NEW MILLENNIUM
CAPITAL CORP.

DIRECT-SHIPPING ORE PROJECT



Mapping of Terrestrial Ecosystems and Surface Deposits: Direct Shipping Ore Project

Technical Report

BY: Groupe Hémisphères

March 2009

Groupe Hémisphères. Mapping of Terrestrial Ecosystems and Surface Deposits: Direct Shipping Ore Project

Technical Report.

March 2009

ERRATUM

As of November 27, 2009

Chapter 2 (page 8, first paragraph)

Replace the first paragraph with :

The TEM for the DSOP was conducted at the level of the ecotype. Higher hierarchical levels of ELC, appropriate to the ecological study of the whole of Labrador, were identified by Wilken (1986) for ecological zones and by Lopoukhine *et al.* (1978) and Meades (1989) for ecoregions. The characteristics of the ecoregions are given in the report in order to show the regional ecological context of the DSOP. For this project, the ecotypes were mapped at a scale of 1/20 000. Hard copies of the maps of the ecotypes for the DSOP are included in Appendices II and III.

PROJECT TEAM

GROUPE HÉMISPHÈRES		
Hugo T. Robitaille	Biologist, M.Sc. Env.	Project leader; botanical and flora inventories; ecosystem mapping; report author.
Marie-Ève Dion	Biologist, M.Sc. Env.	botanical and flora inventories; taxonomy; report author.
Julie Tremblay	Biologist, B.Sc. Biol.	Ecosystem mapping; geomatics.
Dr. Donald McLennan	Biologist, Ph.D.	Ecosystem mapping; report revision
AECOM CANADA		
Robin McKillop	Geomorphologist, M.Sc. P.Geo.	Inventory of geological surface deposits; surface deposit mapping; report author
Donald F. McQuay	Environmental geologist, B.A., agr., geol.	Revision of the surface deposit mapping and the report
Collaborators		
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Steve Driscoll	Geographer, B.Sc.	Manager - Geographical Information System
Casimir Mckenzie		Innu and Naskapi field assistants in the Schefferville region
George Rock		
Réginald Dominique		
Martial Pinette		
Roy Logan		Logistical organization in Schefferville

(Also see the list of personal communications in the bibliography)

Cover illustrations:
Foreground: forested ecosystem, Schefferville (Quebec), photo by Hugo Robitaille (2008)
Background: tundra ecosystem, Schefferville (Quebec), photo by Hugo Robitaille (2008)

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LIST OF ACRONYMS

%	Percentage
°C	Degee Celsius
>	Larger than
<	Smaller than
±	Approximately
3D	Three-dimensional
cm	Centimètre
DSOP	Direct Shipping Ore Project
ELC	Ecological Land Classification
GIS	Geographic Information System
HST	High Subarctic Tundra
LSA	Local Study Area
m	Meter
mASL	Meter above sea level
mm	Millimeter
MFS	Mid Subarctic Forest
MRNF	Ministère des Ressources naturelles et de la Faune
Mt	Million Tonnes
n/a	Not applicable
n/av	Non-available
NML	New Millennium Capital Corp.
RSA	Regional Study Area
SMR	Soil Moisture Regime
SNR	Soil Nutrient Regime
TEM	Terrestrial Ecosystem Mapping

GLOSSARY

Abiotic: Refers to non-living chemical and physical components in the environment, including light, temperature, water, atmospheric gases, wind, rock, soil and overall physiography.

Ablation: The removal of glacier ice through melting, calving, evaporation and/or sublimation.

Accordant: Description of uplands or hill tops with equal elevation, generally formed through post-depositional erosion or melt-out of glacial ice blocks

Alluvial: Pertaining to the sediments (commonly moderately- to well-sorted silt, sand, gravel and cobbles) eroded, transported and deposited by flowing water in contemporary streams.

ArcGIS™ TEM shapefile: Digital geographic information system file containing all terrestrial ecosystem mapping polygon boundary and attribute data (available on CD-ROM, upon request, from New Millennium Capital Corp.).

Biotic: Pertaining to any aspect of life, especially to characteristics of entire populations or ecosystems.

Bog: A type of wetland characterized by the accumulation of acidic peat, a deposit of dead plant material (e.g., mosses).

Calcareous: Composed of, containing, or characteristic of calcium carbonate.

Carbonaceous: Consisting of, containing, or related to carbon.

Chert: A hard, brittle sedimentary rock consisting of microcrystalline quartz.

Colluvial: Pertaining to the sediments (commonly poorly-sorted rubble) deposited by gravitational mass movements.

Craton: A large portion of a continental plate that has been relatively undisturbed since the Precambrian era (~3.8 billion to 540 million years before present).

Creep: Slow downslope movement of Surface material or bedrock due to gravity.

Cryoturbation: The mixing of soil horizons due to freezing and thawing, commonly in association with underlying permafrost

Downwasting: ***In situ*** disintegration of stagnant glacial ice through melting, evaporation, sublimation and erosion.

Drumlin: An elongated "whaleback" or inverted, spoon-shaped hill of Surface material (commonly till) formed beneath a flowing glacier. The stoss (up-ice) side is typically steeper than the lee (down-ice) side, which tapers gradually. Drumlins are commonly used as indicators of ice flow direction.

Direct Shipping Ore Project or DSOP: All activities and infrastructure related to the open-pit iron ore mine project being proposed by NML.

Ecological Land Classification: An approach used to identify terrestrial ecosystems and to classify them into a hierarchy of nested units at progressively smaller scales according to climate, physical land features and vegetation.

Ecoregion: An area of the landscape with characteristic regional climate and landforms, as expressed in typical vegetation physiognomy and composition, soils and topography.

Ecotype: The most detailed ecological classification units within ecoregions, which are used to delineate and describe terrestrial landscapes or, alternatively, ecosystems in this report. Ecotypes occur in predictable landscape positions and feature characteristic landform, site and soil characteristics that can be identified through stereoscopic interpretation of aerial photographs and described in detail during site visits.

Edatopic grid: An arrangement of all ecotypes within an ecoregion into a two-way matrix of estimated soil moisture regime and soil nutrient regime.

Englacial: Within a glacier.

Eolian: Pertaining to fine-grained sediments (dominantly silt and sand) eroded, transported and deposited by the wind.

Ericaceous: Plant family including numerous plants from mostly temperate climates that normally grow in acidic soils.

Esker: Sinuous ridge of sediment (generally sand, gravel, and cobbles) deposited by glacial meltwater in an ice-walled tunnel.

Fact sheet: Technical section of the report describing in detail the nature of a particular landform type or terrestrial ecosystem (ecotype). Each fact sheet includes summary tables of key information.

Fen: A sedge-dominated, groundwater-fed type of wetland that accumulates peat, but is less acidic than a bog.

Glacial debuttressing: The removal of support once provided by glacial ice against a cliff through glacial retreat or downwasting. Recently exposed steep slopes may be prone to failure due to the increase in shear stress.

Glaciofluvial: Pertaining to the sediments (commonly moderately- to well-sorted sand, gravel or cobbles) eroded, transported and deposited by glacial meltwater in ice-contact or proglacial environments.

Glaciolacustrine: Pertaining to the sediments (commonly well-sorted fine sand, silt and clay) deposited through fall-out from suspension in ice-contact or proglacial lakes.

Gleying: A soil process that occurs in waterlogged, anaerobic conditions when iron compounds are reduced and either removed from the soil, or segregated out as mottles or concretions in the soil. Marshy wetlands commonly contain gleyed soils.

Gneiss: A foliated, or banded, metamorphic rock with light-coloured layers, usually quartz and feldspar, alternating with dark-coloured layers of other minerals, usually hornblende and biotite.

Greywacke: A dark grey, coarse-grained sandstone that contains abundant feldspar and rock fragments and commonly has a clay-rich matrix.

Herptile: All reptiles and amphibians (e.g., salamanders, frogs, toads, caecilians, snakes, lizards, turtles, tuataras and crocodilians).

High Subarctic Tundra: One of the two ecoregions within the RSA. The HST Ecoregion has short, cool summers and long winters with severe winds in exposed landscape positions. Tundra vegetation covers more than 50% of this ecoregion.

Humus: A brown or black organic substance consisting of partially or wholly decayed vegetation or animal matter that provides nutrients for plants and increases the ability of soil to retain water.

Hydric: Soil condition that develops under states of water saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part.

Kame: A ridge, mound or terrace of sediments deposited against glacial ice by meltwater. Given their ice-contact depositional setting, kames commonly exhibit complex internal structure and contain localized till deposits.

Kettle: A hole or pit within glacial deposits, formed by the melt-out of a block of glacial ice.

Lag deposit: Residual accumulation of coarse material (e.g., cobbles or boulders) left behind by the winnowing of finer material. For example, boulder lag deposits exposed on a stream bed may be derived from underlying till through removal of surrounding fine sediments by stream flow.

Landform: A distinct, three-dimensional feature on the earth's surface that has originated through a particular set of erosional and/or depositional processes and thus can be recognized wherever it occurs.

Late seral : Final stage of a forest stand evolution in time (corresponding to an old growth forest).

Lithology: The gross physical character of a rock or rock formation.

Local Study Area: Area where DSOP infrastructure and activities will be located and in which detailed terrestrial ecosystem mapping was completed (see Figure 1).

Massive: Sedimentological term referring to deposits without internal structure or layering and with homogeneous composition.

Matrix: Fine-grained portion of a deposit in which coarser rock fragments are embedded.

Mesic: Soil condition referring to well drained soils that retain some water.

Metadata: Information about data, including sources, types and format.

Metamorphism: The process by which rocks are altered in composition, texture or internal structure through intense heat and/or pressure.

Mid Subarctic Forest: One of the two ecoregions within the RSA. Mean annual temperature for the ecoregion is between -5 and -2.5°C, and annual precipitation is around 800 mm, with 300 mm falling as snow. Summers in the MSF Ecoregion are cool and 4 to 5 months long; winters are cold and snowy (Meades, 1990). This combination of climatic factors inhibits continuous tree cover on upland sites, so forest cover becomes discontinuous, and subarctic forests occur that are transitional between the relatively productive, closed boreal forests to the south and the treeless subarctic tundra to the north.

Moraine: Landform deposited directly by glacial ice, typically consisting of grains ranging in size from clay to boulders.

Periglacial: Pertaining to processes, features and climates modified by their close proximity to the margin of a glacier or an ice sheet, or by cold, non-glacial environments.

Permafrost: Perennially frozen soil and/or bedrock typically found in areas with arctic or subarctic climates.

Planform: The shape or outline of an object viewed from above.

Proglacial: In front, or beyond, the snout of a glacier.

Quartzite: A metamorphic rock consisting entirely of quartz, generally formed through metamorphism of sandstone.

Radiocarbon dating: An absolute dating method based on the radioactive decay of Carbon-14 in organic materials.

Regional Study Area: Region encompassing all proposed Direct Shipping Ore Project (DSOP) infrastructure in western Labrador and northern Quebec within which climatic and physiographic characteristics are grossly similar (see inset map in Figure 1).

Riparian: Pertaining to the banks of, or area immediately adjacent to, a watercourse.

Schistose: Pertaining to the form of schist, a highly foliated (banded), medium-grained metamorphic rock that splits easily into flakes or slabs along planes of mica.

Shale: A fine-grained sedimentary rock comprising compacted and hardened clay, silt and/or mud.

Siltstone: A fine-grained sedimentary rock comprising compacted and hardened silt.

Soil moisture regime: A scale, at the ecotype level, ranking the soil moisture level. SMR is estimated from site and soil properties, such as vegetation community and indicator plant species, as well as site (slope position, site shape and topography) and soil (drainage, humus form, texture, depth and coarse fragment content) characteristics.

Soil nutrient regime: A scale, at the ecotype level, ranking the soil nutrient level. SNR is estimated from site and soil properties, such as vegetation community and indicator plant species, as well as site (slope position, site shape and topography) and soil (drainage, humus form, texture, depth and coarse fragment content) characteristics.

Solifluction: The slow, downslope creep of saturated sediment over impermeable material, commonly permafrost.

Sublimation: The process of changing directly from a solid (e.g., ice) to a gas (e.g., water vapour) without passing through a liquid phase.

Supraglacial: On the surface of a glacier.

Talik: An area of unfrozen ground within a region of permafrost, such as is commonly found beneath or immediately adjacent to large lakes or rivers.

Talus: Accumulation of rock fragments at the base of a cliff, resulting from frost shattering and rock-fall.

Terrain: An area of land with a distinctive assemblage of landforms, materials, topography and drainage.

Terrain mapping: The process of dividing the landscape into polygons according to landform, material, topographic relief and variety and drainage characteristics, typically based on aerial photograph interpretation and limited field work.

Terrestrial ecosystem: The environment in which terrestrial organisms live.

Terrestrial ecosystem mapping: The process of classifying and delineating distinct terrestrial ecosystems, thereby providing a mapped inventory of terrestrial ecological resources that may be affected by a proposed development. The methodological approach used in this study is Ecological Land Classification.

Till: Material deposited directly by glacial ice with grains ranging in size from clay to boulders.

Turbiditic: Pertaining to a sedimentary deposit formed by an upward turbidity current, a sudden, underwater flow within a standing body of water, commonly initiated by a subaqueous mass movement.

Veneer: A thin (typically <2 m), commonly discontiguous Surface deposit overlying another material or bedrock.

Xeric: Soil condition that develops through lack of water in soils.

1 INTRODUCTION

This report was produced to make possible the mapping of terrestrial ecosystems and geological surface deposits present in the local study area (LSA). This mapping will be useful to better plan the construction work related to the Direct Shipping Ore Project (DSOP) and to assess the environmental impact resulting from this project.

The terrestrial ecosystem mapping (TEM) makes it possible to classify and map the different terrestrial ecosystems present on a given territory. The TEM includes the forest ecosystems, the tundra, the riparian ecosystems and the wetlands. It also makes it possible to identify the terrestrial ecological resources that could be affected by the proposed project. The approach used for the TEM includes the physical characteristics of the terrestrial ecosystems, such as landscapes, drainage, surface geology and soil types. It also includes certain biological characteristics of the terrestrial ecosystems, specifically the composition of the flora communities and the forest stands. The terrestrial ecosystems are mapped and described in a way that meets the objectives of the DSOP impact study. Among others, these objectives are the identification and the location of significant plant communities, the characterization and location of ecosystems sensitive to disturbances; the characterization of potential wildlife habitats and the identification of sites with a potential for medicinal plants. A supplementary objective was to inventory the potential presence of at-risk plant species inside the LSA.

This report comprises three main sections:

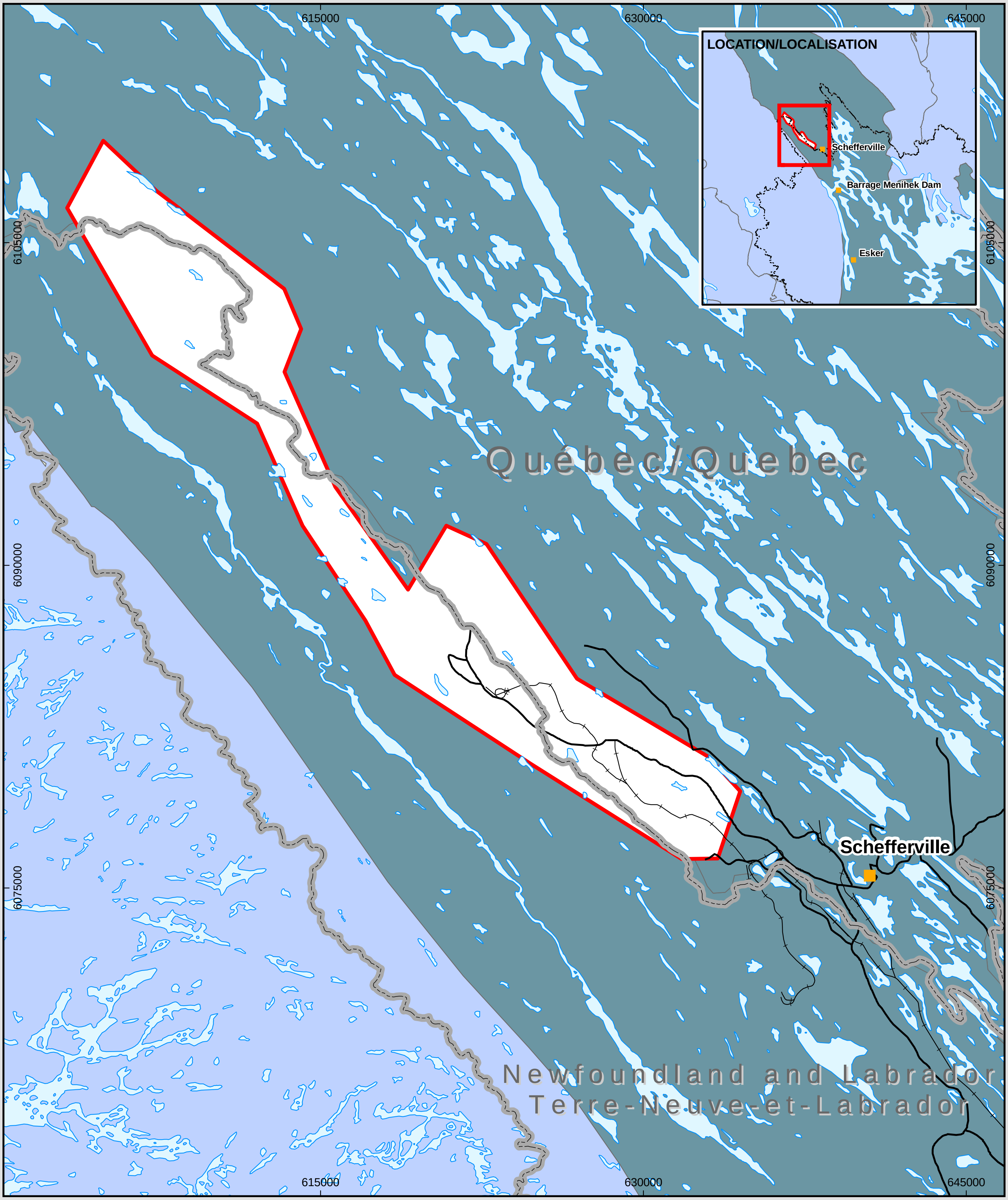
- An analysis of the distribution of the terrestrial ecosystems present in the regional study area (RSA);
- The mapping and the detailed description of the different types of geological surface deposits present in the LSA;
- The classification, mapping and detailed description of the ecotypes within the LSA according to the principle of Ecological Land Classification (ELC).

The boundaries of the RSA and the LSA are shown in figure 1. The detailed mapping is provided in a digital format (ArcGIS^{TM} 9.2 .mxd file) on CD-ROM, which is available upon request from New Millennium Capital Corp. (NML). However, the simplified (paper) maps, which describe the basic information on the geological surface deposits and the terrestrial ecosystems of the LSA, are available in appendices II and III. Appendix I presents the metadata required to understand the codes used for the geographical information system (GIS) and the paper maps.

1.1 Summary of the Direct Shipping Ore Project

The Direct-Shipping Ore Project, or DSOP, is a project for the production of direct-shipping ore, located approximately 20 km north-west of Schefferville. The ore will be extracted in the territories of Newfoundland-and-Labrador and Quebec. It will then be crushed and transported by rail to the Sept-Îles region in Quebec (Figure 1).

Phase 1 of the DSOP involves the mining of two sectors (DSO2 and DSO3, located on both sides of the Quebec-Labrador border) in order to reach a level of production of 1 Mt of ore in year 1, 4 Mt in year 2 and 4 Mt in year 3. The second phase will involve the mining of sector DSO4, also located partly in Quebec and partly in Labrador (Figure 1). The tonnage per year in phase 2, however, has not yet been established. Two of these three sectors (DSO2 and DSO3) have already been developed by another mining company, which means that their biophysical environment was somewhat disturbed.



Legend/Légende

- Boundary/frontière
- Road/route
- Railroad/chemin de fer
- Waterbody/plan d'eau

Ecoregions/Écorégions

- High Subarctic Tundra / Toundra subarctique supérieure
- Mid Subarctic Forest / Forêt subarctique moyenne

FILE, VERSION, DATE, AUTHOR/ FICHIER, VERSION, DATE, AUTEUR: GH-0011-02, 2009-02-19 , J.T.

Direct Shipping Ore Project
Projet de minerai de fer à enfournement direct

Physical & Ecological Setting
Localisation physique et écologique

0 2,5 5 10
Km

N

Scale/échelle: 1:250 000 UTM 19N Nad 83

Sources: Basemapping from NRC, 1:250000, 1993
Ecoregion boundaries from Environment Canada, modified slightly according to field observations

Sources: Fond de carte par RNC, 1/250 000, 1993
Limites des écorégions: Environnement Canada, légèrement modifiées selon les observations sur le terrain

Janvier 2009 January
Projet Pr83 Project

HEMISPHERES le groupe

Figure 1

1.2 Project team

A project team was created to carry out this mandate. This team is made up of geomorphologist Robin McKillop and environmental geologist Donald F. McQuay of the firm AECOM Canada and biologists Hugo Robitaille, Donald McLennan, Marie-Ève Dion and Julie Tremblay of Groupe Hémisphères.

Each member is experienced in doing field surveys and/or in terrestrial ecosystem mapping according to the biographies presented in sections 1.2.1 and 1.2.2. Members of each firm have thus participated in field surveys and in carrying out TEM. Group Hémisphères, in cooperation with NML, organized the support logistics necessary for the field teams responsible for the TEM.

The efforts of these experts, from varied but complementary fields of expertise, were combined to obtain a high level of precision in the interpretation and mapping of the ecosystems and the geological surface deposits. Communications among the different members during the project took place without problems. The synergy among them made it possible to give added value to the mapping while controlling quality.

Paul F. Wilkinson & Associates Inc. was responsible for providing liaison with NML and doing the revision of the preliminary reports.

1.2.1 Groupe Hémisphères

The team from Groupe Hémisphères, which was responsible for the coordination of the project, the terrestrial ecosystem mapping and the survey of plant species at risk, is made up of Hugo Robitaille, Marie-Ève Dion, Julie Tremblay and Donald McLennan.

Hugo Robitaille, M.Sc.Env., is a biologist, and has a Master of Sciences in environmental studies from Université du Québec à Montréal (UQAM). He has been working as a consulting biologist for more than 12 years with municipalities, governments, industry and individuals. He was involved with Hydro-Québec in sustainable management activities in the right-of-ways of the electricity distribution network. He has also acted as an advisor, coordinating the establishment of watershed management councils for the Richelieu and Yamaska rivers. Mr. Robitaille has done many projects characterizing and mapping sensitive ecosystems in which there were a number of flora and fauna species at risk, in Quebec, Labrador, British Columbia and Nepal. He recently carried out the terrestrial ecosystem mapping for the LabMag project (Gartner Lee Limits and Groupe Hémisphères, 2007), which included more than 800 km of the right-of-ways of an energy transmission line and pipeline as well as the mine site, the deep water port and pellet plant.

Mr. Robitaille is currently working on completing complex impact studies in the area of natural resources (mines, hydroelectricity and wind energy). He is coordinating for this purpose the biophysical surveys, evaluating the impacts and proposing measures to mitigate the impacts. Through his positions as director of the Conseil régional de l'environnement de la Montérégie and advisor to the Canadian Centre for International Studies and Cooperation, he has mastered the arts of water and watershed management, staff management, fund-raising, oral and written communication and collaboration with others working in the field.

Mr. Robitaille was the project leader for the ecosystem mapping for the DSOP. He coordinated and took part in producing the different field surveys and ensured that methodologies and deadlines were respected. In collaboration with his team, Mr. Robitaille carried out the TEM and produced the technical report.

Marie-Ève Dion, M.Sc.Env., a biologist, has a Master of Sciences in environmental studies and has been a member of the Groupe Hémisphères team since April 2006. During her MA studies, she did biology field work twice in the fields of planning and conservation, during which surveys of plant communities and research on rare plants were carried out.

In Groupe Hémisphères, she is responsible for various projects establishing surveys of plant, aquatic and terrestrial communities in southern Quebec. She has also done surveys of at-risk species for the National

Capital Commission (Gatineau Park), Parks Canada and the cities of Longueuil and Montreal, as well as under several mandates (characterization of potential development sites, impact studies, wetland delineation). She has managed field teams for surveys as part of various development projects. She has also been responsible for the characterization of ecosystems for wind energy projects and taken part in writing impact studies.

In collaboration with Mr. Robitaille, Ms. Dion has been responsible for producing surveys of ecosystems and flora, and producing the technical report.

Julie Tremblay, B.Sc. Bio., is a biologist, and also holds a certificate in geographical information systems. She is currently completing a specialized graduate diploma in geographical information systems so that she can further her knowledge and acquire higher skills in mapping and spatial analysis. As an undergraduate, she worked for two summers as a research assistant as part of her studies on animal ecology in northern regions, for example in northern Québec and Canada, for the Chaire de recherche en sylviculture et faune (research chair in silviculture and wildlife) and the Centre d'études nordiques (centre for northern studies), affiliated with Université Laval.

She has been able to apply her extensive training and knowledge in biology to terrestrial ecosystem mapping. She is trained in the use of MapInfo™ and ArcGIS™ software.

Ms. Tremblay was put in charge of geomatics and the production of maps of surface deposits and terrestrial ecosystems.

Donald McLennan, Ph.D., is a biologist specializing in terrestrial ecology; he has many years of experience as an environmental consultant and manager of subarctic and arctic ecosystems. More recently, he worked with Groupe Hémisphères to complete the terrestrial ecosystem mapping for the LabMag mine site, the various right-of-ways affected by the project and the Pointe-Noire area. For the past two years, Mr. McLennan has also been working with Jacques Whitford and Associates to set up a quality control, training and project planning department, as well as administrative services for the hydroelectricity development on the Lower Churchill River. Mr. McLennan directed the mapping and evaluation of the terrestrial ecosystems for the development of Lac de Gras mine (Diavik Diamonds Project) in the Northwest Territories and made a significant contribution to the environmental assessment of the biophysical components of the project. He has also worked in the Canadian subarctic and arctic regions on a wide variety of projects, including the assessment of hydroelectricity development and resource development projects in the Mackenzie Delta, the Yukon Coastal Plain, the Hudson Bay Lowlands and the Torngat Mountains, as well as in northern Labrador and Quebec.

Mr. McLennan has also contributed to studies on a series of industrial developments in British Columbia and in north-western United States.

Mr. McLennan was the scientific advisor for all activities related to the mapping and characterization of ecosystems. He revised the preliminary versions of the terrestrial ecosystem maps and made the necessary corrections to the selected polygons and ecotypes.

1.2.2 AECOM Canada, formerly Gartner Lee

The AECOM Canada team, which was responsible for the mapping of the geological surface deposits and writing corresponding sections of the report, is made up of, for the purpose of this project, Robin McKillop and Donald F. McQuay.

Robin McKillop, M.Sc. P.Geo., is a geomorphologist specializing in Quaternary geology. He has applied his knowledge of the origins of landforms and the changes they undergo to predict the general geological, hydrogeological, geotechnical and ecological characteristics of the landscape. Mr. McKillop recently completed the terrain mapping of pipeline corridors and the energy transmission line totalling 800 km for the

LabMag mine project, in Labrador and Quebec, which was used for the terrestrial ecosystem mapping and engineering of the project. He also did the terrain mapping of a proposed road corridor 240 km long in the centre of Nunavut, the bioterrain and slope stability mapping for the proposed site of a mine in the rugged region of north-western British Columbia, terrain resource mapping for the purpose of identifying sources of borrow material in northern Manitoba and terrain mapping and hydrological work to facilitate the selection of well sites in southern Ontario.

As part of his MA studies, Mr. McKillop develop an objective method for assessing terrain hazards in the glacial region on the south coast of British Columbia using qualitative and quantitative analysis of aerial photos. While he was working for Northwest Hydraulic Consultants, Mr. McKillop did a descriptive survey, using aerial photos, of several hundred stream and lake crossings along the proposed route of a gas pipeline between Alaska and Alberta. He also inventoried sediment sources, such as steep stream- and riverbanks, ravines dug by debris flow and talus, in the watersheds of Furry Creek and Mamquam River, between Vancouver and Whistler.

Mr. McKillop was given responsibility for doing the surface deposit mapping of the DSOP sites.

Donald F. McQuay, B.A., agr., geol., principal environmental geologist, is a graduate of the University of Guelph. He spent more than 25 years of his professional life with Gartner Lee Ltd. (now AECOM Canada) where he did feature assessments for the purposes of technical design, planning and characterization of ecological and agricultural conditions. He has worked on various studies on rail, pipeline and energy transmission line corridors in Ontario and elsewhere in Canada. Recently, Mr. McQuay supervised the terrain mapping of pipeline and energy transmission line corridors totalling 800 km for the LabMag mine project, in Labrador and Quebec. He coordinated the work of three soil survey teams assigned to measure and map the soil capability for agriculture in order to determine the location of energy transmission lines inside two major corridors proposed by Ontario Hydro to connect the Bruce Generating Station to the cities of Barrie and London, in Ontario. Again for Ontario Hydro, Mr. McQuay carried out detailed terrain assessments for the main energy transmission line to the Cherrywood station in Pickering, Ontario.

Mr. McQuay carried out terrain assessments of several hundred kilometres of corridors for the selection of the route and construction of pipelines in Ontario, as well as for the study on the double right-of-way of TransCanada Pipelines and Canadian National through Northern Ontario. He has taken part in the mapping of approximately one third of the province of Ontario using existing data, the interpretation of aerial photos and field surveys, in order to define the physical and pedological terrain conditions for various purposes, including forest management, site selection and the construction of public service facilities, the development of sources of aggregate, and planning and land-use management.

Mr. McQuay has taken part in terrain and agricultural assessments for many land-use planning projects, including Seaton Lands, in Pickering, and the Edwardsburg industrial site, in Eastern Ontario, both done on behalf of the Ontario Realty Corporation. His skills in terrain assessment and soil capability for agriculture assessment have also been put to good use in the selection of potential sites for solid waste disposal in Ontario, New Brunswick and British Columbia.

Under the present mandate, Mr. McQuay revised the surface deposit mapping.

1.3 Objectives of the study

The main objective of this study was to classify and map the terrestrial ecosystems located near the proposed infrastructure and activities, in order to complete the information required to carry out the environmental impact assessment. This report, which includes paper format maps (Appendices II and III), was prepared to accompany the digital version of the ArcGIS ™ TEM .mxd file.

The ecosystems were mapped on a scale that permitted proper assessment of the impacts of the DSOP and completion of the general planning for the project. The level of field surveys done is appropriate for the objectives of the mapping, and more than 300 inventory sites were surveyed.

The TEM also makes it possible to assess the quality of wildlife habitats and assess the potential impacts of the DSOP on valued ecosystem components, such as rare plant species, sensitive ecosystems and ecological processes. At the same time as the description of the terrestrial ecosystems and mapping were being done, a detailed inventory of rare status plant species carried out for the LSA. The sampling in the field targeted ecosystems with a strong potential to support rare status plant species.

A mapping of geological surface deposits, more detailed than those usually done for the TEM studies, was carried out because of the high value of this mapping for the engineers and the planners. In addition to providing a basis for the completion of the TEM, the maps of the geological surface deposits show the features, the spatial distribution of surface deposits, the topography and the drainage conditions. This additional information will greatly facilitate the work of the engineers who will have assessed the capacity of the different types of terrain to tolerate the construction of the various infrastructures for the DSOP.

1.4 Organization of the report

This report is structured in a way that ensures a clear understanding of both the biotic and abiotic components of every terrestrial ecosystem found in the LSA. After a brief description of the background of the TEM related to this study (Section 2), the methods used to do the mapping of the terrain and of the TEM are presented (Section 3). Section 4 gives an overview of the physiographic and ecological framework and makes it possible to integrate the TEM into its regional context.

Sections 5 and 6 describe how to use and interpret the maps of the geological surface deposits and terrestrial ecosystems. By consulting Sections 5.1 and 6.1, readers can first of all familiarize themselves with the general presentation of the various geological surface deposits and terrestrial ecosystems found on the maps of the LSA. Some readers may, however, choose not to consult initially Sections 5.2 and 6.2 - 6.3, which contain a series of fact sheets summarizing in detail the characteristics of the geological surface deposits and terrestrial ecosystems. These last three sections were included in the main body of the text to satisfy the readers who want to have a good understanding of each polygon before looking at the mapping presented in Appendices II and III. Readers who are only interested in one or two specific sectors can first consult the maps and then review just the fact sheets related to their sector of interest.

Section 7 provides a general description of the geographical distribution of the geological surface deposits within the LSA and show how they are related to the terrestrial ecosystems present. Section 7 thus includes an appropriate level of detail to permit readers to better understand the dynamics among the features, the nature of the soils and the geological surface deposits, the hydrography, the distribution of vegetation and the distribution of wildlife habitats. Finally all the references cited are listed in Section 8.

2 BACKGROUND OF THE STUDY

2.1 Terrestrial Ecosystem Mapping and Ecological Land Classification

The TEM is a process of rigorous classification and delineation of terrestrial ecosystems carried out according to accepted protocols and standards. Most Canadian provinces have a TEM system. Although these different systems adopt a similar approach, there are differences among them. The protocols can, in fact, vary according to the jurisdiction and the needs of the government departments concerned, but all the TEM systems are based on ecology and include environmental components that are both abiotic and biotic.

In Quebec, the Ministère des Ressources naturelles et de la Faune (MRNF) developed in the 1980s a hierarchical system for the ecological classification of the territory (Robitaille and Saucier, 1998). This system divides the territory into units with representation scales varying from continental (vegetation zone) to local (ecological type). Certain of these representation scales are described in table 1. With respect to the local scale (1:20,000), the Quebec system, however, has a size limit because it considers only productive forest ecosystems in southern Quebec. The characterization of wetlands and riparian ecosystems, or northern ecosystems, is therefore excluded. The approach used in Labrador is ecological land classification (ELC), developed by the federal government (Lopoukhine ***et al.***, 1978; Wiken, 1986). The Labrador territory is, however, only mapped at the regional scale (ecoregion). The ELC system in British Columbia, in addition to having been developed at the local scale (ecotype), includes the non-forest ecosystems mentioned previously (MOE, 2008). This system, although complete, is only available for British Columbia. Table 1 gives the equivalences between certain ecological units developed in Quebec, in British Columbia and by the federal government.

Table 1. Hierarchy of Units Used in Ecological Land Classification in Quebec, British Columbia and in the Federal Government

Term in Quebec	Term in British Columbia	Term in the federal government	Representation scale	Definition
Vegetation Zone / *Zone de végétation*	**Ecodomain or ecodivision / *Écodomaine ou écodivision***	**Ecozone / *Écozone***	**Continental (1:50 000 000)**	An area of the earth's surface representative of large and much generalized units characterized by interactive and adjusting abiotic and biotic factors. Canada is divided into 15 terrestrial "ecozones."
Bioclimatic Domain / *Domaine bioclimatique*	**Ecoprovince / *Écoprovince***	**Ecoprovince / *Écoprovince***	**National (1:10 000 000 – 1:5 000 000)**	A subdivision of an ecozone characterized by major assemblages of structural or surface forms, faunal realms, and vegetation, hydrology, soil, and macro climate.
Land Region / *Région écologique*	**Ecoregion / *Écorégion***	**Ecoregion / *Écorégion***	**Regional (1:3 000 000 – 1:1 000 000)**	A subdivision of an ecoprovince characterized by distinctive regional ecological factors, including climate, physiography, vegetation, soil, water, and fauna.
Land Subregion/ *Sous-région*	n/av	**Ecodistrict / *Écodistrict***		A subdivision of an ecoregion characterized by a distinctive

Term in Quebec	Term in British Columbia	Term in the federal government	Representation scale	Definition
écologique			**Regional (1:500 000 – 1:250 000)**	assemblage of relief, landforms, geology, soil, vegetation, water bodies and fauna.
Land District / *District écologique*	**Ecosection / *Écosection***	n/av	**Regional (1:250 000 – 1:50 000)**	A subdivision of an ecodistrict with recurring patterns of terrain, soil, vegetation, water bodies and fauna.
Ecological Type / *Type écologique*	**Site series / *Type écologique***	**Ecotype/ *Écotype***	**Local (1:50 000 – 1:10 000)**	A subdivision of an ecosection having relatively uniform features and soil, and chronosequence of vegetation.
Internet link www.mrnf.gouv.qc.ca/english/publications/forest/publications/ecological.pdf	**Internet link** http://www.env.gov.bc.ca/ecology/ecoregions/	**Internet link** http://sis2.agr.gc.ca/cansis/nsdb/ecostrat/intro.html#ecological%20land%20classification		

Note: The levels of ecological classification dealt with in this study are shaded in grey..
Source: http://sis.agr.gc.ca/cansis/nsdb/ecostrat/intro.html#references

La CET pour le DSOP a été réalisée à l'échelle de l'écotype. Des niveaux hiérarchiques plus élevés de la CLET, appropriés pour l'étude écologique de l'ensemble du territoire du Labrador, ont été réalisés par Wiken (1986) pour les zones écologiques et par Lopoukhine ***et al.*** (1978) et Meades (1989) pour les écorégions. Les caractéristiques des écorégions sont précisées dans le rapport afin de présenter le contexte écologique régional du DSOP. Les écotypes ont été cartographiés pour ce projet à l'échelle de 1:20,000. Les cartes papiers des écotypes pour le DSOP sont incluses aux annexes II et III.

