply.
TK	Traditional Knowledge
TK report	Banci, V. and R. Spicker. 2015. Inuit Traditional Knowledge for TMAC Resources Inc. Proposed Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP). Prepared for TMAC Resources Inc. Kitikmeot Inuit Association: Kugluktuk, NU.

Topography	The configuration of a surface, including its relief and the position of its natural and man-made features.
TRIM	Terrain Resource Information Management
Tundra	An area with permafrost soils which causes trees to be excluded from the landscape due to the edaphic conditions of the rooting zone within the soil.
UTM	Universal Transverse Mercator
VEC	Valued Ecosystem Component. Those aspects of the environment considered to be of vital importance to a particular region or community, including: a) resources that are either legally, politically, publically, or professionally recognized as important, such as parks, land selections, and historical sites; b) resources that have ecological importance; and c) resources that have social importance.
VSEC	Valued Socio-Economic Component. 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.
Vegetation association	Defines all sites capable of supporting similar plant communities.
Westroad	Westroad Resource Consultants Ltd.
Wetland	Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrotrophic vegetation and various kinds of biological activity which are adapted to a wetland environment (National Wetlands Working Group 1988).
WHIF	Wetland Habitat Inspection Form
WKSS	West Kitikmeot/Slave Study

8. Vegetation and Special Landscape Features

This chapter presents the existing conditions of terrestrial ecosystems and vegetation for the proposed Hope Bay Project (the Project) and identifies and evaluates the potential Phase 2 Project-related effects and cumulative effects on terrestrial ecosystems, landforms, and vegetation within a local and regional context. The assessment is based on information provided in the *Inuit Traditional Knowledge for TMAC Resources Inc. Proposed Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP)* (Banci and Spicker 2015) and the *Hope Bay Belt Project: 2010 Ecosystems and Vegetation Baseline Report* (Appendix V4-8A).

Terrestrial ecosystems, landforms, and vegetation are included in the application because of their key role in Inuit cultural heritage, as well as the habitat and forage they provide for many Arctic wildlife species and at-risk plant and lichens.

8.1 INCORPORATION OF TRADITIONAL KNOWLEDGE

This section discusses how traditional knowledge (TK) was incorporated in baseline data collection, impact prediction, significance assessment, and the development of mitigation and monitoring programs. It also explores any discrepancies between traditional knowledge and knowledge derived from baseline information collected during scientific studies.

8.1.1 Incorporation of Traditional Knowledge for Existing Environment and Baseline Information

Inuit Traditional Knowledge for TMAC Resources Inc. Proposed Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP) (Banci and Spicker 2015) (TK report) was reviewed to identify traditional knowledge related to terrestrial ecosystems. The report compiled information from multiple sources including interviews, studies, and workshops dating back to the 1970s with the most recent workshop in 2013. Overall, the report highlights the holistic nature of Inuit knowledge and land use and makes reference to the importance of the land, wildlife, fish, and plants in the vicinity of the Project and regionally.

The report provides a description of traditionally harvested terrestrial plant species and valued ecological resources within the Project area including a reference to locations where resources are harvested as well as cultural and other uses of plant species within the area surrounding the Project. The Socio-economic and Land Use Baseline (Appendix V6-3A) also provide guidance on TK including information on the harvesting of terrestrial plants. Plant harvesting and species that are harvested was identified through a number of focus group meetings with hunters from the Kitikmeot study communities. Plant species reported as consumed for food include cloudberries (*Rubus chamaemorus)*, blueberries (*Vaccinium uliginosum*), crowberries (*Empetrum nigrum*), and bearberries (*Arctostaphylos* spp.), while mountain sorrel (*Oxyria digyna)*, or sweet leaves, were eaten raw or as fresh greens. Plants identified as having medicinal or other cultural value included Labrador tea (*Rhododenron groenlandicum*) and willows (*Salix* spp.). This information informed the collection of plant and lichen species in the area surrounding the Project and assisted in determining the potential effects on harvestable plant resources. The results of the metals assays on vegetation supported the *Human Health and Environmental Risk Assessment* (also discussed in Volume 6, Section 5, Human Health and Environmental Risk Assessment; Volume 2, Section 2, Traditional Knowledge; and Volume 2, Section 3, Public Consultation and Engagement).

The plant species and ecosystems identified in the TK report have been compared to the baseline mapping and field survey data to identify the presence and distribution of these valued resources throughout the study areas (defined in Section 8.2.4.7).

8.1.2 Incorporation of Traditional Knowledge for Valued Environmental Component Selection

The *TK* report (Banci and Spicker 2015) provides information on traditional land use activities in the Kitikmeot region, where the Project is located. This report describes important environmental components and conditions, presents maps showing sacred burial sites, locations of valuable resources, and annual patterns of behaviour of valued animal species.

The Nunavut Impact Review Board (NIRB) EIS Guidelines (NIRB 2012) for the Project included Valued Socio-economic Components (VSECs) such as land use, food security, and cultural and commercial harvesting, which are all directly associated with the quality and health of terrestrial ecosystems. Due to the dependence of social VSECs on functioning ecosystems, NIRB identified terrestrial ecology as a Valued Ecosystem Component (VEC).

Information on traditional land use and value by local peoples was used for scoping and refining the potential VEC list and to determine if the VEC could interact with the Phase 2 Project. This, along with information from consultation from the public and regulatory agencies, was used to determine the final VEC list.

8.1.3 Incorporation of Traditional Knowledge for Spatial and Temporal Boundaries

The information on traditional use of lands by Inuit provides insight on the value people place on the land and environment. The spatial boundaries include areas in which the Phase 2 Project may have an effect on vegetation and ecosystems of importance to Inuit.

No specific traditional knowledge regarding the temporal aspects of the environmental effects on VECs were presented in the TK. However, TMAC recognizes the enduring relationship between the Inuit and the land, and considers this in all temporal boundaries of the Phase 2 Project activities and components.

8.1.4 Incorporation of Traditional Knowledge for Project Effects Assessment

The selection of VECs that are of importance to Inuit is the principal method to ensure the Phase 2 Project-related effects assessment addresses traditional knowledge and potential effects to Inuit use of the land and resources.

8.1.5 Incorporation of Traditional Knowledge for Mitigation and Adaptive Management

Terrestrial ecosystems and vegetation are included in the application because of their key role in Inuit cultural heritage, habitat, and forage they provide for many Arctic wildlife species, and at-risk plants and lichens.

Outlined within the socio-economic and land use baseline (Appendix V6-3A), concerns regarding the potential for the Project to directly affect wildlife or degrade their forage and habitat quality were raised during focus group sessions and interviews with hunters from the Kitikmeot communities.

Mitigation measures largely pertain to reducing the potential for adverse effects on the habitat of wildlife species, particularly those used by Inuit, as well rare plants, and unique or special landscape features (Table 8.1-1). Avoidance of Project interactions with VECs is the most effective method of reducing Phase 2 Project effects.

To avoid interactions with special features, plants or habitat, baseline information was used to develop environmental sensitivity maps to inform Phase 2 Project design and reduce potential effects to ecosystem and vegetation VECs. Terrestrial ecosystem surveys and mapping, vegetation surveys, terrain and soil mapping, and rare plant surveys were used to identify ecosystems and vegetation that are often considered important, due to their scarcity on the landscape, sensitivity, special habitat features they provide, and/or cultural importance (Table 8.1-1). Baseline ecosystem and vegetation information is included in Appendix V5-8A.

Table 8.1-1. Features included in Environmental Sensitivity Mapping to Inform Project Design

Feature Type	Rationale for Inclusion
Riparian ecosystems and floodplains	Deciduous shrubs are an important food source for ungulates; provide nesting and cover habitat for various wildlife species (e.g., breeding birds); and are used by Inuit for tools, fuel, and hunting.
Ecosystems that can contain esker complexes	Esker-related ecosystems provide important denning habitat for mammals such as foxes, wolves, wolverine, and ground squirrels, and travel corridors for many wildlife species; used as travel routes by Inuit peoples.
Sensitive or rare wetlands	These ecosystems provide important habitat to grizzly bears and caribou in the spring. Shallow open water provides habitat for water bird species. Furthermore, the ecosystems provide food and other materials for Inuit traditional uses.
Bedrock cliff	Steep, exposed bedrock cliffs provide important bird nesting habitat and hunting for Inuit as well as habitat for rare plant species.
Bedrock-lichen veneer ecosystems	Dry, windswept areas support a continuous mat of lichens, an important food source for caribou.
Beaches, marine backshores and intertidal areas	These marine associated areas provide habitat for rare plant species and are travel and foraging areas for Inuit and a variety of wildlife.
Rare plants and lichens known locations	Rare plant species are important to biodiversity and may be federally protected.

Reducing potential effects by avoidance is, where practicable, the most effective mitigation measure to reduce the potential for serious damage or harm. Hence, the locations of these features were identified and Phase 2 Project infrastructure was relocated, where feasible, to avoid effects to these features.

