A Guide To Biophysical Land Classification Hecla-Carroll Lake, 62P-52M Manitoba

July, 1977

Prepared by
Canada-Manitoba Soil Survey
and
Dept. of Renewable Resources and Transportation Services
Technical Report No. 77-3

A GUIDE

TO

BIOPHYSICAL LAND CLASSIFICATION

HECLA-CARROLL LAKE, 62P-52M

MANITOBA

JULY, 1977

BY

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NORTHERN RESOURCE INFORMATION PROGRAM

PREPARED BY

CANADA-MANITOBA SOIL SURVEY

AND

DEPARTMENT OF RENEWABLE RESOURCES AND TRANSPORTATION SERVICES

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PREFACE

The Northern Resource Information Program has been implemented as a cooperative venture between the Canada-Manitoba Soil Survey and the Planning Branch of the Manitoba Department of Renewable Resources and Transportation Services. This program is designed to provide basic data concerning land and land-related resources in northern and eastern Manitoba.

A system of inventory known as a "biophysical land classification" was employed to objectively describe various attributes of land such as soil, surficial deposits, landforms, permafrost and water. By keying on such relatively permanent environmental characteristics, the inventory will remain useful over a long period of time. Interpretation of this basic information for environmental sensitivity, capability for wildlife, forestry, recreation, etc. is possible by relating it to more dynamic features such as vegetation and wildlife populations within an overall climatic framework.

The information obtained from the biophysical land classification is presented in this guide and in map form. The map and accompanying extended legend describe significant attributes of land and show the areal distribution pattern of these conditions.

This guide is written in two sections. Part I describes the survey methodology and concepts and rationale of the approach used in Manitoba. Part II is a general description of the area. The soil and vegetation information is only briefly described as the intention is mainly to provide an overview of the biophysical environment in a map area.

No attempt has been made to provide interpretations of the data for various kinds of land use. Detailed soil, vegetation and related landform data derived from the field program is on file with the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba. Assistance in the interpretation of this data for various uses can be obtained by consultation with the Soil Survey staff.

ACKNOWLEDGEMENTS

The biophysical land classification of the Hecla, 62P and Carroll Lake, 52M map sheet areas was conducted jointly by the Canada-Manitoba Soil Survey and the Manitoba Department of Renewable Resources and Transportation Services, Planning Branch.

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PART I

BIOPHYSICAL LAND CLASSIFICATION IN MANITOBA

1.0 INTRODUCTION

The objective of the present land classification, as with numerous other integrated ecological surveys, is to classify and map terrain in terms of landforms and surface deposits, vegetation, soils, drainage, permafrost, associated aquatic systems and climate. Such an inventory provides an ecologically sound basis for making land use decisions concerning forestry, agriculture, recreation, wildlife, community development and hydrology.

2.0 METHODOLOGY

Previous work in Canada has led to the establishment of a relatively uniform methodology for carrying out biophysical classifications. A hierarchy of four basic classification levels was proposed and defined by Lacate (1969) for the systematic description of terrain. These categories are defined as follows:

Land Region: an area of land characterized by a distinctive regional climate as expressed by vegetation. Mapping scales of 1:1,000,000 to 1:3,000,000 or smaller are used.

Land District: an area of land characterized by a distinctive pattern of relief, geology, geomorphology and associated vegetation. Mapping scales of 1:500,000 to 1:1,000,000 are used.

Land System: an area of land throughout which there is a recurring pattern of landforms, soils and vegetation. Mapping scales of 1:125,000 to 1:250,000 are used.

Land Type: an area of land on a particular landform segment having a fairly homogeneous combination of soils and chronosequence (i.e. successional development) of vegetation. Mapping scales of 1:10,000 to 1:20,000 are used.

The approach taken in Manitoba is patterned after that of Lacate but includes some modification in the definition of the Land Region. All four levels of classification have been used in the Manitoba approach. The basic product of our biophysical classification is a map depicting Land Systems at a scale of 1:125,000. The ground truth and sampling carried out to produce the Land System map is collected at the Land Type level. Land System units, in turn, have been grouped into Land Districts on the basis of general physiographic features. However, Land Districts can also be considered as subdivisions of a Land Region. It is emphasized that the boundaries for Land Districts and Land Regions become really meaningful only after a study of inter-relationships in patterns of land types and land systems.

The relative inaccessibility throughout most of northern and eastern Manitoba has a major influence on the level of detail obtained in ground truthing. Ground truth data for a typical NTS map sheet is collected from an average of 120 sites in each map sheet, i.e. one site for every 140 to 170 square kilometers. Field notes on soils, vegetation and landforms at each site were recorded and representative samples of individual soil associations were collected for laboratory analyses.

Aerial photographs taken during the period 1953 to 1956, at a scale of 1:63,360, were used as the geographical base for sample site selection and for mapping terrain conditions. From field notes and air photo interpretation, boundaries of repetitive patterns of landforms, soils and vegetation (Land Systems) were delineated. These system boundaries were then

transferred from the air photos onto a map manuscript at a scale of 1:125,000 (1 inch equals 2 miles).

It can be seen that such a reduced mapping scale will not permit, nor does the level of field studies warrant, the display of small individual areas having a narrowly defined range in landform, vegetation and soil conditions. The minimum size of most map units delineated at this scale includes a complexity of terrain conditions. Thus, users of biophysical maps should take into consideration the limitations of scale and the level of ground truth. At the 1:125,000 scale, biophysical maps are intended primarily as inventories for broad planning purposes.

3.0 THE LAND REGION - CONCEPT AND RATIONALE

The concept of Land Region as used in this study is changed only slightly from the definition proposed by Lacate (1969). Land Regions are broad areas of uniform climate identified not only on the basis of vegetation, but also by trends in soil development and permafrost conditions.

For instance, the High Subarctic Land Region in Manitoba is defined as a zone of regional climatic conditions which result in a pattern of forest cover interspersed with areas of treeless tundra, i.e. Forest-Tundra transition. This Land Region further exhibits permafrost conditions which are characteristic of the Continuous Permafrost Zone in terms of depth, distribution and surface expression. In addition, soil development and properties in this region are strongly influenced by permafrost which results from the cold climate. Thus, soil development, as it reflects regional climate, becomes a relevant factor in defining the Region. In conclusion, regional climatic zones are discernible by characteristics of vegetation, soils and permafrost development. These three factors and their inter-relationship provide more reliable criteria for the establishment of Land Regions than those based on meteorological data alone. Land Regions of northern and eastern Manitoba, defined in terms aforementioned, are described in Section 4.0.

The degree of climatic uniformity observable in a Land Region favours the development of similar ecosystems on material having similar properties. For example, similar physiographic sites (i.e. those having the same landform, slope, parent soil material and drainage characteristics) may occur in several climatic regions. Within a region, these sites will support the same vegetation communities, but in other regions vegetation on the sites will be different. Thus, beach ridges in an Arctic Land Region support low growing shrubs and forbs, whereas beaches in the Boreal Region usually have dense growth of black spruce or jackpine. Soils display similar trends, as the kind and degree of development of soil profiles vary from region to region on similar physiographic sites. In areas of permafrost, the depth of the thawed layer, and the form and kind of surface expression of patterned ground also vary on similar sites between regions but remain relatively constant on comparable sites within a region (Zoltai, 1973). Land Regions, therefore, describe broad areas where one can expect to find the same kinds of vegetation and soil associations on similar sites.

Because climatic change from one Land Region to another has such importance to the ecology of an area, the Land Region boundaries are also useful for establishing soil series and associations. The soils of each Land Region are subject to climatic conditions which influence not only the thermal regime of the soil but also the various biological and physical activities that take part in soil development. Soils developed on similar parent materials

and drainage conditions but in different Land Regions are given different names to indicate that many of the associated ecologic conditions are dissimilar.

Whereas Land Regions are regions of similar climate-soil-vegetation conditions, their boundaries invariably spread over a transitional zone. A boundary line merely serves as a demarcation of where major ecological changes appear to be most pronounced. For this reason, a particular soil name or vegetation type may be applied in two adjacent Land Regions where site conditions are similar. This situation usually occurs within the limited area of a transition zone along the Region boundary. Changes in regional climate over greater distances will alter site conditions sufficiently to warrant new names for soil associations and vegetation types.

4.0 LAND REGIONS IN NORTHERN AND EASTERN MANITOBA

4.1 Introduction

The Land Region descriptions presented in this section provide a general overview of the climate and related biophysical conditions in northern and eastern Manitoba. The delineation and characterization of the Land Regions is based on a review of existing information on climate, vegetation, soils and permafrost as well as data collected during the current biophysical survey. For those map areas which are not yet studied in detail, Land Region boundaries and descriptions are subject to revision and change as new information becomes available.

Land Regions in northern and eastern Manitoba are shown in Figure 1. The orderly zonation of regions from south to north is a reflection of soil, vegetation and permafrost characteristics being influenced by climate. Zonation is complicated by the presence of local features such as large water bodies, valleys, extensive organic plains and north-south trending ridges. Some of these features favor development of soil-vegetation associations typical of adjacent Land Regions. Such atypical "outlier" associations were considered too small or insignificant to be delineated separately, but their presence should be recognized.

4.2 Selected Biophysical, Climatic and Vegetation Characteristics

In order to compare the Land Regions in the study area, a tentative summary of some of their biophysical properties is presented in Table 1. Pertinent meteorological data for the Land Regions are summarized in Table 2 and vegetation characteristics are summarized in Table 3. The broad vegetation zonation is after Rowe (1972); permafrost regime has been described by Brown (1970), and the soil characteristics are derived from exploratory surveys carried out by the Canada-Manitoba Soil Survey. An attempt has been made to describe the dominant vegetation according to soil type and soil moisture conditions. Local physiographic (site) conditions may change the local climate and hence vegetation development. Such conditions occur on steep south-facing slopes in protected valleys which may make the site warmer, or on north-facing slopes, exposed ridges, snow accumulation areas and in frost pockets, any of which may make the site colder. Sites which are not so influenced may be called normal or mesic, as the vegetation on them expresses the normal effect of the Regional climate (Hills, 1960).

