SOIL SURVEY AND INTERPRETATION FOR RECREATIONAL USE OF AN AREA AT THE JUNCTION OF THE NOTIKEWIN AND PEACE RIVERS

Earth Sciences Report 78-4

G.M. Greenlee

Alberta
RESEARCH COUNCIL

Earth Sciences Report 78-4

Soil Survey and Interpretation for Recreational Use of an Area at the Junction of the Notikewin and Peace Rivers

G.M. Greenlee

Alberta Institute of Pedology
Number M-77-12

Soils Division
Alberta Research Council
1979

Copies of this report are available from:

Publications
Alberta Research Council Library
11315 - 87 Avenue
Edmonton, Alberta
Canada T6G 2C2

Price: $3.00

Editing: A. Campbell
Manuscript Production: D. Goodson, D. Harnden, M. Maduro
Cover Design: L. Chesko

CONTENTS

MAPS

LIST OF FIGURES

LIST OF TABLES

PREFACE

Intensive use of outdoor recreational facilities generally causes these sites to deteriorate within a short time. Perhaps the most obvious undesirable result of recreational use of wilderness is the change in the natural vegetation. Intensive use ultimately reduces plant growth, destroys ground cover, increases soil compaction, and decreases moisture infiltration rates so that surface runoff and soil erosion are increased. In many areas use already exceeds the capabilities of existing or proposed facilities. The solution is to gain control of the situation and direct events, rather than permit events to take their own course. Matching recreational use to the carrying capacity of a region should be a primary objective of resource managers (Bohart, 1968). Areas must be designed for use without undue deterioration of soil, water, and vegetational resources.

Soil is a basic resource and must be considered, regardless of the intended land use. Soils are dynamic, and change as the environment is modified. Intensive recreational use is a severe modification. In developing outdoor recreational areas, the pertinent characteristics of the different soils and slopes need to be recognized. The best approach to erosion control on recreational land is through adequate conservation planning.

The initial phase in planning the use and development of any resource is an inventory of the nature of the resource - its kind, quality, quantity, and distribution (Pluth, 1969). A soil survey not only indicates how much land is available for development, but also how and where different kinds of soil are found in the landscape. Various soils outlined on a map have properties that differ from those of other delineated soils, and different soils have different use capacities.

A soil survey can be a most useful tool for managers planning a well-designed recreational area. A good design directs users away from areas not suitable for heavy use because of characteristics such as coarse texture, excessive wetness, steep slopes, and fragile vegetation. Compared to a design made without the use of soil information, the design made with the use of a soil survey is more compatible with natural land features; lower initial investment is required; and maintenance required after site development is expected to be reduced (Stevens, 1966), thereby reducing maintenance costs.

Simply mapping the soils is not enough however. Specialists bear a responsibility beyond supplying good data; they should be willing to interpret it and to predict the consequences of various alternative actions (Epp, 1977). The purpose of soil interpretations is to provide people with the best information possible in a form that is directly useful to them.

This report, then, is one of a series describing detailed and semi-detailed soil surveys, which are being conducted in Alberta Provincial Parks and recreation areas. A separate report is being written for each area, and a standard explanatory report which is pertinent

to all areas is being prepared. A form of this explanatory report appears in the Introduction to the Kananaskis Lakes Soil Survey Report (Greenlee, 1976).

ACKNOWLEDGMENTS

The Alberta Research Council provided the staff and the Parks Planning Branch of Alberta Recreation and Parks contributed the operating costs for the 1975-76 Provincial Parks soil survey program. The Alberta Research Council published the report and compiled the soil map. The University of Alberta provided office and laboratory space.

Mrs. Pal Foster typed and assisted in compiling and proofreading the report. Mrs. Alyce Campbell edited the report. Mr. Z. Widtman and Mrs. J. Dlask drafted the soil and landform maps, while Mr. J. Beres determined the physical properties of the soils. The soil chemical analyses were determined by the Alberta Soil and Feed Testing Laboratory.

Able field assistance was given by Mr. M. Hennie.

Special acknowledgment is given to the Park Wardens, as well as other Park employees, who cooperated by allowing soil investigations to be conducted throughout the parks, and also invariably offered assistance.

SUMMARY

The mapped area is in the vicinity of the conjunction of the Notikewin River with the Peace, about 39 km (24 miles) north and 27 km (17 miles) east of Manning. The size of the area is approximately 3000 ha (7300 acres). The Notikewin River has incised a valley some 150 m (500 feet) in depth through moderately fine-textured till, within the study area. The predominant surficial material between the two rivers consists of coarse to very coarse textured fluvial sediments, while to the west of the Notikewin is a veneer of fine textured lacustrine sediments overlying moderately fine textured till. The climate is characterized by relatively cold winters and comparatively warm summers. The surveyed area lies within the mixedwood section of the boreal forest region as classified by Rowe (1972).

Eleven map units were recognized in the study area. The key profile types are Orthic Gray Luvisols, Orthic Eutric Brunisols, Cumulic Regosols, Orthic Luvic Gleysols and Terric Mesisols. These are distributed over the landscape in relation to landform, parent material and drainage. Map units consist of single soil series, groupings of series or soil associations; and their distribution is shown on the soil map.

Soil interpretations are made for each map unit for primitive camping areas, fully serviced campgrounds, paths, trails, road location, source of roadfill and source of sand or gravel.

Soils of map units 7 and 9 are the best suited for recreational uses, and these as well as soils of map unit 8 are the most suitable for road construction. In general, most other soils have moderate limitations, except in those areas where excessive slopes result in severe limitations. Careful study of the soil map and tables 4 to 10 inclusive (soil limitation tables) will reveal areas suitable for particular uses.

A soil survey properly interpreted can be one of the most useful tools management has in making a proper design for a recreational area. However, all soil differences which occur in the field cannot be shown on the soil map. Thus for design and construction of specific recreational facilities, an on-site investigation is usually required.

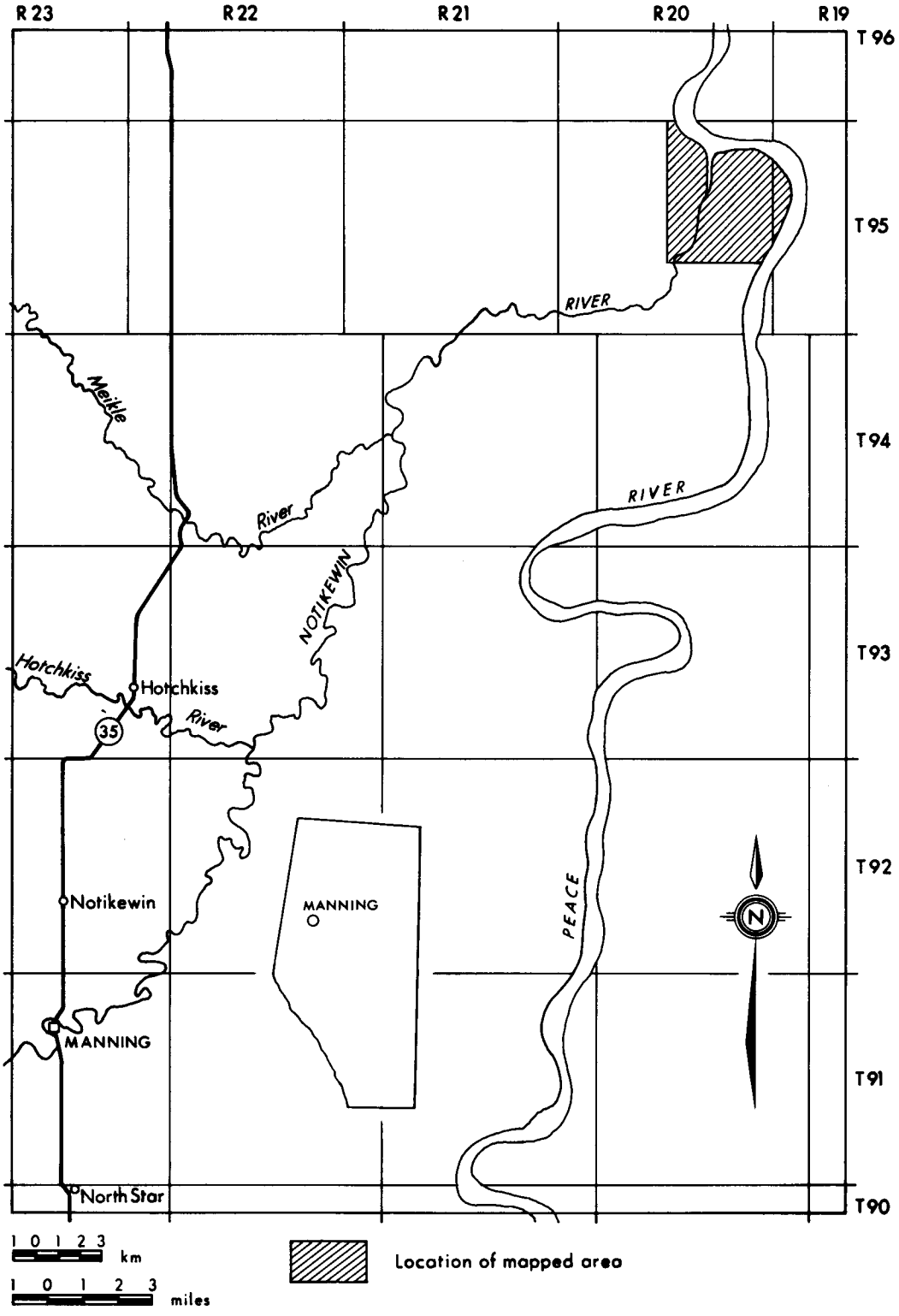


FIGURE 1. Map showing location of mapped area.

SOIL SURVEY AND INTERPRETATION FOR RECREATIONAL USE OF AN AREA AT THE JUNCTION OF THE NOTIKEWIN AND PEACE RIVERS

INTRODUCTION

LOCATION AND SIZE

The area mapped, approximately 3000 ha (7300 acres), is in the vicinity of the conjunction of the Notikewin and Peace Rivers, about 39 km (24 miles) north and 27 km (17 miles) east of Manning (Fig. 1). This is about 113 km (70 miles) north of the town of Peace River. In terms of the legal description, the area is in Tp 96, R 19 W 5th Mer., and includes the portions of Sec. 18, 19, and 30 located on the west side of the Peace River as well as the islands in the river located in Sec. 18, 19, 30, and 31; it extends into Tp 95, R 20, and includes that portion of Sec. 13 located on the west side of the Peace, all of Sec. 14, 15, 22 to 27 inclusive, and the portions of Sec. 34 to 36 situated on the south side of the river.

FIELD TECHNIQUES

The areas surveyed were traversed by motor vehicle along all roads and negotiable trails, and on foot along cut lines and trails not suitable for vehicles. An outboard motor boat was used in the Peace River to gain access into some areas, and foot traverses were made as necessary across areas lacking trails.

Soil pits were dug at frequent intervals to depths of 0.6 to 1.5 m (2 to 5 feet), in order to examine and describe soil horizons and to classify the soils. The usual procedure was to excavate the upper 0.6 m (2 feet) of a soil pit with a shovel, and to examine the lower depths by sampling with a soil auger.

Soil areas were delineated on ozalid copies of photomosaics at a scale of 1:8000 (8 inches = 1 mile). To facilitate field mapping panchromatic black and white aerial photographs at a scale of 1:31,680 (2 inches = 1 mile) were also used with the aid of a pocket stereoscope.

Representative surface and shallow subsurface soil samples were collected for chemical analyses, and subsurface samples were collected at depths of 1 to 1.2 m (3 to 4 feet) for physical analyses.

CHEMICAL ANALYSES

Chemical analyses were carried out by the Alberta Soil and Feed Testing Laboratory (O.S. Longman Building, Edmonton). Surface and subsurface soil samples of the map units, taken at representative sites, were analyzed. Surface samples, material taken from the 0- to 15-cm (0- to 6-inch) depth, consist of five separate samples taken at random locations and bunched together into one composite sample. Subsurface samples are materials from the 15- to 30-cm (6- to 12-inch) depth. The following determinations were made:

(1) *available nitrogen* (N) (Jackson, 1962); general ratings expressed in pounds of available nitrogen per acre are: low - 0 to 20, medium - 21 to 50, and high - 51 or more;

(2) *available phosphorus* (P) (Dickman and Bray, 1940); general ratings expressed in pounds of available phosphorus per acre are: low - 0 to 30, medium - 31 to 70, and high - 71 or more;

(3) *available potassium* (K) (Jackson, 1962); general ratings in pounds of available potassium per acre are: low - 0 to 150, medium - 151 to 300, and high - 301 or more;

(4) *available sulfur* (S) (Carson *et al.*, 1972); general ratings are low (L), medium (M), high (H) and none (nil), with the degree in each category indicated by a "+" or "-" sign;

(5) *soil reaction;* pH was determined with a glass and calomel electrode, using a 2:1 water to soil ratio (Jackson, 1962); acid soils have pH values of 5.5 or less, neutral soils between 5.5 and 7.4, and alkaline soils 7.4 or more;

(6) *electrical conductivity,* an indicator of total water-soluble salt concentration in a soil, was measured by a dip electrode procedure; the electrodes were placed in the supernatant liquid on the surface of a 2:1 water to soil mixture; lawn growth is affected on soils as follows: conductivity 0 to 1, negligible; 1.1 to 3 noticeably restricted; 3.1 or more considerably restricted;

(7) *soluble sulfates* (SO_4) were determined on soil samples having electrical conductivities of 1 or more; a saturated soil paste was prepared according to the procedure outlined in the U.S.D.A. Handbook 60 (Richards, 1954); a saturation extract was obtained by suction, and sulfates were precipitated with $BaCl_2$ crystals by the turbidimetric method and estimated by a visual inspection; results are rated in four categories - high (H), medium (M), low (L) and none (nil), with the degree in each category indicated by a "+" or "-" sign;

(8) *exchangeable sodium* (Na) was determined by flame photometry (Jackson, 1962); results are rated in the same categories as sulfates;

(9) *organic matter* was estimated by a visual inspection of the soil sample; results are rated in the same fashion as sulfates and sodium;

(10) *free lime* was determined by a visual estimation of the degree of effervescence when a 10 percent solution of dilute HCl was added to a soil sample; results are rated in the same manner as organic matter;

(11) *available aluminum* (Al) *and manganese* (Mn) were determined on soil samples having a pH of 5.5 or less. These nutrients were determined by atomic adsorption spectrophotometry (Hoyt and Nyborg, 1971).

