SOIL SURVEY
of
MOONSHINE LAKE PROVINCIAL PARK
and
INTERPRETATION FOR RECREATIONAL USE

by

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PREFACE

This report is one of a series describing detailed and semi-detailed soil surveys, which were conducted in the following Alberta Provincial Parks during the summer of 1976: Cypress Hills, Writing-on-Stone, Dry Island Buffalo Jump, Jarvis Bay, Wabamum Lake, Thunder Lake, Moose Lake and Moonshine Lake. Also included were the Blue Lake Centre in William A. Switzer Provincial Park; as well as areas in the vicinities of Carseland and Hilliard's Bay (on the northwestern shore of Lesser Slave Lake). The total area mapped was approximately 74,000 acres.

A separate report is written for each area; however a standard explanatory section which is pertinent to all areas is presented at the beginning of each. Specific results and interpretations for a particular area are presented in the second section of the report, entitled "Soil Report". A few additional references and an additional glossary of terms specific to a particular area are also included in this section

INTRODUCTION

The growth in population and per capita income has and will continue to exert an unprecedented demand on the natural resources of Alberta. The nature of today's city living and working makes apparent the recreational value of Provincial Parks. Men and women often work in large factories and plants or in crowded offices, far removed from nature or a natural environment. The work week of forty hours or less, however, provides people with a relatively large amount of leisure time and prompts a constant search for off-time recreation to refresh the spirit. It is this trend in our civilization today that places high priority on comprehensive planning that will bring together the special interests in land use, watershed protection, wildlife, forestry, and parks and recreation based on carefully determined requirements.

Soil being one of the basic resources which man manipulates in his land use activities, requires prudent use, protection and proper management in order to realize its inherent potential on a sustained yield basis (Montgomery and Edminster 1966). Recognition of natural phenomena and physical limitations is no less important in campground construction or septic tank location than it is in crop production. The kind of soil dictates to a large degree the type and location of recreational facilities. Some soils are not desirable sites for campgrounds, play areas, picnic grounds, cabin sites or nature study areas; other soils are very desirable sites for recreational uses. Knowledge of the soils of an area provides fundamental information needed in recreation planning. The soil information contained in the reports covering Provincial Parks and proposed park areas within Alberta is designed to be of assistance in planning future development.

ACKNOWLEDGMENTS

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Mrs. Pal Foster typed and assisted in compiling and proof reading the report. Mr. Z. Widtman 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.

G.M. Greenlee provided considerable guidance and advice both in the field and in the preparation of this report.

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

SUMMARY

Moonshine Lake Provincial Park is located about 25 kilometres (16 miles) west and north of the town of Spirit River. It covers an area of about 770 hectares (1900 acres) surrounding the artificially maintained Mirage Lake. The park is situated at the upper elevations of the Peace River lowland and the predominant surficial material is fine-textured glacio lacustrine, though till is occasionally exposed at the surface. Several sizeable areas of organic deposits are also found. The climate is continental with warm summers and cold winters. The park lies within the Mixedwood section of the Boreal Forest Region, where the native forest cover is aspen and white spruce, with lesser amounts of white birch and balsam poplar.

Five Map Units were recognized in the park. The key profile types consist of Dark Gray Luvisols, Orthic Gray Luvisols, Orthic Gleysols - peaty phase, Gleyed Dark Gray Luvisols, and Mesisols. These are distributed over the landscape in relation to parent material, landform and drainage. Map units consist of single soil series or groupings of series; and their distribution is shown on the Soil Map.

Soil interpretations are made for each Map Unit for camp areas, picnic areas, intensive play areas, paths and trails, lawns and landscaping, permanent buildings, septic tank absorption fields, sanitary landfills - trench type, reservoir sites, road location and sources of roadfill, sources of topsoil, and sources of sand or gravel.

In general, soils of Map Unit 3 are best suited for recreational development. High clay content, seasonally high groundwater table, low permeability, and high shrink-swell potential result in slight to moderate limitations for these soils and moderate to severe limitations for the remainder of the soils in the park. These soil areas can be located by careful study of the Soils Map and Table 17 (interpretations table).

A soil survey properly interpreted is a useful guide for general recreation planning and in-site selection. However, all soil differences which occur in the field cannot be shown on a soils map. Thus for design and construction of specific recreational facilities, an on-site investigation is often needed.

METHODS

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 utilized along lake shores and rivers in some areas of otherwise limited access, and foot traverses were made as necessary across areas lacking trails.

Soil pits were dug at frequent intervals to depths of 2 to 5 feet, to examine and describe soil horizons and to classify the soils. The usual procedure was to excavate the upper 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). Panchromatic black and white areal photographs of scales varying from 1:31,680 (2 inches = 1 mile) to 1:12,000 (5.25 inches = 1 mile) were also used with the aid of a pocket stereoscope, to facilitate the field mapping.

Representative surface and shallow subsurface soil samples were collected for chemical analyses, and subsurface samples were collected at depths of 3 to 6 feet for physical analyses.

Chemical and Physical Analyses

Chemical analyses were carried out by the Alberta Soil and Feed Testing Laboratory (O.S. Longman Building, Edmonton). These involved the following determinations:

1) Available nutrients; Available nitrogen (N) and available potassium (K) (Jackson 1962), available phosphorus (P) (Dickman and Bray 1940), and available sulphur (S) (Carson et al 1972).
2) Soil Reaction; pH was determined with a glass and calomel electrode, using a 2:1 water to soil ratio (Jackson 1962).
3) Electrical Conductivity 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.

4) Soluble Sulphates (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 U.S.D.A. Handbook 60 (1954). A saturation extract was obtained by suction, and sulphates were precipitated with $BaCl_2$ crystals by the turbidimetric method and estimated by a visual inspection.