8.2 EXISTING ENVIRONMENT AND BASELINE INFORMATION

This section describes the existing environment and baseline information for the terrestrial ecosystems, wetlands, plant species observed, rare plants, and plant metals content in the vicinity of the Project.

Ecosystems occur as a result of complex interactions between living and non-living components across the landscape. These interactions result in unique species composition, structure and functions. This summary focuses on groups of site-specific plant communities (ecosystems), which are typically characterized by unique assemblages of plant species with a consistent and developing vegetation structure.

8.2.1 Regulatory Framework

The assessment of Phase 2 Project-related effects on ecosystems and vegetation is guided by the relevant regulatory framework and requirements within Nunavut and Canada. A summary of the applicable regulatory and policy framework is provided in Table 8.2-1.

Table 8.2-1. Summary of Applicable Regulatory and Policy Framework for Terrestrial Ecology and Vegetation

Name	Jurisdiction	Description
Canada Species at Risk Act (SARA) (2002)	Federal	• Protects plant species at risk and critical habitat of those species listed on the "List of Wildlife Species at Risk". • Section 137 amends the *Canadian Environmental Assessment Act* (1992) to clarify, for greater certainty, that environmental assessments must always consider effects to listed species, their critical habitat, or the residences of individuals of that species. • Section 79(2) states "the person must identify the adverse effects of the project on the listed species and its critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen those effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plans."
Federal Policy on Wetland Conservation (2014)	Federal	• The Federal Policy on Wetland Conservation (Environment Canada 2014) provides a coordinated federal approach to wetland conservation. This policy provides direction on wetland management, legislation, and related policies and programs which support wetland conservation on federal lands and waters.
Nunavut Scientists Act (2011)	Nunavut	• Requires a licence to conduct environmental research (except for wildlife).
Nunavut Wildlife Act (2003)	Nunavut	• Provides guidelines on wildlife harvesting, habitat protection, respectful conduct toward wildlife, and designation and protection of species at risk and their habitat • Pertinent Regulations are: Wildlife General Regulations (1999), and Wildlife Licenses and Permits Regulations (1999).
Nunavut Land Claims Agreement (1993)	Nunavut	• Provides guidelines for NIRB on the review of potential environmental and social effects of development projects.

8.2.2 Data Sources

This section details existing information and the results of studies completed to characterize baseline vegetation conditions. The description of data sources of information in the baseline includes:

- information from scientific field studies, supplemented by Inuit traditional and community knowledge, where available;
- references to supporting documents, including annual baseline data reports, engineering, and technical reports (included as appendices to the Application); and
- desktop research such as other EA reports and regional studies.

8.2.2.1 Ecosystem Classification

The West Kitikmeot/Slave Study (WKSS) region has a broad level vegetation classification system (RWED 2000; Matthews et al. 2001), which encompasses the Project area (Golder 2009). Golder (2009) created a preliminary regional Ecosystem Land Classification (ELC) for the area around the Project by collating multiple local ecosystem classification projects previously completed for the Project area (Rescan 1997; P. Burt 2003). The resulting ELC compares local ecosystems with the broad level WKSS classification system to enable the assessment of environmental impacts at both local and regional levels (Golder 2009). In 2010, Rescan modified the ELC to account for the new, larger study area and additional sample plot data (Appendix V5-8A).

8.2.2.2 Ecosystem Mapping and Field Surveys

Project baseline studies for terrestrial ecosystems, wetlands, and vegetation were conducted between 1997 and 2014. The baseline data collected in 2010 and 2014 builds on the existing work conducted in 1996 and 1997 by Westroad Resource Consultants Ltd. (Westroad) (Rescan 1997). Westroad conducted preliminary terrestrial ecosystem mapping of the Project area in 1997 (Rescan 1997). In 2010, Rescan (Appendix V5-8A) expanded the existing ELC mapping to include the potential Project infrastructure. Existing data collected to augment the baseline studies includes the following sources:

- West Kitikmeot/Slave Study (WKSS) land cover classification (Matthews et al. 2001);
- *Flora of the Canadian Arctic Archipelago* (Aiken et al. 2007);
- NWT Department of Environmental and Natural Resources;
- Northwest Territories GSRP;
- Quickbird natural color and false-colour infrared satellite imagery;
- 1:15,000 aerial photos digitized via mono-restitution; and
- Inuit Traditional Knowledge for TMAC Resources Inc. Proposed Hope Bay Project, Naonaiyaotit Traditional Knowledge Project (NTKP) (Banci and Spicker 2015).

8.2.2.3 Field Guide and Reference Data

The following guidebooks and reference data were used for field inventories and ecosystem descriptions:

- Burt, P. 2000. *Barren Land Beauties: Showy Plants of the Canadian Arctic*. Outcrop Ltd. Yellowknife, NWT;
- MacKinnon, A., J. Pojar, R. Coupe (eds.). 1992. *Plants of Northern British Columbia*. B.C. Ministry of Forests and Lone Pine Publishing. Canada;
- Mallory, C. and S. Aiken. 2004. *Common Plants of Nunavut*. Department of Education, Iqaluit, Nunavut; and
- Porslid, A. E. and W. J. Cody. 1980. *Vascular Plants of Continental Northwest Territories*. National Museums of Canada. Ottawa, ON, Canada.

Previous studies were used to generate lists of plant species known to occur in the Project area, and for general ecological information.

8.2.3 Methods

This section summarizes the methods and rationale used for the characterization of terrestrial ecosystems, wetlands, and vegetation including the study objectives, study areas, ecosystem classification, mapping, field surveys and analysis, rare plant and lichen survey design, and vegetation metals characterization.

8.2.3.1 Study Objectives

The main objectives of the baseline programs were to:

- map and characterize the terrestrial and wetland ecosystems within a local and regional context;
- document plant and lichen species listed by NatureServe, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), SARA, or otherwise considered rare or of conservation interest;
- document the occurrence and location of invasive plants tracked by the Working Group on General Status of NWT Species; and
- describe baseline metal concentrations in plant collections from the Project area.

8.2.3.2 Study Areas

In order to guide the scope of baseline studies, regional and local study areas (RSA and LSA, respectively) were developed (Figure 8.2-1). These are described further in Section 8.4. The RSA encompasses the area of influence of the Project, beyond which effects are not predicted to occur. It also contains the extent of home ranges for key wildlife species known to inhabit the region. The exceptions to these are widely migrating species such as birds that migrate to the southern hemisphere. The LSA surrounds the proposed Project infrastructure and the area in which direct effects from the Project may occur (Figure 8.2-1).

8.2.3.3 Ecosystem Classification and Mapping

There are two types of ecosystem classification and mapping that were used to describe Project ecology:

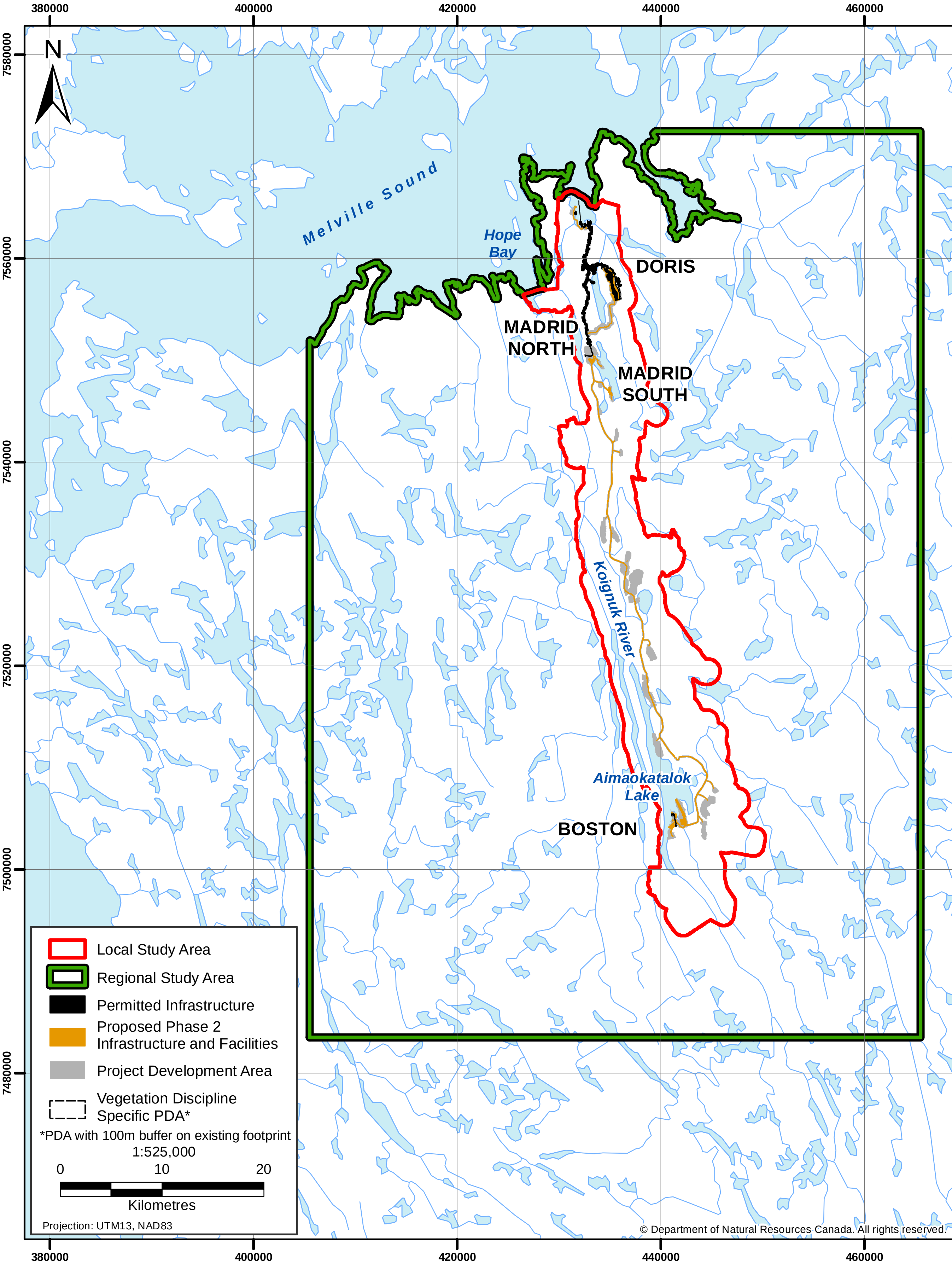
- WKSS (Matthews et al. 2001) classification and mapping which is a relatively coarse scale mapping product used for regional assessments such as cumulative effects; and
- The ELC classification used for Terrestrial Ecosystem Mapping (TEM; Appendix V5-8A) to map local ecosystems that may be affected by Project activities.