2.2 Other relevant TEM projects in Labrador

A good number of TEM projects are underway or have recently been completed in Labrador. The teams working on two of these projects were consulted to guarantee methodological uniformity both in the field work and in the ecotype classification, so that the results from different sectors mapped would be comparable. The ELC for Voisey's Bay (CEAA, 2005) describes in detail the ecotypes of the Voisey's Bay mine development. As for the DSOP, the ecotypes were developed through the inclusion of the physical characteristics of the environment and the identification and classification of plant communities. The ELC for the Lower Churchill region was also done. A good number of meetings and field visits were conducted to compare the two methods and develop classifications correlated to the ecotypes (Withford, 2008a). The TEM for the LabMag project was finally carried out using the same methodology as for the DSOP. Given the geographical proximity of the two study sites, the same ecotype classification was used. This consultation and cooperation will ensure uniformity in the mapping of these projects. Whenever possible, the same descriptive names for ecotypes were used.

3 METHODOLOGY

The production of the TEM for such a large study area required meticulous planning, since the efforts of several scientists had to be coordinated. The production of maps precisely representing the distribution and characteristics of the terrestrial ecosystems present in the LSA was used to develop the foundations for the environmental impact study. This mapping required nine main activities to be carried out, as follows:

3.1 Definition of the context of the study;

3.2 Selection of mapping methods;

3.3 Preparation of aerial photos, interpretation and preliminary mapping;

3.4 Preparation of terrain maps;

3.5 Field visits;

3.6 Development of the classification of terrestrial ecosystems;

3.7 Mapping and correction of databases;

3.8 Data analysis and preparation of the report and final maps;

3.9 Quality assurance and quality control.

A brief description of each of the activities is provided below in order to facilitate understanding of the methodology used.

3.1 Background

The project began with the collection and thorough examination of all existing information relevant to the TEM in Labrador and Quebec. The sources of information consulted include reports and publications from governments and various academic institutions, mapping documents on the surface geology at the regional scale, plant surveys, data related to the wetlands and soils, and manuals describing different methods for the description of terrestrial ecosystems. All the relevant documents were studied in order to better understand the regional biophysical environment, to identify all the major issues related to the terrestrial ecosystems and the distribution of at-risk plant species and to gather the information necessary to support the environmental impact assessment and the identification of mitigation measures. A report containing the main documents used and the assessment of their relevance to this study was prepared by Acterre (2006a).

3.2 Selection of mapping methods

A meeting of all the consultants involved in the mapping of the terrestrial ecosystems was held at the beginning of the project to discuss the different data sources (aerial photos and satellite images), to standardize and to establish a mapping protocol and to assess the needs of the project. One important decision at the meeting was the creation of a list of criteria that would form the basis for the selection of the most appropriate mapping methods. All the consultants agreed that the following activities should be enriched and augmented by the terrestrial ecosystem mapping:

- Identify and classify the wetlands and ecosystems in the important riparian zones;
- Assess the quality of the habitat for endangered plants and animal species;
- Assess the capacity of the terrain to tolerate mining infrastructures and activities; and
- Provide further data related to the geographical distribution of geological surface deposits and terrestrial ecosystems, according to demand.

The TEM for large territories is usually done using stereoscopic analysis of overlapping aerial photos. High-resolution satellite images could have been used, but the high cost of these images, their limited availability, the significant cloud cover and their resolution mean that they are not always suitable for the study. In addition, the possibilities for viewing satellite images stereoscopically are limited. All these restrictions meant it was more appropriate to use aerial photos on the scale 1:20,000 (1973) and 1:10,000 (2004 and 2008) to obtain high-resolution coverage of the LSA.

The TEM should be carried out at scale big enough to permit the identification of the potential impacts of the DSOP and the identification of mitigation measures. The choice of the most appropriate scale, however, requires compromising between the desired level of detail and monetary cost incurred. A bigger scale permits better mapping detail at a high cost, while a small scale means less mapping detail at a lower cost. Since the DSOP will be subject to a range of environmental assessment regimes and regulatory approvals, the level of mapping detail chosen had to satisfy the requirements of the various different government agencies involved.

With respect to the limited availability of aerial photos of this sector, several series of photos were used. The most precise aerial photos were taken in 2004 for the LabMag mine site, at the scale 1:10,000. These photos, however, cover less than 10% of the LSA for the DSOP. Taken in 1973, the aerial stereo-paired photos from the MRNF cover most of the DSOP site. These photos, after being scanned and integrated into a stereo model, were the ones used for most of the TEM work. Colour, stereo-paired photos at the scale 1:10,000 were finally taken in September and October 2008 over the entire DSOP site, three months after the beginning of the TEM. These aerial photos therefore could not be used for the preliminary mapping. They were, however, used to update the information contained in the 1973 photos, in particular with regard to the evolution of the mining zones and the evolution of plant communities.

Table 2. Aerial Photos Used for the Interpretation of Terrestrial Ecosystems

Study area	Year	Approx. scale	Type of photos	Source
Cover most of the LSA	1973	1:20,000	Black and white, scanned and ordered in a stereo model	MRNF
Covers only the western part of the LSA	2004	1:10,000	Black and white in orthoimage	NML, 2004
Covers the entire LSA (aerial photos taken after the beginning of the TEM project)	2008	1:10,000	Color, paper format only	NML, 2008

Several TEM approaches and several classification systems were evaluated. On the basis of provincial standards and an understanding of the general characteristics of the terrestrial ecosystems of Labrador and Quebec, a classification by ecotype approach was adopted, using the ELC principles adopted by the federal government. The different ecotypes were mapped following the TEM protocols and standards from British Columbia and including the riparian and tundra ecosystems as well as the wetlands (RIC, 1997). For the description of landscapes and surface geology, the methodology of the Northern Ontario Engineering Geology Terrain Study was used (Gartner ***et al.***, 1981).

3.3 Preparation of aerial photos, and preliminary mapping

PurView™ software, which permits the 3D visualization of aerial photos, was used to map the surface deposits and terrestrial ecosystems. This software, operated in conjunction with ArcGIS™ 9.2, made possible 3D viewing and the computerized digitization of the surface deposits and terrestrial ecosystems polygons. To do this, stereomodels included internal orientation parameters related to each of the photos during photographing were ordered for the stereoscopic pairs used. A digital elevation model taking into account the topography of the terrain was also provided for the region of interest, so that the visualization of the photos and the digitization of the polygons could be orthorectified.

Terrain maps identifying streams, roads, trails and wetlands were prepared using basic maps at 1/50 000 scale from the federal Department of Natural Resources. The old deposits, those identified for the DSOP, as well as the planned access roads, were also added to the terrain maps, along with updates of the hydrographical network.

3.4 Field visits

Field verification, or ground truthing, is an essential part of the TEM. Given that the territory of the LabMag project was mapped in 2006, no reconnaissance visit was carried out by Groupe Hémisphères. Since the territory was, in fact, already overflown in 2006, the general distribution of terrestrial ecosystems in the environment was already well known.

In addition to permitting the verification of the preliminary interpretation of the aerial photos, the field visits also made it possible to collect detailed information that cannot be inferred from aerial photos: for example, the exact distribution of surface deposits, soils and drainage, or else the variety and percentage of the distribution of plant species that could only be specified through field visits. Since time and financial constraints precluded visiting all the polygons of the LSA, those to be visited were select on the basis of their representativity, their abundance, their ecological importance and their potential sensitivity to impacts from the DSOP. It was assumed that the characteristics recorded in the polygons visited were the same as in the similar polygons that were not visited. All field visits were done using a four-wheel drive vehicle (no helicopter required), as there is a sufficient number of access roads in the territory of the DSOP. To ensure the reliability of the product resulting from the TEM, a total of 19% of the polygons were covered by field visits.

3.4.1 Field work – Surface deposits

Field reconnaissance in support of the terrain mapping and descriptions was completed between Aug. 13 and 18, 2008 by geomorphologist Robin McKillop (AECOM doing business as Gartner Lee Limited [« AECOM »]). With the help of a local First-Nation assistant, Mr. McKillop conducted the field work jointly with ecologist Hugo Robitaille (Groupe Hémisphères), so as to provide the opportunity to collectively identify associations among landforms, soil and vegetation. In addition to prioritizing site visits according to the representativity of polygons, they selected terrain types for field investigation according to uncertainty of aerial photograph interpretations of terrain characteristics caused by such factors as forest canopy or indistinct surface expression. The sensitivity to impacts of particular terrain features was also considered. All sites were accessed along existing mining roads using a 4-wheel drive pick-up truck or on foot. The sedimentological characteristics of natural or excavated exposures of Surface materials were examined in detail. Evidence in soil pits and on the ground surface of cryoturbation, a likely sign of modern or relic permafrost, was recorded.

3.4.2 Field work – Ecosystems

The ecologists from Groupe Hémisphères also prioritized their field visits where sensitivity to disturbances of ecosystems is highest, where the intensity of impacts will be highest and where the aerial photos could not provide all the information required to clearly identify the ecosystem in place. All the work characterizing ecosystems in the field was done in accordance with the ***Field Manual for Describing Terrestrial Ecosystems*** (MoELP-MoF, 1998). Validation was done at three levels of detail in the field in order to provide a reliable description of the site, the soils and the vegetation characteristics for each the ecotype present.

1. **Detailed sampling**

The detailed sampling describes the environmental data of each plot (elevation, slope, aspect, orientation of the slope and relief), its soil (description of soil humus, texture, thickness and colour, drainage and classification by soil order according to the Canadian System of Soil Classification) and its vegetation characteristics (percentage of cover occupied by rare vascular and non-vascular plant species, by stratum). A rare plant inventory was also done at this level of detail. A preliminary document was prepared to facilitate the identification in the field of rare species (Acterre, 2006b.). This document included the important morphological characteristics, the habitat targeted and photos of species.

2. **Cursory sampling**

The cursory sampling shows in large part the same environmental characteristics, and soil and vegetation characteristics as the detailed sampling, but more briefly. A shorter list of environmental data is required, describing only the main properties of the soil and surface deposits. In order to do a more complete survey of the rare plants, an exhaustive list of the vegetation present in every sample plot was, however, drawn up. The cursory sampling facilitated the verification of the description of the ecosystem units and made it possible to visit a larger number of polygons.

3. **Visual inspections**

The visual inspections were carried out in order to verify whether the properties associated with the polygons mapped were accurate. They are often done from strategic sites that permitted an overall view of the site and thus verify several polygons in a short period of time. This part is very important for the mapping and increases the reliability of the TEM products.

All the data were collected on standardized field forms (FS882 forms for site, soil and vegetation) produced by MoELP-MoF (1998) and were digitized subsequently and tabulated using the VENUS software (1997). An example of a field form is available in Appendix IV.

The field visits also made it possible to assess the sensitivity of certain ecosystems to the potential impacts of the DSOP. For example, the ecosystems that contain rare species or unusual habitats for the region, or that have high sensitivity to variations in the hydrological regime, could be particularly sensitive to such impacts. Long transects were also done on sites where the ecotypes presented a higher probability of supporting plant species that are at risk or of interest. The locations of these ecosystems were recorded and will be used as the basis for the preparation of the impact assessment and for the identification of mitigation measures.

3.5 Development of the classification of terrestrial ecosystems

The ecotypes represent the most detailed level of classification used within ecoregions. They are used to describe the terrain of the LSA. The ecotypes are geographically distributed according to the topography and microtopography and present specific characteristics in terms of landforms and properties of the soils that can be identified both in the field and aerial stereo-paired photos (Wiken, 1986). Every ecotype is characterized by the availability of soil water (soil moisture regime, or SMR) and nutrients (soil nutrient regime, or SNR). A specific ecotype thus possesses its own combination of SMR and SNR. Certain ecotypes are very dry and poor (in this case, thin soil on upper slopes), while others are rich and humid (e.g. bogs).

A classification of ecotypes was developed for the LabMag project (2007) on the basis of field sampling of homogeneous sites according to the orientation of the slope and morphological characteristics, soil and humus characteristics as well as the plant structure and composition. The SMR and SNR for each sample plot were deduced from the plant properties, such as the composition of plant communities and their structure, characteristics of the site (orientation of the slope, form of the site and topography) and characteristics of the soils (drainage, humus type, texture, depth and rock content) (MoELP-MoF, 1998). After the repeated sampling of a wide range of sites possessing a combination of soil humidity, nutrients available in the ground and different plant communities, it was possible to deduce a distribution pattern for ecotypes. The ecotypes were thus identified thanks to similarities between the composition of plant communities at the end of succession, their structure and their position on the edatopic grid.

The plant communities at the end of succession are used to represent the ecological potential and to identify the position of an ecotype on an edatopic grid (specific species of plants grow in specific conditions of SMR and SNR). The plant communities at the end of succession, as described in the edatopic grid, are therefore characterized by the ecotypes found on the territory of the DSOP.

Table 3. Typical Edatopic Grid According to RIC (1997)

		SOIL NUTRIENT REGIME				
SOIL MOISTURE REGIME		**Very poor**	**Poor**	**Average**	**Rich**	**Very rich**
	Xeric					
	Subxeric					
	Submesic					
	Mesic					
	Subhygric					
	Hygrice					
	Subhydric					
	Hydric					

An edatopic grid is presented on each of the maps of the mine site (Maps of terrestrial ecosystems, Appendices II and III) for the ecoregions of Mid Subarctic Forest and High Subarctic Tundra that have a very different climate. In order to characterize and interpret the terrestrial ecosystems on an appropriate scale and level of detail, the mapped units represent both the ecotype (***potential*** vegetation) and the successional stage within them (***current*** vegetation). All the ecotypes mapped are grouped into two ecoregions intersecting the LSA. Their main ecological characteristics are summarized and presented in the fact sheets in sections 6.2 and 6.3.

3.6 Mapping and correction of databases

In addition to properly characterizing the ecotypes present in the LSA, the field observations make it possible to increases the precision of the TEM. The nature of the surface deposits could thus be confirmed as well as that of the ecotypes present. All the boundaries of the polygons of the geological surface deposits were then plotted directly in the ArcGIS™ 9.2 software using PurView™, which makes it possible to view aerial photos in 3D. Each polygon of the geological surface deposits was then assigned using the codes presented in Section 5 and detailed in the metadata in Appendix I.

The polygons representing the ecotypes were plotted on the basis of those for the geological surface deposits and dividing them in two or more polygons if necessary. The codes presented in Section 6 and detailed in the metadata of the Appendix I were then assigned to them.

3.7 Analysis data and preparation of the report and final maps

In order to respect the TEM objectives, a few data analyses were required after the mapping was done. Simple requests were performed in order to determine certain spatial statistics such as the percentage of territory area occupied by the various geological surface deposits and ecotypes. These requests have also made it possible to identify the links that may exist between the topography and the plant communities, which can provide an overview of the preferences of certain species with respect to soil conditions and drainage.

The quantity of information that can be conveyed on a paper map is limited by the scale of the map and the format of paper on which it is printed. In this case, more than 100 attributes were associated with certain polygons (see the GIS version of the TEM in shapefile format for ArcGIS™ on the accompanying CD-ROM). It was therefore impossible to represent all the attributes associated with the polygons at the scale chosen for the printing of paper maps. In order to remedy this situation, the maps of the geological surface deposits and the maps of the terrestrial ecosystems were produced separately. In spite of that, only simplified maps could be produced at the selected scales, showing the main characteristics of each polygon. The simplified maps nevertheless provide an appropriate level of detail for the assessment of environmental impacts. If users want information not included on the paper maps, they have to refer to the complete description of each polygon, available in the .mxd files of the TEM in ArcGIS™ 9.2 format (see the GIS version of the TEM in shapefile format for ArcGIS™ on the accompanying CD-ROM). The definition of each of the columns of the SIG database is available in the metadata in Appendix I. Even though the maps of the terrestrial ecosystems make it possible to assess the ecological sensitivity of the sites, the maps of the surface deposits have important implications in terms of engineering and land-use planning.

Although the maps of the geological surface deposits and the terrestrial ecosystems were produced separately, they share the same polygon boundaries. It is unusual for several adjacent polygons to share the same surface deposit characteristics, even though these polygons can have very different terrestrial ecosystem characteristics. In the same way, two contiguous polygons sharing the same terrestrial ecosystem characteristics can differ only with respect to their surface deposits. Explanations of other possible reasons for the division of two apparently identical polygons are presented in Section 5.1.6.

The scale used to produce the maps of the surface deposits and the maps of the terrestrial ecosystems is consistent with that used for the interpretation of the aerial photos. The paper map was printed on the scale 1 : 20 000, the same use for the aerial photos. Even though a map with a larger scale would have made it possible to obtain more detail, it would have resulted in a misrepresentation of the precision of the information conveyed. Users of the map can enlarge part of the map as they see fit, but this will not increase the precision of the mapping or the level of detail.

3.8 Quality assurance and quality contro

Control quality measures have been applied at each step of the study, including project planning, photo interpretation, the collection of data in the field, the input of data and the production of maps, in order to obtain a useful, reliable and understandable mapping product.

Before undertaking the next steps of photo interpretation and field work, the team acquired a better understanding of the regional environment and the local biophysical environment through a detailed review of the literature and a summary of information relevant to the study site (Acterre, 2006A). This preparation also avoided repeating the work presented in the secondary data during the work proposed as part of this report.

Given that the TEM depends on the interpretation of aerial photos, several sites representative of the LSA were selected for the preliminary interpretation. This "test" interpretation, done in collaboration with AECOM Canada and Groupe Hémisphères, attained three important objectives: (1) to assess the ease of application of the different coding systems established for the study area; (2) to ensure that the delineation of polygons as carried out by the geomorphologists from AECOM Canada would provide the information required by the ecologists from Groupe Hémisphères to do the assessment of the terrestrial ecosystems; and (3) to verify the skills of the interpreters. In addition, this preliminary test permitted the members of the team to exchange their views on the criteria used for polygon differentiation.

During the main interpretation phase, each polygon that was likely to be poorly interpreted was selected and verified by another interpreter. Throughout the interpretation process, senior field experts from AECOM

Canada and senior biologists from Groupe Hémisphères performed quality control checks of the interpretation of randomly selected polygons.

The field work carried out in July and August 2008 made it possible to do quality control and assess the accuracy of the photo interpretation by comparing the data with the field observations. In total, 19% of the polygons in the entire LSA were visited and, in several cases, observed in detail. The identification of certain plant species was confirmed, or corrected when necessary, following the identification of plants specimens collected in the field. Some sixty specimens were collected and identified.

All the plant species that could not be identified with certainty were sampled and pressed in a herbarium in order to be identified upon return by an experienced botanist, Marcel Blondeau, consulting botanist, an expert in northern vascular flora.

Before inputting the ecological data sheets using Venus 5.0 software, a check of the quality and consistency of the data was carried out by the project leader and all necessary changes were made. All the digital data were verified by another member of the team in order to detect any systematic data input errors.

Finally, the technical report was revised by the team of Paul F. Wilkinson and Associates Inc.

4 OVERVIEW OF THE REGIONAL STUDY AREA

The following subsections provide an overview of the geology (Subsection 4.1) and ecology (Subsection 4.2) of the Regional Study Area (RSA). The descriptions provide a context for the more detailed terrain and ecosystem mapping.

4.1 Geology

4.1.1 Bed Rock Geology

The entire RSA is underlain by bedrock of the Canadian Shield. Two of the seven geological provinces into which the Canadian Shield is divided underlie the region surrounding Schefferville: Superior and Churchill. Bedrock of the Superior Province, consisting of Archean rocks 2.5 to 4 billion years old, is exposed several kilometres west of Howells River. Lithologies include cherty ironstone underlain by quartzite and the schistose to gneissic equivalents of the quartzite (Wardle ***et al***., 1997).

Bedrock of the Churchill Province is exposed northeast of Howells River, encompassing the Local Study Area (LSA) of DSO 2, 3 and 4, as well as the town of Schefferville. The Churchill Province comprises rocks 1.75 to 2.1 billion years old, including siltstone, shale and greywacke sequences with turbiditic origins and their schistose equivalents (Wardle ***et al***., 1997). Most of the significant iron formations have been found in this province.

The most prominent geological feature of the RSA is the Labrador Trough. The Labrador Trough, associated with the Churchill Province, is a northwest-southeast-trending syncline that extends more than 800 km from western Labrador to the tip of the Ungava Peninsula. It separates the Archean rocks of the Superior Province to the west from the rocks comprising the North Atlantic Craton to the east. Its ridge-and-valley topography strongly influences local drainage patterns.

The rocks of the Labrador Trough are distributed in three belts, representing at least three cycles of tectonic activity and sedimentation (Wyroll, 1971). Initial downwarping of the Archean basement rock allowed transgression of the historic sea, which facilitated deposition and chemical precipitation. Subsequent regressions of the sea, concurrent with volcanic activity, yielded a layering of the Wishart Formation (mainly quartzite) and, above, the Sokoman Formation (iron formations with chert). Finally, major uplift of land in the east led to further deposition and, ultimately, the Menihek Formation (calcareous and carbonaceous shales and slates). Weathered Menihek shales and slates are commonly exposed at surface in DSO 2, 3 and 4.

During periods of metamorphism, the rocks were folded and faulted. Today, folds are locally well-exposed in ridge crests and river gorges east and west of the Howells River Valley. Several streams cross-cut the northwest-southeast-trending folds, some following faults and others following gorges eroded by glacial meltwater. Differential erosion of the iron formations, which dip at about 10-12o to the north-northeast, is responsible for the distinctive terrace-like bedrock surface expression observed in parts of the LSA.

On the high, windswept ridges within the LSA, particularly those surrounding DSO4, weathered bedrock blankets intact rock. Post-glacial frost shattering, facilitated by the subarctic climate and locally fractured bedrock, has led to the accumulation of angular rock fragments against cliff bases and on ridge crests.

4.1.2 Glacial History and Surface Deposits

The main landscape elements of the Quebec/Labrador Peninsula, including ridges, valleys and the pattern of the major drainage network, are the result of deformation and erosion of Pre-Cambrian (up to 3 billion years old) bedrock. Continental glaciations during the Quaternary Period (<2 million years), however, have modified areas of the landscape to different degrees through the erosion of bedrock and deposition of sediment and soil materials.

During the Quaternary Period, continental glaciations repeatedly covered most of Canada, including the Quebec/Labrador Peninsula. The Laurentide Ice Sheet, which extended across mainland Canada from the foothills of the Rocky Mountains to Newfoundland, is believed to have had several centres, or ice divides, from which ice flowed outward. One of those ice divides, the Labrador Divide, appears to have been centred just several tens of kilometres northwest of Schefferville during the most recent, Late Wisconsin, glacial advance, which culminated locally about 8000 years ago (Andrews ***et al***., 1986). The variable orientations of glacially-streamlined landforms (e.g., drumlins, roches moutonnées, striae) within the LSA are consistent with this theory.

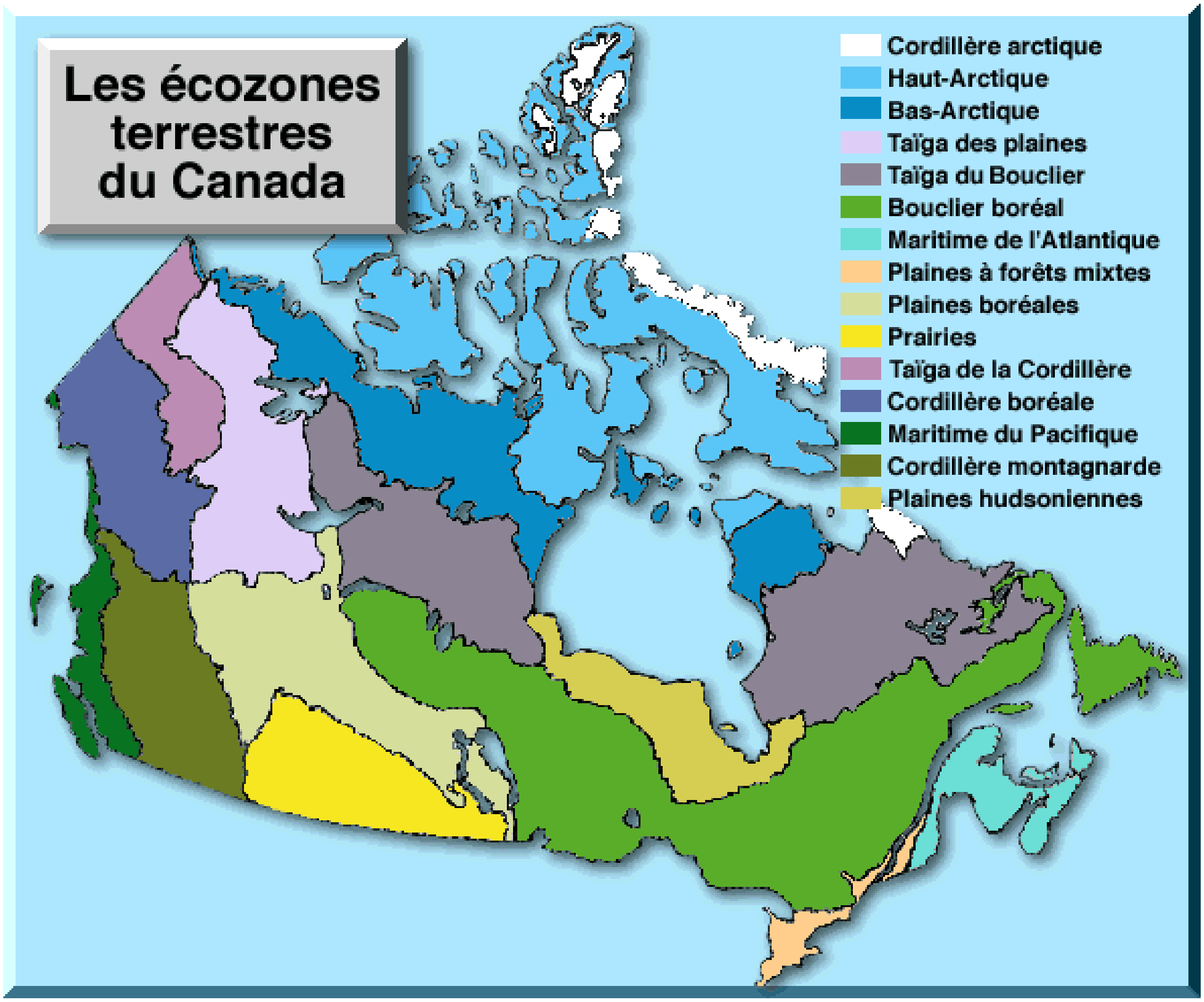
Till deposited beneath actively flowing glaciers and through passive let-down by melting ice covers most of the ground surface. Its continuity and thickness, however, are highly variable. Only a thin, discontinous veneer overlies bedrock west of the Howells River, whereas comparatively thick ground moraine (up to several metres) blankets the uplands to the east. The till is bouldery, with a silty sand matrix. Large erratics are scattered across the rolling plains.

Deglaciation appears to have occurred through gradual concentric retreat of the ice sheet from the margin toward the centre, with isolated areas of in situ downwasting of ice. Kettles and low-relief, hummocky moraine, as found near DSO4, are typical features of stagnant ice. Meltwater spillways and esker complexes radiate outward from the LSA in regional-scale Surface geology mapping (Klassen ***et al***. 1992). Boulder fields in some valley bottoms are probably the result of meltwater erosion of fine-grained sediments. According to radiocarbon dating of peat, the LSA was not ice-free until 5000 to 6000 years ago (Nicholson, 1971).

Early in the post-glacial period, particularly before vegetation had become established, a variety of processes modified the regional landscape. Periglacial activity was concentrated along windswept ridges and plateaux at high elevations, where snow depth during the long winter was minimal. As a result of glacial debuttressing and weathering, cliffs were particularly susceptible to frost shatter and mass movements. Colluvium accumulated along the bases of prominent hills and knobs. Streams eroded channels through glacial drift and formed small fans and deltas where they flowed into broad valley bottoms and lakes. Strong winds deflated till-covered ridges, leaving behind a gravelly surface lag and redistributing fine sediments into sheltered, low-lying areas. In valley bottoms and depressions within rolling to undulating plains, vegetation began to colonize. Wetlands formed in the most poorly-drained areas, such as along bedrock fractures and at the confluence of headwater streams and shallow subsurface drainage pathways, where high groundwater tables slowed the decomposition of organic material.

4.2 Ecological Context

The LSA is entirely within one ecozone, the Taiga Shield Ecozone, which extends from coastal Labrador to central Northwest Territories (Figure 2). The southern part of the Quebec-Labrador border is the boundary between the Taiga Shield Ecozone and the more forested Boreal Shield Ecozone to the south. The landscape of the Taiga Shield Ecozone, which is largely situated on Pre-Cambrian rocks of the Canadian Shield, is best characterized as a rough, rolling upland. Elevations change gradually from about 400 mASL near Churchill Falls to nearly 800 mASL along the ridges of the Howells River Basin, but localized rugged areas of cliffs and canyons exist. Surface deposits are usually thin, and extensive areas of very thin soils over exposed bedrock are common. The Taiga Shield Ecozone in Labrador is transitional between forested and tundra biomes. This ecozone is discontinuously forested where soils permit and, although productivity is considerably lower, includes most of the species found in the Boreal Ecozone. Sporadic to discontinuous permafrost and related periglacial features exist in high, windswept areas, especially in wetlands near ridge crests. Productive forest of white spruce can occur on active floodplains along larger rivers.



Source : http://www.ec.gc.ca/soer-ree/English/Framework/NarDesc/canada_e.cfm

Figure 2. Terrestrial Ecozones of Canada, Showing the Taiga Shield Ecozone (dark grey) in which the DSOP Occurs (from Wiken, 1986)

The LSA is contained within two ecoregions: the MSF and the HST Ecoregion (Figure 1). The MSF ecoregion includes the upland plateaux of central and western Labrador, where eskers and drumlin ridges are characteristic. Many low-lying areas have been inundated by hydroelectric reservoirs, however, so shoreline ecosystems are common. The area has a continental, subarctic climate, with short, cool summers and long, severe, cold winters. The growing season is 100 to 120 days. Black spruce is the dominant tree species, along with white spruce and tamarack. Trembling aspen reaches its northern limit here, and the only native population of jack pine occurs in this ecoregion (DFRA-Innu Nation, 2003). Open lichen woodlands are characteristic and are interspersed across the landscape by extensive ribbed fen-string bog complexes, which dominate depressions. The HST Ecoregion has short cool summers and long winters with severe winds in exposed areas. The growing season is only 80 to 100 days, and annual precipitation ranges from 700 to 1000 mm. Tundra vegetation, described as ‘alpine heath’ by Meades (1990), covers more than 50% of upland plateaux. The HST Ecoregion features shallow fens in depressions and along streamcourses, locally with discontinuous permafrost. Ecotypes of those two Ecoregions are described in details in Section 6.

5 TERRAIN MAPPING AND DESCRIPTION

Terrain mapping is the process of dividing the landscape into polygons according to Surface geological and landform characteristics, typically based on aerial photograph interpretation and selective field work. It provides the foundation for, and is an integral component of, terrestrial ecosystem mapping (TEM). The national and international use of terrain mapping has resulted in the adoption of a variety of coding systems and legends. For consistency with the terrain mapping completed for the LabMag Iron Ore Project (Gartner Lee Limited and Groupe Hémisphères, 2007), including that covering the Howells River Basin, the terrain mapping approach developed as part of the NOEGTS (Gartner ***et al***., 1981) was applied to this study. This mapping system shares similar objectives to this study (Subsection 1.3) and was developed for terrain with a similar geological and geomorphological history.

Subsection 5.1 explains, using illustrative examples, the coding system used on the terrain maps (Appendix II). Subsection 5.2 describes in detail the six types of landforms identified in the LSA. Some readers may prefer to consult the maps (Appendix II) first and then to review only those “fact sheets” in Subsections 5.2.1 – 5.2.8 that are relevant to their interest. The summary description of the LSA (Section 7) contains enough detail that readers who have not read Subsection 5.2 will still understand the main points. Subsection 5.3 relates past and recent observations of permafrost to terrestrial ecosystems in the LSA.

5.1 Description and Interpretation of Terrain Maps

Based on the NOEGTS system, each terrain unit (polygon) is described by four key components: landform, material, topography and drainage. Each component influences to varying degrees soil development and moisture retention, and the type, diversity and structure of vegetation communities. Figure 3 provides a schematic cross-section through several terrestrial ecosystems. It illustrates the relationship between the vegetation and the underlying terrain. Characterization of these four components also permits general inferences about the suitability of the terrain for infrastructure and activities. A brief rationale for characterizing each of these components is provided below.

5.1.1 Landform

Landforms are the result of a particular set of erosional and/or depositional processes. The identification of a particular landform, combined with an understanding of the processes that created it, permits inference about its characteristics. For example, identifying an esker, which is a long, sinuous ridge of sediment deposited by flowing glacial meltwater in ice-walled channels or tunnels, permits the conclusion that it will be composed of stratified, well- to rapidly-drained sand and gravel. The landform is the prime mapping unit.

5.1.2 Material

The type and texture of the material comprising a landform can be inferred from an understanding of its origin. For example, ground moraine, which is deposited directly by glacial ice, is inferred to be composed of a wide range of grain sizes, from clay to boulders, based on the understanding that glaciers do not preferentially erode or deposit material according to size. The material characteristics of landforms provide a basis for inferring drainage conditions, which influence soil development and vegetation communities. The sensitivity of landforms and their associated ecosystems to disturbance is, in part, also inferred from material characteristics. Material is, therefore, a main mapping component.

5.1.3 Topography

The relative relief – low (<15 m), moderate (15 – 60 m) or high (>60 m) – and topographic variety, or surface expression, of a landform have important implications for ecosystems and habitat. For example, high points are likely better drained than intermediate depressions, where wetlands may develop, and hummocky relief may provide greater habitat diversity and shelter for animals. Relief and topographic variety collectively constitute an important mapping component.

5.1.4 Drainage

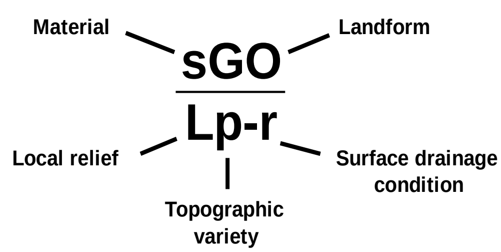
The surface drainage condition of a landform and associated soils, namely the ease with which water infiltrates into and flows through them, has ecological significance. For example, poor drainage promotes the development of organic-rich soils and growth of moisture-tolerant vegetation. Each polygon was assigned to one of seven drainage classes used in the British Columbia Field Manual for Describing Terrestrial Ecosystems (MoELP-MoF, 1998). The rare case of a high groundwater table within a landform whose surface is dry was also documented. Surface drainage condition is the final mapping component.

5.1.5 Terrain Code and Legend Format

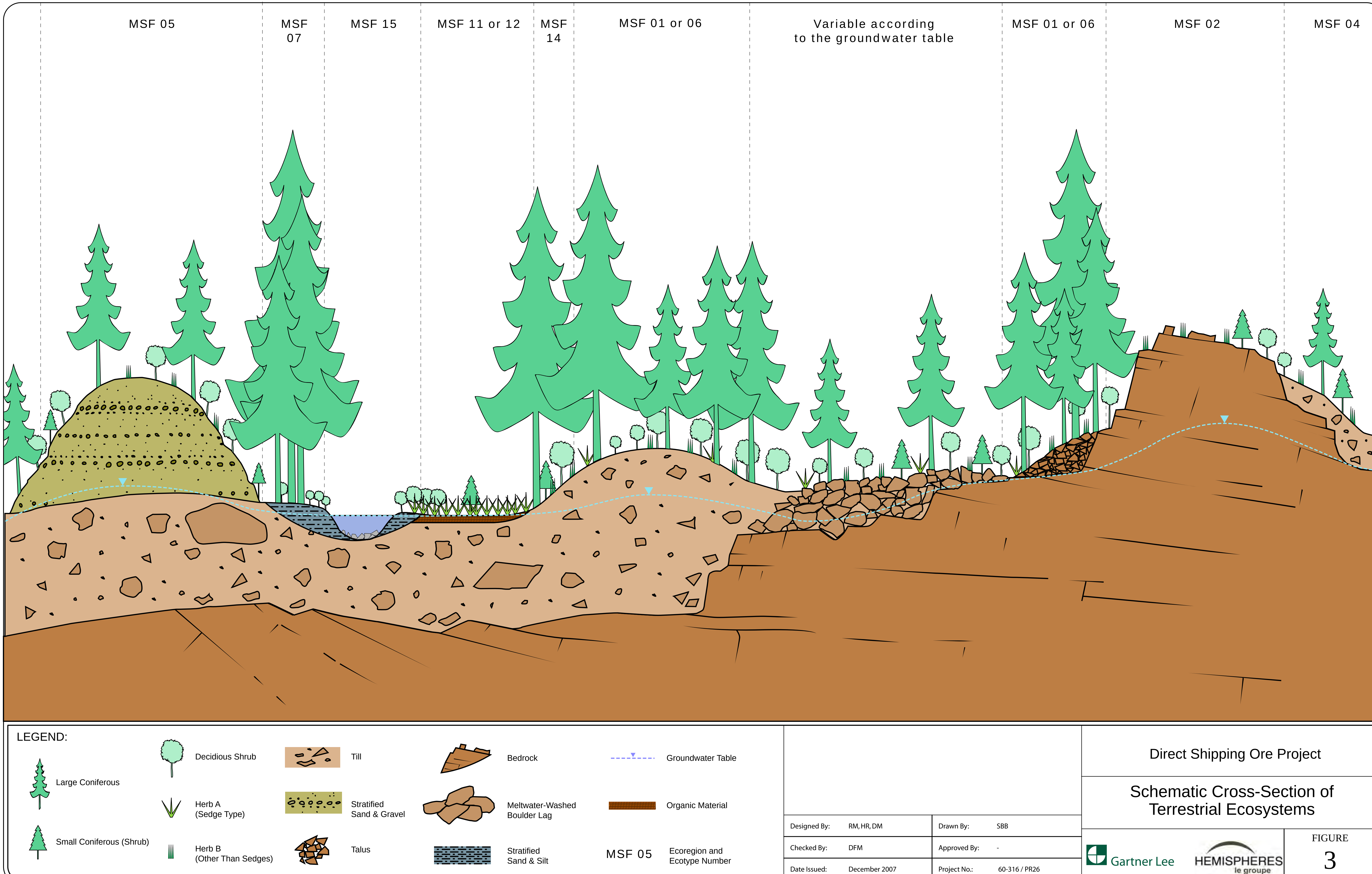
Although the ArcGIS™ platform provides the flexibility to generate any type of terrain code label from the TEM attribute table, a simple, standardized format that contains the key information has been devised. For consistency, each of the four components has a fixed position in the legend format:

MATERIAL	LANDFORM
TOPOGRAPHY	DRAINAGE

Upper and lower case ***letter symbols*** represent particular values of each component (Appendix I). For example, the following terrain code describes rapidly-drained (r) sandy (s) glaciofluvial outwash (GO) with low-relief (L), planar (p) surface topography:



In the "numerator" of the terrain code, two upper-case letter symbols designate a particular landform (e.g., GO). The first letter symbol represents the basic origin of the landform, e.g., glaciofluvial (G); the second letter symbol represents the particular type of landform, e.g., outwash (O). A lower-case letter symbol, which always precedes the landform code, designates the dominant material comprising the landform, e.g., sand (s).



