INTERIM REPORT ON A SOILS INVENTORY IN THE ATHABASCA OIL SANDS AREA

by

L.W. Turchenek

J.D. Lindsay

Alberta Research Council

Soils Division

for

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ABSTRACT

Soils of the AOSERP study area are being mapped using the ecological or biophysical approach to land classification. The basic land unit being mapped is the land system which is an area of land through which there is a recurring pattern of landforms, soils, vegetation chronosequences, and water bodies. Using 1:50,000 airphotos, the land systems are separated at a reconnaissance level of detail. The emphasis in this inventory is on soils and the landforms on which they occur; both are indicated on maps. Vegetation is not indicated on maps and is handled in terms of general soil-drainage-vegetation relationships.

Airphoto interpretation and field checking have been completed in all of the AOSERP high priority area to Township 100. Land system maps have been prepared for 1:50,000 NTS sheets 74D/11, 12, 13, and 14 and 74E/3 and 4; these accompany this report. Maps of the remaining NTS sheets within the high priority area are in preparation. Soils information from the high priority area above Township 100 has been collected, but maps cannot be made until airphotos for this region become available.

The dominant upland soils of the AOSERP study area are Gray Luvisols, formed on medium to very fine textured glacial till and glaciolacustrine deposits, and Eutric Brunisols, formed on coarse textured glaciofluvial deposits. White spruce, trembling aspen, and jack pine are dominant cover species on these soils. Soils developed on materials of recent deposition, mainly alluvium, are Regosols and Gleysols. Soils of low-lying, poorly drained areas are mainly Organic. These soils, a combination of bog and fen peats, occupy a considerable portion of the AOSERP study area, but are mainly relatively thin (< 1 metre thick). The vegetation on the bog soils is dominantly black spruce with sedges on the fens. Relief in the area is generally low, exceptions being parts of the Birch Mountains, Fort Hills, and Richardson Hills.

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1. INTRODUCTION

The objective of the soils inventory is to provide baseline data with respect to the kinds, location and extent of soils in the Alberta Oil Sands Environmental Research Program (AOSERP) study area (Figure 1). Such information will aid in identifying the nature of the interactions between some of the biotic and abiotic components of the environment, predicting the effects of oil sands development on the environment, identifying materials that may be useful in reclamation procedures and providing information that will be useful in the overall development (industrial and non-industrial) of the area. Possible users of inventory information are those involved in forestry, conservation, land use, engineering (highways, etc.), industry, reclamation, recreation and wildlife.

In this inventory, soils are considered in an ecological framework and the ecological, or biophysical, system of land classification has been adopted for mapping the area. In this system, recurring patterns of soils, landforms, vegetation and water bodies are mapped primarily by use of aerial photographs. A study of the soil forming factors (climate, parent material, relief and vegetation acting over time) is inherent in any survey of soil types and distribution and therefore the ecological approach is not greatly different from traditional soil survey. The conceptual framework of the ecological system facilitates differentiation and classification of the land surface rapidly and at a small (reconnaissance) scale, particularly in areas where little basic ecological knowledge is available (Lacate 1969). It provides an initial overview and inventory of wildlands and sets the stage for more detailed work on those areas that warrant closer attention.

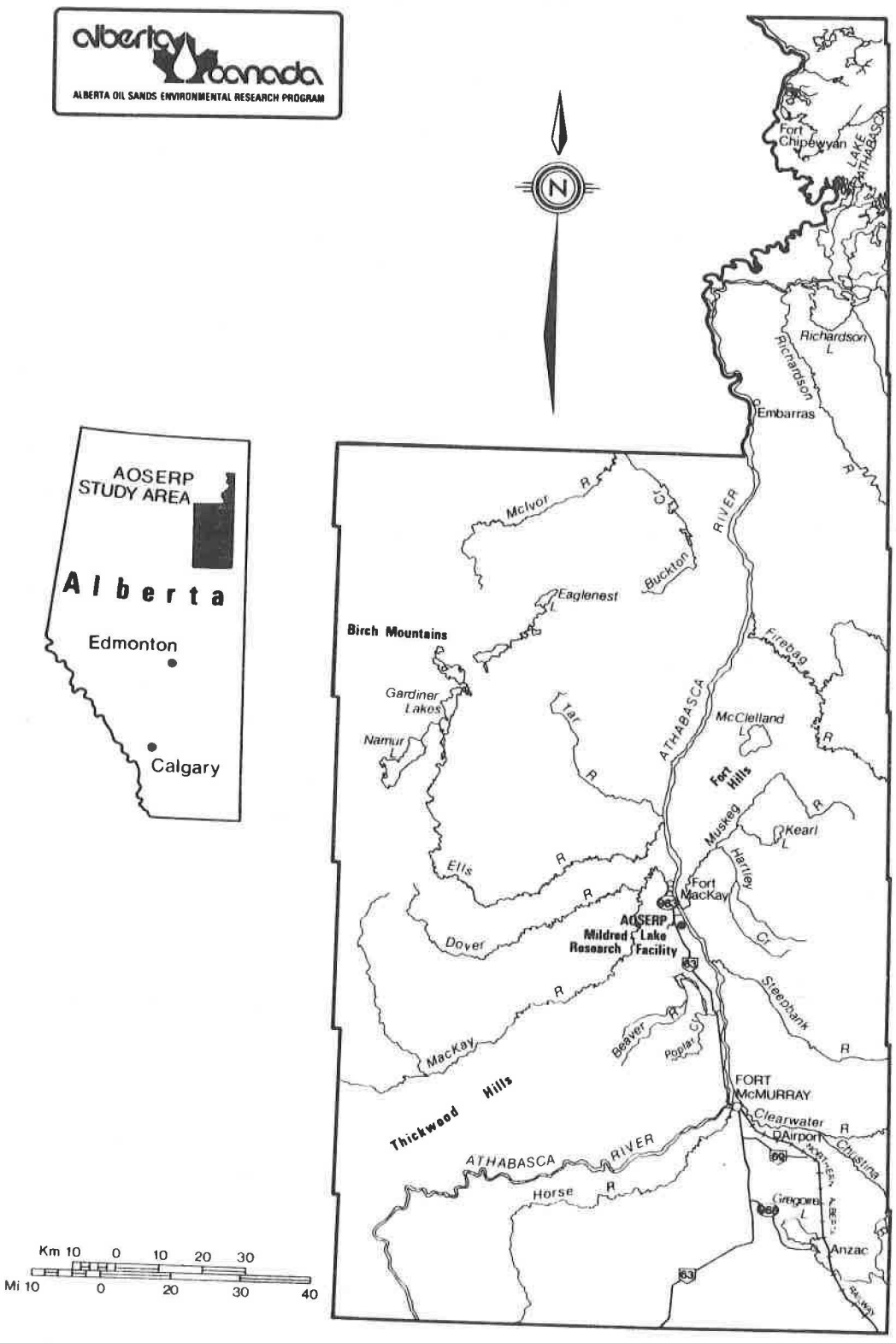

Figure 1. Location of the AOSERP study area.

2. RESUME OF CURRENT STATE OF KNOWLEDGE

A number of surveys and studies on soils, surficial geology and vegetation pertinent to biophysical mapping of the AOSERP study area have been conducted.

Lindsay et al. (1957, 1961, 1962) have mapped and classified the soils of a large portion of northeastern Alberta including the entire Athabasca Oil Sands area at an exploratory level. On maps with a scale of about 1:750,000, separations were made mainly on the basis of soil parent material. The large areas which were separated correspond closely to separations at the "land district" level in the present survey and as such, provide an indication of the major materials, soils and topography that are likely to be encountered.

Crown and Twardy (1970) have soil surveyed on area of eight townships surrounding Fort McMurray. Maps produced at a scale of 1:126,000 provide information on soil materials, landforms, soil map units, drainage classes and of soil capability for agriculture at a semi-detailed level.

Bayrock (1971, 1972a, 1972b, 1972c) and Bayrock and Reimchen (1974) have mapped the surficial geology of NTS sheets 74P, 74E, 74L, 74M, and 84I, at a scale of 1:250,000. In the soils inventory, the establishment of different land systems with soils developed on glacial till is mainly based on the recognition of three types of till in the Athabasca Oil Sands area (Bayrock and Reimchen 1974). Similarly, mapping of different glaciofluvial land systems is partly based on their interpretation of various types of glaciofluvial deposits in the area. Peat deposits have also been mapped in the Fort McMurray sheet (74D), although these appear to be limited to the deeper deposits.

McPherson and Kathol (1977) have recently reported on the surficial geology of potential mining areas in the Athabasca Oil Sands region (Tp 91-98, R 7-3, W4) and provide more detail than the previous surficial geology maps, particularly with respect to distribution of organic deposits.

Rowe's (1972) "forest regions" and "forest sections" are the main basis of subdivision of the Athabasca Oil Sands area into land regions and land subregions within the ecological system of classification adopted for this study. The subregions are (1) Mixedwood, (2) Athabasca South, (3) Upper Mackenzie, and (4) Northwest Transitional (see Section 4.1.2).

A literature review of vegetation in the AOSERP study area has been provided by Stringer (1976). Stringer investigated numerous stands of vegetation in the AOSERP study area and subdivided them into ten distinct vegetation types. These are being adopted as the basis for describing the plant community component of land systems in the land inventory (Section 4.2). Kabzems et al. (1976) have described 23 forest ecosystem types occurring in the mixedwood section of Saskatchewan. The relatively detailed breakdown of vegetation types in this latter report is useful as a guide in recognizing types in the mixedwood section of the oil sands area in addition to those described by Stringer.

A comprehensive review of properties and processes of forest soils has recently been published by Armson (1977). General information on the environment of the Athabasca Oil Sands area can be obtained from the "Atlas of Alberta" (1969) and the "Guide to the Athabasca Oil Sands Area" (Carrigy and Kramers 1973). Physiographic separations in the "Atlas of Alberta" provide the basis for subdivision of the study area at the "land district" level. More detailed information for separating land districts is available in the form of unpublished physiographic maps (Alberta Institute of Pedology).

3. MATERIALS AND METHODS

3.1 AERIAL PHOTOGRAPHS

An ecological (biophysical) land inventory relies on airphoto interpretation with supporting field checks to differentiate and classify various segments of the land surface. Pre-field airphoto interpretation is conducted to make initial delineations and to select sites for examination and sampling in the field. Lacate (1969) indicated that a mapping scale of 1:125,000 is the most useful for reconnaissance surveying at the land system level. Working at a scale of 1:50,000 enables more detailed mapping, though not sufficiently detailed for mapping at the land type level. The use of 1:50,000 airphotos selected for use in the soils inventory thus permits a semi-detailed to reconnaissance level of survey. The 1:50,000 panchromatic black and white airphotos obtained for this project from the National Aerial Photo Library in Ottawa have the further advantage of being the most recent airphotos (1974) available for the region. The photographs (about 900) cover approximately 75% of the project area, the uncovered portion encompassing Tp 101-103, R 6-8, W4 and 105-107, R 6-9, W4. This area will therefore be mapped using older (1960) 1:31,680 airphotos, or if available, by use of infrared false color airphotos at a scale of 1:60,000 which were flown in 1977.

3.2 MAPPING PROCEDURE

The initial step of the mapping procedure is delineation of sufficiently different segments of land on airphotos with the aid of a stereoscope. The delineations are made mainly according to differences in landform and vegetation patterns. Previous soil surveys and surficial geology maps are then examined to aid the prediction of parent material and soil type in each delineated area. Possible sites in which a helicopter is able to land, mainly along seismic cutlines, are selected for each segment.

Since airphotos are taken along east-west flight lines, the field checking was organized to follow flight lines, working northward through the study area upon completion of a line. About fifteen landings along one line through six or seven townships can be accomplished in one day.

Field inspection consists of examining the soils in pits at a single site or along a transect, recording soil properties, parent materials and landforms, and listing vegetation species or groups at the site. In addition, the tree cover, height and diameter (dbh) of the tree stratum, and approximate abundance or cover of the substrata are recorded. Descriptions are made on standard forms (example, Figure 2).

3.3 CLASSIFICATION AND MAPPING CONVENTIONS

3.3.1 Ecological (Biophysical) Land Classification

"Ecological land classification refers to an integrated approach to land survey in which areas of land, as ecosystems, are classified according to their ecological unity" (Wiken and Ironside 1977:273). A brief description of the divisions or levels of generalization with the classification system is given in Table 1 (Canadian Committee on Ecological Land Classifications 1977).

In addition to the divisions described in Table 1, the "land subregion" was introduced by Yuksel and Lindsay (1976) and described as a division of a land region based on vegetation, soil and major physiographic characteristics of the landscape. The subregions correspond with the "forest sections" of Rowe (1972).

DAILY FIELD RECORD SHEET

SITE NO. 001 | MAP UNIT K1N1 | SERIES | PHASE | PROJECT ASERP VE 21 | NAME LWT | DATE 13087

MILITARY GRID REFERENCE: Zone | Let | 100,000 | Easting | Northing
LATITUDE: Deg | Min | Sec
LONGITUDE: Deg | Min | Sec
NTS SHEET: Prim | Let | No | Dir (74E 2W)
LEGAL DESCRIPTION: LSD | Qtr | Sect. | Tp | R | Dir | M

SOIL FEATURES
Profile Description

Horizon	Depth	Color	Texture	Structure	Consist.	React.	% C.F.
LFH	1-0						
Ae	0-7	light gray	ls	m.c.p.	loose		5
Bm_1	7-20	bright yellow brown	sl	v.w.m. s.a.b.	v. friable		"
Bm_2	20-45	yellowish brown	sl	"	"		"
Bt_J	45-90	gray brown	scl-cl	w.m. s.a.b.	firm		"
BC	90+	gray brown	scl	massive	firm		"

Notes:

Soil Classification

BRUN	CHER	GLEY	LUV	ORG	PODZ	REGO	SOLZ	PHASE
MB	B	HG	(GL)	F	HFP	R	SZ	CARB
EB	DB	G		M		HR	SS	CRYIC
SB	BL	LG		H			SO	LITHIC
DYB	DG			FO				PEATY
O	O	O	(O)	TY	O	O	B	SALINE
E	R	R	D	FI	LU	CU	DB	STONY
GL	CA	FE	BR	ME	SM	GL	BL	THIN
GLE	E · SZ	HU	PZ	HU	GL	GLCU	DG	TUPBIC
	GL		SZ	LM	GLSM		G	
	GLR		GL	CU			GLA	
	GLCA		GLD	T			GLB	
	GLE		GLBR	TF			GLDB	
	GLSZ		GLPZ	TME			GLBL	
			GLSZ	THU			GLDG	
							GLG	

SITE FEATURES

Slope Position: crest | (upper) | mid | lower | toe | depression

Aspect: N NE E SE S (SW) W NW

Drainage: very rapidly | rapidly | (well) | moderately well | imperfectly | poorly | very poorly

Perviousness: low | medium | (high)

Seepage: present | absent

Depth to Water Table: m / ft

Depth to Bedrock: m / ft

Elevation: m / ft

LANDFORM DESCRIPTION

Genetic Materials: I x II

Mineral: A - Anthropogenic; C - Colluvial; E - Eolian; F - Fluvial; F^G - Glaciofluvial; L - Lacustrine; L^G - Glaciolacustrine; M - Morainal; U - Undifferentiated

Organic: B - Bog; F - Fen; S - Swamp; O - Undifferentiated

Rock: R - Rock

Surface Expression

Mineral: b - blanket; d - delta; f - fan; (h) - hummocky; l - level; r - ridged; m - rolling; t - terrace; u - undulating; v - veneer; i - inclined; s - steep

Organic: b - blanket; o - bowl; d - domed; h - horizontal; p - plateau; r - ribbed; s - sloping

Modifiers: A - Avalanched; B - Bevelled; C - Cryoturbated; D - Deflated; E - Eroded; F - Failed; G - Glaciated; H - Kettled; K - Karst; N - Nivated; S - Soliflucted; V - Gullied; W - Washed

Active

Inactive

OTHER FEATURES

Slope: simple; complex; 0 - 0.5; 0.5 - 2; 2 - 5; (6 - 9); 10 - 15; 16 - 30; 31 - 45; 46 - 70; 70 - 100; >100

Stoniness/Rockiness: 0 non; 1 slightly; (2) moderately; 3 very; 4 exceedingly; 5 excessively

Erosion: W water; D wind; P pitted; 1 slight; 2 moderate; 3 severe

MATERIAL DESCRIPTION

I x II

Physical Component

Mineral: very coarse | moderately coarse | (medium) | moderately fine | fine | very fine

Organic: fibric | mesic | humic | woody | moss | sedge

Rock: Igneous | Metamorphic | Sedimentary | Shale | Sandstone | Carbonate | Others | Undifferentiated

Chemical Component

Acid (< 5.5)
Neutral (5.5 - 7.5)
Alkaline (>7.5)
Weakly calcareous
Strongly calcareous
Saline

Photographs: Line 14 ph. 198

Capability: Agriculture - ; Forestry - ; Recreation - ; Wildlife - ; Other -

Present Land Use -

Special Notes - (incl. engineering considerations)

Figure 2. Sample of field record sheet.

.... Continued

VEGETATION

General Community Type: Jack pine

Species List

Trees (density - 50) %	Shrubs (density -) %	Herbs (density -) %	Grasses-Mosses (density -) %
jP - 90/ 5 / 5 wS - 10/ 1-2 / 3-4 (% of trees; ht. in meters; dbh in cm)	Ledum (s) Rosa spp (m) Blueberry (s) Bearberry (s) m - minor occurrence s - significant occurrence d - dominant	Bunchberry (m)	lichens (d) grasses (m)

Tree age:

Tree height:

Remarks:

Figure 2. Concluded.

Table 1. Outline of the Ecological Classification System.

Levels of generalization Common scales of mapping	Current definitions
Land region 1:1,000,000 to 1:3,000,000	An area of land characterized by a distinctive regional climate, as expressed by vegetation
Land district 1:500,000 to 1:1,000,000	An area of land characterized by a distinctive pattern of relief, geology, geomorphology
Land system 1:125,000 to 1:250,000	An area of land through which there is a recurring pattern of landforms, soils, vegetation chronosequences and water bodies
Land type 1:10,000 to 1:20,000	An area of land having a fairly homogeneous combination of soil (e.g. soil series) and chronosequence of vegetation
Land phase 1:10,000 and greater	An area of land having a fairly homogeneous combination of soil and vegetation. Subdivision of land type based on vegetation succession as expressed by the existing vegetation at the time of the survey

Mapping in this land inventory is being carried out at the land system level. However, land systems are described in terms of characteristics and proportions of land types which are described in detail during the field checking procedure. Since land systems are more or less complex and of fairly broad areal extent, they are subdivided into mapping units on the basis of proportions of land types within them. The main basis for the mapping unit is the soil profile. These units represent different topography and drainage conditions within each system. Therefore, each mapping unit is a catenary sequence, reflecting differences in drainage and topography on a relatively homogeneous parent material. Vegetation is not incorporated into the mapping unit although it is a part of the mapping unit since changes in drainage are generally reflected in changes in the vegetation community. Vegetation is treated in a more general way, by establishing vegetation-soil-drainage relationships (Section 4.2). Drainage in the mapping unit is reflected through the soil subgroup composition. Topography is not incorporated into the mapping unit but is indicated separately, along with landform, in the land system symbol on the map.

3.3.2 Landform Classification

Landforms are mapped according to the classification system adopted by the Canada Soil Survey Committee (1976). In this system, landforms are considered to represent two basic attributes, material and form. There are four groups recognized in the material category: unconsolidated mineral, organic, consolidated mineral and ice. Textures of unconsolidated mineral and fiber content of organics are recognized in a category called Material Qualifiers.

Surface Expression, or form, associated with a material or deposit is considered in the first instance on the basis of primary depositional form. Post depositional forms, essentially erosional, as well as processes are recognized by a category called

Modifying Processes. A category named Qualifying Descriptors makes possible further qualification of the kinds of materials and the current states of processes, that is, whether they are active or inactive.

3.3.2.1 Genetic materials

Unconsolidated Group

The unconsolidated mineral component is comprised of clastic sediments that may or may not be stratified but whose particles are not cemented together. They are essentially of glacial or post glacial origin, but also include poorly consolidated and weathered bedrock. The classes in this group are listed in Table 2. Properties of those classes which may be encountered in the oil sands area are summarized in Table 8. Classes not included are Anthropogenic, Saprolitic, Volcanic and Marine.

Consolidated Component

The consolidated component (bedrock) is comprised of tightly packed, indurated materials of bedrock origin. The materials include igneous, metamophic, sedimentary and consolidated volcanic rocks. There is one class--bedrock, undifferentiated (R). Bedrock and its surface expressions are included with unconsolidated components in Table 8.

Ice Component

Occurring in mountain icefields and related features, this component is not applicable to this area.

Organic Component

The unconsolidated organic component consists of peat deposits containing more than 17% organic carbon, by weight, that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick.

Table 2. Components of the landform classification system.

Genetic Material	Surface Expression	Modifying Processes
Unconsolidated Group	Mineral	A - avalanched (A)[a]
A - anthropogenic (A)[a]	a - apron	B - bevelled (I)
C - colluvial (A)	b - blanket	C - cryoturbated (A)
E - eolian (A)	f - fan	D - deflated (A)
F - fluvial (I)	h - hummocky	E - channelled (I)
L - lacustrine (I)	i - inclined	F - failing (A)
M - morainal (I)	l - level	H - kettled (I)
S - saprolitic (A)	m - rolling	K - karst (I)
V - volcanic (I)	r - ridged	N - nivated (A)
W - marine (I)	s - steep	P - piping (A)
U - undifferentiated (I)	t - terraced	S - soliflucted (A)
Consolidated Component	u - undulating	V - gullied (A)
R - Bedrock (I)	v - veneer	W - washed (I)
Ice Component	Organic	
I - Ice (A)	b - blanket	Qualifying Descriptors
Organic Component	o - bowl	
B - bog (A)	d - domed	G - glacial
F - fen (A)	f - floating	A - active
S - swamp (A)	h - horizontal	I - inactive
O - organic, indifferentiated (A)	p - plateau	
	r - ribbed	
	s - sloping	
	v - veneer[b]	

[a] Assumed process status.

[b] Obsolete in the system, but used in this inventory.

Classes in the component are bog, fen, organic (undifferentiated) and swamp (Table 2). Their characteristics are as follows:
Bog: Sphagnum or other moss and forest peat materials formed under an ombrotrophic environment due to the slightly elevated nature of the bog tending to be disassociated from nutrient-rich ground water or surrounding mineral soils.

Near the surface it is usually undecomposed (fibric), yellowish to pale brown in color, loose and spongy in consistency with entire Sphagnum plants being readily identified. At depth it becomes darker in color, compacted, and somewhat layered. These materials are extremely acid (pH<4.5), of low bulk density (<0.1 g/cc) and very high fibre content (>85% unrubbed and 50% rubbed). These materials are associated with slopes or depressions with a water table at or near the surface in the spring, and slightly below during the remainder of the year. Bogs are usually covered with Sphagnum although sedges may also grow on them, they may be treed or treeless, and they are frequently characterized by a layer of ericaceous shrubs.

Fen: Sedge peat materials derived primarily from sedges with inclusions of partially decayed stems of shrubs formed in an eutrophic environment due to the close association of the material with mineral-rich waters.

The peat is usually moderately well to well decomposed, dark brown in color with fine to medium sized fibers but may be well decomposed, black with fine fibers, decomposition often becoming greater at lower depths. Fen materials are medium acid to neutral (pH 5.5-7.5), relatively low in fiber (20-80% unrubbed and 2-25% rubbed) and relatively dense (0.1-0.2 g/cc). These materials are associated with relatively open peatlands with mineral-rich water tables that persist seasonally at or very near the surface. They are covered with a dominant component of sedges, although grasses and reeds may be associated in local pools. Sphagnum is usually subordinate or absent, with the more exacting mosses being common. Often there is much low to medium height

shrub cover and sometimes a sparse layer of trees.

Swamp: A peat covered or peat filled area with the water table at or above the peat surface. The dominant peat materials are shallow to deep mesic to humic forest and fen peat formed in a eutrophic environment resulting from strong water movement from the margins or other mineral sources.

Swamps are of minor occurrence in the map area and are not mapped as such. The organic, undifferentiated (o) category is treated similarly, bogs and fens being the only peatlands mapped.

3.3.2.2. Material modifiers. Material modifiers are used to further qualify unconsolidated mineral and organic deposits. In this survey, textural classes (Section 3.3.5) serve to describe unconsolidated mineral deposits. Organic material modifiers are the "fiber classes" which are described in Section 3.3.3.5.

3.3.2.3. Surface expression. The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form, as applied to unconsolidated deposits refers to the product of the initial mode of origin of the materials, and as applied to consolidated materials refers to the product of their modification by geological processes. Surface expression also describes the manner in which unconsolidated genetic materials relate to the underlying unit. The classes of surface expression for unconsolidated and consolidated mineral components are listed in Table 2 and are briefly described in Table 8. The classes for the organic component are listed in Table 2 and those recognized in the map area are defined below.

1. Blanket: A mantle of organic materials thick enough to mask minor irregularities in the underlying unit, but which still conforms to the general underlying topography.

2. Veneer: A class no longer recognized in the system but which is retained for application to thin peat deposits, generally less than 1 m thick.
3. Horizontal: A flat peat surface not broken by marked elevations and depressions.
4. Ribbed: A pattern of parallel or reticulate low ridges associated with fens.
5. Sloping: A peat surface with a generally constant slope not broken by marked irregularities.

3.3.2.4 Slope classes. Slope classes make possible the quantification of the dominant (not necessarily most abundant) slopes within a mapped unit of a local landform. There are 10 slope classes (Table 3).

3.3.2.5 Modifying processes. Terms which describe those geological processes that have modified or are currently modifying genetic materials and their surface expression are considered within the Modifying Process category of the landform system (Table 2). The assumed common process status (active, inactive) is specified in the definition of each modifier. Where this status varies from the assumed state, it must be qualified in the description. Modifiers are used only in on-site descriptions in this survey and are not incorporated into mapping units. Where a modifying process is of major significance, it is discussed in the report. Those recognized in the map area are listed and defined below:

1. Cryoturbated. Surface modified by processes of frost action. It includes the stirring, churning modification and other disturbances of soil resulting from frost action. It involves frost heaving, differential and mass movements, and it produces patterned ground. Assumed process status is active. However, the few cryoturbated areas

Table 3. Definition of slope classes.

Slope Class	Percent	Approximate Degrees	Terminology
1	0-0.5	0	Level
2	0.5-2.5	0.3-1.5	Nearly level
3	2-5	1-3	Very gentle slopes
4	5-9	3.5-5	Gentle slopes
5	10-15	6-8.5	Moderate slopes
6	16-30	9-17	Strong slopes
7	31-45	17-24	Very strong slopes
8	46-70	25-35	Extreme slopes
9	71-100	35-45	Steep slopes
10	> 100	> 45	Very steep slopes

examined in the AOSERP study area had no evidence of current frost action and therefore, are either inactive or possibly intermittent in status.

2. Eroded (Channelled). Surface crossed by a series of abandoned channels. The term applies to fluvial plains, terraces and fans. Assumed process status is inactive.
3. Failing. Modification of surfaces by the formation of tension fractures or by large consolidated or unconsolidated masses moving slowly downslope. Process status is only active.
4. Kettled. Deposit or feature modified by depressions left by melting ice blocks. Depressions can be formed by the melting blocks of ice buried in glaciofluvial, glaciolacustrine or glacial till materials. Kettle depressions usually have steep sides and are bound by an abrupt convex break of slope. They occur in a variety of shapes and sizes from round basins to branching valleys. Assumed process status is inactive.
5. Karst Modified. Modification of carbonate and other rocks by processes of solution, and of overlying unconsolidated materials by collapse resulting from that solution. Assumed process status is active.
6. Gullied. The modification of surfaces by fluvial erosion, resulting in development of parallel and sub-parallel, steep-sided and narrow ravines in both consolidated and unconsolidated materials.
7. Washed. Modification of a deposit or feature by wave action in a body of standing water, resulting in lag deposits, beaches of lag materials and wave-cut platforms. Assumed process status is inactive.

3.3.2.6 Qualifying descriptors. A number of descriptors have been introduced to qualify either the Genetic Materials or the Modifying Process terms (Table 2). The Modifying Process Descriptors are Active (A) and Inactive (I), already introduced above. Glacial (G) is a Modifying Descriptor for clastic genetic material indicating that the material originated in a glacial depositional environment. For example the symbol F indicates a present or recent fluvial deposit, wheras F^{G} is glaciofluvial.

3.3.3 Soil Classification

Soils of the AOSERP study area are being classified according to the Canadian System of Soil Classification (Canada Soil Survey Committee 1976). The following is a description, summarized from the Canadian System, and from "Soils of Canada" (Clayton et al. 1977) of the soil Orders, Great Groups and Subgroups recognized in the AOSERP study area.

3.3.3.1 Luvisolic order. Soils of the Luvisolic order are defined as having eluvial (Ae) horizons and illuvial (Bt) horizons in which silicate clay is the main accumulation product. These horizons are influenced by and developed through leaching of the soluble decomposition products of forest litter, and consequent downward movement and concentration of clays with other associated colloidal materials. Luvisolic soils develop characteristically in well to imperfectly drained sites, in medium to fine textured, base-saturated parent materials under forest vegetation.

Gray Luvisols are the only great group within the Luvisolic order found in the AOSERP study area. These soils form under boreal forest vegetation and are characterized by accumulations of slowly decomposing leaf litters, L-F-H layers, and thin or absent Ah or Ahe horizons. In addition to the diagnostic Ae and Bt horizons, Gray Luvisols commonly have transitional AB or BA horizons.

Soils of the Orthic Gray Luvisol subgroup occur on well to moderately well drained sites. Orthic Gray Luvisols have the properties of the Gray Luvisol great group, but the Ah or Ahe, if present, is less than 5 cm thick. The common horizon sequence is LFH, Ae, AB, Bt, C or Ck (underlined horizons are diagnostic).

The Gleyed Gray Luvisol subgroup, formed under imperfectly drained conditions, differs from the Orthic Gray Luvisol subgroup in having distinct mottles indicative of gleying within 50 cm of the mineral surface or prominent mottles at depths between 50 cm and 100 cm. The common horizon sequence is LFH, Ae, Btgj, Cg. Soils which may belong to the Solonetzic Gray Luvisol subgroup have been encountered on the lacustrine plain west of the Athabasca River. These soils differ from the Orthic Gray Luvisol subgroup in having a Btnj horizon indicative of an intergrade to the Solonetzic order. The Btnj horizon has a harder consistence, more pronounced coatings on the prismatic or blocky peds, and a higher proportion of exchangeable sodium than the Bt horizon of most Gray Luvisols. These soils are commonly associated with saline parent materials. These soils occur in the Dover land system but have not been indicated in the legend due to the uncertainty regarding their classification which will be resolved upon completion of laboratory analysis.

3.3.3.2 Brunisolic order. Soils of the Brunisolic order have formed under forests and are characterized by brownish colored Bm, Btj or Bfj horizons 5 cm thick or more, or Bf horizons less than 10 cm thick. They are distinguished from Luvisolic and Podzolic soils by lacking the diagnostic Bt and Bf horizons, respectively, of these soils.