5) Exchangeable Sodium (Na) was determined by flame photometry (Jackson 1962).

6) Organic Matter was estimated by a visual inspection of the soil sample.

7) Free Lime was determined by a visual estimation of the degree of effervescence when a ten percent solution of dilute HCl was added to a soil sample.

8) 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).

Physical analyses were carried out in the Alberta Institute of Pedology laboratories (ASTM 1970). These involved the following determinations: field moisture content, liquid limit, plastic limit, sieve analysis, and particle size analysis (hydrometer method). Values for optimum moisture content and maximum dry density were obtained from charts prepared by the Alberta Transportation Laboratory of Alberta Transportation (1955).

GENERAL DISCUSSION OF SOIL MAP

The soils were classified according to the System of Soil Classification for Canada (C.D.A. 1974). The areal extent of each different kind of soil is indicated on the soil map. An explanation of the map symbol follows:

Example: 4 — map unit (Soil Report)
topographic class — e 2 — surface stoniness rating (Table 2)
(Table 1)

The Map Units indicate single soil series, groupings of series, or soil associations. A soil series consists of soils that are essentially alike in all major profile characteristics except the texture of the surface (CDA 1972). Where a Map Unit consists of a grouping of series, they occur together in a characteristic pattern within the landscape and it is not feasible to outline each separately because of the scale of the soil map. A soil association simply consists of a sequence of soils of about the same age, derived from similar parent materials, and occurring under similar climatic conditions, but having unlike characteristics because of variations in relief and in drainage (CDA 1972).

Where a Map Unit consists of a single series, other soil series may be found in close proximity. However, the dominant series constitutes roughly 70 to 90% of the Map Unit; the other series are present in such minor amounts that their presence is not considered significant enough to affect the use of a particular Map Unit for recreation.

Where 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.

Where a Map Unit consists of a soil association, the approximate percentages of only the dominant members (which may also be series) are indicated. Minor insignificant amounts of other members often occur, but are not mentioned. Soil interpretations are for the most dominant member of an association, since interpretations for the less dominant members may be very different.

Other miscellaneous symbols appearing on the soil map are defined or explained in the soil report.

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

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] (Greenlee 1971)

Stony 0 -	(stone-free land)	too few stones to be of any hindrance to recreation
Stony 1 -	(slightly stony land)	some stones, only slight to no hindrance to recreation
Stony 2 -	(moderately stony land)	enough stones to cause some interference with recreation
Stony 3 -	(very stony land)	enough stones to constitute a serious handicap to recreation - some clearing is required
Stony 4 -	(exceedingly stony land)	enough stones to prevent recreational use unless considerable clearing is done
Stony 5 -	(excessively stony land)	too stony to permit any recreational use (boulder or stone pavement)

GENERAL DISCUSSION OF LANDFORM MAP

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

The symbols, which appear on the landform map, refer to local landforms. A local landform is considered to be 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, the result being similar local landforms or repetitive landform patterns occurring 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 one repetitive landform pattern in regionally different landform units.

Landforms, in this system, are considered to represent two basic attributes; materials and form. The material category recognizes 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.

[1] See also definitions in The System of Soil Classification for Canada (CDA 1974).

The landform classification system is outlined below. For a more complete description of the landform classification system, see "A Landform Mapping System for Canadian Soil Surveys" (Acton 1975); and the Canadian System of Soil Classification (CSSC 1976).

Genetic Materials

Materials are classified according to their essential properties within a general framework of their mode of formation. Four groups (components) of materials have been recognized to facilitate further characterization of the texture and the surface expression of the materials. These groups and the classes established within these groups are presented below.

Unconsolidated Group

The unconsolidated mineral component is comprised of clastic sediments that may or may not be stratified but whose particles are not cemented together. They are essentially of glacial or post glacial origin but also include poorly consolidated and weathered bedrock.

Classes:

A - Anthropogenic
C - Colluvial
E - Eolian
F - Fluvial
L - Lacustrine
M - Morainal
S - Saprolite
V - Volcanic
U - Unconsolidated, undifferentiated

Definitions

Anthropogenic: Man-made or man-modified materials; including those associated with mineral exploitation and waste disposal. They include materials constructed by man, or geological materials modified by man so that their physical properties (structure, cohesion, compaction) have been drastically altered. These materials will commonly possess a wide range of textures. The assumed process status is active. Examples: areas of landfill, spoil heaps and open-pit mines. On site symbols will be used for Anthropogenic sites where the zone of disturbance is too small to be mapped as an areal unit.

Colluvial: Massive to moderately well stratified, non-sorted to poorly sorted sediments with any range of particle sizes from clay to boulders and blocks that have reached their present position by direct, gravity-induced movements. They are restricted to products of mass-wasting whereby the debris is not carried within, on, or under another medium possessing contrasting properties. The assumed process status is active. Processes include slow displacements such as creep and solifluction and rapid movements such as earth flows, rockslides, avalanches, and falls. Where colluvial materials are derived from an unconsolidated deposit, but overlie a different unit or form a discrete surface expression, they will be mapped as colluvial. But colluvial material derived from unconsolidated Quaternary sediments, which overlies and resembles its parent unit, will be mapped as the parent unit. Colluvial materials exclude those materials deposited at the base of steep slopes by unconsolidated surface run-off or sheet erosion.

Eolian: Sediment generally consisting of medium to fine sand and coarse silt particle sizes that is well-sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded and show signs of frosting. These materials have been transported and deposited by wind action. The assumed process status is inactive. Examples: dunes, veneers and blankets of sand and coarse silt, and loess but excludes volcanic tuffs.