ENGINEERING PROPERTIES

Physical analyses were carried out in the Alberta Institute of Pedology laboratories (ASTM, 1970), on representative samples of map units 1, 2, and 3. These involved the following determinations: field moisture content (Terzaghi and Peck, 1967); liquid limit and plastic limit (PCA, 1962); sieve analysis, and particle size analysis (hydrometer method; PCA, 1962). Values for optimum moisture content and maximum dry density were obtained from charts prepared by the Alberta Transportation Laboratory of Alberta Transportation (1955).

The soils were classified on the basis of these properties according to three systems:

(1) American Association of State Highway Officials (AASHO) System: soils are rated according to field performance in highway construction. In this system soil materials are classified into seven basic groups, designated A-1 to A-7, each group having about the same general load carrying capacity and service. An index ranging from 0 to 20 (from best to worst) ranks material within groups. The best soils for sub-grade are classed as A-1(0), the poorest are A-7 (20).

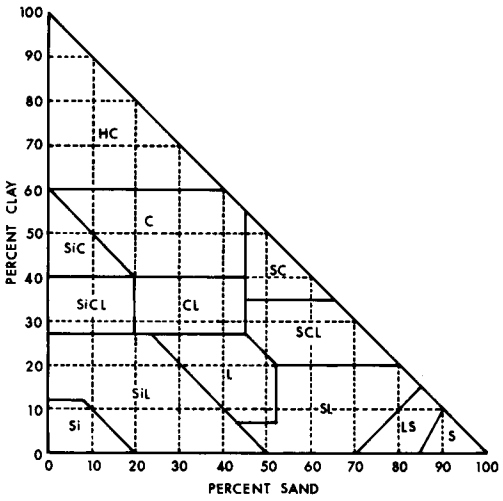
(2) Unified Soil Classification System: soils are identified according to their textures and plasticities and grouped according to their performance as engineering construction materials. Soils are divided into coarse-grained, fine-grained, and organic soils. The letters G, S, M, C, and O stand for gravel, sand, silt, clay, and organic materials respectively. The letters L and H stand respectively for relatively low liquid limit and relatively high liquid limit.

(3) United States Department of Agriculture (USDA) System: soils are classified according to their texture. Figure 2 illustrates this system.

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

Within the study area the Notikewin River has incised a valley some 150 m (500 feet) deep through moderately fine textured till. The highest elevation is slightly more than 425 m (1400 feet) along the western boundary, and the lowest elevation is slightly below the 270 m (900 foot) contour along the southern and western banks of the Peace River, for a difference of about 155 m (500 feet). The Peace and Notikewin Rivers drain the mapped area.

In the southernmost upland portion of the mapped area between the two rivers, a blanket of coarse-textured glaciofluvial sediments at least 1.2 m (4 feet) thick overlies the morainal deposits. Between the upland and the Peace River to the north is a series of very coarse-textured fluvial terraces, each successively lower in elevation. The surficial materials of these terraces are very coarse-textured, while medium to moderately fine textured fluvial sediments are found in the river floodplains.



Legend

very coarse textured
- S - sand
  - CS - coarse sand
  - S - sand
  - FS - fine sand
  - VFS - very fine sand
- LS - loamy sand
  - LCS - loamy coarse sand
  - LS - loamy sand
  - LFS - loamy fine sand
  - LVFS - loamy very fine sand

moderately coarse textured
- SL - sandy loam
  - CSL - coarse sandy loam
  - SL - sandy loam
  - FSL - fine sandy loam

medium textured
- VFSL - very fine sandy loam
- L - loam
- SiL - silt loam
- Si - silt

moderately fine textured
- SCL - sandy clay loam
- CL - clay loam
- SiCL - silty clay loam

fine textured
- SC - sandy clay
- SiC - silty clay
- C - clay

very fine textured
- HC - heavy clay

Figure 2. Soil texture classes: percentages of clay and sand in the main textural classes of soils; the remainder of each class is silt.

Throughout most of the study area to the west of the Notikewin, the till is covered by a veneer of fine textured lacustrine sediments, varying in thickness from slightly less to slightly more than 1 m (3.3 feet).

LANDFORMS

The landform map is included simply to provide additional information about the mapped area. The landforms do not have any direct bearing on the soil interpretations which appear later in the report.

The symbols that appear on the landform map refer to local landforms. A local landform is comprised of a unique assemblage of slopes which are constantly repeated in nature, and which generally owe their unique form to the composition and mode of origin of a surficial deposit (Acton, 1975). This repetitive landform pattern may be associated with different major geologic structures so that similar local landforms or repetitive landform patterns can be found in different regional landform units. An outwash fan of a valley glacier as contrasted to a similar local form associated with continental glaciation would serve as an example of a landform pattern repeated in regionally different landform units.

Landforms, in this system, are considered to represent two basic attributes: materials and form. Materials are classified according to their essential properties within a general framework of their mode of formation and there are four groups of materials: unconsolidated mineral, organic, consolidated mineral, and ice. A number of classes of unconsolidated mineral and organic materials have been established but classes of consolidated materials (bedrock) and ice have not been recognized. Additional descriptors are used to indicate the surface expression or form. A complete description of the system is given in CSSC (1978).

CLIMATE

Only very recent and incomplete meteorological data are available for the mapped area. Records published by Scheelar and Odynsky (1968) indicate that the region may be characterized by relatively cold winters and a cool growing season. However, weather records kept over the 10-year period from 1964 through 1973 at the Peace River Airport, about 113 km (70 miles) south of the study area and at an elevation of 570 m (1866 feet), indicate that the summers are comparatively warm (Environment Canada, 1964-73). The mean annual temperature is 0.4°C (31.3°F), the mean annual precipitation is 37.6 cm (14.80 inches) with 53 percent falling as rain, and the average frost free period is 89 days. July is the warmest month of the year with a mean temperature of 15.4°C (59.7°F), and January is the coldest month with a mean temperature of -22.3°C (-8.1°F). Approximately 44 percent of the mean annual precipitation falls during the three summer months of June, July, and August -- the main tourist season.

VEGETATION

The surveyed area lies within the mixedwood section of the boreal forest region, as classified by Rowe (1972). The Parks Planning Branch of Alberta Recreation and Parks currently conducts biological studies of Provincial Parks and proposed park areas, so the vegetation is not extensively discussed in this report, although some of the more common plant species observed growing on different soils are listed as part of the map unit descriptions. The common and scientific names are as follows (Moss, 1959; Hale, 1963; Conard, 1956): aspen *(Populus temoloides)*, balsam poplar *(Populus balsamifera)*, white spruce *(Picea glauca)*, jack pine *(Pinus banksiana)*, willow *(Salix* spp.*)*, alder *(Alnus* spp.*)*, dogwood *(Cornus stolonifera)*, Canadian buffaloberry *(Shepherdia canadensis)*, low-bush cranberry *(Viburnum edule)*, high-bush cranberry *(Viburnum trilobum)*, beaked hazelnut *(Corylus cornuta)*, wild rose *(Rosa* spp.*)*, wild red raspberry *(Rubus strigosus)*, saskatoon-berry *(Amelanchier alnifolia)*, wolf willow *(Elaeagnus commutata)*, currant *(Ribes* spp.*)*, blueberry *(Vaccinium myrtilloides)*, common bearberry *(Arctostaphylos uva-ursi)*, reindeer lichen *(Cladonia* spp.*)*, horsetail *(Equisetum* spp.*)*, Labrador tea *(Ledum groenlandicum)*, slough grass *(Beckmannia syzigachne)*, and sphagnum moss *(Sphagnum* spp.*)*.

SOILS

Soils were classified according to the Canadian System of Soil Classification (see Appendix A and CSSC, 1978). On the soil map each map unit is represented by a symbol.
Example:

topographic class (Table 1) - $\frac{4}{e2}$ - map unit
- surface stoniness rating (Table 2)

The topographic classes and surface stoniness ratings are defined in tables 1 and 2 respectively.

The map units may be single soil series, groupings of series, or catenas. A soil series consists of soils that are essentially alike in all major profile characteristics except the texture of the surface (CDA, 1976). Within a map unit consisting of a grouping of series, the series are found together in a characteristic pattern within the landscape and it is not feasible to outline each separately at the scale of mapping employed. A catena simply consists of a sequence of soils of about the same age, derived from similar parent materials, and found under similar climatic conditions and in characteristic patterns, but having unlike characteristics because of variations in relief and drainage (CDA, 1976).

If a map unit consists of a single series, other soil series may be found nearby. However, the dominant series constitutes roughly 70 to 90 percent of the map unit; the other series

Table 1. Topographic classes and symbols (CDA, 1974)

Simple Topography Single Slopes (regular surface)	Complex Topography Multiple Slopes (irregular surface)	Slope (%)
A - depressional to level	a - nearly level	0 to 0.5
B - very gently sloping	b - gently undulating	0.5+ to 2
C - gently sloping	c - undulating	2+ to 5
D - moderately sloping	d - gently rolling	5+ to 9
E - strongly sloping	e - moderately rolling	9+ to 15
F - steeply sloping	f - strongly rolling	15+ to 30
G - very steeply sloping	g - hilly	30+ to 60
H - extremely sloping	h - very hilly	over 60

Table 2. Surface stoniness ratings[1] (CSSC, 1978)

Rating	Description
Stony 0	(non-stony phase) - very few stones (<0.01% of surface, stones >30 m or 100 feet apart).
Stony 1	(slightly stony phase) - some stones that hinder cultivation slightly or not at all (0.01 to 0.1% of surface, stones 10 to 30 m or 30 to 100 feet apart).
Stony 2	(moderately stony phase) - enough stones to cause some interference with cultivation (0.1 to 3% of surface, stones 2 to 10 m or 7 to 30 feet apart).
Stony 3	(very stony phase) - sufficient stones to handicap cultivation seriously; some clearing is required (3 to 15% of surface, stones 1 to 2 m or 3 to 7 feet apart).
Stony 4	(exceedingly stony phase) - sufficient stones to prevent cultivation until considerable clearing is done (15 to 50% of surface, stones 0.1 to 0.5 m or 0.3 to 1.5 feet apart).
Stony 5	(excessively stony phase) - too stony to permit cultivation; boulder or stone pavement (>50% of surface, stones >0.1 m or 0.3 feet apart).

[1]Phases of "stoniness" are defined on the basis of the percentage of the land surface occupied by fragments coarser than 15 cm (6 inches) in diameter.

are present in such minor amounts that their presence is not considered significant enough to affect the use of that particular map unit for a given purpose.

If a map unit consists of a grouping of series, the different series generally possess very similar properties. The approximate percentage of each series is indicated in the soil report. Minor insignificant inclusions of other series may be present but are not mentioned in the definition of the map unit.

If a map unit consists of a catena, the approximate percentage of only the dominant members (which may also be series) are indicated. Minor insignificant amounts of other members are often present but are not mentioned. Soil interpretations are for the most dominant member of a catena, and interpretations for the less dominant members may or may not be different.

Eleven map units were recognized in the study area. Soils of the Luvisolic and Regosolic Orders are each dominant in three map units. Two other map units are composed of soils belonging to the Brunisolic Order. Soils of the Gleysolic and Organic Orders are each dominant in one map unit. As well, the soils of one map unit are divided randomly between the Luvisolic and Brunisolic Orders. Pertinent features of the map units are outlined in table 3.

In general, the most common and widespread soils found throughout the forested regions of Alberta are those of the Luvisolic Order, and the mapped area is no exception. These are well to imperfectly drained soils characterized by an Ae horizon near the surface, which generally varies from 7.5 to 30 cm (3 to 12 inches) in thickness, is a leached gray color and contains very little organic matter (humus) and plant nutrients. Luvisolic soils in their natural state commonly have surface L-H and Ah horizons as well. The uppermost L-H horizon consists primarily of leaves, twigs, woody materials and a minor component of mosses, in various stages of decomposition, and ranges from 2.5 to 12.5 cm (1 to 5 inches) or more in thickness. The Ah horizon below this is humus-rich and high in plant nutrients; however, it is usually less than 5 cm (2 inches) thick, and often absent altogether, in Luvisolic soils.

This horizon is commonly referred to as "topsoil" and is much thicker in prairie or grassland soils. When Luvisolic soils are cultivated, the L-H and Ah horizons quickly become mixed with the Ae horizon, resulting in grayish colored fields.

Also the L-H and Ah horizons rapidly break down under conditions of heavy foot traffic in recreation areas, and often disappear completely due to a combination of physical destruction and erosion. When thoroughly dried out, the Ae horizon is often baked and hard, so that plant seedlings may be unable to push up through the crust. Also, entry of moisture from rainfalls may be hampered and runoff increased, causing soil erosion. This problem is especially serious where steep slopes prevail.