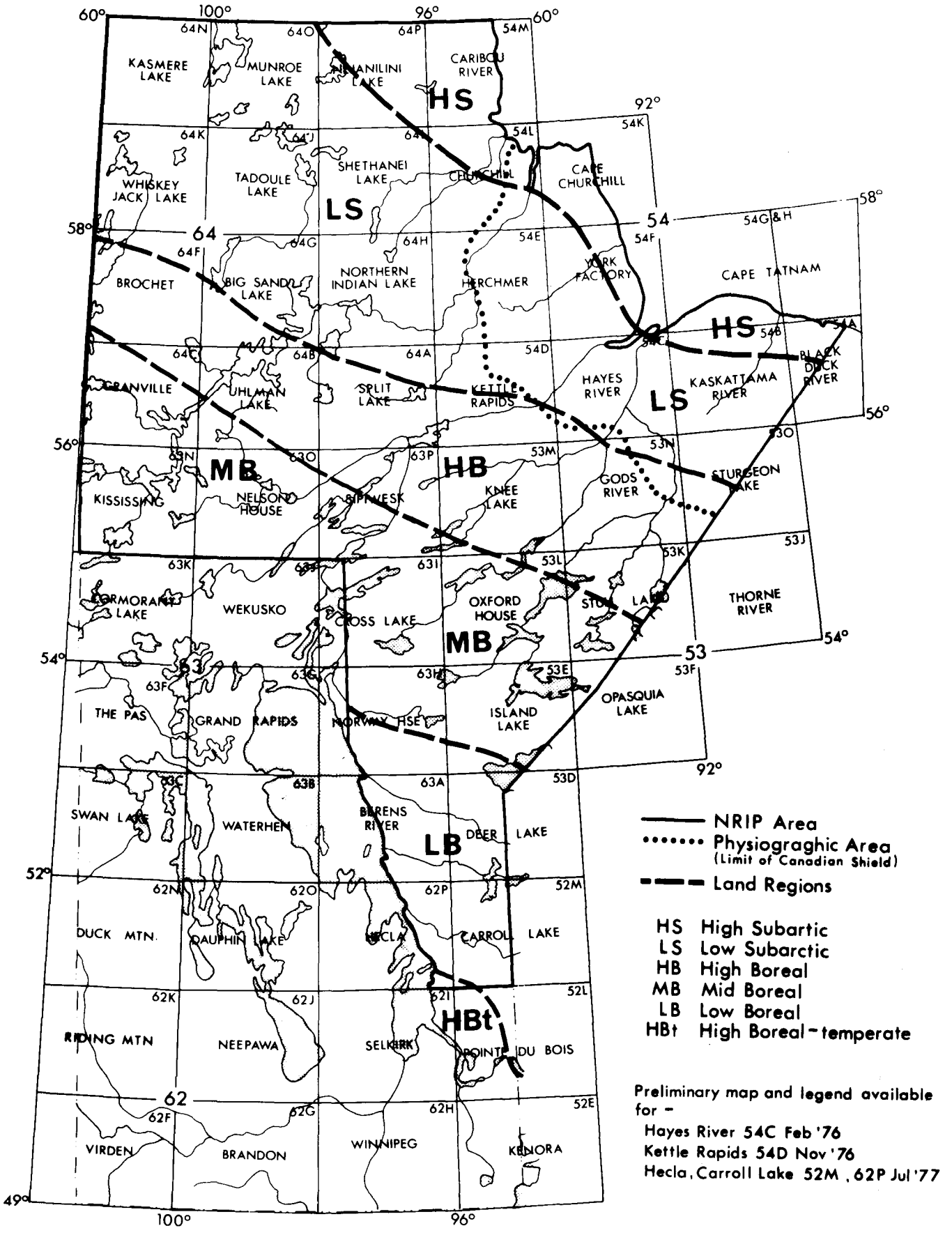


Figure 1 Land regions of Northern and Eastern Manitoba.

Table 1. Selected Biophysical Characteristics of Land Regions in Northern and Eastern Manitoba.

Land Region		Vegetation Zone[1]	Dominant Soils[2]	Organic Landforms	Permafrost Characteristics		
Symbol	Name				Regime[3]	Occurrence and Active Layer, cm	Pattern Ground and Degree of Disturbance
HS	High Subarctic	Forest-tundra transition	Brunisolic Static Cryosol Brunisolic Turbic Cryosol Organo Cryosol	Peat plateaus, palsas, minerotrophic palsas, peat polygons, fens	Continuous	Mineral soils: sand, non-frozen; loam, 40-100+ Organic soils: forest peat 40-60, fen peat, non-frozen	Hummocks, sorted polygons, circles, stripes, nets; very active on all materials in all landscape positions except well drained sands
LS	Low Subarctic	Open coniferous forest	Brunisolic Static Cryosol Brunisols, Luvisols Gleysolic Static Cryosol Organo Cryosol	Peat plateaus, palsas, bog veneer, fens	Discontinuous, widespread	Mineral soils: sand, non-frozen; loam, 40-100+; clay 30-100+ Organic soils: forest peat, 40-60, fen peat, non-frozen	Hummocks & mounds, very active in poorly drained depressions & lower slopes; scattered mounding and broad depressions on upper & mid slopes; all materials except sands
HB	High Boreal	Closed coniferous forest	Brunisols, Luvisols Gleysolic Cryosol Organo Cryosol	Peat plateaus, palsas, bog veneers, fens	Discontinuous, southern fringe, (north)	Mineral soils: sand, loam & clay, non-frozen except for poorly drained loam & clay, 40-100+ Organic soils: forest peat, 60, fen peat, non-frozen	Some hummocks and mounds in poorly drained depressions & lower slopes; apex & upper slope generally free of cryoturbation
MB	Mid Boreal	Closed coniferous forest	Brunisols, Luvisols Gleysolic Static Cryosol Organo Cryosol	Peat plateaus, palsas, bog veneers, bog plateaus, blanket bog, fen	Discontinuous, southern fringe (south)	Mineral soils: non-frozen except for poorly drained clay, 40-100+ Organic soils: forest peat, 60-200, fen peat, non-frozen	Minor occurrence of mounds in depressions and on lower slopes
LB	Low Boreal	Mixed deciduous-coniferous forest	Brunisols, Luvisols, Gleysols, Organic	Bog plateau, flat bog, blanket bog, fens	Localized	Mineral soils: non-frozen Organic soils: non-frozen except for local occurrence of relict frost at 100-200 cm in forest peat	Absent
HBt	High Boreal-temperate	Mixed deciduous-coniferous forest	Luvisols, Brunisols, Gleysols, Organic	Bog plateau, flat bog, blanket bog, fens, swamps	Absent	Absent	Absent

[1] Rowe, J.S. 1972. Forest Regions of Canada, Department of the Environment, Canadian Forestry Service, Publ. No. 1300.
Ritchie, J.C. 1962. A Geobotanical Survey of Northern Manitoba, Arctic Institute of Northern Manitoba, Technical Paper No. 9.

[2] The System of Soil Classification for Canada. 1974. Revised. Canada Department of Agriculture, Publ. No. 1455.
Proc. of the Ninth Meeting of the Canada Soil Survey Committee, Univ. of Sask., Saskatoon. 1973. p. 346-358.

[3] Brown, R.J.E. 1967b. "Permafrost in Canada" map Publ. by Div. of Bldg. Res., Nat. Res. Council (NRC 9769) and Geol. Surv. of Can. (Map 1246A).

Table 2. Climatic Characteristics of Land Regions in Northern and Eastern Manitoba.

Land Region		Mean Temperature, °C			Degree Days 5.5°C May 1-Sept. 30	Frost Free Days	Precipitation, mm		Soil Moisture Deficit, mm
Symbol	Name	Ann.	Jan.	July			Ann.	May 1-Sept. 30	
HS	High Sub-arctic	<-6.6	<-26.1	<16.0	<500	60 to 75	340 to 450	210 to 270	10 to 20
LS	Low Sub-arctic	-6.6 to -4.9	-29.1 to -27.5	14.1 to 14.6	500 to 700	70 to 80	415 to 560	265 to 360	20 to 40
HB	High Boreal	-4.9 to -3.9	-27.5 to -26.3	14.6 to 15.8	700 to 900	80 to 90	415 to 560	265 to 360	20 to 60
MB	Mid Boreal	-3.9 to -1.1	-26.4 to -21.8	15.1 to 18.3	900 to 1250	90 to 100	420 to 555	260 to 350	50 to 75
LB	Low Boreal	-1.0 to 1.7	-22.8 to -19.8	18.0 to 19.5	1300 to 1445	100 to 116	410 to 535	250 to 355	25 to 75
HBt	High Boreal-temperate	< 2.0	<17.1	<19.7	1330 to 1600	100 to 120	410 to 575	250 to 385	75 to 185

References:

1. Temperature and Precipitation normals, 1941-1970, Vol. 1 & 2. Atmospheric Environment Service, Environment Canada.
2. Frost Data, 1941-1970 by G.M. Hemmerick and G.R. Kendall. Atmospheric Environment Service, Environment Canada.
3. Economic Atlas of Manitoba (1960). T.R. Weir (Ed.), Manitoba Dept. of Industry and Commerce.