Fluvial: Sediment generally consisting of gravel and sand with a minor fraction of silt and rarely clay. The gravels are typically rounded and contain interstitial sand. Fluvial sediments are commonly moderately to well-sorted and display stratification, although massive, non-sorted fluvial gravels do occur. These materials have been transported and deposited by streams and rivers. The assumed process status is inactive. Examples: channel deposits, overbank deposits, terraces, alluvial fans and deltas.

Lacustrine: Sediment generally consisting of either stratified fine sand, silt and clay deposited on the lake bed or moderately well-sorted and stratified sand and coarser materials that are beach and other near-shore sediments transported and deposited by wave action. These are materials that have either settled from suspension in bodies of standing fresh water or that have accumulated at their margins through wave action. The assumed process status is inactive. Examples: lake sediments and beaches.

Morainal: Sediment generally consisting of well-compacted material that is non-stratified and contains a heterogeneous mixture of particle sizes, often in a mixture of sand, silt and clay that have been transported beneath, beside, on, within and in front of a glacier and not modified by any intermediate agent. Examples: basal till (ground moraine), lateral and terminal moraines, rubbly moraines of cirque glaciers, hummocky ice-disintegration moraines, and pre-existing, unconsolidated sediments re-worked by a glacier so that their original character is largely or completely destroyed.

Saprolite: Rock containing a high proportion of residual silts and clays formed by alteration, chiefly by chemical weathering. The rock remains in a coherent state, interstitial grain relationships are undisturbed, and no downhill movement due to gravity has occurred. Assumed process status is active. Examples: rotten rock containing corestones.

Volcanic: Unconsolidated pyroclastic sediments of volcanic origin. Assumed process status is inactive. Examples: volcanic dust, ash, cinders, and pumice.

Unconsolidated: A layered sequence of more than three types of genetic material outcropping on a steep erosional escarpment. This complex class is to be used where units relating to individual genetic-materials cannot be delimited separately at the scale of mapping. It may include colluvium derived from the various genetic materials and resting upon the scarp slope.

Organic Component

The unconsolidated organic component consists of peat deposits containing >30% organic matter, by weight, that may be as thin as 10 cm if they overlie bedrock but are otherwise greater than 40 cm and generally greater than 60 cm thick.

Classes:

B - Bog (Sphagnum peat)
N - Fen (Fen or sedge peat)
O - Organic, undifferentiated

Bog: Sphagnum or forest peat materials formed under an ombrotrophic environment due to the slightly elevated nature of the bog tending to be disassociated from nutrient-rich groundwater of surrounding mineral soils. Near the surface it is usually undecomposed (fibric) yellowish to pale brown color, loose and spongy in consistence with entire Sphagnum plants being readily identified. At depths it becomes darker in color, compacted, and somewhat layered. These materials are extremely acid (pH <4.5), of low bulk density (<0.1 g/cc) and very high fibre content (>85% unrubbed and 50% rubbed). These materials are associated with slopes or depressions with a water table at or near the surface in the spring, and slightly below during the remainder of the year. Bogs are usually covered with Sphagnum although sedges may also grow on them, they may be treed or treeless, and they are frequently characterized by a layer of ericaceous shrubs.

Fen: Sedge peat materials derived primarily from sedges with inclusions of partially decayed stems of shrubs formed in an eutrophic environment due to the close association of the material with mineral-rich waters. It is usually moderately well to well decomposed, dark brown in color with fine to medium sized fibers but may be well decomposed, black with fine fibers; decomposition often becoming greater at lower depths. Fen materials are medium acid to neutral (pH 5.5 - 7.5), relatively low in fiber (20 - 80% unrubbed and 2 - 25% rubbed) and relatively dense (0.1 - 0.2 g/cc). These materials are associated with relatively open peatlands with a mineral-rich water table that persists seasonally at or very near the surface. They are covered with a dominant component of sedges, although grasses and reeds may be associated in local pools. Sphagnum is usually subordinate or absent, with the more exacting mosses being common. Often there is much low to medium height shrub cover and sometimes a sparse layer of trees.

Consolidated Component

The consolidated component (bedrock) is comprised of clastic materials that are tightly packed or indurated. They include igneous, metamorphic, sedimentary and consolidated volcanic rocks (bedrock).

Classes:

R - Bedrock, undifferentiated

Ice Component

The ice component includes areas of snow and ice where evidence of active glacier movement is present within the boundary of the defined unit area. This movement will be indicated by features such as crevasses, supraglacial moraines, icefalls, and ogives. The assumed process status is active. Examples: cirque glaciers, mountain icefields, valley and piedmont glaciers.

Classes:

I - Ice, undifferentiated

Qualifying Descriptors

A number of descriptors have been introduced to qualify the Genetic Materials terms. The descriptors qualify:

1. The clastic genetic material terms, and are used to supply additional information about their mode of formation or depositional environment.
2. The status of the Genetic processes. Included in the definitions of the Genetic Materials categories are statements concerning the commonly assumed status of their processes. Where the process status is contrary to the common assumption, it will be indicated.

Classes:

Clastic: G - Glacial, E - Channelled

Process: A - Active, I - Inactive

Definition

Glacial: Used to qualify non-glacial genetic materials where there is direct evidence that glacier ice exerted a strong (but secondary or direct) control upon the mode of origin of the materials. The use of this qualifying descriptor implies that glacier ice was close to the site of the deposition of a material.