<u>Ecosystem Classification</u>

A comprehensive site level ecological classification system has not been developed for Nunavut or north of the treeline in the Northwest Territories. However, a coarse level vegetation classification system was developed for the WKSS region (Matthews et al. 2001). The WKSS mapping was used to characterize the regional study area.

Local ecosystem classification projects have been completed for the Project area. Over a period of two years (1996 and 1997), Rescan created a preliminary local ecosystem classification system for the Project area based on the existing classification projects and field data. Multivariate statistical analysis of 424 field plots identified 13 unique ecosystem units. A distinct assemblage of plant species and unique environmental considerations (soil moisture and nutrients, parent material, drainage, etc.) defines each unit (Rescan 1997). In addition to mapped ecosystem types, 11 non-vegetated map codes were developed to describe other features such as lakes, rivers, and rock outcrops. The TEM methods used to map the LSA are described below.

Figure 8.2-1
Hope Bay Project Ecosystem Study Area Boundaries



Terrestrial Ecosystem Mapping

Ecosystem mapping is effective in stratifying the landscape into meaningful units that reflect a combination of attributes, such as climate, surficial material, soil, and vegetation community (RIC 1998). Terrestrial Ecosystem Mapping requires specialists to interpret ecosystem boundaries and attributes from aerial photographs or digital stereo images. The first step involves the identification of permanent terrain units based on surficial material, geomorphology, and slope. There can be multiple polygons of a terrain unit (terrain polygon). A second step requires the identification of ecosystems mapped within each of the terrain polygons.

Preliminary mapping of 16,115 ha of the Project area was completed in 1997 (Rescan 1997) using 1:15,000 aerial photographs. An additional 40,023 ha were mapped in 2010 using 2008 Quickbird satellite imagery to characterize the ecosystems within the LSA. The total area mapped was 56,340 ha.

Field Surveys

Field surveys identified and recorded the type and distribution of ecosystems and vegetation types within the Project area. Timing of field surveys optimized the likelihood of accurate plant identification (e.g. during flowering and/or fruiting). Characteristics assessed at each site included landform type, soil texture, soil drainage, species composition, structure, and physiognomy. This information was used to confirm and refine the TEM.

Wetland ecosystems were classified to the class and form level according to the *Canadian Wetland Classification System* (Warner and Rubec 1997). Wetland class is based on general site characteristics such as soil type and the extent and quality of predominant vegetation cover. Wetland classes were further subdivided into forms based on surface morphology, surface pattern, water type, and characteristics of the soil (Warner and Rubec 1997). Sampling sites were based on the National Topographic Database (NTDB) mapping and proximity to proposed infrastructure features. Survey plots measured 400 m^2 in large wetlands and to the outer edge of the wetland vegetation in smaller wetlands. A Wetland Habitat Inspection Form (WHIF) was used to collect information relevant to wetland characterization.

8.2.3.4 Rare Plants

Rare plant surveys for plant and lichen species listed by NatureServe, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), SARA, or otherwise considered rare or of conservation interest were conducted in 2014. A qualified botanist applying an “Intuitive Controlled Survey Method” and conducted surveys from July 19 to 24 and August 6 to 17 of 2014. The Intuitive Controlled Survey Method established transects through habitats where target species are more likely to occur. Surveys focussed on areas where infrastructure footprints were identified. All rare taxa encountered were identified to the genus level or lower. The geographic position was recorded and a photograph taken of the rare plant or lichen. The habitat characteristics of the population were recorded, and a general group size was estimated. Where appropriate, at least one example of each rare species encountered in the rare plant and lichen surveys was documented with a voucher specimen by a qualified botanist. Voucher specimens were not taken of individual plants, from small groups, or very rare or listed species.

8.2.3.5 Soil and Vegetation Metal Analysis

Reclamation planning and identification of potential Project effects to human health and wildlife requires tracking metal concentrations in soils and plant tissues. The metals analyses determined existing levels of metals near the Project and at control sites outside of the predicted area of Project effects. The control sites can be used to identify if any changes in the level of metals in soil and plants are due to the Project. Samples were collected and analyzed from soil, lichens, and berries. In 2010, 18 plant tissue samples were collected from 18 sites within the LSA during field surveys. In 2014, an additional 33 plant, soil, and lichen samples were co-collected from 30 sites (21 within the LSA and 9 from reference areas outside the LSA). Samples collected in 2010 and 2014 were analyzed for metals and percent moisture. The berry, soil, and lichen samples collected in 2014 were analysed for 34 metals. This data is used to develop site-specific biotransfer factors (i.e., the relationship between soil metals and vegetation tissue metals) to predict future changes to vegetation metal concentrations that may occur as a result of the Project. Results from the baseline metals analysis were used for Human and Environmental Health Risk (Volume 6, Section 5).

8.2.3.6 Information Caveats and Limitations

Ecosystem mapping is a well-established method for documenting rare and unique ecosystems and assessing potential effects to them; however, ecosystem types that are less than 2 ha may not be mapped at a 1:20,000 mapping scale. Rare plant survey detection is limited to surveyed areas and complete surveys are not possible. For this reason, surveys focussed on areas where Project Footprints were identified. As a result, rare plant species locations are all located in or near Project Footprints and do not represent rare plant distribution throughout the LSA.

8.2.4 Characterization of Baseline Conditions

This section provides:

- a description of the existing conditions;
- the scientific importance of the baseline results;
- discussion of any exceptional existing conditions such as an elevated baseline conditions above an expected environmental or regulatory threshold; and
- data gaps or uncertainties that could potentially affect the confidence in the effects assessment.

8.2.4.1 Regional Setting

The National Ecological Framework is a hierarchal system of ecological classification that provides a way of describing the distribution of ecological patterns across Canada. At its broadest level, this system recognizes two ecozones within Nunavut: the Northern Arctic Ecozone and the Southern Arctic Ecozone (Natural Resources Canada 2003). The Project lies entirely within the Southern Arctic Ecozone (Figure 8.2-2) which extends across central Nunavut. Summers are typically cool and short with a mean temperature of 5˚C. Winters are long and cold with an average temperature ranging from -28ºC near the Mackenzie Delta to -18˚C in Northern Quebec. Precipitation is limited to approximately 200 mm per year. The climatic conditions of the Project area are further detailed in Climate and Meteorology (Volume 4, Section 1). On the south, the Southern Arctic Ecozone is bordered by the Taiga Shield Ecozone, which is demarcated by the northern extent of tree line, and on the North by the Northern Arctic Ecozone.

8.2.4.2 Protected or Conservation Areas

The proposed Project footprint does not overlap with any protected or conservation areas; a Territorial Park and a bird sanctuary are located outside the RSA.

Ovayok Territorial Park is situated 15 km east of Cambridge Bay, (Figure 8.2-2). The park is relatively small and covers an area of approximately 16 km^2. The central feature of the park is the mountain called Ovayok (Mount Pelly).

Figure 8.2-2
Proximity of Roberts Bay to Designated Environmental Areas

The Queen Maud Gulf Migratory Bird Sanctuary is Canada's largest federal protected area, encompassing 61,765 km^2 (Figure 8.2-2). The sanctuary is dominated by wetlands, streams, ponds, and shallow lakes and it was designated as a wetland of international importance in 1982.