Table 3. Vegetation Characteristics of Land Regions in Northern and Eastern Manitoba*

Land Region		Physiographic Area	Dominant Vegetation Types					
			Normal Facies			Wet Facies		
Symbol	Name		Warmer-drier (south slopes, sand)	Normal-mesic (level-moderate slopes)	Cooler-wetter (north slopes, bottom lands)	Impeded drainage (sloughs, kettles, marshes, organic plains)	Lakeshore	Alluvial (streamside)
HS	High Subarctic	Hudson Bay Lowland	Lichen tundra	Lichen tundra-heath	Lichen-moss tundra	Lichen heath palsas and polygonal peat plateaus/sedge cottongrass fens	Sedge-grass meadow/ larch-birch^{d} fens/ willow	Willow-birch^{d}-alder scrub
		Canadian Shield	Heath tundra-lichens-spruce^{b}	Heath tundra-lichens-birch^{d}	Willow-heath tundra	Lichen heath palsas and polygonal peat plateaus/sedge cottongrass fens	Rush-sedge meadows	Spruce^{w}/willow birch^{d}-alder scrub
LS	Low Subarctic	Hudson Bay Lowland	Spruce^{w} (jackpine)	Open spruce^{b}-lichen-mosses	Spruce^{b}-lichen-larch-mosses	Open spruce^{b}-lichen-moss on palsas and peat plateau/ sedge-larch fens	Rush-grass meadow/ willow-alder	Spruce^{w}-poplar^{b}/willow-birch^{d}-alder scrub
		Canadian Shield	Spruce^{w} (jackpine)	Open spruce^{b}-lichens	Open spruce^{b}-lichen moss	Spruce^{b}-larch bogs/spruce^{b}-lichen-moss peat plateau and palsa/sedge-larch cottongrass fens	Sedge meadow	Spruce^{w}/willow-birch^{d}-alder
HB	High Boreal	Hudson Bay Lowland	Spruce^{b} (jackpine, poplar^{w})	Spruce^{b}-mosses (jackpine)	Spruce^{b}-mosses	Spruce^{b}-larch sphagnum bogs/ spruce^{b}-lichen-moss peat plateau/sedge-larch-birch^{d} fens	Sedge meadow	Spruce^{w}/willow birch^{d}/alder
		Canadian Shield	Spruce^{b} (jackpine, poplar^{w}, birch^{w})	Spruce^{b} (jackpine, poplar^{w}, birch^{w})	Spruce^{b}-mosses	Spruce^{b}-larch-sphagnum bogs/ spruce^{b}-lichen-moss peat plateau/sedge-larch-birch^{d} fens	Sedge meadow	Spruce^{w}/willow birch^{d}-alder
MB	Mid Boreal	Canadian Shield	Open spruce^{w}-fir^{b}-poplar^{w} (jackpine)	Spruce^{b}-fir^{b}-mosses	Spruce^{b}-mosses	Spruce^{b}-larch-moss bogs (bog veneer, plateau bogs, sloping bog, patterned fen) Spruce^{b}-birch^{w} palsas and peat plateau	Rush-sedge meadow	Sedge-grass meadow
LB	Low Boreal	Canadian Shield	Jackpine (poplar^{w}) (birch^{w})	Spruce^{w}-poplar^{w} (fir^{b}) (birch^{w})	Spruce^{b}-poplar^{w}	Spruce^{b}-larch bogs/ sedge-larch fens	Sedge-rush meadow	Spruce^{w}-poplar^{b}
HBt	High Boreal-temperate	Canadian Shield	Jackpine (poplar^{w}) (birch^{w})	Spruce^{w}-poplar^{w} (fir^{b}) (birch^{w})	Spruce^{b}-poplar^{w}	Spruce^{b}-larch bogs/ spruce-cedar bogs	Sedge-rush meadow	Spruce^{w}-poplar^{b}-ash^{g}

\- = associated species or groups of plants

/ = different communities in same region

(= successional communities

DOMINANT PLANT SPECIES

Common Name	Symbol	Scientific Name
Alder		Alnus crispa
Ash, green	ash^{g}	Fraxinus pennsylvanica
Birch, Dwarf	birch^{d}	Betula glandulosa
Birch, White or Paper	birch^{w}	Betula papyrifera
Cedar, white	cedar	Thuja occidentalis
Cottongrass		Eriophorum spp.
Heath	He	Various ericaceous shrubs, including species of Vaccinium, Arctostaphylos, & Kalmia
Fir	fir^{b}	Abies balsamifera
Larch		Larix laricina
Lichens		Many species
Mosses		Many species
Pine, Jack	pine^{j}	Pinus banksiana
Poplar, Balsam	poplar^{b}	Populus balsamifera
Poplar, white (aspen)	poplar^{w}	Populus tremuloides
Sphagnum		Sphagnum spp.
Spruce, Black	spruce^{b}	Picea mariana
Spruce, White	spruce^{w}	Picea glauca
Willow		Salix spp.

* after S.C. Zoltai, unpublished manuscript.

PART II

HECLA-CARROLL LAKE AREA, 62P-52M

1.0 GENERAL DESCRIPTION OF AREA

1.1 Location and Extent

The area surveyed (Hecla and Carroll Lake map sheets) covers the portion of Manitoba between the east side of Lake Winnipeg and the Manitoba-Ontario boundary (Lat. 51° 00' - 52° 00' N, Long. 95° 08' - 96° 55' W). The two map areas combined, extend over 11,002 square kilometers (4,248 square miles). The location of the map area in eastern Manitoba is shown in Figure 2.

1.2 History and Present Development*

The map area has undergone little development and settlement. The area was influenced by the fur trade with the native peoples during the 1700's, although most activity was close to established trading posts on river outlets along Lake Winnipeg. After 1800, the Hudson Bay Company became the exclusive trader in the area and in addition to the river outlet posts, establishments were placed on lakes up-river.

The territory was organized into the District of Keewatin in 1876 and incorporated into the province of Manitoba in two parts, in 1881 and 1912. Reserves were established by treaty with the native peoples and except for these lands, the area is controlled by the Crown.

Gold mining activity was initiated south of the Wanipigow River in 1911 when claims were staked at Rice Lake. Mines were active from 1927 to 1968 when the San Antonio mine at Bissett was closed.

The map area is currently the focus of activities in several industries. Traditionally, the forest industry has operated in the area south of Manigotagan and Bissett through to Pine Falls. In recent years, this region has attracted considerable interest in tourism. Several lodges and outpost camps operate in the area. A provincial park has been established south of the map area with the opening of the Cat Lake-Bissett Highway. A national park or wilderness area is tentatively planned to be located in the central portion of the map area, where many of the larger lakes are used for commercial sport fishing. Trapping and domestic hunting by local people is conducted throughout the area. Commercial fishing takes place on Lake Winnipeg and Family Lake. Wild rice leases operate in the area east from the mouth of the Bloodvein River to the Manitoba-Ontario boundary.

All-weather road access to the southern edge of the map areas is provided by Highway 304 which runs north from Pine Falls to Manigotagan then east to Bissett. Winter roads servicing larger communities to the north traverse the map area. Charter and scheduled airlines service the area and provide the normal means of transportation within the area. Communities on Lake Winnipeg receive supplies by barge during the summer with timber being shipped to Pine Falls on return trips.

1.3 Bedrock Geology

The bedrock formations of the Hecla-Carroll Lake area are shown in Figure 3. The major portion of the map area is underlain by granitic, volcanic and metamorphic rocks of Precambrian

* Material in this section is abstracted from East Lake Winnipeg Interim Land Use Plan, 1975. Planning Division, Manitoba Dept. of Mines, Resources and Environmental Management.

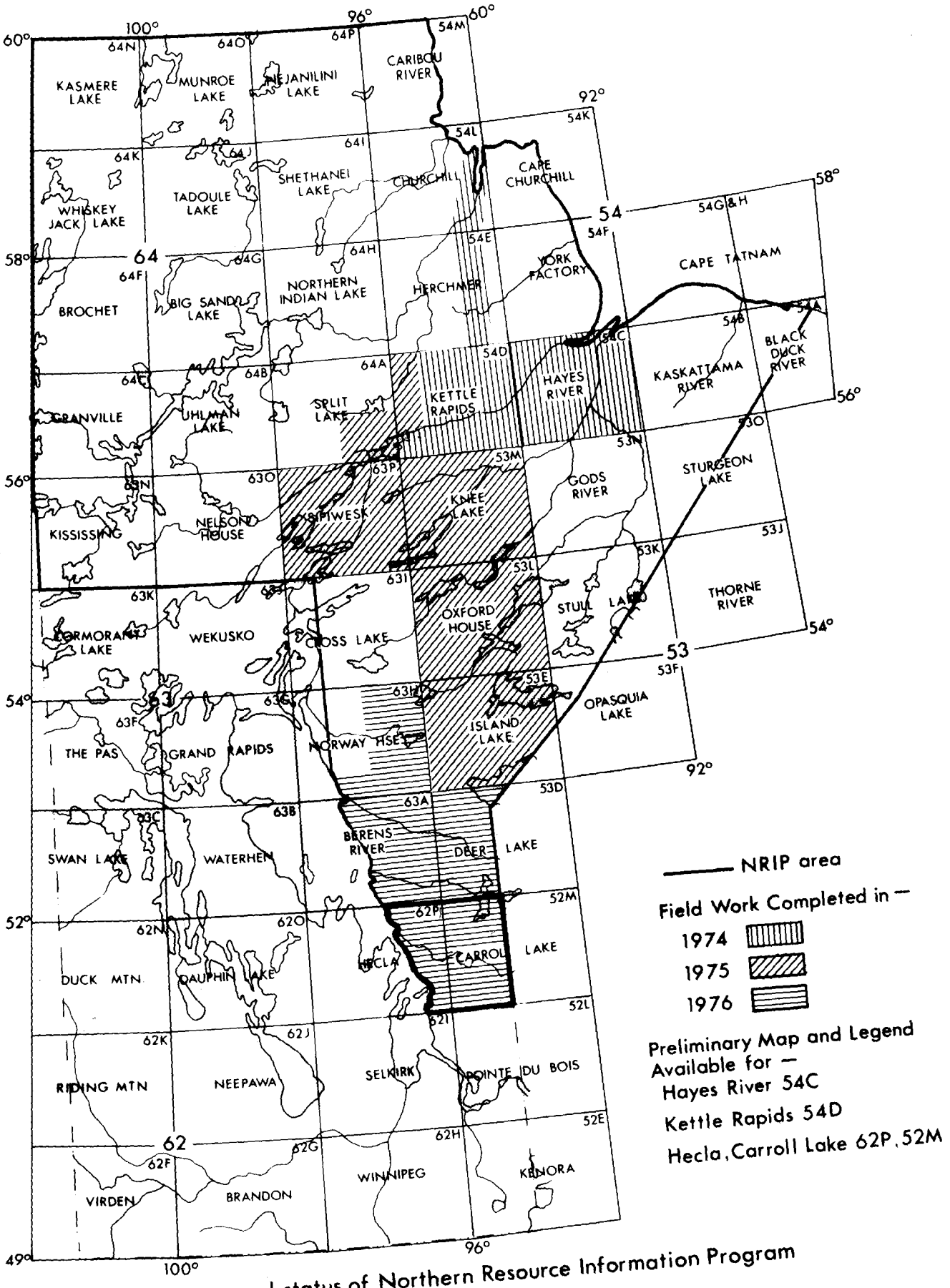


Figure 2 Location and status of Northern Resource Information Program project area.