Direct Shipping Ore Project

Schematic Cross-Section of Terrestrial Ecosystems

Designed By:	RM, HR, DM	Drawn By:	SBB
Checked By:	DFM	Approved By:	-
Date Issued:	December 2007	Project No.:	60-316 / PR26

Gartner Lee

HEMISPHERES le groupe

FIGURE 3

The topography and drainage are specified in the “denominator” of the terrain code. Local relief is indicated by one of three upper-case letters: L (low, <15 m), M (15 – 60 m) or H (high, >60 m). In the example above, relief is low (L). Because relief is interpreted from aerial photographs and base mapping, the values should be considered approximate. Topographic variety within one of the three categories of relief represents local shapes, forms or processes, which are mainly associated with recognizable erosional or depositional processes and may be glacial or post-glacial in age and origin (Gartner ***et al.***, 1981). Lower-case letter symbols, in this case p, for planar, specify topographic variety. The combined designation of relief and topographic variety above, Lp, describes low-relief (L) terrain with a planar (p), or level, surface. The surface drainage condition of the landform is indicated with a lower-case letter symbol, e.g., w, for well drained.

Although the terrain code described above may fully characterize some polygons, many polygons exhibit greater heterogeneity than can be represented with so few letter symbols. For such polygons, the simplified terrain code described above provides only the dominant values of each of the four main components. The headings of the columns within the TEM ArcGISTM attribute table from which the dominant values of landform, material, relief and topographic variety and drainage originate are D1_Ov_Land (dominant landform), D1_Ov_mat3 (dominant material comprising the dominant landform), Dom_relief (dominant relief exhibited by the dominant landform) and Dom_topog1 (dominant topographic variety of the dominant landform) and Dom_drain (dominant surface drainage condition of the dominant landform) respectively.

All terrain-related information can be represented, however, in a more complex, complete terrain code. The practicality of displaying complete terrain codes at the map scale used in this study (i.e., 1:20,000) is limited by constraints associated with label clarity and overlap. Nonetheless, an explanation of the complete terrain code is provided in Appendix I for those users who may wish to display more detailed terrain-related information on enlarged portions of the maps. In addition, a script for generating complete labels from the attribute table is included within the TEM ArcGISTM .mxd file. Indeed, it may be necessary to display the complete terrain codes on field maps to support planning or preliminary design investigations. One must remember, however, that the maps are only as accurate as the scales of the aerial photographs on which the interpretations are based. Detailed plans should always be based on site-specific field investigations, not just on interpretations of aerial photographs and reconnaissance field confirmation.

To facilitate reading the map and making spatial comparisons, standardized colours (based on federal and provincial Surface geology maps and on the NOEGTS mapping) have been assigned to each polygon (Appendix II) according to the most dominant landform. For example, polygons dominated by morainal and glaciofluvial landforms are coloured green and yellow respectively. Colours do not differentiate polygons according to subordinate landforms; again, the digital file must be consulted to fully appreciate any intra-polygon variability.

5.1.6 Terrain Code Examples and Interpretation

The use and meaning of the terrain codes are best conveyed through examples. Therefore, the simplified terrain codes of three distinct terrain polygons are provided below, along with a brief explanation of their meaning and significance.

The most common simplified terrain code in the LSA is tMG/Lu-w. This code represents a well-drained (w), low-relief (L), rolling to undulating (u) ground moraine (MG) composed of till (t). Several adjacent polygons may have identical simplified terrain codes due to differences in subordinate terrain characteristics (recorded in the TEM ArcGISTM .mxd file), in addition to differences in terrestrial ecosystem characteristics. Polygons in which bedrock is inferred to be within about 2 m of the ground surface are indicated by a diagonal hatch pattern.

Near DSO3, the simplified terrain code sGO/Lt-r describes a rapidly-drained (r), low-relief (L) glaciofluvial outwash (GO) terrace (t) composed mainly of sand (s). The description of the surface expression as a terrace implies that material once occupying the central portion of the valley has since been eroded, leaving a bench-like feature perched against the valleyside.

Another common simplified terrain code, which applies to wetlands, is pOT/Lp-v. This code describes very poorly-drained (v), low-relief (L), planar (p) or flat organic terrain (OT), mainly composed of peat (p).

Using this wetland code (i.e., pOT/Lp-v) as an example, the limitations of relying solely on the simplified terrain code for planning or preliminary design purposes must be emphasized. Most wetlands in the LSA are fairly shallow and many are punctuated by bouldery till mounds or bedrock knobs. While the TEM ArcGISTM .mxd file indicates the subordinate presence of bedrock knobs (RN), as would the complete terrain code, no indication of bedrock presence is provided in the simplified terrain codes. Terrain Maps, which convey the primary terrain characteristics of each polygon through the use of colour and simplified terrain codes, provide a valuable overview of general conditions, but the complete digital information should be consulted for determining the capacity of a particular site to support infrastructure of any kind.

5.2 Descriptions of Landform Types

Landforms are the result of a particular set of erosional or depositional processes. Thus, landforms can be classified according to their origins. Given the interactions among the geological processes that create landforms, two landforms of the same type will never be identical and an individual landform may even exhibit considerable internal variability. In addition, post-formation modification of landforms by other processes can lead to considerable external variability. Nevertheless, most landforms are sufficiently distinct that their generic description reflects their primary characteristics reasonably well and can be used to predict soil conditions and engineering properties such as degree of compaction or consolidation.

The following “fact sheets” (Subsections 5.2.1 to 5.2.6) describe in detail the typical characteristics and variability of the six landforms found in the LSA. The summary tables are intended to provide stand-alone descriptive summaries, highlighting each landform’s key features, so they are not numbered or included in the List of Tables at the beginning of this report. Users who are interested in only one or two specific areas may prefer to consult the maps (Appendix II) first and then to review only those summary tables within the following subsections that are relevant to their area of interest.

5.2.1 Bedrock Landforms

Areas of exposed bedrock are scattered throughout the LSA (9 % of total areal coverage), most commonly on ridge and hill crests. Distinguishing bedrock lithology was beyond the scope of the TEM objectives, but such information is available on regional geological maps (e.g., Wardle ***et al***., 1997). A summary of bedrock geology is provided in Subsection 4.1.1.

Two types of erosional bedrock landforms were mapped: knobs and ridges. Bedrock knobs (RN) are protruding, rounded to jagged hills of bedrock, and bedrock ridges (RR) are elevational crests of bedrock, commonly exhibiting linear continuity. Areas where bedrock underlies a drift veneer less than about 2 m thick have been diagonally hatched on the terrain maps (Appendix II).

The distribution of bedrock landforms across the LSA is related to past glacial activity and pre-existing topography. Bedrock is commonly exposed where it exhibits moderate to high local relief and on steep slopes. Ridge crests and abrupt knobs protruding from an otherwise low-relief landscape concentrated the erosive forces of flowing glaciers, and any overburden was easily stripped away. In addition, relatively steep slopes inhibited the accumulation of thick deposits and hastened the erosion of unconsolidated material. Subglacial meltwater activity also appears to have influenced the distribution of bedrock exposure. Particularly during deglaciation, when temperatures were warming and glaciers were melting, considerable volumes of meltwater flowed beneath the ice. Subglacial meltwater floods stripped away overburden in areas where sheetflow became concentrated, in some cases eroding several metres into bedrock.

Bedrock is recognized in aerial photographs by its sharp-edged appearance and systematic structural orientations (e.g., fractures). Where bedrock is overlain by a thin drift veneer (hatched polygons on terrain maps), its close proximity to the surface is inferred from distinct primary structural features and isolated bedrock outcrops. The subarctic climate, shallow snowpack on windswept areas and pre-existing fractures within the folded bedrock predispose ridges and high plateaux to frost shatter. In places, frost-shattered bedrock (bRR or bRN), known as ***felsenmeer***, is so thick and poorly sorted that it is difficult to distinguish from a bouldery till veneer. Only the angularity of the stones provides a reliable indicator of ***in situ*** weathering, as opposed to glacial transport and deposition.

The local relief of bedrock terrain differs across the LSA. In general, it is relatively low (<15 m), but several long ridges between DSO2 and 3 exhibit local relief up to about 60 m. While till may be non-existent on high outcrops of bedrock, it can reach thicknesses of several metres in modest hollows. The ***simplified*** terrain code for such areas would indicate only bedrock presence, but the ***complete*** attribute table within the TEM ArcGIS^{TM}.mxd file would also list a subordinate till veneer.

Bedrock terrain is generally well to rapidly drained, depending on slope steepness and the type and distribution of any overburden. Where depressions and eroded fractures exist on the bedrock surface, however, surface runoff and groundwater may become trapped, over time forming wetlands. Depending on the relative proportions of bedrock and wetlands, such areas were mapped as RN (bedrock knob) or pOT (peaty organic terrain) respectively, with the subordinate presence of the other landform recorded in the TEM ArcGIS^{TM} .mxd file. Ecotypes MSF02, MSF03, MSF04, HST02 and HST03 are commonly associated with bedrock terrain.

Summary Table – Bedrock Landforms	
Distribution: Scattered throughout the LSA (9 % of total areal coverage); most commonly exposed on ridge and hill crests	**Material Composition:** Bedrock, locally weathered into angular fragments
Landform Sub-types: RN, RR	**Sorting:** n/a
Depositional Origin: n/a – eroded, particularly by glacial ice	**Drainage:** Well to rapidly drained
Topographic Surface Expression: Knobby, ridged, planar	**Soil Types:** Folisol
Thickness: n/a, except where thin till or weathered bedrock veneers (<1 m) exist	**Associated Ecotypes:** Ecotypes MSF02, MSF03, MSF04, HST02 and HST03
Variability: Intact bedrock commonly overlain by weathered (frost shattered) fragments on high ridge and hill crests; patchy till veneers (<1 m) too small to be mapped; wetlands present in depressions	**Special Considerations:** Unpredictable groundwater flow, rugged topography, frost shattering of bluffs
Landform: 	**Material:** 

5.2.2 Morainal Landforms

Morainal landforms are accumulations of till, which may contain localized granular deposits. They are the most widespread landforms throughout the LSA (76 % of total areal coverage). Two main types occur: ground moraine and hummocky moraine.

Ground moraine (MG), by far the most common morainal landform, originates through two main processes: active deposition of glacially-eroded material beneath a flowing glacier; or passive deposition of material from ablating glacial ice. Hummocky moraine (MH) is typically associated with melting ice and, thus, can exhibit significant textural variability, including granular deposits. In both cases, the result may be vast rolling to undulating till plains, with wetlands (OT) now occupying depressions.

The thickness of ground moraine is highly variable across the LSA, and even within localized regions. Abandoned open pit mines and the associated test pits and trenches from several decades ago provide the rare opportunity to observe the lateral variability in overburden thickness. Discontinuous till veneers (<2 m) and uniformly thick till blankets (2-5 m) are most common, but erosional till slopes on some valleysides reveal local thicknesses in excess of 10 m. Isolated bedrock knobs commonly protrude through till veneers, in which case the ***complete*** polygon description would include subordinate presence of bedrock knobs (RN). Isolated, irregular mounds of ablation till in DSO4, near the summer 2008 drillers' camp, are mapped as hummocky moraine (MH).

Morainal landforms can vary considerably in material composition, since different environments and modes of deposition from ice result in landforms with different sedimentological characteristics. The silty sand till matrix differs little across the LSA, but the stone content differs substantially. Areas characterized by distinctly bouldery till include the textural modifier b in the ***complete*** digital terrain description. When till is deposited in a meltwater-rich environment near the edge of a glacier, it may become locally interbedded with water-sorted sand and gravel, commonly in the form of a kame moraine (GK).

Post-depositional reworking of till has the potential to modify its characteristics significantly. For example, small boulder fields (bMG) occupying low-lying or valleyside areas are the result of meltwater washing away the fine till matrix sediment, leaving behind the largest boulders. Meltwater-dissected till blankets, which exhibit accordant surfaces separated by gullies, tend to have notably drier soil moisture regimes. A process that is still active on some till deposits, and influences the rate and distribution of tundra vegetation growth, is cryoturbation. Fresh frost boils, sorted stone polygons and contorted soil horizons, were observed on high, windswept, unvegetated to tundra-covered ground throughout the LSA, but most notably in DSO4. While permafrost undoubtedly underlies some of these high areas, on-site reports from drillers and existing literature (e.g., Nicholson and Lewis, 1976) indicate that the depth of the active layer is commonly around 10 m. The classification of a soil as a cryosol requires permafrost within 2 m of the surface in cryoturbated areas.

Due to its generally fine-grained matrix and density, till has a moderate to low permeability. Where exposed at surface, however, weathering increases its permeability. Most of the till in the LSA, given its sandy matrix, is moderately well to well drained, particularly on rolling topography. Ecotypes MSF01, MSF05, MSF06, HST01, HST03 and HST04 are commonly associated with till plains, in part due to moderate to good drainage and a moderately-rich soil nutrient regime.

Summary Table – Morainal Landforms	
Distribution: Widespread throughout the LSA (76 % of total areal coverage)	**Material Composition:** Silty sand till; locally bouldery
Landform Sub-types: MG	**Sorting:** Very poor
Depositional Origin: Deposited directly by glacial ice	**Drainage:** Moderately well to well drained
Topographic Surface Expression: Planar to undulating; locally hummocky	**Soil Types:** Orthic Humo-Ferric Podzol, or Orthic Gleysol
Thickness: Thin veneers (<1 m) to locally >10 m	**Associated Ecotypes:** Ecotypes MSF01, MSF05, MSF06, HST01, HST03 and HST04
Variability: Washed/reworked till; boulder fields; cryoturbation features (frost boils, sorted stone polygons, contorted soil horizons)	**Special Considerations:** Density and thus permeability varies; interstitial lenses of granular material may be present; cryoturbation locally disturbs soil profile on some high, windswept ridges and hills
Landform: 	**Material:** 

5.2.3 *Glaciofluvial Landforms*

Glaciofluvial landforms are the result of sediment deposition from flowing glacial meltwater. Their areal coverage throughout the LSA is low (less than 1 % of total areal coverage), but these landforms are sensitive to disturbance and may be ecologically important. Glaciofluvial landforms are typically composed of moderately- to well-sorted sand and gravel, though large cobbles are not uncommon. Individual grains and stones are typically subrounded to well rounded due to percussive wear during meltwater transport, but the degree of rounding depends on travel distance.

Two main categories of glaciofluvial landforms were identified within the LSA: kames and outwash. Kame (GK) is the broad term applied to mounds or benches of sediment deposited by meltwater in contact with glacial ice. The irregularity of the surface topography of kames provides an indication of the diversity in their depositional environments. Isolated mounds most likely originate from supraglacial or englacial deposition followed by differential melt-out from glacial ice. Due to their complex depositional history, kames commonly exhibit considerable variability in internal characteristics: in addition to stratified sands and gravels, kames may consist of water-laid till deposited by mass movements along the glacier margin. An anomalous kame on the south side of Star Lake with moderate relief exhibits concentric slump features around its margin and a moderately sorted gravelly composition.

Glaciofluvial outwash (GO) refers to material deposited by meltwater in a proglacial setting. Only a few isolated outwash plains, fans emerging from the base of a meltwater channel, exist within the LSA. The grain size distribution of glaciofluvial outwash deposits varies with distance from the glacier margin, but most outwash plains within the LSA consist of moderately sorted, stratified gravelly sand (sGO).

Glaciofluvial landforms generally have relatively high permeabilities due to the absence of silt and clay and their unconsolidated condition. As a result, they tend to be well to rapidly drained, except where localized inclusions of till inhibit infiltration. The groundwater table is typically low in glaciofluvial landforms, which has important implications for the types of ecosystems they can support. Ecotypes MSF01, MSF05, MSF06 and sometimes MSF08 are associated with kames and outwash plains within the LSA.

Summary Table – Glaciofluvial Landforms	
Distribution: Isolated (less than 1 % of total areal coverage); associated with meltwater-incised valley features	**Material Composition:** Sand, gravel, cobbles
Landform Sub-types: GK, GO	**Sorting:** Moderately to very well sorted
Depositional Origin: Deposited by glacial meltwater	**Drainage:** Well to rapidly drained (except moderately to imperfectly drained in low-lying slope positions)
Topographic Surface Expression: Variable: planar, ridged, hummocky, dissected	**Soil Types:** Orthic Humo-ferric Podzol
Thickness: Thin veneers (<1 m) to approx. 5 m	**Associated Ecotypes:** Ecotypes MSF01, MSF05, MSF06 and sometimes MSF08
Variability: Stratified to massive; may be locally interbedded with till where deposited in contact with glacial ice; some silt in matrix in kames	**Special Considerations:** Efficient contaminant transport paths due to relatively high permeability
Landform: 	**Material:** 

5.2.4 Alluvial Lanforms

Alluvium is material that has been transported and subsequently deposited by modern (post-glacial) streams. Due to the scale of aerial photography used in this study, all alluvial landforms, including channel beds and banks, floodplains, fans and deltas, are collectively mapped as alluvial plains (AP). Active alluvial plains and relic terraces exist throughout the LSA (2 % of total areal coverage). The floodplain deposits tend to consist of stratified sand and silt, but many channel beds in the LSA are armoured with cobble or boulder pavements. These stream pavements, actually lag deposits, are the result of long-term preferential erosion of fine sediment from the underlying substrate.

The most significant alluvial plains were mapped, but headwater streams were generally too small to map. Most streams in the LSA are confined by at least one valleyside and have discontinuous floodplains. Their planform configurations may be controlled by the fracture pattern within the underlying bedrock. Several broad, cobble- and boulder-filled glacial meltwater spillways convey modern streamflow, but, based on origin, they are mapped as outwash plains (GO), not as alluvial plains (AP). In places, the longitudinal profile of the streams is controlled by bedrock in the channel bed.

Floodplains of many of the intermediate-sized channels are composed of a mixture of fine sediment and organic material. Some streams contain isolated wetlands in their riparian zone and, locally, banks composed predominantly of peat.

Although alluvium tends to be moderately to well sorted, it generally accumulates in valley bottoms, which have relatively high groundwater tables. As a result, most alluvial soils are imperfectly to poorly drained, especially if partially composed of moisture-retaining peat. Therefore, Ecotypes MSF07, MSF15 and HST05 tend to occur on imperfectly drained, rich alluvial soils.

Summary Table – Alluvial Landforms	
Distribution: Valleys throughout the LSA (2 % of total areal coverage)	**Material Composition:** Silt, sand, gravel, cobbles, boulders, bedrock, peat
Landform Sub-types: AP	**Sorting:** Moderately to very well sorted
Depositional Origin: Deposited by modern stream flow	**Drainage:** Poorly to imperfectly drained
Topographic Surface Expression: Planar, channelled	**Soil Types:** Regosol and Gleysol
Thickness: Generally <2 m	**Associated Ecotypes:** Ecotypes MSF07, MSF15 and HST05
Variability: Cobble and boulder pavements armouring stream bed; silt and peat floodplain deposits; bedrock-controlled longitudinal profiles	**Special Considerations:** Prone to flooding and sedimentation; groundwater table near surface; susceptible to frost heave; commonly associated with organic veneer
Landform: 	**Material:** 

5.2.5 Colluvial Landforms

Colluvium is material that has been transported and subsequently deposited through the force of gravity. Therefore, all landforms that have originated through falls, topples, slides, avalanches or creep are classified as colluvial landforms. Less than 1 % of the area of the LSA is classified as colluvium, partly because most colluvial landforms within it are of insufficient extent to be mapped using 1:20,000-scale aerial photography. However, the presence of localized colluvial deposits in the LSA necessitates description of their landform characteristics.

The most common colluvial landform is a talus pile (CT). Talus is the accumulation of broken rock beneath a cliff prone to frost shatter. Talus piles may contain large boulders through fine sand. Most bedrock knobs with moderate to high relief, such as in the southern part of the LSA, have small talus piles at their bases. High cliffs with near-vertical slopes may have talus piles several metres thick, with surface slopes approximating the natural repose angle of 35^{o}.

Largely because of the relatively low relief of the terrain, slope failures are small and therefore difficult to detect in aerial photographs. Recent slope failures (CS) can, however, be recognized in the field based on their headwall or source area and their deposit morphology. Most of the mapped slope failures are in the vicinity of DSO4 and appear to be related to creep or solifluction within the active layer overlying permafrost. Pioneer species, such as lichens, grasses of the Poa genus and glandular birch, which commonly grow on disturbed soils, may be indicative of a young colluvial soil.

The drainage characteristics of colluvial landforms are largely dependent on the source material. Talus piles tend to be well to rapidly drained, given their coarse texture and steep slopes, whereas earth flow deposits, for example, which typically have a fine matrix, may be only moderately well drained. Over time, colluvial landforms may support Ecotypes MSF05 (coarse phase), MSF01 and HST03 (coarse phase).

Summary Table – Colluvial Landforms	
Distribution: Most significant deposits in the vicinity of DSO4 (less than 1 % of total areal coverage), but small deposits not mappable at 1:20,000 scale throughout the LSA	**Material Composition:** Depends on source material: angular bouldery rubble to sand, silt and clay
Landform Sub-types: CS, CT	**Sorting:** Poorly to very poorly sorted
Depositional Origin: Deposited by gravitational mass movements	**Drainage:** Moderately to rapidly drained
Topographic Surface Expression: Sloping, undulating	**Soil Types:** Orthic Humo-ferric Podzol and Dystric Brunisol
Thickness: Thin veneers (<1 m) to approx. 5 m	**Associated Ecotypes:** Ecotypes MSF05 (coarse phase), MSF01 and HST03 (coarse phase)
Variability: Surface typically coarse rubble and boulders, but finer gravels and sand may exist beneath surface	**Special Considerations:** Talus piles generally have repose angle slopes of about 35^{o} and may be locally unstable
Landform: 	**Material:** 

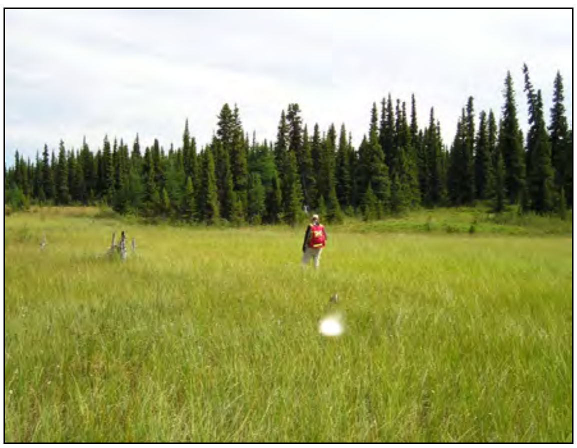
5.2.6 Organic Terrain

Organic terrain, composed of peat and muck, is scattered throughout the LSA (4 % of total areal coverage), largely due to low relief. It exists wherever organic material has accumulated, generally in confined depressions with very poor to poor drainage. All peatlands were initially delineated as organic terrain (OT), as shown on the terrain maps (Appendix II), regardless of their marsh, swamp, bog or fen classification. Subsequently, however, organic units were subdivided according to dominant plant species, soil nutrient regime and drainage characteristics, as shown on the terrestrial ecosystem maps (Appendix III).

Small wetlands are common, but most are punctuated by bedrock knobs or morainal hills, as indicated in the TEM ArcGIS™ .mxd file by the subordinate presence of RN (bedrock knob) or MG (ground moraine) respectively. Rolling to undulating till plains commonly contain poorly-drained peat-filled depressions, which are assigned subordinate presence within the ***complete*** digital attribute table.

The depth of organic terrain is highly variable. In many cases, boulders are visible at or beneath the stagnant water surface in wetlands, indicating that the organic material is relatively shallow. Most valley bottom wetlands appear to be less than 2 m deep. Where topography is undulating to hummocky, however, thicker accumulations of peat may exist.

The defining characteristic of organic terrain throughout the LSA is poor drainage. Perennially high groundwater tables inhibit the decomposition of organic material. Fens occupy valley bottoms, alongside streams and lakes, and fractures within bedrock that have a more or less constant groundwater supply. Many contain areas of open water, the extent and connectivity of which vary seasonally and in response to prolonged rainfall or snowmelt. A variety of moisture-tolerant ecosystems are associated with wetlands, including Ecotypes MSF10, MSF11, MSF12, MSF14 as well as HST06 and HST07.

Summary Table – Organic Terrain	
Distribution: Scattered throughout the LSA (4 % of total areal coverage), especially in valley bottoms	**Material Composition:** Peat, muck
Landform Sub-types: OT	**Sorting:** n/a
Depositional Origin: Accumulation of decomposing organic material	**Drainage:** Very poorly to poorly drained
Topographic Surface Expression: Planar	**Soil Types:** Fibrisol and Mesisol (Organic Order)
Thickness: Generally <2 m, but locally up to several metres	**Associated Ecotypes:** Ecotypes MSF10, MSF11, MSF12, MSF13, MSF14 as wel as HST06 and HST07
Variability: Marsh, swamp, bog, fen; seasonally fluctuating groundwater table; areas of open water; boulder-paved wetlands	**Special Considerations:** Groundwater table is at or near surface and flooding is common
Landform: 	**Material:** 

5.3 Permafrost

Permafrost is ground – soil, Surface deposits or bedrock – that remains below 0^{o}C for more than 1 year. It need not contain ice, yet it is common for ice crystals or lenses to be visible. The LSA is located within the region of sporadic to discontinuous permafrost (Nicholson and Lewis, 1976). Indeed, observations of permafrost in the Schefferville area date back to the mid-1900s, when mining began (Pryer, no date). Between 1973 and 1975, Nicholson (1978) conducted research on permafrost distribution in what is now DSO3. He found that permafrost ranged from 60 to 100 m in depth in high, windswept areas with tundra vegetation. Deep active layers of 10 m or more were observed by Nicholson and Lewis (1976), with deeper active layers in talik zones below or adjacent to large waterbodies. Anecdotal reports from drillers at their summer 2008 camp near DSO4 corroborate this observation; they had not encountered visible (ice-rich) permafrost until at least 9 m below the surface.

A number of fresh and relic features were observed on high, windswept uplands and ridges during the TEM field investigations that suggest permafrost may be present in some areas: frost boils (Figure 4), sorted stone polygons and contorted soil horizons. Temperature measurements were not made, and no ice was encountered in recent road cuts, stream-cut banks or in shallow (<1 m) soil pits. However, the widespread presence of cryoturbation may indicate permafrost at considerable depth, consistent with Nicholson and Lewis (1976), or simply the disruption and churning of shallow soil as a result of freeze-thaw unrelated to permafrost.

The significance of permafrost presence or absence for TEM is related to soil classification and the sensitivity of different landforms, and therefore ecosystems, to disturbance. Based on existing literature and incidental field observations, it is assumed that permafrost may be present in certain exposed sites, but not at depths that directly influence soil rooting conditions (e.g., freezing point, seasonally perched water table). Soils in these sites are best described as cryoturbated phases of a Brunisol or Regosol.

Figure 4. Frost Boils on High, Windswept Ridge near DSO4

6 TERRESTRIAL ECOSYSTEM MAPPING AND DESCRIPTION OF THE LOCAL STUDY AREA

This section, which uses concepts of ELC, describes in detail the terrestrial ecosystems mapped in the LSA. Section 6.1 proposes an interpretation key that will provide a better understanding and interpretation of the fact sheets on the ecotypes. Each ecotype is then described in a series of fact sheets presented in Sections 6.2 (Mid Subarctic Forest ecoregion, or MSF) and 6.3 (High Subarctic Tundra ecoregion, or HST). Since these fact sheets are intended to be autonomous descriptive documents, the summary tables presented are not included in the list of tables included in the table of contents of this report. Readers will perhaps want to go directly to the maps that interested them (Appendices II and III) and then review the related fact sheets.

6.1 How to read and interpret the fact sheets

The descriptive ecological variables for the characterization of environmental, soil and vegetation data for each ecotype are recorded on a fact sheet. The 17 fact sheets classified according to their respective ecoregions are presented below. The MSF ecoregion includes 10 ecotypes and the HST ecoregion includes seven.

Each fact sheet has five main components:

1. **<u>General description of the ecotype</u>**
   This section provides an overview of the ecotype, including the associated edatopic grid, photos, its distribution within the LSA, the characteristics of the geological surface deposits, soils and vegetation. A brief summary text also presents the ecotype.

2. **<u>Summary of the environmental observations</u>**
   This section provides important environmental information on the ecotype, as presented below in the summary table of environmental observations.

Summary of environmental observations	
Inventory Number: **1**	Location: **2**
Elevation: **3**	Typical Position : **4**
Topography: **5**	Sucessional Status : **6**
Drainage: **7**	Soil Types: **8**
Soil Humus Type: **9**	Rooting Depth: **10**
Surface Deposits: **11**	Soil Moisture Regime: **12**
Soil Nutrient Regime: **13**	Natural/Anthropogenic Disturbance: **14**
Plant Species Richness: **15**	Forest Productivity: **16**
Rock Outcrop Cover Percentage: **17**	Coarse Fragment Cover Percentage: **18**
Vegetation Cover Percentage: **19**	Open Water Cover Percentage: **20**

1. **Inventory number:** Any sample number associated with field surveys carried out.
2. **Location:** Overview of the geographical location of the ecotype within the LSA.
3. **Elevation:** Elevation range observed for the ecotype and the average in metres (m) above sea level (asl).
4. **Typical position of the ecosystem:** Position on slope generally occupied by the ecotype. The possibilities are: crest, top of slope, mid-slope, bottom of slope, toe of slope, level or depression.
5. **Topography:** Typical topography (e.g. level, undulating, rolling, valleys, mountainous) associated with the ecotype.
6. **Successional status:** Successional status (without vegetation, herbaceous, shrub, in regeneration, young forest, mature forest or old forest) generally associated with the ecotype.
7. **Drainage:** Soil drainage (very rapidly, rapidly, well, moderately well, imperfectly, poorly, and very poorly drained) of the ecotype (following the RIC standards, 1998). A table of drainage classes can be found Appendix V.
8. **Soil types:** Soil subgroups (following the standards of the Canadian System of Soil Classification, 1998) associated with the ecotype. A table presenting the various soil orders can be found in Appendix VIII.
9. **Soil Humus Type:** Soil humus forms (Green ***et al***., 1993) typical of the ecotype. A diagram in appendix IX shows the numerous soil humus types.
10. **Rooting Depth:** Range and average root depth in centimetres (cm) in the ecotype.
11. **Surface Deposits:** Geological surface deposits associated with the ecotype (see Section 5.2 for detailed descriptions).
12. **Soil Moisture Regime:** The range of soil moisture regimes encompassed by the ecotype. A table characterizing the SMRs is presented in Appendix VI.
13. **Soil Nutrient Regime:** The range of soil nutrient regimes encompassed by the ecotype. Appendix VII shows a table of the various SNRs.
14. **Natural/Anthropogenic Disturbances:** Main natural disturbances (e.g. forest fire, flooding, insect epidemic) and caused by human activity by (e.g. drilling, road construction, infrastructure) in the ecotype.
15. **Plant Species Richness:** Number of plant species within an ecotype (low = a few common plant species, average = several common plant species, high = numerous common plant species, sometimes unusual for this ecoregion).
16. **Forest Productivity:** The natural capacity of the ecosystem to capture energy and produce forest resources (none = associated with non-forest ecosystems; low = the growth rate of trees is low because of poor soil,

unsuitable drainage and harsh climate; intermediate = the growth rate of trees is intermediate because of an average level of soil nutrients and good drainage, but long, cold winters limit productivity; high = the growth rate of trees is high because of the high level of soil nutrients, moderately good drainage and protection from excessive winds).

17. **Rock Outcrop Cover Percentage:** The range and average (%) of rock outcrop cover for the ecotype.
18. **Coarse Fragment Cover Percentage:** The range and average (%) of rocks (from cobbles to boulders) contained in the soils of the ecotype.
19. **Vegetation Cover Percentage:** The range and average (%) of the plant cover (including lichen and mosses) of the ecotype.
20. **Open Water Cover Percentage:** The range and average (%) of the open water cover of the ecotype.

3. Synthesis of Plant Diversity

This third component of the fact sheets summarizes all the information related to the distribution of each plant species sampled for an ecotype. For each species present in the ecotype, they give the frequency (% of sample plots where it is found) and the average cover classes (grouped by tree, shrub, low-shrub, herbaceous and bryophyte layers). A standardized table summarizes this information as follows:

Species Code 1	Latin Name 2	Common Name 3	Plant Form 4	Fréquency (%) 5	Cover Class 6

1. **Species code:** Coding system taken from the MoELP-MoF (1998). It uses the first four letters of the genus and the first three letters of the species to provide a unique identifier for each plant species.
2. **Latin name:** Latin name of each plant species sampled in the ecotype.
3. **Common name:** Common English name, generally recognized, for each plant species sampled in the ecotype.
4. **Plant form:** Plant form for each plant species (tree, shrub, low shrub, herbaceous and bryophyte).
5. **Frequency (%):** Frequency (%) of occurrence [i.e.: (number of sample plots in which the plant is found/total number of sample plots in the ecotype)x100].
6. **Plant Cover Class:** Plant cover class for each plant species. The covers (in %) were estimated in the field and then converted according to the following classes: T: = Trace (only a few individuals); A = <1%; B = 1-5%; C = 5-10%; D = 10-25%; E = 25-40%; F = 40-60%; G = 60-80%; H = 80-100%.

4. Distribution and presence in other similar ecoregions

This fourth component on the fact sheets summarizes the distribution of the ecotype in other regions of Labrador and Quebec, as well as in other regions of Canada.

5. Disturbance and succession

The fifth component of the fact sheets presents the main natural and anthropogenic disturbances and their relationship to plant succession for the ecotype in question.

6.2 Mid Subarctic Forest Ecoregion (MSF)

The general geology, topography and glacial history of the MSF ecoregion are described in Section 4. The overview presented below is focused in particular on climate descriptors. The mean annual temperature is between -5° and -2.5°C and annual precipitation is around 800 mm, with 300 mm falling as snow. The summers are cool and four to five months long, while the winters are cold and snowy (Meades, 1990). The daily average low temperature in the coldest month is -28.9°C and the record low temperature is -49.4°C.

The harsh climate inhibits continuous tree cover on the sites most exposed to the wind. This ecoregion is transitional between the productive, closed boreal forest to the south and, and the treeless subarctic tundra to the north. In the northern part of the ecoregion, on the DSOP site, balsam fir (***Abies balsamea***) disappears from the forest, giving way completely to black spruce (***Picea mariana***), white spruce (Picea glauca) and to tamarack (***Larix laricina***) as the only trees species present in the forest ecosystems. The forests with a completely closed canopy are limited to moderately or imperfectly drained sites, protected from the wind and receiving a constant supply of nutrients from seepage. Large wooded areas formed by open stands of black spruce and lichens (lichen stands) are common on dry sites of low productivity. Semi-open stands of black spruce, mixed with white spruce and tamarack, are found on well-drained sites supported by ground moraine. Forest fires are frequent and usually cover large sectors dominated by lichen stands. Many of these forests are in the first stages of plant succession. The vast complexes of wetlands are common and characterized by a tangle of minerotrophic peatland (fens) stringed or uniform, of forest peatlands and treed swamps.

The table below shows the ecotypes present in the MSF ecoregion. Since they were not found in the LSA, the ecotypes highlighted in grey were classified, described and mapped in the MSF ecoregion, but were not described in detail in the text.