Glaciofluvial: To be used only where fluvial materials show clear evidence of having been deposited either directly in front of, or in contact with, glacier ice. At least one of the following characteristics must be present:

1. Kettles, or otherwise irregular (possibly hummocky or ridged) surface that resulted from the melting of buried or partially buried ice. e.g. pitted outwash, knob and kettle topography.
2. Slump structures and/or their equivalent topographic expression, indicating partial collapse of a depositional landform due to melting of supporting ice. e.g. kame terrace, delta kame.
3. Ice-contact and moulded forms such as gravelly or sandy crevasse fillings and eskers.
4. Non-sorted and non-bedded gravel of an extreme range of particle sizes, such as results from very rapid aggradation at an ice front. e.g. ice-contact gravels.

5. Flowtills.

Glaciolacustrine: To be used where there is evidence that the lacustrine materials were deposited in contact with glacial ice. One of the following characteristics must be present:

1. Kettles or an otherwise irregular surface that is not simply the result of normal settling and compaction in silt, nor the result of piping.
2. Slump structures resulting from loss of support due to melting of retaining ice.
3. Presence of numerous ice-rafted stones in the lacustrine silts.

Channelled: To be used to indicate the presence of glacial melt-water channels in a unit where they are too small and/or too numerous to show individually by an on-site symbol.

Active: To be used to indicate any evidence of the recurrent nature of a modifying process or of the contemporary nature of the process forming a genetic material.

Inactive: To be used to indicate no evidence that the modifying process is recurrent, and also that the processes of formation of the genetic materials have ceased.

Surface Expression

The surface expression of genetic materials is their form (assemblage of slopes) and pattern of forms. Form, as applied to unconsolidated deposits refers specifically to the product of the initial mode of origin of the materials, and, as applied to consolidated materials, refers to the product of their modification by geological processes. Surface expression also expresses the manner in which unconsolidated genetic materials relate to the underlying unit.

Classes for Unconsolidated and Consolidated Components

a - Apron	m - Rolling
b - Blanket	r - Ridged
f - Fan	s - Steep
h - Hummocky	t - Terraced
i - Inclined	u - Undulating
l - Level	v - Veneer

Definitions

Apron: A relatively gentle slope at the foot of a steeper slope, and formed by materials from the steeper, upper slope. Examples: two or more coalescing fans: a simple talus slope.

Blanket: A mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but which still conforms to the general underlying topography. Examples: lacustrine blanket overlying hummocky moraine.

Fan: A fan-shaped form that can be likened to the segment of a cone, and possessing a perceptible gradient from the apex to the toe. Examples: alluvial fans, talus cones; some deltas.

Hummocky: A very complex sequence of slopes extending from somewhat rounded depressions or kettles of various size to irregular to conical knolls or knobs. There is a general lack of concordance between knolls or depressions. Slopes are generally between 5° and 35°. Examples: hummocky moraine, hummocky glaciofluvial.

Inclined: A sloping, unidirectional surface with a generally constant slope not broken by marked irregularities. Slopes are between 1° and 35°. The form of inclined slopes is not related to the initial mode of origin of the underlying material. Examples: terrace scarps, river banks.

Level: A flat or very gently sloping, unidirectional surface with a generally constant slope not broken by marked elevations and depressions. Slopes are generally less than 1°. Examples: floodplain, lake plain, some deltas.

Rolling: A very regular sequence of moderate slopes extending from rounded, sometimes confined concave depressions to broad, rounded convexities producing a wave-like pattern of moderate relief. Slope length is often one mile or greater and gradients greater than 5%. Examples: bedrock controlled ground moraine, some drumlins.

Ridged: A long, narrow elevation of the surface, usually sharp crested with steep sides. The ridges may be parallel, sub-parallel or intersecting. Examples: Eskers, crevasse fillings, washboard moraines, some drumlins.

Steep: Erosional slopes, greater than 35°, on both consolidated and unconsolidated materials. The form of a steep erosional slope on unconsolidated materials is not related to the initial mode of origin of the underlying material. Examples: escarpments, river banks and lakeshore bluffs.

Terraced: Scarp face and the horizontal or gently inclined surface (tread) above it. Examples: Alluvial terrace.

Undulating: A very regular sequence of gentle slopes that extend from rounded, sometimes confined concavities to broad rounded convexities producing a wave-like pattern of low local relief. Slope length is generally less than 0.5 miles and dominant gradient of slopes from 2 to 5%. Examples: Some drumlins, some ground moraine, lacustrine veneers and blanket over morainal deposits.

Veneer: Unconsolidated materials too thin to mask the minor irregularities of the underlying unit surface. A veneer will range between 10 cm and 1 m in thickness and will possess no form typical of the materials genesis. Examples: Shallow lacustrine deposits overlying glacial till, loess cap, etc.

Classes for Organic Component

b - Blanket	h - Horizontal
o - Bowl	p - Plateau
d - Domed	r - Ribbed
f - Floating	s - Sloping

Definitions:

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

Bowl: A bog or fen occupying concave shaped depressions. Examples: bowl bog.

Domed: A bog or fen with an elevated, convex, central area much higher than the margin. Domes may be abrupt (with or without a frozen core) or gently sloping or with a stepped surface. Examples: palsa bog, peat mound, palsa fen.

Floating: A level or flat organic surface associated with very high water tables but without surface water. Example: floating fen.

Horizontal: A flat, unidirectional peat surface not broken by marked elevations and depressions. Examples: flat bog, horizontal fen.

Plateau: A bog with an elevated, flat, central area only slightly higher than the margin. Examples: peat plateau, bog plateau, polygonal peat plateau.

Ribbed: A pattern of parallel or reticulate low ridges associated with fens. Examples: string fen, net fen, water track fen.

Sloping: A unidirectional peat surface with a generally constant slope not broken by marked irregularities. Examples: sloping fen.

MAPPING CONVENTIONS

The following examples illustrate the mapping conventions that are being used:

1) Mh - indicates an area of hummocky morainal materials.

2) F^G_u - indicates an area of undulating glaciofluvial materials.