Table 3. Key to the soils

Map Unit	Classification	Parent Material	Surface Texture	Slope (class and gradient)	Surface Stoniness	Drainage	Comments and Limitations
1	Cumulic Regosol	medium to moderately fine textured fluvial sediments	SiL	c, d (2+ to 9%)	0	well drained	Moderate to severe limitations - flooding hazard (overflow), slippery or sticky when wet, moderate shrink-swell potential, susceptibility to frost heave.
2	Orthic Gray Luvisol - 80% Orthic Luvic Gleysol, peaty phase - 20%	fine textured lacustrine sediments	VFSL to SiL	c to e (2+ to 15%)	0	Luvisol - well drained, Gleysol - poorly drained	Till occasionally within 75 cm (30 in) of surface, but usually below 120 cm (4 ft). The Luvisolic soils have moderate to severe limitations - slippery or sticky when wet, slow permeability, excessive slope, high shrink-swell potential, susceptibility to frost heave. The Gleysolic soils have severe limitations for all uses due to a seasonally high groundwater table or surface ponding.
3	Orthic Gray Luvisol	moderately fine textured till	L	c to f (2+ to 30%)	1	well drained	Slight to severe limitations - slow permeability, excessive slope, moderate shrink-swell potential, susceptibility to frost heave.
4	Orthic Eutric Brunisol	moderately fine textured till	L to CL	g, H (30+ to >60%)	2	well drained	Steep banks result in slumping - causes disturbance of soil solum and highly variable soil depths. Moderate to severe limitations - excessive slope, slippery or sticky when wet, moderate shrink-swell potential, susceptibility to frost heave.
5	Gleyed Cumulic Regosol	medium to moderately fine textured fluvial sediments	SiL	b (0.5+ to 2%)	0	imperfectly drained	Moderate to severe limitations - seasonally high groundwater table or surface ponding, flooding hazard (overflow), slippery or sticky when wet, moderate shrink-swell potential, susceptibility to frost heave.
6	Cumulic Regosol	medium textured fluvial sediments	VFSL	c (2+ to 5%)	0	well drained	This soil was mapped solely on the three islands in the Peace River. Moderate limitations due to flooding hazard (overflow).
7	Orthic Gray Luvisol and Orthic Eutric Brunisol	very coarse textured fluvial sediments (gravel)	gravelly L to gravelly SL	c (2+ to 5%)	2	very rapidly drained	These two soils are intimately and unpredictably associated. They have no limitations for recreational development or road construction, and constitute a good source of gravel.
8	Orthic Eutric Brunisol	very coarse textured fluvial sediments (sand)	LS	c to f (2+ to 30%)	0	very rapidly drained	Moderate to severe limitations- sandy surface texture, erosion hazard, excessive slope. Good source of sand.
9	Orthic Gray Luvisol - 80% Undifferentiated Gleysol - 20%	medium to very coarse textured glaciofluvial sediments	FSL	d (5+ to 9%)	0	Luvisol - rapidly drained, Gleysol - poorly drained	The Luvisolic soils have no limitations for recreational development or road construction, and constitute a good source of sand. The Gleysolic soils have severe limitations for all uses due to a seasonally high groundwater table or surface ponding.
10	Orthic Luvic Gleysol	very coarse textured glaciofluvial sediments overlying moderately fine textured till	FSL to LFS	b (0.5+ to 2%)	0	poorly drained	Till sometimes occurs within 100 cm (40 in) of the surface, but is usually deeper. Severe limitations - seasonally high groundwater table or surface ponding.
TM	Terric Mesisol	Predominantly intermediately decomposed peat overlying undifferentiated mineral material	Organic (Of)	a (0 to 0.5%)	0	very poorly drained	Unsuitable for recreational development, severe limitations for road construction - organic soil, seasonally high groundwater table, susceptibility to frost heave, high shrink-swell potential.

In the mapped area well drained Luvisolic soils are dominant in the upland regions. Gleysolic soils are found in numerous, small, poorly drained depressions; also one larger area of Gleysolic soils was found near the southern boundary between the two rivers. These soils indicate periodic or prolonged water saturation. Only one small Organic soil area was found near the western boundary of the study area. Organic soils commonly develop in poorly and very poorly drained depressions and level areas, and most are water saturated for prolonged periods. They are commonly known as "muskegs" or "bogs."

The soils that are present in the river floodplains belong to the Regosolic Order, and in the study area most are well drained. These are very weakly developed "young" soils, and the lack of horizon development is due to the youthfulness of the parent material which is recent alluvium.

Soils of the Brunisolic Order have sufficient development to exclude them from the Regosolic Order, but lack the degrees or kinds of horizon development specified for soils of other orders. Well drained Brunisolic soils are found on the very steep valley banks, and very rapidly drained Brunisolic soils are found on the very coarse textured fluvial sediments that are present in the mapped area. The steep valley walls result in a high proportion of moisture runoff and low percolation rates. The coarse-textured sediments have very high permeabilities which cause droughty conditions. Both situations result in weakly developed soil horizons and profiles.

Only slight differences are observed among some map units, but these differences are generally significant enough, with respect to some recreational or engineering uses, to justify their separation. The wide variations in horizon thicknesses reported in some of the following map unit descriptions demonstrate the extreme variability commonly found in soils. Thicknesses of comparative horizons of the same soil series can vary as much as 10 to 40 percent from the norm at different points in the landscape.

Common names are employed in the lists of dominant plant species. These lists are very general, and are not complete or exhaustive.

MAP UNIT 1

Classification: Cumulic Regosol

Landform: fluvial terraces (Ft)

Parent Material: medium to moderately fine textured fluvial sediments

Slope: undulating to gently rolling (2+ to 9 percent)

Surface Stoniness: non-stony (0)

Drainage: well drained

Vegetation: various combinations of balsam poplar, white spruce, white birch and aspen; understory of dogwood, alder, willow, some patches of ferns and horsetail

Profile Description: *Cumulic Regosol*

	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
L-H	5-10	2-4	leaf litter		
Ck	0-100+	0-40+	silt loam	amorphous	very friable, moist; soft, dry

Comments: (1) Occasional sand lenses, 5 to 15 cm (2 to 6 inches) thick are present in the profile at various depths.

(2) Horizons of silty clay loam texture (firm consistence, moist) or very fine sandy loam texture (very friable consistence, moist), 20 to 50 cm (8 to 20 inches) thick occasionally are present in the profile at various depths.

(3) Numerous Hb horizons, 1 to 2.5 cm (1/2 to 1 inch) thick occur in the profile at various depths. These are usually about 5 to 20 cm (2 to 8 inches) apart.

Limitations: Moderate for camping areas, paths and trails, moderate to severe for road locations; fair to poor source of roadfill. Specific limitations are flooding hazard (overflow), slippery or sticky when wet, moderate shrink-swell potential, and susceptibility to frost heave. Unsuitable as a source of sand or gravel due to unsuitable texture.

MAP UNIT 2

Classification: Orthic Gray Luvisol - 80 percent
Orthic Luvic Gleysol, peaty phase - 20 percent

Landform: glaciolacustrine blanket and veneer overlying undulating morainal (L^{G}_{bv}/Mu), and glaciolacustrine blanket and veneer overlying hummocky morainal (L^{G}_{bv}/Mh)

Parent Material: fine textured lacustrine sediments

Slope: undulating to moderately rolling (2+ to 15 percent)

Surface Stoniness: non-stony (0)

Drainage: Luvisol - well drained
Gleysol - poorly drained

Vegetation: Luvisol - aspen, Canadian buffaloberry, dogwood, wild rose, some willow, occasional white spruce and white birch
Gleysol - willow, aspen

Profile Description: *Orthic Gray Luvisol*

Horizon	Thickness cm	Thickness inches	Field Texture	Structure	Consistence
L-H	5	2	leaf litter		
Ae	10-20	4-8	very fine sandy loam to silt loam	platy	very friable, moist
Bt	20-35	8-14	silty clay	blocky	very firm, moist
BC	0-25	0-10	silty clay	subangular blocky	very firm, moist
Cca_1	15	6	silty clay loam	subangular blocky	firm, moist; hard, dry
Cca_2	5-15	2-6	very fine sand	amorphous	loose, dry
Cca_3	at 60-100	at 24-40	silty clay	subangular blocky	very firm, moist; very hard, dry

MAP UNIT 2 (continued)

Profile Description: Orthic Luvic Gleysol, peaty phase

Horizon	Thickness cm	Thickness inches	Field Texture	Structure	Consistence
Om	20	8	intermediately decomposed organic material		
Aeg_1	15	6	fine sandy loam	platy	very friable, moist
Aeg_2	30	12	silt loam	platy	very friable, moist
Btg	30	12	silty clay	subangular blocky	very firm, moist
Ccag	at 75	at 30	silty clay loam	subangular blocky	firm, moist

Comments: (1) The Gleysolic soils exist sporadically in low-lying flat areas which individually are of insufficient extent to be outlined as separate map units at the scale of mapping employed.

(2) Moderately fine textured till is occasionally found within 75 cm (30 inches) of the surface, but generally occurs at depths of more than 1.2 m (4 feet).

Limitations: For the Luvisolic soils, moderate for camping areas, paths and trails; moderate to severe for road location; poor source of roadfill. Specific limitations are slippery or sticky when wet, slow permeability, excessive slope, high shrink-swell potential and susceptibility to frost heave. Unsuitable as a source of sand or gravel due to unsuitable texture. The Gleysolic soils have severe limitations for all uses because of a seasonally high groundwater table or surface ponding.

MAP UNIT 3

Classification: Orthic Gray Luvisol

Landform: undulating morainal (Mu), and hummocky morainal (Mh)

Parent Material: moderately fine textured till

Slope: undulating to strongly rolling (2+ to 30 percent)

Surface Stoniness: slightly stony (1)

Drainage: well drained

Vegetation: mostly aspen; patches of white spruce and white birch in river valley; understory of Canadian buffaloberry, dogwood, wild rose

Profile Description: *Orthic Gray Luvisol*

	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
L-H	2.5-7.5	1-3	leaf litter		
Ae	5-7.5	2-3	loam	platy	very friable, moist
Bt	20-30	8-12	clay	blocky	very firm, moist
BC	25-50	10-20	clay loam	amorphous, breaking to subangular blocky	very firm, moist; hard, dry
Cca	at 50-75	at 20-30	clay loam	amorphous, breaking to subangular blocky	very firm, moist; hard, dry

Limitations: None to slight for paths and trails, moderate to severe for other uses; fair source of roadfill. Specific limitations are slow permeability, excessive slope, moderate shrink-swell potential, and susceptibility to frost heave. Unsuitable as a source of sand or gravel due to unsuitable texture.

MAP UNIT 4

Classification: Orthic Eutric Brunisol

Landform: steep morainal (Ms)

Parent Material: moderately fine textured till

Slope hilly to extremely sloping (30 to >60 percent)

Surface Stoniness: moderately stony (2)

Drainage: well drained

Vegetation: (1) North-facing slopes: aspen, low-bush cranberry, wild rose, patches of white spruce and white birch.

(2) South, west, and east-facing slopes: grass, saskatoon-berry, wild rose, raspberry, patches of wolf willow; also forested portions of aspen, low-bush cranberry, wild rose and raspberry.

Profile Description: *Orthic Eutric Brunisol*

	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
L-H	5-7.5	2-3	leaf litter		
Ah	0-5	0-2	loam	granular	very friable, moist
Bm	10-75	4-30	clay loam	subangular blocky	friable to firm, moist
Cca	at 10-75	at 4-30	clay loam	amorphous, breaking to subangular blocky	firm to very firm, moist; hard to very hard, dry

Comments: (1) The Ah horizon is found on grassy south, west, and east-facing slopes, which occupy approximately 30 percent of map unit 4 soil areas. Some tonguing is present where small tongues of the Ah horizon may be as much as 10 cm (4 inches) thick.

(2) Map unit 4 soils are found on steep valley walls, where considerable slumping has resulted. This has caused disturbance and mixing of soil horizons, producing a soil solum which varies greatly in thickness.

Limitations: Moderate to unsuitable for all uses. Specific limitations are excessive slope, slippery or sticky when wet, moderate shrink-swell potential, and susceptibility to frost heave. Unsuitable as a source of sand or gravel due to unsuitable texture.

MAP UNIT 5

Classification: Gleyed Cumulic Regosol

Landform: level fluvial (Fl)

Parent Material: medium to moderately fine textured fluvial sediments

Slope: gently undulating (0.5+ to 2 percent)

Surface Stoniness: non-stony (0)

Drainage: imperfectly drained

Vegetation: willow, dogwood, wild rose, high-bush cranberry, raspberry, horsetail, grass, and forbs

Profile Description: *Gleyed Cumulic Regosol*

	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
L-H	2.5-5	1-2	leaf litter		
Ckg	0-100+	0-40+	silt loam to silty clay loam	amorphous	very friable to firm, moist; soft to slightly hard, dry

Comments: (1) The soil profile is comprised of alternating horizons, varying from silt loam to silty clay loam in texture, and from 5 to 15 cm (2 to 6 inches) thick.

(2) Numerous Hb horizons, 1 to 2.5 cm (1/2 to 1 inch) thick, occur in the profile at various depths. These are usually about 5 to 20 cm (2 to 8 inches) apart.

Limitations: Moderate for camping areas, paths and trails; moderate to severe for road location. Specific limitations are seasonally high groundwater table or surface ponding, flooding hazard (overflow), slippery or sticky when wet, moderate shrink-swell potential and susceptibility to frost heave. Unsuitable as a source of sand or gravel due to unsuitable texture.