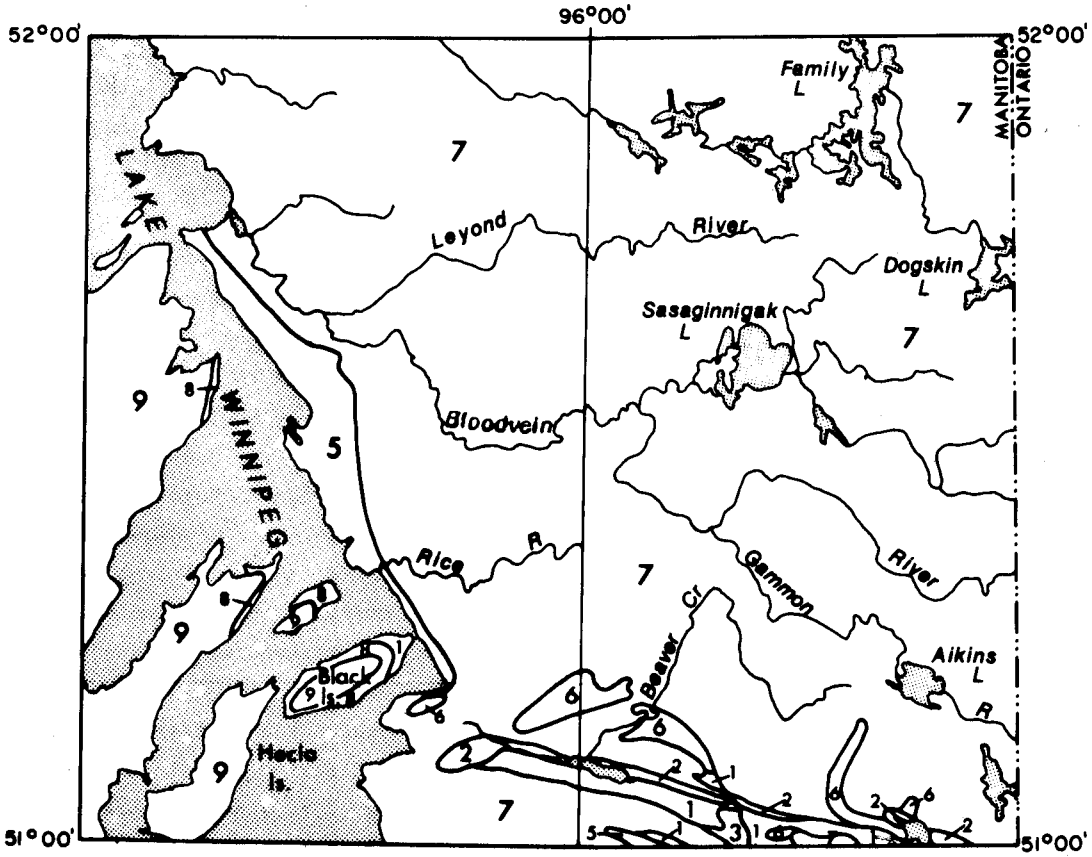


Figure 3 Geological map of Hecla-Carroll Lake area.
Source: Geolgical Map of Manitoba
Manitoba Mines Branch Map 65-1

PRECAMBRIAN

1. Volcanic rocks- basalt, andesite, andesite, rhyolite
2. Greywacke, slate, quartzite, iron-formation, in part altered to schist and gneiss
3. Arkose, feldspathic quartzite, quartzite, conglomerate
5. Complex of granetized sedimentary gneiss and schist; migmatite
6. Mafic and ultramafic intrusions; gabbro, diorite, peridodite, serpentinite
7. Granite, granodiorite, quartz diorite

PALEOZOIC

8. Winnipeg formation; quartzose sandstone, shale
9. Red River Formation; dolomitic limestone, dolomite

age (Davies et al., 1962; Ermanovics, 1970). The area near Wanipigow Lake is characterized by a group of volcanic, sedimentary and derived metamorphic rocks extending as a continuous belt from Lake Winnipeg to the Manitoba-Ontario boundary (Rice Lake Group). This group of rocks is characterized by a number of longitudinal faults. The general easterly trend of the structure is expressed in the physiography as a trench-like depression which contains Wanipigow Lake and the Wanipigow River.

1.4 Glaciation and Surficial Deposits

The Hecla-Carroll Lake map areas lie entirely within the Severn Upland Division of the Canadian Shield Physiographic Region (Bostock, 1970). An overview of the glacial features surrounding the map area is shown in Figure 4.

During mid and late Wisconsin times the western Canadian Shield was subjected to repeated erosion by ice and inundation by Glacial Lake Agassiz. Prest et al. (1960) placed the Patrician Ice Centre to the northeast of the map area and it was this ice body that was mostly responsible for shaping the landscape. A comprehensive review of Glacial Lake Agassiz history is credited to Elson (1966). Zoltai (1966) has investigated the surficial geology of adjoining map areas in western Ontario and identified Lake Agassiz eastern outlets around Lake Nipigon. McPherson (1968, 1970) has studied the Pleistocene stratigraphy of Winnipeg River and the Beausejour area to the south. His findings are in general agreement with Elson's interpretation.

Rolling to hilly bedrock dominated terrain occurs throughout the central and eastern portions of the map area. Immediately east of Lake Winnipeg, extensive organic deposits are found with minor outcrops of bedrock and/or lacustrine deposits. Terrain at higher elevations to the east is characterized by an abundance of lakes and rivers and thin, discontinuous veneers of stony, coarse textured till overlying bedrock. Most areas within the map sheet are below 330 m a.s.l. in elevation and local relief rarely exceeds 30 meters.

2.0 LAND DISTRICTS

Physiographic characteristics and the distribution of surficial deposits throughout the Hecla-Carroll Lake map area are recognized in four Land Districts delineated on Figure 5 and on the biophysical map.

As one traverses from the highest elevations along the Manitoba-Ontario boundary westward to Lake Winnipeg, one encounters Land Districts dominated in turn by (a) bedrock, (b) bedrock and lacustrine clay, and (c) organic deposits (Figure 6). A fourth District, local in extent, occurs to the south of a bedrock trench containing Wanipigow Lake and the Wanipigow River. It is treated as a separate Land District as it contains surficial materials not encountered elsewhere in the map area. These four Land Districts are described in the following section and summarized in Table 4.

2.1 Dogskin Lake Land District

This Land District extends east from approximately 330 m a.s.l. to 400 m a.s.l. along the Manitoba-Ontario boundary. The dominant features are bedrock knolls and ridges in which local relief of 20 to 30 meters are quite common. Joints and hollows of the bedrock surface are filled with stony, coarse textured till derived from the country rock. Modification of the sandy till by colluviation and local runoff often causes weak water sorting and accumulation

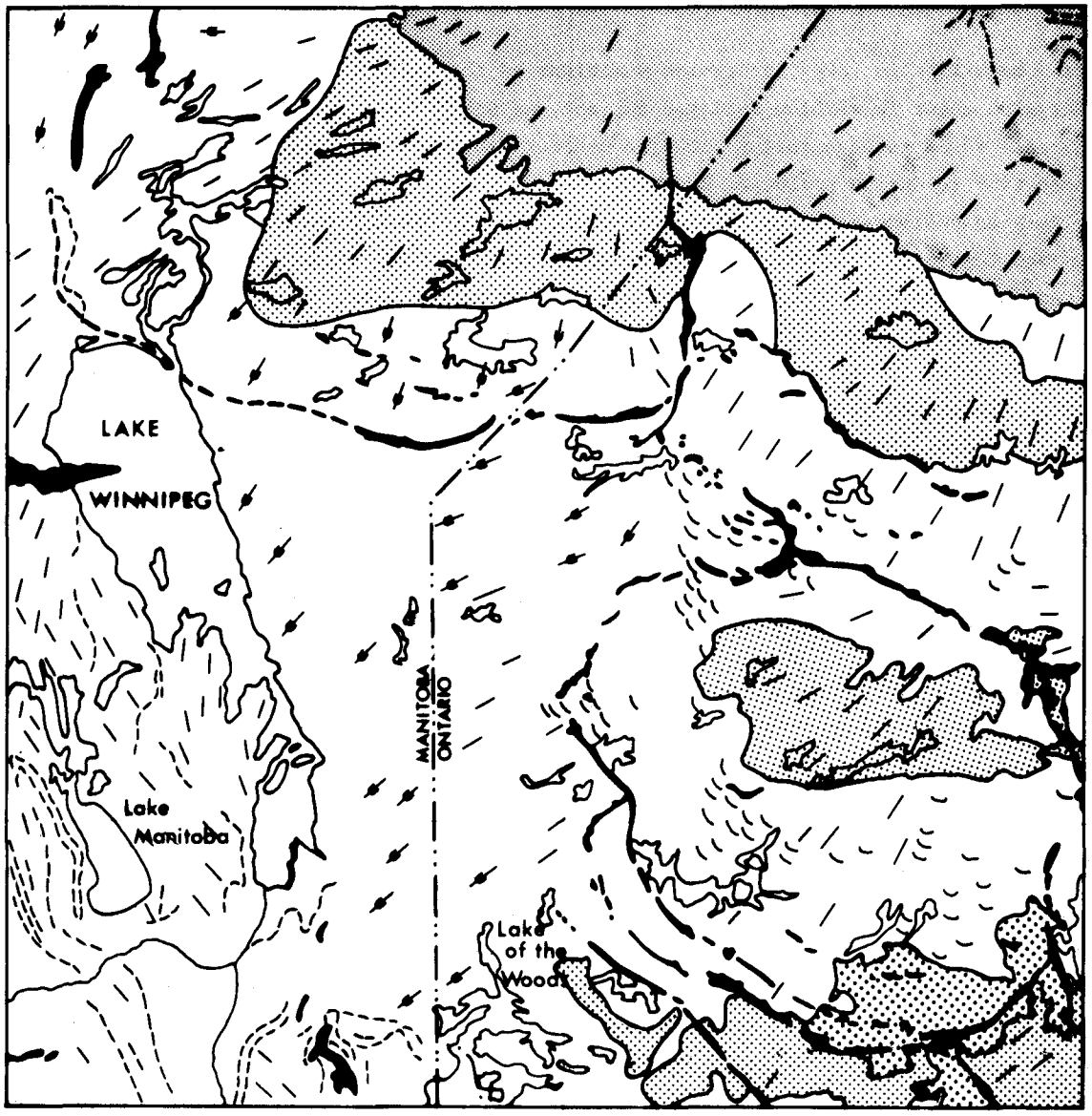


Figure 4 Glacial map of eastern Manitoba and western Ontario.*

- Glacial striation (sense of direction known, inferred or unknown)
- Glacial lineation parrellel to ice-flow direction (fluting, drumlin, roche moutonnées)
- DeGeer moraines
- Prominant strand lines
- Major moraines
- Area of dominantly ground moraine
- Area of maximum marine overlap
- Outwash deposit
- Area of maximum glacial lake coverage

* Source: V. K. Prest, D. R. Grant, V. N. Rampton 1964-66
Glacial Map of Canada GSC Map 1253A

of sorted materials in lower, protected positions on the bedrock surface. Very thin organic deposits also occur in shallow enclosed depressions on the bedrock. However, the amount of organic soil found in association with the bedrock is variable as the peat may be completely destroyed by fire during prolonged droughts.