3) $\frac{L^G_v}{Mu}$ - indicates an area of glaciolacustrine veneer overlying undulating morainal materials.

SOIL CHARACTERISTICS AND INTERPRETATIONS FOR RECREATIONAL USE

Soil surveys provide for classifying, defining and delineating each kind of soil and making predictions of soil behaviour under specific management (Montgomery and Edminster 1966). The soils within an area are mapped and classified without regard for existing or expected land ownership boundaries, or types of uses. Each delineated soil is defined so that the information is available for planning different kinds of land use.

Each kind of soil has its own peculiar set of characteristics and qualities which are described in terms that can be observed (Montgomery and Edminster 1966). These include soil texture; colour; structure; consistence; depth (to rock, hardpan, water table, etc.); kind and amount of coarse fragments; kind, thickness and sequence of soil layers; organic matter content; reaction; and slope. When accurately defined a specific soil can be distinguished from all other kinds of soil.

Most soils can be used for recreational activities of some kind. Some have no limitations for specific kinds of recreational uses; others have moderate to severe limitations for certain uses. Many soil properties affect the use limitations of soils for recreation, and the effects of a given soil property often vary with different uses (Brocke 1970).

The soil properties affecting most recreational uses include susceptibility to flooding, wetness, slope, and surface stoniness (Brocke 1970). Other soil properties also having an effect include: depth to sand and gravel, an impeding horizon and surface soil texture, as they affect permeability and erodibility; texture and plasticity, as they affect shrink-swell potential, and susceptibility to frost heaving; soluble sulphate content, as it affects concrete corrosion hazard; and salinity of the topsoil.

Soils that are subject to flooding during the season of use are considered to have severe limitations for recreation facilities such as camping areas, building sites, and roads. Such areas require permanent design considerations. These soils should not be developed for campsites or building sites unless they are protected by dikes, levees or other flood prevention structures, which may be uneconomical. These soils may be better suited for hiking or nature study areas, or for greenbelt open space, if the flooding is not too frequent. Montgomery and Edminster (1966) suggest one or two floodings during the season of use constitutes only a moderate limitation for picnic areas, playground areas and hiking trails. These are the less permanent facilities that can be moved with relative ease. Thus, the soils can be managed to a high level without maintenance costs rising beyond the financial capacity of the administration.

Soils that are wet all year, even if not flooded, have severe limitations for campsites, roads, hiking trails, playgrounds and picnic areas. The economic feasibility of installing subsurface drainage in these soils is questionable. Soils that are wet only part of the year or those with a water table that fluctuates without actually reaching the surface are not easily detected. These soils are considered to have moderate to severe limitations for most recreational uses, and if possible should be avoided for the more permanent facilities such as camping areas and building sites. With careful planning, design, and management, however, these soils can be used for most recreational facilities. Soils that dry out slowly after rains also present problems where intensive use is contemplated. The soils that are dry during the season of use and have a water table greater than 3 feet from the surface are considered to have slight to no limitations for most recreational uses.

Droughty or very rapidly drained soils also have limitations for many recreational uses. On such sites grass cover needed for playing fields is difficult to establish and maintain. Access roads may be excessively dusty. Vehicles are easily mired down in sandy soils and soil blowing is common. Knowledge of these soil problems enables planners to use corrective conservation practices, such as irrigation, or to choose alternative locations.

The ability of a soil to support a load is important in many kinds of recreational activities. Some soils when wet fail to support structures such as access roads, trails and buildings.

Slope affects the use of soils for recreation. Generally, slopes of less than 2% offer no limitations for use as playgrounds, campsites, sites for recreation buildings, roads and trails. Slopes greater than 9% constitute a severe limitation for playground areas, since levelling costs would become prohibitive. Slopes of more than 15% constitute a severe limitation for camping areas, picnic areas and some building sites for the same reason. The smaller areas required for these facilities as compared to playground areas, account for the greater tolerance. On the other hand, steeply sloping soils are essential for ski runs and are desirable for hiking areas and scenic values. Hiking trails are not limited unless slopes are greater than 30%. Of course, steep, gently sloping and moderately sloping soils can be levelled for campsites, playgrounds and building costs, where the cost is justified. Where this is done it is especially urgent that effective soil conservation practices be applied and maintained, based on the specific conditions at hand.

Permeability is an important property affecting the recreational use of soils. Since no permeability measurements were made, it has been estimated from a consideration of texture, structure and depth to an impeding horizon in the profile (O'Neal, 1952). Soils with very rapid to moderately rapid permeability have no limitations, and soils with slow and very slow permeability have severe limitations. The same classes apply to suitability for road subgrade material but are reversed when considering suitability for reservoir sites. Soils are rated for this purpose on their capacity to hold water without allowing seepage. It should be noted that the degree of limitation due to permeability will vary with climate. In high rainfall areas permeability is much more important than in low rainfall areas.

Surface stoniness limits the use of some soils for recreational facilities. Generally the non-stony (class 0) to slightly stony (class 1) land offers no limitation for recreational facilities. Very stony (class 3) to excessively stony (class 5) land offers severe limitations for camping areas, playground areas and building sites. The expense of removing the stone hazard is considered prohibitive. The very stony (class 3) land is considered to constitute only a moderate limitation for picnic areas and hiking trails because of the lesser areal intensity of use associated with these facilities. In some instances, it is feasible to remove the stones, thus eliminating the hazard. Rounded gravels and stones present hazards on steeply sloping soils used for foot trails.