The Eutric Brunisol great group is dominant in the AOSERP study area, although Dystric Brunisols also occur. Eutric Brunisols have a relatively high degree of base saturation and lack a well developed mineral-organic surface horizon. In addition to the diagnostic Bm horizon of the Brunisolic order,

Eutric Brunsiols are characterized by a pH (in 0.01M $CaCl_2$) of 5.5 or more in some part or all of the uppermost 25 cm of the B horizon or B horizon plus underlying material. An Ah or Ahe, if present, is less than 10 cm thick.

The Eluviated Eutric Brunisol subgroup is dominant in the area and is characterized by the horizon sequence, LFH, Ae or Aej, Bm or Btj, C or Ck. These soils have the general properties of the Eutric Brunisol great group and have an eluvial horizon, Ae or Aej, 2 cm thick or more. Eluviated Eutric Brunisols are rapidly to moderately well drained and, in the AOSERP study area, are commonly found on coarse textured glaciofluvial deposits.

Gleyed Eluviated Eutric Brunisols are found on coarse parent materials under imperfectly drained conditions. These differ from Eluviated Eutric Brunisols in having features indicative of gleying as follows: faint to distinct mottling within 50 cm of the mineral surface, or distinct or prominent mottles at depths between 50 cm and 100 cm.

Soils of the Dystric Brunisol great group are similar to Eutric Brunisols except that they have a pH (in 0.01M $CaCl_2$) of less than 5.5 throughout the uppermost 25 cm or the B horizon or B horizon plus underlying layer. The common horizon sequence for the Eluviated Dystric Brunisol subgroup is, LFH, Ae or Aej, Bm or Bfj, C. That of Gleyed Eluviated Dystric Brunisols is, LFH, Ae or Aej, Bmgj or Bfjgj, Cgj or Cg.

Because the processes of leaching and weathering are relatively weakly developed in Brunisolic soils, they tend to reflect the chemical characteristics, particularly the base status and acidity, of parent materials from which they have been derived. In the AOSERP study area, Brunisols have developed on coarse textured parent materials which lack silicate clays and other weatherable materials from which Bt and Bf horizons could develop. The characteristic genetic process in the region is eluviation-illuviation and Luvisolic

soils form wherever the parent material contains sufficient silicate clays. Podzolization is also evident in some sandy soils by the presence of thin (<10 cm) reddish upper B horizons with high chroma. These are developed in outwash sands in the northeast of the study area. Although they are classified as Brunisolic soils, they have more highly bleached Ae horizons as well as redder B horizons than those further south. These differences may be sufficient to differentiate these soils at the land system level, but they require further investigation before doing so.

3.3.3.3 Gleysolic order. Soils within the Gleysolic order are poorly drained, their profiles reflecting the influence of waterlogging for significant periods. These soils are saturated with water and are under reducing conditions due to lack of aeration, either continuously or during some period of the year. The effects of reducing conditions are reflected by the occurrence of gleyed horizons having dull gray to olive, greenish, or bluish gray moist colors, frequently accompanied by prominent, usually rusty-colored mottles resulting from localized oxidation and reduction of hydrated iron oxides. Gleysolic soils may have organic surface layers up to 60 cm thick if fibric peat or 40 cm if mesic or humic peat.

The soils of this Order are subdivided into three great groups, based on differing characteristics of horizon development. Humic Gleysols have more than 8 cm of Ah horizon. Gleysols have less than 8 cm of Ah and Eluviated Gleysols have Aeg and Btg horizons.

Almost all soils of the Gleysolic order occurring in the AOSERP study area have organic surface layers and have been put into a "peaty Gleysol" group for the purposes of mapping. The subgroups most frequently encountered in field checks, however, are Orthic Luvic Gleysols (LFH or O, Aeg, Btg, Cg), Orthic Gleysols (LFH or O, Bg, Cg) and Rego Gleysols (LFH or O, Cg).

3.3.3.4 Regosolic order. Soils in the Regosolic order are well to imperfectly drained mineral soils with very weakly expressed profile development. They lack any expression of a B horizon, but may have an organic surface layer (L-H) horizon, or a weakly developed organic-mineral Ah horizon. Regosolic soils reflect essentially the characteristics of the C horizons and parent materials from which they are developed.

In the AOSERP study area, Regosolic soils occur on Recent alluvial and fluvial fan materials. All subgroups within the Regosol great group are encountered. The Orthic Regosol subgroup includes soils that may have an (L-H) organic surface layer or a thin or weakly developed Ah, overlying a C horizon, which may or may not be calcareous. Cumulic Regosols have one or more buried Ah horizons, mostly weakly developed and commonly discontinuous. Gleyed Regosols and Gleyed Cumulic Regosols differ from those above in having faint to distinct mottling within 50 cm of the mineral surface.

3.3.3.5 Organic order. Organic soils have formed dominantly from organic deposits, which by definition contain over 17% organic carbon by weight. Classification of Organic soils is based on thickness and degree of decomposition of material in diagnostic layers called tiers. There are three tiers: surface (0-40 cm), middle (40-120 cm) and bottom (120-160 cm).

Definitions of the fiber classes of organic materials are as follows:

1. 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 characteristics upon rubbing.
2. Mesic: Organic matter in an intermediate stage of decomposition; intermediate amounts of fiber are present that can be identified as to their

botanical origin.

3. Humic: Highly decomposed organic material; there are small amounts of fiber present that can be identified as to their botanical origin; fibers that are present can easily be destroyed by rubbing.
4. Woody: Organic material containing more than 50% of woody fibres.

Great groups within the Organic order are Fibrisol, Mesisol, Humisol and Folisol. Of these, only the Fibrisol and Mesisol great groups have been identified in the AOSERP study area, the latter being dominant. Mesisols consist of organic material which is 40 cm thick or more, whereas Fibrisols must be 60 cm or more.

The Typic Mesisol subgroup is characterized by middle and bottom tiers consisting dominantly of mesic material.

The Terric Mesisol subgroup differs from Typic Mesisols in having a terric layer (an unconsolidated mineral stratum 30 cm thick or more) beneath the surface tier.

The Fibric Mesisol subgroup contains 25 cm or more fibric peat in the middle or bottom tiers. These are infrequently encountered in the study area.

The Typic Fibrisol subgroup is characterized by middle and bottom tiers consisting dominantly of fibric material.

The Terric Fibrisol subgroup has a terric layer 30 cm thick or more anywhere beneath the surface tier.

The Mesic Fibrisol subgroup has 25 cm or more mesic peat in the middle or bottom tiers.

Organic soils in the AOSERP study area are developed on two types of organic deposits--moss peat and sedge peat. Moss peat is derived from sphagnum species and other types of mosses in areas under black spruce and tamarack referred to as bogs (Section 3.3.2.1).

Sedge peat is derived from dominantly sedge vegetation occurring with some shrubs and scanty tree vegetation in relatively open peatlands called fens (Section 3.3.2.1).

3.3.4 Terminology for Describing Soils

3.3.4.1. Mineral horizons and layers. Mineral horizons are those that contain 17% or less organic carbon (about 30% organic matter) by weight.

A - This is a mineral horizon formed at or near the surface, in the zone of leaching or eluviation of materials in solution or suspension or of maximum in situ accumulation of organic matter or both. The accumulation of organic matter is usually expressed morphologically by a darkening of the surface soil (Ah) and conversely the removal of organic matter is usually expressed by a lightening of the soil color usually in the upper part of the solum (Ae). The removal of clay from the upper part of the solum (Ae) is expressed by a coarser soil texture relative to the underlying subsoil layers. The removal of iron is indicated usually by paler or less red soil color in the upper part of the solum (Ae) relative to the lower part of the subsoil.

B - This is a mineral horizon characterized by enrichment in organic matter, sesquioxides, or clay, or by the development of soil structure; or by a change of color denoting hydrolysis, reduction or oxidation. The accumulation in B horizons of organic matter (Bh) is evidenced usually by dark colors relative to the C horizon. Clay accumulation is indicated by finer soil textures and by clay cutans coating peds and lining pores (Bt). Soil structure developed in B horizons includes prismatic or columnar units with coatings or

stainings and significant amounts of exchangeable sodium (Bn) and other changes of structure (Bm) from that of the parent material. Color changes include relatively uniform browning due to oxidation of iron (Bm), and mottling of structurally altered material associated with periodic reduction (Bg).

C - This is a mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, (C), excepting (i) the process of gleying, (Cg), and (ii) the accumulation of calcium and magnesium carbonates (Cca), and more soluble salts (Cs, Csa). Marl and diatomaceous earth are considered to be C horizons.

R - This is a consolidated bedrock layer that is too hard to break with the hands (3 on Mohs scale) or to dig with a spade when moist, and that does not meet the requirements of a C horizon. The boundary between the R layer and any overlying unconsolidated material is called a lithic contact.

W - This is a layer of water (in Gleysolic, Organic or Cryosolic soils). It is called a hydric layer in Organic soils.

3.3.4.2 Lowercase suffixes

b - A buried soil horizon.

ca - A horizon of secondary carbonate enrichment in which the concentration of lime exceeds that in the unenriched parent material.

e - A horizon characterized by the eluviation of clay, iron, aluminum or organic matter alone or in combination. When dry, it is usually higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae).

f - A horizon enriched with amorphous material, principally Al and Fe combined with organic matter. It usually has

a hue of 7.5YR or redder or its hue is 10YR near the upper boundary and becomes yellower with depth. When moist, the chroma is higher than 3 or the value is 3 or less.

g - A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction.

h - A horizon enriched with organic matter. It is used with A alone (Ah); or with A and e (Ahe); or with B alone (Bh); or with B and f (Bhf).

j - Used as a modifier of suffixes e, f, g, n, and t to denote an expression of, but failure to meet, the specified limits of the suffix it modifies. It must be placed to the right and adjacent to the suffix it modifies.

k - Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added.

m - A horizon slightly altered by hydrolysis, oxidation, or solution or all three, to give a change in color or structure, or both.

n - A horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces, and hard to very hard consistency when dry. It is used with B, as Bn or Bnt.

s - A horizon with salts, including gypsum, which may be detected as crystals or veins, as surface crusts of salt crystals, by depressed crop growth, or by the presence of salt-tolerant plants.

t - An illuvial horizon enriched with silicate clay. It is used with B alone (Bt), with B and g (Btg), with B and n (Bnt), etc., and meets the following requirements:

1. If any part of an eluvial horizon remains and there is no lithologic discontinuity between it and the Bt horizon, the Bt horizon contains more total and fine clay than the eluvial horizon, as follows:
   (a) If any part of the eluvial horizon has less than 15% total clay in the fine earth fraction (<2mm), the Bt horizon must contain at least 3% more clay.
   (b) If the eluvial horizon has more than 15% and less than 40% total clay in the fine earth fraction, the ratio of the clay in the Bt horizon to that in the eluvial horizon must be 1.2 or more.
   (c) If the eluvial horizon has more than 40% total clay in the fine earth fraction, the Bt horizon must contain at least 8% more clay than the eluvial horizon.
2. A Bt horizon must be at least 5 cm thick. In some sandy soils where clay accumulation occurs in the lamellae, the total thickness of the lamellae should be more than 10 cm in the upper 150 cm of the profile.
3. In massive soils the Bt horizon should have oriented clay in some pores and also as bridges between the sand grains.
4. If peds are present, a Bt horizon has clay skins on some of the vertical and horizontal ped surfaces and in the fine pores, or has illuvial oriented clays in 1% or more of the cross section as viewed in thin section.
5. If a soil shows a lithologic discontinuity between the eluvial horizon and the Bt horizon, or if only a plow layer overlies the Bt horizon, the Bt horizon need show only clay skins in some part,

either in some fine pores or on some vertical and horizontal ped surfaces. Thin sections should show that the horizon has about 1% or more of oriented clay bodies.

y - A horizon affected by cryoturbation as manifested by disrupted and broken horizons and by incorporation of materials from other horizons and mechanical sorting in at least half of the cross section of the pedon.

z - A frozen layer. It may be used with any horizon or layer, e.g. Ohz, Bmz, Cz, Wz.

3.3.4.3 Organic horizons. Organic horizons are found in Organic soils, and commonly at the surface of mineral soils.

O - This is an organic horizon developed mainly from mosses, rushes, and woody materials. It is divided into the following subhorizons.

Of - This is an O horizon consisting dominantly of well-preserved fibers that are readily identifiable as to botanical origin.

Om - This is an O horizon at a stage of decomposition intermediate between fibric and humic materials.

Oh - This is an O horizon at an advanced stage of decomposition. It has the lowest amount of fiber, the highest bulk density, and the lowest saturated water-holding capacity of the O horizons. It is very stable and changes very little physically or chemically with time unless it is drained.

L, F and H - These are organic horizons developed primarily from the accumulation of leaves, twigs, and woody materials with or without a minor component of mosses. Usually they are not saturated with water for prolonged periods.

L - This is an organic horizon characterized by an

accumulation of organic matter, derived mainly from leaves, twigs and woody materials, in which the original structures are easily discernible.

F - This is an organic horizon characterized by an accumulation of partly decomposed organic matter derived mainly from leaves, twigs and woody materials. Some of the original structures are difficult to recognize. The material may be partly comminuted by soil fauna, as in moder, or it may be a partly decomposed mat permeated by fungal hyphae, as in mor.

H - This is an organic horizon characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F horizon by its greater humification due chiefly to the actions of organisms. It is frequently intermixed with mineral grains, especially near the junction with a mineral layer.

3.3.5 Soil Texture

Textural classes are based on sizes of soil separates as indicated in Table 4. Proportions of soil separates in various textural classes are shown in Figure 3. The soil textural classes are grouped as follows:

1. Very coarse textured--sands, loamy sands
2. Moderately coarse textured--sandy loams, fine sandy loam
3. Medium textured--very fine sandy loam, loam, silt loam, silt
4. Moderately fine textured--sandy clay loam, clay loam, silty clay loam
5. Fine textured--sandy clay, silty clay, clay
6. Very fine textured--heavy clay

Table 4. Sizes of soil separates.

Separate	Diameter (mm)
Very coarse sand	2.0-1.0
Coarse sand	0.5-0.25
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
Fine clay	less than 0.002

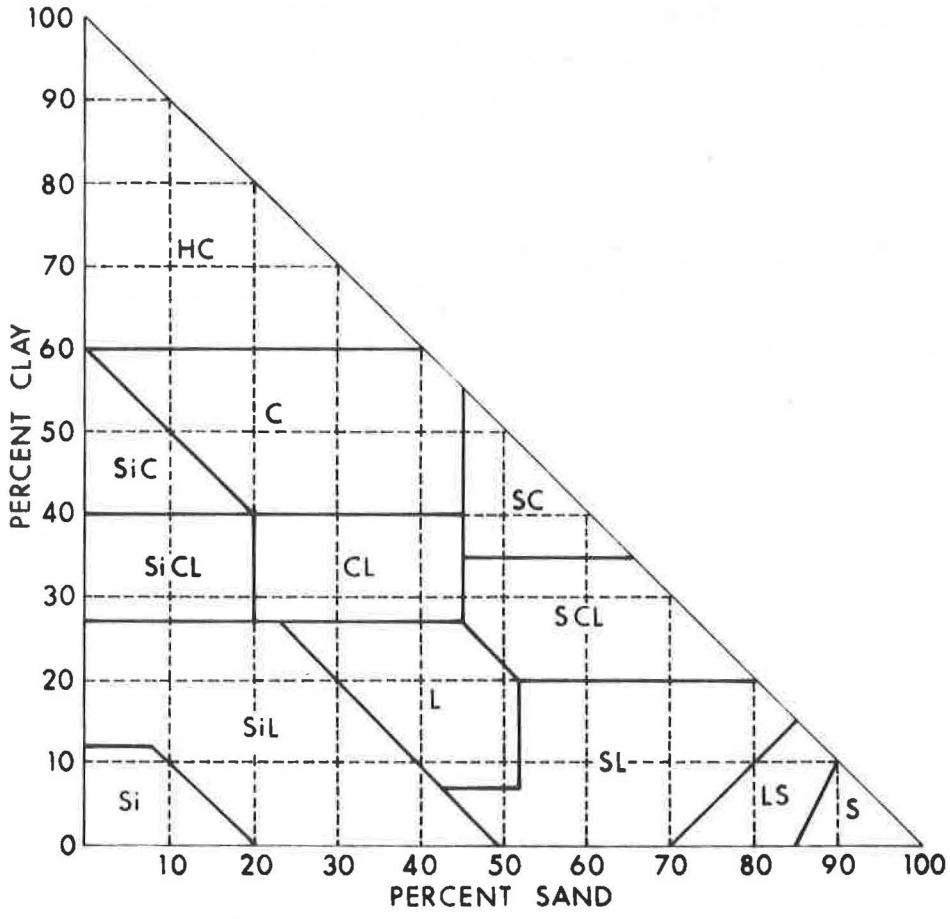

Figure 3. Chart showing proportions of soil separates in soil textural classes.

3.3.6 Other Soil Properties

The following properties are partially described in the Field Record Sheet (Figure 2) and are completely described in the Canadian System of Soil Classification (1976): soil structure, consistence, roots, pores, clay films, horizon boundaries, stoniness and rockiness, and erosion. Soil color is described by use of Munsell notations (e.g., 10YR 5/3 m - hue, value and chroma of moist sample) as well as the appropriate color name (brown for the notation above).

3.3.7 Other Mapping Conventions

Other mapping conventions such as concepts of dominance and significance of soils, and of land system complexes, are indicated in the legend.

4. RESULTS AND DISCUSSION

4.1 DESCRIPTION OF ECOLOGICAL UNITS

4.1.1 Land Regions

The Boreal Forest is the only land region recognized in northern Alberta (Rowe 1972). White spruce *(Picea glauca)* and black spruce *(P. mariana)* are the characteristic forest species; other prominent species are tamarack *(Larix laricina)*, balsam fir *(Abies balsamea)* and jack pine *(Pinus banksiana)*. Although the forests are mainly coniferous, there is a general admixture of broadleaved trees such as trembling aspen *(Populus tremuloides)*, white birch *(Betula papyrifera)* and balsam fir *(Populus balsamifera)*. (Nomenclature follows Moss 1959).

The climate of the Athabasca Oil Sands area, as reflected by the soil temperature regime, is Cryoboreal (Clayton et al. 1977). The Birch Mountains, however, have a subarctic regime transitional to Cryoboreal (Table 5).

Soil moisture regimes in the study area are variable. Most of the area is Humid (showing slight moisture deficit). Much of the area south of Muskeg Mountain and the Athabasca River is Aquic (saturated for moderately long periods), the remainder being Humid. The sandy soils near Lake Athabasca have a Humid to Subhumid (showing significant moisture deficit) regime. The Birch Mountains are Humid with Subaquic areas (saturated for short periods). The area north of the Birch Mountains to the Athabasca delta is Aquic and Humid.

4.1.2 Land Subregions

Four major subregions in the oil sands area are recognized according to Rowe (1972). These include: (1) Mixedwood, (2) Athabasca South, (3) Upper Mackenzie, and (4) Northwest Transitional (Figure 4).

Legend

I. Mixedwood Subregion
   a. Dover Plain
   b. Stoney Mountain Upland
   c. McMurray Lowland
   d. Algar Sand Plain
   e. Thickwood Hills Upland
   f. Clearwater Plain
   g. Muskeg Mountain Upland
   h. Not named
   i. Not named
   j. Birch Mountain Upland

II. Upper Mackenzie Subregion
   a. Embarras Plain
   b. Calumet Plain
   c. Athabasca Delta Plain

III. Athabasca South Subregion
   a. Fort Hills Upland
   b. Richardson Hills Upland
   c. Firebag Hills Upland

IV. Northwestern Transition Subregion
   a. Kazan Upland

- - - subregion boundary

▪▪▪▪▪ district boundary

——— system boundary

Figure 4. Land subregions and districts in the eastern half of the AOSERP study area.

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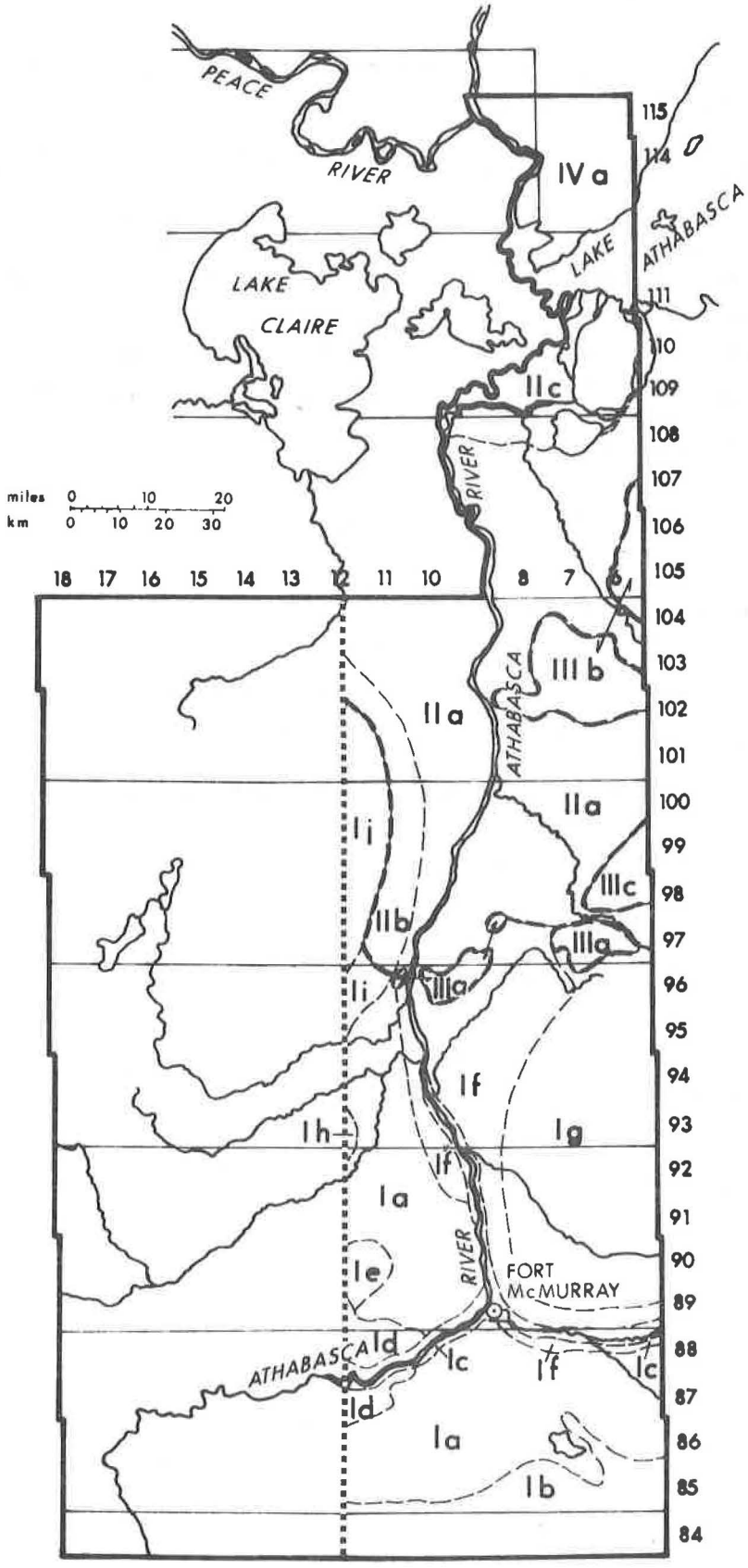

Figure 4. Concluded.

Table 5. Characteristics of soil temperature classes in the AOSERP study area.

Characteristics	Subarctic (very cold)	Cryoboreal (cold to moderately cold)
Mean annual soil temperature[a]	-7°C to <2°C	2°C to <8°C
Mean summer soil temperature	5°C to <8°C	8°C to <15°C
Growing season (≥ 5°C)	< 120 days	120-220 days
Growing season degree-days (≥ 5°C)[b]	< 555	555 to <1250
Thermal period (≥ 5°C)	none	No significant days days
Thermal period degree-days (≥ 5°C)	none	< 33

[a] Measured at 50 cm depth.

[b] Excess of daily mean temperature above 5°C accumulated through the growing season.

4.1.2.1 Mixedwood Subregion. The largest in the study area, this subregion is characterized by a forest association, of the well-drained uplands, consisting of

> a mixture in varying proportions of trembling aspen and balsam poplar, white and Alaska birches, white spruce and balsam fir, the last two especially prominent in old stands. The cover types of greatest areal extent is the trembling aspen, a result of the ability of this species to regenerate readily following disturbance. In addition to its usual dominance on sandy areas, jack pine enters into the forest composition on the drier till soils, and mixes with black spruce on the plateau-like tops of the higher hills. Lower positions and upper water-catchment areas develop black spruce and tamarack muskeg in which, however, the accumulation of peat is not deep (Rowe 1972:36).

Dominant soils are Gray Luvisols and Organic soils.

Bedrock deposits are shales and sandstones of the Cretaceous Clearwater, Grand Rapids, Shaftsbury and Labiche Formations which are buried by varying thicknesses of glacial till. The oil sands of the McMurray Formation and sandstones and shales of the Clearwater Formation underlie shallow glaciolacustrine and glaciofluvial deposits in the lowlands. Along the Athabasca River, Devonian carbonates of the Waterways Formation are exposed (Green et al. 1970). Relief in the Mixedwood Subregion is generally low, exceptions being the eastern slopes of the Birch Mountains and the north-facing escarpment of Stoney Mountain. The elevation ranges from approximately 200 to 800 m above sea level.

4.1.2.2 Athabasca South Subregion. This area consists mainly of sandy uplands derived by glacial action from the underlying sandstones and quartzites of the Athabasca Formation (probably late Precambrian). The main tree species is jack pine which is frequently mixed with black spruce on the poorly drained sandy sites. The moisture regime is Subhumid with Eutric Brunisols

and Dystric Brunisols being the dominant soils. Relief is relatively high in this subregion. Elevation ranges from 300 to 450 m.

4.1.2.3 Upper Mackenzie Subregion. Located in the northern portion of the project area, this subregion is characterized by white spruce and balsam poplar on alluvial flats bordering rivers. Balsam fir and white and Alaska birches are prominent south of Lake Athabasca. Upland communities are dominated by jack pine and trembling aspen, with black spruce and tamarack in moist to wet positions. Moisture regimes are mainly Humid and Aquic, with Subhumid, higher-lying, sandy areas. Soils are mainly Gray Luvisols, Eutric Brunisols, Organics and Regosols. Devonian carbonates and evaporites are deeply buried by glacial till, glaciolacustrine and alluvial sediments. The elevation range is about 200 to 350 m.

4.1.2.4. Northwest Transitional Subregion. This subregion lies north of Lake Athabasca in the northeast portion of the study area and is characterized by areas of bog and barren rock interspersed with open stands of stunted trees. Black spruce is dominant with white spruce occurring on well-drained soils. This area occurs, for the most part, in the Precambrian (Canadian) Shield region. The climate is Subarctic and Cryoboreal with dominantly Humid and Subaquic soil moisture regimes. Permafrost is a common feature of this subregion. The elevation range is about 200 to 300 m.

4.1.3 Land Districts

4.1.3.1. Districts of the Mixedwood Subregion.

Morainal Districts:

Birch Mountains Upland. This is the most easterly and north-easterly of a series of plateaus which grouped together

form a large physiographic region called the Alberta Plateau (Clayton et al. 1977; Bostock 1970). The plateaus consist mainly of undulating to rolling moraine. Desposits of glacial till are both thick and thin, overlying Cretaceous shales and siltstones. Large areas of colluviated and slumped bedrock and glacial materials occur along the eastern margins of the hills which are highly dissected and deeply incised. The elevation range is approximately 350 to 800 m. (See Figure 4 for map districts).

Thickwood Hills Upland. This is a lower plateau on the eastern margin of the Alberta Plateau which consists of undulating ground moraine and hummocky moraine overlying Cretaceous shales. The glacial till of this upland is medium to moderately fine textured and is called Horse River till by Bayrock and Reimchen (1974). Small areas of glaciofluvial deposists also occur. Approximate elevations are 450 to 500 m.

Stony Mountain Upland. The prominent feature of this upland within the project area is the highly dissected, hummocky, north-facing escarpment south of Gregoire Lake. This upland is another eastern plateau within the Alberta Platea. Surficial material is medium textured glacial till known as Kinosis till (Bayrock and Reimchen 1974). To the west, the till is more similar to the Horse River till of the Thickwood Hills Upland. To the east, the glacial till gradually changes to the sandier composition of Gipsy till (Bayrock and Reimchen 1974). Shales of the Cretaceous Labiche and Joli Fou Formations underlie the upland. Elevation range is about 50 to 750 m.

Muskeg Mountain Upland. This upland, east of the Athabasca River and north of the Clearwater River, consists almost entirely of undulating ground moraine which overlies Cretaceous shales. There are some inclusions of glaciofluvial outwash and ice-contact deposits, but the dominant material is medium textured glacial till of the Kinosis type (Bayrock and Reimchen 1974). The till gradually changes eastward to the sandier composition of Gipsy till. In terms of the broader physiographic division of

Clayton et al. (1977), this upland lies near the northwest extremity of the Saskatchewan Plain. The elevation range of the Muskeg Hills Upland is 350 to 650 m.

Glaciolacustrine District:

Dover Plains. The Dover Plain consists of level to undulating, thick and thin glaciolacustrine deposits, mainly overlying glacial till which in turn overlies Cretaceous shales. Included in these deposits are mixed glaciolacustrine materials which consist of stratified silts and clays but have inclusions of till, pebbles and gravel in them (Bayrock 1971). These deposits are difficult to classify genetically because they have features similar to till as well as glacio-lacustrine sediments. However, in the Dover Plain, they are mainly fine textured and soils, landforms and vegetation occurring on them are much the same as on normal glaciolacustrine sediments. The Dover Plain includes the Gregoire Lake area, a low-lying, glaciolacustrine basin, which has been called the Methy Portage Plain (Atlas of Alberta 1969). Abandoned beach ridges lying along higher lands such as the Stony Mountain Upland or the Thickwood Hills are prominent features of the plain. The range in elevation is about 300 to 500 m.

Aeolian District:

Algar Sand Plain. This district lies along the upper reaches of the Athabasca River within the AOSERP study area. It consists of aeolian sands which form a cover in dune or undulating sheet form. Both parabolic and longitudinal dunes are found, but the former type predominate. The dunes show effective wind direction from southeast to east (Macpherson and Kathol 1977). The elevation range is approximately 400 to 500 m.

Glaciofluvial and (Recent) Fluvial Districts:

Clearwater Plains. This is a belt along the Athabasca and Clearwater River valleys extending north to the Fort Hills Upland. This district consists mainly of thin (up to 10 m) outwash deposits overlying glacial till or the Cretaceous

Clearwater and McMurray Formations. The outwash sand commonly contains reworked bitumen which gives the outwash, in some locations, an appearance similar to oil sand of the McMurray Formation.

Meltwater channel sediment, which refers to stratified material deposited along channels that conducted meltwater from ice sheets, also occurs in this district. In some areas, the gravels and sands of these sediments directly overlie shale, oil sand or shale and limestone of the Clearwater Formation. Mildred Lake and Ruth Lake are examples of elongated channels in a meltwater channel sediment area. In addition to sands and gravels, stony and bouldery gravel deposits and thin, stony eroded till deposits occur along some of the channels. In the Ruth Lake area, some of the stony gravels may be remnants of a pre-existing outwash body along the Athabasca River. MacPherson and Kathol (1977) present a thorough discussion of outwash and meltwater channel sediments in this area.