Ecotype	Code in Québec	Complete name	Description
FSM01	RE12	Black Spruce/White Spruce – Labrador Tea – Feathermoss (Forested Ecosystem)	Black spruce stand with white spruce subdominant; thin to thick moraine or colluvial deposits; medium soil texture; well drained.
FSM02	RO	Crowberry – Map Lichen – Rock Outcrop (Non-Forested Ecosystem)	Ericaceae community; rock outcrops; little or no Surface geological deposits; variable soil texture; very rapid drainage.
FSM03	DS	Glandular Birch – Crowberry –Thin Soil (Non-Forested Ecosystem)	Low-shrub community; thin soils on summits or upper slopes; variable soil texture; rapid drainage.
FSM04	RE10	Black Spruce – Lichen – Rock (Forested Ecosystem)	Dominated by rock and rock outcrops; scattered black spruce and Ericaceae species; very thin moraine deposits; variable soil texture; rapid drainage.
FSM05	RE11	Black Spruce – Lichen – Open Forest (Forested Ecosystem)	Black spruce lichen stand with some tamarack; thin to thick moraine or glaciofluvial Surface deposits; coarse soil texture; well to rapidly drained.
FSM06	RE25	White Spruce/Black Spruce – Feathermoss – Seepage	White spruce stand, with black spruce subdominant; moss-covered forest floor; medium to thick moraine or colluvial

Ecotype	Code in Québec	Complete name	Description
		(Forested Ecosystem)	deposits; fine to medium soil texture; imperfect drainage with seepage.
FSM07	RE25f	White Spruce – Willow – Sedges – Riparian (Forested Riparian Ecosystem)	White spruce stand with moss-covered forest floor; thin to thick fluvial deposits; fine soil texture; riparian ecosystem; periodically flooded sites; imperfect to poor drainage.
FSM08	BS1	Black Spruce/Tamarack – Glandular Birch – Sphagnum Bog (Forested Wetland Ecosystem)	Forested bog with black spruce and tamarack stand; organic deposits dominated by peatmoss; poor drainage.
FSM09	BS1f	Tamarack/Black Spruce – Sedges – Fluvial Fen (Forested Riparian Ecosystem)	Tamarack stand; forest fen; organic or fluvial deposits; poor drainage.
FSM10	Bbu	Black Spruce Forested Fen (Forested Wetland Ecosystem)	Uniform forested fen; organic deposits; ground cover dominated by sedge and grass; poorly drained.
FSM11	Fns	Structured Herb Fen (Non-Forested Wetland Ecosystem)	Structured herb fen; organic deposits; ground cover dominated by sedge and grass; very poor drainage.
FSM12	Fnu	Uniform Herb Fen (Non-Forested Wetland Ecosystem)	Uniform herb fen; organic deposits; ground cover dominated by sedge and grass; poor to very poor drainage.
FSM13	Fnn	Non-Uniform Herb Fen (Non-Forested Wetland Ecosystem)	Open water randomly distributed in ponds; herb fen; organic deposits; ground cover dominated by sedge and grass, very poor drainage.
FSM14	Fau	Uniform Shrub Fen (Non-Forested Wetland Ecosystem)	Uniform shrub fen; dominated by various shrub species of the Ericaceae family; ground cover dominated by sedge and grass; poor drainage.
FSM15	Fauf	Uniform Riparian Shrub Fen (Non-Forested Riparian Ecosystem)	Non-forested riparian shrub fen; fluvial or organic deposits; ground cover dominated by sedge and grass; soil richer and plant community more diverse than Ecotype MSF14; imperfect to poor drainage.

6.2.1 Ecotype MSF01: Black Spruce/White Spruce – Labrador Tea - Red-Stemmed Feathermoss) (Forested Ecosystem)

Ecotype MSF01 is the zonal or normal ecosystem of the MSF ecoregion. The zonal or normal sites have one SMR and one SNR on average (neither too rich, nor too poor; neither too dry, nor too wet), can support ecosystems in advanced succession (mature forest or old forest) and reflects the pressure from the climate of the ecoregion. They can be used to characterize and map the spatial boundaries of the ecoregion. Ecotype MSF01 is present mostly over thick moraine everywhere within the LSA, but mostly concentrated in the south, in sectors DSO2 and DSO3. Compared with Ecotype MSF05, Ecotype MSF01 is less abundant, a more closed canopy of black and white spruce as well as a cover of higher, denser shrubs. The shrubs are mostly dominated by the glandular birch (***Betula glandulosa***), the herbs by the tufted hairgrass (***Deschampsia cespitosa***) and bunchberry (***Cornus canadensis***) and the bryophytes by red-stemmed feathermoss (***Pleurozium schreberi***) and, in lesser abundance, by various species of lichen. The typical soils are humoferric podzols with natural and anthropogenic disturbance of the mor type humus. In short, the MSF01 covers 9% of the LSA.

General Description of Ecotype MSF01

Soil Nutrient Regime

←Poor Rich→

Soil Moisture Regime (← Wet Dry→)

	A	B	C	D	E
0					
1					
2					
3					
4		**MSF01**			
5					
6					
7					
8					

Aerial View

Ground View – Stand

Ground View – Vegetation

HEMISPHERES le groupe

Synthesis of Environmental Observations Ecotype MSF01	
Inventory numbers: DSO123; DSO137; DSO15; DSO24; DSO25; DSO317; DSO366; DSO57 (total of 8 plots)	**Location:** Widely distributed on flat or gently sloping sites with thin to thick tills; less common than Ecotype MSF05. Constitutes the normal or zonal site for the MSF ecoregion.
Distribution within the study area: LSA: 9%	
Elevation: 587-666 m (average of 638 m)	**Typical Position:** Mid-slope or bottom of slope
Topography: Generally on a gentle slope or undulating terrain	**Successional Status:** Mostly mature forest, except after forest fires where shrubs and regenerating forest dominate.
Drainage: Moderately well to well	**Soil Types:** Humo-ferric podzol or orthic dystric brunisol
Soil Humus Type: Hemimor or thick humimor	**Rooting Depth:** 10 to 32 cm (average of 23 cm)
Surface Deposits: Predominantly on thick moraine with medium texture; sometimes at bottom of slopes on medium texture glaciofluvial deposits.	**Soil Moisture Regime:** 4 (mesic)
Soil Nutrient Regime: B (C) (poor, in places medium)	**Natural/Anthropogenic Disturbance:** Extensive forest fires, drill holes at future mine sites
Plant Species Richness Medium	**Forest Productivity:** Intermediate
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0 to 10% (average of 4%)
Vegetation Cover Percentage: 75 to 94% (average of 86%)	**Open Water Cover Percentage:** 0 to 5% (average of less than 1%)

Typical Soil Photo

Humo-ferric Podzol

Synthesis of Plant Diversity in Ecotype MSF01					
Species with Status: No plant species with status was encountered in Ecotype MSF01.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
LARILAR	***Larix laricina***	tamarack	Tree	25	B
PICEGLA	***Picea glauca***	white spruce	Tree	62	D
PICEMAR	***Picea mariana***	black spruce	Tree	75	C
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	100	E
BETUPUM	***Betula pumila***	low birch	Shrub	12	A
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	12	A
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	25	B
SALIPEL	***Salix pellita***	silky willow	Shrub	12	B
VACCANG	***Vaccinium angustifolium***	blueberry	Shrub	12	E
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	62	B
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	50	D
LINNBOR	***Linnaea borealis***	twinflower	Low Shrub	25	D
VACCBOR	***Vaccinium boreale***	northern blueberry	Low Shrub	12	B
VACCCAE	***Vaccinium caespitosum***	dwarf blueberry	Low Shrub	25	D
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	50	A
CARELEP	***Carex leptonervia***	leptonerved sedge	Herbaceous	25	D
CARETRI	***Carex tribuloides***	blunt broom sedge	Herbaceous	12	C
COPTGRO	***Coptis groenlandica***	gold thread	Herbaceous	25	A
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	62	C
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	62	D
DESCFLE	***Deschampsia flexuosa***	wavy hairgrass	Herbaceous	12	B
LYCOALP	***Lycopodium alpinum***	alpine club-moss	Herbaceous	12	B
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	50	B
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	25	B
PYROMIN	***Pyrola minor***	lesser wintergreen	Herbaceous	12	A
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	75	B
TRIEBOR	***Trientalis borealis***	broad-leaved starflower	Herbaceous	50	A
CLADONI	***Cladonia*** sp.	(none)	Bryophyte	12	B
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	62	B
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	75	D

Synthesis of Plant Diversity in Ecotype MSF01					
Species with Status: No plant species with status was encountered in Ecotype MSF01.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
DICRANU	***Dicranum*** sp.	Dicranum	Bryophyte	12	C
FLAVCUC	***Flavocetraria cucullata***	(none)	Bryophyte	12	C
PELTIGE	***Peltigera*** sp.	dog lichen	Bryophyte	12	A
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	100	F
POLYTRI	***haircap mosshum*** sp.	haircap moss	Bryophyte	38	D
RACODIU	***Racodium*** sp.	(none)	Bryophyte	12	C
STEREOC	***Stereocaulon*** sp.	foam lichens	Bryophyte	12	D

Notes:* * *Frequency in %:* *(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100

***** *Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype MSF01 is, with MSF05, the most abundant ecotype in the ecoregion of the LSA. These similar ecotypes are dispersed more or less uniformly through the MSF ecoregion in the sectors further to the south of Menihek and Churchill Falls, mainly on the deep tills with medium texture or on glaciofluvial outwash terraces (DFRA-Innu Nation, 2003). Similar ecotypes are also found in the vicinity of Voisey's Bay (CEAA, 2005).

Disturbance and succession

Ecotype MSF01 has a greater closure of the canopy and its ground cover offers a larger quantity of fuel, which means that the stands of trees can produce more intense fires over a greater area. According to the field visit and photo interpretation, only one forest fire has occurred recently in Ecotype MSF01 within the LSA. The stands of mature forest predominate, however, in the LSA, indicating a low incidence of fires sufficiently intense to cause a significant change in the forest stands. Following a forest fire, it is easy to confuse ecotypes MSF01 and MSF05 because the plant communities that colonized them are dominated by glandular birch, the regeneration of dispersed conifers and lichens. The trees and the forest cover were partly removed or destroyed where there was mining exploration for the DSOP. In addition, several ecosystems were destroyed by the creation of infrastructures for old mining projects that took place from the 50s to the 80s.

6.2.2 Ecotype MSF05: Black spruce – Lichen – Open Forest (Forested Ecosystem)

Ecotype MSF05 is the most widespread ecotype in the MSF ecoregion. It is found on thin till on the DSOP site, as well as on glaciofluvial deposits (sector of Star Lake and Stream). This ecotype is perfectly visible from the sky because of the very distinctive pale-coloured cover of the lichens. Ecotype MSF05 is characterized by a poor closure of the canopy (15 to 25%), by slow growing black spruce, shrubs dominated by Labrador tea, glandular birch (Betula glandulosa) and bog blueberry (Vaccinium uliginosum), by very poor herbaceous cover, as well as very dense and continuous cover of reindeer lichen (Cladina rangiferina). The typical soils are humoferric podzols with Mor type humus. In short, the MSF05 covers 15% of the LSA.

General description of Ecotype MSF05

Soil Nutrient Regime

←Poor Rich →

Soil Moisture Regime (←Wet Dry →)

	A	B	C	D	E
0					
1					
2					
3	**MSF05**				
4					
5					
6					
7					
8					

Aerial View

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype MSF05	
Inventory numbers: DSO04; DSO185; DSO199; DSO316; DSO363; DSO400; DSO406 (total of 7 plots)	**Location:** Occupies extensive areas at crest or on moderate slopes throughout the LSA
Distribution within the study area: LSA: 15%	
Elevation: 548-694 m (average of 624 m)	**Typical Position:** Generally at crest of slopes. Occasionally at middle or lower slope and toe of slope and on level ground.
Topography: Flat or gently rolling, sometimes with low relief.	**Successional Status:** Mostly young or mature forests, except where forest fires have occurred. Regenerating glandular birch and black spruce dominate on burnt sites.
Drainage: Mostly well drained	**Soil Types:** All humo-ferric podzols
Soil Humus Type: Mor (Humimor)	**Rooting depth:** 5 to 40 cm (average of 20 cm)
Surface Deposits: Typically thick; coarse glaciofluvial deposits or thin to thick tills	**Soil Moisture Regime:** 3 (4) (submesic)
Soil Nutrient Regime: B (C) (poor, sometimes medium)	**Natural/Anthropogenic Disturbance:** Extensive low-intensity fires; drill holes at future mine sites; destruction of several such ecosystems by former mining activities.
Plant Species Richness: Low	**Forest Productivity:** Low
Rock Outcrop Cover Percentage: 0 to 5% (average of 3%)	**Coarse Fragment Cover Percentage:** 1 to 40% (average of 9%)
Vegetation Cover Percentage: 50 to 97% (average of 88%)	**Open Water Cover Percentage:** 0%

Typical Soil Photo

Humic Gleysol

Synthesis of Plant Diversity in Ecotype MSF05					
Species with Status: No plant species with status was encountered in Ecotype MSF05.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
LARILAR	***Larix laricina***	tamarack	Tree	29	B
PICEGLA	***Picea glauca***	white spruce	Tree	43	C
PICEMAR	***Picea mariana***	black spruce	Tree	86	C
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	100	D
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	57	C
SALIPEL	***Salix pellita***	silky willow	Shrub	14	C
VACCANG	***Vaccinium angustifolium***	blueberry	Shrub	14	C
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	57	B
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	71	B
VACCCAE	***Vaccinium caespitosum***	dwarf blueberry	Low Shrub	14	D
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	71	B
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	14	E
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	29	A
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	14	D
DESCFLE	***Deschampsia flexuosa***	wavy hairgrass	Herbaceous	29	B
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	14	C
GEOCLIV	***Geocaulon lividum***	false toadflax	Herbaceous	14	B
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	86	B
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	14	B
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	29	C
CLADDEF	***Cladonia deformis***	lesser sulphur-cup	Bryophyte	14	A
CLADONI	***Cladonia*** sp.	(none)	Bryophyte	14	B
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	29	C
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	71	G
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	57	D
RACOMIT	***Racomitrium*** sp.	(none)	Bryophyte	14	B
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	14	D
STEREOC	***Stereocaulon*** sp.	foam lichens	Bryophyte	29	B

Notes:* *** ***Frequency in %: ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

******** ***Plant cover***

T = Trace (only few individuals)	***A = less than 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype MSF05 is the most abundant ecotype in the MSF ecoregion. Similar ecotypes are disperse through the MSF ecoregion, in particular in the Churchill Falls region, mainly on glaciofluvial outwash terraces of coarse texture (DFRA-Innu Nation, 2003) and in the vicinity of Voisey's Bay (CEAA, 2005).

Disturbance and succession

The open canopy and the lack of fuelwood indicate that the fires within Ecotype MSF05 are of low intensity and mainly confined to the lichen layer. One recent fire was observed within the LSA. This confirms the low frequency of forest fires observed in the Howells River basin region, where the mature forest stands are the most abundant. The burn sites usually have dense stands of glandular birch with scattered regeneration of small black spruce. The lichens located in the exploration trenches were damaged by the circulation of machinery. There is frequent confusion between this ecotype and young stands following a localized fire on mesic sites (Ecotype MSF01), since the latter are commonly invaded by lichens after having been disturbed.

6.2.3 Ecotype MSF06: White Spruce/Black Spruce - Feathermoss – Seepage (Forested Ecosystem)

Ecotype MSF06 is one of the most productive forest ecotypes in the MSF ecoregion; it is found on sites enriched by seepage rich in nutrients. Ecotype MSF06 is growing throughout the LSA on deep tills. It is distributed mostly at bottom of slope, where the groundwater table is close to the surface and the water is loaded with nutrients. Ecotypes MSF01 and MSF05 are intermingled with Ecotype MSF06, with the latter occupying the bottom of slopes or shallow depressions. Ecotype MSF06 is dominated by white and black spruce that are large for such a northerly ecosystem, by a shrub layer that is well developed and dominated by several species of willow (***Salix*** sp.) and glandular birch (***Betula glandulosa***), by a varied herbaceous layer dominated by large-leaved goldenrod (***Solidago macrophylla***) and palmate sweet coltsfoot (***Petasites palmatus***), as well as by an abundant and varied moss layer. The typical soils are eutric brunisols or gleyed melanics and sometimes even humic gleysols, with a Mormoder type humus. It covers a total of 2% of the LSA.

General Description of Ecotype MSF06

Soil nutrient Regime

←Poor Rich →

Soil Moisture Regime ←Dry Wet→

	A	B	C	D	E
0					
1					
2					
3					
4					
5			MSF06		
6					
7					
8					

Aerial View

Ground View – Stand

Ground View –Vegetation

Synthesis of Environmental Observations in Ecotype MSF06	
Inventory numbers: DSO06; DSO32; DSO358; DSO72 (total of 4 plots)	**Location:** Distributed throughout the LSA, at the bottom of slopes and in shallow depressions, where seepage increases forest productivity.
Distribution within the study area: LSA: 2%	
Elevation: 552-734 m (average of 640 m)	**Typical Position:** Bottom of slopes and depressions
Topography: Getle slope	**Successional Status:** All but one populations of samples or mapped were mature forests.
Drainage: Moderately well to imperfect	**Soil Types** Gleying eutric or melanic brunisol; humic gleysol in places
Soil Humus Type: Mormoder	**Rooting depth:** 30 cm and deeper
Surface Deposits: Morainal or glaciofluvial deposits	**Soil Moisture Regime:** 5 (6) (subhygric)
Soil Nutrient Regime: C or D (medium to rich)	**Natural/Anthropogenic Disturbance:** Forest fires are rare because of wet soils and position at bottom of slopes; at future mining sites, some drill lines cross the MSF06 ecotype, altering plant and soil integrity locally; destruction of several such ecosystems by former mining activities.
Plant Species Richness High	**Forest Productivity:** High
Rock Outcrop Cover Percentage: 0 to 6% (average of 5%)	**Coarse Fragment Cover Percentage:** 0 to 10% (average of 5%)
Vegetation Cover Percentage: 70 to 95% (average of 81%)	**Open Water Cover Percentage:** 0 to 10% (average of 6%)

Typical Soil Photo

Melanic Brunisol

Synthesis of Plant Diversity in Ecotype MSF06					
Species with Status: No plant species with status was encountered in Ecotype MSF06.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
LARILAR	***Larix laricina***	tamarack	Tree	50	C
PICEGLA	***Picea glauca***	white spruce	Tree	50	D
PICEMAR	***Picea mariana***	black spruce	Tree	25	D
SALIBEB	***Salix bebbiana***	Bebb's willow	Tree	50	C
ALNURUG	***Alnus rugosa***	rough alder	Shrub	25	D
AMELBAR	***Amelanchier bartramiana***	mountain serviceberry	Shrub	25	C
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	100	D
JUNICOM	***Juniperus communis***	common juniper	Shrub	25	B
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	25	C
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	50	C
SALIGLA	***Salix glauca***	northern willow	Shrub	25	A
SALIPEL	***Salix pellita***	silky willow	Shrub	25	D
SALIPLA	***Salix planifolia***	flatleaf willow	Shrub	25	C
SALIPYR	***Salix pyrifolia***	balsam willow	Shrub	25	B
SALIVES	***Salix vestira***	rock willow	Shrub	25	D
SALIX	***Salix*** sp.	willow	Shrub	25	B
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	50	B
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	25	B
LINNBOR	***Linnaea borealis***	twinflower	Low Shrub	50	B
RUBUCAN	***Rubus canadensis***	Canada blackberry	Low Shrub	25	A
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	25	A
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	25	C
CARELEP	***Carex leptonervia***	leptonerved sedge	Herbaceous	25	D
CAREX	***Carex*** sp.	sedge	Herbaceous	25	D
COPTGRO	***Coptis groenlandica***	gold thread	Herbaceous	50	A
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	50	B
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	25	C
EQUISET	***Equisetum*** sp.	horsetail	Herbaceous	25	A
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	25	B
ERIOGLA	***Eriophorum angustifolium***	narrow-leaved cottongrass	Herbaceous	25	F
ERIOGRA	***Eriophorum gracile***	slender cottongrass	Herbaceous	25	A

Synthesis of Plant Diversity in Ecotype MSF06					
Species with Status: No plant species with status was encountered in Ecotype MSF06.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
ERIORUS	***Eriophorum russoleum***	bog cotton	Herbaceous	25	B
LUZULA	***Luzula*** sp.	woodrush	Herbaceous	50	A
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	25	C
LYCOCOM	***Lycopodium complanatum***	ground cedar	Herbaceous	25	A
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	75	B
POLYVIV	***Polygonum viviparum***	alpine bistort	Herbaceous	25	A
RUBUPUB	***Rubus pubescens***	hairy raspberry	Herbaceous	25	B
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	75	B
STREAMP	***Streptopus amplexifolius***	clasping-leaved streptopus	Herbaceous	25	A
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	25	F
VACCOXY	***Vaccinium oxycoccos***	small cranberry	Herbaceous	25	A
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	25	F
POLYTRI	***haircap mosshum*** sp.	haircap moss	Bryophyte	25	D
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	50	F

Notes: ******* ***Frequency in %:*** ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

******* **Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype MSF06 is a common ecotype through the MSF ecoregion. Within the LSA, it is present in complexes beside the two most abundant ecotypes: MSF01 and MSF05. Similar forest ecosystems are found in other zones in Quebec and Labrador, within the boreal forest and the taiga, where drainage is imperfect and soil richness is high. The plant communities can, however, vary according to the local climate.

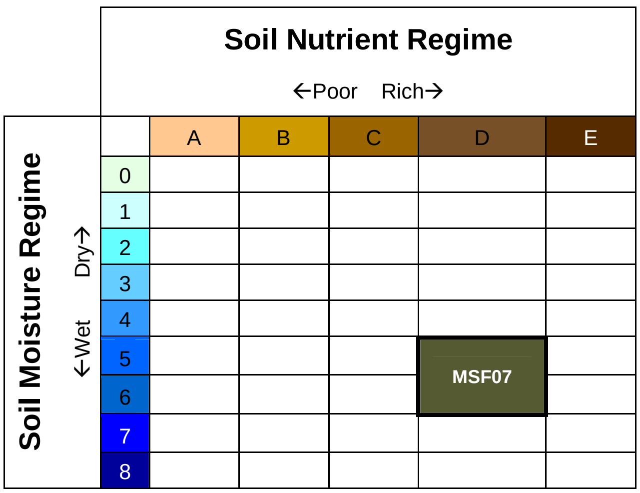
Disturbance and succession

Although the density of trees in Ecotype MSF06 is higher, the high soil humidity inhibits the frequency and severity of forest fires that cause the succession of forest stands. At the mine site, the trees and vegetation on the forest floor of Ecotype MSF06 undergo locally the impacts of the drill lines.

6.2.4 Ecotype MSF07: White Spruce – Willow – Sedge – Riparian (Forested Riparian Ecosystem)

Ecotype MSF07 is, with Ecotype MSF06, one of the most productive forest ecosystems in the MSF ecoregion. This ecotype is, however, confined to a few rare valley bottoms in the LSA. The Ecotype MSF07 is found on sites adjacent to streams and lakes. These sites are enriched either by flooding, or by seepage from adjacent streams or lakes. Ecotype MSF07 is associated with ecotypes MSF01, MSF05 and MSF06. The arboreous layer of Ecotype MSF07 is made up of tall white and black spruce. The shrub layer is varied and composed of various species of willow. The herbaceous layer is also abundant and varied, and it is composed of water avens (Geum rivale) and sedge (Carex sp.). The moss layer is mostly composed of peatmoss (Sphagnum sp.). The typical soils are humic gleysols and Mormoder type humus. It covers a total of 1% of the LSA.

General Description of Ecotype MSF07



Aerial View

No photo available

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype MSF07	
Inventory numbers: DSO183 (total of 1 plot)	**Location:** Restricted to the banks of certain streams located in undisturbed sections of the LSA.
Distribution within the study area: LSA: 1%	
Elevation: ‘‘- .	**Typical Position:** On flat ground or in depressions
Topography: At the bottom of valleys, along streams or on lake shores.	**Successional Status:** The only site of samples was a mature forest.
Drainage: Imperfect to poor	**Soil Types:** Humic gleysol
Soil Humus Type: Mormoder	**Rooting depth:** 20 cm
Surface Deposits: Fluvial or lacustrine	**Soil Moisture Regime:** 5-6 (from subhygric to hygric)
Soil Nutrient Regime: D (rich)	**Natural/Anthropogenic Disturbance:** Episodic and seasonal flooding; some drill lines cross Ecotype MSF07 and alter vegetation and soil locally; destruction of some such ecosystems by former mining activities.
Plant Species Richness: High	**Forest Productivity:** High
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 5%
Vegetation Cover Percentage: 82%	**Open Water Cover Percentage:** 13%

Typical Soil Photo

Humic Gleysol

Synthesis of Plant Diversity in Ecotype MSF07					
Species with Status: No plant species with status was encountered in Ecotype MSF07.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
LARILAR	***Larix laricina***	tamarack	Tree	100	C
PICEGLA	***Picea glauca***	white spruce	Tree	100	D
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	100	B
SALIPEL	***Salix pellita***	silky willow	Shrub	100	B
SALIPLA	***Salix planifolia***	flatleaf willow	Shrub	100	D
SALIVES	***Salix vestira***	rock willow	Shrub	100	D
ACHIMIL	***Achillea millefolium***	common yarrow	Herbaceous	100	A
ASTEPUN	***Arctostaphylos rubra***	red bearberry	Herbaceous	100	A
BROMUS	***Bromus*** sp.	brome	Herbaceous	100	A
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	100	B
CAREAQU	***Carex aquatilis***	water sedge	Herbaceous	100	F
CAREVAG	***Carex vaginata***	sheathed sedge	Herbaceous	100	A
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	100	A
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	100	C
GEUMRIV	***Geum rivale***	water avens	Herbaceous	100	D
GLYCERI	***Glyceria*** sp.	manna-grass	Herbaceous	100	A
LUZUPAR	***Luzula parviflora***	small-flowered woodrush	Herbaceous	100	A
POLYVIV	***Polygonum viviparum***	alpine bistort	Herbaceous	100	A
POTEPAL	***Potentilla palustris***	marsh cinquefoil	Herbaceous	100	A
PYROMIN	***Pyrola minor***	lesser wintergreen	Herbaceous	100	A
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	100	A
MNIUM	***Mnium*** sp.	star moss	Bryophyte	100	B
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	100	B
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	100	F

***Notes:** * Frequency in %: (presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100*

***** Plant cover***

T = Trace (only few individuals)	***A = less than 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype MSF07 is common across the MSF ecoregion, but it does not cover a large surface, being limited to the bottoms of big valleys and along smaller stream beds at the crest of slopes. In the Howells River basin, Ecotype MSF07 forms long, narrow ecosystems along streams and the Howells River. It is also common in the sector between Astray and Emeril and the sector between Churchill Falls and Esker, but again in limited areas. There are similar ecosystems in other boreal and taiga ecoregions in Quebec and Labrador, where the hydrological network is well developed. The plant community can, however, vary according to the local climate and the moisture regime of the watercourses.

Disturbance and succession

The Ecotype MSF07 is characterized by seasonal and episodic flooding that sometimes occurred during growth period. As for Ecotype MSF06, the location of the ecosystem near watercourses and lakes, as well as the high soil humidity, reduce the frequency and severity of forest fires. A few drill lines cross this ecotype within the LSA, affecting locally the vegetation and the biological and physical integrity of the soil.

6.2.5 MSF08 Ecotype: Black Spruce/Tamarack – Glandular Birch – Sphagnum Bog (Forested Wetland Ecosystem)

Ecotype MSF08 is common in the LSA, usually associated with complexes of wetlands composed of forest (Ecotype MSF10) and non- forest (Ecotype MSF12) fens. As for the other ecotypes associated with wetlands, Ecotype MSF08 is located in depressions and lowlands, where the drainage is imperfect or poor, but not very poor. This ecotype is usually wooded and dominated by black spruce and tamarack. The shrub layer is mostly composed of bog blueberry and Labrador tea, while the herbaceous layer is essentially made up of palmate sweet coltsfoot and wood horsetail (***Equisetum sylvaticum***). The moss layer is dominated by peatmoss. As in other ecotypes associated with wetlands, the soils are mostly of the organic order, although humic gleysols also occur. It covers a total of 1% of the LSA.

General Description of Ecotype MSF08

Soil Nutrient Regime

←Poor Rich→

Soil Moisture Regime (← Wet Dry→)

	A	B	C	D	E
0					
1					
2					
3					
4					
5					
6		MSF08			
7					
8					

Aerial View

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype MSF08	
Inventory numbers: DSO181; DSO328; DSO331 (total of 3 plots)	**Location:** Widely distributed over the entire LSA, but mostly concentrated in the southern part, where soil drainage is imperfect to poor.
Distribution within the study area: LSA: 1%	
Elevation: 537-633 m (average of 598 m)	**Typical Position:** Bottom of slopes and depressions
Topography: Flat	**Successional Status:** Only mature forest, except for one instance, reflecting infrequent forest fires.
Drainage: Imperfect to moderately well drained.	**Soil Types:** Fibrisol or humic gleysol
Soil Humus Type: Mor or Moder	**Rooting depth:** 10 to 40 cm (average of 30 cm)
Surface Deposits: Mostly organic deposits over moraine.	**Soil Moisture Regime:** 4 or 5 (mesic or subhygric)
Soil Nutrient Regime: C (medium)	**Natural/Anthropogenic Disturbance:** Episodic and seasonal (spring) flooding caused by fluctuations in the water table; some localized drill lines cross this ecotype in the LSA, disturbing the vegetation and affecting soil physical and biological integrity.
Plant Species Richness: Intermediate	**Forest Productivity:** Low
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0 to 30% (average of 18%)
Vegetation Cover Percentage: 50 to 100% (average of 86%)	**Open Water Cover Percentage:** 0 to 10% (average of 7,5%)

Typical Soil Photo

Humic Gleysol

Synthesis of Plant Diversity in Ecotype MSF08					
Species with Status: No plant species with status was encountered in Ecotype MSF08.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
LARILAR	***Larix laricina***	tamarack	Tree	67	B
PICEGLA	***Picea glauca***	white spruce	Tree	33	E
PICEMAR	***Picea mariana***	black spruce	Tree	100	D
AMELBAR	***Amelanchier bartramiana***	mountain serviceberry	Shrub	33	A
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	67	D
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	67	B
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	100	B
MYRIGAL	***Myrica gale***	sweet gale	Shrub	33	B
SALIPEL	***Salix pellita***	silky willow	Shrub	67	B
VACCANG	***Vaccinium angustifolium***	blueberry	Shrub	33	B
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	100	D
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	67	B
GAULHIS	***Gaultheria hispidula***	creeping snowberry	Low Shrub	33	B
LINNBOR	***Linnaea borealis***	twinflower	Low Shrub	33	B
RUBUCHA	***Rubus chamaemorus***	cloudberry	Low Shrub	33	C
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	33	B
CARECAN	***Carex canescens***	silvery sedge	Herbaceous	33	C
CARELIM	***Carex limosa***	mud sedge	Herbaceous	33	C
CAREPAU	***Carex pauciflora***	pauciflorus sedge	Herbaceous	33	A
CARETRS	***Carex trisperma***	three-fruited sedge	Herbaceous	33	D
CAREX	***Carex*** sp.	sedge	Herbaceous	33	A
COPTGRO	***Coptis groenlandica***	gold thread	Herbaceous	67	A
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	67	B
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	33	B
DESCFLE	***Deschampsia flexuosa***	wavy hairgrass	Herbaceous	33	A
EPILANG	***Epilobium angustifolium***	fireweed	Herbaceous	33	A
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	100	C
ERIOANG	***Eriophorum angustifolium***	narrow-leaved cottongrass	Herbaceous	33	A
GEOCLIV	***Geocaulon lividum***	false toadflax	Herbaceous	33	B
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	33	A

Synthesis of Plant Diversity in Ecotype MSF08					
Species with Status: No plant species with status was encountered in Ecotype MSF08.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	100	C
PLATDIL	***Platanthera dilatata***	scentbottle	Herbaceous	33	A
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	67	B
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	33	B
VACCOXY	***Vaccinium oxycoccos***	small cranberry	Herbaceous	33	A
VAHLAT	***Vahlodea atropurpurea***	mountain hairgrass	Herbaceous	33	D
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	33	B
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	100	F
POLYTRI	***haircap mosshum*** sp.	haircap moss	Bryophyte	33	B
SPHACOM	***Sphagnum compactum***	compact peatmoss	Bryophyte	67	E
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	100	D

***Notes:** * Frequency in %: (presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100*

***** Plant cover***

T = Trace (a few individuals)	***A = < 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype MSF08 is common across the MSF ecoregion. In the Howells River basin, Ecotype MSF08 is largely represented in complexes with other ecotypes associated with wetlands. It is also common in the sector between Astray and Emeril and the sector between Churchill Falls and Esker. Similar ecotypes are dispersed in other ecoregions of the boreal forest and the taiga in Quebec and Labrador (DFRA-Innu Nation, 2003 and CEAA, 2005).

Disturbance and succession

Episodic and seasonal flooding caused by fluctuations in the groundwater table or by persistent seepage represent the key ecological process in Ecotype MSF08. Unlike Ecotype MSF07, flooding in Ecotype MSF08 occurs when there is a rise in the groundwater table in the spring and is not related to flooding caused by the overflow of a watercourse or lake. The water from this flooding does not contain nutrients that enrich the soil. This flooding is also more persistent, which often render the soils anaerobic and reduces productivity. The high soil humidity, however, reduces the frequency of fires. The burn sites usually have dense stands of Labrador tea mixed with glandular birch, black spruce seedlings and saplings and tamarack and a recolonization of peatmoss. In the LSA, the ecosystems of Ecotype MSF08 are often crossed by drill lines, modifying locally vegetation and the biological and physical integrity of the soil.

6.2.6 Ecotype MSF10: Black Spruce Forested Fen (Forested Wetland Ecosystem)

Ecotype MSF10 is mostly concentrated in the southern portion of the LSA, where the complexes of wetlands are the most abundant. This ecotype is found in complexes with ecotypes MSF08 and MSF12. As with the other wetlands, Ecotype MSF10 is located in depressions that have poorly drained soils. This ecotype forms a gradient between the mesic ecosystems such as MSF01 and MSF05 and the non-forest wetlands such as ecotypes MSF12 and MSF14. The soils are always organic and the drainage poor. The arboreous layer is entirely dominated by black spruce and tamarack. The shrub layer is dominated by sweet gale (***Myrica gale***) and bog laurel (***Kalmia polifolia***). The herbaceous layer is varied and dominated by sedge and deergrass (***Trichophorum cespitosum***), while the moss layer is almost exclusively dominated by peatmoss. It covers a total of 1% of the LSA.

General Description of Ecotype MSF10

Soil Nutrient Regime

←Poor Rich→

Soil Moisture Regime (←Wet Dry→)

	A	B	C	D	E
0					
1					
2					
3					
4					
5					
6	**MSF10**				
7					
8					

Aerial View

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype MSF10

Inventory numbers: DSO177; DSO401 (total of 2 plots)	**Location:** Widely distributed over the entire LSA, but mostly concentrated in the southern part, where wetland complexes are most abundant. Ecotype MSF10 is almost always found in complexes with Ecotype MSF12 and Ecotype MSF14.
Distribution within the study area: LSA: 1%	
Elevation: 539-547 m (average of 543 m)	**Typical Position:** Depressions
Topography: Always associated with flat topography.	**Successional Status:** Mostly mature forests (some young forests)
Drainage: Imperfect to poor	**Soil Types:** Organic soil: fibrisol
Soil Humus Type: Organic	**Rooting depth:** 10 to 50 cm (average of 30 cm)
Surface Deposits: Thin layer of organic deposits on moraine	**Soil Moisture Regime:** 7 (6) (subhydric)
Soil Nutrient Regime: B (poor)	**Natural/Anthropogenic Disturbance:** Episodic and seasonal flooding. Some drill lines at the future mine sites cross Ecotype MSF10 altering vegetation and soil integrity locally.
Plant Species Richness: Intermediate	**Forest Productivity:** Low
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0 to 10% (average of 1.25%)
Vegetation Cover Percentage: 69 to 99% (average of 90%)	**Open Water Cover Percentage:** 0 to 20% (average of 14%)

TYpical Soil Photo

Organic Soil : Profile of Fibrisol

Synthesis of Plant Diversity in Ecotype MSF10

Species with Status:

No plant species with status was encountered in Ecotype MSF10.

Species code	Latin name	Common name	Plant form	Frequency (%)*	Cover Class **
LARILAR	***Larix laricina***	tamarack	Tree	100	B
PICEMAR	***Picea mariana***	black spruce	Tree	100	D
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	100	C
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	100	A
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	50	B
LONIVIL	***Lonicera villosa***	fly-honeysuckle	Shrub	50	A
MYRIGAL	***Myrica gale***	sweet gale	Shrub	100	D
SALIPED	***Salix pedicellaris***	bog willow	Shrub	50	B
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	50	A
LINNBOR	***Linnaea borealis***	twinflower	Low Shrub	50	B
RUBUCHA	***Rubus chamaemorus***	cloudberry	Low Shrub	50	C
ASTERAU	***Eurybia radula***	low rough aster	Herbaceous	50	B
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	50	D
CAREAQU	***Carex aquatilis***	water sedge	Herbaceous	100	D
CAREECH	***Carex echinata***	star sedge	Herbaceous	50	A
CARELEP	***Carex leptonervia***	leptonerved sedge	Herbaceous	50	D
CARELIM	***Carex limosa***	mud sedge	Herbaceous	50	B
CAREPAU	***Carex pauciflora***	pauciflorus sedge	Herbaceous	100	B
COPTGRO	***Coptis groenlandica***	gold thread	Herbaceous	50	A
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	50	A
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	50	B
ERIOPHO	***Eriophorum*** sp.	sheathed cottonsedge	Herbaceous	50	B
ERIORUS	***Eriophorum russoleum***	bog cotton	Herbaceous	50	A
ERIOVIR	***Eriophorum virginicum***	tawny bog cotton	Herbaceous	50	A
MAIATRI	***Maianthemum trifolium***	three-leaved Solomon's seal	Herbaceous	50	A
RUBUPUB	***Rubus pubescens***	hairy raspberry	Herbaceous	50	B
SMILTRI	***Smilacina trifolia***	three-leaved Solomon's seal	Herbaceous	50	A
SOLIDAG	***Solidago*** sp.	goldenrod	Herbaceous	50	B
SOLIGRA	***Solidago graminifolia***	narrow-leaved goldenrod	Herbaceous	50	B
SOLIULI	***Solidago uliginosa***	bog goldenrod	Herbaceous	50	A
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	100	D

Synthesis of Plant Diversity in Ecotype MSF10					
Species with Status: No plant species with status was encountered in Ecotype MSF10.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
VACCOXY	***Vaccinium oxycoccos***	small cranberry	Herbaceous	100	A
SPHACOM	***Sphagnum compactum***	compact peatmoss	Bryophyte	50	G
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	100	F

Notes: * ***Frequency in %:*** ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

** ***Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Without being as abundant as the MSF08 ecosystem within the MSF ecoregion, Ecotype MSF10 is often found in complexes with ecotypes MSF11 MSF12, and MSF14. Similar ecotypes are found in other boreal and taiga ecoregions in Quebec and Labrador, including the Churchill Falls region (Withford, 2008a) and around Voisey's Bay (CEAA, 2005).