Surface texture is an important soil property to consider. High clay or sand content in the surface horizon constitutes a severe limitation for playgrounds, campsites or other uses that involve heavy foot traffic by people or horses. Soils high in clay become sticky and slippery when wet and dry out slowly after rains. On the other hand, loose sandy soils are undesirable as they are unstable when dry, making it difficult to establish sod grasses capable of withstanding concentrated foot traffic. Generally, sandy loam and loam surface soil textures are the most desirable for recreational uses involving heavy use by people.

Soil depth affects many uses. Soils underlain by bedrock or sand and gravel at shallow depths cannot be levelled for playgrounds except at high cost. Roads, trails, basements and reservoirs are very difficult to construct on soils with shallow bedrock, and soils with shallow sand and gravel are undesirable sites for reservoirs.

It is difficult to establish vegetation on shallow soils overlying impervious soil layers, rock or sand and gravel, thus making them poor locations for playing fields and other intensive use areas.

Sewage disposal is also an important consideration in designing recreation areas. Some soils absorb septic effluent rapidly and other soils absorb it very slowly. Soils that are slowly or rapidly permeable, poorly drained, subject to flooding, shallow to rock, or steeply sloping all have severe limitations for septic tank filter fields. These include soils of high clay content, sandy soils and Gleysolic soils. The most desirable soils for sewage disposal have a moderate permeability, are well drained and are situated in nearly level areas. The most desirable soils for sewage disposal are also the most desirable soils for sanitary land fills. In some cases where soils cannot handle the volume of waste involved, sewage lagoons can be used. These also are feasible only in soils that meet the special requirements for sewage lagoons.

Shrink-swell potential is inferred from Atterberg limits. Soils with low to medium shrink-swell potential are considered to have no to slight limitations for recreational facilities. Soils with a very high shrink-swell potential are considered to constitute severe limitations for building sites and road subgrade materials, as these soils tend to be unstable with changing moisture conditions. Soils with a high shrink-swell potential offer moderate limitations for use and thus should be avoided if possible.

The suitability of the underlying soil material for road subgrade depends upon the additional property of susceptibility to frost action. Generally soils high in silt content are highly susceptible to frost action. Other factors, such as the availability of water, also affect this parameter. The availability of water is dependent upon climatic conditions and depth to water table. Thus, soils high in silt content may not necessarily undergo appreciable frost heaving unless they are imperfectly or poorly drained, or subject to high rainfall shortly before freezing. Frost heaving is not generally considered to be a serious problem for roads in Alberta except in poorly drained locations where the water table is near the soil surface.[1] A frost design soil classification is shown in Table 3.

1. Personal Communication, Mr. H. H. Rix, Highways Division, Alberta Research Council.

Table 3. Frost Design Soil Classification[1]

Frost Group	Kind of Soil	% Finer than 0.02 mm by weight	Typical Soil Types Under Unified Soil Classification System
F1	Gravelly soils	3 to 10	GW, GP, GW-GM, GP-GM
F2	(a) Gravelly soils	10 to 20	GM, GW-GM, GP-GM
	(b) Sands	3 to 15	SW, SP, SM, SW-SM, SP-SM
F3	(a) Gravelly soils	over 20	GM, GC
	(b) Sands, except very fine silty sands	over 15	SM, SC
	(c) Clays, PI > 12	-	CL, CH
F4	(a) All silts	-	ML, MH
	(b) Very fine silty sands	over 15	SM
	(c) Clays, PI < 12	-	CL, CL-ML
	(d) Varved clays and other fine-grained, banded sediments	-	CL and ML; CL, ML, and SM; CL, CH, and ML; CL, CH, ML, and SM

[1] From United States Army Corps of Engineers 1962.

The soluble sulphate content of the underlying soil material is an important factor for buildings with concrete foundations, as well as for underground conduits. The U.S. Bureau of Reclamation (1966) has established classes for sulphate attack on concrete. Soils with 0 to 0.1% soluble sulphate content are considered to have no limitations for standard concrete foundations, and soils with 0.1 to 0.2% are considered to have slight limitations. Soils with 0.2 to 0.5% soluble sulphate content are considered to have moderate limitations, and foundations may require sulphate resistant concrete. Soils with greater than 0.5% soluble sulphate are considered to have severe limitations and should be avoided.

Salinity and depth of topsoil affect soil suitabilities for lawns and landscaping, and sources of topsoil. An electrical conductivity of less than 1 (mmhos/cm) and a depth of topsoil of more than 6 inches offer no limitations. An electrical conductivity of more than 3 (mmhos/cm) and a depth of topsoil of less than 3 inches render severe limitations.

Productive capacity of soils for vegetation of different kinds is closely related to the feasibility of many recreational enterprises. The ability of soils to grow sods than can take concentrated human traffic has already been noted as a factor in such areas as playgrounds and campsites. The development of such vegetative conservation practices as shade tree plantings, living fences, plant screens and barriers to trespass is guided by soil conditions. The capacity of an area to produce economically harvestable crops of game is dependent in part upon the productive ability of its soils.

Thus we find that basic soil qualities and characteristics are closely associated with the various types of outdoor recreational activities. By knowing the characteristics and qualities of the different kinds of soils and their behaviours, and with the aid of a soil map, soil scientists and other specialists can develop soil interpretations for recreational uses. Interpretations for recreation can best be made locally by those familiar with the soils and conditions in the area.

EXPLANATION OF SOIL INTERPRETATIONS

Soil limitation or suitability ratings are for evaluating each soil for a particular use (Olsen et al. 1971). Interpretations are based on evaluation of the soil to a depth of about 40 inches; however, some interpretations can be made below the 5 foot depth. These interpretations are made largely from soil descriptions and field observations made during the 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.