8.2.4.3 Regional Ecology

The terrain within the region is comprised largely of flat and rolling bedrock covered by thin veneers of morainal, lacustrine, and fluvial deposits. Exposed bedrock is common, as repeated glacial advance and recession has removed much of the surficial material. Much of the exposed bedrock still bears striation from rocks entrained in glaciers (Natural Resources Canada 2003). Permafrost is found throughout the region and, although annual precipitation is low, many low-lying areas (as well as low-gradient hillsides) remain permanently saturated. This is due to very low rates of evaporation and transpiration as well as a continual supply of moisture from within the soil profile due to seasonal melting of permafrost.

The occurrence and development of Arctic wetlands, common throughout the region, is closely connected to the freezing and thawing of soil. The freeze-thaw action results in a number of distinct wetland types depending on the amount of dynamism in the active layer (the layer of soil above the permafrost, which is subject to periodic thawing), the depth of the surficial organic material, landscape position, and the properties of the subsurface mineral parent material. Many Arctic wetlands are located in depressions, caused by glacial scour, that have filled with water from snowmelt. Kettle and kame topography also promotes wetland development (Gracz 2007).

A lack of full-size trees along its southern edge defines the southern border of the Southern Arctic Ecozone. Stunted forms of common tree species, such as dwarf birch (*Betula nana*), green alder (*Alnus viridis* spp. *crispa*), willow species (*Salix* spp.) and less commonly, white and black spruce (*Picea glauca* and *mariana*) grow throughout the ecozone. Sedge meadows, tussock tundra, and heath tundra dominate the ground layers. Sparsely vegetated areas, such as the wind-swept crests of eskers, are also common.

Table 8.2-2 summarizes the results of the WKSS ecological classification within the RSA. Of the 22 potential land and water classification units, 18 units occur in the RSA. The Heath Tundra (< 30% rock) and Heath/Bedrock (30-80% bedrock) comprise more than 40% of the total area. Shallow water, is the next most prevalently mapped ecosystem unit (19%). Table 8.2-2 presents the areas for WKSS ecological classification units and the ecologically equivalent Local Ecosystem units (Rescan 1997) within the RSA. Figure 8.2-3 shows the WKSS ecological classifications in the RSA.

Table 8.2-2. Correlation of Regional ELC Units with the WKSS Classification

ELC Code	WKSS ELC Unit	Local Ecosystem Unit(s)	Area (ha)	% of RSA
0	Unclassified	NA	4,811	1.0%
1	Lichen Veneer	Carex-Lichen (CL)	3,357	0.7%
2	Deep Water	Lakes (LA) and Salt Water (SW)	22,133	4.5%
3	Esker Complex	Carex-Lichen (CL) and Dwarf Shrub-Heath (SH)	1,235	0.3%
4	Wetland (Sedge Meadow)	Wet Meadow (WM), Polygonal Ground (PG) and Emergent Marsh (EM)	27,572	5.6%
5	Shallow Water	Ponds (PD) and Shallow Open Water (OW)	94,990	19.4%
6	Tussock/Hummock	Eriophorum Tussock Meadow (TM)	46,523	9.5%
7	Heath Tundra	Dryas Herb Mat (DH) and Betula-Ledum-Lichen (BL)	98,430	20.1%
10	Bedrock Association	Rock Outcrop (RO) and Carex-Lichen (CL)	21,937	4.5%
11	Riparian Tall Shrub	Riparian Willow (RW)	14,241	2.9%

ELC Code	WKSS ELC Unit	Local Ecosystem Unit(s)	Area (ha)	% of RSA
13	Heath/Boulder	Carex-Lichen (CL) and Dwarf Shrub-Heath (SH)	6,013	1.2%
14	Heath/Bedrock	Dryas Herb Mat (DH) and Carex-Lichen (CL)	98,023	20.0%
15	Boulder Association	Blockfield (BI)	3,501	0.7%
16	Bare Ground	Barren (BA) and Exposed Soil (ES)	2,114	0.4%
17	Low Shrub	Dry Willow (DW) and Betula-Moss (BM	34,018	6.9%
18	Gravel Deposit	Barren (BA) and Exposed Soil (ES)	11,505	2.3%
TOTAL			**490,404**	**100**

8.2.4.4 Local Ecology

Local ecosystem units were grouped into Marine, Upland and Lowland community category (Table 8.2-3). Marine ecosystem units are strictly limited to the edge of the active marine environment along the shore of Roberts Bay. Upland ecosystem units are generally associated with bedrock outcrops and till or colluvial deposits found on the lower slopes of the outcrops. Lowland ecosystem units dominate the LSA and encompass the extensive lower slopes and plains and generally occur on lacustrine, marine, and fluvial deposits. The lowland ecosystems are mapped as single ecosystem unit discernible on satellite imagery, however, most of these wet ecosystems (including the EM, WM, OW and PG) are more accurately described as wetland complexes. These complexes are assemblages of fens, bogs, marshes, open water and other terrestrial ecosystem types which comprise much of the lowland regions of the LSA.

A summary of the LSA ecosystem mapping from 1997 and 2010 and the area of each ecosystem unit mapped (excluding the more detailed wetland classifications) is presented in Table 8.2-4 and shown on Figure 8.2-4. See Rescan (1997) for additional ecosystem unit descriptions and the detailed methodology used to develop the classifications. The most common and widespread ecosystem within the LSA is the Eriophorum Tussock Meadow. This ecosystem unit occurs in a variety of lowland landscape positions on gentle slopes. It is characterized by distinct well-formed cotton-grass (*Eriophorum vaginatum*) tussocks (Plates 8.2-1 and 8.2-2). The Betula-Ledum-Lichen (BL) unit occurs extensively across the level-to-gentle hillslopes across the LSA (Plate 8.2-3). This ecosystem typifies the drier tundra ecosystems present in the Project vicinity and often occurs in association with boulders. A distinct arctic wetland ecosystem is the Polygonal Ground (PG). Periglacial processes define these ecosystems rather than dominant vegetation or environmental conditions. They can occur as high-centre polygons with palsas surrounded by WM depressions (Plate 8.2-4) or as low-centre polygons with linear ridges underlain by ice-wedges. Complete descriptions of each ecosystem unit are provided in Appendix V5-8A, which also contains plot data and vegetation cover estimates for each species by plot.

Wetlands within the LSA are widely distributed and comprise approximately 17% of the mapped area. Some wetlands occur at too fine of a scale to be mapped (e.g. bogs), and thus the total distribution of wetlands in the LSA is likely underestimated. Common wetlands in the north of the LSA are fens and bogs, and large, shallow water bodies that are thought to have formed from the heaving and melting of ground ice under periglacial conditions (Rescan 1997). In the east of the LSA, many shallow ponds are formed in troughs behind what were once offshore sandbars now exposed above sea level due to isostatic rebound (Rescan 1997).