Disturbance and succession

As with Ecotype MSF08, the episodic and seasonal flooding caused by fluctuations in the groundwater table or by persistent seepage constitute the key ecological process in Ecotype MSF10. Unlike Ecotype MSF07, the flooding in Ecotype MSF10 occurs when there is a rise in the groundwater table in the spring and is not related to flooding caused by the overflow of a watercourse or lake. The water from this flooding therefore does not contain nutrients that enrich the soil. This flooding is also more persistent, which often renders the soils anaerobic and reduces productivity. The forest fires in this ecotype are extremely rare. In the LSA, the ecosystems of Ecotype MSF10 are on a few occasions crossed by drill lines, modifying the vegetation and the biological and physical integrity of the soil locally. Some of the ecosystems of Ecotype MSF10 were also destroyed by past mining activities until 1982.

6.2.7 Ecotype MSF11: Structured Herb Fen (Non-Forested Wetland Ecosystem)

Although they are commonly found in the MSF ecoregion, the structured fens (MSF11), also named stringed fens, are very scattered within the LSA and are confined to the south. The vegetation is dominated by sedge and the marsh trefoil (Menyanthes trifoliata) in the water-filled depressions. The soils are organic and the drainage very poor. Ecotype MSF11 is found in complexes with ecotypes MSF10, MSF12 and MSF14. It covers less than 1% of the LSA.

General Description of Ecotype MSF11

Soil Nutrient Regime

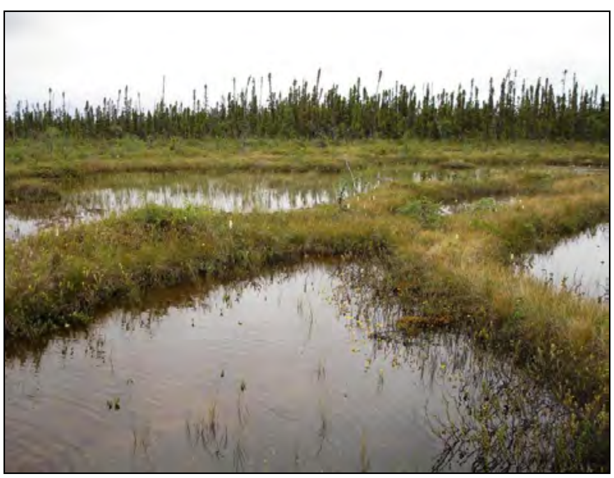
←Poor Rich→

Soil Moisture Regime (← Wet Dry→)

	A	B	C	D	E
0					
1					
2					
3					
4					
5					
6					
7					
8		**MSF11**			

Aerial View

Ground View – Stand



Ground View – Vegetation

Synthesis of Environmental Observations Ecotype MSF11	
Inventory numbers: DSO13 (total of 1 plot)	**Location:** Found in depressions where soils are very poorly drained and where seepage is slow. Rare within the LSA, restricted to a few small depressions.
Distribution within the study area: LSA: less than 1%	
Elevation: 662 m	**Typical Position** In depressions
Topography: Flat	**Successional Status:** Dominated by herb (sedge) with a few scattered shrubs.
Drainage: Poor to very poor drainage	**Soil Types:** Organic soils: fibrisol
Soil Humus Type: Organic	**Rooting depth:** 25 cm
Surface Deposits: Organic deposits in depressions	**Soil Moisture Regime:** 7 (subhydric)
R Soil Nutrient Regime: C (medium)	**Natural/Anthropogenic Disturbance:** Episodic and seasonal flooding caused by fluctuations in the water table..
Plant Species Richness: Intermediate	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0%
Vegetation Cover Percentage: 65%	**Open Water Cover Percentage:** 35%

Typical Soil Photo

Organic Soil: Profile of Fibrisol

Synthesis of Plant Diversity in Ecotype MSF 11					
Species with Status: No plant species with status was encountered in Ecotype MSF11.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
BETUGLA	***Betula glandulosa***	glandular birch	Arbuste	100	C
KALMPOL	***Kalmia polifolia***	bog laurel	Arbuste	100	A
SALIGLA	***Salix glauca***	northern willow	Arbuste	100	A
VACCULI	***Vaccinium uliginosum***	bog blueberry	Arbuste	100	B
CAREAQU	***Carex aquatilis***	water sedge	Herbacée	100	B
CARELIM	Carex limosa	mud segde	Herbacée	100	C
ERIOSPI	***Eriophorum russoleum***	bog cotton	Herbacée	100	B
MENYTRI	***Menyanthes trifoliata***	buckbean	Herbacée	73	B
TRICCES	***Trichophorum cespitosum***	deergrass	Herbacée	100	D
VACCOXY	***Vaccinium oxycoccos***	small cranberry	Herbacée	100	D
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	100	H

Notes:* *** ***Frequency in %: ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

****** ***Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecosystems of the same type as those found for Ecotype MSF11 are widely distributed in Quebec and Labrador as well as in the rest of subarctic Canada. The composition in plant species can, however, vary significantly according to the climate and regional geography (Meades, 1990). In an inventory carried out using Landsat satellite images, Meades (1990) presents the distribution of structured fens in Labrador. This study shows that there is a great abundance of these fens in the MSF ecoregion. This abundance is not, however, reflected in the LSA since the topography is more pronounced locally there than for the rest of the ecoregion, preventing the formation of a huge complex of wetlands.

Disturbance and succession

The most significant disturbance for Ecotype MSF11 is the seasonal but prolonged flooding of this type of ecosystem. The distinctive hummocks forming the structured fens are the result of a slow, lateral movement of water that has occurred since the end of last glacial period. The formation of these hummocks is still continuing today.

6.2.8 *Ecotype MSF12: Uniform Herb Fen (Non-Forested Wetland Ecosystem)*

The uniform herb fens (Ecotype MSF12) represent the most common wetland ecotype in the LSA. Just like the structured herb fens (MSF11), the uniform herb fens are ecosystems dominated by sedge. However, it has a greater concentration of shrubs dominated by glandular birch and bog willow (***Salix pedicellaris)***. Stunted black spruce and tamarack can also be found on higher microsites. The topography can be planar or with a depression in the middle of the wetland. As in other fens and peatlands, the soils are organic and usually fibrisols. The soil drainage is mostly poor, sometimes very poor, but still better than in Ecotype MSF11. Within the LSA, Ecotype MSF12 can be found in complexes beside MSF10 (forest fen) and MSF08 (bog forest) ecotypes, or alone in small isolated depressions. Ecotype MSF12 covers 2% of the LSA.

General Description of Ecotype MSF12

Soil Nutrient Regime (←Poor Rich→)

Soil Moisture Regime (←Wet Dry→)

	A	B	C	D	E
0					
1					
2					
3					
4					
5					
6					
7		MSF12			
8					

Aerial View

Ground View – Stand

Ground View – Vegetation

HEMISPHERES le groupe

Synthesis of Environmental Observations Ecotype MSF12	
Inventory numbers: DSO19; DSO71 (total of 2 plots)	**Location:** Found in depressions where soil drainage is impaired; Ecoptype MSF12 is widely distributed over the entire LSA, but mostly concentrated in the southern part; represented by either extensive wetlands or small isolated pockets in upland settings.
Distribution within the study area: LSA: 2%	
Elevation: 624-663 m (average of 638 m)	**Typical Position:** In depressions
Topography: Flat	**Successional Status:** The cover in all sites visited was dominated by herbaceous species and plant communities comprised mostly of sedges and mosses.
Drainage: Poor to very poor drainage	**Soil Types:** Organic soil: mostly fibrisol; in places melisol.
Soil Humus Type: Organic	**Rooting depth:** 20 to 40 cm (average of 30 cm)
Surface Deposits: Organic deposits	**Soil Moisture Regime:** 7 (8) (subhydric, in places hydric)
Soil Nutrient Regime: B (poor)	**Natural/Anthropogenic Disturbance:** Episodic and seasonal flooding caused by fluctuations in the water table. Some drill lines at future mining sites cross Ecotype MSF12 ecotype, disturbing soil and vegetation integrity locally.
Plant Species Richness: Intermediate	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0 to 30% (average of 2.7%)
Vegetation Cover Percentage: 55 to 95% (average of 76%)	**Open Water Cover Percentage:** 5 to 50% (average of 20%)

Typical Soil Photo

Organic Soil: Profile of Fibrisol

Synthesis of Plant Diversity in Ecotype MSF12					
Species with Status: No plant species with status was encountered in Ecotype MSF12.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
PICEMAR	***Picea mariana***	black spruce	Tree	50	C
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	100	C
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	50	A
PICEMAR	***Picea mariana***	black spruce	Shrub	100	C
SALIPED	***Salix pedicellaris***	bog willow	Shrub	50	D
SALIPEL	***Salix pellita***	silky willow	Shrub	50	C
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	50	C
RUBUCAN	***Rubus canadensis***	Canada blackberry	Low Shrub	50	C
RUBUCHA	***Rubus chamaemorus***	cloudberry	Low Shrub	50	A
ASTERAU	***Eurybia radula***	low rough aster	Herbaceous	50	A
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	50	A
CAREBIG	***Carex bigelowii***	Bigelow's sedge	Herbaceous	50	D
CAREBRU	***Carex brunnescens***	brownish sedge	Herbaceous	50	A
CARELIM	***Carex limosa***	mud sedge	Herbaceous	50	C
COPTGRO	***Coptis groenlandica***	gold thread	Herbaceous	50	A
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	50	D
EPILANG	***Epilobium angustifolium***	fireweed	Herbaceous	50	A
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	50	C
ERIOGRA	***Eriophorum gracile***	slender cottongrass	Herbaceous	100	B
GLYCFER	***Glyceria fernaldii***	Fernald's mannagrass	Herbaceous	50	D
JUNCFIL	***Juncus filiformis***	thread rush	Herbaceous	50	C
MAIATRI	***Maianthemum trifolium***	three-leaved Solomon's seal	Herbaceous	50	A
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	50	C
PLATDIL	***Platanthera dilatata***	scentbottle	Herbaceous	50	A
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	50	D
VACCOXY	***Vaccinium oxycoccos***	small cranberry	Herbaceous	50	B
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	50	D
POLYTRI	***haircap mosshum*** sp.	haircap moss	Bryophyte	50	D
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	100	G

Notes:* * *Frequency in %: ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

** ***Plant cover***

T = Trace (only few individuals)	***A = less than 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecosystems of the same type as those found for Ecotype MSF12 are widely distributed in Quebec and Labrador as well as in the rest of subarctic Canada. The composition in plant species can, however, vary significantly according to the climate and regional geography (Wiken, 1986). Ecotype MSF12 is common, but limited to small areas across the LSA.

Disturbance and succession

The most significant disturbance for Ecotype MSF12 is the seasonal but prolonged flooding of this type of ecosystem. The current fens are, in many cases, the outcome of a very slow accumulation of organic matter that has occurred since the last glaciation. On the DSOP site, a few polygons of Ecotype MSF12 are crossed by drill lines, which have affected locally the vegetation and the biological and physical integrity of the soil. Some of the ecosystems of Ecotype MSF12 were also destroyed by past mining activities.

6.2.9 Ecotype MSF14: Uniform Shrub Fen (Non-Forested Wetland Ecosystem)

Uniform shrub fens (Ecotype MSF14) are characteristic of the landscape of the LSA. As with Ecotype MSF10, they are found in the transition zone between the very humid uniform herb fen (MSF12) and the more mesic forested ecotypes (MSF08, MSF06, MSF05 and MSF01). They support shrub species that tolerate poor drainage, the most common being bog laurel and glandular birch. Bushy tamarack are also dispersed on higher microsites. As with other wetland ecotypes, the strongly gleyed soils are mostly orthic and humic gleysols. The soil drainage ranges from imperfect to poor, the sites are humic in the spring and the groundwater table declines with the arrival of summer. Ecotype MSF14 covers less than 1% of the LSA.

General Description of Ecotype MSF14

<table>
<tr><th colspan="7">Soil Nutrient Regime
←Poor Rich→</th></tr>
<tr><td>Soil Moisture Regime (←Wet Dry→)</td><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td></td><td>0</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>1</td><td></td><td></td><td></td><td></td><td></td></tr>
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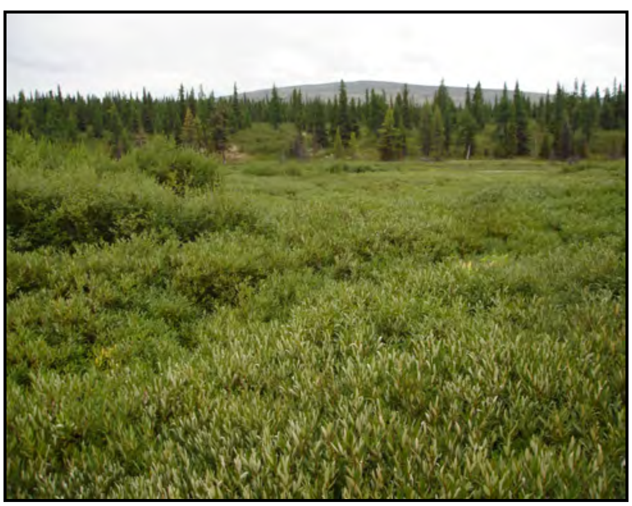
<tr><td></td><td>3</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>5</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>6</td><td></td><td colspan="3">MSF14</td><td></td></tr>
<tr><td></td><td>7</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>8</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Aerial View

Ground View – Stand



Ground View – Vegetation

HEMISPHERES le groupe

Synthesis of Environmental Observations Ecotype MSF 14	
Inventory numbers: DSO129; DSO14; DSO150; DSO151; DSO314; DSO333; DSO367 (total of 7 plots)	**Location:** Found in depressions, where soils are poorly drained. The Ecotype MSF14 is widely distributed over the intire LSA, but mostly concentrated in the southern part, where complexes of wet zones are most frequent. It is more commonlly found in association with Ecotypes MSF08, MSF10 and MSF12. Ecotype MSF14 is, in fact, transitory between Ecotype MSF11 or MSF12 and forested ecotypes such as MSF01, MSF05 or MSF08.
Distribution within the study area: LSA: Less than 1 %	
Elevation: 648-653 m (average of 651 m)	**Typical Position:** Toe of slopes or depressions
Topography: Flat	**Successional Status:** All sites visited were dominated by shrubs.
Drainage: Imperfectly to poorly drained	**Soil Types:** Humic gleysol or orthic gleysol, in places organic soils (mesisol).
Soil Humus Type: Mor (Hydromor) or Moder (Hydromoder)	**Rooting depth:** 20 cm
Surface Deposits: Thin layer of organic deposits over fine to medium moraine.	**Soil Moisture Regime:** 6(7) (hygric, in places subhydric)
Soil Nutrient Regime: B (poor)	**Natural/Anthropogenic Disturbance:** Episodic and seasonal flooding (onlyl in spring) caused by fluctuations in the water table. Certain drill lines cross Ecotoype FSM14.
Plant Species Richness: Intermediate	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0 to 20 % (average of 6 %)
Vegetation Cover Percentage: 77 to 95% (average of 86%)	**Open Water Cover Percentage:** 0 to 20% (average of 9%)

Typical Soil Photo

View of the various horizons of humic gleysol.
Note the grey colour at bottom.

Synthesis of Plant Diversity in Ecotype MSF 14

Species with Status:

No plant species with status was encountered in Ecotype MSF 14.

Species code	Latin name	Common name	Plant form	Frequency (%)*	Cover Class **
LARILAR	***Larix laricina***	tamarack	Tree	14	B
ANDRGLA	***Andromeda glaucophylla***	bog rosemary	Shrub	14	B
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	43	C
CHAMCAL	***Chamaedaphne calyculata***	leatherleaf	Shrub	14	B
KALMANG	***Kalmia angustifolia***	sheep-laurel	Shrub	14	C
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	57	B
MYRIGAL	***Myrica gale***	sweet gale	Shrub	29	B
SALIARC	***Salix arctophila***	Eastern Arctic willow	Shrub	14	B
SALIPLA	***Salix planifolia***	flatleaf willow	Shrub	14	C
SALIVES	***Salix vestira***	rock willow	Shrub	14	A
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	29	B
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	14	A
RUBUCHA	***Rubus chamaemorus***	cloudberry	Low Shrub	14	C
ASTEPUN	***Arctostaphylos rubra***	red bearberry	Herbaceous	14	A
ASTERAU	***Eurybia radula***	low rough aster	Herbaceous	43	B
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	29	B
CAREAQU	***Carex aquatilis***	water sedge	Herbaceous	57	D
CAREBUX	***Carex buxbaumii***	Buxbaum's sedge	Herbaceous	14	A
CARELEP	***Carex leptonervia***	leptonerved sedge	Herbaceous	14	A
CARELET	***Carex leptalea***	bristle-stalked ssedge	Herbaceous	14	A
CARELIM	***Carex limosa***	mud sedge	Herbaceous	86	D
CAREPAU	***Carex pauciflora***	pauciflorus sedge	Herbaceous	29	C
CAREROT	***Carex rostrata***	beaked sedge	Herbaceous	29	E
CAREUTR	***Carex utriculata***	Northwest Territory sedge	Herbaceous	14	F
CAREVAG	***Carex vaginata***	sheathed sedge	Herbaceous	14	A
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	29	A
ERIOANG	***Eriophorum angustifolium***	narrow-leaved cottongrass	Herbaceous	29	B
ERIOGRA	***Eriophorum gracile***	slender cottongrass	Herbaceous	14	A
ERIORUS	***Eriophorum russoleum***	bog cotton	Herbaceous	43	D
JUNCFIL	***Juncus filiformis***	thread rush	Herbacée	14	A

Synthesis of Plant Diversity in Ecotype MSF 14					
Species with Status: No plant species with status was encountered in Ecotype MSF 14.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ** **
MENYTRI	***Menyanthes trifoliata***	buckbean	Herbaceous	14	D
RUBUPUB	***Rubus pubescens***	hairy raspberry	Herbaceous	14	A
SMILTRI	***Smilacina trifolia***	three-leaved Solomon's seal	Herbaceous	14	C
SOLIULI	***Solidago uliginosa***	bog goldenrod	Herbaceous	14	B
TRICALP	***Trichophorum alpinum***	alpine bulrush	Herbaceous	29	B
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	57	D
TRIGMAR	***Triglochin maritima***	seaside arrowgrass	Herbaceous	29	A
VACCOXY	***Vaccinium oxycoccos***	small cranberry	Herbaceous	14	B
VAHLAT	***Vahlodea atropurpurea***	mountain hairgrass	Herbaceous	14	C
POLYTRI	***Polytrichum*** sp.	haircap moss	Bryophyte	14	D
SPHACOM	***Sphagnum compactum***	compact peatmoss	Bryophyte	43	D
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	71	F

***Notes:* * *Frequency in %:* (presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100**

***** *Plant cover***

T = Trace (only few individuals)	***A = less than 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotypes similar to the MSF14 are widely distributed across other boreal and taiga ecoregions in Labrador, in northern Quebec, as well as in the rest of subarctic Canada. The composition of the plant communities varies a lot, however, according to the climate and local geography (Wiken, 1986). Ecotype MSF14 is confined to the fringes of ecotypes MSF11and MSF12.

Disturbance and succession

Episodic and seasonal flooding caused by fluctuations in the groundwater table constitute the most significant natural disturbance affecting Ecotype MSF14. On the DSOP site, several of the polygons of Ecotype MSF14 are crossed by drill lines, affecting locally the vegetation and the biological and physical integrity of the soil. Some of the ecosystems of Ecotype MSF14 were also destroyed by past mining activities.

6.2.10 Ecotype MSF15: Uniform Riparian Shrub Fen (Non-Forested Wetland Ecosystem)

The uniform riparian shrub fen (Ecotype MSF15) is the most productive and varied non-forested ecotype in the MSF ecoregion. It has dense, varied shrub and herbaceous layers. Ecotype MSF15 is located in sites adjacent to streams and enriched either by seasonal flooding, or by seepage from watercourses. It is often found in complexes with Ecotype MSF07. The main shrub species are silky willow (***Salix pellita***) and glandular birch, and bluejoint (***Calamagrostis canadensis)***, large-leaved goldenrod and palmate sweet coltsfoot are the main herbaceous species found. The typical soils are humic regosols and humic gleysols. It covers 1% of the LSA.

General Description of Ecotype MSF15

Soil Nutrient Regime

←Poor Rich→

Soil Moisture Regime (←Wet Dry→)	A	B	C	D	E
0					
1					
2					
3					
4					
5					
6				MSF15	
7				MSF15	
8				MSF15	

Aerial View

Ground View – Stand

Ground View – Vegetation

HEMISPHERES le groupe

Synthesis of Environmental Observations Ecotype MSF15	
Inventory numbers: DSO136; DSO149; DSO175; DSO191; DSO197; DSO27; DSO28; DSO354; DSO356; DSO362; DSO74 (total of 11 plots)	**Location:** Limited to the banks of various types of streams. Ecotype MSF15 is widely distributed over the entire LSA.
Distribution within the study area: LSA: 1%	
Elevation: 541-661 m (average of 613 m)	**Typical Position:** Toe of slopes to depressions
Topography: Flat terrain or gentle slope	**Successional Status:** Low shrubs were dominant at all sites.
Drainage: Moderately well to poorly drained	**Soil Types:** Humic regosol and humic gleysol
Soil Humus Type: Mostly Moder (Mullmoder)	**Rooting depth:** 12 to 30 cm (average of 21 cm)
Surface Deposits: All surveyed deposits were fluvial or thin organic deposits covering fluvial deposits.	**Soil Moisture Regime:** Mostly 5 (subhygric), in places 6 or 7 (hygric ou subhydric).
Soil Nutrient Regime: Mostly D (rich), in places B or C (poor or medium).	**Natural/Anthropogenic Disturbance:** Episodic and seasonal (in spring and following heavy rains) flooding caused by fluctuations in stream water level. Intensive wildlife grazing. Some drill lines at the DSOP sites cross Ecotype MSF15 altering vegetation and soil integrity locally.
Plant Species Richness: High	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0 to 15% (average of 2%)
Vegetation Cover Percentage: 40 to 88% (average of 66%)	**Open Water Cover Percentage:** 5 to 50% (average of 26%)

Typical Soil Photo

View of the various horizons of humic regosol.

Synthesis of Plant Diversity in Ecotype MSF15					
Species with Status: No plant species with status was encountered in Ecotype MSF15					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
LARILAR	***Larix laricina***	tamarack	Tree	9	B
PICEGLA	***Picea glauca***	white spruce	Tree	27	B
PICEMAR	***Picea mariana***	black spruce	Tree	9	C
ALNURUG	***Alnus rugosa***	rough alder	Shrub	18	E
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	64	D
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	9	B
LONIVIL	***Lonicera villosa***	fly honeysuckle	Shrub	18	A
MYRIGAL	***Myrica gale***	sweet gale	Shrub	27	D
RIBEGLA	***Ribes glandulosum***	skunk currant	Shrub	27	C
SALIPED	***Salix pedicellaris***	bog willow	Shrub	9	D
SALIPEL	***Salix pellita***	silky willow	Shrub	64	E
SALIPLA	***Salix planifolia***	flatleaf willow	Shrub	18	E
SALIVES	***Salix vestita***	rock willow	Shrub	9	A
SALIX	***Salix*** sp.	willow	Shrub	9	A
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	9	B
ACHIMIL	***Achillea millefolium***	common yarrow	Herbaceous	27	B
AGROREP	***Agropyron repens***	quitch grass	Herbaceous	9	B
AGROSCA	***Agrostis scabra***	tickle grass	Herbaceous	9	A
ALCHFIL	***Alchemilla filicaulis***	thinstem lady's mantle	Herbaceous	18	B
ASTEPUN	***Arctostaphylos rubra***	red bearberry	Herbaceous	36	B
ASTERAU	***Eurybia radula***	low rough aster	Herbaceous	9	B
BROMCIL	***Bromus ciliatus***	fringed brome	Herbaceous	9	C
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	82	D
CAREAQU	***Carex aquatilis***	water sedge	Herbaceous	36	D
CARELEP	***Carex leptonervia***	leptonerved sedge	Herbaceous	9	D
CAREPAU	***Carex pauciflora***	pauciflorus sedge	Herbaceous	9	A
CARERAR	***Carex rariflora***	few-flowered sedge	Herbaceous	9	A
CARETRI	***Carex tribuloides***	blunt broom sedge	Herbaceous	9	A
COPTGRO	***Coptis groenlandica***	gold thread	Herbaceous	27	B
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	45	C

Synthesis of Plant Diversity in Ecotype MSF15					
Species with Status: No plant species with status was encountered in Ecotype MSF15					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	9	B
DESCFLE	***Deschampsia flexuosa***	wavy hairgrass	Herbaceous	9	B
ELYMTRA	***Elymus trachycaulus***	slender wheat grass	Herbaceous	9	A
EPILANG	***Epilobium angustifolium***	fireweed	Herbaceous	45	B
EQUIPAL	***Equisetum palustre***	marsh horsetail	Herbaceous	9	B
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	36	B
FRAGVIR	***Fragaria virginiana***	Virginia strawberry	Herbaceous	27	C
GALIUM	***Galium*** sp.	galium	Herbaceous	9	B
GEOCLIV	***Geocaulon lividum***	false toadflax	Herbaceous	9	C
GEUMRIV	***Geum rivale***	water avens	Herbaceous	27	B
GLYCFER	***Glyceria fernaldii***	Fernald’s mannagrass	Herbaceous	9	C
LOLIUM	***Lolium*** sp.	ryegrass	Herbaceous	9	D
LUZUPAR	***Luzula parviflora***	small-flowered woodrush	Herbaceous	9	A
NUPHVAR	***Nuphar variegatum***	spatterdock	Herbaceous	9	C
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	55	B
PLATDIL	***Platanthera dilatata***	scentbottle	Herbaceous	9	A
POLYVIV	***Polygonum viviparum***	alpine bistort	Herbaceous	9	A
POTEPAL	***Potentilla palustris***	marsh cinquefoil	Herbaceous	9	B
RHINMIN	***Rhinanthus minor***	Boston weed	Herbaceous	18	A
RUBUPUB	***Rubus pubescens***	hairy raspberry	Herbaceous	36	B
SOLIDAG	***Solidago*** sp**.**	goldenrod	Herbaceous	9	A
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	73	D
SPARGAN	***Sparganium*** sp**.**	bur reed	Herbaceous	9	B
STREAMP	***Streptopus amplexifolius***	clasping-leaved streptopus	Herbaceous	9	B
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	18	D
TRIEBOR	***Trientalis borealis***	broad-leaved starflower	Herbaceous	9	A
VACCOXY	***Vaccinium oxycoccos***	small cranberry	Herbaceous	9	A
VIOLINC	***Viola incognita***	largeleaf white violet	Herbaceous	9	D
CLIMDEN	***Climacium dendroides***	northern tree moss	Bryophyte	9	B
HERAMAX	***Hepatica*** sp	hepatic	Bryophyte	18	C

Synthesis of Plant Diversity in Ecotype MSF15					
Species with Status: No plant species with status was encountered in Ecotype MSF15					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
MNIUM	***Mnium*** sp.	star moss	Bryophyte	9	D
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	36	C
POLYTRI	***haircap mosshum*** sp.	haircap moss	Bryophyte	9	E
PTILCIL	***Ptilidium ciliare***	(none)	Bryophyte	9	D
PTILCRI	***Ptilium crista-castrensis***	plume moss	Bryophyte	9	B
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	45	F
TOMENIT	***Tomentypnum nitens***	shining feather moss	Bryophyte	18	D

Notes: * ***Frequency in %:*** ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

** ***Plant cover***

T = Trace (only few individuals)	***A = less than 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotypes similar to Ecotype MSF15 are widely distributed across Labrador, northern Quebec and everywhere across subarctic Canada. The composition of the plant communities can vary a lot, however, according to the climate and local geography (Wiken, 1986). Ecotype MSF15 is confined to the not very steep banks of watercourses of variable sizes.

Disturbance and succession

Episodic and seasonal flooding (in the spring or after heavy rain) is caused by fluctuations in the water levels of bordering watercourses. Each year, the flooding deposits more sediment, contributing to the maintenance of the high level of nutrients in the soil. Drill lines cross Ecotype MSF15 on the mine site and affect the local vegetation and the biological and physical integrity of the soil. Some of the ecosystems of Ecotype MSF15 were entirely destroyed by past mining activities.

6.3 The High Subarctic Tundra (HST) Ecoregion

The climate of the High Subarctic Tundra (HST) ecoregion is characterized by short, cool summers and long, windy winters. The growth period lasts only 80 to 100 days, and annual precipitation varies from 700 to 1000 mm. In the LSA, the different ecotypes of the HST ecoregion are found in the vast majority of cases at elevations higher than 650 m. The ecotypes found inside the HST are all considered to be open, i.e. devoid of arboreous vegetation. All the ecotypes in the HST ecoregion support, in fact, vegetation characteristic of the alpine tundra that is described by Meades (1990). She mentions in her report that more than 50% of the upland plateaux, characteristic of the HST ecoregion, supports vegetation dominated by shrubs, low shrubs and grass. The HST ecoregion contains discontinuous permafrost and small areas of wetlands with thin organic soils, mostly located in depressions and around lakes.

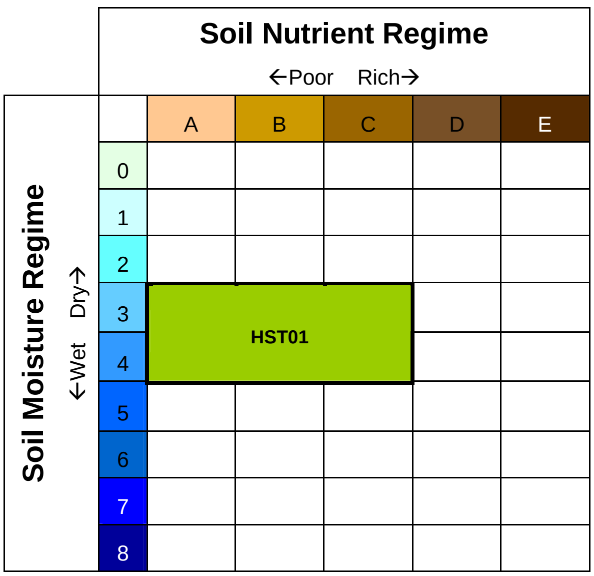
Seven ecotypes belonging to the HST ecoregion were identified as shown in the following list.

Ecotype	Complete Name	Description
High Subarctic Tundra (HST)		
01	Alpine Shrub – Glandular Birch – Mesic	Mesic ecosystem dominated by herbs and shrubs; thick till; silty texture; well to moderately well drained.
02	Rock Outcrop – Crowberry – Xeric	Dry ecosystem dominated by lichen-covered rock outcrops; thin or no soil; medium texture; very rapid drainage.
03	Low Alpine Shrub/Lichens – Subxeric	Subxeric ecosystem dominated by Ericaceae and lichen species; thin till on bedrock; medium to coarse texture; good to rapid drainage.
04	Large-leaved Goldenrod Alpine Shrub – Seepage	Ecosystem with soils enriched by seepage and dominated by tall shrubs and a dense and diverse ground cover; thick till deposits; medium or fine texture; moderate to imperfect drainage.
05	Uniform Riparian Shrub Fen	Riparian fen; fluvial or organic deposits; ground cover dominated by sedge and grass; imperfect to poor drainage.
06	Uniform Herb Fen	Uniform herb fen; organic deposits; ground cover dominated by sedge and grass; poor to very poor drainage.
07	Uniform Shrub Fen	Uniform shrub fen; dominated by diverse shrub species of the Ericaceae family; ground cover dominated by sedge and grass; poor drainage.

6.3.1 *Ecotype HST01: Alpine Shrub – Glandular Birch – Mesic*

Mostly concentrated in the northern portion of the LSA, Ecotype HST01 is also scattered in small pockets in the south. It is found on till deposits of medium texture and variable thickness. This ecotype is considered to be the zonal, or normal, ecosystem. The zonal or normal sites have one intermediate SMR and one intermediate SNR (neither too rich, nor too poor; neither too dry, nor too wet) and reflect the pressure from the climate of the ecoregion. They can be used to characterize and map the spatial boundaries of the ecoregion. The zonal sites indicate an important change in terms of regional climate and mark the boundary between the MSF and HST ecoregions. Trees are absent or infrequent (shrub forms only) within Ecotype HST01. The shrub layer is dominated by glandular birch, bog blueberry and mountain cranberry (***Vaccinium vitis-idaea***), while the herbaceous layer is dominated by Bigelow's sedge (***Carex bigelowii***) and large-leaved goldenrod. Several lichens and mosses are also found scattered on the ground cover. The soils are mostly melanic brunisols and eutric brunisols with Mor type humus, indicating an average level of nutrients in the soil. Ecotype HST01 covers 13% of the LSA.

Description of Ecotype HST01



Aerial View

No photo available

Ground View –– Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype HST01	
Inventory numbers: DSO10; DSO110; DSO118; DSO128; DSO380; DSO41; DSO42; DSO45; DSO75; DSO77; DSO87; DSO91; DSO97 (total of 13 plots)	**Location:** Develops where till is thick enough to support a continuous and diverse plant cover.
Distribution within the study area: LSA: 13 %	
Elevation: 699-854 m (average of 751 m)	**Typical Position:** Mostly at mid-slopes, sometinmes in depressions or at crest of slopes.
Topography: Undulating	**Successional Status:** Low-shrub or herbaceous species were dominant at all sites visited.
Drainage: Mostly well drained, moderately well drained in places	**Soil Types:** Melanic or eutric brunisol
Soil Humus Type: Mor	**Rooting depth:** 10 to 25 cm (average of 17 cm)
Surface Deposits: Medium to thick till	**Soil Moisture Regime:** Mostly 4 (mesic)
Soil Nutrient Regime: B (C) (poor to medium)	**Natural/Anthropogenic Disturbance:** No natural disturbance observed; drill lines at future mine sites; destruction of several of these ecosystems by former mining activity in the southern part of the LSA.
Plant Species Richness: Low	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0 to 25% (average of 6%)	**Coarse Fragment Cover Percentage:** 15 to 30% (average of 21%)
Vegetation Cover Percentage: 50 à 80% (average of 70%)	**Open Water Cover Percentage:** 0%

Typical Soil Photo

Melanic Brunisol

Synthesis of Plant Diversity in Ecotype HST01					
Species with Status: No plant species with status was encountered in Ecotype HST01.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
POPUBAL2	***Populus balsamifera***	balsam poplar	Tree	8	H
AMELBAR	***Amelanchier bartramiana***	mountain serviceberry	Shrub	8	A
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	77	D
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	38	B
SALIGLA	***Salix glauca***	northern willow	Shrub	8	A
SALIPED	***Salix pedicellaris***	bog willow	Shrub	15	B
VACCMAC	***Vaccinium macrocarpon***	large cranberry	Shrub	8	D
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	77	B
ARCTALP	***Arctostaphylos alpina***	alpine bearberry	Low Shrub	31	A
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	38	B
LOISPRO	***Loiseleuria procumbens***	alpine azalea	Low Shrub	8	B
PHYLCAE	***Phyllodoce caerulea***	purple mountain-heather	Low Shrub	15	B
VACCCAE	***Vaccinium caespitosum***	dwarf blueberry	Low Shrub	8	C
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	77	C
AGROSCA	***Agrostis scabra***	tickle grass	Herbaceous	8	A
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	31	B
CAREBIG	***Carex bigelowii***	Bigelow’s sedge	Herbaceous	69	C
CAREBRU	***Carex brunnescens***	brownish sedge	Herbaceous	15	C
CARERAR	***Carex rariflora***	few-flowered sedge	Herbaceous	8	B
CAREVAG	***Carex vaginata***	sheathed sedge	Herbaceous	8	A
CAREX	***Carex*** sp.	sedge	Herbaceous	8	A
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	8	C
DESCFLE	***Deschampsia flexuosa***	wavy hairgrass	Herbaceous	23	C
EPILANG	***Epilobium angustifolium***	fireweed	Herbaceous	8	A
ERIOANG	***Eriophorum angustifolium***	narrow-leaved cottongrass	Herbaceous	8	A
ERIOGRA	***Eriophorum gracile***	slender cottongrass	Herbaceous	8	B
ERIOSPI	***Eriophorum russoleum***	bog cotton	Herbaceous	8	H
GRAMIN	***Graminea*** sp.	graminaceous	Herbaceous	15	B
HIERALP	***Hierochloe alpina***	alpine vanilla grass	Herbaceous	8	B
JUNCEFF	***Juncus effusus***	soft rush	Herbaceous	8	D

Synthesis of Plant Diversity in Ecotype HST01					
Species with Status: No plant species with status was encountered in Ecotype HST01.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
JUNCTRI	***Juncus trifidus***	three-leaved rush	Herbaceous	8	C
JUNCUS	***Juncus*** sp.	rush	Herbaceous	8	B
LUZUCON	***Luzula confusa***	northern woodrush	Herbaceous	8	B
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	31	B
LYCOSEL	***Lycopodium selago***	northern fir moss	Herbaceous	15	A
PEDIGRO	***Pedicularis groenlandica***	Greenland lousewort	Herbaceous	8	A
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	8	B
POLYVIV	***Polygonum viviparum***	alpine bistort	Herbaceous	8	A
PYROLA	***Pyrola*** sp.	wintergreen	Herbaceous	8	B
PYROMIN	***Pyrola minor***	lesser wintergreen	Herbaceous	15	C
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	38	B
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	8	D
ALECTOR	***Alectora*** sp	alectora	Bryophyte	8	B
BRYODIV	***Bryocaulon divergens***	bryocaulon	Bryophyte	8	A
CLADCRI	***Cladonia crispata***	(none)	Bryophyte	8	B
CLADINA	***Cladina*** sp.	reindeer lichen	Bryophyte	23	D
CLADONI	***Cladonia*** sp.	(none)	Bryophyte	15	B
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	38	C
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	77	E
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	31	E
POA ARC	***Poa arctica***	Arctic bluegrass	Bryophyte	8	A
POLYTRI	***Haircap mosshum*** sp.	haircap moss	Bryophyte	15	C
PTILCIL	***Ptilidium ciliare***	(none)	Bryophyte	38	D
SPHACOM	***Sphagnum compactum***	compact peatmoss	Bryophyte	8	C
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	15	F
STEREOC	***Stereocaulon*** sp.	foam lichens	Bryophyte	15	C

Notes:* *** ***Frequency in %: ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

****** ***Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype HST01 is distributed across the HST ecoregion in western and northern Labrador, where the soils are sufficiently deep and well drained. Ecosystems of the same type as HST01 are also found in Quebec, but much more to the north, in the territory dominated by tundra. The composition of the plant species can, however, vary significantly according to the climate and regional geography.