It is important that the proper perspective be placed on the use of soil interpretations in recreation planning (Montgomery and Edminster 1966). The interpretations are for soils in the natural state only and not for disturbed areas. Nor do they include other factors, such as location, aesthetic values, and nearness to population centres. A soil survey properly interpreted is a useful guide for general recreation planning and in site selection; however, all soil differences which occur in the field cannot be shown on the soils map. Thus for design and construction of specific recreational facilities, an "on-site" investigation is often needed.

The soils are grouped into three categories according to their limitations or suitabilities for specific uses. They are evaluated by considering the interaction of the various properties to give an overall degree of limitation or suitability to each soil area. The three categories of limitations are as follows:

(1) S - None to slight limitations - Soils relatively free of limitations that affect the intended use, or the limitations are easy to overcome.

(2) M - Moderate limitations - Soils having limitations that need to be recognized but can be overcome with correct planning, careful design and good management.

(3) V - Severe limitations - Soils with limitations severe enough to make the proposed use questionable. It does not mean the soil cannot be used for

a specific use, but it does mean that careful planning and design, and very good management are needed. This often includes major soil reclamation work. In many cases the limitations will not be economically feasible to correct.

The soils are simply rated as good (G), fair (F), poor (P) or unsuitable (U) as sources of topsoil, or sand and gravel.

Interpretations are not included for wildlife use. However, it is recognized that all soils are suited for some form of wildlife and that this is an important use which is compatible with certain other uses.

DEFINITION OF SELECTED USES AND GUIDES FOR DEVELOPING SOIL INTERPRETATIONS

The guides set forth in Tables 4 through 15 are suggested for use in developing soil interpretations for camp areas, picnic areas, intensive play areas, paths and trails, lawns and landscaping, permanent buildings, septic tank absorption fields, sanitary landfills - trench type, reservoir sites, road location and sources of roadfill, sources of topsoil, and sources of sand or gravel, respectively. The information in these tables presents the nature and degree of limitations or suitabilities for selected park uses.

These guides are useful in evaluating each kind of soil to be grouped into limitation and suitability classes for different recreational and other uses. It is recognized that interactions among some soil and other properties listed in these guides may be great enough to change the limitation or suitability rating by one class. If a moderate or severe limitation occurs in a given map unit, lesser limitations are usually not specified. Limitations due to slope are not subdivided once the limitation becomes severe for the specified use. It follows, however, that the steeper the slope, the more severe the limitation, and this fact should be considered in using the soil interpretation tables.

It is not anticipated that all of these interpretations will be needed in all areas; however, they should all be useful in some areas.

Table 4. Guides for Developing Soil Interpretations for Camp Areas.

This guide applies to soils to be used intensively for tents and small camp trailers, and the accompanying activities of outdoor living (Olsen et al. 1971.)

It is assumed that little site preparation will be done other than shaping and levelling for tent areas and gravelling for parking areas. The soil should be suitable for heavy foot traffic by humans, and for limited vehicular traffic (see Table 13, ratings for road location and sources of roadfill). Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of a site (see Table 8, ratings for lawns and landscaping).

Table. 4.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	None.	None during season of use.	Subject to flooding during season of use
Watness[1] (soil drainage)	Very rapidly, rapidly, well and moderately well drained soils with no ponding. Water table below 30 inches during season of use	Moderately well and imperfectly drained soils with no ponding. Water table below 20 inches during season of use	Imperfectly drained soils with occasional ponding of short duration, poorly and very poorly drained soils. Water table above 20 inches during season of use
Slope	0 to 9% (aA - dD)	9+ to 15% (eE)	Greater than 15% (fF - hH)
Permeability[2]	Moderate to very rapid (more than 0.6 inches/hour)	Moderately slow (0.2 to 0.6 inches/hour)	Slow and very slow (less than 0.2 inches/hour)
Surface stoniness[3]	0 to 1	2	3, 4 and 5
Rockiness[4]	No rock exposures	Rock exposures greater than 30 feet (10 m) apart and cover less than 25% of the surface	Rock exposures less than 30 feet (10 m) apart and cover greater than 25% of the surface
Surface soil texture[5]	SL, FSL, VFSL, L and LS with textural B horizon. Not subject to soil blowing	CL, SCL, SiCL, SiL, LS and sand other than loose sand	SC, SiC, C, loose sand and soils subject to severe blowing. Organic soils.

1. See definitions of soil drainage classes in Glossary.

2. In low rainfall areas, soils may be rated one class better. See definitions of soil permeability classes in Glossary.

3. See definitions of surface stoniness in section entitled "General Discussion of Soil Map"

4. Very shallow soils are rated as having a severe limitation for rockiness. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).

5. See definitions of soil textural classes in Glossary.

Table 5. Guides for Developing Soil Interpretations for Picnic Areas.

This guide applies to soils considered for intensive use as park type picnic areas, and are subject to heavy foot traffic by humans (Olsen et al. 1971). It is assumed that most vehicular traffic will be confined to access roads and parking areas (see Table 13, ratings for road location and sources of roadfill). Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the evaluation of a site (see Table 8, ratings for lawns and landscaping).