Figure 8.2-3
Regional Study Area WKSS Ecosystem Land Classification

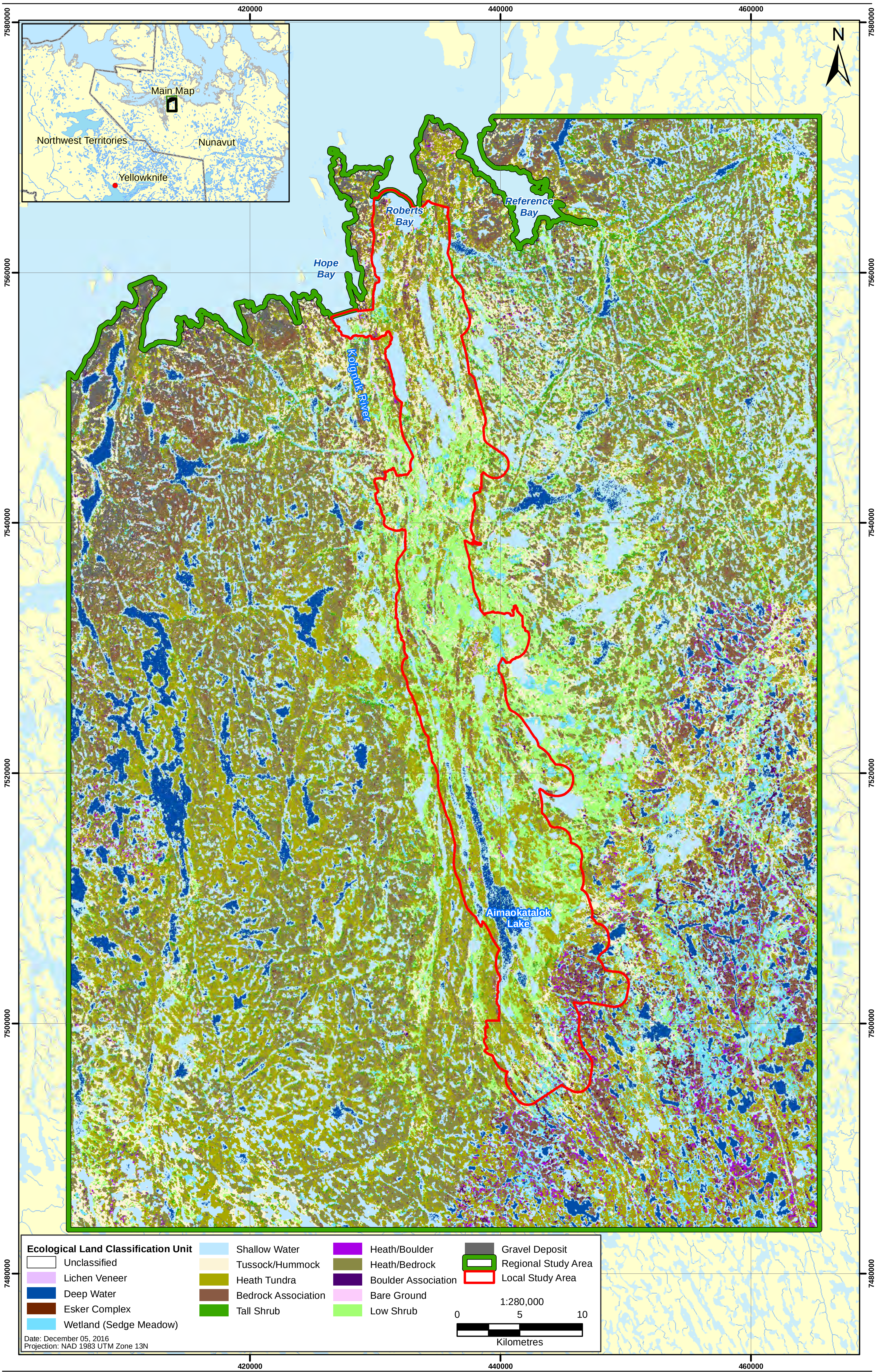


Figure 8.2-4
Distribution of Ecosystems in the Local Study Area

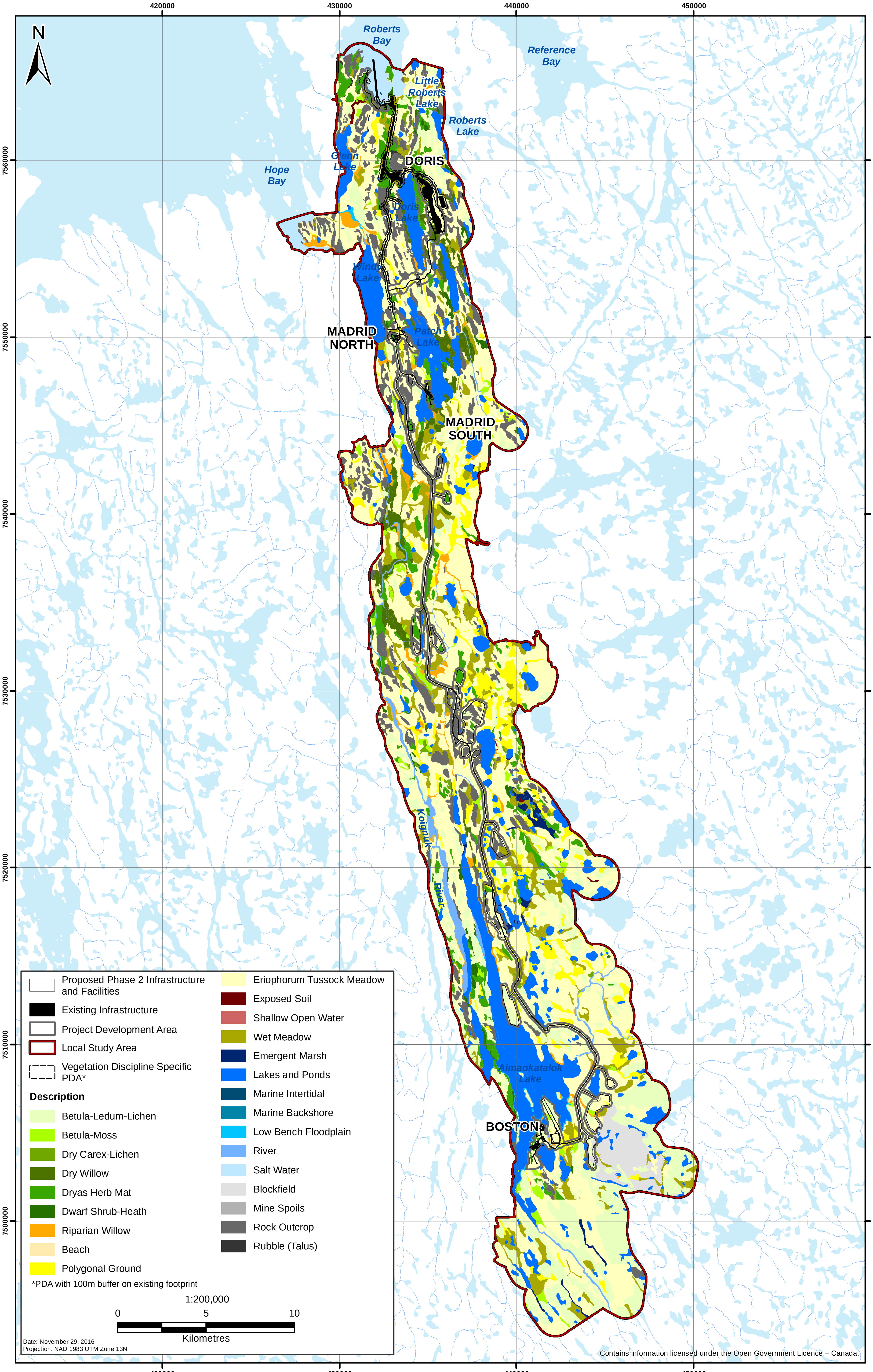


Table 8.2-3. Description of Ecosystem Units and Function

Category	General Ecosystem Unit	Description	Ecological function and/or importance to wildlife or humans
Marine	Marine Intertidal (MI)	Wet, medium nutrient marine community strictly limited to intertidal flats and shorelines containing low floral diversity of salt-tolerant herbs, with no shrubs, mosses or lichens. 50-90% cover. Vegetation height is generally very low to low.	Limited extent of ecosystems across the landscape which represent boundary between marine and terrestrial environment.
	Marine Backshore (MB)	Dry, nutrient poor community occurring directly upslope of marine backshore communities characterized by extensive deposits of washed marine sands with highly variable (but generally sparse) herb layer and few shrub, moss or lichen species. <50% cover. Vegetation height is generally very low to low.	
Upland Ecosystems	Dry Carex-Lichen (CL)	Dry, nutrient poor community restricted to exposed bedrock outcrops characterized by a variable but generally sparse cover of sedges, lichens and dwarf shrubs. Vegetation height is generally very low to low.	High lichen cover provides an important food source for muskox and caribou. Low vegetation cover provides denning habitat for fox, wolverine, and wolf.
	Dwarf Shrub-Heath (SH)	Mesic, poor to medium nutrient community restricted to moderate to steep slopes of glacial till over bedrock (often containing frost mounds) containing arctic heather and a highly variable assemblage of dwarf shrubs, herbs, moss and lichen in response to microtopography and aspect. Vegetation height in this community can vary from low to moderate.	When found as eskers, this unit can be a travel corridor for wildlife movement. Low vegetation cover provides denning habitat for fox, wolverine, and wolf.
	Dryas-Herb Mat (DH)	Dry to mesic, poor to medium nutrient community occurring on very thin, poorly developed soils on bedrock outcrops and morainal deposits dominated by Arctic avens and a high diversity of dwarf shrubs and herbs. Vegetation height is generally very low to low.	High shrub cover results in wildlife habitat opportunities and increases depth/duration of snow cover which remains longer and provides meltwater later in growing season and nutrients to downstream communities.
	Betula-Ledum-Lichen (BL)	Dry to mesic, poor to medium nutrient community occurring on hillslopes of glacial till containing thick covers of low dwarf birch, Labrador tea and a variety of dwarf shrubs, sedges, herbs and lichens. Vegetation height is generally very low to low.	
Lowland Ecosystems	Riparian Willow (RW)	Wet to very wet, medium to rich nutrient community restricted to active floodplains and seasonally fluctuating water tables with a thick cover of willow species and variable (often extensive) cover of sedges, cotton-grass, and moss species. Vegetation height is generally high, up to several metres.	Wood from willows and shrubs are harvested by Inuit for arrow shafts, sleds, drying racks, fires, and for smoking foods. The unit provides forage habitat for ungulates as well as nesting and habitat for numerous wildlife species.
	Dry Willow (DW)	Mesic, medium nutrient community occurring on steep slopes (typically fluvial, marine or lacustrine) with a thick cover of willow (occasionally dwarf birch) and few other species. Vegetation height is generally moderate.	