MAP UNIT 6

Classification: Cumulic Regosol

Landform: fluvial terraces (Ft)

Parent Material: medium textured fluvial sediments

Slope: undulating (2+ to 5 percent)

Surface Stoniness: non-stony (0)

Drainage: well drained

Vegetation: various combinations of white birch, white spruce, aspen and balsam poplar; with an understory consisting of combinations of dogwood, low-bush cranberry, wild rose, willow, raspberry, currant, and horsetail

Profile Description: *Cumulic Regosol*

	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
L-H	7.5-10	3-4	leaf litter		
Ck	0-100+	0-40+	very fine sandy loam	amorphous	very friable, moist; soft, dry

Comments: (1) Map unit 6 soils are very similar to those of map unit 1; however the map unit 6 soils are somewhat coarser textured.

(2) Map unit 6 soils were mapped only on the three islands in the Peace River.

(3) Numerous Hb horizons, 1 to 2.5 cm (1/2 to 1 inch) thick, occur in the profile at various depths. These are usually about 5 to 20 cm (2 to 8 inches) apart.

Limitations: None to slight for paths, trails and road location; moderate for camping areas. Good source of roadfill. The only limitation is flooding hazard (overflow). Poor source of sand and unsuitable as a source of gravel due to unsuitable texture.

MAP UNIT 7

Classification: Orthic Gray Luvisol and Orthic Eutric Brunisol (these two soils are intimately and unpredictably associated)

Landform: fluvial terrace (Ft)

Parent Material: very coarse textured fluvial sediments (gravel)

Slope: undulating (2+ to 5 percent)

Surface Stoniness: moderately stony (2)

Drainage: very rapidly drained

Vegetation: sparse forest, consisting of aspen, jack pine, and white spruce; understory comprised of Canadian buffaloberry, wild rose, bearberry, grass, patches of reindeer lichen, and blueberry

Profile Description: *Orthic Gray Luvisol*

Horizon	Thickness cm	Thickness inches	Field Texture	Structure	Consistence
L-H	2.5	1	leaf litter		
Ae	15-20	6-8	gravelly loam to gravelly sandy loam	platy	very friable to loose, moist; soft to loose, dry
Bt	at 15-20	at 6-8	gravelly clay loam	subangular blocky	slightly hard, dry

Profile Description: *Orthic Eutric Brunisol*

Horizon	Thickness cm	Thickness inches	Field Texture	Structure	Consistence
L-H	2.5	1	leaf litter		
Bm_1	15-20	6-8	gravelly loam to gravelly sandy loam	amorphous	very friable to loose, moist; soft to loose, dry
Bm_2	at 15-20	at 6-8	gravelly loam to gravelly sandy loam	amorphous	very friable to loose, moist; soft to loose, dry

Comments: The L-H horizon is very fragile, and breaks down readily under foot traffic.

Limitations: None to slight for all uses. Good source of gravel.

MAP UNIT 8

Classification: Orthic Eutric Brunisol

Landform: fluvial terraces (Ft), and hummocky glaciofluvial (F_h^G)

Parent Material: very coarse textured fluvial sediments (sand)

Slope: undulating to strongly rolling (2+ to 30 percent)

Surface Stoniness: non-stony (0)

Drainage: very rapidly drained

Vegetation: aspen, alder, willow, grass, bearberry, wild rose, saskatoon-berry, hazelnut, dogwood, scattered white spruce and white birch, occasional balsam poplar

Profile Description: *Orthic Eutric Brunisol*

	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
L-H	2.5	1	leaf litter		
Bm	50-75	20-30	loamy sand	amorphous	loose, moist; soft, dry
BC	15-70	6-28	sand	amorphous	loose, moist or dry
Cca	at 90-120	at 36-48	sand	amorphous	loose, moist or dry

Comments: (1) The L-H horizon is very fragile, and breaks down readily under foot traffic.

(2) Occasional pockets of gravel are found below the 30 cm (12 inch) depth in the soil profile.

Limitations: Moderate to severe. Good source of roadfill and sand. Specific limitations are sandy surface texture, erosion hazard, excessive slope.

MAP UNIT 9

Classification: Orthic Gray Luvisol - 80 percent
Undifferentiated Gleysol - 20 percent

Landform: glaciofluvial blanket overlying hummocky morainal (F_b^G/Mh)

Parent Material: medium to very coarse textured glaciofluvial sediments

Slope: gently rolling (5+ to 9 percent)

Surface Stoniness: non-stony (0)

Drainage: Luvisol - rapidly drained
Gleysol - poorly drained

Vegetation: Luvisol - aspen, alder, balsam poplar, low-bush cranberry, wild rose, raspberry, a few willow and small white spruce

Gleysol - willow, aspen

Profile Description: *Orthic Gray Luvisol*

Horizon	Thickness cm	Thickness inches	Field Texture	Structure	Consistence
L-H	2.5-7.5	1-3	leaf litter		
Ae_1	7.5-25	3-10	fine sandy loam	platy	very friable, moist
Ae_2	7.5-25	3-10	loamy fine sand	platy	loose, moist or dry
Bt	25-50	10-20	sandy clay loam	subangular blocky	very firm, moist; hard, dry
Cca_1	2.5-27.5	1-11	very fine sandy loam to loamy fine sand	amorphous	loose, moist or dry
Cca_2	at 85	at 34	fine sand	amorphous	loose, moist or dry

Comments: (1) The Gleysolic soils are found in small randomly located depressions which individually are of insufficient size to be outlined as separate map units at the scale of mapping employed.

(2) Gleying is occasionally evident in the Cca horizons of the Luvisolic soils.

Limitations: (For the Luvisolic soils): None to slight for all uses. Good source of roadfill and sand. The Gleysolic soils have severe limitations for all uses due to a seasonally high groundwater table or surface ponding.

MAP UNIT 10

Classification: Orthic Luvic Gleysol

Landform glaciofluvial blanket and veneer overlying level morainal (F^{G}_{bv}/M1)

Parent Material: very coarse textured glaciofluvial sediments overlying moderately fine textured till

Slope: gently undulating (0.5+ to 2 percent)

Surface Stoniness: non-stony (0)

Drainage: poorly drained

Vegetation: sparse young growth of willow, white spruce, Canadian buffaloberry, white birch, aspen, balsam poplar, alder, grass, and horsetail

Profile Description: *Orthic Luvic Gleysol*

	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
Of-Oh	10-20	4-8		organic surface layer	
Aeg	7.5	3	fine sandy loam to loamy fine sand	platy	very friable to loose, moist
Btg	15-20	6-8	loam	amorphous, breaking to subangular blocky	very friable, moist
BCg	25-50	10-20	loamy fine sand	amorphous	loose, moist
Ccag	at 50-75	at 20-30	loamy fine sand	amorphous	loose, moist
IICg (till)	at 100+	at 40+	clay loam	amorphous	very firm, moist

Comments: (1) A water table was often encountered at about 100 cm (40 inches) below the surface.

(2) The till was usually more than 100 cm (40 inches) below the surface.

Limitations: Severe for all uses; poor source of roadfill and sand. Specific limitation is a seasonally high groundwater table or surface ponding.

TM (Organic Soil)

Classification: Terric Mesisol

Landform: horizontal bog (Bh)

Parent Material: predominantly intermediately decomposed peat overlying undifferentiated mineral material

Slope: nearly level (0 to 0.5 percent)

Surface Stoniness: non-stony (0)

Drainage: very poorly drained

Vegetation: labrador tea, sphagnum moss, reindeer lichen, a few white spruce

Profile Description: *Terric Mesisol*

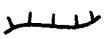
	Thickness				
Horizon	cm	inches	Field Texture	Structure	Consistence
Of	10	4	undecomposed peat		
Om	65	26	intermediately decomposed peat		
IIC	at 75	at 30	undifferentiated mineral material		

Comments: It can be assumed that the mineral material underlying the Terric Mesisol soils will be the same as the parent material of the adjacent mineral soils.

Limitations: Severe for road location; unsuitable for all other uses. Specific limitations are organic soil, seasonally high groundwater table, susceptibility to frost heave and high shrink-swell potential.

MISCELLANEOUS LAND TYPES

(1)  This symbol indicates small wet or water filled depressions, characterized by fringe growths of slough grass, willow and other types of hydrophytic vegetation. The soils were not identified in these areas; however peaty phases of Gleysols can be expected, and they are characterized by organic surface layers ranging from 15 to 40 cm (6 to 16 inches) in thickness. These soils have severe limitations for all uses, due to their extreme wetness and the thickness of the surface organic layers.

(2)  This symbol indicates escarpments. The soils were not differentiated in these areas. They have severe limitations for all uses because of extreme slopes.

SOIL INTERPRETATIONS

Soil interpretations are predictions of soil performance under different uses. They are based on evaluation of the soil to a depth of about 100 cm (40 inches); however, some interpretations can be made below the 150 cm (5 foot) depth. The interpretations are based largely on soil descriptions and observations made during the field soil mapping program. Only surface and shallow subsurface soil samples were collected for routine chemical analyses, while only limited numbers of deeper subsurface samples were collected for engineering tests. Engineering properties of some map units sampled were extrapolated to other map units not sampled, where soils of the different map units were developed on like or very similar parent materials. The results of chemical and physical analyses are given in tables 4 and 5.

It is important that these soil interpretations be viewed with the proper perspective. The interpretations are for soils in the natural, undisturbed state only. Nor are other factors considered, such as location, aesthetic values, and nearness to population centers. A soil survey properly interpreted is a useful guide for general recreation planning and site selection; however, all soil differences found in the field cannot be shown on the soil map. Thus, prior to design and construction of specific recreational facilities, an on-site investigation is usually required.

The soil interpretations are not recommendations for land use, and do not eliminate the need for land use planning. However they are valuable tools for the planner, as they indicate the limitations and suitabilities of various kinds of soil for particular uses. The planner can use the interpretations to help predict the type and degree of problems likely to be encountered, and plan the kind and amount of on-site investigation needed to determine corrective measures. However, the actual number of on-site investigations can be reduced considerably by the use of a soil survey map and accompanying soil interpretations.

Using the basic soil survey data of an area, it is possible to make soil performance predictions, based on field soil morphology and the laboratory determined soil physical and chemical properties. Soils in the provincial parks are used mainly for recreational pursuits and building sites, and as road construction materials.

Definitions of the soil limitation and suitability ratings are as follows (USDA unpublished guide):

(1) A *none to slight* soil limitation is the rating given soils that have properties favorable for the rated use. The degree of limitation is minor and can be overcome easily. Good performance and low maintenance can be expected.

(2) A *moderate* soil limitation is the rating given soils that have properties moderately favorable for the rated use. This degree of limitation can be overcome or modified by

Table 4. Chemical analyses of selected map units[1]

Map Unit	Sample Depth (cm)	Pounds per Acre Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sodium[2]	Sulfur[2]	Soil Reaction (pH)	Conductivity (mmhos/cm)	Sulfate[2]	Organic Matter[2]	Free Lime[2] ($CaCO_3$)	Remarks
1	0-15	8	26	486	L	H+	6.9	0.2	-	L+	-	forest - aspen, balsam poplar, dogwood, rose
1	15-30	6	3	315	L-	M-	6.4	0.3	-	L+	-	
2	0-15	7	38	289	L-	M+	7.1	0.9	-	M-	-	aspen forest
2	15-30	7	5	307	L-	H-	6.5	0.4	-	L+	L	
3	0-15	9	62	218	L-	M-	6.9	0.7	-	L+	-	forest - aspen, rose
3	15-30	12	6	196	L-	L-	6.7	1.2	M-	L+	-	
4	0-15	10	86	466	L-	M	7.5	0.2	-	L+	-	forest - aspen, rose
4	15-30	12	9	457	L-	L	7.7	0.2	-	L+	-	
5	0-15	7	2	471	L-	H-	7.9	0.4	-	L+	L+	cleared area - grass, rose, willow
5	15-30	8	2	429	L-	M+	7.2	0.3	-	L+	L	
6	0-15	6	47	266	L-	M	6.1	0.2	-	L+	-	forest - white spruce, white birch
6	15-30	6	14	72	L-	L-	7.4	0.3	-	L+	H-	
7	0-15	6	110	280	L	L	7.6	0.5	-	L+	-	forest - white spruce, aspen, white birch, rose, grass, bearberry
7	15-30	6	90	127	L-	M-	6.8	0.7	-	L+	-	
8	0-15	6	138	240	L-	L+	7.7	0.3	-	L+	-	forest - aspen, white spruce, white birch, alder, grass, bearberry
8	15-30	6	84	108	L-	L-	8.3	0.3	-	L+	-	
9	0-15	7	168	215	L-	L	7.1	0.3	-	L+	-	aspen forest
9	15-30	8	106	167	L-	M	7.6	0.3	-	L+	-	

[1] Chemical analyses done by Alberta Soil and Feed Testing Laboratory

[2] These tests are rated into four categories: High (H), Medium (M), Low (L), and none (-). The degree within each category is indicated by a + or - sign. The tests for organic matter and free lime are visual estimates only.

Table 5. Physical analyses of selected map units[1]

Map Unit	Depth (cm)	Field Moisture (%)	Mechanical analysis: Percentage passing sieve 1 inch	3/4 inch	5/8 inch	#4 (4.7 mm)	#10 (2.0 mm)	#40 (0.42 mm)	#200 (0.074 mm)	Percentage smaller than 0.05 mm	0.005 mm	0.002 mm	0.001 mm	Liquid Limit	Plasticity Index	Optimum Moisture (%)[2]	Maximum Dry Density (lb/ft³)[2]	Classification AASHO	Unified	USDA
1	90-120	27	100	100	100	100	100	100	100	97	74	54	46	60	30	31	87.5	A-7-5 (20)	CH	SiC
1	90-120	7	100	100	100	100	100	100	81	67	19	16	15	28	5	23	97.5	A-4 (8)	ML	SiL
2	90-120	24	100	100	100	100	100	100	99	97	90	79	66	72	41	32	85.0	A-7-5 (20)	CH	HC
3	90-120	11	100	100	99	97	96	92	74	73	57	38	30	39	14	26	94.0	A-6 (10)	CL	C

[1] Map Units developed on similar parent material: 1, 5 and 6; 3 and 4.