Disturbance and succession

The main ecological process in Ecotype HST01 is the effect of the harsh subarctic climate on the development of vegetation and soil processes. The vegetation does not include trees and is typical of the HST ecoregion (Meades, 1990). Many signs of cryoturbation have also been observed on the soil surface, also reflecting the harshness of the climate. On the DSOP site, a few polygons of Ecotype HST01 are crossed by drill lines, which have affected locally the vegetation and the biological and physical integrity of the soil. Some of the ecosystems of Ecotype HST01 located in the southern part of the LSA were destroyed by past mining activities until 1982.

6.3.2 Ecotype HST02: Rock Outcrop – Crowberry – Xeri

Ecotype HST02 is dominated by rock outcrops and is mostly without vegetation. The low shrub layer is dominated by bog blueberry, crowberry (***Empetrum nigrum***) and mountain cranberry (***Vaccinium vitis-idaea***). The herbaceous layer is not very developed. The lichens growing directly on the rocks, such as those of the Rhizocarpon genus, cover most of the surface. The drainage is very rapid, the SMR is very dry (0) and the SNR poor (A). The thin (folisols) or sometimes non-existent soils show very little evidence of development. Ecotype HST01 covers 1% of the LSA.

Description of Ecotype HST02

Soil Nutrient Regime

←Poor Rich→

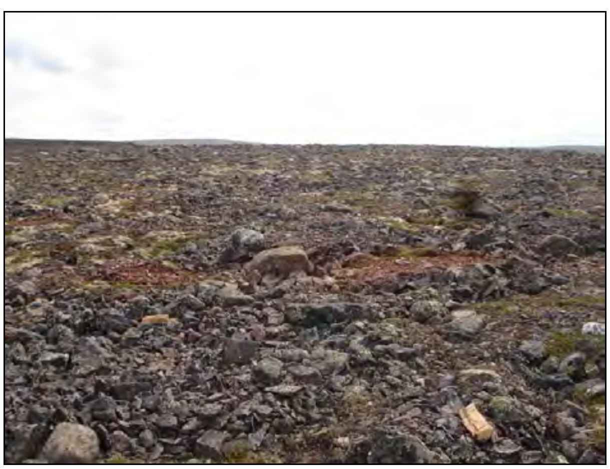
Soil Moisture Regime (← Wet DrySec)

	A	B	C	D	E
0	HST02				
1					
2					
3					
4					
5					
6					
7					
8					

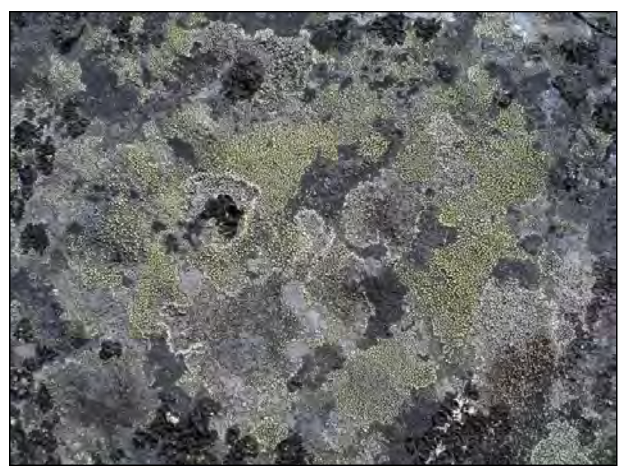
Aerial View

No photo available

Ground View – Stand

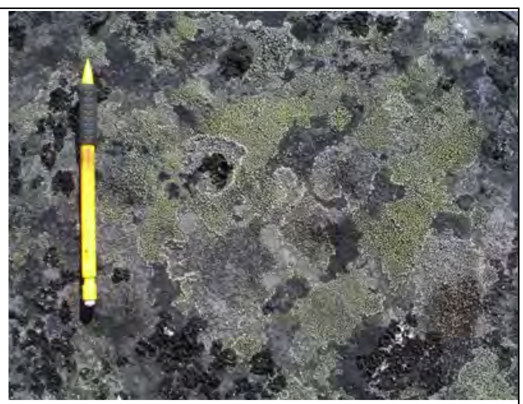


Ground View – Vegetation



Synthesis of Environmental Observations in Ecotype HST02	
Inventory numbers: DSO319; DSO320; DSO369; DSO377; DSO38; DSO82 (total of 6 plots)	**Location:** On rocky outcrops and rocky till deposits. Found over the entire LSA but mostly concentrated in the northern part.
Distribution within the study area: LSA: 1%	
Elevation: 668-761 m (average of 735 m)	**Typical Position:** Summits and crests
Topography: Undulating	**Successional Status:** Initial, dominated by rock and lichen
Drainage: Very rapid	**Soil Types:** Folisols
Soil Humus Type: Mor (if any)	**Rooting depth:** Maximum 10 cm
Surface Deposits: Rocky outcrop	**Soil Moisture Regime:** 1 and 2 (xeric and subxeric)
Soil Nutrient Regime: A (B) (very poor to poor)	**Natural/Anthropogenic Disturbance:** No disturbance observed at any of the sites visited. Some of these ecosystems were probably destroyed by former mining activity.
Plant Species Richness: Low	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 50 to 70% (average of 60%)	**Coarse Fragment Cover Percentage:** 5 to 20% (average of 13%)
Vegetation Cover Percentage: 20 to 30% (average of 25%)	**Open Water Cover Percentage:** 0%

Typical Soil Photo



Rock Outcrop

Synthesis of Plant Diversity in Ecotype HST02					
Species with Status: No plant species with status was encountered in Ecotype TSS02					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	50	B
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	17	B
LEDUPAL	***Rhododendron tomentosum***	marsh Labrador tea	Shrub	17	A
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	100	B
ARCTALP	***Arctostaphylos alpina***	alpine bearberry	Low Shrub	17	B
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	100	C
LOISPRO	***Loiseleuria procumbens***	alpine azalea	Low Shrub	67	B
PHYLCAE	***Phyllodoce caerulea***	purple mountain heather	Low Shrub	33	B
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	100	B
ARCTRUB	***Arctostaphylos rubra***	red bearberry	Herbaceous	17	B
CAREBIG	***Carex bigelowii***	Bigelow's sedge	Herbaceous	67	A
CARESAX	***Carex saxatilis***	miliary sedge	Herbaceous	17	A
JUNCTRI	***Juncus trifidus***	three-leaved rush	Herbaceous	33	A
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	17	A
ALECTOR	***Alectora*** sp.	alectora	Bryophyte	33	B
CLADCRI	***Cladonia crispata***	(none)	Bryophyte	17	B
CLADINA	***Cladina*** sp.	reindeer lichen	Bryophyte	33	C
CLADONI	***Cladonia*** sp.	(none)	Bryophyte	33	C
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	67	C
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	33	D
FLAVNIV	***Flavocetraria nivalis***	crinkled snow lichen	Bryophyte	33	B
PTILCIL	***Ptilidium ciliare***	(none)	Bryophyte	17	B
RACOMIT	***Racomitrium*** sp.	(none)	Bryophyte	17	D
RHIZGEO	***Rhizocarpon*** sp.	map lichen	Bryophyte	100	F
SALIUVA	***Salix uva-ursi***	bearberry willow	Bryophyte	17	B

Notes: * ***Frequency in %:*** ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

** ***Plant cover***

T = Trace (only few individuals)	***A = less than 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype HST02 is distributed across the HST ecoregion in western and northern Labrador, where there is thin or no soil. Ecosystems of the same type as HST02 are also found in Quebec, but much more to the north, in the territory dominated by tundra. The composition of the plant species can, however, vary significantly according to the climate and regional geography. These types of ecosystems are also common in the relatively high-elevation boreal ecoregions south of the Quebec-Labrador border.

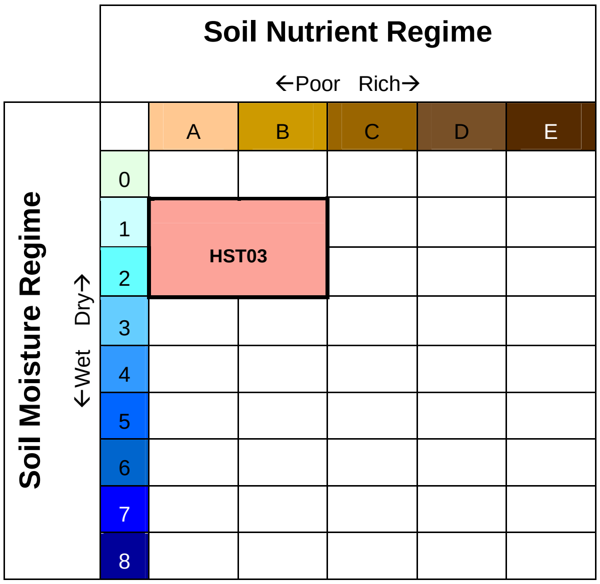
Natural disturbance and succession

As a result of the presence of rocky substrate and soils ranging from thin to non-existent, Ecotype HST02 is permanently in the initial stage of succession. No anthropogenic disturbances were observed during field work. Some of these ecosystems were, however, probably destroyed by past mining activities.

6.3.3 Ecotype HST03: Low Alpine Shrub/Lichens – Subxeric

Ecotype HST03 is found throughout the LSA, but mostly concentrated in the north. Ecotype HST03 supports a community of plant species suited to drought conditions and a harsh climate. The shrub layer is dominated by glandular birch, crowberry and bog blueberry. The herbaceous layer is not very developed and the bryophyte layer is dominated by lichens. Ecotype HST03 is usually supported by thin, or very thin, tills. The soils are thin and dominated by frequently cryoturbated melanic brunisols and eutric brunisols, with Mor type humus. This is the most common and widespread ecotype in the HST portion of the LSA. This ecotype occupies 43 % of the LSA.

Description of Ecotype HST03



Aerial View

No photo available

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype HST03	
Inventory Numbers : DSO01; DSO11; DSO124; DSO300; DSO36; DSO37; DSO376; DSO40; DSO49; DSO54; DSO61; DSO96; DSO99. (total of 13 plots)	**Location:** Mostly concentrated in the northern part of the LSA. Ecotype HST03 is also found in the southern part in a mosaic with ecotypes of the MSF Ecoregion. Exposure to wind is very high, especially in winter.
Distribution within the study area: LSA: 43 %	
Elevation: 625-806 m (average of 724 m)	**Typical Position:** Mostly at upper slope, sometimes at mid-slope or at summit.
Topography: Rolling or gentle slope	**Successional Status:** All sites visited were dominated by low-shrub vegetation.
Drainage: Mostly rapid. In places well drained	**Soil Types:** Melanic Brunisol or thin Euthric Brunisol.
Soil Humus Type: Mor	**Rooting Depth:** 15 to 25 cm (average of 20 cm)
Soil Nutrient Type: Fine matrix tills with a low percentage of rock outcrop	**Soil Moisture Regime:** 3 and 2 (submesic and subxeric)
Surface Deposits:: B (A) (poor, in places very poor)	**Natural/Anthropogenic Disturbance:** No disturbance was observed at any of the visited sites.
Plant Species Richness: Low	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0 to 20% (average of 7%)	**Coarse Fragment Cover Percentage:** 15 to 50% (average of 33%)
Vegetation Cover Percentage: 35 to 85 % (average of 54%)	**Open Water Cover Percentage:** 0%

Typical Soil Photo

Eutric Brunisol

Synthesis of Plant Diversity in Ecotype HST03					
pecies with Status: No plant species with status was encountered in Ecotype HST03.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
BETUGLA	***Betula glandulosa***	blandular birch	Shrub	100	D
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	8	C
VACCANG	***Vaccinium angustifolium***	blueberry	Shrub	8	A
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	100	C
ARCTALP	***Arctostaphylos alpina***	alpine bearberry	Low Shrub	54	B
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	100	C
LOISPRO	***Loiseleuria procumbens***	alpine azalea	Low Shrub	62	B
PHYLCAE	***Phyllodoce caerulea***	purple mountain-heather	Low Shrub	15	B
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	46	A
ARCTRUB	***Arctostaphylos rubra***	red bearberry	Herbaceous	8	C
CAREBIG	***Carex bigelowii***	Bigelow's Sedge	Herbaceous	46	A
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	15	B
DIAPLAP	***Diapensia lapponica***	Lapland diapensia	Herbaceous	8	A
HARRHYP	***Harrimanella hypnoides***	moss bell heather	Herbaceous	8	A
JUNCTR	***Juncus trifidus***	three-leaved rush	Herbaceous	15	A
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	38	B
LYCOSEL	***Lycopodium selago***	northern fir-moss	Herbaceous	54	A
PYROMIN	***Pyrola minor***	lesser wintergreeb	Herbaceous	15	A
CLADINA	***Cladina*** sp.	reindeer lichen	Bryophyte	46	C
CLADONI	***Cladonia*** sp.	(none)	Bryophyte	23	B
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	69	D
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	77	E
FLAVNIV	***Flavocetraria nivalis***	crinkled snow lichen	Bryophyte	8	C
POLYTRI	***Polytrichum*** sp.	haircap moss	Bryophyte	15	B
PTILCIL	***Ptilidium ciliare***	(none)	Bryophyte	23	D
RACOMIT	***Racomitrium*** sp.	(none)	Bryophyte	31	C
RHIZGEO	***Rhizocarpon geographicum***	map lichen	Bryophyte	8	D
SALIUVA	***Salix uva-ursi***	bearberry willow	Bryophyte	15	B
STEREOC	***Stereocaulon*** sp.	foam lichens	Bryophyte	15	C

***Notes:* * *Frequency in %:* (presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100**

HEMISPHERES le groupe

** ***Plant cover***

T = Trace (only few individuals)	***A = less than 1%***	***B = 1 to 5%***
C = 5 to 10%	***D = 10 to 25%***	***E = 25 to 40%***
F = 40 to 60%	***G = 60 to 80%***	***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype HST03 usually occupies landforms characterized by thin soil on rock. Given the abundance of such landforms in western and northern Labrador, Ecotype HST03 is likely very widespread there outside the LSA. Ecosystems of the same type as HST03 are also found in Quebec on thin soil, but much more to the north, in the territory dominated by tundra. The composition of the plant species can, however, vary significantly according to the climate and regional geography.

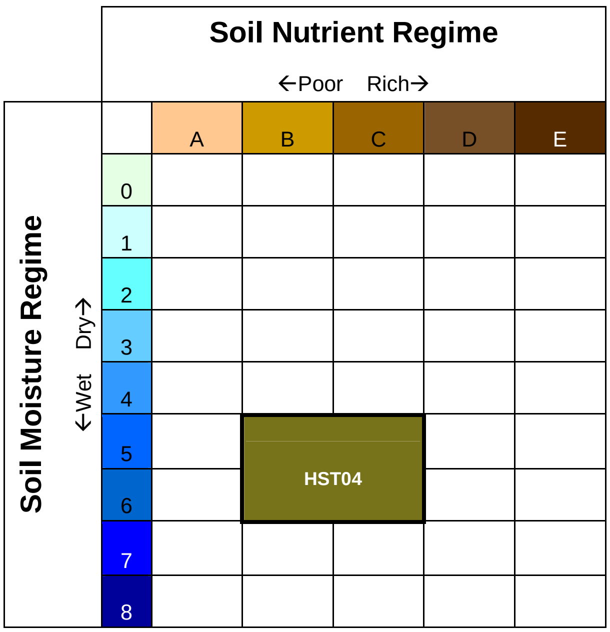
Natural disturbance and succession

The effects on the vegetation and the soil processes caused by rapid drainage (thin soil on rocky substrate) and exposure to harsh, drying winter minds are the main natural disturbances in Ecotype HST. Several drill and bulk sampling lines cross the HST03 ecotype throughout the LSA, affecting locally the vegetation and the biological and physical integrity of the soil. Some of these ecosystems were entirely destroyed, however, by past mining activities.

6.3.4 Ecotype HST04: Large-leaved Goldenrod Alpine Shrub – Seepage

Ecotype HST04 is found everywhere in the LSA, but mostly concentrated in the north, on the plateau at a higher elevation. This ecosystem is dominated by tall shrubs, mostly glandular birch and species of willow. The herbaceous layer is varied and dense, and is well protected by the shrub foliage. It is mostly composed of large-leaved goldenrod and palmate sweet coltsfoot. The arboreous layer is non-existent or insignificant. Ecotype HST04 is found on thick basal tills of medium texture, often at bottom of slope, where seepage is present, which makes the ground more humid and richer than in Ecotype HST01. The soils are usually gleyed (humic gleysol or orthic gleysol), reflecting persistent seepage, and the humus forms are mostly Hemimor, or even Moder, indicating a medium to rich SNR. This ecotype occupies 1% of the LSA.

Description of Ecotype HST04



Aerial View

No photo available

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype HST04	
Inventory numbers: DSO105; DSO30; DSO389; DSO81; DSO90 (total of 5 plots)	**Location:** Restricted to parts of the LSA located above 650 m. Partially protected from dessicating winds, which makes possible the growth of high shrubs. Seepage is present much of the year.
Distribution within the study area: LSA: 1 %	
Elevation: 686-768 m (average of 730 m)	**Typical Position:** Mid to lower slope
Topography: Gently slope or or wide depressions	**Successional Status:** All sites visited were dominated by shrubs.
Drainage: Moderately well drained	**Soil Types:** Humic gleysol or orthic gleysol
Soil Humus Type: Moder (Mullmoder) and Mor	**Rooting depth:** 25 cm
Surface Deposits: Thick layer of lodgment or ablation tills	**Soil Moisture Regime:** 5 and 4 (subhygric and mesic)
Soil Nutrient Regime: B to D (poor to rich)	**Natural/Anthropogenic Disturbance:** No disturbance was observed at any of the sites visited.
Plant Species Richness: Intermediate	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 10 to 25% (average of 18%)
Vegetation Cover Percentage: 65 to 90% (average of 78%)	**Open Water Cover Percentage:** 0 to 10% (average of 5%)

Typical Soil Photo

Humic gleysol with seepage

Synthesis of Plant Diversity in Ecotype HST 04

Species with Status:

No plant species with status was encountered in Ecotype HST04.

Species code	Latin name	Common name	Plant form	Frequency (%)*	Cover Class **
ALNURUG	***Alnus rugosa***	speckled alder	Shrub	20	F
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	80	D
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	20	D
SALIPEL	***Salix pellita***	silky willow	Shrub	20	D
SALIPLA	***Salix planifolia***	flatleaf willow	Shrub	20	C
SALIVES	***Salix vestita***	rock willow	Shrub	20	C
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	40	C
VIBUEDU	***Viburnum edule***	mooseberry	Shrub	20	C
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	20	B
POTETRI	***Potentilla tridentata***	three-toothed cinquefoil	Low Shrub	40	B
RUBUPUB	***Rubus pubescens***	hairy raspberry	Low Shrub	20	B
VACCCAE	***Vaccinium caespitosum***	dwarf billberry	Low Shrub	20	B
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	40	B
ACHIMIL	***Achillea millefolium***	common yarrow	Herbaceous	20	A
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	40	C
CAREGYN	***Carex gynocrates***	ridged sedge	Herbaceous	20	A
CARELEP	***Carex leptonervia***	leptonerved sedge	Herbaceous	20	D
CAREVAG	***Carex vaginata***	sheathed sedge	Herbaceous	20	A
COPTGRO	***Coptis groenlandica***	threeleaf goldthread	Herbaceous	20	A
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	20	B
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	40	C
FRAGVIR	***Fragaria virginiana***	Virginia Strawberry	Herbaceous	20	B
GRAMIN	***Graminea*** sp.	grasses	Herbaceous	20	E
LUZUPAR	***Luzula parviflora***	small-flowered woodrush	Herbaceous	20	B
LYCOANN	***Lycopodium annotinum***	stiff clubmoss	Herbaceous	40	B
PETAPAL	***Petasites palmatus***	sweet petasites	Herbaceous	60	B
POLYVIV	***Polygonum viviparum***	alpine bistort	Herbaceous	20	A
PYROMIN	***Pyrola minor***	lesser wintergreen	Herbaceous	20	A
SENEPAU	***Senecio pauciflorus***	few-flowered senecio	Herbaceous	20	B
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	100	D

HEMISPHERES
le groupe

Synthesis of Plant Diversity in Ecotype HST 04					
Species with Status: No plant species with status was encountered in Ecotype HST04.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
STELLON	***Stellaria longifolia***	long-leaved chickweed	Herbaceous	20	B
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	20	B
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	20	C
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	40	C
FLAVCUC	***Flavocetraria cucullata***	(none)	Bryophyte	20	B
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	80	E
POLYTRI	***Polytrichum*** sp.	haircap moss	Bryophyte	40	G
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	80	D

Notes:* *** ***Frequency in %: ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

****** ***Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Ecotype HST04 is distributed throughout in HST ecoregion, where persistent zones of seepage are found. Ecosystems of the same type as HST04 are also found in Quebec on thick soil, but much more to the north, in the territory dominated by tundra. The composition of the plant species can, however, vary significantly according to the climate and regional geography.

Disturbance and succession

The main ecological process of Ecotype HST04 is the effect of persistent seepage in protected depressions. This has produced a lush community of tall shrubs, where the availability of nutrients is normally poor and the winter winds are persistent. The drainage from sites on upper slopes provides a constant supply of humidity and nutrients, and the ecosystems of Ecotype HST04 are located at bottom of slope, usually sheltered from the wind. A few drill and bulk sampling lines cross Ecotype HST04 throughout the LSA, affecting locally the vegetation and the biological and physical integrity of the soil. Some of these ecosystems were entirely destroyed, however, by past mining activities.

6.3.5 Ecotype HST05: Uniform Riparian Shrub Fen

Ecotype HST05, the uniform riparian shrub fen, is found along watercourses, where the high humidity and strong concentrations of nutrients increase the productivity and diversity of plant species. Ecotype HST05 is characterized by a dense layer of shrubs mostly composed of glandular birch and silky willow, as well as by a varied herbaceous layer mostly composed of large-leaved goldenrod, gold thread (***Pedicularis groenlandica***) and tufted hairgrass. Flooding is periodical and significant in the spring or after heavy precipitation. The drainage is moderate to imperfect. Sediment is deposited locally by floodwater, while the soils are enriched by underground irrigation from watercourses. The soils are mostly cumulic regosols, where there is sedimentation, and gleyed brunisols, where there is underground irrigation, but no sedimentation. The SMR varies between submesic and subhydric, depending on periodical flooding, and the SNR is rich. This ecotype occupies 1% of the LSA.

Description of Ecotype HST05

Soil Nutrient Regime

←Poor Rich→

Soil Moisture Regime ←Wet Dry→

	A	B	C	D	E
0					
1					
2					
3					
4					
5				HST05	
6					
7					
8					

Aerial View

No photo available

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations Ecotype HST05	
Inventory numbers: DSO103; DSO104; DSO122; DSO381 (total of 4 plots)	**Location:** Restricted to parts of the LSA located above 650 m. Exclusively along watercourses.
Distribution within the study area: LSA: 1%	
Elevation: 675 to 757 m (average of 713 m)	**Typical Position:** Depressions
Topography: Gentle slope, bottom of valley	**Successional Status:** All sites visited were dominated by shrubs.
Drainage: Mmoderately to imperfectly drained	**Soil Types:** Humic regosol, cumulic regosol or gleyinig brunisol
Soil Humus Type: Mormoder or absent	**Rooting depth:** 15 to 25 cm (average of 18 cm)
Surface Deposits: All sites visited had fluvial deposits.	**Soil Moisture Regime:** 5 (6) (subhygric at the time of the visits, but variable throughout the year depending on flooding)
Soil Nutrient Regime: C-D (medium to rich)	**Natural/Anthropogenic Disturbance:** Periodical flooding; no anthropogenic disturbance was observed on the visited sites.
Plant Species Richness: High	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0 to 50% (average of17%)	**Coarse Fragment Cover Percentage:** 2 to 5% (average of 4%)
Vegetation Cover Percentage: 25 to 98% (average of 68%)	**Open Water Cover Percentage:** 0 to 15% (average of 7%)

Typical Soil Photo

Humic Regosol with underground irrigation coming from the watercourse

Synthesis of Plant Diversity in Ecotype HST05

Species with Status:

No plant species with status was encountered in Ecotype HST05.

Species code	Latin name	Common name	Plant form	Frequency (%)*	Cover Class **
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	75	D
KALMPOL	***Kalmia polifolia***	bog-laurel	Shrub	25	B
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	25	B
MYRIGAL	***Myrica gale***	sweet gale	Shrub	25	C
SALIARC	***Salix arctophila***	Eastern Arctic willow	Shrub	25	C
SALIPEL	***Salix pellita***	silky willow	Shrub	50	D
VACCMAC	***Vaccinium macrocarpon***	large cranberry	Shrub	25	C
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	25	B
EMPENIG	***Empetrum nigrum***	crowberry	Low Shrub	25	B
PHYLCAE	***Phyllodoce caerulea***	purple mountain-heather	Low Shrub	25	A
POTETRI	***Potentilla tridentata***	three-toothed cinquefoil	Low Shrub	75	B
VACCCAE	***Vaccinium caespitosum***	dwarf blueberry	Low Shrub	25	B
VACCVIT	***Vaccinium vitis-idaea***	mountain cranberry	Low Shrub	25	B
ACHIMIL	***Achillea millefolium***	common yarrow	Herbaceous	50	C
AGROREP	***Agropyron repens***	quitch grass	Herbaceous	25	A
AGROSCA	***Agrostis scabra***	tickle grass	Herbaceous	25	B
ALCHFIL	***Alchemilla filicaulis***	thinstem lady's mantle	Herbaceous	25	B
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	25	B
CAREAQU	***Carex aquatilis***	water sedge	Herbaceous	25	C
CAREGYN	***Carex gynocrates***	ridged sedge	Herbaceous	25	A
CARELEP	***Carex leptonervia***	leptonerved sedge	Herbaceous	25	D
CARELIM	***Carex limosa***	mud sedge	Herbaceous	25	B
CARERAR	***Carex rariflora***	few-flowered sedge	Herbaceous	25	A
CARESAX	***Carex saxatilis***	miliary sedge	Herbaceous	25	B
CAREVAG	***Carex vaginata***	sheathed sedge	Herbaceous	25	B
DANTHON	***Danthonia*** sp.	oat-grass	Herbaceous	25	B
DANTSPI	***Danthonia spicata***	poverty oat-grass	Herbaceous	25	C
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	75	B
DESCFLE	***Deschampsia flexuosa***	wavy hairgrass	Herbaceous	50	B
ELYMTRA	***Elymus trachycaulus***	slender wheat grass	Herbaceous	25	D

Synthesis of Plant Diversity in Ecotype HST05					
Species with Status: No plant species with status was encountered in Ecotype HST05.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	25	C
GEUMRIV	***Geum rivale***	water avens	Herbaceous	25	B
JUNCTRI	***Juncus trifidus***	three-leaved rush	Herbaceous	25	D
LUZUPAR	***Luzula parviflora***	small-flowered woodrush	Herbaceous	25	A
LYCOALP	***Lycopodium alpinum***	alpine club-moss	Herbaceous	25	C
PACKIND	***Packera indecora***	elegant groundsel	Herbaceous	25	A
PEDIGRO	***Pedicularis groenlandica***	Greenland lousewort	Herbaceous	100	B
PETAPAL	***Petasites palmatus***	sweet petasites	Herbaceous	50	B
PHEGCON	***Phegopteris connectilis***	longbeech fern	Herbaceous	25	A
PHLEALP	***Phleum alpinum***	alpine Timothy	Herbaceous	25	A
POTEPAL	***Potentilla palustris***	marsh cinquefoil	Herbaceous	25	A
PYROMIN	***Pyrola minor***	lesser wintergreen	Herbaceous	25	D
SENEPAU	***Senecio pauciflorus***	few-flowered senecio	Herbaceous	50	A
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	100	C
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	50	B
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	25	C
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	50	C
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	75	E

Notes: * Frequency in %: (presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100

***** Plant cover***

T = Trace (only few individuals)   A = less than 1%   B = 1 to 5%
C = 5 to 10%   D = 10 to 25%   E = 25 to 40%
F = 40 to 60%   G = 60 to 80%   H = 80 to 100%

HEMISPHERES le groupe

Distribution of the ecotype and presence in other similar ecoregions

Ecotype HST05 is distributed throughout the HST ecoregion, along permanent watercourses. No intermittent watercourses support this ecotype, since the drainage by them is too good, and the level of humidity and nutrients is consequently too low. Ecosystems of the same type as HST05 are also found in Quebec in similar ecoregions, but located much more to the north, in the territory dominated by tundra. The composition of the plant species can, however, vary significantly according to the climate and regional geography.

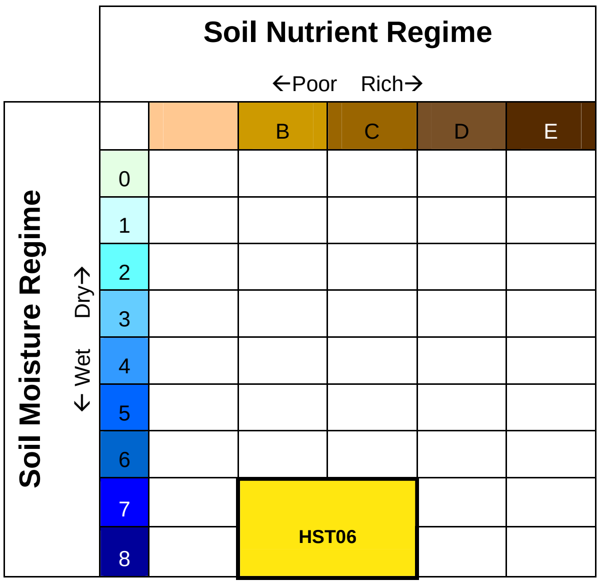
Disturbance and succession

The main ecological processes of Ecotype HST05 are the flooding as well as the underground irrigation coming from watercourses. These two processes enrich the soils of the ecosystems of Ecotype HST05, increasing their productivity and their plant diversity. These ecosystems are, in fact, the richest and most varied of the HST ecoregion. Drill and bulk sampling lines were observed on a few occasions crossing Ecotype HST05 throughout the LSA, affecting locally the vegetation and the biological and physical integrity of the soil. Some of these ecosystems were entirely destroyed, however, by past mining activities.

6.3.6 Ecotype HST06: Uniform Herb Fen

Ecotype HST06 is the high-elevation equivalent of Ecotype MSF12. The uniform herb fens are ecosystems dominated by sedge and sheathed cottonsedge (***Eriophorum*** sp.), but the dominant species are not the same ones as in low-elevation fens, reflecting a climate similar to that in the tundra. The ecosystems of Ecotype HST06 are found in the bottoms of depressions or adjacent to small lakes, where the drainage is sufficiently poor to generate the development of organic deposits. The soils are organic, usually fibrisols. Soil of the Cryosol order was identified, confirming the presence of permafrost (Trenhaile, 2004). The soil drainage is very poor and the sites are very humid in the spring, the groundwater table dropping slightly with the arrival of summer. Ecotype HST06 covers less than 1% of the LSA.

Description of Ecotype HST06



Aerial View

No photo available

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype HST06	
Inventory numbers: DSO02; DSO115; DSO171; DSO306; DSO341; DSO83; DSO98 (total of 7 plots)	**Location:** Restricted to parts of the LSA located above 650 m. Exclusively located in depressions or on the periphery of lakes.
Distribution within the study area: SLA: less than 1%	
Elevation: 610-793 m (average of 710 m)	**Typical Position:** Depression
Topography: Flat	**Successional Status:** All sites visited were dominated by herbaceous vegetation.
Drainage: Imperfectly to poorly drained.	**Soil Types:** Fibrisol or organic cryosol
Soil Humus Type: Organic	**Rooting Depth:** 15 to 40 cm (average of 25 cm)
Surface Deposits: Organic	**Soil Moisture Regime:** 7-8 (hygric to hydric)
Soil Nutrient Regime: B (poor)	**Natural/Anthropogenic Disturbances:** Continuous flooding with a high water table; only one anthropogenic disturbance (exploration drilling) noted in the northern part of the LSA.
Plant Species Richness: Intermediate	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 0 to 3% (average of 2%)
Vegetation Cover Percentage: 70 to 92% (average of 81%)	**Open Water Cover Percentage:** 5 to 30 % (average of 18%)

Typical Soil Photo

Cross section of fibrisol

Synthesis of Plant Diversity in Ecotype HST06					
Species with Status: No plant species with status was encountered in Ecotype HST06.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
ALNURUG	***Alnus rugosa***	speckled alder	Shrub	14	F
ANDRGLA	***Andromeda glaucophylla***	bog rosemary	Shrub	14	A
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	86	D
KALMPOL	***Kalmia polifolia***	bog-laurel	Shrub	57	A
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	71	B
RIBEGLA	***Ribes glandulosum***	skunk currant	Shrub	14	A
SALIARC	***Salix arctophila***	Eastern Arctic willow	Shrub	29	A
SALIPEL	***Salix pellita***	silky willow	Shrub	29	B
SALIPLA	***Salix planifolia***	flatleaf willow	Shrub	14	B
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	71	B
RUBUCHA	***Rubus chamaemorus***	cloudberry	Low Shrub	29	B
AGROSCA	***Agrostis scabra***	tickle grass	Herbaceous	14	B
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	14	B
CAREAQU	***Carex aquatilis***	water sedge	Herbaceous	29	D
CAREEXI	***Carex exilis***	starved sedge	Herbaceous	14	D
CARELAC	***Carex lacustris***	lake sedge	Herbaceous	14	C
CARELIM	***Carex limosa***	mud sedge	Herbaceous	71	B
CARERAR	***Carex rariflora***	few-flowered sedge	Herbaceous	14	B
CAREROS	***Carex rossii***	Ross' sedge	Herbaceous	14	D
CAREROT	***Carex rostrata***	beaked sedge	Herbaceous	29	B
CARESAX	***Carex saxatilis***	miliary sedge	Herbaceous	14	A
CORNCAN	***Cornus canadensis***	bunchberry	Herbaceous	14	C
DESCCES	***Deschampsia cespitosa***	tufted hairgrass	Herbaceous	14	D
EQUISYL	***Equisetum sylvaticum***	wood horsetail	Herbaceous	14	C
ERIOANG	***Eriophorum angustifolium***	narrow-leaved cottongrass	Herbaceous	57	C
ERIOGRA	***Eriophorum gracile***	slender cottongrass	Herbaceous	29	D
ERIORUS	***Eriophorum russoleum***	bog cotton	Herbaceous	29	C
LYCOALP	***Lycopodium alpinum***	alpine club-moss	Herbaceous	14	B
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	14	D
LYCOSEL	***Lycopodium selago***	northern fir-moss	Herbaceous	14	A

Synthesis of Plant Diversity in Ecotype HST06					
Species with Status: No plant species with status was encountered in Ecotype HST06.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
PEDIGRO	***Pedicularis groenlandica***	Greenland lousewort	Herbaceous	14	B
PETAPAL	***Petasites palmatus***	palmed petasite	Herbaceous	14	B
POLYVIV	***Polygonum viviparum***	alpine bistort	Herbaceous	29	A
POTEPAL	***Potentilla palustris***	marsh cinquefoil	Herbaceous	29	B
PYROMIN	***Pyrola minor***	lesser wintergreen	Herbaceous	14	C
SENEPAU	***Senecio pauciflorus***	few-flowered senecio	Herbaceous	29	A
SOLIMAC	***Solidago macrophylla***	large-leaved goldenrod	Herbaceous	29	D
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	86	F
TRIEBOR	***Trientalis borealis***	broad-leaved starflower	Herbaceous	14	A
CLADRAN	***Cladina rangiferina***	grey reindeer lichen	Bryophyte	14	D
CLADSTE	***Cladina stellaris***	star-tipped reindeer lichen	Bryophyte	14	C
PLEUSCH	***Pleurozium schreberi***	red-stemmed feathermoss	Bryophyte	29	E
SPHACOM	***Sphagnum compactum***	compact peatmoss	Bryophyte	29	F
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	86	F
STEREOC	***Stereocaulon*** sp.	foam lichens	Bryophyte	14	C
TOMENIT	***Tomentypnum nitens***	shining feather moss	Bryophyte	14	B

***Notes:* * *Frequency in %:* (presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100**

**** *Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregion

Ecotype HST06 occupies depressions and perimeters of lakes in the landscape of the LSA. It is common, but confined to small areas. Further south, there are, however, huge complexes of fens within the HST ecoregion. This is the case, for example, in the sector between Esker and Churchill Falls (Gartner Lee Limited and Groupe Hémisphères, 2007). The same ecotype is also found in boreal forest and much farther north in Quebec, in depressions and on the perimeters of lakes. The composition of the plant species can, however, vary significantly according to the climate and regional geography.