Category	General Ecosystem Unit	Description	Ecological function and/or importance to wildlife or humans
	Low Bench Floodplain (FP)	Permanently wet, medium to rich community restricted to active floodplains of rivers, streams and lake outlets lacking shrub and lichen cover and containing hydrophilic herbs and water tolerant mosses. Vegetation height is generally very low.	
	Betula-Moss (BM)	Mesic to moist, poor to medium nutrient community located in depressions or gently sloping fluvial and lacustrine plains typified by a high cover of dwarf birch (and often willow) and a thick moss layer, with few herbs or lichens present. Vegetation height is generally moderate.	
	Wet Meadow (WM)	Wet to very wet, medium to rich nutrient community occurring on plains and gentle lower slopes with constant water seepage dominated by thick covers of cotton-grass and sedges, few shrubs and lichens, and limited moss cover. Vegetation height is generally moderate.	The unit provides spring habitat for grizzly bears and caribou and can be habitat for other terrestrial and avian species, including small mammals which are prey for predators and raptors. Arctic wetlands play a role in carbon cycling and CO_2 accumulation in the atmosphere.
	Emergent Marsh (EM)	Permanently saturated rich to very rich communities which are rarely extensive and dominated by sedges, some hydrophilic herbs, and no shrubs of lichens, typically occurring along watercourses and ponds. Vegetation height is generally moderate.	
	Polygonal Ground (PG)	Mosaic of disjunct communities comprised of drier communities (raised palsa mounds with communities similar to birch-Ledum-lichen or birch-moss) and wet depressions (normally wet meadows) which typically occur in depressions and valley bottoms near lakes and ponds. Vegetation height is generally low to moderate.	
	Eriophorum Tussock Meadow (TM)	Moist to wet, medium to rich nutrient, widespread community type characterized by deep tussocks of sheathed cotton-grass and a variety of dwarf shrubs (on drier tussock tops), herbs, and mosses found in low lying plain of organic material overlying fine textures marine and lacustrine materials (permafrost almost always occurs at the organic – mineral transition). Vegetation height is generally low to moderate.	Arctic wetlands play a role in carbon cycling and CO_2 accumulation in the atmosphere.

8.2.4.5 Field Survey Plot Data

A total of 166 sample plots and 166 visual plots were surveyed within the LSA in 2010 to characterize the local ecosystem units. Consistent with the ecosystem mapping TM, BL, and DH were the most commonly sampled ecosystem units. Data from the terrestrial field plots were used to modify some of the Rescan 1997 ecosystem unit descriptions. The data were also used to confirm ecosystem mapping classification and polygon boundaries.

Table 8.2-4. Local Ecosystem Mapping Summary

Map Code	Description	Total LSA (ha)	Percent of LSA
BA	Barren	6	0.01%
BE	Beach	21	0.04%
BI	Blockfield	979	1.74%
BL	Betula-Ledum-Lichen	7,076	12.56%
BM	Betula-Moss	1,708	3.03%
CL	Dry Carex-Lichen	527	0.94%
DH	Dryas Herb Mat	4,345	7.71%
DW	Dry Willow	1,244	2.21%
EM	Emergent Marsh	751	1.33%
ES	Exposed Soil	78	0.14%
FP	Low Bench Floodplain	123	0.22%
LA & PD	Lakes and Ponds	8,215	14.58%
MB	Marine Backshore	18	0.03%
MI	Marine Intertidal	3	0.01%
MS	Mine Spoils	17	0.03%
OW	Shallow Open Water	11	0.02%
PG	Polygonal Ground	2569	4.56%
RI	River	798	1.42%
RO	Rock Outcrop	3280	5.82%
RU	Rubble	20	0.03%
RW	Riparian Willow	1,230	2.18%
SH	Dwarf Shrub-Heath	742	1.32%
SW	Salt Water	741	1.32%
TM	Eriophorum Tussock Meadow	15,630	27.74%
WM	Wet Meadow	6,210	11.02%
TOTAL		**56,340**	

A total of 52 ground surveys and 40 visual surveys were conducted within the LSA in 2010. The majority (75%) of the wetlands surveyed occur as complexes. Fens are over half (58%) of the wetlands surveyed (Table 8.2-5). Fens are nutrient-medium peatland ecosystems dominated by sedges and brown mosses. Bogs were the next most common wetland types surveyed, accounting for 23% of field plots. Bogs are acidic and nutrient-poor ecosystems dominated by *Sphagnum* or brown moss which are isolated from mineral-enriched groundwater. Bogs commonly comprised the polygonal ground ecosystems.

8.2.4.6 Ecosystems and Plants of Interest

Plants and Ecosystems of Cultural Importance

The TK report identifies numerous traditionally harvested food, medicinal, or culturally important plants (Banci and Spicker 2015). Harvested berries include cloudberries, blueberries, crowberries, and bearberries. Liquorice root (also called mahok) is also an important springtime food source. Leaves of the mountain sorrel and beach peas are also harvested and consumed. Other plants having medicinal or other cultural importance include white arctic heather, crowberries, and Labrador tea.

Plate 8.2-1. Typical Eriophorum Tussock Meadow (TM) ecosystem unit.

Plate 8.2-2. Close-up of typical Eriophorum vaginatum tussocks.

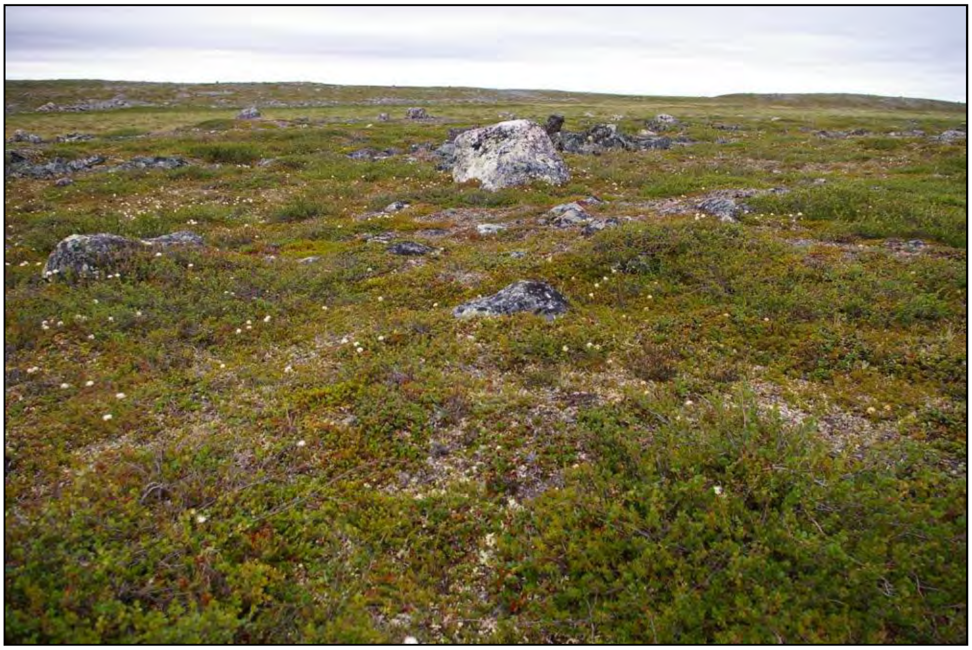


Plate 8.2-3. Bouldery Betula Ledum Lichen (BL) ecosystem unit typical of southern portions of the LSA.

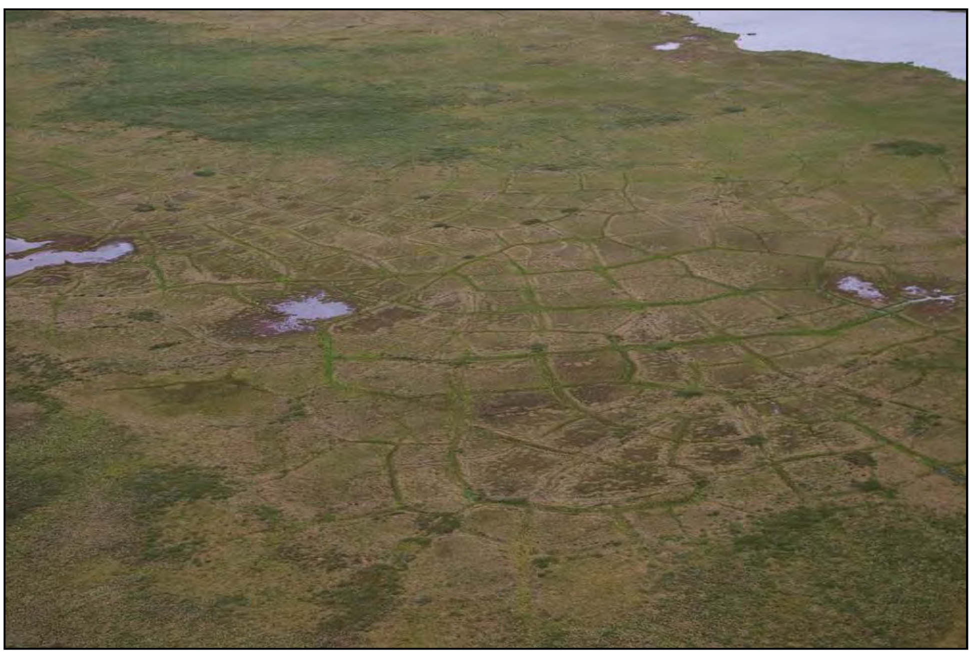


Plate 8.2-4. Aerial view of a typical Polygonal Ground (PG) ecosystem unit.