[2] These values are obtained from charts worked out by the Highways Testing Laboratory, Alberta Transportation.

special planning, design, or maintenance. During some part of the year the performance of the planned use is somewhat less desirable than for soils rated slight. Some soils rated moderate require treatment such as artificial drainage, runoff control to reduce erosion, extended sewage absorption fields, extra excavation, or some modification of certain features through manipulation of the soil. For these soils, modification is needed for construction plans generally used for soils of slight limitation. Modification may include special foundations, extra reinforcement of structures, sump pumps, and the like.

(3) A *severe* soil limitation is the rating given soils that have one or more properties unfavorable for the rated use, such as steep slopes, bedrock near the surface, flooding hazard, high shrink-swell potential, a seasonal high water table, or a sandy surface texture. This degree of limitation generally requires major soil modification, special design, or intensive maintenance. Modification might require the soil material to be removed or replaced. Some of these soils can be improved by reducing or removing the soil feature that limits its use, but in most situations it is difficult and costly to alter the soil or to design a structure so as to compensate for a severe degree of limitation.

(4) A rating of *good* means the soils have properties favorable for the rated use. Good performance and minimal maintenance can be expected.

(5) A rating of *fair* means the soil is moderately favorable for the rated use. One or more soil properties make these soils less desirable than those rated good.

(6) A rating of *poor* means the soil has one or more properties unfavorable for the rated use. Overcoming the unfavorable property requires special design, extra maintenance, or costly alteration.

(7) A rating of *unsuitable* means the soil cannot be used for the rated use.

Soils of map units 7 and 9 are the best suited for recreational uses, and these as well as soils of map unit 8 are the most suitable for road construction in the mapped area. In general, most other soils have moderate limitations, except in those areas where excessive slopes result in severe limitations. Soils of map units 1, 5, and 6 are susceptible to flooding; soils of map units 1, 2, and 5 may be slippery or sticky when wet; soils of map units 2 and 3 exhibit slow permeability; soils of map units 1, 3, 4, and 5 have a moderate shrink-swell potential; soils of map units 3 and 4 are moderately susceptible to frost heaving; and map unit 5 soils have moderate limitations due to a seasonally high groundwater table or surface ponding. Map unit 8 soils have moderate limitations for recreation due to sandy surface textures, which make them susceptible to wind erosion. Soils of map units 1, 2, and 5 have severe limitations for road construction because of susceptibility to frost

Table 6. Soil limitations for primitive camping areas[1]

Map Symbol[2]	Degree of Limitation			
	None to Slight	Moderate	Severe	Unsuitable
1/c0 1/d0		Flood Slip		
2/c0 2/d0 2/e0		Slip Clay Sl Perm		
3/c1 3/d1		Clay Sl Perm		
3/f1		Slope Clay Sl Perm		
4/g2		Slip	Slope Er	
4/H2		Slip		Slope Er
5/b0		Wet Flood Slip		
6/c0		Flood		
7/c2	NL			
8/c0 8/e0		Sandy Er		
8/f0		Slope Sandy Er		
9/d0	NL			
10/b0			Wet	
TM/a0			Org Wet	

[1]Surface stoniness was not considered in determining these ratings.

[2]For explanation, see section entitled SOILS.

Abbreviations

Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
NL - No limitations
Org - Organic soil
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Sl Perm - Slow permeability
Wet - Seasonally high groundwater table or surface ponding

heave; and in addition, map unit 2 soils have a high shrink-swell potential. Map unit 4 soils are severely limited or are unsuitable for all uses due to excessive slopes; and map unit 10 soils have severe limitations due to a seasonally high groundwater table or surface ponding. The Terric Mesisol soils are severely limited for road construction, and unsuitable for all other uses, because of extreme wetness and the inherent properties of Organic soils. Severe limitations do not necessarily prevent the use of certain soils for recreational purposes; however, when planning development and construction of park facilities, it is important to bear the limitations in mind, since to alleviate them may require careful or expensive construction procedures. Soils of most map units are unsuitable as sources of sand or gravel, due to unsuitable textures; however, map unit 7 soils constitute a good source of gravel, and soils of map units 8 and 9 are good sources of sand.

Table 7. Soil limitations for fully serviced campgrounds[1]

Map Symbol[2]	Degree of Limitation			
	None to Slight	Moderate	Severe	Unsuitable
1/c0 1/d0		Flood Slip		
2/c0 2/d0		Slip Clay Sl Perm		
2/e0		Slope Slip Sl Perm		
3/c1 3/d1		Clay Sl Perm		
3/f1		Clay Sl Perm	Slope	
4/g2 4/H2		Slip		Slope Er
5/b0		Wet Flood Slip		
6/c0		Flood		
7/c2	NL			
8/c0		Sandy Er		
8/e0		Slope Sandy Er		
8/f0		Sandy Er	Slope	
9/d0	NL			
10/b0			Wet	
TM/a0			Org Wet	

[1]Surface stoniness was not considered in determining these ratings.

[2]For explanation, see section entitled SOILS.

Abbreviations

Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
NL - No limitations
Org - Organic soil
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Sl Perm - Slow permeability
Wet - Seasonally high groundwater table or surface ponding

The limitations and suitabilities of the various soils for selected uses are shown in tables 6 to 12 inclusive. The ratings were determined on the basis of the morphological, physical, and chemical properties of the soils, as well as steepness of slope. The principal limiting properties are indicated, and are generally listed in decreasing order of importance.

Limitations due to slope are not further subdivided once the slope becomes steep enough to cause a severe limitation for a specified use. It follows, however, that the steeper the slope, the more severe the limitation, and this fact should be kept in mind while using the soil interpretation tables. In tables 6 to 10 inclusive, the soil limitations for various uses have been designated as none to slight, moderate, severe, and unsuitable. In tables 11 and 12, the suitability of soils as sources of roadfill and as sources of sand or gravel respectively, have been designated as good, fair, poor, and unsuitable.

Table 8. Soil limitations for paths[1]

Map Symbol[2]	Degree of Limitation			
	None to Slight	Moderate	Severe	Unsuitable
1/c0 1/d0		Slip		
2/c0 2/d0		Slip		
2/e0		Slope Er Slip		
3/c1 3/d1	NL			
3/f1			Slope Er	
4/g2 4/H2			Slope Er Slip	
5/b0		Wet Slip		
6/c0	NL			
7/c2	NL			
8/c0		Sandy Er		
8/e0		Slope Sandy Er		
8/f0		Sandy Er	Slope	
9/d0	NL			
10/b0			Wet	
TM/a0			Org Wet	

[1]Surface stoniness was not considered in determining these ratings.

[2]For explanation, see section entitled SOILS.

Abbreviations

Er - Erosion hazard
NL - No limitations
Org - Organic soil
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Wet - Seasonally high groundwater table or surface ponding

Table 9. Soil limitations for trails[1]

Table 9. Soil Limitations for Trails[1]

Map Symbol[2]	Degree of Limitation			
	None to Slight	Moderate	Severe	Unsuitable
1/c0 1/d0		Slip		
2/c0 2/d0 2/e0		Slip		
3/c1 3/d1	NL			
3/f1		Slope Er		
4/g2 4/H2			Slope Er Slip	
5/b0		Wet Slip		
6/c0	NL			
7/c2	NL			
8/c0 8/e0		Sandy Er		
8/f0		Slope Sandy Er		
9/d0	NL			
10/b0			Wet	
TM/a0			Org Wet	

[1]Surface stoniness was not considered in determining these ratings.

[2]For explanation, see section entitled SOILS.

Abbreviations

Er - Erosion hazard
NL - No limitations
Org - Organic soil
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Wet - Seasonally high groundwater table or surface ponding

Table 10. Soil limitations for road location[1]

Map Symbol[2]	Degree of Limitation			
	None to Slight	Moderate	Severe	Unsuitable
1/c0 1/d0		M. Sh-Sw	Frost	
2/c0 2/d0			Clay Sh-Sw Frost	
2/e0		Slope	Clay Sh-Sw Frost	
3/c1 3/d1		Clay M. Sh-Sw Frost		
3/f1		Clay M. Sh-Sw Frost	Slope	
4/g2		Clay M. Sh-Sw Frost	Slope	
4/H2		Clay M. Sh-Sw Frost		Slope
5/b0		Wet M. Sh-Sw	Frost	
6/c0		Flood		
7/c2	NL			
8/c0	NL			
8/e0		Slope Er		
8/f0			Slope Er	
9/d0	NL			
10/b0			Wet	
TM/a0			Org Wet Frost Sh-Sw	

[1] Stoniness was not considered in determining these ratings.

[2] For explanation, see section entitled SOILS.

Abbreviations

Clay - High clay content
Flood - Flooding hazard (overflow)
Frost - Susceptibility to frost heave
M. Sh-Sw - Moderate shrink-swell potential
NL - No limitations
Org - Organic soil
Sh-Sw - High shrink-swell potential
Slope - Excessive slope
Wet - Seasonally high groundwater table or surface ponding

Table 11. Soil suitability as source of roadfill[1]

Map Symbol[2]	Degree of suitability			
	Good	Fair	Poor	Unsuitable
1/c0 1/d0		M. Sh-Sw	Frost	
2/c0 2/d0 2/e0			Clay Sh-Sw Frost	
3/c1 3/d1		Clay M. Sh-Sw Frost		
3/f1		Clay M. Sh-Sw Frost Slope		
4/g2		Clay M. Sh-Sw Frost	Slope	
4/H2		Clay M. Sh-Sw Frost		Slope
5/b0		Wet M. Sh-Sw	Frost	
6/c0	NL			
7/c2	NL			
8/c0 8/e0	NL			
8/f0		Slope Er		
9/d0	NL			
10/b0			Wet	
TM/a0				Org Wet Frost Sh-Sw

[1] Stoniness was not considered when determining these ratings.

[2] For explanation, see section entitled SOILS.

ABBREVIATIONS

Clay - High clay content
Er - Erosion Hazard
Frost - Susceptibility to frost heave
M. Sh-Sw - Moderate shrink-swell potential
NL - No limitations
Org - Organic soil
Sh-Sw - High shrink-swell potential
Slope - Excessive slope
Wet - Seasonally high groundwater table or surface ponding

Table 12. Soil suitability as source of sand or gravel

Map Symbol[1]	Degree of suitability			
	Good	Fair	Poor	Unsuitable
1/c0 1/d0				Text
2/c0 2/d0 2/e0				Text
3/c1 3/d1 3/f1				Text
4/g2 4/H2				Text
5/b0				Text
6/c0			Text	
7/c2	NL			
8/c0 8/e0 8/f0	NL			
9/d0	NL			
10/b0			Wet	
TM/a0				Org Wet

[1] For explanation, see section entitled SOILS.

ABBREVIATIONS

NL - No limitations
Org - Organic soil
Text - Unsuitable texture
Wet - Seasonally high groundwater table or surface ponding

REFERENCES

Acton, D.F. (1975): A landform mapping system for Canadian soil surveys; Saskatchewan Institute of Pedology Publication M26, Saskatoon, Canada, 19 pages.

Alberta Transportation (1955): Plots of plasticity index vs liquid limit showing standard proctor optimum moisture content in percent and maximum density in pounds per cu ft; Highway Testing Laboratory, Edmonton, Canada.

American Society for Testing and Materials (1970): Annual Book of ASTM Standards, Part 11; Philadelphia, U.S.A., 982 pages.

Bohart, C.V. (1968): Good recreation area design helps prevent site deterioration; Journal of Soil and Water Conservation, Vol. 23, p. 21-22.

Brady, N.C. (1974): The Nature and Properties of Soils, 8th edition; MacMillan Publishing Co. Ltd., New York, U.S.A., 639 pages.

Canada Department of Agriculture (1974): The system of soil classification for Canada; Queen's Printer, Ottawa, 255 pages.

Canada Department of Agriculture, Research Branch (1976): Glossary of terms in soil science. Publication 1459 (Revised). Information Canada, Ottawa, 44 pages.

Canada Soil Survey Committee, Subcommittee on Soil Classification (1978): The Canadian system of soil classification. Can. Dep. Agric. Publ. 1646. Supply and Services Canada, Ottawa, 164 pages.

Canada Energy, Mines and Resources (1973): The National Atlas of Canada, 4th Edition; Surveys and Mapping Branch, Ottawa, 254 pages.

Canada Soil Survey Committee (1976): The Canadian system of soil classification (draft copy); Agriculture Canada, Ottawa, 171 pages.

Carson, J.A., Crepin, J.M. and Nemunis-Siugzdinis, P. (1972): A sulphate-sulphur method used to delineate the sulphur status of soils; Canadian Journal of Soil Science, Vol. 52, p. 278-281.

Clayton, J.S., Ehrlich, W.A., Cann, D.B., Day, J.H. and Marshall, I.B. (1977): Soils of Canada, Vol. 1, Soil Report; Research Branch, Canada Department of Agriculture, Ottawa, 243 pages.

Conard, H.S. (1956): How to Know the Mosses and Liverworts; Wm. C. Brown Co., Dubuque, Iowa, U.S.A., 226 pages.

Day, J.H. (editor) (1974): Proceedings of the Canada Soil Survey Committee Organic Soil Mapping Workshop, held at Winnipeg, Manitoba; Soil Research Institute, Central Experimental Farm, Ottawa, 98 pages.

Densmore, J. and Dahlstrand, N.P. (1965): Erosion control on recreation land; Journal of Soil and Water Conservation, Vol. 20, p. 261-262.