Between bedrock outcrops, the intervening valleys and depressions are commonly occupied by bogs and fens. The organic deposits in these areas consist of deep (up to 5 and 6 m) woody forest and sphagnum peat and minor areas of deep fen peat. These organic deposits are usually underlain by fine textured lacustrine sediments. Local pockets of lacustrine clay may be found on lower slopes of the rock outcrop throughout the district. However, their occurrence is much reduced at elevations above 330 m a.s.l.

This district contains an abundance of lakes, rivers and streams. The numerous water bodies of the area are characterized by very irregular bedrock controlled shorelines. All of the surface waters in the district flow westerly towards Lake Winnipeg but the drainage pattern is very irregular due to the strong bedrock influence.

An idealized cross-section of the bedrock dominated terrain in the Dogskin Lake District is shown in Figure 6A.

2.2 Bloodvein River Land District

This Land District occurs to the west of the Dogskin Lake District and covers an area where elevations are generally below 330 m a.s.l. The western boundary of this district adjoins the extensive organic deposits east of Lake Winnipeg at around 270 m a.s.l.

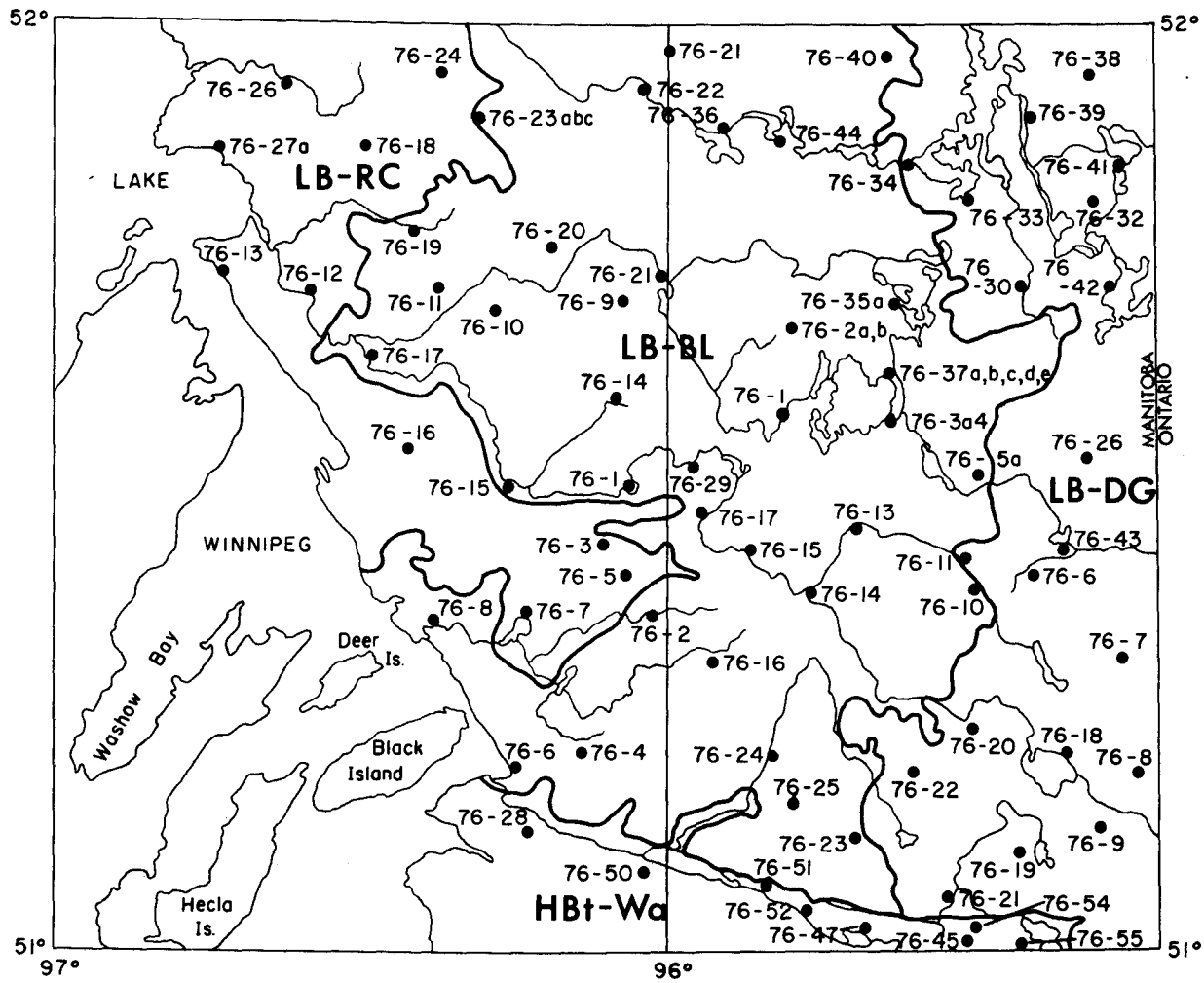
The surface of this district is dominated by gently to steeply sloping rugged bedrock outcrop which is only partially covered by veneers and blankets of clayey lacustrine sediments. Pockets of sandy till and deep organic deposits may be found in association with the rock outcrop, but are much less common than lacustrine clay. As in the Dogskin Lake District, the lacustrine deposits generally accumulate on the lower slopes and depressions of bedrock outcrops; the crests and upper slopes of outcrops remain largely bare. Lacustrine clay deposits range from 1 to 2 meters in thickness, except along major rivers and large lakes where deposits 3 meters deep have been found. In many cases, a discontinuous veneer of noncalcareous till occurs in association with bedrock outcrops. These till pockets are often found on the lee side of outcrops and tend to be finer textured and more sorted than the till in the Dogskin Lake District. Organic deposits are widely distributed and generally occupy the intervening depressions and valleys between outcrops. These organic deposits consist of deep (3 to 4 m) woody forest peat, sphagnum peat and minor areas of fen peat, all underlain by fine textured lacustrine sediments.

The numerous lakes of the district occupy irregular shaped depressions between areas of rock outcrop. Many rivers and streams flowing through the district follow an irregular drainage pattern toward Lake Winnipeg. The bedrock influence has deranged the drainage pattern and causes many rapids and low falls.

A cross-section illustrating the distribution of materials in this bedrock dominated terrain is shown in Figure 6B.

2.3 Rice River Land District

This land district occurs in the western portion of the map area and appears as a dominantly poorly drained organic plain broken by occasional rock outcrops. Topography over most



LAND REGIONS

LB Low Boreal

HBt High Boreal-temperate

LAND DISTRICTS

BL Bloodvein River

DG Dogskin Lake

RC Rice Lake

WA Wanipigow Lake

Figure 5 Land districts and locations of ground truth sites in the Hecla, Carroll Lake map area.

Table 4. Land Districts of the Hecla-Carroll Lake Map Area (62P-52M).

Land District		Physiographic Characteristics			Soil Type		Drainage and Hydrological Characteristics	
Symbol	Name	Elevation, meters a.s.l.	Surficial Deposits	Topography and Landforms	Dominant	Subdominant	Soil Drainage	Hydrology*
BL	Bloodvein River	270-330	Dominantly Precambrian bedrock with minor pockets of clay textured lacustrine sediments.	Gently to steeply sloping bedrock outcrops partially subdued by lacustrine veneers and blankets on the lower slopes and depressions.	Solonetzic Gray Luvisol	Gleyed Solonetzic Gray Luvisol; Solonetzic Gray Luvisol, lithic phase	Imperfect to poor	Surface drainage is poorly developed due to influence of resistant bedrock. The many lakes generally occupy bedrock depressions and their shoreline is controlled by the fracture pattern of the bedrock. Small lakes with smooth organic shorelines occur but are not common. Major Watershed Divisions: Manigotagan River (5RA) Bloodvein River (5RB) Berens River lower (5RD) Drainage Direction: West to Lake Winnipeg
			Deep woody forest peat with minor Sphagnum and fen peat, underlain by lacustrine clay.	Level to gently sloping bogs; minor raised bogs and patterned fens occupy the depressions and valleys between bedrock outcrops.	Typic Mesisol	Typic Mesisol, sphagnic phase	Poor to very poor	
			Deep deposits of clay textured lacustrine sediments.	Locally extensive, gently sloping lacustrine clay blankets and plains occur north of Wanipigow Lake.	Solonetzic Gray Luvisol	Gleyed Solonetzic Gray Luvisol	Moderately well to imperfect	
DG	Dogskin Lake	330-400	Dominantly bare Precambrian bedrock outcrops associated with minor pockets of loamy sand to sand textured till on the rock surface.	Steeply sloping rugged bare bedrock outcrops. Till veneers and pockets are only extensive on the protected sides and lower slopes of outcrops.	Eluviated Dystric Brunisol, lithic phase	Gleyed Eluviated Dystric Brunisol, lithic phase	Well to imperfect	Surface drainage is poorly developed due to the influence of resistant bedrock. The many lakes generally occupy bedrock depressions and their configuration is controlled by the fracture pattern of the bedrock. Lakes with organic shorelines are rare. Major Watershed Divisions: Manigotagan River (5RA) Bloodvein River (5RB) Berens River lower (5RD) Berens River upper (5RC) Drainage Direction: West to Lake Winnipeg
			Deep woody forest peat with minor Sphagnum and fen peat underlain by lacustrine clay.	Level to very gently sloping bogs; minor bog plateaus and patterned fens occupy depressions and valleys between outcrops.	Typic Mesisol	Typic Mesisol, sphagnic phase	Poor to very poor	
			Deep skeletal loamy sand to sand textured till.	Locally extensive gently to steeply sloping morainal blankets occur in the vicinity of Aikens, Dogskin and Family Lakes.	Eluviated Dystric Brunisol		Well to moderately well	
RC	Rice River	214-270	Dominantly shallow deposits of fen peat and/or discontinuous Sphagnum peat overlying fen peat, underlain by lacustrine clay.	Extensive plains of level to depressional patterned and horizontal fens, occasionally broken by bedrock outcrops.	Terric Mesisol, sphagnic phase	Terric Mesisol	Very poor	Lakes in this district, few in number and small, are characterized by regular, smooth organic shorelines; Lake Winnipeg, marking the western boundary of the district, is the most prominent water feature. Major rivers, while still influenced by the underlying bedrock, often have shores composed of clay banks or swamps. Major Watershed Divisions: Manigotagan River (5RA) Bloodvein River (5RB) Berens River lower (5RD) Drainage Direction: West to Lake Winnipeg
			Shallow deposits of discontinuous Sphagnum peat overlying forest peat, underlain by lacustrine clay.	Level to gently sloping flat bogs or bog plateaus occur in raised positions above surrounding fens.	Terric Mesisol, sphagnic phase	Terric Mesisol	Poor to very poor	
			Shallow to deep clay textured lacustrine sediments.	Locally extensive gently sloping to undulating lacustrine clay blankets occur along major rivers and near the shore of Lake Winnipeg; occasional bedrock outcrops may occur at the surface.	Solonetzic Gray Luvisol	Orthic Gray Luvisol	Moderately well to imperfect	