Table 8.2-5. Distribution of Ground Wetland Plots by Class and Form Type

Class	Primary Wetland Form[1]	Number of Wetland Field Plots	Percent of Total Wetland Plots
Fen	horizontal fen	11	21.2
	lowland polygon fen	19	36.5
Bog	lowland polygon bog	8	15.4
	peat mound bog	3	5.8
	palsa bog	0[2]	0.0
Marsh	lacustrine marsh	4	7.7
	slope marsh	1	1.9
	basin marsh	1	1.9
Open Water	shallow open water	n/a[2]	0.0
Terrestrial sites		5	9.6
Total		**52**	**100**

[1] *This field lists the primary wetland type identified at the field plot*
[2] *Present as sub-dominant community only. See Appendix 9 of the baseline study (Appendix V5-8A)*

Consultation as part of the TK report also reveals a number of plants or ecosystems of importance for starting fires, providing food such as berries, or providing habitat. These include riparian areas which are important sources of wood and provide shelter for ptarmigan. Wetlands are also valuable as they provide habitat for cloudberries and act as a source of water for caribou during hot periods.

All plants of cultural importance, with the exception of mountain sorrel and beach pea, were recorded during the 2014 rare plant surveys (Appendix V5-8B). Species, such as Arctic heather, liquorice root, and bear berries were encountered throughout mesic to very-dry tundra ecosystems such as the Dryas Herb ecosystem unit. Willow shrubs and dwarf (scrub) birch were frequently noted within the riparian and shrub-dominated areas which include the low bench floodplain and riparian willow ecosystem units.

Sensitive or at Risk Ecosystems

Unique landscape features are often considered rare or sensitive, due to their scarcity on the landscape, special habitat features they provide, and/or cultural importance. Landscape features known to support, or suspected of supporting, rare plant species include cliff faces, eskers, pingos, and the margins of wetlands. Some of these features, such as cliff faces and pingos cannot be mapped at the baseline mapping scale, and thus remain as described features only. However, the locations of cliffs were identified as point sources during the assessment of raptor nesting habitat.

In some cases, the same feature may serve as both potential rare plant habitat, important wildlife habitat (i.e. nesting habitat for raptors), or have important traditional uses. From the list of map codes (Table 8.2-3), the following vegetation associations were identified as potentially sensitive on the basis of habitat use:

- riparian ecosystems (map code RW): Deciduous shrubs are an important food source for ungulates; provide nesting and cover habitat for various wildlife species (e.g. breeding birds); and are used by Inuit for tools, fuel, and hunting.
- esker complexes (map codes: CL and SH; Esker Complex Unit in WKSS mapping): Esker-related ecosystems provide important denning habitat for mammals such as foxes, wolves, wolverine,

and ground squirrels, and travel corridors for many wildlife species; used as travel routes by Inuit peoples;

- sedge-dominated wetland, shallow open water and marsh ecosystems (map codes: WM, PG, OW, and EM): These ecosystems provide important habitat to grizzly bears and caribou in the spring. Furthermore, the ecosystems provide food and other materials for Inuit traditional uses. They are sensitive to even minor disturbances;
- bedrock cliff (map code: RO): Steep, exposed bedrock cliffs provide important bird nesting habitat and habitat for rare plant species; and
- bedrock-lichen veneer (map code: CL): Dry, windswept areas support a continuous mat of lichens, an important food source for caribou.

Sensitive wetlands ecosystems include those that are rare or fragile, and whose formation and maintenance is dependent on factors that are uncommon or threatened. They can be dependent on unique environmental and geographic factors and/or complex ecological processes (Farmer 1993; McPhee et al. 2000). For rare wetland ecosystems, the following must be known in order to determine the level of risk, or rarity:

- the ecosystem must be definable by an accepted and tested method of classification; and
- there must be knowledge of the number of occurrences of the particular ecosystem, and the distribution thereof.

Nunavut does not have a defined site-level ecological classification system for wetlands, thus it is not possible to determine rarity. However, there are a number of wetland-related landscape features present within the Arctic that are considered uncommon or unique (NWT Department of Environment and Natural Resources 2012). However, none of these three wetland related landscape features was mapped during baseline mapping.

These include the following:

1. **Saline Sulphur Springs** — landscape features forming when saline water up wells due to artesian flow. The water becomes saline upon contact with the saline parent material. At the surface, salt precipitates out of solution, forming unique features.
2. **Pingos —** mounds or small hills composed of a thin layer of soil overtop of ice. The ice is forced up due to water pressure, causing the soil surface to rise. They are dynamic in that they are constantly in a state of rising or falling due to changes in soil temperature and hydrology.
3. **Karst Wetlands —** wetlands associated with karst landscapes. Karst landscapes form due to the dissolution of soluble bedrock by surface and subsurface water. Usually, the bedrock is carbonate-derived, such as limestone or dolomite. The resulting landscape is dominated by shallow basins and hollows.

Sensitive wetlands are those whose functional components are susceptible to even minor amounts of disturbance (McPhee et al. 2000). They are often considered fragile due to the transient and changing nature of the natural processes that lead to their creation. Natural disturbance is an important and constant feature of Arctic ecosystems. Mechanical disturbances such as freeze-thaw processes, thermokarst landscape formation, wind, slope processes, and flooding occur on a constant basis, significantly influencing wetland development, over various spatial and temporal scales (International Arctic Science Committee 2010).

Arctic wetland ecosystems are sensitive to anthropogenic disturbance. Even small, low intensity disturbances, such as vehicle use on Arctic tundra, often create immediate and persistent effects on vegetation and soils (Forbes, Ebersole, and Strandberg 2001). In general, lowland ecosystems are more likely to be susceptible to disturbance, as small changes to vegetation cover and/or soils may result in altered ecosystem values, particularly in wet areas. Disturbance in areas with saturated soil affect soil thaw characteristics that define many ecosystems. For instance, vehicle use may affect the depth of thaw resulting in increased melting of permafrost (Kevan et al. 1995). Changes in soil temperature, thaw depth, and vegetation disturbance commonly result and can persist for many years (Harper and Kershaw 1996; Kemper and MacDonald 2009). Disturbance often changes vegetation structure and composition, and may increase localized erosion by channelizing water flow (Kevan et al. 1995; Forbes, Ebersole, and Strandberg 2001).

Upland ecosystems are generally dryer and water shedding, so physical disturbances may have a limited effect on water movement relative to lowland ecosystems. However, the vegetation species growing in dryer areas are often slower to recover following disturbance (Kemper and Macdonald 2009; Jorgenson, Ver Hoef, and Jogenson 2010). The marine ecosystem units are generally sparsely vegetated and characterized by unstable substrates that are constantly or erratically disturbed by tides, ice scouring and wave action. Vegetation that occurs in these ecosystem units should have a greater ability to re-colonize after disturbance, but literature reviews of Arctic marine foreshores indicate that knowledge in this area is limited.

Plant Species Richness

A total of 6,067 plants were recorded during the field surveys within the Project area, accounting for 871 species (Table 8.2-6). The lichens represent the most species-rich category. The second richest category is the vascular plants, followed by mosses and algae.

Table 8.2-6. Total Species Richness by Taxonomic Category

Vascular Plants	Mosses	Liverworts	Lichens	Total
262	204	38	367	871

Rare Plant Species

Of the 871-species identified in the field, 23 are tracked by the National General Status Working Group (NGSWG) and NatureServe Canada (Table 8.2-7; Figure 8.2-5). Of these, eight lichen species are categorized to be at risk (S1 or S1S2) and two lichen species may be at risk (S1S3). Eleven species are considered sensitive, including three lichen species and eight vascular plant species. The rank of the remaining two tracked species of vascular plant rank is secure. An additional 29 species are either not ranked and documented from only a few known locations or were considered rare but were not ranked and previously undocumented in Nunavut. None of the rare plant species listed in Table 8.2-7 is in Schedule 1 of SARA (2002). Rare plant surveys locations and species information is contained in Appendices V5-8B, V5-8C, V5-8D and V5-8E.

Invasive Plant Species

There is limited information available for invasive plant species in Nunavut. Information regarding invasive plants was compiled from the NWT Department of Environment and Natural Resources 2010, the Invasive Species Specialist Group (ISSG) Global Invasive Species Database and the Evergreen Native Plant Database and compared with field data collected in 2010 (Appendix 5).