Dickman, S.R. and Bray, R.H. (1940): Colorimetric determination of phosphate; Industrial and Engineering Chemistry, Analysis Edition, Vol. 12, p. 665-668.

Dooling, P.J. (1969): Soils, carrying capacity, and resource based recreation systems; Report of 4th Annual British Columbia Soil Science Workshop, British Columbia Department of Agriculture, Victoria, Canada.

Dotzenko, A.D., Papamichos, N.T. and Romine, D.S. (1967): Effect of recreational use on soil and moisture conditions in Rocky Mountain National Park; Journal of Soil and Water Conservation, Vol. 22, p. 196-197.

Emmons, W.H., Allison, I.S., Stauffer, C.R. and Thiel, G.A. (1960): Geology: Principles and Processes, 5th edition; McGraw-Hill Book Co. Inc., New York, Toronto, London, 491 pages.

Environment Canada: Monthly record meteorological observations in Canada, 1964 to 1973; Information Canada, Ottawa.

Epp, P.F. (1977): Guidelines for assessing soil limitations for trails in the southern Canadian Rockies; unpublished M.Sc. thesis, Department of Soil Science, Edmonton, Canada, 164 pages.

Frissel, S.S. and Duncan, D.P. (1965): Campsite preference and deterioration in the Quetico-Superior canoe country; Journal of Forestry, Vol. 63, p. 256-260.

Greenlee, G.M. (1976): Soil survey of Kananaskis Lakes area and interpretations for recreational use; Alberta Research Council, Open File Report 76-1, Edmonton, Canada, 87 pages.

Hale, M.E. (1969): How to Know the Lichens; Wm. C. Brown Co., Dubuque, Iowa, U.S.A., 226 pages.

Hoyt, P.B. and Nyborg, M. (1971): Toxic metals in acid soils: I. estimation of plant-available aluminum; Soil Science Society of America Proceedings, Vol. 35, p. 236-240.

_____ (1971): Toxic metals in acid soils: II. estimation of plant-available manganese; Soil Science Society of America Proceedings, Vol. 35, p. 241-244.

Jackson, M.L. (1962): Soil Chemical Analysis; Prentice-Hall Inc., Englewood Cliffs, New Jersey, U.S.A., 498 pages.

Means, R.E. and Parcher, J.V. (1964): Physical Properties of Soils; Charles E. Merrill, Columbus, Ohio, U.S.A., 464 pages.

Moss, E.H. (1959): Flora of Alberta; University of Toronto Press, Toronto, Canada, 546 pages.

Pluth, D. (1969): Soil classification and soil survey as a basis for land use planning; Report of the 4th Annual British Columbia Soil Science Workshop, British Columbia Department of Agriculture, Victoria, Canada.

Portland Cement Association (1962): PCA Soil Primer; Portland Cement Association, Chicago, Illinois, U.S.A., 52 pages.

Richards, L.A. (editor) (1954): Diagnosis and Improvement of Saline and Alkali Soils; Handbook 60, United States Department of Agriculture, Washington, D.C., 160 pages.

Rowe, J.S. (1972): Forest regions of Canada; Canadian Forestry Service, Department of Environment, Publication No. 1300, Ottawa, 172 pages.

Scheelar, M.D. and Odynsky, Wm. (1968): Reconnaissance soil survey of the Grimshaw and Notikewin area; University of Alberta Bulletin No. SS-8, 80 pages.

Simonson, R.W. (1957): What Soils Are; *in* Soil, the 1957 Yearbook of Agriculture, United States Department of Agriculture, Washington, D.C., p. 17-31.

Stevens, M.E. (1966): Soil surveys as applied to recreation site planning; Journal of Forestry, Vol. 64, p. 314-316.

Terzaghi, K. and Peck, R.B. (1967): Soil Mechanics in Engineering Practice, 2nd edition; John Wiley and Sons Inc., New York, 729 pages.

United States Department of Agriculture (1957): The Yearbook of Agriculture; United States Department of Agriculture, Washington, D.C., 78 pages.

United States Department of Agriculture (undated): Procedure Guide, Section 400 - Application of Soil Survey Information: 403 - Rating Soils for Selected Uses; unpublished guide for interim use, Soil Conservation Service, United States Department of Agriculture.

APPENDIX A

SOIL FORMATION

Soil is continuous over all the earth's land surfaces, except steep and rugged mountain peaks and lands of ice and snow (Simonson, 1957), and areas where it has been removed by man's activities. Soils may be regarded as products of their environment (Clayton *et al.*, 1977). They are not static, but dynamic, and will change with modifications in the environment. The most important factors determining the kinds of soils that develop are climate, vegetation, organisms, relief, time, and parent material. Because these factors and the interrelationships between them vary, the various soils that have developed differ from one another, both locally and regionally. The differences may be small or large, depending upon the nature of the factors involved; variations in climate and parent material, in particular, can cause large differences among soils.

IDENTIFICATION OF SOIL PROFILES AND HORIZONS

The soil profile as viewed in vertical section is a succession of layers or horizons approximately parallel to the land surface, and extending from the surface of the soil down into the underlying and relatively unchanged geological material (Clayton *et al.*, 1977). These horizons reflect the historical development of soil from the original parent material which involved the processes of physical breakdown or weathering of rock fragments, the chemical weathering or alteration and solution of rock and mineral particles, biological activities including the growth of plants and decomposition of plant material, and the production of humus (soil organic matter) by the work of macro and micro soil organisms. These processes change the material, transfer components from one part of the soil to another, and cause the development of soil structure. Each soil horizon differs from adjacent genetically related layers in properties such as color; structure; texture; consistence; and chemical, biological, and mineralogical composition.

The A horizon, the uppermost layer in the mineral soil profile, usually is the part of the soil in which organic matter is most plentiful. In soils formed under forest cover, clay particles, organic matter, iron and aluminum oxides have been leached from the A horizon, both in suspension and in solution.

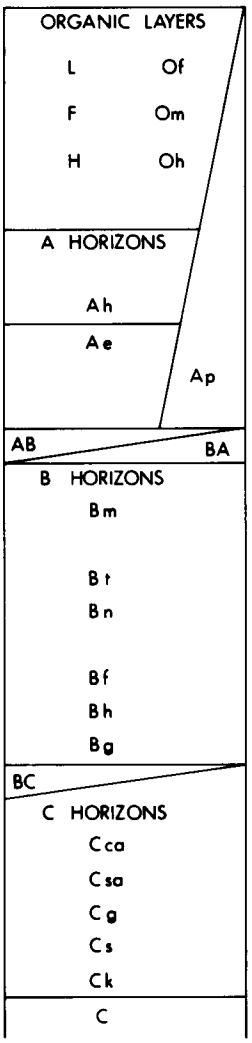
The B horizon, where present, lies immediately beneath the A, often of a color that is transitional between that of the A and C horizons. The B horizon commonly has more clay than either the A or the C horizon, and may have a blocky or prismatic structure. Concentrations of iron or aluminum oxides, usually in combination with organic matter, mark the B horizons of some soils.

Table 13. Outline of Canadian soil classification system

Order	Great Group	Distinguishing Characteristics
Brunisolic (Sufficient development to exclude them from the Regosolic order, but lack degrees or kinds of development specified for other orders)	Melanic Brunisol	Ah > 10 cm (4 inches), pH > 5.5
	Eutric Brunisol	Ah < 10 cm (4 inches), pH > 5.5
	Sombric Brunisol	Ah > 10 cm (4 inches), pH < 5.5
	Dystric Brunisol	Ah < 10 cm (4 inches), pH < 5.5
Chernozemic (Surface horizons darkened by accumulation of organic matter from decomposition of xerophytic or mesophytic plants representative of grasslands or grassland-forest with associated plants)	Brown	Brownish Ah, subarid to semiarid climate
	Dark Brown	Dark brown Ah, semiarid climate
	Black	Black Ah, subhumid climate
	Dark Grey	Surface L-H, eluvial Ah, subhumid climate
Cryosolic (Permafrost within 1 m of surface, or 2 m if > 1/3 of pedon strongly cryoturbated)	Turbic Cryosol	Mineral soil, cryturbation, permafrost within 2 m (80 inches) of surface, usually patterned ground
	Static Crysol	Mineral soil, no cryoturbation, permafrost within 1 m (40 inches) of surface
	Organic Cryosol	Organic soil, permafrost within 1 m (40 inches) of surface
Gleysolic (Features indicative of periodic or prolonged water saturation, and reducing conditions - mottling and gleying)	Humic Gleysol	Ah ≥ 10 cm (4 inches), no Bt
	Gleysol	Ah < 10 cm (4 inches), no Bt
	Luvic Gleysol	Has a Btg, usually has an Ahe or an Aeg
Luvisolic (Light colored eluvial horizons - Ae, illuvial B horizons of silicate clay accumulation - Bt, developed under forest vegetation)	Gray Brown Luvisol	Forest mull Ah, Ae and Bt, MAST[1] > 8°C
	Gray Luvisol	May or may not have Ah, has Ae and Bt, usually MAST[1] < 8°C.
Organic (Composed dominantly of organic materials, most are water saturated for prolonged periods)	Fibrisol	Dominantly fibric
	Mesisol	Dominantly mesic
	Humisol	Dominantly humic
	Folisol	Forest leaf litter over rock or fragmental material, rarely water saturated
Podzolic (Accumulation in B horizons of amorphous material, composed mainly of humified organic matter combined in varying degrees with Al and Fe)	Humic Podzol	Bh ≥ 10 cm (4 inches), OC[2] > 1%, Fe < 0.3%, OC[2] /Fe ≥ 20.
	Ferro-Humic Podzol	Bhf ≥ 10 cm (4 inches), OC[2] > 5%, Fe + Al ≥ 0.6% (0.4% for sands)
	Humo-Ferric Podzol	Bf or thin Bhf + Bf ≥ 10 cm (4 inches), OC[2] = 0.5 - 5% Fe + Al ≥ 0.6% (0.4% for sands)
Regosolic (Development too weak to meet requirements of any other order)	Regosol	Ah < 10 cm (4 inches), Bm absent or < 5 cm (2 inches)
	Humic Regosol	Ah ≥ 10 cm (4 inches), Bm absent or < 5 cm (2 inches)
Solonetzic (Solonetzic B horizon - Bn or Bnt - columnar or prismatic structure, hard to extremely hard when dry, exchangeable Ca/Na ≤ 10)	Solonetz	Lack a continous Ae ≥ 2 cm (1 inch)
	Solodized Solonetz	Ae ≥ 2 cm (1 inch), intact columnar Bnt or Bn
	Solod	Ae ≥ 2 cm (1 inch), distinct AB or BA (disintegrating Bnt)

[1] MAST - mean annual soil temperature

[2] OC - organic carbon



L-F-H	well drained decomposing plant litter, primarily leaves, twigs, woody materials. L - slightly decomposed, F - partly decomposed, H - well decomposed.
O	poorly drained decomposing peat, mainly mosses, rushes, woody materials. Of - fibric - least decomposed; Om - mesic - moderately decomposed; Oh - humic - most highly decomposed.
A	Organic - mineral horizons at or near the surface.
	Ah - dark colored, humus-rich horizon
	Ae - light colored, eluviated horizon, characterized by removal of clay, iron, aluminum or organic matter, alone or in combination.
	Ap - horizons disturbed by man's activities, that is, by cultivation, or pasturing, or both.
AB, BA	horizons transitional to A and B.
B	a mineral horizon differing from A and C by the following characteristics:
	m - slightly altered by hydrolysis, oxidation, or solution or all three, to give a change in color, or structure or both.
	t - a significant accumulation of silicate clay.
	n - a columnar or prismatic structure, hard consistence when dry and significantly high exchangeable sodium.
	f - a significant accumulation of Fe + Al combined with organic matter.
	h - a significant accumulation of illuvial organic matter.
	g - a significant expression of gleying.[1]
BC	a horizon transitional to B and C.
C	a horizon comparitively unaffected by soil forming processes, except for:
	ca - an accumulation of lime.
	sa - an accumulation of water-soluble salts.
	g - a significant expression of gleying.
	s - denotes the presence of salts, including gypsum ($CaSO_4$).
	k - denotes the presence of lime.

[1] "Gleying" refers to a soil forming process operating under poor drainage conditions, which result in the reduction of iron and other elements, in gray colors, and mottles.

NOTE:
The lower case letters shown above in the A, B and C horizons are sometimes combined to express combinations of characteristics.

FIGURE 3. Diagram of a soil profile and definitions of soil horizon symbols (CSSC 1976). Copied from the National Atlas of Canada (1973).

The C horizon is the deepest of the three major horizons, and constitutes the parent material of soils. It may have accumulated in place from the breakdown of hard rock, or it may have been moved to its present location by water, wind, or ice. The C horizon is comparatively unaffected by soil-forming processes, except gleying and the accumulation of calcium and magnesium carbonates, and water soluble salts. It is commonly lighter colored than the A or B horizons.