The approximate elevation range of the Clearwater Plain is 200 to 350 m.

McMurray Lowland. The McMurray Lowland district consists of the relatively deep valleys of the Athabasca and Clearwater Rivers and the lower reaches of their tributaries. Both fluvial (alluvial) deposits and the valley banks, mainly mapped as rough, broken land, are included in this district. The flood plain of the Athabasca River consists mainly of alluvial sand, although smaller amounts of silt and clay also occur (Macpherson and Kathol 1977). Much of the alluvial sediment directly overlies the Waterways Formation limestone. The valley of the Athabasca River south of Fort McMurray almost entirely consists of rough, broken valley soils with very little alluvium. Elevation changes can be quite large from alluvial flats to the tops of banks and from the lower to upper reaches of the river. The approximate range is 200 to 450 m.

Other Districts. Two small districts on the western edge of the present mapping area (Ii and Ih) have not been named or thoroughly investigated and are, therefore, not described at this time.

4.1.3.2 Districts of the Upper Mackenzie Subregion

Embarras Plains. Similar to the Clearwater Plain, this is an undulating glaciofluvial plain consisting of outwash deposits and meltwater channels along the Athabasca River. The outwash deposits are somewhat thicker than in the Clearwater Plain and large areas have been reworked by aeolian activity, forming both undulating aeolian veneers and dunes. The elevation range is 250 to 300 m. This plain forms the north-west extremity of the Saskatchewan Plain and is located just south of the Great Slave Plain (Bostock 1970). The bedrock underlying this region consists mainly of Devonian limestone.

Calumet Plain. The Calumet Plain consists of a series of alluvial fan deposits skirting the Birch Mountains. The landform is level, slightly inclined or undulating. The deposits are mainly medium to fine textured, becoming sandier with depth, and overlying glacial deposits. A large proportion of the fan material is likely derived from the Cretaceous shales exposed in valleys in the Birch Mountains. The elevation range is 250 to 350 m.

Athabasca Delta Plain. This is a large Recent deltaic area, consisting of clayey to sandy sediments, formed by the Athabasca and Peace Rivers. This plain is the southernmost section of the large Great Slave Plain (Bostock 1970). The surface relief is level to depressional. Soils are mainly Regosols, Gleysols and Organics. Elevational variation in this area is low, being approximately 200 m throughout. Lakes, both large and small, and streams are numerous through the whole area.

4.1.3.3 Districts of the Athabasca South Subregion

Fort Hills Uplands. The Fort Hills Upland district consists of hummocky and rolling, highly dissected kame and kame moraine deposits. Elevation is 200 to 250 m with local relief up to 15 m. The dominantly sandy sediments are believed to have been deposited as a kame delta or fan complex (Macpherson and Kathol 1977). Other features of the area are the presence of sinkholes and aeolian deposits. Lenses and layers of till, clay, coarse sand and gravel and reworked bitumen also occur. The underlying bedrock is mainly the McMurray Formation. A smaller kame moraine area to the west of the Athabasca River is included in the district. It is similar to the Fort Hills deposits but appears to contain coarser grained sand and a higher percentage of till. This kame may have originally been connected to the Fort Hills but has since been dissected into two separate segments by the Athabasca River.

A third kame complex within this district occurs east of the Fort Hills, along the Firebag River. This complex is higher with elevations up to about 430 m. This also consists predominantly of sandy deposits with a large component of till.

Richardson Hills Upland. This is an area of hummocky and rolling, highly dissected kame and kame moraine deposits. Glacial till inclusions are not as common as in the Fort Hills Uplands district, the deposits consisting mainly of medium sands with boulders. Elevation range is 300 to 450 m with local relief of up to 30 m. A unique feature of this upland is the presence of numerous, small water bodies. The deposits overlie Middle Devonian limestone on the west and Precambian granitic plutonic rocks to the east.

Firebag Hills Upland. A small part of this upland lies within the eastern margin of the study area. Surficial deposits are thick to very thick sands and gravels that have been over-ridden by glacial ice forming fluted and drumlinized terrain. Topography is undulating to rolling. The underlying bedrock

is sandstone and siltstone of the McMurray Formation, but to the north and east Precambian rock underlies the sands. The elevation range of the upland within the project area is about 450 to 650 m.

4.1.3.4 Districts of the Northwestern Transition Subregion.

Kazan Upland. This is a very large portion of the Canadian Shield which extends into the Northwest Territories, Saskatchewan and Manitoba. The land is essentially bare of surficial deposits and granitic rock outcrops form as much as 95% of the surface in many places. The topography is primarily controlled by the bedrock surface and consists of rolling and gently rolling knolls. Soils are developed on glacial or post-glacial sands, dune sands and small areas of lacustrine clays. These are generally thin deposits overlying the bedrock. Bogs and fens occupy much area between rock outcrops (Lindsay et al. 1962). Elevation within the project area is about 200 to 300 m.

This region, lying north of Lake Athabasca, is a low priority area for the soils inventory project. The area has not been investigated and the description above and in Section 4.1.2.4 has been entirely obtained from the literature. Considering that most of the area is rock outcrop, these descriptions are almost complete at the land system level and at the level of detail of this survey. The descriptions have been included at this time as it is not likely that field checks will be made until the end of the program unless changes in the present priority areas are made.

4.1.4 Land Systems

Because data such as laboratory analysis of soil samples are not yet available, detailed descriptions of land systems are not presented in this report. The map legend, which accompanies the maps, should be referred to for descriptions of the soil, parent material and landform components of land systems. For information on vegetation, refer to Section 4.2.

A total of 17 land systems and 22 mapping units have been recognized and incorporated into the legend thus far. The legend is open-ended and is subject to change as more area is covered and more information gathered in subseqent survey work. The following are general descriptions and explanations of concepts and methods of mapping land systems.

Within most land districts, one or two land systems are predominant: for example, Horse River (HRR1) is the major land system in the Thickwood Hills Upland district. However, a particular land system may occur as a major or minor component of any land district where similar parent marterials, landforms, vegetation and suite of soils occur. As an example, Mildred (MIL1 or 2) occurs in almost all land districts.

The land system, as used here, is similar to the concept of the soil association which is 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 they are all present in significant proportions" (Canada Soil Survey Committee 1976).

Two of the land system components, soils and landforms, are indicated by symbols on land system maps. The third component, vegetation, is treated in a more general manner for a particular land system and can be determined from the soil-drainage-vegetation table (Section 4.2).

Variations in proportions of soil types within a land system are handled by means of map units. For example, Mildred is a land system with predominantly Eluviated Eutric Brunisols and some Gleysols. Where the Gleysols are minor, the map unit is MIL1; where they are significant, occurring 15 to 40% of a land segment, the map unit is MIL2. However, where a change in predominance of soil orders occurs on the same parent material and similar landform, a new land system name is used. Thus, where Gleysols become dominant on the same material that Mildred is formed on, the name is changed to Bitumount. There is only

one map unit for Bitumount BMT1, as significant variations have not been recognized.

Variations in landforms in a particular land system are indicated by means of different symbols for surface expression (hummocky, h; undulating, u; etc.) and by indicating slope class. The same land system can not occur on different genetic materials, even if landforms have similar surface expression and slope.

Variations in vegetation within land systems are not possible to describe at the level of detail of this survey. Such variations are further complicated by fire history and succession whose investigation are not within the scope of this study.

In using the land system maps, only symbols which are identical indicate somewhat similar segments of land. Thus, two areas of $\frac{MIL1}{F^{G}u,2-3}$, within the same district or in different districts, are essentially similar, but are different from $\frac{MIL2}{F^{G}u,2-3}$ or $\frac{MIL1}{F^{G}r,2-3}$.

4.2 SOIL-DRAINAGE-VEGETATION RELATIONSHIPS IN THE AOSERP STUDY AREA

The main structural and compositional features of the major plant communities in the AOSERP study area have been described by Stringer (1976). Plant community mapping units and criteria for identifying these units at a scale of 1:25,000 were also established. Ten distinct vegetation types were defined by cluster analysis (Table 6). These are used as a basis for indicating vegetation types in soil-drainage-vegetation relationships in Table 7. However, the designations for the various types have been reduced to indicate the dominant cover species only (Table 6). Moreover, some vegetation types occur on a small scale and cannot be readily separated on 1:50,000 airphotos. Stringer's vegetation types (2), (3) and (4) have, therefore, been reduced to a more general willow-alder vegetation

Table 6. Vegetation types recognized in the AOSERP study area.

Vegetation Type	Symbol	Corresponding Vegetation Type of Stringer (1976)
fen	fen	1) fen
willow-alder	Wi-Al	2) sandbar willow scrub
		3) tall river alder-willow scrub
		4) tall willow scrub
balsam poplar	6P	5) bottomland balsam poplar forest
white birch-dwarf birch	wB-dB	
white spruce-aspen	wS-As	6) upland white spruce-aspen forest
white spruce-balsam fir	wS-bF	
mixedwood	M	
black spruce	bS	7) black spruce bog forest
black spruce-tamarack	bS-Lt	8) semi-open black spruce - tamarack bog forest and muskeg
tamarack-fen	Lt-fen	9) lightly forested tamarack and open muskeg
jack pine	jp	10) jack pine forests

type. On the other hand, some of the vegetation clusters (Upland Mixedwood and Deciduous Forest and the Upland Mixedwood and Coniferous Forest) which were too varied to be clearly defined as vegetation types, are nevertheless easily recognizable and cover extensive areas. In addition to white spruce-aspen, therefore, dominantly coniferous white spruce-balsam fir and a mixedwood type are recognized in Table 7. Another different vegetation type which was recognized on poorly drained (Gleysolic) soils, mainly on the alluvial fans at the base of the Birch Mountains, consisted dominantly of white birch and dwarf birch (*Betula glandulosa*). The inclusion of these additional vegetational types are based on observation while field checking. No systematic study of vegetation was made, but the recognition of various vegetation types supports Stringer's conclusion that the vegetation is complex and more extensive studies are required in order to determine the full range of vegetation types. The relationships and vegetation types in Table 7 should, therefore, be regarded as first approximation only.

4.3 AREA MAPPED TO DATE

During the 1977 field season, 24 days of field checking were carried out using a helicopter, and on several more days, a vehicle was used to check soils along main roads. Approximately 300 sites were visited with one or two, and often three to five examinations of soils in pits or auger holes being made at each site. Thirty-two sites were soil sampled, a total of about 250 horizon samples being taken for analysis. The area mapped and classified to date, including 4200 km^2 in 1976, is about 8500 km^2 (Figure 5). That portion of the high and medium priority areas between Township 100 and Lake Athabasca (Township 111), about 3360 km^2, was also field checked, but land system boundaries have not been delineated because of lack of airphotos for the area.

Table 7. Soil-drainage-vegetation relationships in the AOSERP study area.

Soil	Eluviated Eutric Brunisol	Orthic Gray Luvisol	Cumulic Regosol Orthic Regosol	G.E.E.B.,+ G.G.L. G.C.R., G.R.	Peaty Gleysols	Terric Mesisol Terric Fibrisol	Typic Mesisol Typic Fibrisol Fibric Mesisol
Drainage / Land System	Rapid to well	Well to moderately well	Moderately well to imperfect	Imperfect	Poor	Poor to very poor	Very poor
Heart	jP*			Wi - Al	bS		
Mildred	jP* M			Wi - Al	bS		
Firebag	jP* M			Wi - Al	bS		
Kearl	jP* M			Wi - Al	bS bS-Lt		
Ruth	jP* M	M*		Wi - Al	bS bS-Lt		
Kinosis		wS-As* M		Wi - Al	bS		
Horse River		wS-As*		Wi - Al	bS		
Legend		M* jP wS-As		Wi - Al	bS wB-dB		
Dover		wS-As*		Wi - Al bP	bS wB-db		
Buckton		wS-bF* wS-As	wS-bF* wS-As	Wi - Al	bS wB-dB		
Namur			wS-bF* wS-As	Wi - Al	wB-db		
McMurray			bP* wS-As	Wi - Al bP	bS wB-dB		
Bitumont	jP M			Wi - Al	bS wB-dB		
Steepbank		wS-As M		Wi - Al	bS* wB-dB		
Algar		wS-As		Wi - Al bP	bS wB-dB*		
Kenzie						bS* bS-Lt	bS, bS-Lt Lt-fen
Eaglesham							fen Lt-fen

* dominant in system

\+ G.E.E.B. = Gleyed Eluviated Eutric Brunisol; G.G.L. = Gleyed Gray Luvisol; G.C.R. = Gleyed Cumulic Regosol; G.R. - Gleyed Regosol.

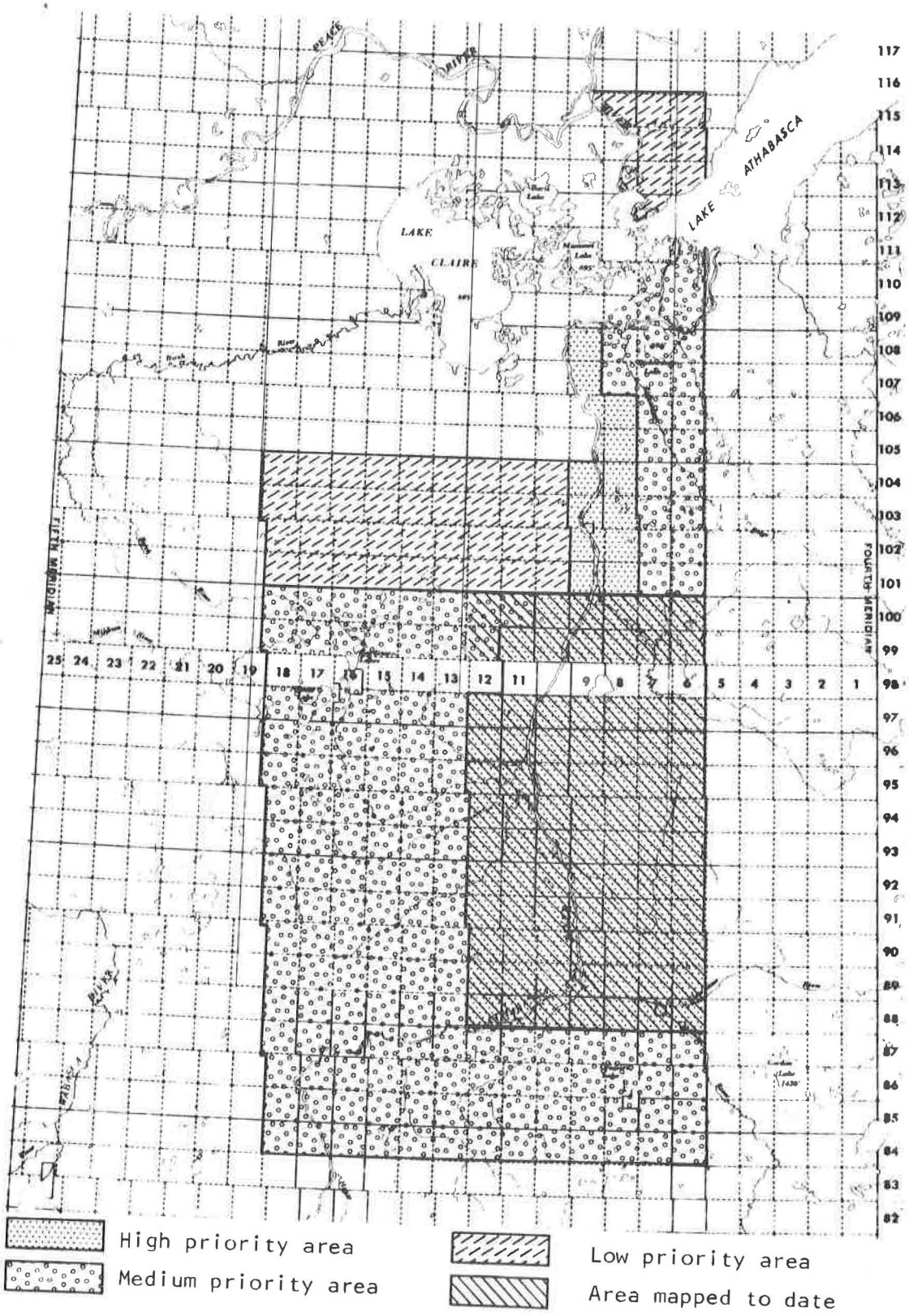

Figure 5. Area mapped and classified to the end of 1977.

4.4 SOIL DESCRIPTIONS AND ANALYSES

The sites at which soils were sampled in 1976 are indicated in Figure 6. Various analyses and profile descriptions of these soils are presented in Appendix 8.1. In addition, engineering test data have been completed for some samples collected in 1977. These appear in Appendix 8.2. The methods and classification system used in this table and those described by the Alberta Department of Highways (1960), American Society for Testing and Materials (1971) and Portland Cement Association (1962). Methods of laboratory analysis are those approved by the Canadian Soil Survey Committee (McKeague 1976). The soil samples collected during 1977 will be analysed in 1978 and the data presented in the next annual report.

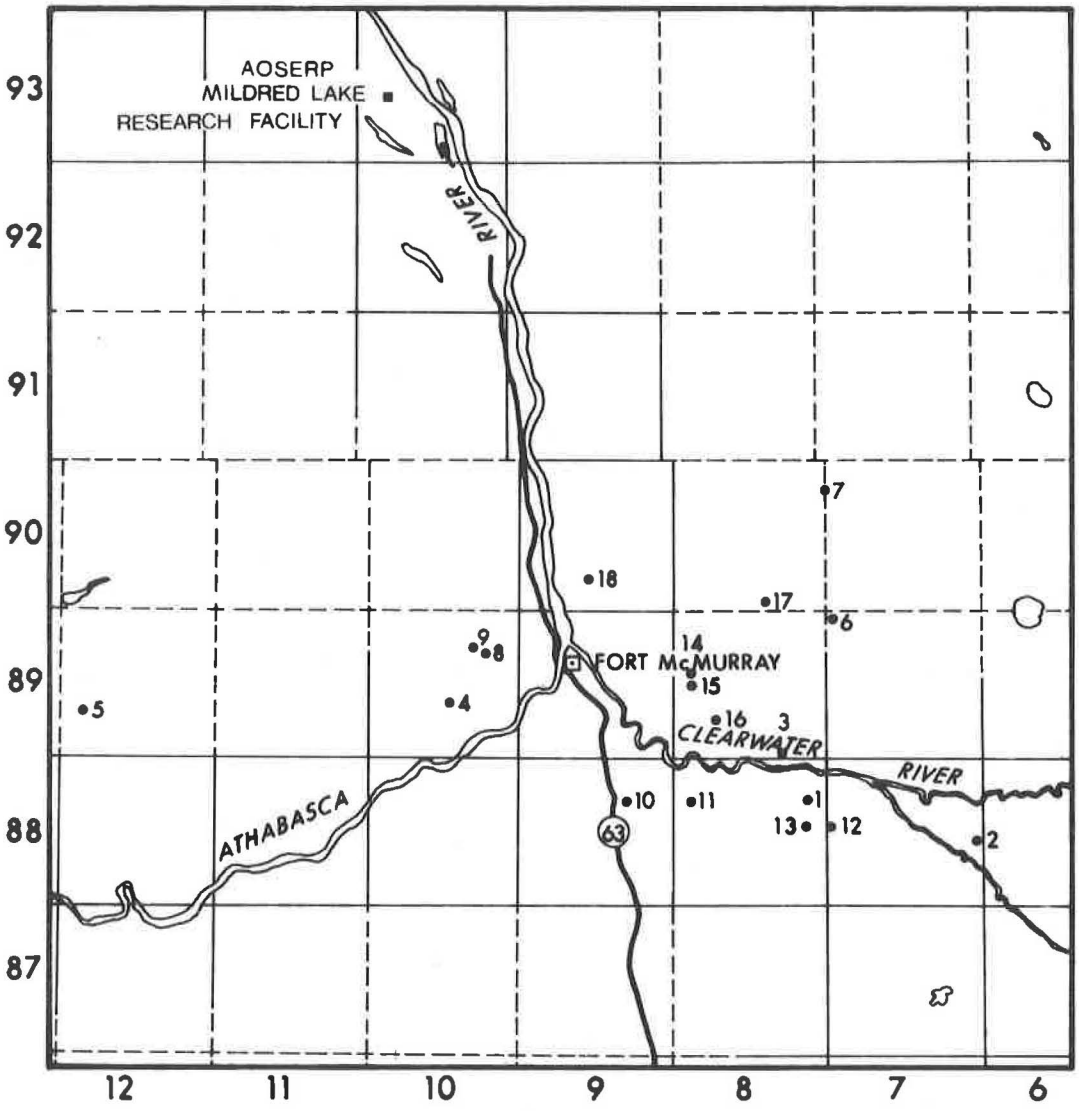

Figure 6. Locations of soil sampling sites in 1976.

5. CONCLUSIONS AND RECOMMENDATIONS

A total of 8500 km^2 of the AOSERP high priority area (as identified by the Vegetation Technical Research Committee in 1976) have been mapped to date. An additional 3360 km^2 in the high and medium priority areas north of Township 100 have been field checked. A legend has been prepared for the seventeen land systems and twenty two map units recognized in the project area thus far. Maps have been prepared for NTS sheets 74D/11, 12, 13, 14 and 74E/3 and 4. Maps for the remainder of the area that has been field checked are to be prepared during early 1978.

Using the ecological (biophysical) system for land classification, the AOSERP study area has been subdivided into regions, subregions, districts and systems. Emphasis is on mapping soils and landforms. The vegetation component of land systems is treated in a more general manner on the basis of broad soil-drainage-vegetation relationships.

Organic deposits are extensive throughout the study area except in the sandy terrain in the northeast toward Lake Athabasca. In the area surveyed thus far, these deposits have been generally thin (< 1m). Ice was frequently encountered until mid-August and, therefore, much peat depth information could not be obtained until late in the season. As depths of organic deposits are often difficult to interpret from airphotos, more frequent observations should be made in the field and these should be delayed to the latter half of the field season to overcome the ice problem. For detailed information on depth and quality of organic deposits, intensive field observation and probing of the peat soils would be required.

6. FUTURE PLANS

The soils inventory program in the AOSERP study area is to be continued in 1978-79. Drafting of maps within the high priority area is expected to be completed in early 1978. Drafting of maps north of Township 100 can also be completed in early 1978, provided airphotos for the area can be obtained. However, upon completion of the vegetation and landform survey by INTERA Environmental Consultants, it is possible that the need for landform mapping the the soils inventory will be obviated and that only land systems will need to be determined for land segments already delineated. The co-operation between Soils Division-ARC, INTERA and Program Management which has already been initiated should make this possible. The landform and surficial geology mapping of the medium and low priority areas (including NTS sheets 84A and 84H) will also be valuable in mapping land systems as no surficial geology maps for these areas are currently available.

Field checking in 1978 will be carried out initially in the Gregoire Lake area (NTS sheets 74D/5, 6 and 7) and will be continued northward from NTS sheets 84A/7 and 8. The program is flexible, however, and work can be initiated in any new priority areas identified by Program Management, provided materials, particularly airphotos, are available. The legend will be used as set up in 1977, but it is open-ended and additions will be made to it as necessary.

Due to a late start in 1977, helicopter field checking was confined to weekends for the most part, this resulting from competition for use of the helicopter with other AOSERP projects. An arrangement whereby a helicopter could be available for several block periods of up to two or three weeks at a time would be more suitable for 1978. The most intensive period of field checking will likely be during July, August and September at which time ice in peat bogs will be minimal.

It is proposed that guides for soil and land system interpretations be developed in the next year. Guides would take the form of establishing degrees of limitation for various types of land uses such as road construction, building sites, recreation, etc. Guidelines for many of these interpretations have already been developed. However, guidelines for reclaimability of materials and for sources of materials such as peat moss to aid reclamation of disturbed areas require research and development.

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8. APPENDICES

8.1 PROFILE DESCRIPTIONS AND ANALYSIS OF SOILS SAMPLED IN 1977

Site: MC-1
Land System: RUT1-KNZ1
Location: SW 25 - 88 - 8 - 4
Classification: Orthic Gray Luvisol
Parent Material: Morainal (till overlying glaciofluvial sand)
Drainage: moderately well drained
Topography: rolling; sample site - north aspect, middle of moderate slope

Profile Description:

L-H - not described

Ae_1 - 0 to 5 cm; gray (10YR 6/1 m), sandy loam; weak, fine, granular, very friable; diffuse, wavy boundary.

Ae_2 - 5 to 11 cm; grayish brown (10YR 5/2 m); sandy loam; weak, fine, subangular blocky; friable; gradual, irregular boundary.

Bt_1 - 11 to 25 cm; dark yellowish brown (10YR 4/4 m); sandy loam; weak, fine subangular blocky; friable, gradual, irregular boundary.

Bt_2 - --- ; dark yellowish brown (10YR 6/4 m); sandy loam; weak, fine, subangular blocky; friable; diffuse, irregular boundary.

IIC - --- ; yellowish brown (10YR 5/6 m); loamy sand, single grain, loose.

Table 8. Analysis - Site MC-1.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq(%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae_1	4.5	5.5	-	2.7	0.02	0.07	1.5	0.4	71	26	3	1
Ae_2	4.7	5.4	-	5.0	0.01	0.1	2.8	0.7	67	29	4	2
Bt_1	4.6	5.1	-	12.0	0.04	0.3	6.5	2.4	62	31	7	-
Bt_2	5.8	6.3	-	7.6	0.03	0.2	5.9	1.5	73	13	14	8
IIC	6.5	7.3	0.5	3.5	0.01	0.07	3.4	1.1	83	12	5	4

Site: MC-2
Land System: RUT1
Location: NE 13 - 7 - 88 - 4
Classification: Eluviated Eutric Brunisol
Parent Material: Glaciofluvial sand
Drainage: well drained
Topography: undulating; sample site - West aspect; upper very gentle slope

Profile Description:

LH - not described

Ae - 0 to 10 cm; light gray (10YR 7/1 m); sandy loam; single-grain; loose; clear, smooth boundary.

Bm_1 - --- ; dark reddish brown (5YR 3/4 m); sand; single-grain; loose; gradual, smooth boundary.

Bm_2 - ; strong brown (7.5YR 5/6 m); sand; single-grain; loose; gradual, smooth boundary.

C - --- ; yellowish brown (10YR 5/4 m); sand; single-grain; loose.

Table 9. Analysis - Site MC-2.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq(%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae	3.8	4.6	-	2.3	0.03	0.04	0.8	0.2	69	27	4	1
Bm_1	4.8	5.5	-	4.7	0.01	0.1	1.5	0.5	92	-	8	3
Bm_2	5.0	5.9	-	1.9	0.02	0.08	0.8	0.2	96	-	4	2
C	4.9	5.9	-	1.1	0.00	0.05	0.3	0.2	97	-	3	1

Site: MC-3
Land System: MIL1
Location: SW 2 - 89 - 8 - 4
Classification: Orthic Luvic Gleysol
Parent Material: Glaciofluvial or glaciolacustrine fine sand overlying till
Drainage: poorly drained
Topography: undulating; sample site - lower very gentle slope

Profile Description:

LH - not described

Aeg - 0 to 7 cm; light brownish gray (10YR 6/2 m); fine sandy loam; common, fine, distinct, mottles (5YR 5/6 m); very weak, very fine, granular; very friable; clear, smooth boundary.

Btjg - 7 to 25 cm; light yellowish brown (10YR 6.4 m); loam; many medium, prominent mottles (5YR 5/6 m); very weak; very fine to fine, granular; very gradual, irregular boundary.

Cg - 25 to 50 cm; yellowish brown (10YR 5/4 m); loamy fine sand; many, medium, prominent mottles (5YR 5/6 m); very weak, very fine to fine, granular; very friable, gradual, irregular boundary.

IICg - 50+ cm; brown (10YR 5/3 m); clay; many, medium, prominent mottles (5YR 5/6 m); moderate to strong, medium, subangular blocky; firm.

Table 10. Analysis - Site MC-3.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Aeg	3.9	4.8	-	4.2	0.02	0.09	0.7	0.3	52	41	7	1
Btjg	4.5	5.6	-	3.4	0.04	0.06	0.8	0.4	48	33	19	2
Cg	4.5	5.5	-	3.4	0.02	0.04	0.9	0.6	86	11	3	2
IICg	4.3	4.7	-	22.3	0.3	0.3	7.8	5.1	12	42	46	13

Site: MC-4
Land System: ALG1
Location: SW 15 - 89 - 10 - 4
Classification: Orthic Gray Luvisol
Parent Material: Clayey glaciolacustrine
Drainage: moderately well drained
Topography: undulating; sample site - upper, nearly level slope

Profile Description:

LH - --- ; mainly leaves and wood fragments

Ae - 0 to 12 cm; silt loam; strong, fine, platy; friable; abrupt, smooth boundary.

Bt_1 - 12 to 26 cm; clay; strong, coarse, subangular blocky; very firm; gradual, wavy boundary.

Bt_2 - 26 to 40 cm; clay; strong, coarse, subangular blocky; very firm; gradual, wavy boundary.

C - 40+ cm; clay; massive; very firm.

Table 11. Analysis - Site MC-4.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq(%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae	4.4	5.2	-	8.2	0.03	0.2	1.6	1.8	23	66	11	-
Bt_1	4.4	4.6	-	23.2	0.1	0.3	2.8	10.5	15	39	46	19
Bt_2	4.8	5.1	-	28.5	0.3	0.4	4.7	17.7	13	31	56	25
C	5.3	5.6	-	27.6	0.6	0.5	4.8	18.7	11	30	59	28

Site: MC-5
Land System: HRT1
Location: NW 8 - 89 - 12 - 4
Classification: Gleyed Eluviated Eutric Brunisol
Parent Material; Coarse eolian deposits
Drainage: moderately to imperfectly drained
Topography: undulating; sample site - upper, very gentle slope

Profile Description:

LH - no description

Aeg - 0 to 5 cm; light brownish gray (10YR 6/2 m); loamy sand; common, medium, distinct mottles (5YR 5/8 m); very weak, fine, platy; loose; clear, smooth boundary.

Bmg - 5 to 35 cm; strong brown (7.5YR 5/6 m); sandy loam; common, medium distinct mottles (5YR 5/8 m); very weak, fine, granular; loose; gradual, smooth boundary.

Cg - 35+ cm; yellowish brown (1pYR 5/6 m); loamy sand; common, medium, distinct mottles (5YR 5/8 m); very weak, fine, granular; loose.

Table 12. Analysis - Site MC-5.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations Me/100g Na	K	Ca	Mg	Particle Size Distribution (%) Sand	Silt	Clay	Fine C
Aeg	4.9	5.7	-	6.2	0.02	0.09	2.8	0.7	77	20	3	3
Bmg	5.4	6.1	-	5.6	0.04	0.08	3.0	1.4	71	21	8	3
Cg	5.8	6.7	-	6.7	0.04	0.1	4.1	1.7	85	9	6	4

Site: MC-6
Land System: KIN1
Location: SE 31 - 89 - 7 - 4
Classification: Orthic Gray Luvisol
Parent Material: Clayey morainal (till)
Drainage: moderately well drained
Topography: undulating; sample site - upper nearly level slope

Profile Description:

LH - no description

Aej_1 - 0 to 5 cm; light gray (10YR 7/1 m); silt loam; strong medium, platy; friable; clear, smooth boundary.