Figure 8.2-5
Rare Plant Observations in the Hope Bay Local Study Area

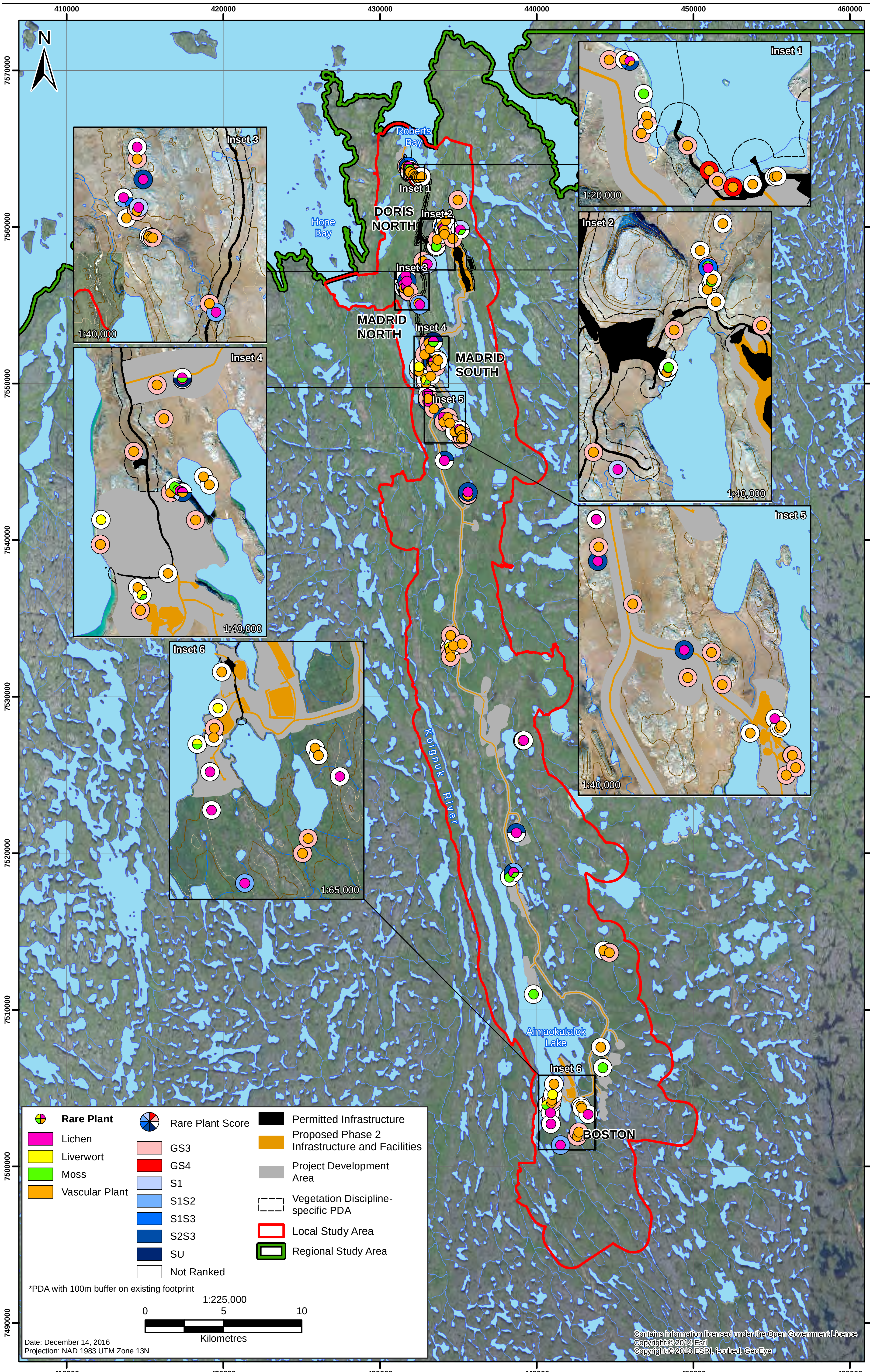


Table 8.2-7. Rare Lichen, Liverwort, Mosses, and Vascular Plants Identified in the Project Area

Species Category	Taxon	NatureServe Rank
Lichen	*Allocetraria madreporiformis*	S1S3 (May be at risk)
	Anaptychia crinalis	S1 (At risk)
	Collema auriforme s. lat.	Not ranked, previously undocumented in Nunavut
	Collema ceraniscum	S2S3 (Sensitive)
	Collema fuscovirens	S1S2 (At risk)
	Collema polycarpum	Not ranked, previously undocumented in Nunavut
	Collema tenax var. *expansum*	Not ranked, previously undocumented in Nunavut
	Endocarpon pulvinatum	S1S3 (May be at risk)
	Endocarpon pusillum	S1S2 (At risk)
	Evernia perfragilis	S2S3 (Sensitive)
	Hypogymnia imshaugii	Not ranked, first found in Nunavut in 2012, known in the Arctic only from the Hope Bay and Bathurst Inlet areas
	Leciophysma finmarkicum	S2S3 (Sensitive)
	Lemphlemma radiatum	S1 (At risk)
	Leptogium schraderi	SU (Not ranked due to lack of supporting specimens; the record from this project is the first documented from Nunavut)
	Leptogium turgidum	Not ranked, previously undocumented in Nunavut
	Lichinella nigritella	Not ranked, first discovered for Nunavut in 2012 and now known only from two localities in Nunavut
	Lobaria linita	S1S2 (At risk)
	Lobaria scrobiculata	S1 (At risk)
	Ramalina almquistii	S1S2 (At risk)
	Tuckermanopsis americana	S1S2 (At risk)
Liverwort	*Apometzgeria pubescens*	Not ranked, previously undocumented in Nunavut
	Frullania brittoniae	Not ranked, previously known in Nunavut from a single site
	Radula holtii	Not ranked, previously undocumented in Nunavut
Moss	*Aloina rigida*	Not ranked, previously documented in Nunavut from very few records.
	Brachythecium udum	Not ranked, previously undocumented in Nunavut, previously known definitively in North America in only one locality.
	Bryum blindii	Not ranked but known from few localities throughout its range
	Campylium laxifolium	Not ranked, previously undocumented in Nunavut, known previously in North America from three records
	Campylophyllum sommerfeltii	Not ranked, previously undocumented in Nunavut
	Encalypta vittiana	Not ranked, previously undocumented in Nunavut
	Hedwigia ciliata	Not ranked, previously known in Nunavut from a single locality
	Seligeria subimmersa	Not ranked, previously undocumented in Nunavut
	Sphagnum platyphyllum	Not ranked, previously undocumented in Nunavut
	Tortula cuneifolia	Not ranked, previously known in Nunavut from a single locality

Species Category	Taxon	NatureServe Rank
Vascular Plant	*Astragalus australis* var. *lepagei*	GS3 (Sensitive)
	Braya glabella ssp. *glabella*	Not ranked but rare
	Calamagrostis deschampsioides	GS3 (Sensitive)
	Carex microglochin	GS4 (Secure)
	Chrysosplenium rosendahlii	Not ranked, known from few localities worldwide
	Coptidium pallasii	GS3 (Sensitive)
	Draba arabisans	Not ranked, first found in Nunavut in 2012
	Festuca richardsonii	Not ranked in NatureServe's General Status Ranks
	Gentianella tenella	GS4 (Secure), but this appears to be in error; known from very few localities in Nunavut
	Halerpestes cymbalaria	Not ranked in NatureServe's General Status Ranks
	Kobresia sibirica	GS3 (Sensitive)
	Oxytropis deflexa var. *foliolosa*	GS3 (Sensitive)
	Oxytropis nigrescens var. *uniflora*	Not ranked in NatureServe's General Status Ranks
	Petasites sagittatus	Not ranked in NatureServe's General Status Ranks,
	Plantago canescens	GS3 (Sensitive)
	Potentilla uschakovii	Not ranked in NatureServe's General Status Ranks
	Puccinellia arctica	GS3 (Sensitive)
	Salix ovalifolia var. *ovalifolia*	Not ranked in NatureServe's General Status Ranks, first found in Nunavut in 2012
	Salix sp. 1 (eskers)	Not ranked in the NatureServe's General Status Ranks, a species discovered new for science in 2012
	Utricularia intermedia	GS3 (Sensitive)

Field surveys found one potentially invasive plant, common dandelion (*Taraxacum officiniale*). There are two subspecies of common dandelion (*Taraxacum officinale*) one of which is native (formerly known as *Taraxacum lacerum)* and the other is invasive (*T. officinale* ssp. *officinale*). Plant species were generally not identified to the subspecies level and thus field personnel were unable to determine the invasive status. Based on the location of occurrence and lack of human disturbance, it is believed that this species was likely native.

8.2.4.7 Metal Concentrations in Plant Tissues

Vegetation and soils sampling was conducted in July and August 2010 in August 2014 to characterize metal concentrations. Fifty-eight berry samples were collected and included *Empetrum nigrum, Arctostaphylos alpina*, and *Vaccinium sp.* Sampling for vegetation included 67 lichen samples of either *Flavocetraria cucullata or F. nivalis.* Samples were collected both at sites adjacent to proposed infrastructure and at nine reference sites where Project effects are not anticipated (Figure 8.2-6).

Assays detected twelve metals of interest during baseline studies. Most of the tissue samples had concentrations below detection limits (Rescan 2011). The un-summarized analytical results for all the metals analyzed in the lichen tissue samples (in both wet and dry weights) is presented Appendix 10 of the baseline report (Appendix V5-8A) and in Appendix V5-8F. There are no territorial or federal guidelines for metal limits in vegetation.