A particular soil is recognized by identifying the various layers or horizons that make up its profile, and a system has been devised to facilitate this recognition (Clayton *et al.*,

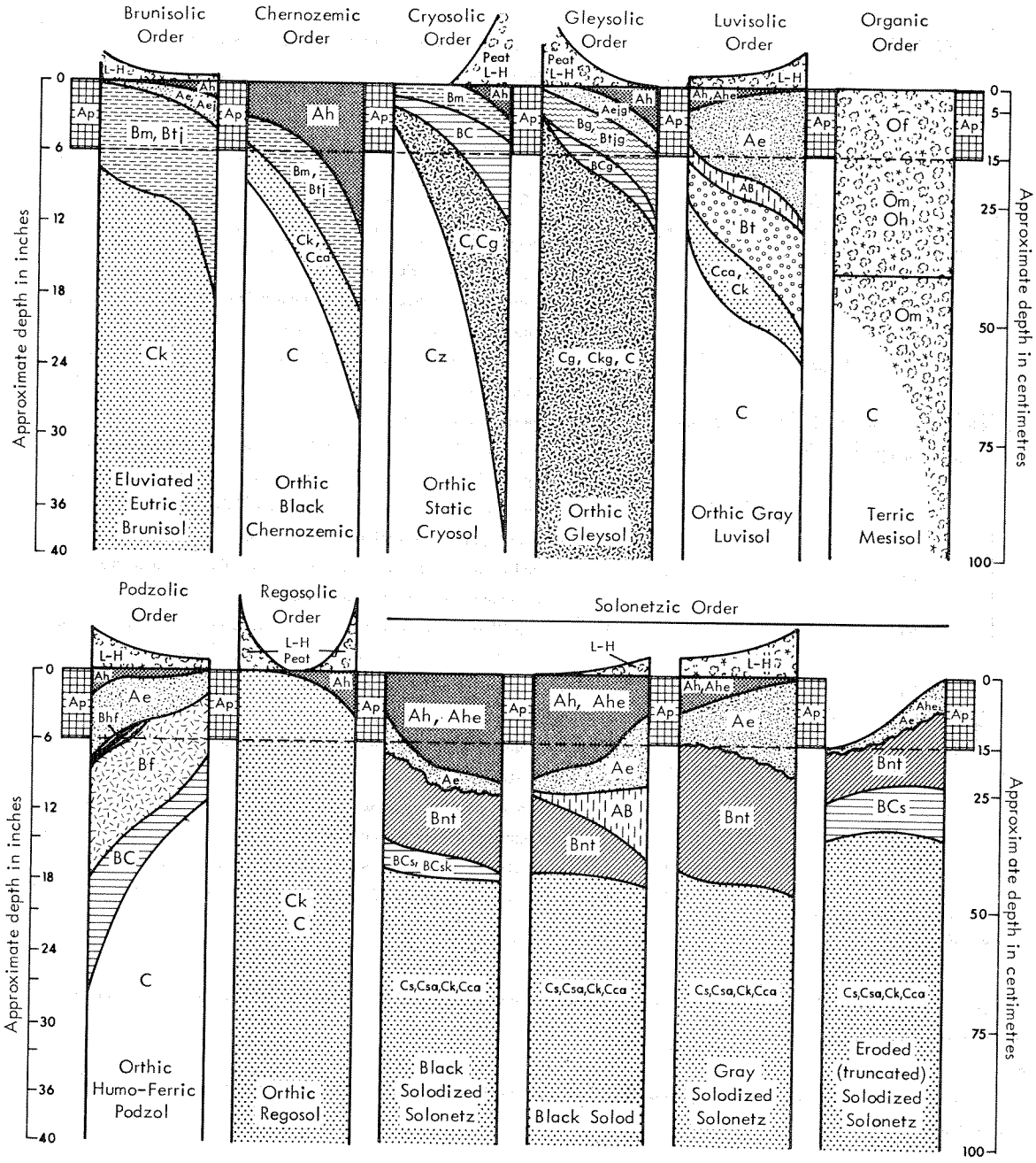


FIGURE 4. Diagrammatic horizon patterns of some representative soil profiles (CDA 1974).

1977). This system involves the recognition of major organic layers, master mineral horizons and layers, and further subdivision of these horizons by designation of features secondary or subordinate to those characteristics of the main horizons. The Canadian System of Soil Classification (CSSC, 1978) provides a comprehensive outline of the classification scheme and the official criteria for identification of horizons and layers. Figure 3 gives more generalized definitions of the soil horizons, and the symbols used to designate them in profile descriptions. Table 13 gives a generalized outline of the Canadian soil classification system. Figure 4 gives diagrammatic horizon patterns of some representative soil profiles from the various orders.

GLOSSARY

adsorption complex - The group of substances in the soil capable of adsorbing water and nutrients.

alluvium - A general term for all detrital material deposited or in transit by streams, including gravel, sand, silt, clay and all variations and mixtures of these.

amorphous - Without definite form or shape.

bedrock - The solid rock underlying soils and the regolith in depths ranging from zero (where exposed by erosion) to several hundred feet.

blanket - A mantle of unconsolidated materials thick enough to mask minor irregularities in an underlying landform, but still conforming to the general underlying topography.

cation - An ion carrying a positive charge of electricity. The common soil cations are calcium, magnesium, sodium, potassium, and hydrogen.

cation exchange - The interchange between a cation in solution and another on the surface of any surface-active material such as clay or organic matter.

cation exchange capacity - The total amount of exchangeable cations that a soil can adsorb.

conservation, soil - (1) Protection of the soil against physical loss by erosion or against deterioration; that is, excessive loss of fertility by either natural or artificial means. (2) A combination of all methods of management and land use that safeguard the soil against depletion or deterioration by natural or man-induced factors.

consistence, soil - (1) The resistance of a material to deformation or rupture. (2) The degree of cohesion or adhesion of the soil mass. Terms used for describing consistence at various soil moisture contents are:

(a) **extremely hard** - Consistence at which dry soil material is extremely resistant to pressure and cannot be broken in the hands.

(b) **firm** - Consistence at which moist soil material crushes under moderate pressure between the thumb and forefinger, but resistance is distinctly noticeable.

(c) **friable** - Consistence at which moist soil material crushes easily under gentle to moderate pressure between the thumb and forefinger, and coheres when pressed together.

(d) **hard** - Consistence at which dry soil material is moderately resistant to pressure; it can be broken in the hands without difficulty, but considerable pressure is necessary to break it between the thumb and forefinger.

(e) **loose** - Consistence at which dry or moist soil material is noncoherent.

(f) **nonplastic** - Consistence of soil material at which a roll 4 cm long and 4 mm thick (1-1/2 x 1/8 inch) cannot be formed.

(g) **nonsticky** - Consistence of wet soil material at which after the release of pressure, practically no soil material adheres to the thumb and forefinger.

(h) **plastic** - Consistence of soil material at which a roll 4 cm long and 2 mm thick (1-1/2 x 1/16 inch) can be formed but will not support its own weight.

(i) **rigid** - Consistence at which dry soil material cannot be broken except by extreme pressure.

(j) **slightly hard** - Consistence at which dry soil material is weakly resistant to pressure and easily broken between the thumb and forefinger.

(k) **slightly plastic** - Consistence of soil material at which a roll 4 cm long and 4 mm thick (1-1/2 x 1/8 inch) can be formed but will not support its own weight.

(l) **slightly sticky** - Consistence of wet soil material at which after pressure is applied, the soil material adheres to both the thumb and forefinger, but comes off one or the other rather cleanly. The soil is not appreciably stretched when the digits are separated.

(m) **soft** - Consistence at which dry soil material is weakly coherent and fragile, and breaks to a powder or individual grains under very slight pressure.

(n) **sticky** - Consistence of wet soil material at which after pressure is applied, the soil material adheres strongly to both the thumb and forefinger, and tends to stretch somewhat and pulls apart rather than pulling free from either digit.

(o) **very firm** - Consistence at which moist soil material is crushable between the thumb and forefinger, but strong pressure is required.

(p) **very friable** - Consistence at which moist soil material is crushed under very gentle pressure, but coheres when pressed together.

(q) **very hard** - Consistence at which dry soil material is very resistant to pressure; it can be broken in the hands only with difficulty, and is not breakable between the thumb and forefinger.

(r) **very plastic** - Consistence of soil material at which a roll 4 cm long and 2 mm thick (1-1/2 x 1/16 inch) can be formed and will support its own weight.

(s) **very sticky** - Consistence of wet soil material at which after pressure is applied, the soil material adheres strongly to both the thumb and forefinger, and is decidedly stretched when they are separated.

cryoturbation - All disturbances of the soil resulting from frost action; for example frost heaving, solifluction.

Cumulic Regosol - A subgroup of soils in the Regosolic order. They have, either from the surface or below any thin Ah horizon, layers that vary in color or organic matter contents irregularly with depth.

drainage - The removal of excess surface water or groundwater from land by natural runoff and percolation, or by means of surface or subsurface drains.

drainage classes, soil - These are defined in terms of available water storage capacity (AWSC) and source of water. Soil drainage refers to the rapidity and extent of removal of water from soils in relation to additions. It is affected by a number of factors acting separately or in combination; including texture, structure, slope gradient, length of slope, water holding capacity, and evapotranspiration.

(a) **very rapidly drained** - Water is removed from the soil very rapidly in relation to supply. Excess water flows downward very rapidly if underlying material is pervious. There may be very rapid subsurface flow during heavy rainfall, provided there is a steep gradient. Soils have very low AWSC (usually <1 inch or 2.5 cm) within the control section, and are usually coarse textured and/or shallow. Water source is precipitation.

(b) **rapidly drained** - Water is removed from the soil rapidly in relation to supply. Excess water flows downward if underlying material is pervious. Subsurface flow may occur on steep gradients during heavy rainfall. Soils have low AWSC (1 to 1.5 inches or 2.5 to 3.8 cm) within the control section, and are usually coarse textured and/or shallow. Water source is precipitation.

(c) **well drained** - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material, or laterally as subsurface flow. Soils have intermediate AWSC (1.5 to 2 inches or 3.8 to 5 cm) within the control section, and are generally intermediate in texture and depth. Water source is precipitation. On slopes subsurface flow may occur for short durations, but additions are equalled by losses.

(d) **moderately well drained** - Water is removed from the soil somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient or some combination of these. Soils have intermediate to high AWSC (2 to 2.5 inches or 5 to 6.2 cm) within the control section, and are usually medium to fine textured. Precipitation is the dominant water source in medium to fine textured soils; precipitation and significant additions by subsurface flow are necessary in coarse textured soils.

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

(f) **poorly drained** - Water is removed so slowly in relation to supply that the soil remains wet for a comparatively large part of the time that the soil is not frozen. Excess water is evident in the soil for a large part of the time. Subsurface and/or groundwater flow in addition to precipitation are the main water sources; there may also be perched water tables with precipitation exceeding evapotranspiration. Soils have wide ranges in AWSC, textures and depth; and are gleyed subgroups, gleysols and organics.

(g) **very poorly drained** - Water is removed from the soil so slowly that the water table remains at or on the surface the greater part of the time that the soil is not frozen. Excess water is present in the soil the greater part of the time. Groundwater and subsurface flow are the major water sources. Precipitation is of lesser importance except where there is a perched water table with precipitation exceeding evapotranspiration. Soils have a wide range in AWSC texture and depth; and are either gleysolic or organic.

drift, glacial - Rock debris transported by glaciers and deposited either directly from the ice or from the meltwater.

droughty soil - Sandy or very rapidly drained soil.

electrical conductivity, soil - Measurement on a saturated soil paste or a water extract from the saturated soil, made to estimate the salt content of the soil.

eluviation - The transportation of soil material in suspension or in solution within the soil by the downward or lateral movement of water.

erosion - The wearing away of the land surface by running water, wind, ice or other geological agents, including such processes as gravitational creep.

escarpment - A steep face or ridge of high land.

exchangeable cation - A cation that is held by the adsorption complex of the soil and is easily exchanged with other cations of neutral salt solutions.

fan - An accumulation of debris brought down by a stream on a steep gradient and debouching on a gently sloping plain in the shape of a fan, forming a section of a very low cone.

field moisture content - The amount of water held in a soil mass, expressed as weight of water divided by weight of dried soil and multiplied by 100 to give a percentage.

floodplain - The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.

fluvial - Produced by the action of a stream or river.

forb - A herbaceous plant which is not a grass, sedge or rush.

frost free period - The period or season of the year between the last spring frost and the first autumn frost.

frost heave - The raising of a surface due to the accumulation of ice in the underlying soil.

glaciofluvial - Produced by the action of a meltwater stream flowing from wasting glacier ice.

glaciolacustrine - Pertaining to, derived from, or deposited in those lakes bordering glaciers or formed from meltwaters of wasting glacier ice.

gleyed soil - Soil affected by a soil-forming process, operating under poor drainage conditions, which results in the reduction of iron and other elements; and in gray colors, and mottles.

grass - Plant of a large family characterized by rounded and hollow jointed stems, narrow sheathing leaves, flowers borne in spikes, and hard grain-like seeds.

gravel - Rock fragments 2 mm to 7.5 cm (3 inches) in diameter.

groundwater - Water that is passing through or standing in the soil and the underlying strata in the zone of saturation. It is free to move by gravity.

herb - Any flowering plant except those developing persistent woody bases and stems above ground.

hummocky moraine - An area of knob and kettle topography that may have been formed either along a live ice front or around masses of stagnant ice.

humus - (1) The fraction of the soil organic matter that remains after most of the added plant or animal residues have decomposed. It is usually dark colored. (2) Humus is also used in a broader sense to designate the humus forms referred to as forest humus. (3) All the dead organic material on and in the soil that undergoes continuous breakdown, change and synthesis.

illuviation - The process of depositing soil material removed from one horizon in the soil to another, usually from an upper to a lower horizon in the soil profile. Illuvial substances include silicate clay, hydrous oxides of iron and aluminum, and organic matter.

infiltration - The downward entry of water into the soil.

lacustrine - Pertaining to, produced by, or formed in a lake or lakes.

leaching - The downward movement within the soil of materials in solution.

lichen - A plant body without true roots, stems or leaves; that grows on earth, rocks and trees.

lime (in soil) - A soil constituent consisting principally of calcium carbonate; and including magnesium carbonate, and perhaps the oxide and hydroxide of calcium and magnesium.

liquid limit - Moisture content at which a soil passes from a plastic to a liquid state.

marsh - Periodically flooded or continually wet areas having the surface not deeply submerged. It is covered dominantly with sedges, cattails, rushes or other hydrophytic plants.