Table 4 (continued)

Land District			Physiographic Characteristics		Soil Type		Drainage and Hydrological Characteristics	
Sym-bol	Name	Elevation, meters a.s.l.	Surficial Deposits	Topography and Landforms	Dominant	Subdominant	Soil Drainage	Hydrology*
WA	Wanipigow Lake	214-330	Dominantly shallow clay textured lacustrine sediments underlain by silt textured sediments.	Level to gently sloping lacustrine plains and blankets, broken by occasional bedrock outcrops, occupy the floor of a trench formed by steep bedrock ridges rising sharply along the north and south sides of Wanipigow Lake.	Solonetzic Gray Luvisol	Orthic Gray Luvisol	Moderately well to imperfect	Lakes and rivers are irregularly shaped and strongly bedrock controlled. The bedrock trench is drained by the Wanipigow River; the remainder of the district is drained by the Manigotagan River and its tributaries. Major Watershed Divisions: Wanipigow River lower (5RA-D) Gold Creek (5RA-H) Drainage Direction: West to Lake Winnipeg
			Deep lacustrine clay textured sediments.	Gently sloping to undulating lacustrine clay blankets occur within the trench at elevations above 270 m; bedrock outcrops frequently at the surface.	Solonetzic Gray Luvisol	Gleyed Solonetzic Gray Luvisol	Moderately well to imperfect	
			Precambrian bedrock with minor pockets of clay textured lacustrine sediments.	Gently to steeply sloping bedrock outcrops partially subdued by lacustrine veneers and blankets on the lower slopes and depressions.	Solonetzic Gray Luvisol	Gleyed Solonetzic Gray Luvisol; Solonetzic Gray Luvisol, lithic phase	Imperfect to poor	
			Deep forest and fen peat underlain by lacustrine clay.	Level to gently sloping flat bogs and horizontal fens occur in depressions between bedrocks and as locally extensive plains near Lake Winnipeg.	Typic Mesisol, sphagnic phase	Typic Mesisol	Poor to very poor	
			Locally extensive deep sand textured glacial fluvial deposits	Level to gently sloping glacial outwash plains occur west of Wanipigow Lake and south of Wallace Lake.	Eluviated Dystric Brunisol		Rapid to well	

* Watershed Divisions as described by Fedoruk, A.N. (1970). "Proposed Watershed Divisions of Manitoba", ARDA Rept. 10, Man. Dept. Mines & Nat. Res., 89 p.

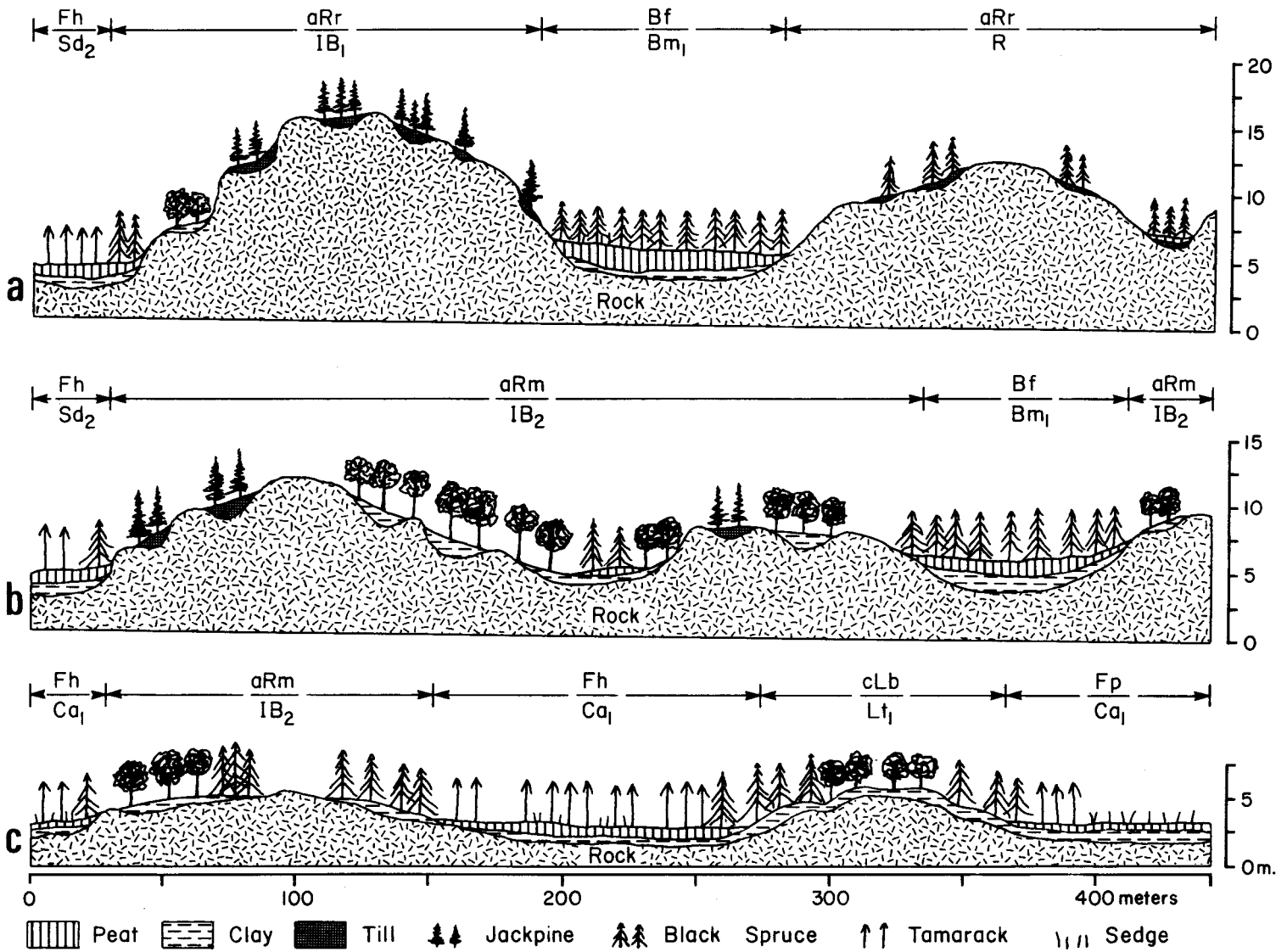


Figure 6. Typical cross-section through portions of three land districts: (a) Dogskin River (b) Bloodvein River (c) Rice River .

of the district is very gently sloping to level and depressional. The land surface of the district slopes gently westward, elevations decreasing from 270 m a.s.l. to 214 m a.s.l. at Lake Winnipeg.

The organic terrain is dominated by large patterned fens with smaller areas of flat bog and blanket bog interrupted by low bedrock outcrops. Relief within this district is usually less than 3 meters. Although the organic terrain is extensive the average depth of the deposits is more shallow than that encountered in the two Land Districts to the east. The dominant organic materials are mesic fen peat, seldom exceeding 2 m in depth. They are underlain by calcareous lacustrine sediments ranging in texture from clay to fine sandy loam; clayey lacustrine sediments are dominant. Shallow to deep clay deposits also occur at the surface adjacent to larger rivers and streams and along the east shore of Lake Winnipeg.

In contrast to the Dogskin and Bloodvein land districts to the east, the Rice River district is characterized by relatively few, small lakes, most of which have smooth regular organic shorelines. The most prominent water feature of the district is the Lake Winnipeg shoreline which marks the entire western boundary of the district. Several rivers and streams flow westward across the district, draining into Lake Winnipeg. A typical cross-section within this district is illustrated in Figure 6C.

2.4 Wanipigow Lake Land District

This Land District occupies the extreme southern portion of the map area. Its physiography is best described in terms of two subdivisions. A narrow, elongate, bedrock-controlled trench occurs along the northern portion of the district. Rock ridges forming the walls of this trench rise up to 30 meters in height. South of the trench, the district is dominated by gently to steeply sloping bedrock outcrops which occur mainly at elevations above 270 meters. At lower elevations near Lake Winnipeg, shallow lacustrine clay plains associated with organic deposits characterize the more gentle topography.