Ae_2 - 5 to 12 cm; light brownish gray (10YR 6/2 m); silt loam; strong, medium, angular blocky; friable; clear, smooth boundary.

Bt_1 - 12 to 25 cm; dark yellowish brown (10YR 3/4 m); clay loam; strong, medium to coarse, angular blocky; firm; gradual, wavy boundary.

Bt_2 - 25 to 45 cm; dark brown (10YR 4/3 m); clay loam; common; medium, faint mottles (5YR 5/6 m); strong, medium to coarse, angular blocky; firm; gradual, wavy boundary.

C - 45+ cm; dark yellowish brown (10YR 4/4 m); clay; common, medium, faint mottles (5YR 5/6 m); strong, medium, angular, blocky; firm.

Table 13. Analysis - Site MC-6.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq(%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae_1	4.5	5.3	-	6.3	0.3	0.09	2.8	0.8	33	58	9	1
Ae_2	4.5	5.2	-	6.3	0.04	0.08	3.0	0.8	36	52	12	2
Bt_1	4.2	4.6	-	16.1	0.02	0.2	6.0	2.4	27	38	35	13
Bt_2	4.2	4.7	-	14.7	0.4	0.2	5.4	2.6	36	30	34	14
C	4.1	4.5	-	21.3	0.3	0.2	7.5	4.0	24	34	42	18

Site: MC-7
Land System: RUT[1]
Location: SW 30 - 90 - 7 - 4
Classification: Eluviated Dystric Brunisol
Parent Material: Coarse morainal (till)
Drainage: well drained
Topography: undulating; sample site - upper, very gentle slope.

Profile Description:

LH - mainly leaves and needles

Ae_1 - 0 to 50 cm; light gray (10YR 7/1 m); sandy loam (gravelly); very weak, fine, granular; very friable; clear, smooth boundary.

Ae_2 - 5 to 20 cm; light gray (10YR 7/2 m); sandy loam; very weak, fine, gradular, very friable; clear, smooth boundary.

Bmj - 20 to 50 cm; brown (75YR 5/4 m); loamy sand; very weak, fine subangular blocky; very friable; gradual, smooth boundary.

C - 50+ cm; reddish brown (2.5 YR 5/4 m); sandy loam; structureless; very friable.

Table 14. Analysis - Site MC-7.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eg (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae_1	3.7	4.2	-	3.7	0.03	0.09	0.9	0.2	54	43	3	-
Ae_2	3.8	4.6	-	-	-	-	-	-	68	28	4	1
Bm	4.5	5.3	-	-	-	-	-	-	86	11	3	1
C	4.4	5.1	-	-	-	-	-	-	72	20	8	4

Site: MC-8

Land System: DOV1

Location: SE 26 - 89 - 10 - 4

Classification: Orthic Gray Luvisol

Parent Material: Clayey glaciolacustrine

Drainage: well drained

Topography: undulating; sample site - upper very gentle slope

Profile Description:

LFH - 5 to 0 cm; leaves and wood fragments; moderately decomposed.

Ae_1 - 0 to 6 cm; light gray (10YR 7/1 m); silt loam, strong, fine, platy; firm; clear, smooth boundary.

Ae_2 - 6 to 18 cm; pale brown (10YR 6/3 m); sandy clay loam, strong, coarse, subangular blocky; firm; clear, smooth boundary.

Bt - 18 to 45 cm; dark yellowish brown (10YR 4/4 m); clay; strong, coarse, subangular blocky; firm; gradual, wavy boundary.

C - 45+ cm; dark yellowish brown (10YR 3/4 m); clay loam; strong, coarse, subangular blocky; firm.

Table 15. Analysis - Site MC-8

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae_1	4.4	4.8	-	9.3	0.09	0.2	3.7	2.2	23	53	24	6
Ae_2	-	-	-	-	-	-	-	-	-	-	-	-
Bt	4.5	4.8	-	17.2	0.09	0.2	6.7	5.1	15	35	50	16
C	4.6	4.9	-	16.1	0.1	0.2	6.3	4.9	28	33	39	14

Site: MC-9
Land Systems: DOV1
Location: NW 26 - 89 - 10 - 4
Classification: Orthic Gray Luvisol
Parent Material: Clayey glaciolacustrine
Drainage: moderately well drained
Topography: undulating; sample site - nearly level

Profile Description:

LFH - 5 to 0 m

Ae - 0 to 10 cm; grayish brown (10YR 5/2 m); silt loam; strong, coarse, platy; friable; clear, smooth boundary.

Bt - 10 to 30 cm; dark grayish brown (10YR 4/2 m); silty clay loam; strong, coarse, subangular blocky; firm; gradual, smooth boundary.

C - 30+ cm; dark brown (10YR 4/3 m); clay; moderate, medium granular; firm.

Table 16. Analysis - Site MC-9.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae	5.1	5.9	-	8.1	0.09	0.2	3.1	2.4	18	63	19	3
Bt	5.4	5.9	-	16.1	0.2	0.2	6.8	5.6	16	51	33	10
C	6.3	6.6	-	24.3	0.4	0.3	12.1	9.5	16	38	46	22

Site: MC-10
Land Systems: DOV1
Location: SW 26 - 88 - 9 - 4
Classification: Orthic Luvic Gleysol
Parent Material: Clayey glaciolacustrine
Drainage: imperfectly to poorly drained
Topography: undulating; sample site - slightly mounded position

Profile Description:

LFH - 12 to 0 cm; moderately decomposed leaves and feather-moss with some needles and wood fragments.

Aeg - 0 to 7 cm; light brownish gray (10YR 6/2 m); silt loam; common, medium, distinct mottles (5YR 5/6 m); moderate, medium, platy; friable; clear, smooth boundary.

Btg - 7 to 25 cm; yellowish brown (10YR 5/4 m); clay; many, coarse, distinct mottles (5YR 5/6 m); moderate, medium subangular blocky; firm; gradual, smooth boundary.

BCg - 25 to 40 cm; dark brown (10YR 4/3 m); clay; many, coarse, distinct mottles (5YR 5/6 m); moderate, medium, subangular blocky; firm; gradual, smooth boundary.

Cg - 40+ cm; dark grayish brown (10YR 4/2 m); clay; many, coarse, distinct mottles (5YR 5/6 m); moderate, medium, subangular blocky; firm.

Table 17. Analysis - Site MC-10

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Aeg	4.5	5.2	-	5.5	0.04	0.2	2.0	0.7	32	60	8	1
Btg	4.8	4.9	-	27.2	0.07	0.7	13.5	5.6	16	38	56	24
BCg	4.6	4.8	-	29.9	0.1	0.8	15.7	7.4	9	34	57	24
Cg	4.4	4.7	-	34.9	0.3	0.6	17.1	8.4	2	34	64	28

Site: MC-11
Land Systems: RUT1-KNZ1
Location: SE 30 - 88 - 8 - 4
Classification: Peaty Rego Gleysol
Parent Material: coarse loamy glaciofluvial
Drainage: poorly drained
Topography: undulating; sample site - lower, nearly level slope

Profile Description:

Om - 25 to 0 cm; dominantly moderately decomposed sphagnum moss composition; some leaves and needles.

Cg_1 - 0 to 30 cm; yellowish brown (10YR 5/4 m); sandy clay loam (gravelly); common, medium, distinct mottles (5YR 5/6 m); massive; slightly sticky; diffuse, smooth boundary.

Cg_2 - 30+ cm; yellowish brown (10YR 5/6 m); sandy clay loam (gravelly); common, medium, distinct mottles (5YR 5/6m), massive; slightly sticky.

Table 18. Analysis - Site MC-11.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g Na	K	Ca	Mg	Particle Size Distribution (%) Sand	Silt	Clay	Fine C
Cg_1	6.3	7.2	2.2	20.8	0.05	0.2	15.9	5.0	52	27	21	11
Cg_2	6.8	7.5	2.2	15.3	0.04	0.2	14.9	3.7	52	25	23	11

Site: MC-12

Land System: RUT1-KNZ1

Location: SW 19 - 88 - 7 - 4

Classification: Gleyed Eluviated Eutric Brunisol

Parent Material: coarse loamy till

Drainage: moderately well to imperfectly drained

Topography: undulating; sample site - upper, nearly level slope

Profile Description:

LFH - 7 to 0 cm; mainly moderately decomposed leaves with some wood fragments.

Ahe - 0 to 8 cm; dark grayish brown (10YR 4/2 m); loam; few, medium, distinct mottles (7.5YR 5/6 m); moderate, medium, granular; friable; gradual, smooth boundary.

Bm - 8 to 35 cm; dark yellowish brown (10YR 4/4m); loam; few medium, distinct mottles (7.5YR 5/6 m); moderate, fine to medium, subangular blocky; friable; gradual, smooth boundary.

Cg - 35+ cm; dark yellowish brown (10YR 3/4 M); loam; few, medium, distinct mottles (7.5 YR 5/6 m); moderate, fine to medium, subangular blocky; friable.

Table 19. Analysis - Site MC-12.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eg (%)	TEC me/100g	Exch. Cations me/100g Na	K	Ca	Mg	Particle Size Distribution (%) Sand	Silt	Clay	Fine C
Ahe	6.3	7.0	0.3	19.0	0.3	0.2	14.0	3.4	48	38	14	6
Bm	6.3	6.9	0.3	8.9	0.07	0.1	6.3	1.8	49	37	14	5
Cg	7.3	7.7	6.8	-	-	-	-	-	49	28	23	10

Site: MC-13
Land System: RUT1·KNZ1
Location: SW 18 - 88 - 8 - 4
Classification: Gleyed Gray Luvisol
Parent Material: Clayey morainal (till)
Drainage: moderately well to imperfectly drained
Topography: undulating; sample site - upper, very gentle slope

Profile Description:

LFH - 10 to 0 cm; moderately decomposed moss with some leaves and wood fragments.

Ae - 0 to 7 cm; light brownish gray (10YR 6/2 m); sandy loam; moderate, fine to medium platy; friable; clear, smooth boundary.

Bt_1 - 7 to 23 cm; dark yellowish brown (10YR 4/6 m); sandy loam; moderate, fine to medium, subangular blocky; friable; gradual, smooth boudnary.

Bt_2 - 23 to 45 cm; dark yellowish brown (10YR 4/4 m); loam; moderate, fine to medium subangular blocky; friable; gradual, smooth boundary.

Cgj - 45+ cm; dark yellowish brown (10YR 4/4 m); clay loam; common, medium, distinct mottles (7.5YR 5/8 m); massive; sticky.

Table 20. Analysis - Site MC-13.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae	3.9	4.6	-	4.9	0.01	0.08	1.0	0.0	51	42	7	-
Bt_1	4.2	4.8	-	8.9	0.01	0.2	2.8	1.0	54	29	17	4
Bt_2	4.5	4.8	-	17.3	0.04	0.3	7.6	3.3	45	26	29	15
Cgj	5.0	5.3	-	19.1	0.1	0.3	11.0	4.4	43	27	30	20

Site: MC-14
Land System: RUT1-KNZ2
Location: SE 31 - 89 - 8 - 4
Classification: Peaty Orthic Luvic Gleysol
Parent Material: morainal (till)
Drainage: poorly drained
Topography: nearly level; sample site - upper slope position

Profile Description:

Om - 40 to 0 cm; moderately to highly decomposed mosses with leaves and wood fragments.

Ah - 0 to 3 cm; black (10YR 2/1 m); silt loam; strong, medium to coarse, platy; friable; clear, smooth boundary.

Btg_1 - 3 to 15 cm; dark grayish brown (2.5YR 4/3 m); silt loam; many, coarse, prominent mottles (5YR 5/6 m); strong medium to coarse, subangular blocky; friable; clear, smooth boundary.

Btg_2 - 15 to 35 cm; grayish brown (2.5YR 5/3 m); clay; many, coarse, prominent mottles (5YR 5/6 m); strong, medium to coarse, subangular blocky; friable; clear, smooth boundary.

Cg - 35+ cm; yellowish brown (10YR 5/8 m); clay; many, coarse, prominent mottles (5YR 5/6 m); massive; sticky.

Table 21. Analysis - Site MC-14.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ah	6.2	6.8	-	58.4	0.07	0.1	47.7	5.4	21	53	26	12
Btg_1	6.4	7.0	-	13.0	0.05	0.1	9.4	1.5	22	58	20	8
Btg_2	6.4	7.0	-	9.3	0.06	0.1	6.5	1.2	21	31	48	7
Cg	6.6	7.0	0.2	24.3	0.06	0.4	17.5	3.9	8	32	60	24

Site: MC-15

Land System: RUT1-KNZ2

Location: NE 18 - 89 - 8 - 4

Classification: Orthic Gray Luvisol

Parent Material: Morainal (till) along meltwater channel

Drainage: well drained

Topography: undulating; sample site - crest of a very gentle slope

Profile Description:

LFH - 4 to 0 cm

Ae_1 - 0 to 6 cm; light gray (10YR 7/1 m); very fine sandy loam; strong, medium to coarse, platy; friable; clear, wavy boundary.

Ae_2 - 6 to 10 cm; light brownish gray (10YR 6/2 m); loam; strong, coarse granular; friable; clear, wavy boundary.

Bt_1 - 10 to 22 cm; dark yellowish brown (10YR 4/4 m); clay; strong, coarse, subangular blocky; firm; clear, wavy boundary.

Bt_2 - 22 to 50 cm; dark yellowish brown (10YR 3/4 m); clay; strong, coarse, subangular blocky; firm; gradual, wavy boundary.

C - 50+ cm; dark yellowish brown (10YR 4/6 m); loam; massive, firm.

Table 22. Analysis - Site MC-15.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq(%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae_1	3.9	4.8	-	5.1	0.05	0.08	1.2	0.00	48	45	7	2
Ae_2	4.1	4.9	-	5.1	0.03	0.05	1.1	0.05	48	41	11	4
Bt_1	4.3	4.8	-	22.2	0.03	0.2	8.4	3.2	25	31	44	19
Bt_2	4.8	5.1	-	19.6	0.05	0.2	11.0	3.9	27	33	40	27
C	5.2	5.5	-	16.7	0.06	0.2	11.1	3.6	44	27	29	17

Site: MC-16

Land System: HRT2-KNZ2

Location: NE 8 - 89 - 8 - 4

Classification: Eluviated Eutric Brunisol

Parent Material: Coarse glaciofluvial (meltwater channel) deposits

Drainage: rapidly to well drained

Topography: undulating; nearly level; sample site - crest of very gentle slope.

Profile Description:

LFH - 5 to 0 cm; moderately decomposed leaves and needles with some wood fragments.

Ae_1 - 0 to 8 cm; light gray (10YR 7/1 m); sand; single-grain; loose; clear, wavy boundary.

Ae_2 - 8 to 17 cm; light yellowish brown (10YR 6/4 m); silt loam; single grain; loose; clear, wavy boundary.

Bm - 17 to 38 cm; dark yellowish brown (10YR 4/6 m); sand; single-grain; loose; gradual, wavy boundary.

C - 38+ cm; dark yellowish brown (10YR 4/4 m); loamy sand; single-grain, loose.

Table 23. Analysis - Site MC-16.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae_1	4.2	4.9	-	1.6	0.00	0.04	0.2	0.0	84	14	2	1
Ae_2	4.4	5.0	-	7.3	0.03	0.2	2.5	1.0	27	54	19	3
Bm	5.2	6.1	-	3.2	0.01	0.07	1.3	0.4	89	3	8	2
C	6.1	6.8	-	7.0	0.01	0.1	3.3	1.7	80	5	15	7

Site: M-17
Land System: KIN1
Location: SE 3 - 90 - 8 - 4
Classification: Orthic Gray Luvisol
Parent Material: Morainal (till)
Drainage: well to moderately well drained
Topography: undulating; sample site - crest of a very gentle slope

Profile Description:

LFH - 4 to 0 cm; moderately decomposed leaves and needles with some wood fragments.

Ae - 0 to 5 cm; light gray (10YR 7/1 m); loam; moderate to strong, medium, platy; friable; clear, wavy boundary.

Bt_1 - 5 to 10 cm; (7.5YR 4/4 m); heavy clay; strong, coarse, subangular blocky; very firm; gradual, wavy boundary.

Bt_2 - 10 to 25 cm; (7.5YR 4/4 m); heavy clay; strong, coarse, subangular blocky; very firm; gradual, wavy boundary.

Bt_3 - 25 to 50 cm; dark brown (7.5YR 3/3 m); heavy clay; strong, very coarse, subangular blocky; very firm; gradual, wavy boundary.

C - 50+ cm; dark yellowish brown (10YR 4/4 m); clay loam; massive; firm.

Table 24. Analysis - Site MC-17.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Ae	6.2	7.1	0.2	6.1	0.02	0.07	4.2	0.8	42	47	11	8
Bt_1	4.4	4.8	-	24.3	0.03	0.2	7.6	3.3	12	39	49	18
Bt_2	4.2	4.6	-	38.4	0.07	0.4	9.6	4.9	6	31	63	24
Bt_3	4.2	4.3	-	31.1	0.4	0.6	14.4	6.9	2	24	74	36
C	5.5	6.3	-	19.1	0.2	0.2	11.3	5.4	43	25	32	18

Site: MC-18

Land System: RUT1

Location: SW 9 - 90 - 9 - 4

Classification: Rego Gleysol

Parent Material: Glaciofluvial (Meltwater channel) sands

Drainage: poorly drained

Topography: undulating; sample site - lower, very gentle slope

Profile Description:

LFH - 10 to 0 cm; moderately to highly decomposed peat with leaves and wood fragments

Cg_1 - 0 to 20 cm; brown (10YR 5/3 m); loamy sand; many, medium, distinct mottles (5YR 5/6 m); single grain; loose; diffuse, wavy boundary.

Cg_2 - 20 to 45 cm; dark grayish brown (10YR 4/2 m) sandy loam; many, medium, distinct mottles (5YR 5/6 m); massive; friable; diffuse, wavy boundary.

Cg_3 - 45+ cm; dark yellowish brown (10YR 4/4 m); sandy loam; many medium, distinct mottles (5YR 5/6 m); single grain, loose.

Table 25. Analysis - Site MC-18.

Hor.	pH $CaCl_2$	pH H_2O	$CaCO_3$ eq (%)	TEC me/100g	Exch. Cations me/100g				Particle Size Distribution (%)			
					Na	K	Ca	Mg	Sand	Silt	Clay	Fine C
Cg_1	5.7	7.2	-	2.5	0.01	0.03	1.5	0.3	87	6	7	2
Cg_2	6.3	7.2	-	6.7	0.03	0.1	4.2	1.4	57	27	16	5
Cg_3	6.3	7.1	-	7.3	0.06	0.1	4.3	1.6	79	6	15	8

8.2 ENGINEERING TEST DATA OF SOME SOILS SAMPLED IN 1977

Site Sample	Location	System	Material	Horizon	Depth(cm)	Mechanical Analysis (% passing) 1 in	3/4 in	5/8 in	#4	#10	#40	#200	Liquid Limit(%)	Plasticity Index	Unified Classification	AASHO Classification
M4-9	NW 10 92-11	DOV	lacustrine	CK	130-150	-	-	-	-	-	-	-	44	24	CL	-
M5-6	SE 28 92-12	DOV	lacustrine	Ck	49-90	100	100	98	97	97	96	82	43	20	CL	A-7-6(14)
M5-7	SE 28 92-12	DOV	lacustrine	Ck	90-135	-	-	-	-	-	-	-	40	20	CL	-
M6-7	SW 17 94-11	DOV	till	IICk	70-120	100	100	100	99	99	96	76	38	16	CL	A-6(8)
M8-6	NW 29 96-12	HRR	till	Ck	48-80	87	87	87	84	83	74	44	25	8	SC	A-4(2)
M9-6	SW 20 97-12	DOV	lacustrine	Ck	120-150	100	100	100	98	98	93	57	37	19	CL	A-6(8)
M11-6	SE 8 93-8	KIN	till	IIBm	27-60	-	-	-	-	-	-	-	23	9	SC	-
M12-6	NW 10 93-6	KIN	till	IIC	68-93	-	-	-	-	-	-	-	18	5	SC	-
M13-6	SE 9 94-6	KIN	till	BC	90-120	-	-	-	-	-	-	-	19	6	SC	-
M14-5	NW 25 96-6	KIN	till	BC	54-100	100	100	98	98	96	87	57	24	10	CL	A-4(4)
M17-7	NW 13 87-10	DOV	lacustrine	Ck	85-150	100	100	100	100	100	99	79	44	21	CL	A-7-6(13)
M17-6	NW 13 87-10	DOV	lacustrine	Ck	60-85	100	100	100	100	100	100	88	46	21	CL	A-7-6(13)

Site Sample	Location	System	Material	Horizon	Depth(cm)	Mechanical Analysis (%passing) 1 in	3/4 in	5/8 in	#4	#10	#40	#200	Liquid Limit(%)	Plasticity Index	Unified Classification	AASHO Classification
M18-6	NE 8 90-12	HRR	till	BC	60-100	100	100	98	98	97	93	63	30	12	CL	A-6(6)
M19-5	NE 13 99-11	NAM	fluvial	Cgj	65-92	100	100	100	100	100	100	98	66	24	MH	S-7-5(18)
M20-5	NE 12 100-12	BKN	colluvial	Ck_2	75+	100	100	100	100	100	95	50	33	10	CL	A-4(3)
M24-5	NE 9 98-4	FIR	glacio-fluvial	C	68-115	100	100	100	100	99	81	1	NP	NP	SW	A-3
M26-5	NE 12 100-8	MIL	glacio-fluvial	C	55-90	100	100	100	100	99	95	3	NP	NP	SW	A-3
M27-6	SE 6 97-9	KIN	till	Ck	85-110	-	-	-	-	-	-	-	32	14	SS	-
M29-6	SW 8 100-12	LGD	till	C	50-80	100	100	98	94	90	63	5	NP	NP	SW	A-3
M30-5	SW 8 100-12	LGD	till	C	45-65	100	98	94	88	81	60	30	28	9	SC	A-24
M31-6	SE 19 85-8	KIN	till	C	67-120	100	100	100	98	96	79	46	28	9	SC	A-4(2)
M32-1	SW 1 101-12	RB	shale	-	500+	-	-	-	-	-	-	-	62	22	MH	-

OUTLINE OF MINERAL LANDFORMS IN THE AOSERP STUDY AREA

GENETIC MATERIAL

M - Morainal. Poorly sorted, nonstratified sediments deposited direcly from glacial ice.

L - Lacustrine. Well sorted, stratified sands, silts, or clays deposited in still, fresh water.

L^G - Glaciolacustrine.

F - Fluvial. Well sorted, stratified, gravel and sand deposited by running water.

F^G - Glaciofluvial.

C - Colluvial. Well to poorly sorted boulders to clays deposited at the base of slopes through gravity flow.

E - Eolian. Well sorted, poorly compacted silts and sands deposited by wind.

U - Undifferentiated. Undifferentiated sediments where mode of deposition is complex or unknown.

R - Rock. Consolidated bedrock materials.

Examples:

El - level eolian

F^G_h - hummocky glaciofluvial

SURFACE FORM

l - level. Generally flat, even surface lacking irregularities. Slopes less than 1%.

u - undulating. A regular sequence of broad, shallow topographic lows and broad, low highs. Slopes usually from 2 to 5%.

h - hummocky. Generally a broken, irregular surface with distinct knobs or mounds and depressions. Slopes generally from 5 to 35%.

m - rolling. A regular sequence of broad topographic lows, long side slopes and broad topographic highs. Slopes greater than 5%.

r - ridged. Long, narrow elevation of the surface, usually sharp crested with steep sides. Ridges may be parallel, subparallel or intersecting.

s - steep. Erosional slopes, greater than 35%.

i - inclined. Sloping, unidirectional surface with a generally constant, unbroken slope.

t - terrace. Scarp face and the horizontal or gently inclined surface (tread) above it.

f - fan. Fan-shaped form that can be likened to the segment of a cone, and possessing a perceptible gradient from apex to toe.

a - apron. Relatively gentle slope at the foot of a steeper slope, formed by materials from the steeper, upper slope.

v - veneer. Thin surface deposits which mask little of the configuration of underlying bedrock or deposit.

b - blanket. Mantle of thin surface deposits which subdue but no not completely mask the configuration of the underlying bedrock or deposit.

111°30′ R10 25′ R9 20′ R8 111°15′

57°45′ Tp101 Tp100 40′ Tp99 35′ Tp98 57°30′

RUT 1-KNZ 2 / F Gu-Bv,2-3
KNZ 2-HRT 2 / Bv-Er,2-4
RUT 1 / F Gu,3
MMY2 / Fu,2-3
MIL1-HRT1 / F Gu-Eu,3-4
RUT 2 / F Gu,2-3
EMBARRAS PLAIN
MIL 1 / F Gu,3-4
Twenty-sixth Base Line
MIL 2 / F Gu,2-3
BMT 1-KNZ 2 / F Gu-Bv-2
POINT BRULE
EMBARRAS PLAIN
RUT 2 / F Gu,2-3
MMY 2 / Fu,2-3
MMY1 / Fut,2-4
MIL 2 / F Gu,2-3
LOWLAND
MIL 1 / F Gu,3
MIL 2 / F Gu,2-3
RUT 2-KNZ 2 / F Gu-Bv,2-3
MIL2-KNZ2 / F Gu-Bv,2-3
MIL 2 / F Gu,2-3
MIL 2 / F Gu,2-3
MMY2 / Fu,2-3
MIL 1 / F Gu,3-4
MIL 1 / F Gu,3
MIL 1 / F Gu,3-4
MMY 2 / Fu,2-3
MIL 2 / F Gu,2-3
KNZ1-HRT 2 / Bh-Er,2-3
MIL 1 / F Gu,3-4
HRT1-KNZ 1 / Er-Bh,2-3
MIL 2 / F Gu,2-3
KNZ 1-RUT 2 / Bh-F Gu,2
EMBARRAS PLAIN
MIL 1 / F Gu,3-4
EGL 1 / Nh,1
EGL 1-MIL 2 / Nh-F Gu,2-3

Firebag River, Coffey Lake, Furlough Island, Dalkin Island, Lorna Island, Williscroft I., McCLELLAND LAKE

FIREBAG RIVER

ALBERTA

WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Miles
Metres 1000 500 0 1000 2000 3000 4000 Mètres
Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level
Transverse Mercator Projection
North American Datum 1927
MAGNETIC DECLINATION 26°18′ EAST
AT CENTRE OF MAP, 1964
Annual change decreasing 4.6′

ÉQUIDISTANCE DES COURBES 25 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927
DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964 : 26°18′ EST
Variation annuelle décroissante 4.6′

Produced by the ARMY SURVEY ESTABLISHMENT, R.C.E.
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Roads: Routes:

		more than 2 lanes / plus de 2 voies	2 lanes / 2 voies
hard surface, all weather	pavée, toute saison		
		less than 2 lanes / moins de 2 voies	
hard surface, all weather	pavée, toute saison		
loose surface, all weather	de gravier, toute saison	2 lanes or more / 2 voies ou plus	less than 2 lanes / moins de 2 voies
loose surface, dry weather	de gravier, période sèche		
cart track	de terre		
trail or portage	sentier ou portage		
Railway, normal gauge, single track	Chemin de fer, voie unique (écartement normal)	siding / voies d'evitement	station / gare
Horizontal control point, with elevation	Point géodésique, avec cote		454 △
Bench mark, with elevation	Repère de nivellement, avec cote		BM 157 →
Spot elevation; precise, approximate	Point coté; précis, approximatif	450	450 +

Building	Bâtiment	Church	Église
School	École	Post Office	Bureau de poste P
Cemetery	Cimetière		C
Mine or Open cut	Mine ou fosse à ciel ouvert		
Lighthouse	Phare		
Power transmission line	Ligne de transport d'énergie		
River with bridge	Rivière avec pont		
Stream, intermittent or dry	Cours d'eau intermittent, ou à sec		
Lake intermittent, indefinite	Lac intermittent, rive imprécise		
Marsh or Swamp	Marais ou marécage		
Depression contours	Courbes de cuvette		

TABLEAU D'ASSEMBLAGE DU SYSTÈME NATIONAL DE RÉFÉRENCE CARTOGRAPHIQUE

111°45′ 111°00′ 58°00′

74 E/13E	74 E/14W	74 E/14E
74 E/12E	74 E/11W	74 E/11E
74 E/5E	74 E/6W	74 E/6E

57°15′ 57° 111°45′ 111°00′

INDEX TO ADJOINING MAPS OF
THE NATIONAL TOPOGRAPHIC SYSTEM

FIREBAG RIVER
74 E/11W
EDITION 1

111°15′ 111°00′ 57°30′ 57°15′ R8 10′ 05′ R7 Tp 98 Tp 97 Tp 96 Tp 95 25′ 20′

MIL 2 - KNZ 2 / F Gu - Bv, 2 - 3
EGL 1 - KNZ 1 / Nh - Bh, 1
MIL 1 / F Gu, 3-4
EGL 1 - MIL 2 / Nh - F Gu, 2-3
MMY 2 / Fu, 2-3
EMBARRAS PLAIN
MIL 1 / F Gu, 3-4
MIL 2 - EGL 1 / F Gu - Nh, 2-3
MIL 1 / F Gu, 3-4
FIR 1 / F Gh, 3-5
FORT HILLS UPLAND
MIL 1 / F Gu, 3-4
MMY 2 / Fu, 2-3
FIREBAG RIVER
KNZ 1 - MIL 2 / Bh - F Gu, 2-3
BMT 1 - KNZ 2 / F Gu - Bv, 2
FIR 1 / F Gh, 4-5
FORT HILLS UPLAND
MIL 2 - KNZ 2 / F Gu - Bv, 2-3
EGL 1 / Nr, 1
String Bog
FIR 1 / F Gh, 5
FIR 2 / F Gh, 5
FORT HILLS UPLAND
FIR 2 - KNZ 2 / F Gh - Bv, 3-5
FIR 2 / F Gh, 5
KNZ 2 - FIR 2 / Bv - F Gu, 2-3
KNZ 1 - EGL 1 / Bh - Nh, 1
KNZ 2 - MIL 2 / Bv - F Gu, 2-3
EGL 1 - BMT 1 / Nh - F Gu, 2
KNZ 1 - EGL 1 / Bh - Nh, 1
EGL 1 - KNZ 1 / Nh - Bh, 1
Muskeg
MIL 2 - KNZ 2 / F Gu - Bv, 2-3
MMY 2 / Fu, 2
MIL 2 - KNZ 2 / F Gr - Bv, 2-3
FIR 2 / F Gh, 5
EGL 1 - KNZ 1 / Nh - Bh, 1
FIR 2 / F Gh, 5
FIR 2 - KNZ 2 / F Gh - Bv, 3-4
MIL 2 - KNZ 2 / F Gu - Bv, 2-3
CLEARWATER LOWLAND
Twenty-fifth Base Line
KNZ 1 - BMT 1 / Bh - F Gu, 2
KNZ 1 - HRT 2 / Bh - Eu, 2-3
MIL 2 / F Gu, 3
KNZ 2 - MIL 2 / Bv - F Gu, 2-3
FIR 1 / F Gh, 3-5
EGL 1 / Nh, 1
KNZ 2 - BMT 1 / Bv - F Gu, 2
FIR 1 / F Gu, 3-4
FIR 2 / F Gh, 3-4
FIR 1 / F Gu, 3-4
MIL 2 / F Gu, 3
FIR 1 / F Gu, 3-4
MMY 2 / Fu, 2
KNZ 2 - STP 1 / Bv - Mu, 2
FIR 1 / F Gu, 3-4
MIL 2 - KNZ 2 / F Gu - Bv, 2-3
MIL 2 / F Gu, 3
KNZ 2 - BMT 1 / Bv - F Gu, 2
EGL 1 / Nh, 1
KNZ 1 - EGL 1 / Bh - Nh, 1
KNZ 2 - BMT 1 / Bv - F Gu, 2
KEARL LAKE
KNZ 2 - KIN 1 / Bv - Mu, 2-4
KIN 1 / Mu, 3
EGL 1 / Nh, 1
STP 1 - KNZ 2 / Mu - Bv, 2
KNZ 2 - STP 1 / Bv - Mu, 2
MUSKEG MOUNTAIN UPLAND
KNZ 2 - KIN 1 / Bv - Mu, 2-4
FIR 1 / F Gu, 3-4
KNZ 1 / Bh, 1
KIN 1 / Mu, 3
KNZ 2 - STP 1 / Bv - Mu, 2
STP 1 - KNZ 2 / Mu - Bv, 2 - 3