maximum dry density - See "optimum moisture content."

mesophyte - A plant that grows under intermediate moisture conditions.

moraine - A mound, ridge or other distinct accumulation of unsorted, unstratified glacial drift, predominantly till, deposited chiefly by direct action of glacial ice in a variety of topographic landforms.

morphology, soil - The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness and arrangement of the horizons in the profile; and by the texture, structure, consistence and porosity of each horizon.

moss - A small plant having primitive leaves and stems, and propogated and disseminated by spores; one-celled particles of living matter with a firm protective wall.

mottling - Spotting or blotching of different colors or shades of colors interspersed with the dominant color.

mull - A zoogenous forest humus form (H horizon) consisting of an intimate mixture of well humified organic matter and mineral soil that makes a gradual transition to the horizon underneath.

optimum moisture content - The water content of soil at which the dry density is a maximum ("maximum dry density").

organic matter, soil - The organic fraction of the soil; including plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population.

orthic - A subgroup referring to the modal or central concept of various great groups in the Brunisolic, Chernozemic, Cryosolic, Gleysolic, Luvisolic, Podzolic and Regozolic orders of the Canadian system of soil classification.

outwash - Stratified detritus (chiefly sand and gravel) washed out from a glacier by meltwater streams and deposited in front of or beyond the terminal moraine or the margin of an active glacier.

parent material - The unconsolidated and more or less chemically weathered mineral or organic matter from which the solum of a soil has developed by pedogenic processes.

particle size analysis - The determination of the various amounts of the different separates in a soil sample, usually by sedimentation, sieving, micrometry or combinations of these methods.

peat - Unconsolidated soil material consisting largely of undecomposed, or only slightly decomposed, organic matter.

peaty phase (of soil) - Any mineral soil having a surface horizon of 15 to 60 cm (6 to 24 inches) of fibric moss peat or 15 to 40 cm (6 to 16 inches) of other kinds of peat.

percolation - The downward movement of water through saturated or nearly saturated soil.

permeability, soil - The ease with which gases and liquids penetrate or pass through a bulk mass of soil or a layer of soil. The following classes are used to rate soil permeability:

Permeability Class	Rate of Permeability
Very slow	Less than 0.06 inches/hour
Slow	0.06 to 0.2 inches/hour
Moderately slow	0.2 to 0.6 inches/hour
Moderate	0.6 to 2.0 inches/hour
Moderately rapid	2.0 to 6.0 inches/hour
Rapid	6.0 to 20.0 inches/hour
Very rapid	More than 20.0 inches/hour

plasticity - The property of a material which allows it to be deformed rapidly, without rupture, without elastic rebound, and without volume change.

plastic limit - The moisture content at which a soil passes from a semisolid to a plastic state.

runoff - The portion of the total precipitation on an area that flows away through stream channels. Surface runoff does not enter the soil. Groundwater runoff or seepage flow from groundwater enters the soil before reaching the stream.

rush - A grass-like herb growing in marshy ground, and having cylindrical leafless stems.

sedge - A grass-like herb that grows in marshy places.

sediment - Solid material, both mineral and organic, that is in suspension, is being transported; or has been moved from its site of origin by air, water, gravity or ice, and has come to rest on the earth's surface either above or below sea level.

separates, soil - Mineral particles less than 2.0 mm in equivalent diameter, ranging between specified size limits. The name and size limits of separates recognized by soil pedologists in Canada and the United States are: very coarse sand, 2.0 to 1.0 mm; coarse sand, 1.0 to 0.5 mm; medium sand, 0.5 to 0.25 mm; fine sand, 0.25 to 0.10 mm; very fine sand, 0.10 to 0.05 mm; silt, 0.05 to 0.002 mm; and clay, less than 0.002 mm.

shrink-swell potential - Susceptibility to volume change due to loss or gain in moisture content.

sieve analysis - A laboratory test to determine the amounts of gravel and sand fractions in a soil.

slumping - The downward movement, such as settling or sliding, of a mass of sediment or soil.

soil - The naturally occurring, unconsolidated mineral or organic material, at least 10 cm (4 inches) thick, that occurs on the earth's surface and is capable of supporting plant growth.

soil survey - The systematic examination, description, classification and mapping of soils in an area.

solum, soil (plural - sola) - The upper horizons of a soil in which the parent material has been modified and in which most plant roots are contained. It usually consists of A and B horizons.

structure, soil - The combination or arrangement of primary soil particles into secondary particles, units or peds. The peds are characterized and classified on the basis of type (amorphous, blocky, columnar, etc.), class or size (fine, medium, coarse, very coarse) and grade or distinctness (weak, moderate, strong). The types of soil structure are described as follows:

(a) **amorphous (massive)** - A coherent mass showing no evidence of any distinct arrangement of soil particles.

(b) **blocky (angular blocky)** - Soil particles are arranged around a point and bounded by flat surfaces, faces rectangular, vertices sharply angular.

(c) **columnar** - Soil particles are arranged around a vertical axis and bounded by relatively flat vertical surfaces, vertical edges near top of columns are not sharp (columns may be flat-topped, round-topped or irregular).

(d) **granular** - Soil particles are arranged around a point and bounded by flat spheroidal surfaces, characterized by rounded vertices.

(e) **platy** - Soil particles are arranged around a horizontal plane and generally bounded by relatively flat horizontal surfaces, horizontal planes more or less developed.

(f) **prismatic** - Soil particles are arranged around a vertical axis and bounded by relatively flat well defined vertical surfaces, edges sharp.

(g) **single grain** - Loose, incoherent mass of individual particles, as in sands.

(h) **subangular blocky** - Soil particles are arranged around a point and bounded by flat surfaces, faces subrectangular, vertices mostly oblique or subrounded.

terrace - Any long, narrow, relatively level surface bounded along one edge by a steeper ascending slope; terraces commonly are found along the margin and above the level of a body of water and mark the former water level.

terric layer - An unconsolidated mineral substratum underlying organic soil material.

texture, soil - The relative proportions of the various soil separates in a soil, as described by the classes of soil texture shown in Figure 2. The sand, loamy sand and sandy loam classes are further subdivided on the basis of the proportions of the various sand separates present.

till - Unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel and boulders intermingled in any proportion.

tonguing - Interfingering of one soil horizon into another situated below; vertical dimensions of the tongued portion usually greater than horizontal dimensions.

topography - The physical features of a district or region, such as those represented on a map, taken collectively; especially the relief and contours of the land.

topsoil - (1) The layer of soil moved in cultivation. (2) The A horizon. (3) The Ah horizon. (4) Presumably fertile soil material used to topdress roadbanks, gardens and lawns.

veneer - Unconsolidated materials too thin to mask the minor irregularities of an underlying landform surface.

water table - The upper surface of groundwater or that level below which the soil is saturated with water.

xerophyte - A plant capable of surviving periods of prolonged moisture deficiency.

SOIL MAP OF NOTIKEWIN RIVER AREA

Tp. 95, R. 19 - 20, W 5

Soil Classification:

MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Regosolic	Cumulic Regosol	medium to moderately fine textured fluvial sediments
2	Luvisolic ~ 80% Gleysolic ~ 20%	Orthic Gray Luvisol Orthic Luvic Gleysol ~ peaty phase	fine textured lacustrine sediments
3	Luvisolic	Orthic Gray Luvisol	moderately fine-textured till
4	Brunisolic	Orthic Eutric Brunisol	moderately fine-textured till
5	Regosolic	Gleyed Cumulic Regosol	medium to moderately fine textured fluvial sediments
6	Regosolic	Cumulic Regosol	medium textured fluvial sediments
7	Luvisolic Brunisolic	Orthic Gray Luvisol Orthic Eutric Brunisol	very coarse textured fluvial sediments (gravel)
8	Brunisolic	Orthic Eutric Brunisol	very coarse textured fluvial sediments (sand)
9	Luvisolic ~ 80% Gleysolic ~ 20%	Orthic Gray Luvisol Undifferentiated Gleysol	medium to very coarse textured fluvial sediments
10	Gleysolic	Orthic Luvic Gleysol	very coarse textured glaciofluvial sediments overlying moderately fine textured till
TM	Organic	Terric Mesisol	predominantly intermediately decomposed peat overlying undifferentiated mineral material

LEGEND:

- wet or water-filled depression
- escarpment
- soil line
- direction of slope
- boundary of mapped area

Map Symbol:

7 — map unit
c 2 — surface stoniness rating
topographic class

APPROXIMATE SCALE:

660 0 660 1320 1980 Feet

Compiled from uncontrolled mosaic

Mapped and Compiled by:
G. M. Greenlee, P. Ag.
Soils Division
1977

Alberta Research Council

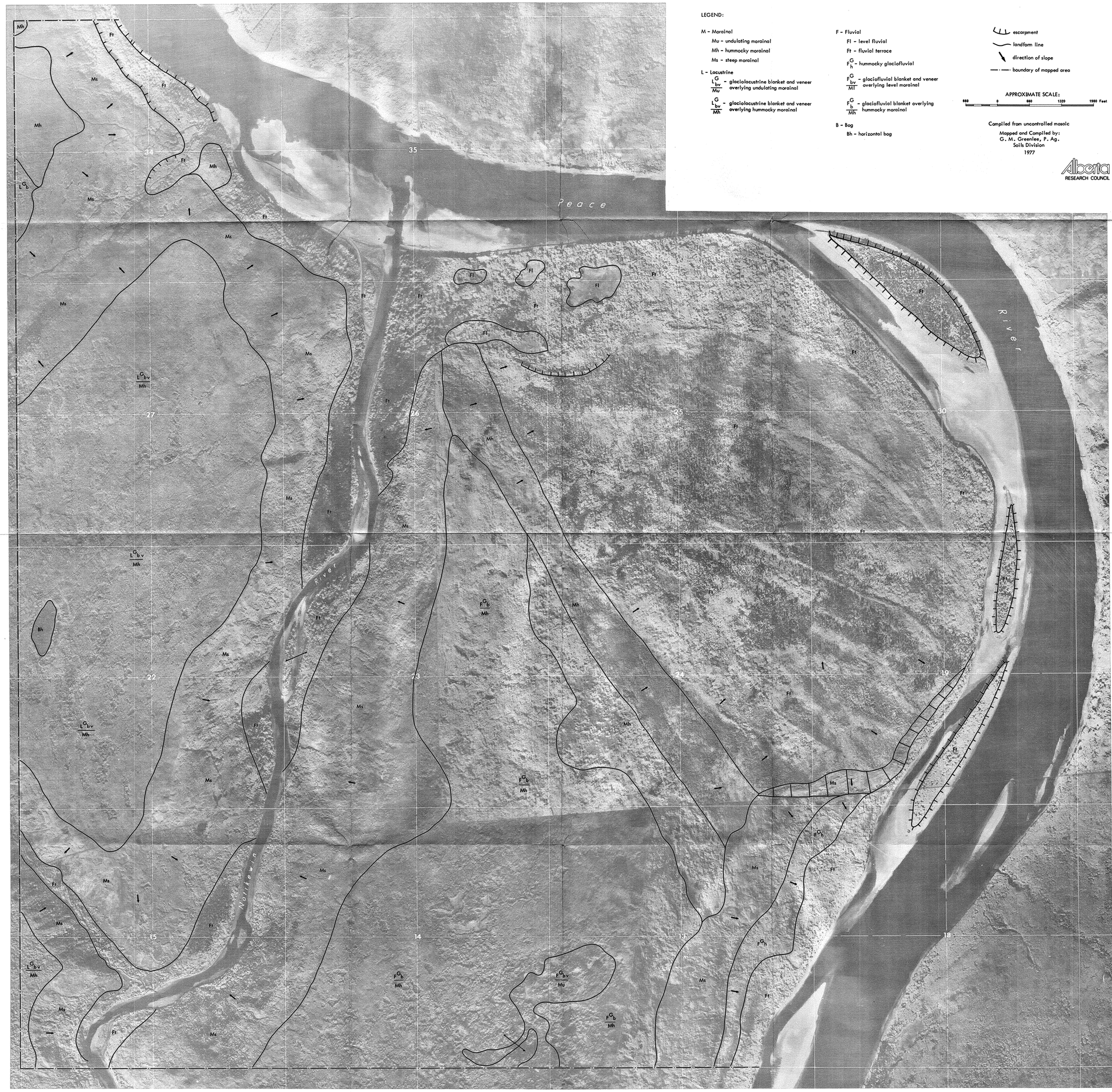
Peace River

Notikewin River

35 27 26 25 30 22 23 24 19 15 14 13 18

LANDFORM MAP OF NOTIKEWIN RIVER AREA

Tp. 95, R. 19 - 20, W 5



LEGEND:

M – Morainal
- Mu – undulating morainal
- Mh – hummocky morainal
- Ms – steep morainal

L – Lacustrine
- L^{G}_{bv}/Mu – glaciolacustrine blanket and veneer overlying undulating morainal
- L^{G}_{bv}/Mh – glaciolacustrine blanket and veneer overlying hummocky morainal

F – Fluvial
- Fl – level fluvial
- Ft – fluvial terrace
- F^{G}_{h} – hummocky glaciofluvial
- F^{G}_{bv}/MT – glaciofluvial blanket and veneer overlying level morainal
- F^{G}_{b}/Mh – glaciofluvial blanket overlying hummocky morainal

B – Bog
- Bh – horizontal bog

escarpment

landform line

direction of slope

boundary of mapped area

APPROXIMATE SCALE:

660 0 660 1320 1980 Feet

Compiled from uncontrolled mosaic

Mapped and Compiled by:
G. M. Greenlee, P. Ag.
Soils Division

1977

Alberta
RESEARCH COUNCIL