The surface deposits within the bedrock controlled trench exhibit more variation in stratigraphy than is noted elsewhere in the District. West of Bissett and below 300 m a.s.l. (900 feet), the dominant material is lacustrine clay sediments underlain by calcareous silt textured materials at depths from 0.5 to 3 meters. Noncalcareous fluvial sand is found occasionally underlying the lacustrine sediments. Above 300 m a.s.l. the silty lacustrine deposits are less common and lacustrine clay sediments, interrupted by occasional rock outcrops, are dominant.

The terrain south of the trench is dominated by bedrock outcrops with minor pockets and veneers of calcareous lacustrine clay on lower slopes and depressions. Deep deposits of mesic forest peat, usually underlain by clay, occur in depressional areas between outcrops. Below 230 m elevation, the terrain grades into poorly drained organic plains of fen and forest peat, underlain by lacustrine clay. Occasional rock outcrops as well as local areas of well-drained lacustrine clay are found close to the Lake Winnipeg shoreline.

Minor areas of glacial outwash deposits are found within the trench as well as to the south on bedrock dominated terrain. These deposits occur as well-drained plains of acidic sand and gravel of variable depths. They are local in extent and occur mainly southwest of Wallace Lake and east of Manigotagan. The variability noted in the surficial deposits of this district, particularly in the bedrock trench, may allude to a shallow near-shore environment in the late

stages of Glacial Lake Agassiz, with the trench acting as a melt-water channel.

Drainage over much of the district is poorly developed. The trench-like configuration along the northern edge of the district results in a small independent watershed drained by Wanipigow Lake and Wanipigow River flowing westward into Lake Winnipeg. The remainder of the District within the map area is drained by the Manigotagan River and its tributaries.

3.0 LAND SYSTEMS

The basic document of the biophysical land classification is the map and legend which depict land systems at a scale of 1:125,000. In other words, each map unit is equivalent to a land system. The boundaries of most map units are drawn initially on the basis of landforms and related surface deposits. The landform units are usually further refined in terms of topographic variation and patterns of soils, drainage condition and vegetation.

The various components (i.e. Land Types) of each map unit on the biophysical map are identified by symbols and their relative proportions indicated by deciles. The system of symbolization describing a map unit is explained on the biophysical map legend. Definitions of landform terminology are contained in Appendix 1. Soil-related terms are explained in Appendix 2.

During the field program the sites visited generally belong to a portion of the landscape equivalent to a Land Type or complex of Land Types. The locations of detailed site investigations in the Hecla-Carroll Lake map area are shown in Figure 5. Soil analysis, site descriptions and vegetation data from these sites are on file with the Canada-Manitoba Soil Survey, Ellis Building, University of Manitoba.

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A P P E N D I C E S

1.0 DESCRIPTIONS OF LANDFORMS (refer to Geomorphology Section on Map Legend)

BEDROCK CLASSES -

ACIDIC (aR): igneous intrusive or extrusive bedrock having more than 66 percent SiO_2.

BASIC (bR): igneous intrusive or extrusive bedrock having less than 66 percent SiO_2.

BEDROCK (R): A general term for the rock, usually solid, that is exposed or underlies unconsolidated surficial material. Types of bedrock encountered are grouped into "acidic, basic or carbonatic" classes.

CARBONATIC (cR): Sedimentary rocks containing large amounts of calcite and other carbonate materials.

UNDIFFERENTIATED (uR): a bedrock material where differentiation into a specific class is impractical or impossible.

BOG - see Genetic Organic Landform Classes

EROSIONAL MODIFIER -

CHANNELED (c): Modification of a deposit or feature by the cutting of channels and removal of material from along local drainage ways.

DEFLATED (l): Modification by erosive action of wind.

DISSECTED (i): A network of gullies, ravines, valleys and remnant flat-topped interstream ridges formed by stream erosion acting on a relatively even topographic surface.

ERODED (e): The production or modification of a landform by the action of streams, waves or glaciers.

WASHED (w): Landforms which have been modified in some manner by wave action are said to be washed. The process results in the sorting of surface materials or the formation of scattered minor beaches.

FEN - see Genetic Organic Landform Classes

GENETIC MINERAL LANDFORM CLASSES -

ALLUVIAL (A): accumulation of material deposited during comparatively recent geologic time by a stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its flood plain or delta, or as a cone or fan at the base of a mountain slope.

COLLUVIAL (C): accumulation of any loose, heterogenous and incoherent mass of material or rock fragments (variable mixture of boulders to clay) deposited chiefly by mass-wasting, usually at the base of a steep slope or cliff.

EOLIAN (E): accumulation of deposits (sand and silt) whose constituents were transported (blown) and laid down by atmospheric currents, or of deposits produced or eroded by the wind.

GLACIOFLUVIAL (G): pertaining to the outwash deposits and landforms, produced by meltwater streams associated with and flowing from wasting glacier ice. Such stratified sediments, depending on the depositional environment, are classed as ice contact deposits or outwash sediments.

(a) Ice contact deposits: these are found in kames, eskers and kame moraines. They are englacial materials deposited within, upon, or immediately adjacent to glacier ice. In addition to a distinctive surface form, ice contact deposits are characterized by extreme range and abrupt changes in grain-size, inclusions of till bodies and marked deformation of strata.

(b) Outwash sediments: they are proglacial deposits that include stratified materials, mainly well sorted sands and gravels deposited by streams usually in the form of fans, terraces and valley trains.

GLACIOLACUSTRINE (L): Materials deposited in glacial lakes; specifically, landforms and deposits composed of suspended materials transported by streams into lakes bordering a glacier which has since disappeared.

MORAINAL (M): accumulations of unsorted, unstratified glacial drift, predominantly till, deposited chiefly by the direct action of glacier ice in a variety of landforms that are primarily independent of control by the surface underlying the drift.

MARINE (W): Materials deposited in marine environments. These may form a blanket of deeper-water silts and clays, or occur as a series of marine nearshore features composed largely of gravels and sands and deposited as spits, bars and beaches.

UNDIFFERENTIATED (U): Deposits whose genesis cannot be determined from the available evidence, or mixtures of deposits resulting from the interaction of several genetic processes.

GENETIC ORGANIC LANDFORM CLASSES -

BOG (B): A bog is a peat-covered or peat-filled area, generally with a high water table. Since the surface of the peatland is slightly elevated, bogs are either unaffected or partly affected by nutrient-rich groundwaters from the surrounding mineral soils. The groundwater is generally acidic and low in nutrients (ombrotrophic). The dominant peat materials are sphagnum and forest peat, underlain, at times, by fen peat.

Categories of Bogs:

BOG PLATEAU (Bp): The height of these peat landforms varies from 0.5 to 1 meter and is due to greater peat deposition as compared to the surrounding wet fen areas. Bog plateaus are often teardrop shaped.

BOG VENEER (Bv): This type of bog occurs when a shallow peat (generally between 40-100 cm thick) covers slopes and to some degree, depressions and uplands. The surface topography is often micro-hummocky (sphagnum mounds). Permafrost is discontinuous in this type of bog, and most often found in the better developed mounds.

BOWL BOG (Bp): This type of bog has developed in topographic depressions and has a concave peat surface.

BLANKET BOG (Bl): This type of bog occurs when peat covers the uplands, slopes and depressions alike up to a considerable degree of slope.

FLAT BOG (Bf): This type of bog is a level peatland area having only slight differences in the level of its surface. Irregularities or slopes of the substratum are completely or almost completely masked by the peat deposit.

PALSA (Ba): A mound of peat with a frozen peat and/or mineral core, occurring in waterlogged, treeless or sparsely wooded fens. The height of a palsa is generally between 1 and 3 meters, while the width is in the order of some tens of meters.

PEAT MOUND (Bm): Permanently frozen treeless mounds (0.5 to 1 meter in diameter and about 30 to 50 cm high) which occur in water saturated fens.

PEAT PLATEAU (Bt): Peat plateaus are associated with permafrost and their height (approximately 1 m) is dominantly due to ice lens formation in the frozen core. Their sizes range from several hectares to tens of hectares.

POLYGONAL PEAT PLATEAU (By): These frozen organic landforms resemble peat plateaus as they are elevated about 1 m above the surrounding fen areas. The surface of this type of peat plateau is dominated by a polygonal pattern caused by ice wedge formation. The surface morphology resulting from ice wedge formation is expressed as a network of polygons having high, near level or slightly depressed centers. The outline of each polygon is marked by a polygonal trench often containing a wedge-shaped accumulation of ice.

FEN (F): A fen is a peat-covered or peat-filled area with a high water table, which is usually at the surface. The dominant materials are shallow to deep, well to moderately decomposed fen peat. The waters are mainly rich in nutrients (minerotrophic) and are derived from mineral soils. The peat materials are therefore higher in both nutrients and pH than the peats associated with bogs.

Categories of Fens:

COLLAPSE SCAR (Fc): These fen areas have developed as a result of melting of permafrost in organic landforms such as peat plateaus and palsas. The collapsed portion of the landform has a high water table and the collapsing edge may form a steep bank.

Characteristic are the leaning trees on the banks and submerged or partly submerged dead trees in the collapse area.

FLOATING FEN (Ff): This type of fen occupies areas over a shallow water surface. The fen vegetation forms a floating or quaking peat mat encroaching on a water surface.

HORIZONTAL FEN (Fh): This type of fen consists of extensive flat, low lying areas that show very slight differences in the level of the peat surface. The water table is usually at or close to the surface.

MINEROTROPHIC PALSA (Fm): This type of fen occurs mainly in the coastal area of the Hudson Bay Lowlands. These organic landforms have an elevated, slightly convex surface (due to ice lens formation in both the organic layers and the underlying minerals) and are generally surrounded by water saturated fens. The organic material is often layered with alluvial deposits.

PATTERNED FEN (Fp): This type of fen occupies very gently sloping areas and its characteristic feature is a pattern of ridges (strangs) and hollows (flarks). These sites are extremely wet throughout the summer.

SLOPING FEN (Fl): This type of fen occupies appreciably sloping areas and is often found in areas with higher water table. It is fed by seepage rather than by a distinctly localized outflow of spring water.

SWAMP (S): A swamp is a peat-covered or peat-filled area. The peat surface is level or slightly concave in cross section. The water table is frequently at or above the peat surface. There is strong water movement from margins or other mineral sources. The microrelief is hummocky, with many pools present. The waters are neutral or slightly acid. The dominant peat materials are shallow to deep mesic to humic forest and fen peat.