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KEARL LAKE
ALBERTA
WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3
Metres 1000 500 0 1000 2000 3000 4000 Metres
Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level

Transverse Mercator Projection
North American Datum 1927

MAGNETIC DECLINATION 25°54′ EAST
AT CENTRE OF MAP 1964
Annual change decreasing 4.5′

ÉQUIDISTANCE DES COURBES 25 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964 : 25°54′ EST
Variation annuelle décroissante 4.5′

Roads: Routes:

hard surface, all weather	pavée, toute saison	less than 2 lanes / moins de 2 voies; 2 or more / 2 voies ou plus
hard surface, all weather	pavée, toute saison	less than 2 lanes / moins de 2 voies; 2 lanes or more / 2 voies ou plus
loose surface, all weather	de gravier, toute saison	2 lanes or more / 2 voies ou plus; less than 2 lanes / moins de 2 voies
loose surface, dry weather	de gravier, période sèche	
cart track	de terre	
trail or portage	sentier ou portage	
Railway, normal gauge, single track	Chemin de fer, voie unique (écartement normal)	station / gare; siding / voie d'évitement
Horizontal control point, with elevation	Point géodésique, avec cote	454
Bench mark, with elevation	Repère de nivellement, avec cote	BM 157
Spot elevation; precise, approximate	Point coté; précis, approximatif	450 ; 450

Buildings: Bâtiment; Church: Église; School: École; Post Office: Bureau de poste; Cemetery: Cimetière; Mine or Open cut: Mine ou fosse à ciel ouvert; Lighthouse: Phare; Power transmission line: Ligne de transport d'énergie; River or Stream: Rivière avec pont; Stream, intermittent or dry: Cours d'eau intermittent, ou à sec; Lake intermittent, indefinite: Lac intermittent, rive imprécise; Marsh or Swamp: Marais ou marécage; Depression contours: Courbes de cuvette

TABLEAU D'ASSEMBLAGE DU SYSTÈME NATIONAL DE RÉFÉRENCE CARTOGRAPHIQUE

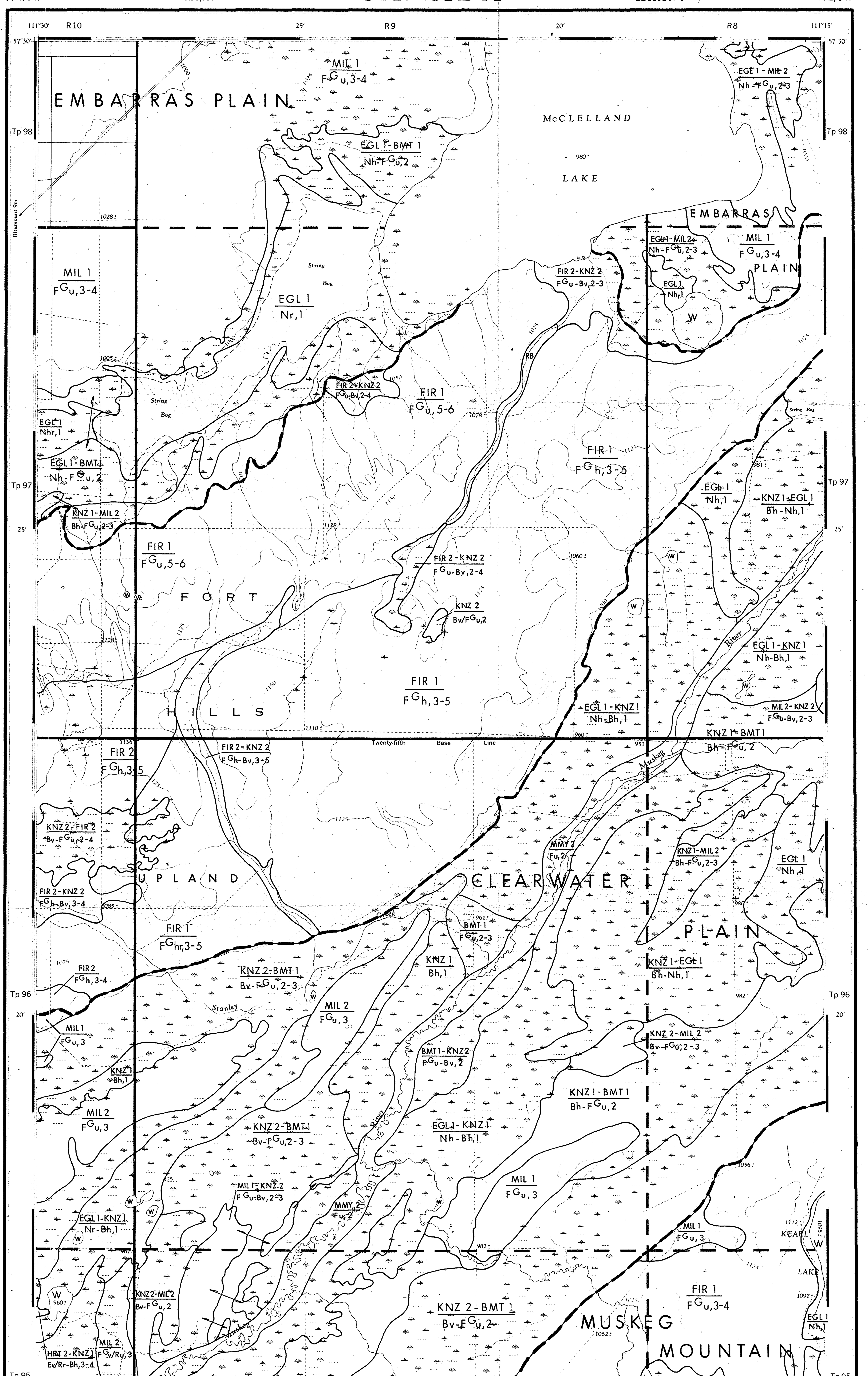
INDEX TO ADJOINING MAPS OF THE NATIONAL TOPOGRAPHIC SYSTEM

KEARL LAKE
74 E/6E
EDITION 1

74 E/6W 1:50,000

CANADA

EDITION 1 74 E/6W



111°30′ R10
25′
R9
20′
R8
111°15′
57°30′
Tp 98
Tp 97
25′
Tp 96
20′
Tp 95
57°15′
Bitumount 9m
EMBARRAS PLAIN
MIL 1
FGu,3-4
EGL 1-BMT 1
Nh-FGu,2
McCLELLAND
980
LAKE
EGL 1 - MIL 2
Nh - FGu, 2-3
EMBARRAS
EGL 1-MIL 2
Nh-FGu,2-3
MIL 1
FGu,3-4
PLAIN
EGL 1
Nh,1
W
1028
MIL 1
FGu,3-4
String
Bog
EGL 1
Nr,1
FIR 2-KNZ 2
FGu-Bv,2-3
RB
1005
FIR 2-KNZ 2
FGu-Bv,2-4
FIR 1
FGu,5-6
1078
String Bog
EGL 1
Nhr,1
EGL 1-BMT 1
Nh-FGu,2
FIR 1
FGh,3-5
981
EGL 1
Nh,1
KNZ 1-EGL 1
Bh-Nh,1
KNZ 1-MIL 2
Bh-FGu,2-3
1128
FIR 1
FGu,5-6
FIR 2 - KNZ 2
FGu-Bv,2-4
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KNZ 2
Bv/FGu,2
W
River
EGL 1-KNZ 1
Nh-Bh,1
1128
FIR 1
FGh,3-5
HILLS
1110
EGL 1-KNZ 1
Nh-Bh,1
MIL 2-KNZ 2
FGu-Bv,2-3
1136
FIR 2
FGh,3-5
FIR 2-KNZ 2
FGh-Bv,3-5
Twenty-fifth Base Line
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951
KNZ 1-BMT 1
Bh-FGu,2
Muskeg
1125
KNZ 2-FIR 2
Bv-FGu,2-4
MMY 2
Fu,2
KNZ 1-MIL 2
Bh-FGu,2-3
EGL 1
Nh,1
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CLEARWATER
FIR 2-KNZ 2
FGh-Bv,3-4
1085
Creek
961
BMT 1
FGu,2-3
PLAIN
FIR 1
FGhr,3-5
1075
FIR 2
FGh,3-4
KNZ 2-BMT 1
Bv-FGu,2-3
KNZ 1
Bh,1
KNZ 1-EGL 1
Bh-Nh,1
982
Stanley
MIL 2
FGu,3
MIL 1
FGu,3
KNZ 2-MIL 2
Bv-FGu,2-3
BMT 1-KNZ 2
FGu-Bv,2
KNZ 1
Bh,1
KNZ 1-BMT 1
Bh-FGu,2
MIL 2
FGu,3
KNZ 2-BMT 1
Bv-FGu,2-3
EGL 1-KNZ 1
Nh-Bh,1
River
1056
MIL 1
FGu,3
MIL 1-KNZ 2
FGu-Bv,2-3
MMY 2
Fu,2
EGL 1-KNZ 1
Nr-Bh,1
MIL 1
FGu,3
1112
KEARL
1095
W
967
982
LAKE
W
960
KNZ 2-MIL 2
Bv-FGu,2
FIR 1
FGu,3-4
1097
KNZ 2-BMT 1
Bv-FGu,2
MUSKEG
1062
EGL 1
Nh,1
HRT 2-KNZ 1
Ev/Rr-Bh,3-4
MIL 2
FGv/Ru,3
Muskeg
MOUNTAIN
UPLAND
KNZ 1
Bh,1
KNZ 1-HRT 1
Bh-Ev/Rr,3
KNZ 2-HRT 1
Bv-Ev/Rr,3
1027
Hartley
938
Ck
STP 1-KNZ 2
Mu-Bv,2-3
KNZ 2-STP 1
Bv-Mu,2
KNZ 1
Bh,1
KIN 1-MIL 2
Mu-FGu,3
111°30′ R10
MIL 2-KNZ 2
FGu-Bv,3-4
25′
R9
20′
KIN 1-MIL 2
Mu-FGu,3
KNZ 2
Bv/Mu,2
R8
111°15′

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KEARL LAKE

ALBERTA

WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

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CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level

Transverse Mercator Projection,
North American Datum 1927

MAGNETIC DECLINATION 26 00′ EAST
AT CENTRE OF MAP 1964
Annual change decreasing 4.5′

EQUIDISTANCE DES COURBES 25 PIEDS
Élevations en pieds au dessus du niveau moyen de la mer

Projection transverse de Mercator
Réseau geodésique nord américain de 1927

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964: 26 00′ EST
Variation annuelle décroissante 4.5′

TABLEAU D'ASSEMBLAGE DU SYSTÈME NATIONAL DE RÉFÉRENCE CARTOGRAPHIQUE

74 E 12E	74 E 11W	74 E 11E
74 E 5E	74 E 6W	74 E 6E
74 E 4E	74 E 3W	74 E 3E

INDEX TO ADJOINING MAPS OF THE NATIONAL TOPOGRAPHIC SYSTEM

KEARL LAKE
74 E/6W
EDITION 1

74 E/3 W 1:50,000 **CANADA** EDITION 1 74 E/3 W

111°30′ R 10 25′ R 9 20′ R 8 111°15′ 57°15′

KNZ1-HRT1 Bh-Ev/Rr,3 | KNZ 1 Bh,1 | KNZ2-HRT1 Bv-Ev/Rr,3 | KNZ2-BMT1 Bv-F^{G}u,2 | FIR 1 F^{G}u,3-4 | KNZ1-STP1 Bh-Mu,2

MIL2-KNZ2 F^{G}u-Bv,3-4 | KNZ2-HRT1 Bv-Ev/Rr,3 | KIN1-MIL2 Mu-F^{G}u,3 | KIN1-MIL2 Mu-F^{G}u,3

Tp 95

KNZ2-MIL2 Bv-F^{G}u,2-3 | KNZ2-STP1 Bv-Mu,2 | STP1-KNZ2 Mu-Bv,2-3

KNZ 2 Bv/F^{G}u,2 | KNZ 2 Bv/Mu,2

KIN1-MIL2 Mu-F^{G}u,3 | KIN1-MIL2 Mu-F^{G}u,3 | KIN 1 Mu,3

KNZ 2 Bv-F^{G}u,2 | KIN 1 Mu,3

10′ Tp 94

KNZ2-MIL2 Bv-F^{G}u,2-3

MUSKEG MOUNTAIN UPLAND

KNZ1-EG1 Bh-Nh,1 | KNZ 1 Bh,1 | KNZ2-HRT2 Bv-Er,3 | MMY 2 Fu,2 | KNZ2-STP1 Bv-Mu,2

KNZ 1 Bh,1 | KNZ2-HRT2 Bv-Er,3 | MIL1-HRT1 F^{G}u-Eu,3 | MIL2-KNZ2 F^{G}u-Bv,3-4 | KNZ2-HRT2 Bv-Eru,3 | KNZ 1 Bh,1 | KNZ2-STP1 Bv-Mu,2

05′ Tp 93

CLEARWATER PLAIN

KNZ2-MIL2 Bv-F^{G}v/Mu,3 | RUT1 F^{G}u,3 | MMY 2 Fu,3 | RUT1-KNZ2 F^{G}u-Bv,3 | KNZ2-STP1 Bv-Mu,2

Twenty-fourth Base Line

MIL2-KNZ2 F^{G}v/Mu-Bv,3 | KNZ2-RUT1 Bv-F^{G}u,3 | KIN1-KNZ2 Mur-Bv,3 | KNZ2-STP1 Bv-Mu,2

Mildred Lake 2m Tp 92

ATHABASCA RIVER | McMURRAY LOWLAND | STEEPBANK RIVER | Hartley Creek | Falls R.

MMY 2 Fu,3

111°30′ R 10 25′ R 9 20′ R 8 111°15′ 57°00′

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HARTLEY CREEK

ALBERTA

WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Milles

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level

Transverse Mercator Projection
North American Datum 1927

MAGNETIC DECLINATION 25°44′ EAST
AT CENTRE OF MAP 1964
Annual change decreasing 4.4′

ÉQUIDISTANCE DES COURBES 25 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964: 25°44′ EST
Variation annuelle décroissante 4.4′

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Roads:	Routes:	
loose surface	de gravier	dry weather / période sèche
wagon, cart track	de terre	
trail or portage	sentier ou portage	
Spot elevation; precise, approximate	Point coté; précis, approximatif	450 450 ±
Depression contours	Courbes de cuvette	
Cliff or low relief	Falaise ou relief peu accentué	
Esker	Esker	
Pingo	Buttes de terre	
String bogs	Marais en chapelet	
Power transmission line	Ligne de transport d'énergie	
Mine or Open cut	Mine ou fosse à ciel ouvert	

Building	Bâtiment	Post Office	Bureau de poste P
School	École	Church	Église
Horizontal control point	Point géodésique		△
Astronomical monument	Repère astronomique		⊕
R.C.M.P. Detachment	Poste de la G.R.C.		
Intermittent stream	Cours d'eau intermittent		
Intermittent lake	Lac intermittent		
Marsh or Swamp	Marais ou marécage		
Tundra polygons	Sols polygonaux		
Tundra ponds	Étangs de toundra		
Icefield or Glacier	Champ de glace ou glacier		

TABLEAU D'ASSEMBLAGE DU SYSTÈME NATIO
DE RÉFÉRENCE CARTOGRAPHIQUE

111°45′ 111° / 57°30′ / 56°45′

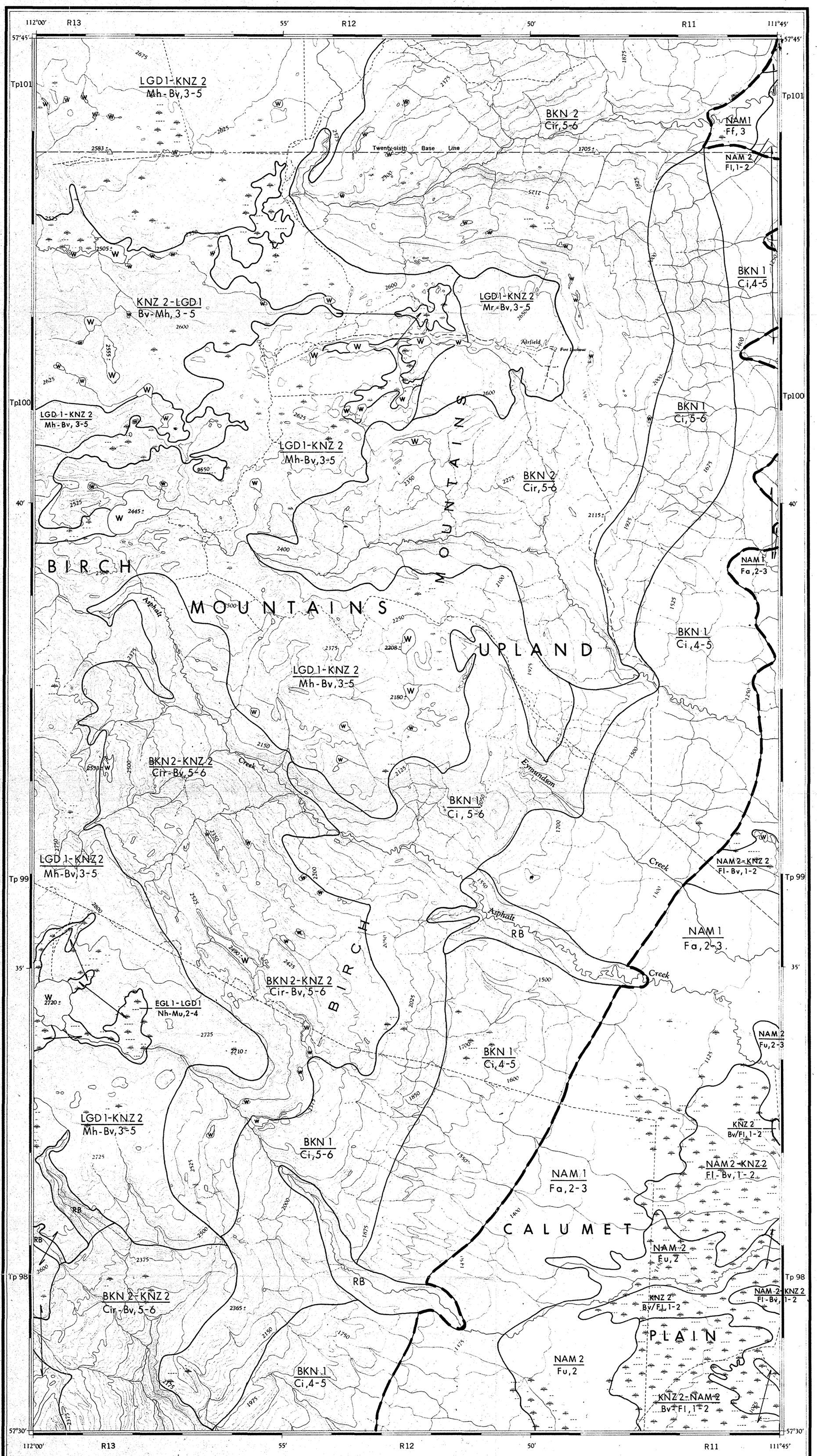
74 E/5 E	74 E/6 W	74 E/6 E
74 E/4 E	74 E/3 W	74 E/3 E
74 D/13 E	74 D/14 W	74 D/14 E

INDEX TO ADJOINING MAPS OF
THE NATIONAL TOPOGRAPHIC SYSTEM

HARTLEY CREE
74 E/3 W
EDITION 1

74 E/12 W | 1:50,000 | EDITION 1 | 74 E/12 W

CANADA



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ASPHALT CREEK

ALBERTA

WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

alberta canada
ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Miles 1 0 1 2 3 Miles
Metres 1000 500 0 1000 2000 3000 4000 Mètres
Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level

Transverse Mercator Projection
North American Datum 1927

MAGNETIC DECLINATION 26°33′ EAST
AT CENTRE OF MAP 1964
Annual change decreasing 4.6′

ÉQUIDISTANCE DES COURBES 25 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927

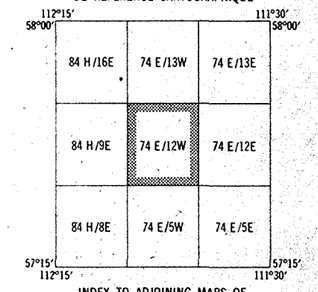
DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964 : 26°33′ EST
Variation annuelle décroissante 4.6′

Roads: Routes:

hard surface, all weather	pavée, toute saison	more than 2 lanes / plus de 2 voies	2 lanes / 2 voies
hard surface, all weather	pavée, toute saison	less than 2 lanes / moins de 2 voies	
loose surface, all weather	de gravier, toute saison	2 lanes or more / 2 voies ou plus	less than 2 lanes / moins de 2 voies
loose surface, dry weather	de gravier, période sèche		
cart track	de terre		
trail or portage	sentier ou portage		
Railway, normal gauge, single track	Chemin de fer, voie unique (écartement normal)	siding / voies d'évitement	station / gare
Horizontal control point, with elevation	Point géodésique, avec cote		454
Bench mark, with elevation	Repère de nivellement, avec cote		BM 157
Spot elevation; precise, approximate	Point coté; précis, approximatif	450	450

Building	Bâtiment	Church	Église
School	École	Post Office	Bureau de poste
Cemetery	Cimetière		
Mine or Open cut	Mine ou fosse à ciel ouvert		
Lighthouse	Phare		
Power transmission line	Ligne de transport d'énergie		
River with bridge	Rivière avec pont		
Stream, intermittent or dry	Cours d'eau intermittent, ou à sec		
Lake intermittent, indefinite	Lac intermittent, rive imprécise		
Marsh or Swamp	Marais ou marécage		
Depression contours	Courbes de cuvette		

TABLEAU D'ASSEMBLAGE DU SYSTÈME NATIONAL DE RÉFÉRENCE CARTOGRAPHIQUE



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ASPHALT CREEK
74 E/12W
EDITION 1

74 E/3 E 1:50,000 **CANADA** EDITION 1 74 E/3 E

111°15′ R 8 10′ 05′ R 7 111°00′

57°15′ 57°15′

Tp 95 Tp 95

KNZ2 - STP1 Bv-Mu,2

STP1 - KNZ 2 Mu-Bv,2-3

KIN1 Mu,3

KNZ2-STP1 Bv-Mu2

KNZ2 - KIN1 Bv-Mu,2-4

KNZ 2- STP 1 Bv-Mu,2

KIN1 Mu,3

KIN1-KNZ2 Mu-Bv,3-4

KNZ2-KIN1 Bv-Mu,2-4

STP1-KNZ2 Mu-Bv,2

10′ Tp 94 10′ Tp 94

1222± KIN 1 Mu,3

1353±

KNZ 2- STP 1 Mu-Bv,3-4

KNZ2-KIN1 Bv-Mu,3

KNZ 2 Bv/Mu,2

1680± W

W W

KNZ 2 Bv/Mu,2

KNZ 2-KIN 1 Bv-Mu,2-4

MUSKEG MOUNTAIN UPLAND

1592±

1712±

KIN1-KNZ2 Mu-Bv,3-4

KNZ2-KEL1 Bv-F^{G}r,3-4

KNZ2-KIN1 Bv-Mh,3-4

1317±

1580±

KNZ 2 Bv/Mu,2

KNZ2 - STP 1 Bv-Mu,2

05′ Tp 93 05′ Tp 93

Falls

River

Steepbank

KNZ 2-STP 1 Bv-Mu, 2

KIN 1 Mu,2-3

KNZ 2 Bv/Mu,2

KNZ2-HRT2 Bv-Eur,3

KNZ2-KEL1 Bv-F^{G}r,3

Creek

Hartley

North

1352± Twenty-fourth Base Line 1640±

1577

KNZ2-KEL1 Bv-F^{G}r,3

KNZ1-EGL1 Bh-Nh,1

Tp 92 Tp 92

Rapids

KNZ2-HRT2 Bv-Eur,3

KIN1-KNZ 2 Mur-Bv,3

KIN 1 Mu,2-3

KNZ 1 Bh,1

KNZ 1 Bh,1

KNZ 1 Bh,1

57°00′ 57°00′

111°15′ R 8 10′ 05′ R 7 111°00′

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HARTLEY CREEK

ALBERTA

WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Miles 1 0 1 2 3 Milles

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level

Transverse Mercator Projection
North American Datum 1927

MAGNETIC DECLINATION 25°36′ EAST
AT CENTRE OF MAP 1964
Annual change decreasing 4.4′

ÉQUIDISTANCE DES COURBES 25 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964 : 25°36′ EST
Variation annuelle décroissante 4.4′

Roads:	Routes:	
loose surface	de gravier	dry weather / période sèche
wagon, cart track	de terre	
trail or portage	sentier ou portage	
Spot elevation; precise, approximate	Point coté; précis, approximatif	450 450 ±
Depression contours	Courbes de cuvette	
Cliff or low relief	Falaise ou relief peu accentué	
Esker	Esker	
Pingo	Buttes de terre	
String bogs	Marais en chapelet	
Power transmission line	Ligne de transport d'énergie	
Mine or Open cut	Mine ou fosse à ciel ouvert	

Building	Bâtiment	Post Office	Bureau de poste
School	École	Church	Église
Horizontal control point	Point géodésique		
Astronomical monument	Repère astronomique		
R.C.M.P. Detachment	Poste de la G.R.C.		
Intermittent stream	Cours d'eau intermittent		
Intermittent lake	Lac intermittent		
Marsh or Swamp	Marais ou marécage		
Tundra polygons	Sols polygonaux		
Tundra ponds	Étangs de toundra		
Icefield or Glacier	Champ de glace ou glacier		

TABLEAU D'ASSEMBLAGE DU SYSTÈME NATIO
DE RÉFÉRENCE CARTOGRAPHIQUE

111°30′ 110°

57°30′

74 E/6 W	74 E/6 E	74 E/7 W
74 E/3 W	74 E/3 E	74 E/2 W
74 D/14 W	74 D/14 E	74 D/15 W

56°45′

111°30′ 110°

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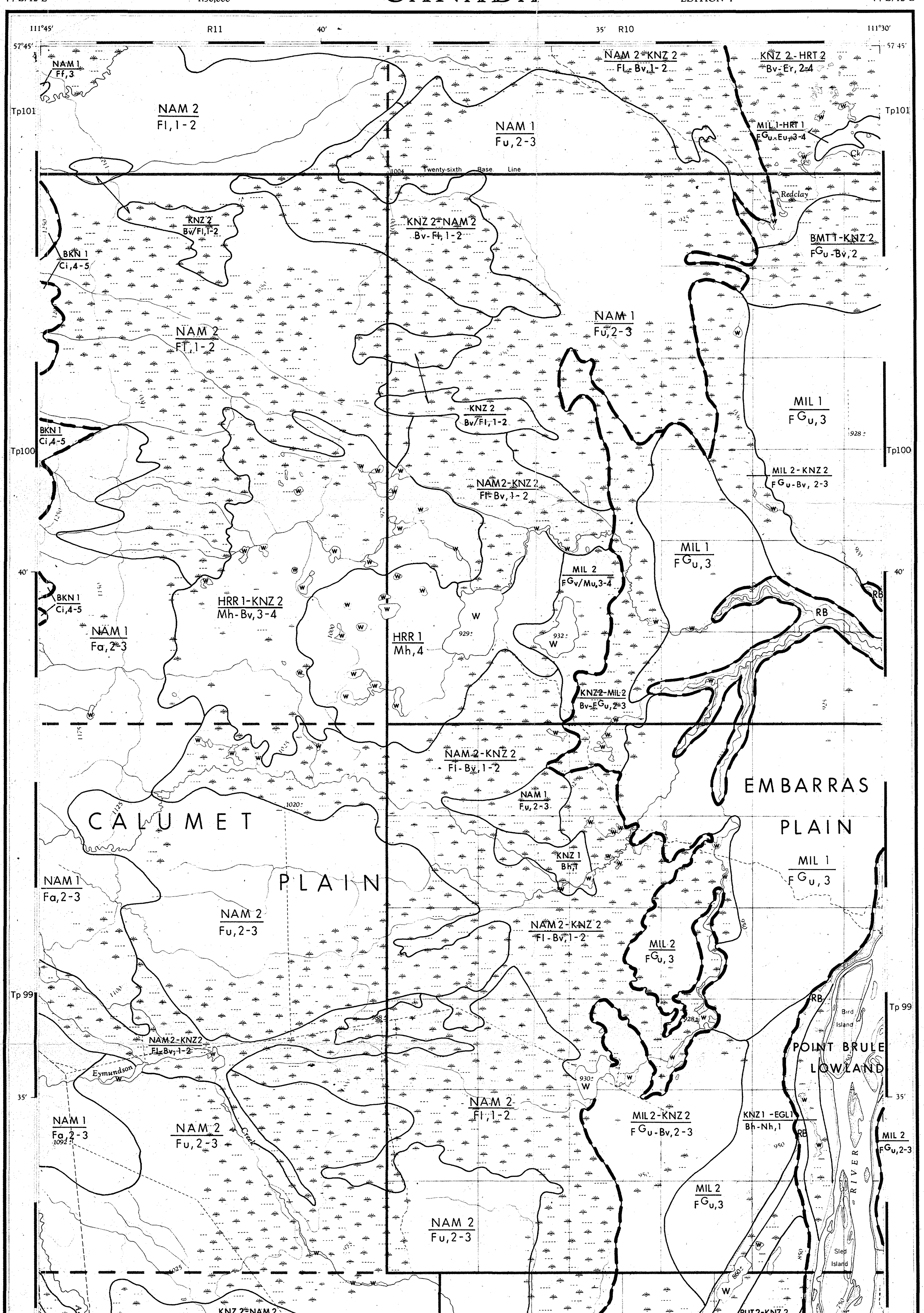
THE NATIONAL TOPOGRAPHIC SYSTEM

HARTLEY CREEK
74 E/3 E
EDITION 1



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ASPHALT CREEK

ALBERTA

WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

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ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Miles 1 0 1 2 3 Miles
Metres 1000 500 0 1000 2000 3000 4000 Mètres
Yards 1000 500 0 1000 2000 3000 4000 Verges

Roads:	Routes:
hard surface, all weather	pavée, toute saison
hard surface, all weather	pavée, toute saison
loose surface, all weather	de gravier, toute saison
loose surface, dry weather	de gravier, période sèche
cart track	de terre
trail or portage	sentier ou portage
Railway, normal gauge, single track	Chemin de fer, voie unique (écartement normal)
Horizontal control point, with elevation	Point géodésique, avec cote
Bench mark, with elevation	Repère de nivellement, avec cote
Spot elevation, precise, approximate	Point coté, précis, approximatif

CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level

ÉQUIDISTANCE DES COURBES 25 PIEDS
Élevations en pieds au dessus du niveau moyen de la mer

Transverse Mercator Projection
North American Datum 1927

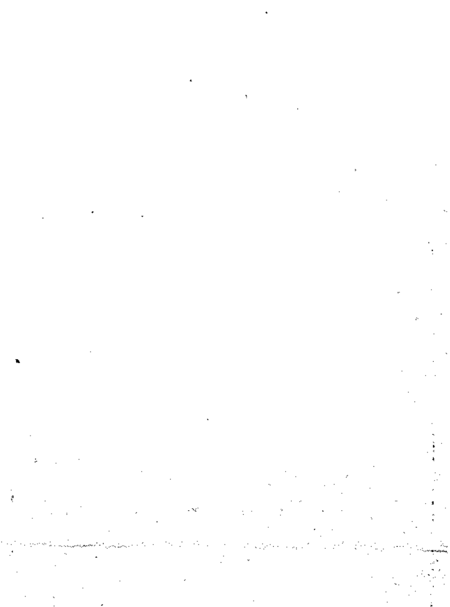
Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927

MAGNETIC DECLINATION 26°26′ EAST
AT CENTRE OF MAP 1964
Annual change decreasing 4.6′

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964: 26°26′ EST
Variation annuelle décroissante 4.6′

Building	Bâtiment
School	École
Church	Église
Post Office	Bureau de poste
Cemetery	Cimetière
Mine or Open-cut	Mine ou fosse à ciel ouvert
Lighthouse	Phare
Power transmission line	Ligne de transport d'énergie
River with bridge	Rivière avec pont
Stream, intermittent or dry	Cours d'eau intermittent, ou à sec
Lake intermittent, indefinite	Lac intermittent, rive imprécise
Marsh or Swamp	Marais ou marécage
Depression contours	Courbes de cuvette

TABLEAU D'ASSEMBLAGE DU SYSTÈME NATIONAL DE RÉFÉRENCE CARTOGRAPHIQUE



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ASPHALT CREEK
74 E/12 E
EDITION 1

FIREBAG RIVER

ALBERTA

WEST OF FOURTH MERIDIAN

SCALE 1:50,000 ÉCHELLE

Miles 1 0 1 2 3 Milles

Metres 1000 500 0 1000 2000 3000 4000 Mètres

Yards 1000 500 0 1000 2000 3000 4000 Verges

CONTOUR INTERVAL 25 FEET
Elevations in Feet above Mean Sea Level

Transverse Mercator Projection
North American Datum 1927

MAGNETIC DECLINATION 26 18' EAST
AT CENTRE OF MAP 1964
Annual change decreasing 4.6'

ÉQUIDISTANCE DES COURBES 25 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer

Projection transverse de Mercator
Réseau géodésique nord-américain unifié 1927

DÉCLINAISON MAGNÉTIQUE AU CENTRE
DE LA FEUILLE EN 1964 : 26 18' EST
Variation annuelle décroissante 4.6'

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Roads: Routes:

- hard surface, all weather ..... pavée, toute saison ..... more than 2 lanes / plus de 2 voies ; 2 lanes / 2 voies
- hard surface, all weather ..... pavée, toute saison ..... less than 2 lanes / moins de 2 voies
- loose surface, all weather ..... de gravier, toute saison ..... 2 lanes or more / 2 voies ou plus ; less than 2 lanes / moins de 2 voies
- loose surface, dry weather ..... de gravier, période sèche
- cart track ..... de terre
- trail or portage ..... sentier ou portage
- Railway, normal gauge, single track ..... Chemin de fer, voie unique (écartement normal) ..... siding / voie d'évitement ; CNR / CPR
- Horizontal control point, with elevation ..... Point géodésique, avec cote 454
- Bench mark, with elevation ..... Repère de nivellement, avec cote ..... BM 157
- Spot elevation; precise, approximate ..... Point coté; précis, approximatif ..... 450 ± 450 ±

- Building ..... Bâtiment
- School ..... École
- Church ..... Église
- Post Office ..... Bureau de poste ..... P
- Cemetery ..... Cimetière ..... (C)
- Mine or Open cut ..... Mine ou fosse à ciel ouvert
- Lighthouse ..... Phare
- Power transmission line ..... Ligne de transport d'énergie
- River with bridge ..... Rivière avec pont
- Stream, intermittent or dry ..... Cours d'eau intermittent, ou à sec
- Lake intermittent, indefinite ..... Lac intermittent, rive imprécise
- Marsh or Swamp ..... Marais ou marécage
- Depression contours ..... Courbes de cuvette

ECOREGIONS AND ECODISTRICTS IN THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA

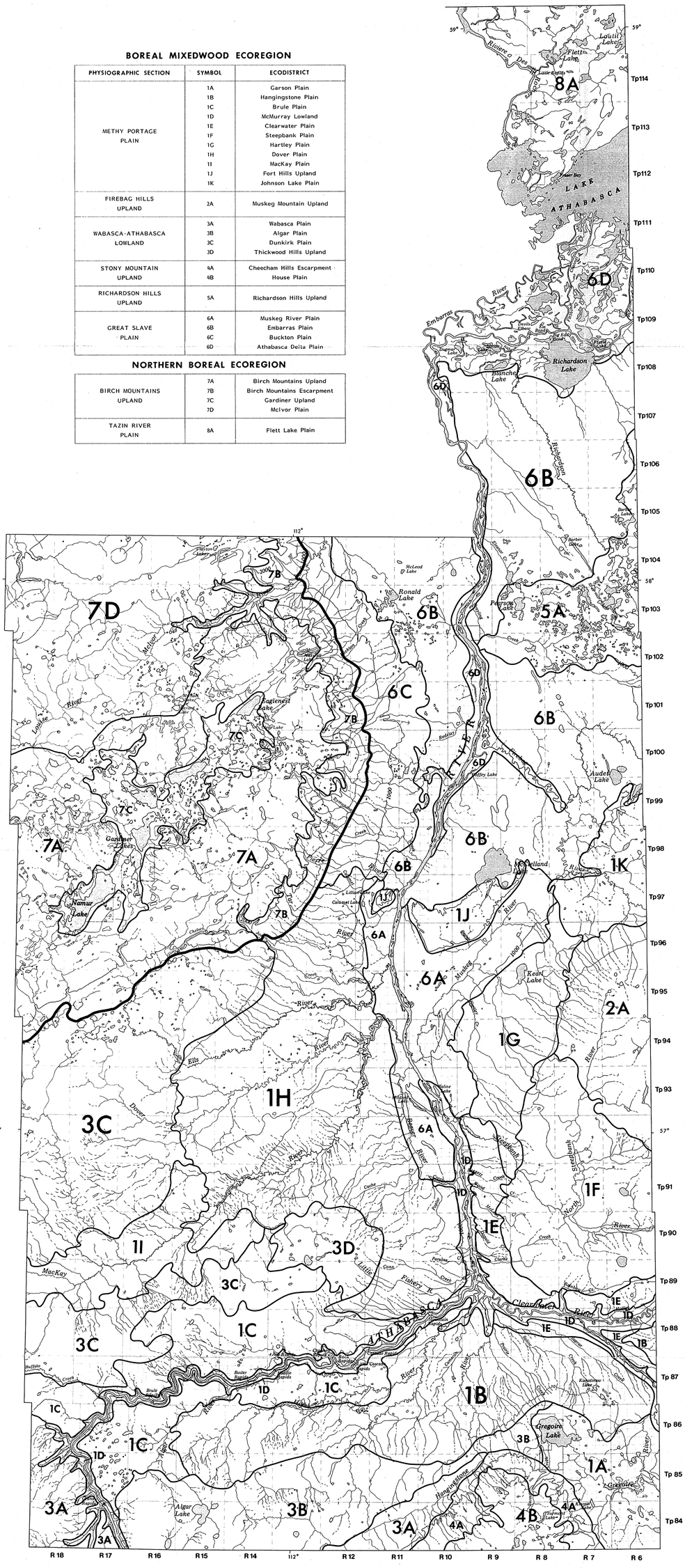
SCALE - 1:500,000

BOREAL MIXEDWOOD ECOREGION

PHYSIOGRAPHIC SECTION	SYMBOL	ECODISTRICT
METHY PORTAGE PLAIN	1A	Garson Plain
	1B	Hangingstone Plain
	1C	Brule Plain
	1D	McMurray Lowland
	1E	Clearwater Plain
	1F	Steepbank Plain
	1G	Hartley Plain
	1H	Dover Plain
	1I	MacKay Plain
	1J	Fort Hills Upland
	1K	Johnson Lake Plain
FIREBAG HILLS UPLAND	2A	Muskeg Mountain Upland
WABASCA-ATHABASCA LOWLAND	3A	Wabasca Plain
	3B	Algar Plain
	3C	Dunkirk Plain
	3D	Thickwood Hills Upland
STONY MOUNTAIN UPLAND	4A	Cheecham Hills Escarpment
	4B	House Plain
RICHARDSON HILLS UPLAND	5A	Richardson Hills Upland
GREAT SLAVE PLAIN	6A	Muskeg River Plain
	6B	Embarras Plain
	6C	Buckton Plain
	6D	Athabasca Delta Plain

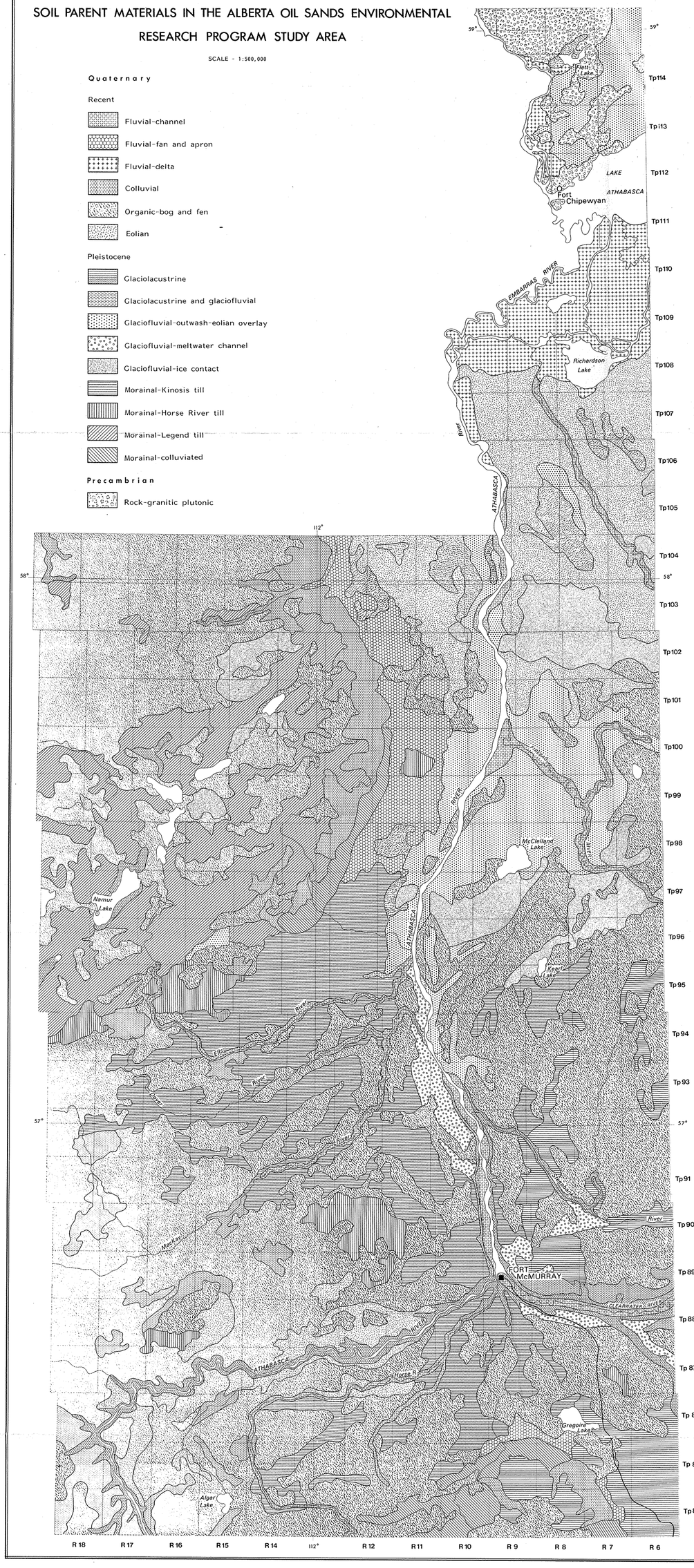
NORTHERN BOREAL ECOREGION

BIRCH MOUNTAINS UPLAND	7A	Birch Mountains Upland
	7B	Birch Mountains Escarpment
	7C	Gardiner Upland
	7D	McIvor Plain
TAZIN RIVER PLAIN	8A	Flett Lake Plain



SOIL PARENT MATERIALS IN THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA

SCALE - 1:500,000

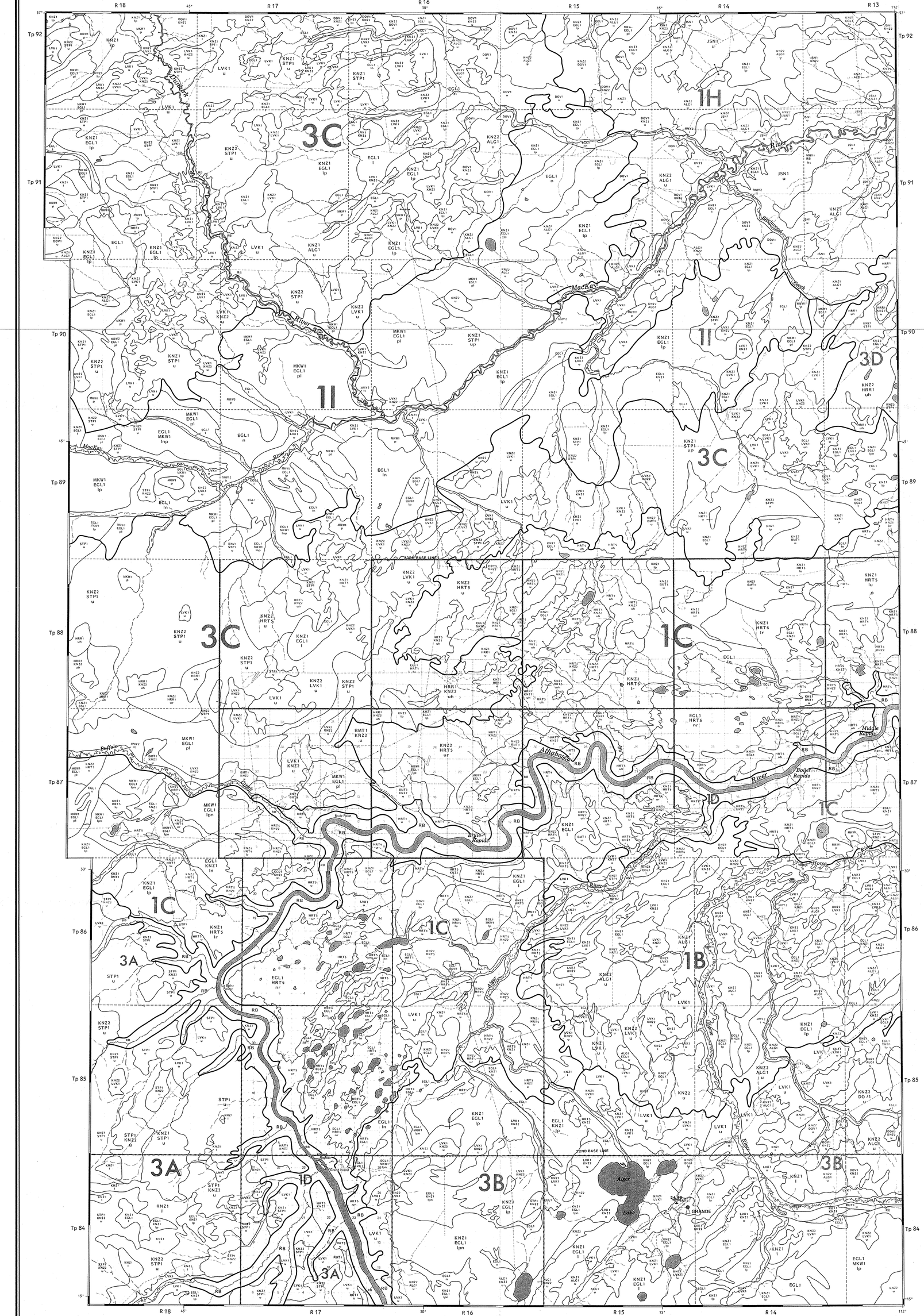


SOIL MAP OF THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA (MAP 1)

SCALE 1 INCH TO 2 MILES OR 1:126,720

2 1 0 2 4 6 8 Miles

2 1 0 2 4 6 8 10 12 Kilometres



LEGEND

SOIL GROUP	GENETIC MATERIAL	SOIL UNIT	DOMINANT SOILS	SIGNIFICANT SOILS	INCLUSIONS	SURFACE EXPRESSION	DRAINAGE CLASS
ALGAR	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	ALG1	peaty Gleysols	Gleyed Gray Luvisol	Orthic Gray Luvisol	Undulating; veneers and blankets; 0 to 5% slopes	Poorly
BITUMOUNT	Eolian and glaciofluvial; sandy; neutral; non to slightly stony	BMT1	peaty Gleysols	Gleyed Eluviated Eutric Brunisol	Eluviated Eutric Brunisol Organics	Undulating; 0 to 5% slopes	Poorly
BUCKTON	Colluvial; loamy to clayey; acid to neutral; non to moderately stony	BKN1	Orthic Gray Luvisol Orthic Regosol		peaty Gleysols Organics bedrock outcrops	Inclined, ridged; 6 to 30% slopes	Well
CHIPEWYAN	Fluvial; delta deposits; loamy; calcareous; non-stony	CPN1	Gleyed Cumulic Regosol	Gleyed Regosol Rego Gleysol	peaty Gleysols Organics	Ridged, undulating; 0 to 5% slopes	Imperfectly
DISTURBED LANDS	Anthropogenic; land disturbed by construction and mining activities	DL	Undifferentiated			Undifferentiated	Variable
DOVER	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	DOV1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Solonetzic Gray Luvisol Organics	Undulating, inclined; veneers and blankets; 0 to 15% slopes	Moderately well to well
EAGLESHAM	Fen; mesic and fibric (fennic) peat; eutic; variable thickness	EGL1	Typic Mesisol	Fibric Mesisol Terric Mesisol Typic Fibrisol	sphagnic Organics peaty Gleysols	Level, ribbed; 0 to 2% slopes	Very poorly
FIREBAG	Glaciofluvial; ice contact deposits; sandy; acid to neutral; moderately to exceedingly stony	FIR1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Hummocky, undulating,(kettled); 2 to 15% slopes	Rapidly
		FIR2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		FIR3	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Hummocky, (kettled, eroded); 6 to 30% slopes	Very rapidly
HEART	Eolian; sandy; acid to neutral; variable thickness; slightly stony in deflated veneer areas	HRT4	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Undulating, hummocky, ridged, (duned); veneers and blankets; 2 to 15% slopes	Rapidly
		HRT5	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		HRT6	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Ridged, hummocky, (duned, eroded); 6 to 30% slopes	Very rapidly
HORSE RIVER	Morainal; loamy to clayey; calcareous; moderately to very stony	HRR1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, hummocky; 2 to 15% slopes	Well
JOSLYN	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	JSN1	Gray Solodized Solonetz	Solonetzic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics Gray Solod	Undulating; veneers and blankets; 0 to 5% slopes	Well to imperfectly
KEARL	Glaciolacustrine; beach ridges; sandy; neutral; non to slightly stony	KEL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics	Ridged; 2 to 9% slopes	Well to rapidly
KENZIE	Bog; fibric (sphagnic and forest) and mesic peat; dysic; variable thickness	KNZ1	Fibric Mesisol	Mesic Fibrisol Typic Fibrisol Fibric Organic Cryosol	Terric Mesisol fennic Organics	Level, plateau, (mounded); 0 to 2% slopes	Very poorly
		KNZ2	Terric Mesisol	Terric Fibric Mesisol Terric Fibrisol Fibric Mesisol	peaty Gleysols fennic Organics	Level, undulating; 0 to 5% slopes	Poorly
KINOSIS	Morainal; loamy; acid to neutral; moderately to exceedingly stony	KNS1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating; 2 to 15% slopes	Well
LEGEND	Morainal; loamy to clayey; acid; moderately to exceedingly stony	LGD1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, ridged; 6 to 15% slopes	Well to imperfectly
LIVOCK	Glaciolacustrine and glaciofluvial over till; loamy; calcareous; non to slightly stony	LVK1	Orthic Gray Luvisol	Brunisolic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating; veneers and blankets; 0 to 5% slopes	Well
MAMAWI	Fluvial; delta deposits; loamy; calcareous; non-stony	MMW1	Rego Gleysol	Gleyed Cumulic Regosol Gleyed Regosol	peaty Gleysols Organics	Level, undulating; 0 to 2% slopes	Poorly
		MMW2	Rego Gleysol		peaty Gleysols	Level; 0 to 0.5% slopes	
McMURRAY	Fluvial; channel deposits; sandy to clayey; neutral to calcareous; non to slightly stony	MMY1	Cumulic Regosol Orthic Regosol	Gleyed Cumulic Regosol peaty Gleysols	Organics	Level, undulating, terraced, inclined; 0 to 5% slopes	Imperfectly
		MMY2	Gleyed Cumulic Regosol peaty Gleysols	Cumulic Regosol Orthic Regosol	Organics	Level, terraced; 0 to 2% slopes	Poorly
MIKKWA	Bog; fibric (sphagnic and forest) and mesic peat; dysic; frozen less than 1m from surface	MKW1	Fibric Organic Cryosol	Mesic Organic Cryosol Typic Fibrisol	fennic Organics	Plateau, inclined, (mounded); 0 to 9% slopes	Very poorly
		MKW2	Terric Mesic Organic Cryosol	Terric Mesisol Mesic Organic Cryosol	fennic Organics		
MILDRED	Glaciofluvial; outwash plains; sandy; acid to neutral; non to moderately stony	MIL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	peaty Gleysols	Undulating; 2 to 9% slopes	Rapidly
		MIL2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
NAMUR	Fluvial; fans and aprons; loamy to clayey; acid to neutral; non to slightly stony	NAM1	Orthic Regosol Cumulic Regosol	Gleyed Regosol peaty Gleysols	Organics	Fan, apron; 0 to 5% slopes	Imperfectly
		NAM2	Gleyed Regosol peaty Gleysols	Orthic Regosol Cumulic Regosol	Organics	Fan, apron, level; 0 to 2% slopes	Poorly to imperfectly
ROCK	Rock outcrops; undifferentiated	R	Non soil		lithic Brunisols Organics	Hummocky; 6 to 30% slopes	Rapidly
ROUGH BROKEN	Undifferentiated; steep, unstable stream banks	RB	Undifferentiated		bedrock outcrops	Inclined, steep; slopes >15%	Rapidly
RUTH LAKE	Glaciofluvial; meltwater channel deposits; sandy and gravelly; acid to neutral; slightly to excessively stony	RUT1	Eluviated Eutric Brunisol Eluviated Dystric Brunisol Orthic Gray Luvisol	Gleyed Eluviated Eutric Brunisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, inclined; 2 to 9% slopes	Moderately well to rapidly
STEEPBANK	Morainal and glaciolacustrine; loamy to clayey; neutral; non to moderately stony	STP1	peaty Gleysols	Gleyed Gray Luvisol Orthic Gray Luvisol	Organics	Undulating, level; 0 to 5% slopes	Poorly
SURMONT	Morainal; colluviated; loamy to clayey; acid; slightly to very stony	SRT1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating, inclined; 2 to 15% slopes	Well

LAND UNITS IN THE BOREAL MIXEDWOOD ECOREGION

PHYSIOGRAPHIC SECTION	SYMBOL	ECODISTRICT
METHY PORTAGE PLAIN	1A	Carson Plain
	1B	Hangingstone Plain
	1C	Brule Plain
	1D	McMurray Lowland
	1E	Clearwater Plain
	1F	Steepbank Plain
	1G	Hartley Plain
	1H	Dover Plain
	1I	MacKay Plain
	1J	Fort Hills Upland
	1K	Johnson Lake Plain
FIREBAG HILLS UPLAND	2A	Muskeg Mountain Upland
WABASCA-ATHABASCA LOWLAND	3A	Wabasca Plain
	3B	Algar Plain
	3C	Dunkirk Plain
	3D	Thickwood Hills Upland
STONY MOUNTAIN UPLAND	4A	Cheechan Hills Escarpment
	4B	House Plain
RICHARDSON HILLS UPLAND	5A	Richardson Hills Upland
GREAT SLAVE PLAIN	6A	Muskeg River Plain
	6B	Embarras Plain
	6C	Buckton Plain
	6D	Athabasca Delta Plain

LAND UNITS IN THE NORTHERN BOREAL ECOREGION

BIRCH MOUNTAINS UPLAND	7A	Birch Mountains Upland
	7B	Birch Mountains Escarpment
	7C	Gardiner Upland
	7D	McIvor Plain
TAZIN RIVER PLAIN	8A	Flett Lake Plain

EXPLANATION OF TERMS

DOMINANT SOILS - constitute over 40% of the soil unit
SIGNIFICANT SOILS - constitute 15 to 40% of the soil unit
INCLUSIONS - constitute less than 15% of the soil unit
DRAINAGE CLASS - predominant drainage class within soil unit; there may be other subdominant classes within a unit

SURFACE EXPRESSION

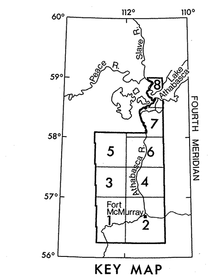
a - apron
f - fan
h - hummocky
i - inclined
l - level
m - rolling
n - ribbed fen
p - plateau bog
r - ridged
s - steep
t - terraced
u - undulating

MAP SYMBOL

HRR1 — dominant soil unit
KNZ2 — subordinate soil unit
uh — surface expression

REFERENCE

SOIL BOUNDARY
ECODISTRICT BOUNDARY
HARD SURFACE - ALL WEATHER
LOOSE SURFACE - ALL WEATHER
LOOSE SURFACE - DRY WEATHER
TRUCK TRAIL
SEISMOGRAPH LINE OR TRAIL
RAILWAY
PIPE LINE
TRANSMISSION LINE
CITY BOUNDARY
PARK BOUNDARY
TOWNSHIP LINE - UNSURVEYED
SURVEYED
SECTION LINE
QUARTER SECTION LINE
FOREST HEADQUARTERS
RANGER STATION
FORESTRY CABIN
LOOKOUT TOWER
RECREATION AREA
AIRSTRIP - REGULAR, OCCASIONAL
RIVER - RAPIDS AND FALLS
RIVER OR CREEK
CREEK - INTERMITTENT
LAKE
DITCH OR CANAL



KEY MAP

alberta canada
ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM
Alberta Environment
Environment Canada

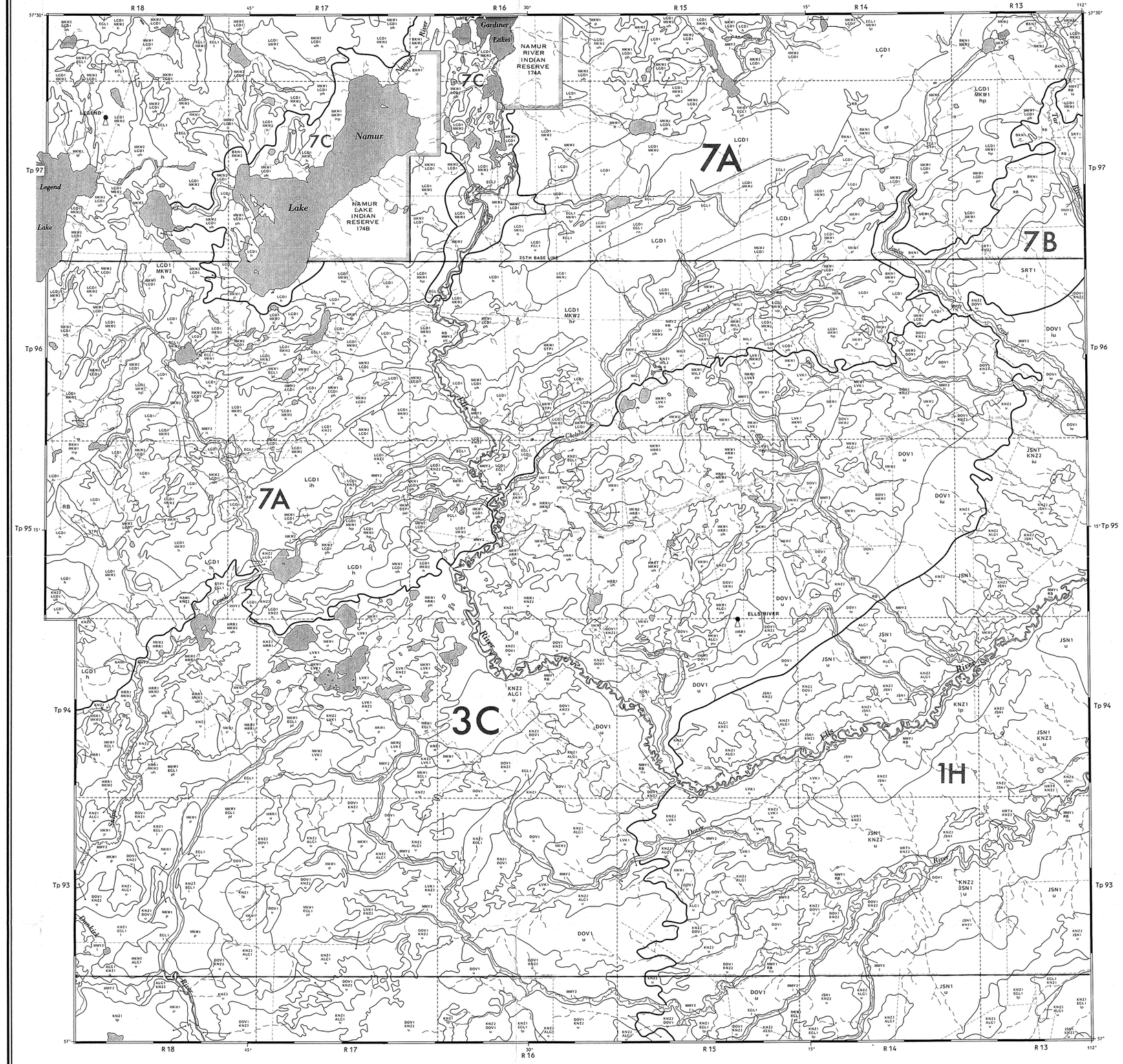
Soil information by the Soils Department, Alberta Research Council. Base map provided by Cartographic Services, Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. Map compiled by the Alberta Research Council and published by the Research Management Division, Alberta Environment. Map to be used with AOSERP Report 122, Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area. Drafted by Z. Widman and J. Diask.