Disturbance and succession

The main natural disturbance in Ecotype HST06 consists of episodic and seasonal flooding caused by fluctuations in the groundwater table. These can flood the ecosystem for long periods. Strong winds also blow on the plateaux, subjecting them to a long, cold winter. Exploration drilling was done in an ecosystem belonging to Ecotype HST06 in the northern part of the LSA, affecting locally the vegetation and the biological and physical integrity of the soil. Some of these ecosystems were entirely destroyed, however, by past mining activities.

6.3.7 Ecotype HST07: Uniform Shrub Fen

Uniform shrub fens (Ecotype HST07) are infrequent in the landscape of the LSA. These ecosystems are confined to the transition zone between the uniform herb fen (HST06), very humid, and the more mesic ecotypes (HST04 and HST01). No bushy trees were revorded. The shrub species that are found tolerate poor drainage, the most common being silky willow and glandular birch. The most common herbaceous plants are species of sedge and sheathed cottonsedge, as well as palmate sweet coltsfoot and bluejoint. As in other wetland ecotypes, the soils are either organic (fibrisols), strongly gleyed (orthic gleysols and humic gleysols). The soil drainage varies from imperfect to poor and the sites are hydric in the spring, when the groundwater table is highest. The humidity level of the soil decreases, however, with the arrival of summer. Ecotype HST07 covers less than 1% of the LSA.

Description of Ecotype HST07

Soil Nutrient Regime

←Poor Rich→

Soil Moisture Regime (←wet Dry→)

	A	B	C	D	E
0					
1					
2					
3					
4					
5					
6					
7		HST07	HST07		
8					

Aerial View

No photo available

Ground View – Stand

Ground View – Vegetation

Synthesis of Environmental Observations in Ecotype HST07	
Numéro d'inventaire: DSO388; DSO46 (total of 2 plots)	**Location:** Found in depressions or bordering lakes where soils are poorly drained. Ecotype HST07 is distributed over the entire LSA, but mostly concentrated in the northern part, where most of the HST Ecoregion is located. It is commonly found in association with Ecotype HST06. In fact Ecotype HST07 is transitory between the mesic Ecotypes HST04 or HST01 and Ecotype HST06 (herbaceous fen).
Distribution within the study area: SLA: less than 1%	
Elevation: 696 to 702 m (average of 699 m)	**Typical Position:** Depression
Topography: Flat	**Successional Status:** All sites visited were dominated by shrubs.
Drainage: Poor	**Soil types:** Organic soils organiques (fribrisol) or gleysols (ortic gleysols or humic gleysol)
Soil Humus Type: Organic	**Rooting Depth:** 15 cm
Surface Deposits: Organic or thick till	**Soil Moisture Regime:** 6 (7) (hygric,in places subhydric)
Soil Nutrient Regime: B or D (poor or rich if enriched by seepage)	**Natural/Anthropogenic Disturbances:** Periodic flooding with a high water table in the spring; only one anthropogenic disturbance (exploration drilling) was observed in the northern part of the LSA.
Plant Species Richness: High	**Forest Productivity:** None
Rock Outcrop Cover Percentage: 0%	**Coarse Fragment Cover Percentage:** 5 to 20% (average of 12,5%)
Vegetation Cover Percentage: 40 to 70% (average of 55%)	**Open Water Cover Percentage:** 10 to 15% (average of 12,5 %)

Typical Soil Photo

Cross section of fibrisol

Synthesis of Plant Diversity in Ecotype HST 07					
Species with Status: No plant species with status was encountered in Ecotype HST07.					
Species code	**Latin name**	**Common name**	**Plant form**	**Frequency (%)***	**Cover Class ****
BETUGLA	***Betula glandulosa***	glandular birch	Shrub	100	D
KALMPOL	***Kalmia polifolia***	bog laurel	Shrub	50	A
LEDUGRO	***Ledum groenlandicum***	Labrador tea	Shrub	50	B
SALIARC	***Salix arctophila***	eastern arctic willow	Shrub	50	D
SALIGLA	***Salix glauca***	northern willow	Shrub	50	A
SALIPEL	***Salix pellita***	silky willow	Shrub	100	C
SALIPLA	***Salix planifolia***	flatleaf willow	Shrub	50	D
VACCULI	***Vaccinium uliginosum***	bog blueberry	Shrub	50	C
EMPENIG	***Empetrum nigrum***	crowberry	Low shrub	50	C
VACCCAE	***Vaccinium caespitosum***	dwarf blueberry	Low shrub	50	A
AGROSCA	***Agrostis scabra***	tickle grass	Herbaceous	50	B
CALACAN	***Calamagrostis canadensis***	bluejoint	Herbaceous	100	B
CAREAQU	***Carex aquatilis***	water sedge	Herbaceous	100	C
CARECAN	***Carex canescens***	silvery sedge	Herbaceous	50	C
CARELIM	***Carex limosa***	mud sedge	Herbaceous	100	C
CARESAX	***Carex saxatilis***	miliary sedge	Herbaceous	50	E
EQUIFLU	***Equisetum fluviatile***	water horsetail	Herbaceous	50	B
ERIOGLA	***Eriophorum angustifolium***	narrow-leaved cottongrass	Herbaceous	50	D
ERIOGRA	***Eriophorum gracile***	slender cottongrass	Herbaceous	50	A
LYCOANN	***Lycopodium annotinum***	stiff club-moss	Herbaceous	50	B
PETAPAL	***Petasites palmatus***	palmate sweet coltsfoot	Herbaceous	100	B
RHINANT	***Rhinanthus*** sp.	rhinanthus sp.	Herbaceous	50	B
TRICCES	***Trichophorum cespitosum***	deergrass	Herbaceous	50	D
SPHACOM	***Sphagnum compactum***	compact peatmoss	Bryophyte	50	F
SPHAGNU	***Sphagnum*** sp.	peatmoss	Bryophyte	50	D

Notes: * ***Frequency in %:*** ***(presence of plant in surveyed ecosystem/total number of samples for this ecosystem) X 100***

** ***Plant cover***

T = Trace (only few individuals) ***A = less than 1%*** ***B = 1 to 5%***
C = 5 to 10% ***D = 10 to 25%*** ***E = 25 to 40%***
F = 40 to 60% ***G = 60 to 80%*** ***H = 80 to 100%***

Distribution of the ecotype and presence in other similar ecoregions

Within the LSA, Ecotype HST07 is limited to the fringes of HST06 ecotypes and lakes. Ecotypes similar to the HST07 are widely distributed across other boreal and taiga ecoregions in Labrador, northern Quebec, as well as in the rest of subarctic and arctic Canada. The composition of the plant communities varies greatly, however, according to the climate and local geography (Wiken, 1986).

Disturbance and succession

Episodic and seasonal flooding caused by fluctuations in the groundwater table constitute the most significant natural disturbance affecting Ecotype HST07. In the LSA, a single polygon represented by Ecotype HST07 is crossed by drill lines, affecting locally the vegetation and the biological and physical integrity of the soil. Some of the ecosystems of Ecotype HST07 were also destroyed by past mining activities.

6.4 Anthropogenically Altered Landscapes

A substantial portion of the LSA (approximately 9%) has been disturbed by previous mining activity, which culminated in 1982, in some cases to such an extent that the original condition of the landscape is no longer recognizable. Mining-related alterations to the landscape include large open pits; extensive piles of unprocessed, ore-rich rock, waste rock and tailings; numerous test pits and trenches; survey cut-lines; access roads and landings; and abandoned camps, infrastructure and equipment. In anthropogenically altered areas that have not been disturbed for several decades, pioneer species of vegetation have begun to colonize the surface. The rate of colonization has been slow, though, most likely due to the harsh climate, rocky soils and concentrated mineralization. The following pioneer plant species were usually found on those sites: rough alder (Alnus rugosa), bearberry willow (Salix uva-ursi), flatleaf willow (Salix planifolia), dwarf birch (Betula glandulosa) as well as several grass species. Those species should seriously be seen as good candidates for mined sites (old roads and railway, tailing, etc.) restoration.

Open pits up to several hundred metres across and more than a hundred metres deep represent the most significant alteration to the landscape. They have steep bedrock walls and are commonly partly filled with groundwater and surface runoff. Evidence of recent rockfalls from the walls of the pit was observed. Within the deepest pits, snow drifts persist well into the summer at the base of the north-facing walls. For the most part, very little vegetation has grown within the pits, except where groundwater seeps from the walls or around the perimeter of pit-bottom lakes that have formed.

Most of the pits are surrounded by giant piles of unprocessed or waste rock, which represent thousands of truck loads of blasted material. The flanks of the rock piles typically maintain a natural repose angle of approximately 35o, except where erosion has led to slope failures and slope wash. Due to the silty to fine sandy nature of the rock piles, gullying and piping processes have deformed the margins of the piles and led to a reduction in flank steepness. Iron-stained soils and vegetation representing a ‘halo’ of influence are common around the piles, where rainfall and snowmelt have carried fine sediments beyond the original limits of the piles.

The surface of the rock piles commonly exhibits a gravelly armour layer, a lag deposit left by wind that has blown away the finest sediments. They also tend to be fairly dry, given the relatively uniform distribution of grain sizes and their mode of deposition. However, willow and alder species have begun to colonize the piles, particularly where wind-blown fine sediments have been deposited or in shallow depressions that retain their moisture. The establishment of shrubs triggers more rapid colonization, due to the added shelter provided by the vegetation, as well as the source of seeds.

The absence of frost boils or other signs of cryoturbation in the rock piles suggests that permafrost has not permeated the deposits, as one might expect farther north. This observation also corroborates the hypothesis that isolated areas of permafrost on high, windswept ridges are relic features from a cooler, early post-glacial climate.

Summary Table – Anthropogenically Altered Landscapes	
Distribution: Scattered throughout the LSA, with concentrated nodes of disturbance near Sectors 2 and 3 (9% of the total areal coverage)	**Material Composition:** Silt, sand, gravel, boulders; bedrock in walls of open pits
Landform Sub-types: N/A	**Sorting:** Poor
Depositional Origin: Dumped from trucks, blasted	**Drainage:** Moderately well to well drained
Topographic Surface Expression: Planar to undulating; locally hummocky	**Soil Types:** Regosols
Thickness: 0 m (erosional) to >100 m (deposits)	**Associated Ecotypes:** No related ecotype
Variability: Flank steepness less than repose due to slope failures and washing; blast rock (boulders) mixed with finer material	**Special Considerations:** Silt-rich deposits predisposed to slope failures; fresh disturbance of surface can expose fine sediments to wind or water erosion
Landform: 	**Material:** 

7 TERRESTRIAL ECOSYSTEM DESCRIPTION OF LOCAL STUDY AREA SUB-UNITS

The following section summarizes the general terrain and ecosystem characteristics within the LSA and illustrates the strong dependency of the identified ecotypes on terrain features. Table 4 summarizes the approximate areal distributions of landforms and ecotypes.

Table 4. Areal Distribution of Landforms (a) and Ecotypes (b) within the LSA

a)

Landform Code	Landform	% Areal Coverage in LSA
AP	Alluvial plain	2
CS	Slope failure	0
CT	Talus pile	0
GK	Kame, kame field, kame terrace, kame moraine	0
GO	Outwash plain, valley train	0
MG	Ground moraine	76
OT	Organic terrain	4
RN	Bedrock knob	0
RR	Bedrock ridge	9
	Disturbed terrain associated with previous mining activities	9
Total:		**100**

b)

Ecotypes code	Ecotypes description	% Areal Coverage in LSA
Mid Subarctic Forest (MSF)		
01	Black Spruce/White Spruce – Labrador Tea – Feathermoss	10
02	Crowberry – Map Lichen – Rock Outcrop	0
03	Glandular Birch – Crowberry –Thin Soil	0
04	Black Spruce – Lichen – Rock	0
05	Black Spruce – Lichen – Open Forest	15
06	White Spruce/Black Spruce – Feathermoss Seepage	2
07	White Spruce – Willow-Sedges – Riparian	1
08	Black Spruce/Tamarack – Glandular Birch – Sphagnum Bog	1
09	Tamarack/Black Spruce – Sedges – Fluvial Fen	0
10	Black Spruce Forested Fen	0
11	Structured Herb Fen	0
12	Uniform Herb Fen	2
13	Non-Uniform Herb Fen	0
14	Uniform Shrub Fen	0
15	Uniform Riparian Shrub Fen	1
	TOTAL MSF	**32**
High Subarctic Tundra (HST)		
01	Alpine Shrub – Glandular Birch – Mesic	13
02	Rock Outcrop – Crowberry – Xeric	1
03	Low Alpine Shrub/Lichens – Subxeric	43
04	Large-leaved Goldenrod Alpine Shrub – Seepage	0
05	Uniform Riparian Shrub Fen	1
06	Uniform Herb Fen	0
07	Uniform Shrub Fen	0
	TOTAL HST	**58**
Disturbed terrain associated with previous mining activities		**10**
	TOTAL	**100**

7.1 Local study area presentation

The types and characteristics of the terrestrial ecosystems within the LSA reflect the thickness and continuity of Surface deposits and soil, the local drainage conditions and the elevation and aspect. The LSA can be broken down into two distinct ecoclimatic types: the MSF Ecoregion below about 650 mASL, and the HST Ecoregion above this elevation (Annexe III). Below 650 mASL, the landscape is largely forested, with forested and non-forested wetlands in depressions. Above 650 mASL, a suite of largely treeless terrestrial ecosystems occurs that more closely resembles the arctic tundra ecosystems of northern Labrador and Quebec. As in arctic ecosystems, wind is an important factor in the distribution and composition of terrestrial ecosystems above 650 mASL. Slope aspect also influences the distribution of the HST and MSF ecosystems. It is not uncommon to observe MSF ecosystems above 650 mASL on southwest-facing slopes exposed to the sun.

Bedrock is exposed in 9 % of the LSA. Outcrops (RN and RR) with moderate relief (i.e., 15-60 m) are common in high elevation ridge crests, which were subjected to the most intense glacial scour, but are uncommon in low-relief upland areas and in valleys. Through weathering, mainly frost shatter, many bedrock surfaces have accumulated a thin cover of cobbles and boulders (bRN and bRR), which can be distinguished from till-derived boulders by their distinct angularity and occasional jigsaw-like arrangement (Figure 5). In general, exposed bedrock is well to rapidly drained, with thin Regosolic or Brunisolic soils restricted to fractures and sheltered depressions. Bedrock-dominated areas are covered by Ecotypes HST02 and HST03.

Although punctuated by isolated bedrock outcrops, till (tMG) has by far the greatest areal coverage of any landform within the LSA, 76 %. Discontinuous till veneers (<2 m) predominate on upper valleysides and the flanks of ridges, typically representing a transitional area between exposed bedrock and thicker, more continuous till blankets. Silty sand till veneers typically support well-drained soils and vegetation communities tolerant of periodic dry conditions. For example, within the LSA, Ecotypes MSF05 and HST03 cover a large, continuous area of well-drained till. However, thick, moderately drained till located on lower slopes is covered by MSF01, MSF06, HST01 and HST04.

Till blankets ranging in thickness from about 2 to 5 m occupy middle and lower valleysides, as well as valley bottoms not subjected to major erosion by glacial meltwater. Landforms composed of till most commonly exhibit a low-relief (i.e., <15 m), rolling to undulating surface expression, except where the underlying bedrock is rugged. Cobbley ablation till, deposited in association with downwasting ice and meltwater, exhibits a low-relief hummocky surface expression (Figure 6). Rail cuts and valleyside scarps reveal localized areas of till with depths of more than 10 m. Although much more common in the Howells River Valley, boulder fields derived from meltwater-washed till were observed in some valleyside positions. On slopes, the till is generally well drained, supporting Ecotype MSF01. In localized depressions and low-lying areas, however, the till may be moderately to moderately well drained. The soil moisture in these areas is sufficient to promote the development of gleysol soils and support Ecotypes MSF08 and, to a lesser extent, HST07.

Less than 1 % of the LSA is mapped as colluvium. Colluvial deposits, in the form of talus aprons below cliffs, are widespread but generally too small to be mapped at a scale of 1:20,000. A few isolated mass-movement deposits are identified in the northern half of the LSA. In most cases, their downslope movement appears to be occurring through creep and, possibly, solifluction. These isolated deposits may be relic features of early post-glacial time, and no longer active. If stable enough, colluvial landforms support Ecotypes MSF01 (coarse phase) with limited tree development and HST04 (coarse phase).

Evidence of glacial meltwater floods is widespread within the LSA. Extensive valleyside deposits of till have been dissected, or channelled, by meltwater, in places exposing underlying bedrock. However, surprisingly few glaciofluvial deposits exist (less than 1 % of areal coverage). A number of cobble-boulder spillways and small outwash fans occur in the vicinity of DSO4 (Figure 7). The fans are only moderately sorted sand, gravel and cobbles; they contain enough silt that most exhibit moderate to imperfect drainage. Ecotypes MSF05 and HST03 are commonly associated with such glaciofluvial landforms. Certain narrow valleys and low-lying areas in the vicinity of Star Lake contain outwash terraces and fine sandy outwash veneers. Ecotypes MSF01 and, to a lesser extent, MSF06 are commonly associated with those areas.

Several streams, which tend to follow the roughly northwest-southeast-oriented bedrock fractures and fold axes, exist within the LSA (2 % of areal coverage). Their beds are commonly armoured with cobble and boulder pavements derived from the underlying till substrate. However, most have discontinuous alluvial floodplains composed of sand and silt, with localized organics. Imperfectly drained Cumulic Regosols in such floodplain areas support diverse vegetation communities such as those associated with Ecotypes MSF07, MSF15 and HST05. Bedrock is exposed in some stream beds, forming cascade or step-pool channels with less diverse riparian vegetation (Figure 8). Riparain areas have a high biodiversity compared to the rest of the LSA and are important habitats for wildlife.

Wetlands are scattered throughout the LSA, typically occupying eroded fractures within the underlying bedrock, isolated depressions within a rolling till blanket or low-lying areas at the confluence of surface or subsurface drainage paths. They have an areal coverage of 4 %, much lower than was the case in the LabMag Iron Ore Project LSA. Most wetlands (pOT) are shallow, as indicated by boulders exposed in their centres, and exhibit poorly to very poorly drained mineral soils. Ecotypes MSF10, MSF12, MSF14, HST06 and HST07 are associated with wetlands. Some, however, contain peaty organic material with thicknesses up to several metres. The groundwater table is at or near surface throughout the wetlands, with areas of open water being common. Some wetlands have formed along the base of the valleysides in association with groundwater seepage areas. All soils associated with fen wetlands are either Mesisol or Fibrisol (Organic Order) of various depths. As for the riparian areas, the wetlands shelter specific plant communities representing unique habitats for herptiles, birds and various mammals.

A considerable portion of the LSA (i.e., 9 %) has been anthropogenically disturbed (A), mainly by mining activity, which ended in 1982. Alongside open pit mines, waste rock and tailings piles are up to 100 m high. Some have existed and been stable long enough that vegetation, mainly willows and grasses, has begun to establish itself on the surface, particularly in pockets of fine sediment. Abandoned access roads, as well as the spoil from test pits and trenches, are also becoming vegetated.

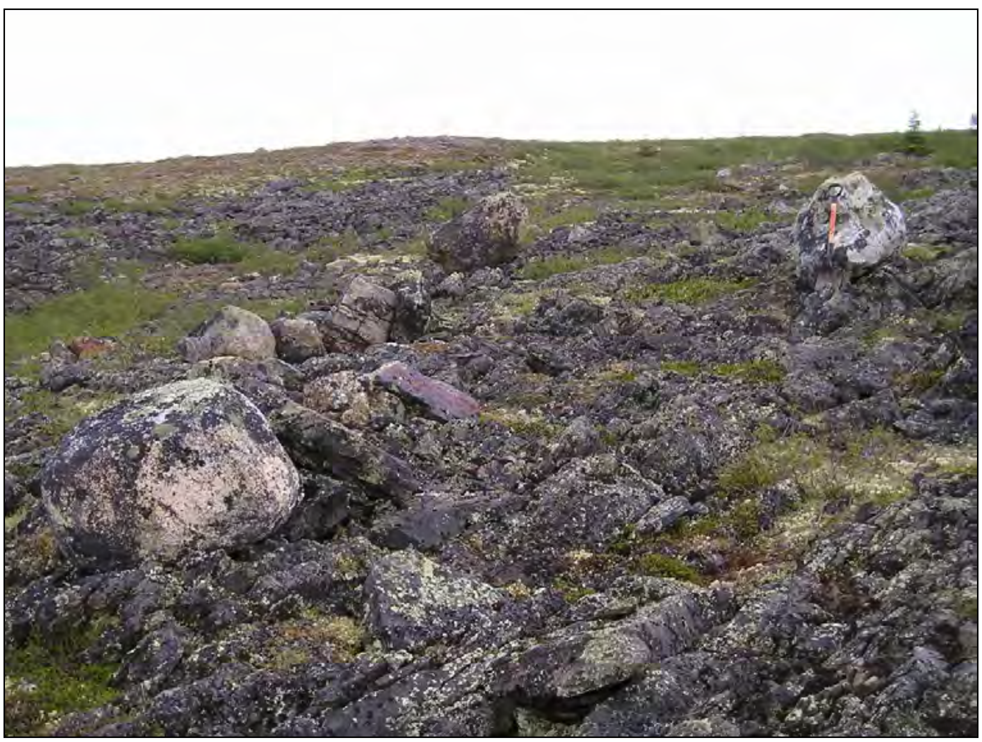


Figure 5. Frost-Shattered Bedrock and Rounded Till-Derived Boulders

Figure 6. Cobbley Ablation Till near Star Lake

Figure 7. Sinuous Cobble-Boulder Meltwater Spillway near DSO4

Figure 8. Bedrock Step-Pool Stream

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8 BIBLIOGRAPHY

Acterre (2006a). ***LabMag Iron Ore Project Terrestrial Ecosystem Literature Review***. Rapport soumis à LabMag GP Inc.

Acterre (2006b). ***LabMag Iron Ore Project Rare Plants Field Identification Cards***. Rapport soumis à LabMag GP Inc.

Andrews, J.T., G.H. Miller, J.-S. Vincent and W.W. Shilts (1986). ***Quaternary correlations in Arctic Canada***. Quaternary Science Reviews 5: 243-249.

CEAA (2005). ***Voisey's Bay Mine and Mill Environmental Assessment Panel Report – Section 12: Terrestrial Environment and Wildlife***. Agence canadienne de l'évaluation environnementale, Ottawa, Ontario, site internet http://www.ceaa.gc.ca/010/0001/0001/0011/0002/12_e.htm, consulté le 08-08-12.

Canadian System of Soil Classification (1998). ***The Canadian system of soil classification***. Troisième édition. Soil Classification Working Group, Direction de la recherche, Agriculture et Agroalimentaire Canada, Ottawa.

Comité d'experts sur la prospection pédologique d'agriculture Canada (1987). ***Le système canadien de classification des sols***, 2e éd., Publication 1646 du ministère de l'Agriculture du Canada,170 p.

DFRA-Innu Nation (2003). ***Forest Ecosystem Strategy Plan for Forest Management District No. 19***. Rapport preparé par l'équipe de planification de la Innu Nation et le ***Department of Forest Resources and Agrifoods***, Terre-Neuve-et-Labrador, site internet http://www.env.gov.nl.ca/env/Env/EA%202001/pdf%20files/1062%20%20Crown%20District%2019A%20Forest % 20Plan%20-%20Goose%20Bay/Strategy%20Plan/Text.pdf, consulté le 08-07-02.

Gartner, J.F., J.D. Mollard and M.A. Roed (1981). ***Ontario Engineering Geology Terrain Study Users' Manual***. Commission géologique de l'Ontario, Northern Ontario Engineering Geology Terrain Study 1, 51 pp.

Gartner Lee Limited et Groupe Hémisphères (2007). ***LabMag Iron Ore Project Labrador Study Area Terrestrial Ecosystem Mapping***. Rapport présenté à LabMag GP Inc. 132 p., 54 cartes et 16 annexes.

Gore, P. (1979). ***Mass Wasting, Georgia Perimeter College.*** Site internet http://gpc.edu/~pgore/geology/geo101/masswasting.html, consulté le 08-08-02.

Green, R., R.L. Trowbridge and K. Klinka (1993). ***Towards a taxonomic classification of humus forms***. Supplement to Forest Sciences, Vol. 39, No. 1, Washington, D.C.

Klassen, R.A., S. Paradis, A.M. Bolduc and R.D. Thomas (1992). ***Glacial landforms and deposits***, Labrador, Terre-Neuve et l'est du Québec. Commission géologique du Canada, Carte 1814A, échelle 1:1 000 000.

LabMag GP Inc. (2006). ***LabMag Iron Ore Project: Project Description/Registration***. Soumis à l'Agence canadienne de l'évaluation environnementale.

Legros, J.P. (2007). ***Les grands sols du monde***. Presse Polytechniques et Universitaires Romandes, Lausane, Fig2.52, 574 p. Consulté en ligne le 08-12-05 http://books.google.ca/books?id=g9dj-Flnr_4C&pg=PA80&lpg=PA80&dq=cl%C3%A9+de+d%C3%A9termination+des+principales+formes+d'humus&source=web&ots=gEV2NEPciy&sig=WK5PbZBKRxm9GGW0oinSo_OyEIo&hl=fr&sa=X&oi=book_result&resnum=1&ct=result.

Lopoukhine, N., D. Proute and H. Hirvonen (1978). ***Ecological Land Classification of Labrador – A Reconnaissance. Ecological Land Classification Series No. 4***. Environnement Canada, Hull, QC, 85 pp.

Meades, S.J. (1990). ***Natural Regions of Newfoundland and Labrador***. Protected Areas Association. 374 pp.

MRNFP (2003). ***Norme de cartographie écoforestière, troisième inventaire écoforestier***. Ministère des Ressources naturelles, de la Faune et des Parcs. Direction des inventaires forestiers. 95pp.

MOE (2008). Site internet http://www.env.gov.bc.ca/ecology/tem/, consulté le 08-09-25.

MoELP-MoF (1998). ***Field Manual for Describing Terrestrial Ecosystems***. Land Management Handbook No. 25. Ministry of Environment, Lands and Parks et Ministry of Forests, Colombie-Britannique, site internet http://ilmbwww.gov.bc.ca/risc/pubs/teecolo/fmdte/deif.htm, consulté le 08-09-25.

Nicholson, F.H. (1971). ***Evolution of the Landscape of the Schefferville area***. In The Physical Environment of the Schefferville Area, ***McGill Sub-Arctic Research Laboratory***, McGill University, 2 pp.

Nicholson, F.H. (1978). ***Special Project. Prediction of Permafrost Distribution for Subarctic Mining Operations***. Rapport final. ***McGill Subarctic Research Station***, Schefferville, Quebec.

Nicholson, F.H. and J.S. Lewis (1976). ***Active Layer and Suprapermafrost Groundwater Studies***, Schefferville, Quebec. Réimprimé de ***Proceedings of the 2nd Conference on Soil Water Problems in Cold Regions***, September 1-2, 1976. Edmonton, Alberta. p. 15-30.

Pryer, R.W.J. (s.d). Mine Railroads in Labrador-Ungava. Quebec North Shore and Labrador Railway Co., Canada.

RIC (1997). ***Standard for Terrestrial Ecosystem Mapping in British Columbia***. Resource Inventory Committee, Colombie-Britannique, site internet http://ilmbwww.gov.bc.ca/risc/pubs/teecolo/tem/indextem.htm, consulté le 08-07-15.

Robitaille, A. et J.-P. Saucier (1998). ***Paysages régionaux du Québec méridional***. Direction de la gestion des stocks forestiers et la direction des relations publiques du ministère des Ressources naturelles du Québec. Les Publications du Québec, 213 p.

Trenhaile, A.S. (2004). ***Geomorphology: A Canadian Perspective***. Oxford University Press, 440 pp.

VENUS (2002). ***Version 5.0, RIC, Ecosystems Working Group***. Ministry of Environment, Lands and Parks, et Ministry of Forests, Colombie-Britannique.

Wardle, R.J., C.F. Gower, B. Ryan, G.A.G. Nunn, D.T. James and A. Kerr (1997). ***Geological Map of Labrador, 1:1 000 000 scale***. Department of Energy and Mines, Terre-Neuve-et-Labrador, inventaires géologiques, Carte 97-07.

Wiken, E. (1986). ***A National Ecological Framework for Canada – Overview***. Ecological Land Classification Series No. 19. Environnement Canada, Hull, QC, 26 pp. + carte.

Withford, J. (2008a). ***Project Area Ecological Land Classification, Lower Churchill Hydroelectric Generation Project.*** Report prepared for Newfoundland and Labrador Hydro, St. John's, NL. Minaskuat Inc. 2008b. Regional Ecological Land Classification Environmental Baseline Report (LCP 5357722). Report prepared for Newfoundland and Labrador Hydro, St. John's, NL***.***

Wyroll, K.H. (1971). ***The geology of the Schefferville area***. In The Physical Environment of the Schefferville Area, ***McGill Sub-Arctic Research Laboratory***, McGill University, 6 pp.

HEMISPHERES le groupe

APPENDICES

APPENDIX I

METADATA

Table A. Metadata of the ArcGIS™ Terrestrial Ecosystems Mapping Shape File

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
FID	Unique identifier attributed by the database	Automatically generated by the database		
Shape	Type of object		Point, line, polygon	
ID	Ecosystem polygons numbered in the order of digitizing	Numbered by air-photo interpreter	Refer directly to the Excel/ArcGIS TEM databases	Directly digitized in ArcGIS format
TERRNOCODE	Polygon number in the attribute table	Generated directly in the Excel database on surficial deposits		
TERRLABEL	Attribute label of surficial deposits polygon	Labeled by air-photo interpreter in the Excel database on surficial deposits		
D1_Ov_mat1	Least dominant material in first dominant landform	Air-photo interpretation, inference from understanding of landform origin, and representative field checks	Table L	Gartner ***et al***. (1981).
D1_Ov_mat2	Middle dominant material in first dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D1_Ov_mat3	Most dominant material in first dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D1_Ov_Land	First dominant landform (if two dominant landforms present, then this landform is slightly more prevalent than the second dominant landform)	Air-photo interpretation and representative field checks	Table M	Identical to D1_Ov_mat1
D1_Un_mat1	Least dominant material in landform that underlies first dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D1_Un_mat2	Middle dominant material in landform that underlies first dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D1_Un_mat3	Most dominant material in landform that underlies first dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
D1_Un_Land	Landform that underlies first dominant landform (only present if first dominant landform overlies another landform; if D1_Un_Land = R (bedrock), then first dominant landform thickness is <1-2 m)	Identical to D1_Ov_Land	Table M	Identical to D1_Ov_mat1
D2_Ov_mat1	Least dominant material in second dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D2_Ov_mat2	Middle dominant material in second dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D2_Ov_mat3	Most dominant material in second dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D2_Ov_Land	Second dominant landform (if two dominant landforms present, then this landform is slightly less prevalent than the first dominant landform)	Identical to D1_Ov_Land	Table M	Identical to D1_Ov_mat1
D2_Un_mat1	Least dominant material in landform that underlies second dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D2_Un_mat2	Middle dominant material in landform that underlies second dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D2_Un_mat3	Most dominant material in landform that underlies second dominant landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
D2_Un_Land	Landform that underlies second dominant landform (only present if second dominant landform overlies another landform; if D2_Un_Land = R (bedrock), then second dominant landform thickness is <2 m)	Identical to D1_Ov_Land	Table M	Identical to D1_Ov_mat1
S1_Ov_mat1	Least dominant material in first subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
S1_Ov_mat2	Middle dominant material in first subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S1_Ov_mat3	Most dominant material in first subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S1_Ov_Land	First subordinate landform (if two subordinate landforms present, then this landform is slightly more prevalent than the second subordinate landform)	Identical to D1_Ov_Land	Table M	Identical to D1_Ov_mat1
S1_Un_mat1	Least dominant material in landform that underlies first subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S1_Un_mat2	Middle dominant material in landform that underlies first subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S1_Un_mat3	Most dominant material in landform that underlies first subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S1_Un_Land	Landform that underlies first subordinate landform (only present if first subordinate landform overlies another landform; if S1_Un_Land = R (bedrock), then first subordinate landform thickness is <2 m)	Identical to D1_Ov_Land	Table M	Identical to D1_Ov_mat1
S2_Ov_mat1	Least dominant material in second subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S2_Ov_mat2	Middle dominant material in second subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S2_Ov_mat3	Most dominant material in second subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S2_Ov_Land	Second subordinate landform (if two subordinate landforms present, then this landform is slightly less prevalent	Identical to D1_Ov_Land	Table M	Identical to D1_Ov_mat1

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
	than the first subordinate landform)			
S2_Un_mat1	Least dominant material in landform that underlies second subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S2_Un_mat2	Middle dominant material in landform that underlies second subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S2_Un_mat3	Most dominant material in landform that underlies second subordinate landform	Identical to D1_Ov_mat1	Table L	Identical to D1_Ov_mat1
S2_Un_Land	Landform that underlies second subordinate landform (only present if second subordinate landform overlies another landform; if S2_Un_Land = R (bedrock), then second subordinate landform thickness is <2 m)	Identical to D1_Ov_Land	Table M	Identical to D1_Ov_mat1
Dom_relief	Local topographic relief of first dominant landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1
Dom_topog1	Most dominant topographic variety (surface expression) of first dominant landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1
Dom_topog2	Middle dominant topographic variety (surface expression) of first dominant landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1
Dom_topog3	Least dominant topographic variety (surface expression) of first dominant landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1
Sub_relief	Local topographic relief of first subordinate landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
Sub_topog1	Most dominant topographic variety (surface expression) of first subordinate landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1
Sub_topog2	Middle dominant topographic variety (surface expression) of first subordinate landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1
Sub_topog3	Least dominant topographic variety (surface expression) of first subordinate landform	Identical to D1_Ov_Land	Table N	Identical to D1_Ov_mat1
Dom_drain	Surface drainage condition of first dominant landform	Identical to D1_Ov_Land	Table O	MoELP-MoF (1998).
Sub_drain	Surface drainage condition of first subordinate landform	Identical to D1_Ov_Land	Table O	Identical to Dom_drain
WaterTable	Suspected high water table in first dominant landform	Air-photo interpretation and representative field checks; inferred from surrounding landforms and water bodies	Table O	Identical to D1_Ov_mat1
Ecodistric	Associated biogeoclimatic zone according to Meades (1990)	Limits of biogeoclimatic zones from ***Natural Regions of Newfoundland and Labrador*** maps	Codes MSF = Mid Subarctic Forest HST = High Subarctic Tundra	Meades (1990).
Gr_checking	Level of ground-based observation (field observations)	Field	Codes (See report) Field records Y = Yes N = No	MoELP-MoF (1998).
Code_TEM	Polygon number in the attribute table	Directly generated in the Excel TEM database	Refer to the Excel /ArcGIS TEM database for each site of the study area	Excel TEM database
Toponym_1	Toponym code for the primary polygon component (for non forested polygons)	Attributed by the air-photo interpreter directly in the Excel TEM database from the coding system of the ***Carte Écoforestière*** of Québec	Codes WATER = Water Body GR = Gravel Pit DIS = Disturbed	MRNFP (2003).