MORPHOLOGY AND SURFACE FORM CATEGORY -

APRON (a): An extensive, continuous, gently sloping and blanket-like deposit of unconsolidated material derived from an identifiable source such as the edge of a large esker or along fault scarps.

BLANKET (b): an extensive area of relatively thick (>1 m) surface deposits which subdue but do not completely mask the configuration of the underlying bedrock or deposit.

COMPLEX (x): a mixture of several morphologic units (the nature of this unit generally must be explained in written text).

DELTA (Δ): usually a triangular shaped area composed of stratified materials (ranging from coarse to fine) deposited by streams into large bodies of water.

DRUMLINIZED (d): Elongated, smooth, streamlined ridges with long axes parallel to the direction of ice movement.

FAN (f): A gently sloping, fan-shaped mass of detritus forming a section of a very shallow cone, commonly at a place where there is a noticeable change in gradient.

HUMMOCKY (h): Terrain having a broken, irregular surface with distinct knobs or mounds and depressions.

KETTLED (k): An area of glacial drift pitted with numerous steep-sided, bowl- or basin-shaped depressions that often contain lakes; surface drainage is generally deranged.

PLAIN (p): An area of comparatively flat, smooth, and level land having few or no prominent surface irregularities, but sometimes having a considerable unit tilt.

RIDGED (r): Terrain characterized by long, narrow elevations which may occur independently or in parallel or intersecting patterns. Ridges usually have sharp crests and steep sides.

ROLLING (m): Terrain having a smooth, regular surface with broad topographic lows and broad topographic highs. Slopes are usually more than 1 kilometer in length.

TERRACED (t): a long, narrow, relatively level or gently inclined surface bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope; a large bench or step-like ledge breaking the continuity of a slope.

UNDULATING (u): Terrain having a smooth, regular surface with broad shallow topographic lows and broad medium to subdued topographic highs. Slopes are usually less than 1 kilometer in length.

VENEER (v): an extensive area of thin (1 m) unconsolidated surficial deposits which mask little of the configuration of the underlying bedrock or deposits.

TEXTURAL CATEGORIES -

CLAYEY (c): material less than 2 mm contains 35% or more clay by weight and particles 2 mm to 25 cm size are less than 35% by volume.
Includes heavy clay loam, heavy silty clay loam, sandy clay, silty clay, clay and heavy clay.

FRAGMENTAL (f): gravel, cobbles and boulders (2 mm to more than 25 cm) containing too little fine materials to fill the spaces larger than 1 mm.

LOAMY (l): material less than 2 mm contains less than 35% clay by weight and includes coarser materials up to very fine sand size. Particles of 2 mm to 25 cm size are less than 35% by volume.
Includes 2 main groups of texture:
(1) Light (less than 18% clay by weight):
sandy loam, fine sandy loam, loam, very fine sandy loam, loamy very fine sand, loam, silt loam, silt
(2) Heavy (18-35% clay by weight):
sandy loam, fine sandy loam, loam, very fine sandy loam, silt loam, sandy clay loam, clay loam, silty clay loam

SANDY (s): material less than 2 mm contains less than 18% clay and more than 70% sand exclusive of loamy very fine sand and very fine sand. Particles of 2 mm to 25 cm size are less than 35% by volume.
Includes sands and loamy sands.

SKELETAL (s): modifies the main textural categories containing more than 35% by volume of particles coarser than 2 mm size.

TOPOGRAPHIC EXPRESSION - refers to the physical features of a land district or land system such as those represented on a map, especially the relief and contours of the land.

RELIEF CLASS: Relief refers to elevations or inequalities of a land surface. Land having no unevenness or differences of elevation is called level; gentle relief is called undulating, strong relief, rolling and very strong relief, hilly. Six classes of local relief are applied to map unit separations and are intended to describe the average maximum relief condition. The classes of relief are designated by alpha symbols and defined as follows:

a	0-2 meters
b	3-5 meters
c	6-20 meters
d	21-50 meters
e	51-100 meters
f	100 meters

SLOPE CLASS: Six broad slope classes are defined to enable a quantification of the dominant (not necessarily most abundant) slopes within a mapped unit of local landform.

Class	Degrees	Percent	Description
1	0-2	0-5	level to very gently sloping
2	3-7.5	6-15	gently to moderately sloping
3	8-15	16-30	strongly sloping
4	16-30	31-60	very strongly to extremely sloping
5	30	60	steeply and very steeply sloping
6	Complex		

SWAMP: see Genetic Organic Landform Classes

2.0 GLOSSARY OF TERMS

ASSOCIATE, SOIL - A nontaxonomic but cartographic grouping of soils or land segments which combines related soils into units having similarity in geomorphic position, landform, edaphic and mechanical properties of soils (climate, drainage, particle size, etc.) and to some degree similarity in the geological nature of the soil materials and taxonomic classes.

ASSOCIATION, SOIL - A natural grouping of soil associates based on similarities in climatic or physiographic factors and soil parent materials. It may include a number of soil associates provided that they are all present in significant proportions.

CALCAREOUS SOIL - Soil containing sufficient calcium carbonate, (often with magnesium carbonate) to effervesce visibly when treated with hydrochloric acid.

CALCIUM CARBONATE EQUIVALENT - refers to the percent of carbonates in the soil expressed on the basis of calcium carbonate. Terms used to express the carbonate content of soils are:

noncalcareous	<1%
weakly calcareous	1-5%
moderately calcareous	6-15%
strongly calcareous	16-25%
very strongly calcareous	26-40%
extremely calcareous	> 40%

DECILE PORTION - A one-tenth portion. As used on the biophysical map, the symbol $\frac{1Md^{6}}{Sk_{2}} \mid \frac{Bv^{4}}{My_{2}}$ means that the loamy drumlinized moraine and the soils of the Sky Pilot association cover six-tenths and the bog veneer and the soils of the Myre Lake association cover four-tenths of the map unit.

DRAINAGE (SOIL) - (1) The rapidity and extent of the removal of water from the soil by runoff and flow through the soil. (2) As a condition of the soil, it refers to the frequency and duration of periods when the soil is free of saturation.

EROSION - The wearing away of the land surface by detachment and transport of soil and rock material through the action of moving water, wind or other geological processes.

FIBER CATEGORY - Three main classes of fiber content are used to describe organic (peat) materials. The fiber classes are defined in terms of relative amounts of fiber (particles exceeding 0.15 mm in diameter) persisting in the organic soil material and its durability as it reflects the degree of decomposition of the material. Definition of the fiber classes are as follows:

FIBRIC: The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.

MESIC: Organic material in an intermediate stage of decomposition; intermediate amounts of fiber are present that can be identified as to their botanical origin.

HUMIC: Highly decomposed organic material; there is a small amount of fibers present that can be identified as to their botanical origin, fibers that are present can be easily destroyed by rubbing.

FIBRIC - see Fiber Category

GLEYED SOIL - An imperfectly or poorly drained soil in which the material has been modified by reduction or alternating reduction and oxidation. These soils have lower chromas or more prominent mottling or both in some horizons than the associated well drained soil.

HUMIC - see Fiber Category

MESIC - see Fiber Category

MOTTLE - Irregularly marked spots or streaks, usually yellow or orange but sometimes blue, interspersed with the dominant colour. Mottling in soils indicates poor aeration and lack of good drainage.

PARENT MATERIAL - The unaltered or essentially unaltered mineral or organic material from which the soil profile develops by pedogenic processes.

PERMAFROST - (1) Perennially frozen material underlying the solum. (2) A perennially frozen soil horizon.

PERMAFROST TABLE - The upper boundary of permafrost, usually coincident with the lower limit of seasonal thaw (active layer).

REACTION, SOIL - The acidity or alkalinity of a soil.

Acid reactions are characterized as follows:

extremely acid	pH below 4.5
very strongly acid	pH 4.5 to 5.0
strongly acid	pH 5.1 to 5.5
medium acid	pH 5.6 to 6.0
slightly acid	pH 6.1 to 6.5

Neutral reactions are from pH 6.6 to 7.3

Alkaline reactions are characterized as follows:

mildly alkaline	pH 7.4 to 7.8
moderately alkaline	pH 7.9 to 8.4
strongly alkaline	pH 8.5 to 9.0
very strongly alkaline	pH above 9.0

SOIL - The unconsolidated material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. Soil has been subjected to and influenced by genetic and environmental factors of: parent material, climate (including moisture and temperature effects), macro- and micro-organisms, and topography, all acting over a period of time.

SOLUM - The upper horizons of a soil above the parent material and in which the processes of soil formation are active. It usually comprises the A and B horizons.

TEXTURAL CATEGORIES - Three categories of texture are utilized to describe the nature of the mineral deposits associated with a landform. The texture classes within each category are estimated in terms of size and the distribution of primary particles. Significant inclusions of very coarse particles (gravel, cobbles and boulders) within a deposit are indicated by adding the term "skeletal" as a modifier to the symbol for a textural category.

Primary Particles

Name of Separate	Diameter, mm
Boulders, stones	>250
Cobbles	250-75
Gravel	75-2.0
Very coarse sand	2.0-1.0
Coarse sand	1.0-0.5
Medium sand	0.5-0.25
Fine sand	0.25-0.10
Very fine sand	0.10-0.05
Silt	0.05-0.002
Clay	Less than 0.002

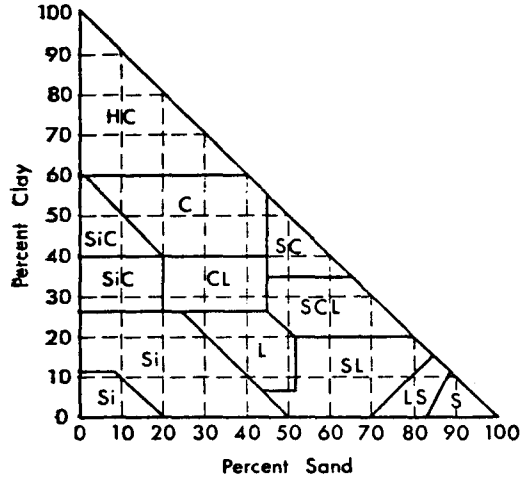

Figure 7. Particle size classes used in describing soil texture. Percentages of clay and sand in the main textural classes; the remainder of each class is silt.