SOIL MAP OF THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA (MAP 3)

SCALE 1 INCH TO 2 MILES OR 1:126,720

2 1 0 2 4 6 8 Miles

2 1 0 2 4 6 8 10 12 Kilometres



LEGEND

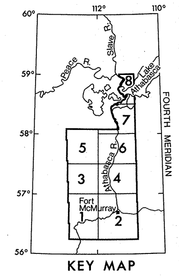
SOIL GROUP	GENETIC MATERIAL	SOIL UNIT	DOMINANT SOILS	SIGNIFICANT SOILS	INCLUSIONS	SURFACE EXPRESSION	DRAINAGE CLASS
ALGAR	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	ALG1	peaty Gleysols	Gleyed Gray Luvisol	Orthic Gray Luvisol	Undulating; veneers and blankets; 0 to 5% slopes	Poorly
BITUMOUNT	Eolian and glaciofluvial; sandy; neutral; non to slightly stony	BMT1	peaty Gleysols	Gleyed Eluviated Eutric Brunisol	Eluviated Eutric Brunisol Organics	Undulating; 0 to 5% slopes	Poorly
BUCKTON	Colluvial; loamy to clayey; acid to neutral; non to moderately stony	BKN1	Orthic Gray Luvisol Orthic Regosol		peaty Gleysols Organics bedrock outcrops	Inclined, ridged; 6 to 30% slopes	Well
CHIPEWYAN	Fluvial; delta deposits; loamy; calcareous; non-stony	CPN1	Gleyed Cumulic Regosol	Gleyed Regosol Rego Gleysol	peaty Gleysols Organics	Ridged, undulating; 0 to 5% slopes	Imperfectly
DISTURBED LANDS	Anthropogenic; land disturbed by construction and mining activities	DL	Undifferentiated			Undifferentiated	Variable
DOVER	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	DOV1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Solonetzic Gray Luvisol Organics	Undulating, inclined; veneers and blankets; 0 to 5% slopes	Moderately well to well
EAGLESHAM	Fen; mesic and fibric (fennic) peat; eutic; variable thickness	ECL1	Typic Mesisol	Fibric Mesisol Terric Mesisol Typic Fibrisol	sphagnic Organics peaty Gleysols	Level, ribbed; 0 to 2% slopes	Very poorly
FIREBAG	Glaciofluvial; ice contact deposits; sandy; acid to neutral; moderately to exceedingly stony	FIR1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Hummocky, undulating,(kettled); 2 to 15% slopes	Rapidly
		FIR2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		FIR3	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Hummocky, (kettled, eroded); 6 to 30% slopes	Very rapidly
HEART	Eolian; sandy; acid to neutral; variable thickness; slightly stony in deflated veneer areas	HRT4	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Undulating, hummocky, ridged, (duned); veneers and blankets; 2 to 15% slopes	Rapidly
		HRT5	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		HRT6	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Ridged, hummocky, (duned, eroded); 6 to 30% slopes	Very rapidly
HORSE RIVER	Morainal; loamy to clayey; calcareous; moderately to very stony	HRR1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, hummocky; 2 to 15% slopes	Well
JOSLYN	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	JSN1	Gray Solodized Solonetz	Solonetzic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics Gray Solod	Undulating; veneers and blankets; 0 to 5% slopes	Well to imperfectly
KEARL	Glaciolacustrine; beach ridges; sandy; neutral; non to slightly stony	KEL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics	Ridged; 2 to 9% slopes	Well to rapidly
KENZIE	Bog; fibric (sphagnic and forest) and mesic peat; dysic; variable thickness	KNZ1	Fibric Mesisol	Mesic Fibrisol Typic Fibrisol Fibric Organic Cryosol	Terric Mesisol fennic Organics	Level, plateau, (mounded); 0 to 2% slopes	Very poorly
		KNZ2	Terric Mesisol	Terric Fibric Mesisol Terric Fibrisol Fibric Mesisol	peaty Gleysols fennic Organics	Level, undulating; 0 to 5% slopes	Poorly
KINOSIS	Morainal; loamy; acid to neutral; moderately to exceedingly stony	KNS1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating; 2 to 15% slopes	Well
LEGEND	Morainal; loamy to clayey; acid; moderately to exceedingly stony	LGD1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, ridged; 6 to 15% slopes	Well to imperfectly
LIVOCK	Glaciolacustrine and glaciofluvial over till; loamy; calcareous; non to slightly stony	LVK1	Orthic Gray Luvisol	Brunisolic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating; veneers and blankets; 0 to 5% slopes	Well
MAMAWI	Fluvial; delta deposits; loamy; calcareous; non-stony	MMW1	Rego Gleysol	Gleyed Cumulic Regosol Gleyed Regosol	peaty Gleysols Organics	Level, undulating; 0 to 2% slopes	Poorly
		MMW2	Rego Gleysol		peaty Gleysols	Level; 0 to 0.5% slopes	
McMURRAY	Fluvial; channel deposits; sandy to clayey; neutral to calcareous; non to slightly stony	MMY1	Cumulic Regosol Orthic Regosol	Gleyed Cumulic Regosol peaty Gleysols	Organics	Level, undulating, terraced, inclined; 0 to 5% slopes	Imperfectly
		MMY2	Gleyed Cumulic Regosol peaty Gleysols	Cumulic Regosol Orthic Regosol	Organics	Level, terraced; 0 to 2% slopes	Poorly
MIKKWA	Bog; fibric (sphagnic and forest) and mesic peat; dysic; frozen less than 1m from surface	MKW1	Fibric Organic Cryosol	Mesic Organic Cryosol Typic Fibrisol	fennic Organics	Plateau, inclined, (mounded); 0 to 9% slopes	Very poorly
		MKW2	Terric Mesic Organic Cryosol	Terric Mesisol Mesic Organic Cryosol	fennic Organics		
MILDRED	Glaciofluvial; outwash plains; sandy; acid to neutral; non to moderately stony	MIL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	peaty Gleysols	Undulating; 2 to 9% slopes	Rapidly
		MIL2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
NAMUR	Fluvial; fans and aprons; loamy to clayey; acid to neutral; non to slightly stony	NAM1	Orthic Regosol Cumulic Regosol	Gleyed Regosol peaty Gleysols	Organics	Fan, apron; 0 to 5% slopes	Imperfectly
		NAM2	Gleyed Regosol peaty Gleysols	Orthic Regosol Cumulic Regosol	Organics	Fan, apron, level; 0 to 2% slopes	Poorly to imperfectly
ROCK	Rock outcrops; undifferentiated	R	Non soil		lithic Brunisols Organics	Hummocky; 6 to 30% slopes	Rapidly
ROUGH BROKEN	Undifferentiated; steep, unstable stream banks	RB	Undifferentiated		bedrock outcrops	Inclined, steep; slopes >15%	Rapidly
RUTH LAKE	Glaciofluvial; meltwater channel deposits; sandy and gravelly; acid to neutral; slightly to excessively stony	RUT1	Eluviated Eutric Brunisol Eluviated Dystric Brunisol Orthic Gray Luvisol	Gleyed Eluviated Eutric Brunisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, inclined; 2 to 9% slopes	Moderately well to rapidly
STEEPBANK	Morainal and glaciolacustrine; loamy to clayey; neutral; non to moderately stony	STP1	peaty Gleysols	Gleyed Gray Luvisol Orthic Gray Luvisol	Organics	Undulating, level; 0 to 5% slopes	Poorly
SURMONT	Morainal; colluviated; loamy to clayey; acid; slightly to very stony	SRT1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating, inclined; 2 to 15% slopes	Well

LAND UNITS IN THE BOREAL MIXEDWOOD ECOREGION

PHYSIOGRAPHIC SECTION	SYMBOL	ECODISTRICT
METHY PORTAGE PLAIN	1A	Garson Plain
	1B	Hangingstone Plain
	1C	Brule Plain
	1D	McMurray Lowland
	1E	Clearwater Plain
	1F	Steepbank Plain
	1G	Hartley Plain
	1H	Dover Plain
	1I	MacKay Plain
	1J	Fort Hills Upland
	1K	Johnson Lake Plain
FIREBAG HILLS UPLAND	2A	Muskeg Mountain Upland
WABASCA-ATHABASCA LOWLAND	3A	Wabasca Plain
	3B	Algar Plain
	3C	Dunkirk Plain
	3D	Thickwood Hills Upland
STONY MOUNTAIN UPLAND	4A	Cheechan Hills Escarpment
	4B	House Plain
RICHARDSON HILLS UPLAND	5A	Richardson Hills Upland
GREAT SLAVE PLAIN	6A	Muskeg River Plain
	6B	Embarras Plain
	6C	Buckton Plain
	6D	Athabasca Delta Plain

LAND UNITS IN THE NORTHERN BOREAL ECOREGION

BIRCH MOUNTAINS UPLAND	7A	Birch Mountains Upland
	7B	Birch Mountains Escarpment
	7C	Gardiner Upland
	7D	McIvor Plain
TAZIN RIVER PLAIN	8A	Flett Lake Plain



KEY MAP

REFERENCE

- SOIL BOUNDARY
- ECODISTRICT BOUNDARY
- HARD SURFACE - ALL WEATHER (5)
- LOOSE SURFACE - ALL WEATHER (51)
- LOOSE SURFACE - DRY WEATHER
- TRUCK TRAIL
- SEISMOGRAPH LINE OR TRAIL
- RAILWAY
- PIPE LINE
- TRANSMISSION LINE
- CITY BOUNDARY
- PARK BOUNDARY
- TOWNSHIP LINE - UNSURVEYED
- SURVEYED
- SECTION LINE
- QUARTER SECTION LINE (8 — 1)
- FOREST HEADQUARTERS (FH)
- RANGER STATION (RS)
- FORESTRY CABIN
- LOOKOUT TOWER
- RECREATION AREA
- AIRSTRIP - REGULAR, OCCASIONAL (35_17, 24_14)
- RIVER - RAPIDS AND FALLS
- RIVER OR CREEK
- CREEK - INTERMITTENT
- LAKE
- DITCH OR CANAL

EXPLANATION OF TERMS

DOMINANT SOILS - constitute over 40% of the soil unit
SIGNIFICANT SOILS - constitute 15 to 40% of the soil unit
INCLUSIONS - constitute less than 15% of the soil unit
DRAINAGE CLASS - predominant drainage class within soil unit; there may be other subdominant classes within a unit

SURFACE EXPRESSION

a - apron
f - fan
h - hummocky
i - inclined
l - level
m - rolling
n - ribbed fen
p - plateau bog
r - ridged
s - steep
t - terraced
u - undulating

MAP SYMBOL

HRR1 — dominant soil unit
KNZ2 — subordinate soil unit
s/h — surface expression

ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Alberta Environment Environnement Canada

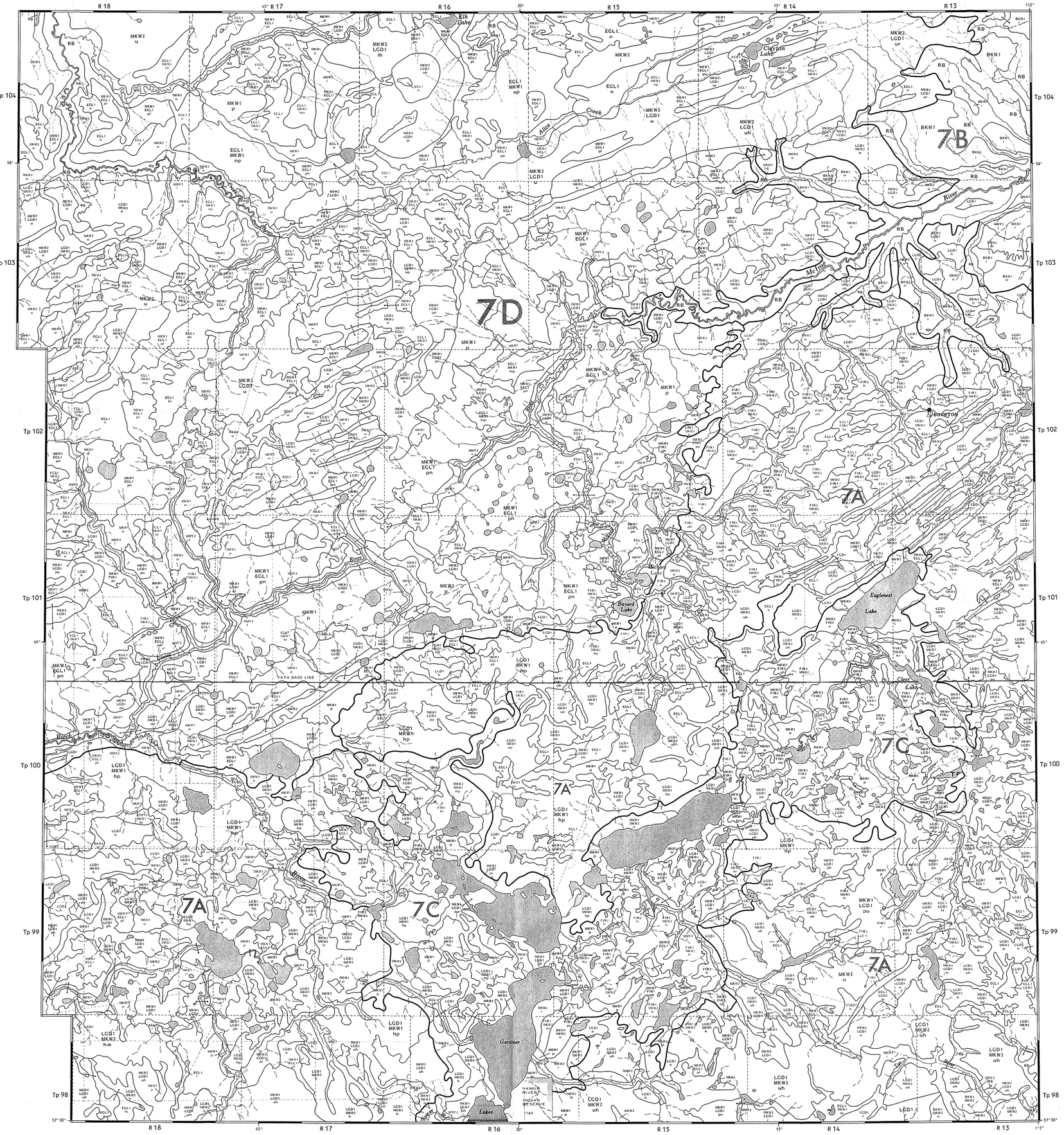
Soil information by the Soils Department, Alberta Research Council. Base map provided by Cartographic Services, Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. Map compiled by the Alberta Research Council and published by the Research Management Division, Alberta Environment. Map to be used with AOSERP Report 122, Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area. Drafted by Z. Widman and J. Olask.

SOIL MAP OF THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA (MAP 5)

SCALE 1 INCH TO 2 MILES OR 1:126,720

2 1 0 2 4 6 8 Miles

2 1 0 2 4 6 8 10 12 Kilometres



LEGEND

SOIL GROUP	GENETIC MATERIAL	SOIL UNIT	DOMINANT SOILS	SIGNIFICANT SOILS	INCLUSIONS	SURFACE EXPRESSION	DRAINAGE CLASS
ALGAR	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	ALG1	peaty Gleysols	Gleyed Gray Luvisol	Orthic Gray Luvisol	Undulating; veneers and blankets; 0 to 5% slopes	Poorly
BITUMOUNT	Eolian and glaciofluvial; sandy; neutral; non to slightly stony	BMT1	peaty Gleysols	Gleyed Eluviated Eutric Brunisol	Eluviated Eutric Brunisol Organics	Undulating; 0 to 5% slopes	Poorly
BUCKTON	Colluvial; loamy to clayey; acid to neutral; non to moderately stony	BKN1	Orthic Gray Luvisol Orthic Regosol		peaty Gleysols Organics bedrock outcrops	Inclined, ridged; 6 to 30% slopes	Well
CHIPEWYAN	Fluvial; delta deposits, loamy; calcareous; non-stony	CPN1	Gleyed Cumulic Regosol	Gleyed Regosol Rego Gleysol	peaty Gleysols Organics	Ridged, undulating; 0 to 5% slopes	Imperfectly
DISTURBED LANDS	Anthropogenic; land disturbed by construction and mining activities	DL	Undifferentiated			Undifferentiated	Variable
DOVER	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	DOV1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Solonetzic Gray Luvisol Organics	Undulating, inclined; veneers and blankets; 0 to 5% slopes	Moderately well to well
EAGLESHAM	Fen; mesic and fibric (fennic) peat, eutic, variable thickness	EGL1	Typic Mesisol	Fibric Mesisol Terric Mesisol Typic Fibrisol	sphagnic Organics peaty Gleysols	Level, ribbed; 0 to 2% slopes	Very poorly
FIREBAG	Glaciofluvial; ice contact deposits; sandy; acid to neutral; moderately to exceedingly stony	FIR1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Hummocky, undulating,(kettled); 2 to 15% slopes	Rapidly
		FIR2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		FIR3	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Hummocky, (kettled, eroded); 6 to 30% slopes	Very rapidly
HEART	Eolian; sandy; acid to neutral; variable thickness; slightly stony in deflated veneer areas	HRT4	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Undulating, hummocky, ridged, (duned); veneers and blankets; 2 to 15% slopes	Rapidly
		HRT5	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		HRT6	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Ridged, hummocky, (duned, eroded); 6 to 30% slopes	Very rapidly
HORSE RIVER	Morainal; loamy to clayey; calcareous; moderately to very stony	HRR1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, hummocky; 2 to 15% slopes	Well
JOSLYN	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	JSN1	Gray Solodized Solonetz	Solonetzic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics Gray Solod	Undulating; veneers and blankets; 0 to 5% slopes	Well to imperfectly
KEARL	Glaciolacustrine; beach ridges; sandy; neutral; non to slightly stony	KEL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics	Ridged; 2 to 9% slopes	Well to rapidly
KENZIE	Bog; fibric (sphagnic and forest) and mesic peat; dysic; variable thickness	KNZ1	Fibric Mesisol	Mesic Fibrisol Typic Fibrisol Fibric Organic Cryosol	Terric Mesisol fennic Organics	Level, plateau, (mounded); 0 to 2% slopes	Very poorly
		KNZ2	Terric Mesisol	Terric Fibric Mesisol Terric Fibrisol Fibric Mesisol	peaty Gleysols fennic Organics	Level, undulating; 0 to 5% slopes	Poorly
KINOSIS	Morainal; loamy; acid to neutral; moderately to exceedingly stony	KNS1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating; 2 to 15% slopes	Well
LEGEND	Morainal; loamy to clayey; acid; moderately to exceedingly stony	LGD1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, ridged; 6 to 15% slopes	Well to imperfectly
LIVOCK	Glaciolacustrine and glaciofluvial over till; loamy; calcareous; non to slightly stony	LVK1	Orthic Gray Luvisol	Brunisolic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating; veneers and blankets; 0 to 5% slopes	Well
MAMAWI	Fluvial; delta deposits; loamy; calcareous; non-stony	MMW1	Rego Gleysol	Gleyed Cumulic Regosol Gleyed Regosol	peaty Gleysols Organics	Level, undulating; 0 to 2% slopes	Poorly
		MMW2	Rego Gleysol		peaty Gleysols	Level; 0 to 0.5% slopes	
McMURRAY	Fluvial; channel deposits; sandy to clayey; neutral to calcareous; non to slightly stony	MMY1	Cumulic Regosol Orthic Regosol	Gleyed Cumulic Regosol peaty Gleysols	Organics	Level, undulating, terraced, inclined; 0 to 5% slopes	Imperfectly
		MMY2	Gleyed Cumulic Regosol peaty Gleysols	Cumulic Regosol Orthic Regosol	Organics	Level, terraced; 0 to 2% slopes	Poorly
MIKKWA	Bog; fibric (sphagnic and forest) and mesic peat; dysic; frozen less than 1m from surface	MKW1	Fibric Organic Cryosol	Mesic Organic Cryosol Typic Fibrisol	fennic Organics	Plateau, inclined, (mounded); 0 to 9% slopes	Very poorly
		MKW2	Terric Mesic Organic Cryosol	Terric Mesisol Mesic Organic Cryosol	fennic Organics		
MILDRED	Glaciofluvial; outwash plains; sandy; acid to neutral; non to moderately stony	MIL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	peaty Gleysols	Undulating; 2 to 9% slopes	Rapidly
		MIL2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
NAMUR	Fluvial; fans and aprons; loamy to clayey; acid to neutral; non to slightly stony	NAM1	Orthic Regosol Cumulic Regosol	Gleyed Regosol peaty Gleysols	Organics	Fan, apron; 0 to 5% slopes	Imperfectly
		NAM2	Gleyed Regosol peaty Gleysols	Orthic Regosol Cumulic Regosol	Organics	Fan, apron, level; 0 to 2% slopes	Poorly to imperfectly
ROCK	Rock outcrops; undifferentiated	R	Non soil		lithic Brunisols Organics	Hummocky; 6 to 30% slopes	Rapidly
ROUGH BROKEN	Undifferentiated; steep, unstable stream banks	RB	Undifferentiated		bedrock outcrops	Inclined, steep; slopes >15%	Rapidly
RUTH LAKE	Glaciofluvial; meltwater channel deposits; sandy and gravelly; acid to neutral; slightly to excessively stony	RUT1	Eluviated Eutric Brunisol Eluviated Dystric Brunisol Orthic Gray Luvisol	Gleyed Eluviated Eutric Brunisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, inclined; 2 to 9% slopes	Moderately well to rapidly
STEEPBANK	Morainal and glaciolacustrine; loamy to clayey; neutral; non to moderately stony	STP1	peaty Gleysols	Gleyed Gray Luvisol Orthic Gray Luvisol	Organics	Undulating, level; 0 to 5% slopes	Poorly
SURMONT	Morainal; colluviated; loamy to clayey; acid; slightly to very stony	SRT1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating, inclined; 2 to 15% slopes	Well

LAND UNITS IN THE BOREAL MIXEDWOOD ECOREGION

PHYSIOGRAPHIC SECTION	SYMBOL	ECODISTRICT
METHY PORTAGE PLAIN	1A	Garson Plain
	1B	Hangingstone Plain
	1C	Bryde Plain
	1D	McMurray Lowland
	1E	Clearwater Plain
	1F	Steepbank Plain
	1G	Hartley Plain
	1H	Dover Plain
	1I	MacKay Plain
	1J	Fort Hills Upland
	1K	Johnson Lake Plain
FIREBAG HILLS UPLAND	2A	Muskeg Mountain Upland
WABASCA-ATHABASCA LOWLAND	3A	Wabasca Plain
	3B	Algar Plain
	3C	Dunkirk Plain
	3D	Thickwood Hills Upland
STONY MOUNTAIN UPLAND	4A	Cheecham Hills Escarpment
	4B	House Plain
RICHARDSON HILLS UPLAND	5A	Richardson Hills Upland
GREAT SLAVE PLAIN	6A	Muskeg River Plain
	6B	Embarras Plain
	6C	Buckton Plain
	6D	Athabasca Delta Plain

LAND UNITS IN THE NORTHERN BOREAL ECOREGION

BIRCH MOUNTAINS UPLAND	7A	Birch Mountains Upland
	7B	Birch Mountains Escarpment
	7C	Gardiner Upland
	7D	McIver Plain
TAZIN RIVER PLAIN	8A	Flett Lake Plain

REFERENCE

SOIL BOUNDARY	TRANSMISSION LINE	FORESTRY CABIN
ECODISTRICT BOUNDARY	CITY BOUNDARY	LOOKOUT TOWER
HARD SURFACE - ALL WEATHER	PARK BOUNDARY	RECREATION AREA
LOOSE SURFACE - ALL WEATHER	TOWNSHIP LINE - UNSURVEYED	AIRSTRIP - REGULAR, OCCASIONAL
LOOSE SURFACE - DRY WEATHER	SURVEYED	RIVER - RAPIDS AND FALLS
TRUCK TRAIL	SECTION LINE	RIVER OR CREEK
SEISMOGRAPH LINE OR TRAIL	QUARTER SECTION LINE	CREEK - INTERMITTENT
RAILWAY	FOREST HEADQUARTERS	LAKE
PIPE LINE	RANGER STATION	DITCH OR CANAL

EXPLANATION OF TERMS

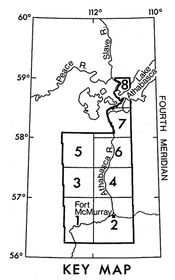
DOMINANT SOILS - constitute over 40% of the soil unit
SIGNIFICANT SOILS - constitute 15 to 40% of the soil unit
INCLUSIONS - constitute less than 15% of the soil unit
DRAINAGE CLASS - predominant drainage class within soil unit; there may be other subdominant classes within a unit

SURFACE EXPRESSION

a - apron
f - fan
h - hummocky
i - inclined
l - level
m - rolling
n - ribbed fen
p - plateau bog
r - ridged
s - steep
t - terraced
u - undulating

MAP SYMBOL

HRR1 — dominant soil unit
KNZ1 — subordinate soil unit
uh — surface expression



KEY MAP

alberta canada
ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM
Alberta ENVIRONMENT
Environment Canada
Environnement Canada

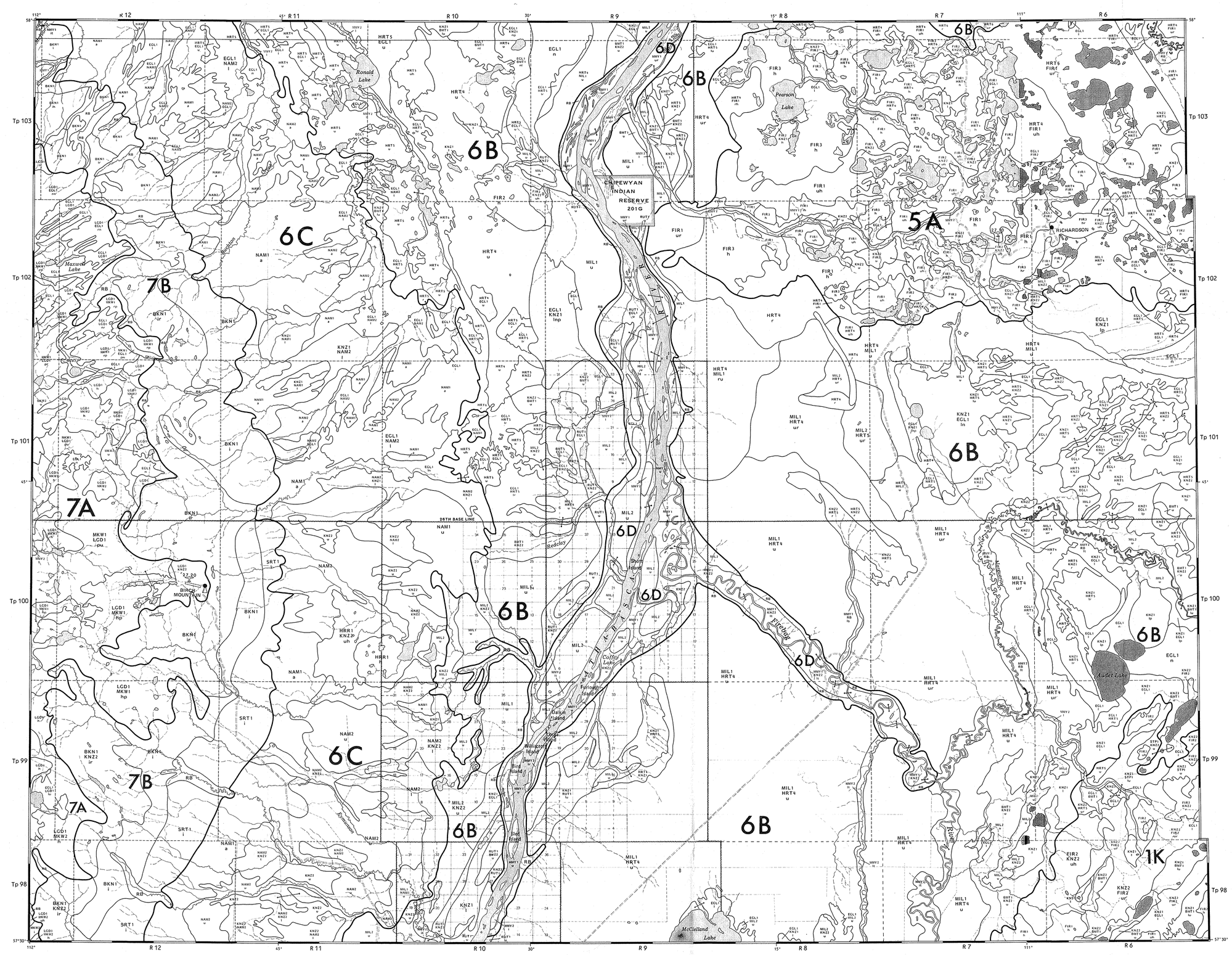
Soil information by the Soils Department, Alberta Research Council. Base map provided by Cartographic Services, Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. Map compiled by the Alberta Research Council and published by the Research Management Division, Alberta Environment. Map to be used with Alberta Report 32?, Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area. Drafted by Z. Holtman and J. Glaza.