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
Percent_1	Percentage of cover for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database	Refer to the Excel/ArcGIS TEM database for each site of the study area	Excel TEM database
Ecotype_1	Ecotype code for the primary polygon component	Ecotypes classification system of the TEM project, established by the project team	See Table B for the Complete List of Ecotypes for the TEM	Refer to Section 6 – Terrestrial Ecosystem Mapping – TEM Final Report
Cover_1	Forest cover type for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database from the coding system of the ***Carte Écoforestière*** of Québec	Codes R = Resinous M = Mixed (Resinous and Hardwood) H = Hardwood	Identical to Toponym_1
Closure_1	Average closure of forest canopy for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database from the coding system of the ***Carte Écoforestière*** of Québec	See Table C for Closure of Forest Canopy Code Definitions	Identical to Toponym_1
Height_1	Average height of forest cover for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database from the coding system of the ***Carte Écoforestière*** of Québec	See Table D for Height of Forest Cover Code Definitions	Identical to Toponym_1
Struc_1	Plant forms for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database from the coding system of the ***Carte Écoforestière*** of Québec	See Table E for Plant Forms Code Definitions	Identical to Gr_checking
Moisture_1	Soil moisture regime for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database from MoELP-MoF (1998), (section 1)	See Table F for Soil Moisture Regimes Code Definitions	Identical to Gr_checking
Nutrient_1	Soil nutrient regime for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database from MoELP-MoF (1998), (section 1)	See Table G for Soil Nutrient Regimes Code Definitions	Identical to Gr_checking
Disturb_1	Type of disturbance for the primary polygon component	Attributed by the air-photo interpreter directly in the Excel TEM database from the coding system of the ***Carte Écoforestière*** of Québec	See Table K Ecosystemic Disturbances Code Definitions	Identical to Toponym_1

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
Toponym_2	Identical to Toponym_1	Identical to Toponym_1	Identical to Toponym_1	Identical to Toponym_1
Percent_2	Percentage of cover for the secondary polygon component	Identical to Percent_1	Identical to Percent_1	Identical to Toponym_1
Ecotype_2	Identical toEcotype_1	Identical to Ecotype_1	Identical to Ecotype_1	Refer to Section 6 – Terrestrial Ecosystem Mapping – TEM Final Report
Cover_2	Identical to Cover_1	Identical to Cover_1	Identical to Cover_1	Identical to Toponym_1
Closure_2	Identical to Closure_1	Identical to Closure_1	Identical to Closure_1	Identical to Toponym_1
Height_2	Identical to Height_1	Identical to Height_1	Identical to Height_1	Identical to Toponym_1
Struc_2	Identical to Struc_1	Identical to Struc_1	Identical to Struc_1	Identical to Gr_checking
Moisture_2	Identical to Moisture_1	Identical to Moisture_1	Identical to Moisture_1	Identical to Gr_checking
Nutrient_2	Identical to Nutrient_1	Identical to Nutrient_1	Identical to Nutrient_1	Identical to Gr_checking
Disturb_2	Identical to Disturb_1	Identical to Disturb_1	Identical to Disturb_1	Identical to Gr_checking
Toponym_3	Identical to Toponym_1	Identical to Toponym_1	Identical to Toponym_1	Identical to Toponym_1
Percent_3	Percentage of cover for the tertiary polygon component	Identical to Percent_1	Identical to Percent_1	Identical to Toponym_1
Ecotype_3	Identical to Ecotype_1	Identical to Ecotype_1	Identical to Ecotype_1	Refer to Section 6 – Terrestrial Ecosystem Mapping – TEM Final Report
Cover_3	Identical to Cover_1	Identical to Cover_1	Identical to Cover_1	Identical to Toponym_1
Closure_3	Identical to Closure_1	Identical to Closure_1	Identical to Closure_1	Identical to Toponym_1
Height_3	Identical to Height_1	Identical to Height_1	Identical to Height_1	Identical to Toponym_1
Struc_3	Identical to Struc_1	Identical to Struc_1	Identical to Struc_1	Identical to Gr_checking
Moisture_3	Identical to Moisture_1	Identical to Moisture_1	Identical to Moisture_1	Identical to Gr_checking

Field Name (Column Title)	Description	Data Source	Contents/Codes Tables	Reference
Nutrient_3	Identical to Nutrient_1	Identical to Nutrient_1	Identical to Nutrient_1	Identical to Gr_checking
Disturb_3	Identical to Disturb_1	Identical to Disturb_1	Identical to Disturb_1	Identical to Gr_checking
Slope_class	Category of average polygon slope (%), based on averaged raster (pixel) values	25 m-grid Digital Elevation Model; based on rasterization of base map contour data for the area	No slope: 0% to 3%, code A; Very Gentle: 3% to 8%, code B; Gentle: 8% to 15%, code C; Moderate: 15% to 30%, code D; Steep: 30% to 40%, code E; Very steep: more than 40%, code F	Natural Resources Canada 1:50 000 digital base mapping
Shape_Length	Length of the longest polygon axis in meters	Automatically generated by ArcGIS		
Shape_Area	Area of polygon in square meters	Automatically generated by ArcGIS		

Table B. Ecotypes Description and Codes (Terrestrial Ecosystems)

Ecotype	Complete Name	Description
	High Subarctic Tundra (HST)	
01	Alpine Shrub – Glandular Birch – Mesic	Mesic ecosystem dominated by herbs and shrubs; thick till; silty texture; well to moderately well drained.
02	Rock Outcrop – Crowberry – Xeric	Dry ecosystem dominated by lichen-covered rock outcrops; thin or no soil; medium texture; very rapid drainage.
03	Low Alpine Shrub/Lichens – Subxeric	Subxeric ecosystem dominated by Ericaceae and lichen species; thin till on bedrock; medium to coarse texture; good to rapid drainage.
04	Large-leaved Goldenrod Alpine Shrub – Seepage	Ecosystem with soils enriched by seepage and dominated by tall shrubs and a dense and diverse ground cover; thick till deposits; medium or fine texture; moderate to imperfect drainage.
05	Uniform Riparian Shrub Fen	Riparian fen; fluvial or organic deposits; ground cover dominated by sedge and grass; imperfect to poor drainage.
06	Uniform Herb Fen	Uniform herb fen; organic deposits; ground cover dominated by sedge and grass; poor to very poor drainage.
07	Uniform Shrub Fen	Uniform shrub fen; dominated by diverse shrub species of the Ericaceae family; ground cover dominated by sedge and grass; poor drainage.
	Mid Subarctic Forest (MSF)	
01	Black Spruce/White Spruce – Labrador Tea – Feathermoss (Forested Ecosystem)	Black spruce stand with white spruce subdominant; thin to thick moraine or colluvial deposits; medium soil texture; well drained.
02	Crowberry – Map Lichen – Rock Outcrop (Non-Forested Ecosystem)	Ericaceae community; rock outcrops; little or no surficial geological deposits; variable soil texture; very rapid drainage.
03	Glandular Birch – Crowberry –Thin Soil (Non-Forested Ecosystem)	Low-shrub community; thin soils on summits or upper slopes; variable soil texture; rapid drainage.
04	Black Spruce – Lichen – Rock (Forested Ecosystem)	Dominated by rock and rock outcrops; scattered black spruce and Ericaceae species; very thin moraine deposits; variable soil texture; rapid drainage.
05	Black Spruce – Lichen – Open Forest (Forested Ecosystem)	Black spruce lichen stand with some tamarack; thin to thick moraine or glaciofluvial surficial deposits; coarse soil texture; well to rapidly drained.
06	White Spruce/Black Spruce – Feathermoss Seepage (Forested Ecosystem)	White spruce stand, with black spruce subdominant; moss-covered forest floor; medium to thick moraine or colluvial deposits; fine to medium soil texture; imperfect drainage with seepage.
07	White Spruce – Willow-Sedges – Riparian (Forested Riparian Ecosystem)	White spruce stand with moss-covered forest floor; thin tothick fluvial deposits; fine soil texture; riparian ecosystem; periodically flooded sites; imperfect to poor drainage.
08	Black Spruce/Tamarack – Glandular Birch – Sphagnum Bog (Forested Wetland Ecosystem)	Forested bog with black spruce and tamarack stand; organic deposits dominated by peatmoss; poor drainage.
09	Tamarack/Black Spruce – Sedges – Fluvial Fen (Forested Riparian Ecosystem)	Tamarack stand; forest fen; organic or fluvial deposits; poor drainage.
10	Black Spruce Forested Fen (Forested Wetland Ecosystem)	Uniform forested fen; organic deposits; ground cover dominated by sedge and grass; poorly drained.
11	Structured Herb Fen (Non-Forested Wetland Ecosystem)	Structured herb fen; organic deposits; ground cover dominated by sedge and grass; very poor drainage.
12	Uniform Herb Fen (Non-Forested Wetland Ecosystem)	Uniform herb fen; organic deposits; ground cover dominated by sedge and grass; poor to very poor drainage.
13	Non-Uniform Herb Fen (Non-Forested Wetland Ecosystem)	Open water randomly distributed in ponds; herb fen; organic deposits; ground cover dominated by sedge and grass; very poor drainage.
14	Uniform Shrub Fen (Non-Forested Wetland Ecosystem)	Uniform shrub fen; dominated by various shrub species of the Ericaceae family; ground cover dominated by sedge and grass; poor drainage.
15	Uniform Riparian Shrub Fen (Non-Forested Riparian Ecosystem)	Non-forested riparian shrub fen; fluvial or organic deposits; ground cover dominated by sedge and grass; soil richer and plant community more diverse than Ecotype MSF14; imperfect to poor drainage.

Table C. Forest Canopy Closure Percentage Classes and Code Definitions

Percentage Forest Canopy Closure	Closure Code
More than 80%	A
Between 60% and 80%	B
Between 40% and 60%	C
Between 25% and 40%	D
Between 15% and 25%	E
Less than 15%	F

Table D. Forest Cover Height Classes and Code Definitions

Class of Forest Cover Height	Height Code
More than 22 m	1
Between 17 m and 22 m	2
Between 12 m and 17 m	3
Between 7 m and 12 m	4
Between 4 m and 7 m	5
Between 2 m and 4 m	6

Table E. Ecosystems Plant Forms and Code Definitions[1]

Ecosystems Plant Forms	Structure Code
Sparse	CL
Herb	H
Shrub	AR Low: ARb (< 2m)
	High : ARh (> 2m)
Regeneration	RE
Young Forest	JF
Mature Forest	FM

Table F. Soil Moisture Regimes (SMR) Classes and Code Definitions

Classes of Soil Moisture Regime	Code
Very xeric (TX)	0
Xeric (X)	1
Subxeric (SX)	2
Submesic (SM)	3
Mesic (M)	4
Subhygric (SHG)	5
Hygric (HG)	6
Subhydric (SHD)	7
Hydric (HD)	8

Table G. Soil Nutrient Regimes (SNR) Classes and Code Definitions

Classes of Soil Nutrient Regime	Code
Very Poor	a
Poor	b
Medium	c
Rich	d
Very Rich	e

Table K. Ecosystemic Disturbances Classes and Code Definitions

Classes of Ecosystemic Disturbance	Code
Totally burnt	br
Totally cut	ct
Cut with seed reserves	crs

Table L. Material Type Code Definitions

Code	Material type	Description
b	boulders, bouldery	Grain sizes >256 mm
c	clay, clayey	Grain sizes <0.004 mm, which have cohesive properties
g	gravel, gravelly	Grain sizes between 2 and 64 mm
p	peat, muck	Organic material
r	rubble	Angular rock fragments (e.g. talus)
s	sand, sandy	Grain sizes between 0.0625 and 2 mm
m	silt, silty	Grain sizes between 0.004 and 0.0625 mm
t	till	Mixture of grain sizes, from clay to boulders, due to deposition in contact with glacial ice

Table M. Landform Code Definitions

Code	Landform	Description
ME	End moraine	Discrete sharp-crested or hummocky ridge of sediment deposited at the margin of a glacier through a variety of processes, including direct deposition from ice and drop-out from meltwater
MG	Ground moraine	Sediment deposited beneath a flowing or down-wasting glacier, commonly in thick contiguous blankets
MH	Hummocky moraine	Sediment deposited beneath a glacier and/or during ablation of glacial ice with strongly undulating surface topography
GD	Ice contact delta, esker delta, kame delta, delta moraine	Accumulation of generally moderately to well sorted sediment that was transported by glacial meltwater and deposited in standing water against glacial ice
GE	Esker, esker complex, crevasse filling	Long, commonly sinuous ridge (or complex of ridges, which may be braided) of generally moderately to well sorted sediment deposited by a meltwater stream flowing on, in or under a glacier
GK	Kame, kame field, kame terrace, kame moraine	Mound or bench of generally moderately to well sorted sediment, which may be locally mixed with till deposits, that was transported by glacial meltwater and deposited on, in or under a glacier
GO	Outwash plain, valley train	Broad, flat to gently sloping accumulation of generally moderately to well sorted sediment that was transported and deposited by glacial meltwater in a proglacial setting
AP	Alluvial plain	A plain formed from the deposition of moderately to well sorted sediments transported by flowing water, usually adjacent to a stream that periodically overflows
ED	Sand dunes	Hill, mound or ridge of wind-blown fine sediments, with a grain size range almost exclusively between 0.05 and 0.5 mm
OT	Organic terrain	Accumulation of mainly organic material, including peat and muck, in a marsh, swamp, bog or fen
RL	Bedrock plateau	Elevated area, or upland, of bedrock with subdued relief
RN	Bedrock knob	Protruding rounded to jagged hill of bedrock
RP	Bedrock plain	Broad, mainly level expanse of bedrock
RR	Bedrock ridge	Elevational crest of bedrock, commonly having linear continuity
/R	Bedrock below a drift veneer (<2 m)	Bedrock of unspecified sub-variety exists at shallow depth (<2 m) beneath a sediment veneer

Table N. Topography Code Definitions

Code	Local topographic relief	Description
L	Mainly low local relief (<15 m)	Area where local topographic relief is mainly less than 15 m
M	Mainly moderate local relief (15-60 m)	Area where local topographic relief is mainly between 15 and 60 m
H	Mainly high local relief (>60 m)	Area where local topographic relief is mainly more than 60 m
Code	**Topographic variety (surface expression)**	**Description**
c	channelled	Terrain through which flowing water has recently, or in the past, eroded linear and/or sinuous depressions
d	dissected, gullied	Terrain that once exhibited a relatively uniform surface and has since become cut by fluvial and/or hillslope processes, which may form V-shaped incisions
j	jagged, rugged, cliffed	Terrain characterized by abrupt changes in slope, sharp-edged landforms and bluffs
k	kettled, pitted	Relatively uniform, level terrain with bowl-shaped concavities, or holes, in the surface
n	knobby, hummocky	Strongly undulating to ruggedly hilled terrain
p	plain	Broad, mainly level terrain
r	ridged	Terrain exhibiting linear, elevational crests
s	sloping	Mainly evenly sloping terrain with significant steepness
t	terraced	Level terrain edged by a steep slope
u	undulating to rolling	Terrain that has wave-like rises and falls
w	washed, reworked	Terrain through which flowing water, unrelated to the landform origin, has altered and/or redistributed sediment

Table O. Surface Drainage Condition Definitions

Code	Surface drainage condition	Description
x	Very rapidly drained	Water is removed from the soil very rapidly in relation to supply
r	Rapidly drained	Water is removed from the soil rapidly in relation to supply
w	Well drained	Water is removed from the soil readily, but not rapidly
m	Moderately well drained	Water is removed from the soil somewhat slowly in relation to supply because of imperviousness or lack of gradient
I	Imperfectly drained	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season
p	Poorly drained	Water is removed so slowly in relation to supply that the soil remains wet for much of the time that it is not frozen
v	Very poorly drained	Water is removed from the soil so slowly that the water table remains at or near the surface for most of the time the soil is not frozen
h	Suspected high water table	Ground may be dry, but water table is likely near surface

APPENDIX II

MAPS OF THE GEOLOGICAL SURFACE DEPOSITS

[INSÉRER CARTES DES DÉPÔT DE SURFACE]

Hemis_PR83b_AnnexeIInord_Map terrain36x48_090420.pdf

[INSÉRER CARTES DES DÉPÔT DE SURFACE]

Hemis_PR83b_AnnexeIIsud_Map terrain36x48_090420.pdf

APPENDIX III

TERRESTRIAL ECOSYSTEM MAPS

[INSÉRER CARTES ÉCOLOGIQUES]

Hemis_PR83b_AnnexeIInord_Carte ecosystemes 36x48_090420.pdf

[INSÉRER CARTES ÉCOLOGIQUES]

Hemis_PR83b_AnnexeIIIsud_Carte ecosystemes 36x48_090420.pdf

APPENDIX IV

SAMPLE OF ECOSYSTEM FIELD FORM

Appendix IV

Sample Terrestrial Ecosystem Inspection Form

Sample Full Terrestrial Ecosystem Inspection Form (3 sections)

Section 1: General terrestrial ecosystem description

ECOSYSTEM FIELD FORM

DATE Y M D (1) | PLOT NO. (2)

PROJECT ID. (3) | FIELD NO. (4) | SURVEYOR(S) (5)

SITE DESCRIPTION

LOCATION

GENERAL LOCATION (6)				
FOREST REGION (7)	MAPSHEET (8)	UTM ZONE (9)	LAT./ NORTH. (10)	LONG./ EAST.
AIRPHOTO NO. (11)	X CO-ORD. (12)	Y CO-ORD.	MAP UNIT (13)	

SITE DIAGRAM

(14)

SITE INFORMATION

PLOT REPRESENTING (15)				
BGC UNIT (16)	SITE SERIES (17)	TRANS./ DISTRIB. (18)	ECOSECTION (19)	
MOISTURE REGIME (20)	NUTRIENT REGIME (21)	SUCCESS. STATUS (22)	STRUCT. STAGE (23)	REALM/ CLASS (24)
ELEV. (27) m.	SLOPE (28) %	ASPECT (29) °	MESO SLOPE POS. (30)	SURFACE TOPOG. (31)

SITE DISTURB. (25)	PHOTO ROLL (26)
EXPOS. TYPE (32)	FRAME NOS.

NOTES

(34)

SUBSTRATE (%)

ORG. MATTER		ROCKS	
DEC. WOOD	(33)	MINERAL SOIL	
BEDROCK		WATER	

FS882 (1) HRE 98/5

Section 2; Soil description

SOIL DESCRIPTION

GEOLOGY BEDROCK (3)	C. F. LITH. (4)	SURVEYOR(S) (1)	PLOT NO. (2)
TERRAIN (5) TEXTURE 1 2	SURFICIAL MATERIAL 1 2	SURFACE EXPR. 1 2	GEOMORPH. PROCESS 1 2
SOIL CLASS (6)	HUMUS FORM (7)	HYDROGEO. (8)	
ROOTING DEPTH (9) cm	ROOT RESTRICT. LAYER TYPE (11)	WATER SOURCE (12)	DRAINAGE (14)
R.Z. PART. SIZE (10)	DEPTH cm	SEEPAGE (13) cm	FLOOD RG. (15)

PROFILE DIAGRAM (33)

ORGANIC HORIZONS/LAYERS

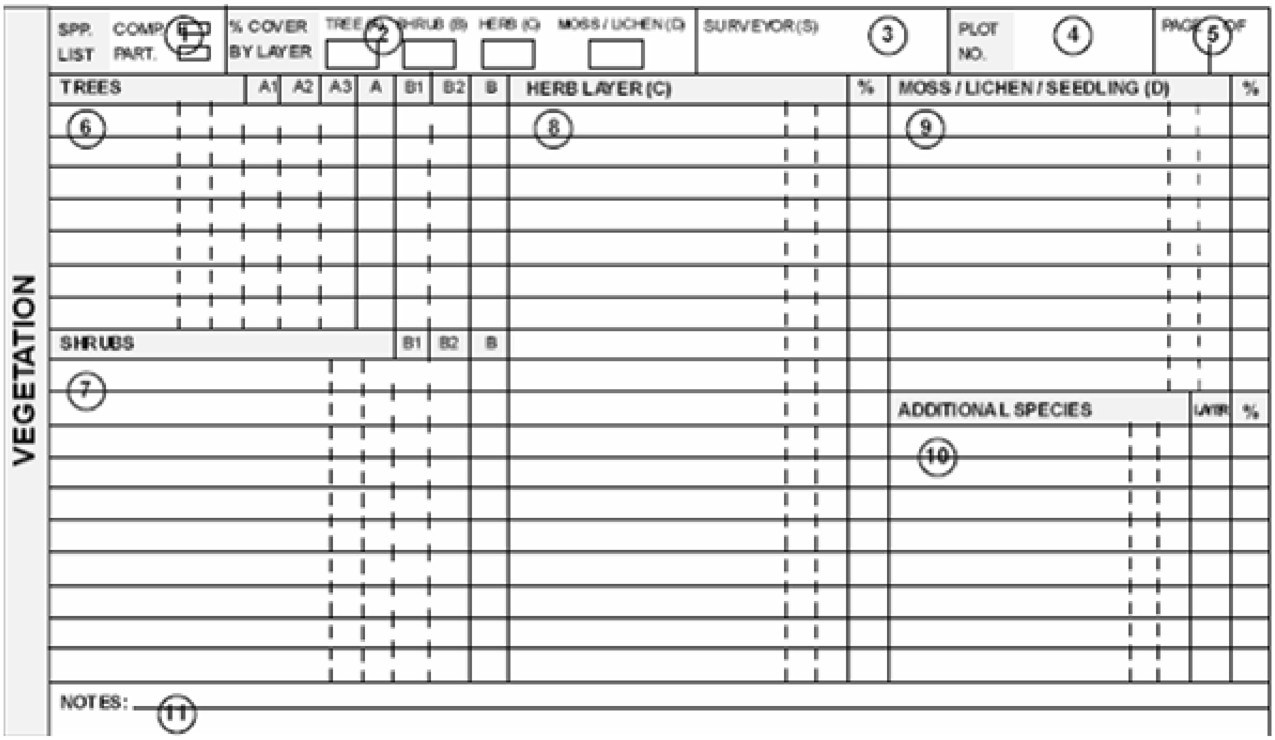
HOR/ LAYER	DEPTH	FABRIC STRUCTURE	FABRIC vPOST	MYCEL. AB	FECAL AB	ROOTS AB	ROOTS SIZE	pH	COMMENTS (consistency, character, fauna, etc)
(16)	(17)	(18)		(19)	(20)	(21)		(22)	(23)

MINERAL HORIZONS/LAYERS

HOR/ LAYER	DEPTH	COLOUR	ASP.	TEXT.	% COARSE FRAGMENTS G	C	S	TOTAL	SHAPE	ROOTS AB	ROOTS SIZE	STRUCTURE CLASS	STRUCTURE KIND	pH	COMMENTS (mottles, clay films, effervesc., etc):
(24)	(25)	(26)		(27)			(28)			(29)		(30)		(31)	(32)

NOTES: (34)

Section 3: Vegetation Description


VEGETATION
SPP. LIST
COMP. PART.
% COVER BY LAYER
TREE (A)
SHRUB (B)
HERB (C)
MOSS / LICHEN (D)
SURVEYOR(S)
PLOT NO.
PAGE OF
TREES
A1
A2
A3
A
B1
B2
B
HERB LAYER (C)
%
MOSS / LICHEN / SEEDLING (D)
%
SHRUBS
B1
B2
B
ADDITIONAL SPECIES
LAYR
%
NOTES:
1
2
3
4
5
6
7
8
9
10
11

Ground Partial Terrestrial Ecosystem Inspection Form (2 sections)

Section 1: General terrestrial ecosystem description, soil and surficial geology

GROUND INSPECTION FORM

G ☐ vs V ☐	PHOTO	X:	Y:	DATE
PROJECT ID.		SURV.		
MAP SHEET		PLOT #	POLY. #	
UTM ZONE	LAT. / NORTH	LONG. / EAST		
ASPECT °		ELEVATION m		
SLOPE %	SMR	SNR		

MESO SLOPE POSITION	☐ Crest ☐ Upper slope	☐ Mid slope ☐ Lower slope ☐ Toe	☐ Depression ☐ Level
DRAINAGE - MINERAL SOILS	☐ Very rapidly ☐ Rapidly	☐ Well ☐ Mod. well ☐ Imperfectly	☐ Poorly ☐ Very poorly
MOISTURE SUBCLASSES - ORGANIC SOILS	☐ Aqueous ☐ Peraquic	☐ Aquic ☐ Subaquic	☐ Perhumid ☐ Humid
MINERAL SOIL TEXTURE	☐ Sandy (LS,S) ☐ Loamy (SL,L,SCL,FSL)	☐ Silty (SiL,Si) ☐ Clayey (SiCL,CL,SC,SiC,C)	

ORGANIC SOIL TEXTURE ☐ Fibric ☐ Mesic ☐ Humic	SURF. ORGANIC HORIZON THICKNESS ☐ 0–40 cm ☐ > 40 cm
HUMUS FORM ☐ Mor ☐ Moder ☐ Mull	ROOT RESTRICTING LAYER Depth________ cm Type__________
COARSE FRAGMENT CONTENT ☐ < 20% ☐ 20–35% ☐ 35–70% ☐ > 70%	

TERRAIN COMPONENT: TC1 ☐ TC2 ☐ TC3 ☐

TERRAIN TEXTURE	SURFICIAL MATERIAL	SURFACE EXPRESSION	GEOMORPH PROCESS
1	1	1	1
2	2	2	2

ECOSYSTEM COMPONENT: EC1 ☐ EC2 ☐ EC3 ☐

BGC UNIT	ECOSECTION
SITE SERIES	SITE MODIFIERS
STRUCTURAL STAGE	CROWN CLOSURE %

ECOSYSTEM POLYGON SUMMARY

	%	SS	SM	ST
EC1				
EC2				
EC3				

TERRAIN POLYGON SUMMARY

	%	Classification
TC1		
TC2		
TC3		

Section 2: Vegetation description and site sketch

DOMINANT / INDICATOR PLANT SPECIES

TOTAL %	A:	B:	C:	D:

L.	SPECIES	%	L.	SPECIES	%	L.	SPECIES	%

COMPLETE ☐ PARTIAL ☐

Tree Mensuration

Spp.	DBH	Ht. Calculation to DBH						Ht. to DBH	Total HT	BH Age	Path Y/N
		Top	Bot	SD	SL	HD	HT				

NOTES (site diagram, exposure, gleying, etc.)

APPENDIX V

DESCRIPTION OF DRAINAGE CLASSES

Description of soil drainage

Very rapidly drained

Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall provided there is a steep gradient. Soils have very low available water storage capacity (usually less than 2.5 cm) within the control section and are usually coarse textured, or shallow, or both. Water source is precipitation.

Rapidly drained

Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low available water storage capacity (2.5-4 cm) within the control section, and are usually coarse textured, or shallow, or both. Water source is precipitation.

Well drained

Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity (4-5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations but additions are, equaled by losses.

Moderately well drained

Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient, or some combination of these. Soils have intermediate to high water storage capacity (5-6 cm) within the control section and are usually medium to fined textured. Precipitation is the dominant water source in medium to fine textured soils; precipitation and significant additions by subsurface flow are necessary in coarse textured soils.

Imperfectly drained

Water is removed from the soil sufficiently slowly in relation to supply, to keep the soil wet for a significant part of the growing season. Excess water moves slowly downward if precipitation is the major supply. If subsurface water or groundwater, or both, is the main source, the flow rate may vary but the soil remains wet for a significant part of the growing season. Precipitation is the main source if available water storage capacity is high; contribution by subsurface flow or groundwater flow, or both, increases as available water storage capacity decreases. Soils have a wide range in available water supply, texture, and depth, and are gleyed phases of well drained subgroups.

Poorly drained

Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface flow or groundwater flow, or both, in addition to precipitation are the main water sources; there may also be a perched water table, with precipitation exceeding evapotranspiration. Soils have a wide range in available water storage capacity, texture, and depth, and are gleyed subgroups, Gleysols, and Organic soils.

Very poorly drained

Water is removed from the soil so slowly that the water table remains at or on the surface for the greater part of the time the soil is not frozen. Excess water is present in the soil for the greater part of the time. Groundwater flow and subsurface flow are the major water sources. Precipitation is less important except where there is a perched water table with precipitation exceeding evapotranspiration. Soils have a wide range in available water storage capacity, texture, and depth, and are either Gleysolic or Organic.

Extrait de : http://sis.agr.gc.ca/cansis/nsdb/slc/v3.1.1/snf/drainage.html

APPENDIX VI

DESCRIPTION SOIL MOISTURE REGIMES

Soil Moisture Regime (SMR) – Definitions and Codes

Code	Class	Description	Primary water source/ Typical Site Conditions	Code	Class	Description	Primary water source/ Typical Site Conditions
0	Very xeric	Water is removed form the soil very rapidly in relation to supply; the soil remains wet for a negligible amount of time following precipitations. Normally linked to a very rapid drainage, depending on the amount of precipitation.	Precipitation**/** Summit of hill or mountain; surrounding cliffs	5	Sub-hygric	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season; temporary infiltrations and some mottling of the soil are possible. Linked to a moderate to imperfect drainage, depending on the amount of precipitation.	Precipitation and infiltration**/** Ecosystem located on lower slope
1	Xeric	Water is removed form the soil very rapidly in relation to supply; the soil remains wet for a brief period of time following precipitations. Linked to a rapid to very rapid drainage, depending on the amount of precipitation.	Precipitation**/** Ecosystem located on upper slope	6	Hygric	Water is removed from the soil sufficiently slowly in relation to supply to keep the soil wet for a significant part of the growing season; permanent infiltrations (if on a gradient) and mottling in the soil are common. Link to imperfect or poor drainage, depending on the amount of precipitation.	Infiltration**/** Natural ecosystem located at bottom of slope
2	Sub-xeric	Water is removed form the soil rapidly in relation to supply; the soil remains wet for short periods of time following precipitations. Linked to a rapid drainage, depending on the amount of precipitation.	Precipitation**/** Ecosystem located on upper or mid-slope	7	Sub-hydric	Water is removed from the soil so slowly that the water table remains at or near the surface for most of the year; gleying mineral soils or organic soils; permanent infiltration < 30 cm under the surface. Linked to a poor or very poor drainage, depending on the amount of precipitation.	Permanent infiltration of the water table or continuous irrigation / Natural ecosystem located in a depression (often associated with wetlands)
3	Sub-mesic	Water is removed form the soil rapidly in relation to supply; water is available for moderately short periods following precipitations. Usually linked to a well-drained soil.	Precipitation**/** Ecosystem located on upper or mid-slope.	8	Hydric	Water is removed from the soil so slowly that the water table remains at or near the surface all year long; gleying mineral soils or organic soils. Linked to very poor drainage.	Permanent water table from a natural source or irrigation / Wetlands
4	Mesic	Water is removed form the soil rather slowly in relation to supply; the soil can remain significantly wet, but sometime for short periods of the year. Soil wetness is directly linked to climate. Linked to a well to moderately well drained soil, depending on the amount of precipitation.	Precipitation and/or infiltration**/** Ecosystem located on mid- or lower slope.				

Modified from ***Field Manual for Describing Terrestrial Ecosystems***. MoELP-MoF (1998).

APPENDIX VII

DESCRIPTION OF SOIL NUTRIENT REGIMES

Soil Nutrient Regime (SNR) – Definitions and codes

	Oligotrophic	Submesotrophic	Mesotrophic	Permesotrophic	Eutrophic	Hypereutrophic
CODES	**A** **Very poor**	**B** **Poor**	**C** **Moderate**	**D** **Rich**	**E** **Very rich**	**F** **Salted**
Available nutrients	**very low**	**low**	**moderate**	**abundant**	**very abundant**	**accumulation of salt**
Type of humus		Mor				
				Moder		
					Mull	
Horizon A		horizon Ae present				
				horizon A absent		
					horizon Ah present	
Proportion of organic matter		low (clear)				
			medium (colored)			
				high (dark)		
Growth rate	slow					
			moderate			
				rapid		
Depth of the soil	extremely superficial					
				very superficial to deep		
Texture of the soil		coarse texture				
				medium to fine texture		
% coarse fragments		high				
				moderate to low		
Mineralogy of parent materials		low base (low Ca content)				
			medium base (medium Ca content)			
				strong base (high Ca content)		
Soil pH		extremely to moderately acid				
			moderately acid			
				lightly acid to moderately alkaline		
Infiltration			temporary →		permanent	

Modified from ***Field Manual for Describing Terrestrial Ecosystems***. MoELP-MoF (1998).

APPENDIX VIII

DESCRIPTION OF SOIL CLASSES

Key to soil orders

A. Soils that have permafrost within 1 m of the surface or 2 m if strongly cryoturbated.

Cryosolic order

B. Other soils that:

1. Have organic horizons (more than 17% organic C by weight) that extend from the surface to one of the following:
   a) A depth of 60 cm or more if the surface layer is fibric material (Of) having a bulk density of less than 0.1 g/cm^3.
   b) A depth of 40 cm or more if the surface layer consists of mesic or humic material (Om or Oh) having a bulk density greater than 0.1 g/cm^3.
   c) A depth of more than 40 cm if only folic materials (L, F, and H) are present, or at least 10 cm if lithic or fragmentary materials are present. Folic materials must be more than twice the thickness of a mineral soil layer if the mineral layer is less than 20 cm thick.
2. Have at least one mineral horizon or layer within 40 cm of the surface in addition to the organic horizons (0) as follows:
   a) If a mineral horizon thinner than 40 cm occurs at the surface, the organic horizon or horizons must have a total thickness of at least 40 cm.
   b) If one or more mineral horizons or layers occur within 40 cm of the surface, the organic material must occupy more than 40 cm of the upper 80 cm of the control section.

Organic order

C. Other soils that have a podzolic B horizon and do not have a Bt horizon within 50 cm of the mineral surface.

Podzolic order

D. Other soils that are saturated with water and under reducing conditions either continuously or during some period of the year as indicated either by direct measurements of the water table and the oxidation-reduction status or by any of the following morphological features within 50 cm of the mineral surface:

1. Chromas of 1 or less, without mottles, on ped surfaces or in the matrix if peds are lacking in materials that develop higher chromas under oxidizing conditions.
2. Chromas of 2 or less, in hues of 10YR or redder, on ped surfaces or in the matrix if peds are lacking, accompanied by prominent mottles.
3. Chromas of 3 or less, in hues yellower than 10YR, on ped surfaces or in the matrix if peds are lacking, accompanied by prominent mottles.
4. Hues bluer than 10Y, with or without mottles, on ped surfaces or in the matrix if peds are lacking.

Gleysolic order

E. Other soils that have a solonetzic B horizon.

Solonetzic order

F. Other soils that have a chernozemic A horizon and any one of the following:

1. No Ae horizon.
2. A weakly expressed Ae horizon (Aej) with a dry color value lower than 5.
3. An Ae horizon thinner than an overlying Ah or Ap horizon that does not appear to be eluviated.
4. An Ae horizon not more than 5 cm thick if the chernozemic A is eluviated (Ahe) as indicated by gray streaks and splotches when the soil is dry.

Chernozemic order

G. Other soils that have a Bt horizon.

Luvisolic order

H. Other soils that have either Bm, Btj, or Bfj horizons at least 5 cm thick.

Brunisolic order

I. Other soils.

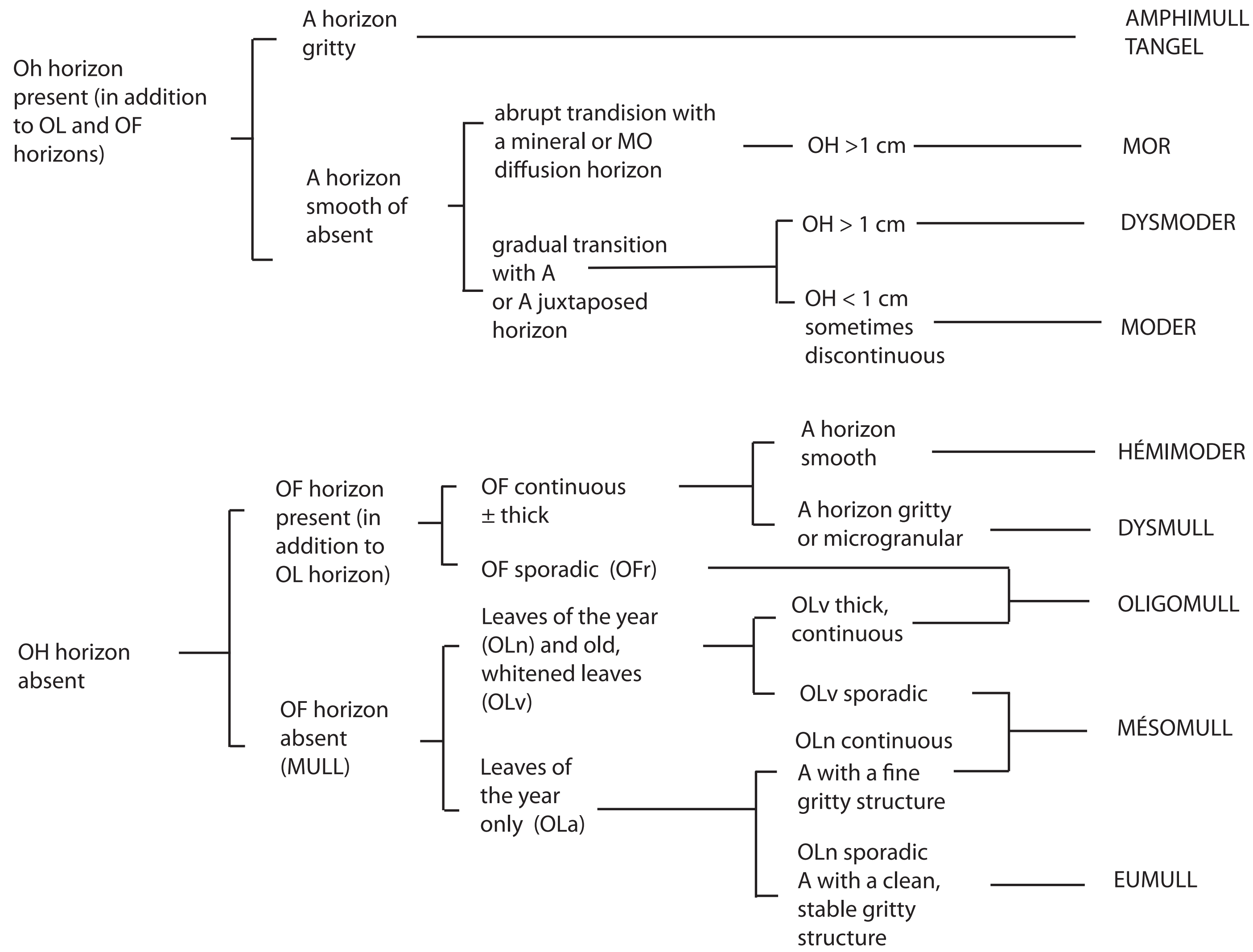
Regosolic order

Reference : ***The Canadian System of Soil Classification***, 1987. Agriculture Canada Expert Committee on Soil Survey http://sis.agr.gc.ca/cansis/publications/manuals/cssc2.pdf

APPENDIX IX

DESCRIPTION OF THE DIFFERENT HUMUS TYPES

Key to the main forms of humus



Adapted from : *Les grands sols du monde*, Jean-Paul Legros, 2007, fig. 2.52.