SOIL MAP OF THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA (MAP 6)

SCALE 1 INCH TO 2 MILES OR 1:126,720

2 1 0 2 4 6 8 Miles

2 1 0 2 4 6 8 10 12 Kilometres



LEGEND

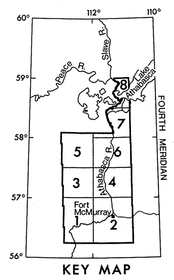
SOIL GROUP	GENETIC MATERIAL	SOIL UNIT	DOMINANT SOILS	SIGNIFICANT SOILS	INCLUSIONS	SURFACE EXPRESSION	DRAINAGE CLASS
ALGAR	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	ALG1	peaty Gleysols	Gleyed Gray Luvisol	Orthic Gray Luvisol	Undulating; veneers and blankets; 0 to 5% slopes	Poorly
BITUMOUNT	Eolian and glaciofluvial; sandy; neutral; non to slightly stony	BMT1	peaty Gleysols	Gleyed Eluviated Eutric Brunisol	Eluviated Eutric Brunisol Organics	Undulating; 0 to 5% slopes	Poorly
BUCKTON	Colluvial; loamy to clayey; acid to neutral; non to moderately stony	BKN1	Orthic Gray Luvisol Orthic Regosol		peaty Gleysols Organics bedrock outcrops	Inclined, ridged; 4 to 30% slopes	Well
CHIPEWYAN	Fluvial; delta deposits, loamy; calcareous; non-stony	CPN1	Gleyed Cumulic Regosol	Gleyed Regosol Rego Gleysol	peaty Gleysols Organics	Ridged, undulating; 0 to 5% slopes	Imperfectly
DISTURBED LANDS	Anthropogenic; land disturbed by construction and mining activities	DL	Undifferentiated			Undifferentiated	Variable
DOVER	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	DOV1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Solonetzic Gray Luvisol Organics	Undulating, inclined; veneers and blankets; 0 to 5% slopes	Moderately well to well
EAGLESHAM	Fen; mesic and fibric (fennic) peat; eutic; variable thickness	EGL1	Typic Mesisol	Fibric Mesisol Terric Mesisol Typic Fibrisol	sphagnic Organics peaty Gleysols	Level, ribbed; 0 to 2% slopes	Very poorly
FIREBAG	Glaciofluvial; ice contact deposits; sandy; acid to neutral; moderately to exceedingly stony	FIR1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Hummocky, undulating,(kettled); 2 to 15% slopes	Rapidly
		FIR2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		FIR3	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Hummocky, (kettled, eroded); 6 to 30% slopes	Very rapidly
HEART	Eolian; sandy; acid to neutral; variable thickness; slightly stony in deflated veneer areas	HRT4	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Undulating, hummocky, ridged, (duned); veneers and blankets; 2 to 15% slopes	Rapidly
		HRT5	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		HRT6	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Ridged, hummocky, (duned, eroded); 6 to 30% slopes	Very rapidly
HORSE RIVER	Morainal; loamy to clayey; calcareous; moderately to very stony	HRR1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, hummocky; 2 to 15% slopes	Well
JOSLYN	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	JSN1	Gray Solodized Solonetz	Solonetzic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics Gray Solod	Undulating; veneers and blankets; 0 to 5% slopes	Well to imperfectly
KEARL	Glaciolacustrine; beach ridges; sandy; neutral; non to slightly stony	KEL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics	Ridged; 2 to 9% slopes	Well to rapidly
KENZIE	Bog; fibric (sphagnic and forest) and mesic peat; dysic; variable thickness	KNZ1	Fibric Mesisol	Mesic Fibrisol Typic Fibrisol Fibric Organic Cryosol	Terric Mesisol fennic Organics	Level, plateau, (mounded); 0 to 2% slopes	Very poorly
		KNZ2	Terric Mesisol	Terric Fibric Mesisol Terric Fibrisol Fibric Mesisol	peaty Gleysols fennic Organics	Level, undulating; 0 to 5% slopes	Poorly
KINOSIS	Morainal; loamy; acid to neutral; moderately to exceedingly stony	KNS1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating; 2 to 15% slopes	Well
LEGEND	Morainal; loamy to clayey; acid; moderately to exceedingly stony	LGD1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, ridged; 6 to 15% slopes	Well to imperfectly
LIVOCK	Glaciolacustrine and glaciofluvial over till; loamy; calcareous; non to slightly stony	LVK1	Orthic Gray Luvisol	Brunisolic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating; veneers and blankets; 0 to 5% slopes	Well
MAMAWI	Fluvial; delta deposits; loamy; calcareous; non-stony	MMW1	Rego Gleysol	Gleyed Cumulic Regosol Gleyed Regosol	peaty Gleysols Organics	Level, undulating; 0 to 2% slopes	Poorly
		MMW2	Rego Gleysol		peaty Gleysols	Level; 0 to 0.5% slopes	
McMURRAY	Fluvial; channel deposits; sandy to clayey; neutral to calcareous, non to slightly stony	MMY1	Cumulic Regosol Orthic Regosol	Gleyed Cumulic Regosol peaty Gleysols	Organics	Level, undulating, terraced, inclined; 0 to 5% slopes	Imperfectly
		MMY2	Gleyed Cumulic Regosol	Cumulic Regosol Orthic Regosol	Organics	Level, terraced; 0 to 2% slopes	Poorly
MIKKWA	Bog; fibric (sphagnic and forest) and mesic peat; dysic; frozen less than 1m from surface	MKW1	Fibric Organic Cryosol	Mesic Organic Cryosol Typic Fibrisol	fennic Organics	Plateau, inclined, (mounded); 0 to 9% slopes	Very poorly
		MKW2	Terric Mesic Organic Cryosol	Terric Mesisol Mesic Organic Cryosol	fennic Organics		
MILDRED	Glaciofluvial; outwash plains; sandy; acid to neutral; non to moderately stony	MIL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	peaty Gleysols	Undulating; 2 to 9% slopes	Rapidly
		MIL2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
NAMUR	Fluvial; fans and aprons; loamy to clayey; acid to neutral; non to slightly stony	NAM1	Orthic Regosol Cumulic Regosol	Gleyed Regosol peaty Gleysols	Organics	Fan, apron; 0 to 5% slopes	Imperfectly
		NAM2	Gleyed Regosol peaty Gleysols	Orthic Regosol Cumulic Regosol	Organics	Fan, apron, level; 0 to 2% slopes	Poorly to imperfectly
ROCK	Rock outcrops; undifferentiated	R	Non soil		Lithic Brunisols Organics	Hummocky; 6 to 30% slopes	Rapidly
ROUGH BROKEN	Undifferentiated; steep, unstable stream banks	RB	Undifferentiated		bedrock outcrops	Inclined, steep; slopes >15%	Rapidly
RUTH LAKE	Glaciofluvial; meltwater channel deposits; sandy and gravelly; acid to neutral; slightly to excessively stony	RUT1	Eluviated Eutric Brunisol Eluviated Dystric Brunisol Orthic Gray Luvisol	Gleyed Eluviated Eutric Brunisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, inclined; 2 to 9% slopes	Moderately well to rapidly
STEEPBANK	Morainal and glaciolacustrine; loamy to clayey; neutral; non to moderately stony	STP1	peaty Gleysols	Gleyed Gray Luvisol Orthic Gray Luvisol	Organics	Undulating, level; 0 to 5% slopes	Poorly
SURMONT	Morainal; colluviated; loamy to clayey; acid; slightly to very stony	SRT1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating, inclined; 2 to 15% slopes	Well

LAND UNITS IN THE BOREAL MIXEDWOOD ECOREGION

PHYSIOGRAPHIC SECTION	SYMBOL	ECODISTRICT
METHY PORTAGE PLAIN	1A	Carson Plain
	1B	Hangingstone Plain
	1C	Brule Plain
	1D	McMurray Lowland
	1E	Clearwater Plain
	1F	Steepbank Plain
	1G	Hartley Plain
	1H	Dover Plain
	1I	MacKay Plain
	1J	Fort Hills Upland
	1K	Johnson Lake Plain
FIREBAG HILLS UPLAND	2A	Muskeg Mountain Upland
WABASCA-ATHABASCA LOWLAND	3A	Wabasca Plain
	3B	Algar Plain
	3C	Dunkirk Plain
	3D	Thickwood Hills Upland
STONY MOUNTAIN UPLAND	4A	Cheecham Hills Escarpment
	4B	House Plain
RICHARDSON HILLS UPLAND	5A	Richardson Hills Upland
CREAT SLAVE PLAIN	6A	Muskeg River Plain
	6B	Embarras Plain
	6C	Buckton Plain
	6D	Athabasca Delta Plain

LAND UNITS IN THE NORTHERN BOREAL ECOREGION

BIRCH MOUNTAINS UPLAND	7A	Birch Mountains Upland
	7B	Birch Mountains Escarpment
	7C	Gardiner Upland
	7D	McIvor Plain
TAZIN RIVER PLAIN	8A	Flett Lake Plain



REFERENCE

SOIL BOUNDARY
ECODISTRICT BOUNDARY
HARD SURFACE - ALL WEATHER
LOOSE SURFACE - ALL WEATHER
LOOSE SURFACE - DRY WEATHER
TRUCK TRAIL
SEISMOGRAPH LINE OR TRAIL
RAILWAY
PIPE LINE
TRANSMISSION LINE
CITY BOUNDARY
PARK BOUNDARY
TOWNSHIP LINE - UNSURVEYED
SURVEYED
SECTION LINE
QUARTER SECTION LINE
FOREST HEADQUARTERS
RANGER STATION
FORESTRY CABIN
LOOKOUT TOWER
RECREATION AREA
AIRSTRIP - REGULAR, OCCASIONAL (35-17, 24-14)
RIVER - RAPIDS AND FALLS
RIVER OR CREEK
CREEK - INTERMITTENT
LAKE
DITCH OR CANAL

EXPLANATION OF TERMS

DOMINANT SOILS - constitute over 40% of the soil unit
SIGNIFICANT SOILS - constitute 15 to 40% of the soil unit
INCLUSIONS - constitute less than 15% of the soil unit
DRAINAGE CLASS - predominant drainage class within soil unit; there may be other subdominant classes within a unit

SURFACE EXPRESSION

a - apron
f - fan
h - humocky
i - inclined
l - level
m - rolling
n - ribbed fen
p - plateau bog
r - ridged
s - steep
t - terraced
u - undulating

MAP SYMBOL

HRR1 — dominant soil unit
KNZ2 — subordinate soil unit
wh — surface expression

alberta canada
ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM
Alberta Environment
Environment Canada Environnement Canada

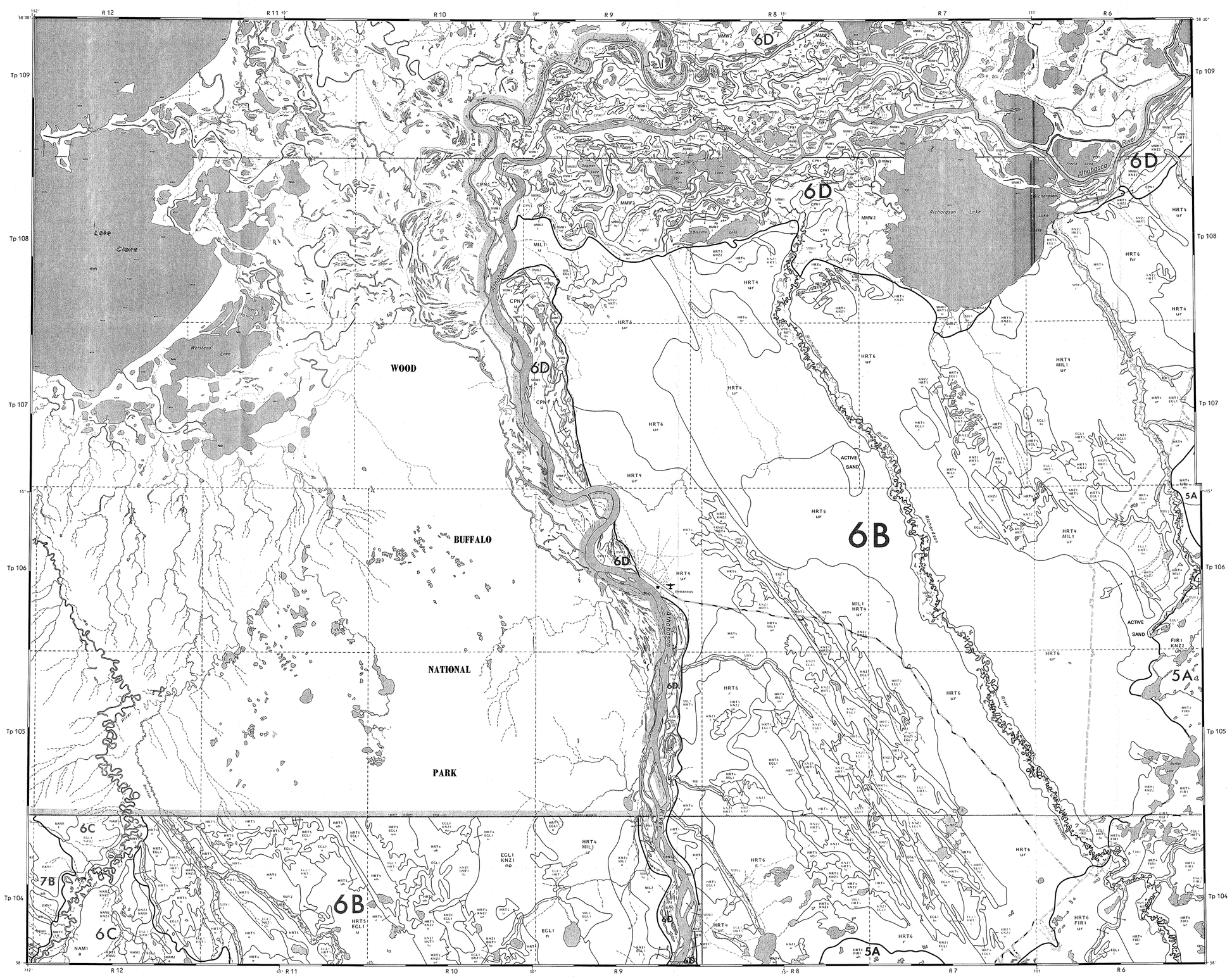
Soil information by the Soils Department, Alberta Research Council. Base map provided by Cartographic Services, Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. Map compiled by the Alberta Research Council and published by the Research Management Division, Alberta Environment. Map to be used with AOSERP Report 122, Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area. Drafted by Z. Waltman and J. Dlask.

SOIL MAP OF THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA (MAP 7)

SCALE 1 INCH TO 2 MILES OR 1:126,720

2 1 0 2 4 6 8 Miles

2 1 0 2 4 6 8 10 12 Kilometres



LEGEND

SOIL GROUP	GENETIC MATERIAL	SOIL UNIT	DOMINANT SOILS	SIGNIFICANT SOILS	INCLUSIONS	SURFACE EXPRESSION	DRAINAGE CLASS
ALGAR	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	ALG1	peaty Gleysols	Gleyed Gray Luvisol	Orthic Gray Luvisol	Undulating; veneers and blankets; 0 to 5% slopes	Poorly
BITUMOUNT	Eolian and glaciofluvial; sandy; neutral; non to slightly stony	BMT1	peaty Gleysols	Gleyed Eluviated Eutric Brunisol	Eluviated Eutric Brunisol Organics	Undulating; 0 to 5% slopes	Poorly
BUCKTON	Colluvial; loamy to clayey; acid to neutral; non to moderately stony	BKN1	Orthic Gray Luvisol Orthic Regosol		peaty Gleysols Organics bedrock outcrops	Inclined, ridged; 6 to 30% slopes	Well
CHIPEWYAN	Fluvial; delta deposits, loamy; calcareous; non-stony	CPN1	Gleyed Cumulic Regosol	Gleyed Regosol Rego Gleysol	peaty Gleysols Organics	Ridged, undulating; 0 to 5% slopes	Imperfectly
DISTURBED LANDS	Anthropogenic, land disturbed by construction and mining activities	DL	Undifferentiated			Undifferentiated	Variable
DOVER	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	DOV1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Solonetzic Gray Luvisol Organics	Undulating, inclined; veneers and blankets; 0 to 5% slopes	Moderately well to well
EAGLESHAM	Fen; mesic and fibric (fennic) peat; eutic; variable thickness	EGL1	Typic Mesisol	Fibric Mesisol Terric Mesisol Typic Fibrisol	sphagnic Organics peaty Gleysols	Level, ribbed; 0 to 2% slopes	Very poorly
FIREBAG	Glaciofluvial; ice contact deposits; sandy; acid to neutral; moderately to exceedingly stony	FIR1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Hummocky, undulating,(kettled); 2 to 15% slopes	Rapidly
		FIR2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		FIR3	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Hummocky, (kettled, eroded); 6 to 30% slopes	Very rapidly
HEART	Eolian; sandy; acid to neutral; variable thickness; slightly stony in deflated veneer areas	HRT4	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Undulating, hummocky, ridged, (duned); veneers and blankets; 2 to 15% slopes	Rapidly
		HRT5	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		HRT6	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Ridged, hummocky, (duned, eroded); 6 to 30% slopes	Very rapidly
HORSE RIVER	Morainal; loamy to clayey; calcareous; moderately to very stony	HRR1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, hummocky; 2 to 15% slopes	Well
JOSLYN	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	JSN1	Gray Solodized Solonetz	Solonetzic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics Gray Solod	Undulating; veneers and blankets; 0 to 5% slopes	Well to imperfectly
KEARL	Glaciolacustrine; beach ridges; sandy; neutral; non to slightly stony	KEL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics	Ridged; 2 to 9% slopes	Well to rapidly
KENZIE	Bog; fibric (sphagnic and forest) and mesic peat; dysic; variable thickness	KNZ1	Fibric Mesisol	Mesic Fibrisol Typic Fibrisol Fibric Organic Cryosol	Terric Mesisol fennic Organics	Level, plateau, (mounded); 0 to 2% slopes	Very poorly
		KNZ2	Terric Mesisol	Terric Fibric Mesisol Terric Fibrisol Fibric Mesisol	peaty Gleysols fennic Organics	Level, undulating; 0 to 5% slopes	Poorly
KINGSIS	Morainal; loamy; acid to neutral; moderately to exceedingly stony	KNS1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating; 2 to 15% slopes	Well
LEGEND	Morainal; loamy to clayey; acid; moderately to exceedingly stony	LGD1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, ridged; 6 to 15% slopes	Well to imperfectly
LIVOCK	Glaciolacustrine and glaciofluvial over till; loamy; calcareous; non to slightly stony	LVK1	Orthic Gray Luvisol	Brunisolic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating; veneers and blankets; 0 to 5% slopes	Well
MAMAWI	Fluvial; delta deposits; loamy; calcareous; non-stony	MMW1	Rego Gleysol	Gleyed Cumulic Regosol Gleyed Regosol	peaty Gleysols Organics	Level, undulating; 0 to 2% slopes	Poorly
		MMW2	Rego Gleysol		peaty Gleysols	Level; 0 to 0.5% slopes	
McMURRAY	Fluvial; channel deposits; sandy to clayey; neutral to calcareous; non to slightly stony	MMY1	Cumulic Regosol Orthic Regosol	Gleyed Cumulic Regosol peaty Gleysols	Organics	Level, undulating, terraced, inclined; 0 to 5% slopes	Imperfectly
		MMY2	Gleyed Cumulic Regosol peaty Gleysols	Cumulic Regosol Orthic Regosol	Organics	Level, terraced; 0 to 2% slopes	Poorly
MIKKWA	Bog; fibric (sphagnic and forest) and mesic peat; dysic; frozen less than 1m from surface	MKW1	Fibric Organic Cryosol	Mesic Organic Cryosol Typic Fibrisol	fennic Organics	Plateau, inclined, (mounded); 0 to 9% slopes	Very poorly
		MKW2	Terric Mesic Organic Cryosol	Terric Mesisol Mesic Organic Cryosol	fennic Organics		
MILDRED	Glaciofluvial; outwash plains; sandy; acid to neutral; non to moderately stony	MIL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	peaty Gleysols	Undulating; 2 to 9% slopes	Rapidly
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NAMUR	Fluvial; fans and aprons; loamy to clayey; acid to neutral; non to slightly stony	NAM1	Orthic Regosol Cumulic Regosol	Gleyed Regosol peaty Gleysols	Organics	Fan, apron; 0 to 5% slopes	Imperfectly
		NAM2	Gleyed Regosol peaty Gleysols	Orthic Regosol Cumulic Regosol	Organics	Fan, apron, level; 0 to 2% slopes	Poorly to imperfectly
ROCK	Rock outcrops; undifferentiated	R	Non soil		lithic Brunisols Organics	Hummocky; 6 to 30% slopes	Rapidly
ROUGH BROKEN	Undifferentiated; steep, unstable stream banks	RB	Undifferentiated		bedrock outcrops	Inclined, steep; slopes >15%	Rapidly
RUTH LAKE	Glaciofluvial; meltwater channel deposits; sandy and gravelly; acid to neutral; slightly to excessively stony	RUT1	Eluviated Eutric Brunisol Eluviated Dystric Brunisol Orthic Gray Luvisol	Gleyed Eluviated Eutric Brunisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, inclined; 2 to 9% slopes	Moderately well to rapidly
STEEPBANK	Morainal and glaciolacustrine; loamy to clayey; neutral; non to moderately stony	STP1	peaty Gleysols	Gleyed Gray Luvisol Orthic Gray Luvisol	Organics	Undulating, level; 0 to 5% slopes	Poorly
SURMONT	Morainal; colluviated; loamy to clayey; acid; slightly to very stony	SRT1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating, inclined; 2 to 15% slopes	Well

LAND UNITS IN THE BOREAL MIXEDWOOD ECOREGION

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LAND UNITS IN THE NORTHERN BOREAL ECOREGION

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	7B	Birch Mountains Escarpment
	7C	Gardiner Upland
	7D	McIvor Plain
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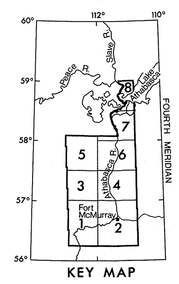


KEY MAP

REFERENCE

SOIL BOUNDARY
ECODISTRICT BOUNDARY
HARD SURFACE - ALL WEATHER
LOOSE SURFACE - ALL WEATHER
LOOSE SURFACE - DRY WEATHER
TRUCK TRAIL
SEISMOGRAPH LINE OR TRAIL
RAILWAY
PIPE LINE
TRANSMISSION LINE
CITY BOUNDARY
PARK BOUNDARY
TOWNSHIP LINE - UNSURVEYED
SURVEYED
SECTION LINE
QUARTER SECTION LINE
FOREST HEADQUARTERS
RANGER STATION
FORESTRY CABIN
LOOKOUT TOWER
RECREATION AREA
AIRSTRIP - REGULAR, OCCASIONAL
RIVER - RAPIDS AND FALLS
RIVER OR CREEK
CREEK - INTERMITTENT
LAKE
DITCH OR CANAL

EXPLANATION OF TERMS

DOMINANT SOILS - constitute over 40% of the soil unit
SIGNIFICANT SOILS - constitute 15 to 40% of the soil unit
INCLUSIONS - constitute less than 15% of the soil unit
DRAINAGE CLASS - predominant drainage class within soil unit; there may be other subdominant classes within a unit

SURFACE EXPRESSION

a - apron
f - fan
h - hummocky
i - inclined
l - level
m - rolling
n - ribbed fen
p - plateau bog
r - ridged
s - steep
t - terraced
u - undulating

MAP SYMBOL

HRR1 — dominant soil unit
KNZ2 — subordinate soil unit
uh — surface expression

ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM

Alberta Environment — Environment Canada — Environnement Canada

Soil information by the Soils Department, Alberta Research Council. Base map provided by Cartographic Services, Resource Evaluation and Planning Division, Alberta Energy and Natural Resources. Map compiled by the Alberta Research Council and published by the Research Management Division, Alberta Environment. Map to be used with ACRESP Report 172, Soils Inventory of the Alberta Oil Sands Environmental Research Program Study Area. Drafted by E. Widman and J. Glask.

SOIL MAP OF THE ALBERTA OIL SANDS ENVIRONMENTAL RESEARCH PROGRAM STUDY AREA (MAP 8)

SCALE 1 INCH TO 2 MILES OR 1:126,720

2 1 0 2 4 6 8 Miles

2 1 0 2 4 6 8 10 12 Kilometres

LEGEND

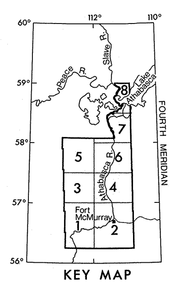
SOIL GROUP	GENETIC MATERIAL	SOIL UNIT	DOMINANT SOILS	SIGNIFICANT SOILS	INCLUSIONS	SURFACE EXPRESSION	DRAINAGE CLASS
ALGAR	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	ALG1	peaty Gleysols	Gleyed Gray Luvisol	Orthic Gray Luvisol	Undulating; veneers and blankets; 0 to 5% slopes	Poorly
BITUMOUNT	Eolian and glaciofluvial; sandy; neutral; non to slightly stony	BMT1	peaty Gleysols	Gleyed Eluviated Eutric Brunisol	Eluviated Eutric Brunisol Organics	Undulating; 0 to 5% slopes	Poorly
BUCKTON	Colluvial; loamy to clayey; acid to neutral; non to moderately stony	BKN1	Orthic Gray Luvisol Orthic Regosol		peaty Gleysols Organics bedrock outcrops	Inclined, ridged; 6 to 30% slopes	Well
CHIPEWYAN	Fluvial; delta deposits, loamy; calcareous; non-stony	CPN1	Gleyed Cumulic Regosol	Gleyed Regosol Rego Gleysol	peaty Gleysols Organics	Ridged, undulating; 0 to 5% slopes	Imperfectly
DISTURBED LANDS	Anthropogenic; land disturbed by construction and mining activities	DL	Undifferentiated			Undifferentiated	Variable
DOVER	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	DOV1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Solonetzic Gray Luvisol Organics	Undulating, inclined; veneers and blankets; 0 to 5% slopes	Moderately well to well
EAGLESHAM	Fen; mesic and fibric (fennic) peat; euic; variable thickness	EGL1	Typic Mesisol	Fibric Mesisol Terric Mesisol Typic Fibrisol	sphagnic Organics peaty Gleysols	Level, ribbed; 0 to 2% slopes	Very poorly
FIREBAG	Glaciofluvial; ice contact deposits; sandy; acid to neutral; moderately to exceedingly stony	FIR1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Hummocky, undulating,(kettled); 2 to 15% slopes	Rapidly
		FIR2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		FIR3	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Hummocky, (kettled, eroded); 6 to 30% slopes	Very rapidly
HEART	Eolian; sandy; acid to neutral; variable thickness; slightly stony in deflated veneer areas	HRT4	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	Gleyed Brunisols peaty Gleysols	Undulating, hummocky, ridged, (duned); veneers and blankets; 2 to 15% slopes	Rapidly
		HRT5	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
		HRT6	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Orthic Regosol	peaty Gleysols Organics	Ridged, hummocky, (duned, eroded); 6 to 30% slopes	Very rapidly
HORSE RIVER	Morainal; loamy to clayey; calcareous; moderately to very stony	HRR1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, hummocky; 2 to 15% slopes	Well
JOSLYN	Glaciolacustrine over till; clayey; calcareous; non to slightly stony	JSN1	Gray Solodized Solonetz	Solonetzic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics Gray Solod	Undulating; veneers and blankets; 0 to 5% slopes	Well to imperfectly
KEARL	Glaciolacustrine; beach ridges; sandy; neutral; non to slightly stony	KEL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics	Ridged; 2 to 9% slopes	Well to rapidly
KENZIE	Bog; fibric (sphagnic and forest) and mesic peat; dysic; variable thickness	KNZ1	Fibric Mesisol	Mesic Fibrisol Typic Fibrisol Fibric Organic Cryosol	Terric Mesisol fennic Organics	Level, plateau, (mounded); 0 to 2% slopes	Very poorly
		KNZ2	Terric Mesisol	Terric Fibric Mesisol Terric Fibrisol Fibric Mesisol	peaty Gleysols fennic Organics	Level, undulating; 0 to 5% slopes	Poorly
KINOSIS	Morainal; loamy; acid to neutral; moderately to exceedingly stony	KNS1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating; 2 to 15% slopes	Well
LEGEND	Morainal; loamy to clayey; acid; moderately to exceedingly stony	LGD1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, ridged; 6 to 15% slopes	Well to imperfectly
LIVOCK	Glaciolacustrine and glaciofluvial over till; loamy; calcareous; non to slightly stony	LVK1	Orthic Gray Luvisol	Brunisolic Gray Luvisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating; veneers and blankets; 0 to 5% slopes	Well
MAMAWI	Fluvial; delta deposits; loamy; calcareous; non-stony	MMW1	Rego Gleysol	Gleyed Cumulic Regosol Gleyed Regosol	peaty Gleysols Organics	Level, undulating; 0 to 2% slopes	Poorly
		MMW2	Rego Gleysol		peaty Gleysols	Level; 0 to 0.5% slopes	
McMURRAY	Fluvial; channel deposits; sandy to clayey; neutral to calcareous; non to slightly stony	MMY1	Cumulic Regosol Orthic Regosol	Gleyed Cumulic Regosol peaty Gleysols	Organics	Level, undulating, terraced, inclined; 0 to 5% slopes	Imperfectly
		MMY2	Gleyed Cumulic Regosol peaty Gleysols	Cumulic Regosol Orthic Regosol	Organics	Level, terraced; 0 to 2% slopes	Poorly
MIKKWA	Bog; fibric (sphagnic and forest) and mesic peat; dysic; frozen less than 1m from surface	MKW1	Fibric Organic Cryosol	Mesic Organic Cryosol Typic Fibrisol	fennic Organics	Plateau, inclined, (mounded); 0 to 9% slopes	Very poorly
		MKW2	Terric Mesic Organic Cryosol	Terric Mesisol Mesic Organic Cryosol	fennic Organics		
MILDRED	Glaciofluvial; outwash plains; sandy; acid to neutral; non to moderately stony	MIL1	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol	peaty Gleysols	Undulating; 2 to 9% slopes	Rapidly
		MIL2	Eluviated Dystric Brunisol	Eluviated Eutric Brunisol Gleyed Eluviated Eutric Brunisol peaty Gleysols	Organics		
NAMUR	Fluvial; fans and aprons; loamy to clayey; acid to neutral; non to slightly stony	NAM1	Orthic Regosol Cumulic Regosol	Gleyed Regosol peaty Gleysols	Organics	Fan, apron; 0 to 5% slopes	Imperfectly
		NAM2	Gleyed Regosol peaty Gleysols	Orthic Regosol Cumulic Regosol	Organics	Fan, apron, level; 0 to 2% slopes	Poorly to imperfectly
ROCK	Rock outcrops; undifferentiated	R	Non soil		lithic Brunisols Organics	Hummocky; 6 to 30% slopes	Rapidly
ROUGH BROKEN	Undifferentiated; steep, unstable stream banks	RB	Undifferentiated		bedrock outcrops	Inclined, steep; slopes >15%	Rapidly
RUTH LAKE	Glaciofluvial; meltwater channel deposits; sandy and gravelly; acid to neutral; slightly to excessively stony	RUT1	Eluviated Eutric Brunisol Eluviated Dystric Brunisol Orthic Gray Luvisol	Gleyed Eluviated Eutric Brunisol Gleyed Gray Luvisol peaty Gleysols	Organics	Undulating, inclined; 2 to 9% slopes	Moderately well to rapidly
STEEPBANK	Morainal and glaciolacustrine; loamy to clayey; neutral; non to moderately stony	STP1	peaty Gleysols	Gleyed Gray Luvisol Orthic Gray Luvisol	Organics	Undulating, level; 0 to 5% slopes	Poorly
SURMONT	Morainal; colluviated; loamy to clayey; acid; slightly to very stony	SRT1	Orthic Gray Luvisol	Gleyed Gray Luvisol peaty Gleysols	Organics	Hummocky, undulating, inclined; 2 to 15% slopes	Well

LAND UNITS IN THE BOREAL MIXEDWOOD ECOREGION

PHYSIOGRAPHIC SECTION	SYMBOL	ECODISTRICT
METHY PORTAGE PLAIN	1A	Garson Plain
	1B	Hangingstone Plain
	1C	Brule Plain
	1D	McMurray Lowland
	1E	Clearwater Plain
	1F	Steepbank Plain
	1G	Hartley Plain
	1H	Dover Plain
	1I	MacKay Plain
	1J	Fort Hills Upland
	1K	Johnson Lake Plain
FIREBAG HILLS UPLAND	2A	Muskeg Mountain Upland
WABASCA-ATHABASCA LOWLAND	3A	Wabasca Plain
	3B	Algar Plain
	3C	Dunkirk Plain
	3D	Thickwood Hills Upland
STONY MOUNTAIN UPLAND	4A	Cheecham Hills Escarpment
	4B	House Plain
RICHARDSON HILLS UPLAND	5A	Richardson Hills Upland
GREAT SLAVE PLAIN	6A	Muskeg River Plain
	6B	Embarras Plain
	6C	Buckton Plain
	6D	Athabasca Delta Plain

LAND UNITS IN THE NORTHERN BOREAL ECOREGION

BIRCH MOUNTAINS UPLAND	7A	Birch Mountains Upland
	7B	Birch Mountains Escarpment
	7C	Gardiner Upland
	7D	McIvor Plain
TAZIN RIVER PLAIN	8A	Flett Lake Plain



KEY MAP

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