Table 5.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	None during season of use	May flood 1 or 2 times for short periods during season of use	Floods more than 2 times during season of use
Wetness[1] (soil drainage)	Very rapidly, rapidly, well and moderately well drained soils. Water table below 20 inches during season of use.	Moderately well drained soils subject to occasional ponding. Imperfectly drained soils not subject to ponding. Water table above 20 inches for short periods during season of use.	Poorly and very poorly drained soils. Imperfectly drained soils subject to ponding. Water table above 20 inches and often near the surface for a month or more during season of use
Slope	0 to 9% (aA - dD)	9+ to 15% (eE)	Greater than 15% (fF - hH)
Permeability[2]	Moderately slow to very rapid (more than 0.2 inches/hour)	Slow (0.06 to 0.2 inches/hour)	Very slow (less than 0.06 inches/hour)
Surface stoniness[3]	0 to 2	3	4 and 5
Rockiness[4]	Rock exposures roughly 100 to 300 or more feet (30 - 100 m) apart and cover less than 10% of the surface	Rock exposures 30 to 100 feet (10 - 30 m) apart and cover about 10 to 25% of the surface	Rock exposures less than 30 feet (10 m) apart and cover greater than 25% of the surface
Surface soil texture[5]	SL, FSL, VFSL, L and LS with textural B horizon. Not subject to soil blowing	CL, SCL, SiCL, SiL, LS and sand other than loose sand	SC, SiC, C, sand and soils subject to severe blowing. Organic soils

1. See definitions of soil drainage classes in Glossary.

2. In low rainfall areas, soils may be rated one class better. See definitions of soil permeability classes in Glossary.

3. See definitions of surface stoniness in section entitled "General Discussion of Soil Map

4. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).

5. See definitions of soil textural classes in Glossary.

Table 6. Guides for Developing Soil Interpretations for Playing Fields.

This guide applies to soils that are to be used intensively for organized games, such as fastball, baseball, football, volleyball, badminton, and others (Olsen et al. 1971). These areas are subject to heavy foot traffic by humans. A level surface, good drainage, and a surface soil texture and consistence that provide a firm surface which is not slippery and sticky when wet are generally required. The most desirable soils are free of rock outcrops and surface stones. Soil suitability for growing and maintaining vegetation is not a part of this guide, but is an important item to consider in the final evaluation of a site (see Table 8, ratings for lawns and landscaping).

Table 6.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	None during season of use	May flood once in 3 years during season of use	May flood more than once in 3 years during season of use
Wetness[1] (soil drainage)	Very rapidly, rapidly, well and moderately well drained soils with no ponding or seepage. Water table below 30 inches during season of use	Moderately well drained soils subject to occasional ponding or seepage of short duration. Imperfectly drained soils. Water table below 20 inches during season of use	Imperfectly drained soils subject to ponding, poorly and very poorly drained soils. Water table above 20 inches and too wet for use for 1 to 5 weeks during season of use
Slope	0 to 2% (aA - bB)	2+ to 5% (cC)	Greater than 5% (dD - hH)
Permeability[2]	Moderate to very rapid (more than 0.6 inches/hour)	Moderately slow (0.2 to 0.6 inches/hr)	Slow and very slow (less than 0.2 inches/hour)
Surface stoniness[3]	0 to 1	2	3, 4 and 5
Rockiness[4]	Rock exposures more than 300 feet (100 m) apart and cover less than 2% of the surface	Rock exposures 100 to 300 feet (30 - 100 m) apart and cover about 2 to 10% of the surface	Rock exposures less than 100 feet (30 m) apart and cover more than 10% of the surface
Depth to bedrock	More than 40 inches	20 to 40 inches[5]	Less than 20 inches
Depth to sand or gravel	More than 40 inches	20 to 40 inches[5]	Less than 20 inches
Surface soil[6] texture	SL, FSL, VFSL, L and LS with textural B horizon. Not subject to soil blowing	CL, SCL, SiCL, SiL, LS and sand other than loose sand	SC, SiC, sand and LS subject to soil blowing. Organic soils

1. See definitions of soil drainage classes in Glossary.

2. In arid regions, soils may be rated one class better. See definitions of soil permeability classes in Glossary.

3. See definitions of surface stoniness in section entitled "General Discussion of Soil Map"

4. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).

5. These soils have severe limitations if slopes are greater than 2%.

6. See definitions of soil textural classes in Glossary.

Table 7. Guides for Developing Soil Interpretations for Paths and Trails.

This guide applies to soils to be used for local and cross country footpaths, and trails for bridle paths. It is assumed that these areas will be used as they occur in nature and that little or no soil will be moved (excavated or filled) (Olsen et al. 1971). The steeper the slope upon which a trail is to be built, the more soil that will have to be moved to obtain a level tread, and the more miles of trail needed to cover a given horizontal distance (Coen and Holland 1976). Soil features, such as surface texture and structure, that affect trafficability, dust, and design and maintenance of trafficways, should be given special emphasis.

Table 7.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	Not subject to flooding during season of use	May flood 1 or 2 times during season of use	Subject to flooding more than 2 times during season of use
Wetness[1] (soil drainage)	Very rapidly, rapidly, well and moderately well drained soils. Water table below 20 inches during season of use	Moderately well drained soils subject to occasional seepage or ponding, and imperfectly drained soils. Water table may be above 20 inches for short periods during season of use	Poorly and very poorly drained soils. Water table above 20 inches and often near the surface for a month or more during season of use
Slope[2]	0 to 15% (aA - eE)	15+ to 30% (fF)	Greater than 30% (gG - hH)
Surface stoniness[3]	0 to 2	3	4 and 5
Rockiness[4]	Rock exposures roughly 100 feet (30 m) apart and cover less than 10% of the surface	Rock exposures 30 to 100 feet (10 - 30 m) apart and cover 10 to 25% of the surface	Rock exposures less than 30 feet (10 m) apart and cover more than 25% of the surface
Surface soil[5] texture	SL, FSL, VFSL and L	SiL, SiCL, SCL, CL and LS	SC, SiC, C, sand and soils subject to severe blowing. All very gravelly, very cherty, very cobbly and very channery soils. Organic soils

1. See definitions of soil drainage classes in Glossary.

2. Slope in this context refers to the slope of the ground surface, not the slope of the tread of the trail. Soil erodibility is an important item to consider in rating this limitation. Some adjustments in slope range may be needed in different climatic zones.

3. See definitions of surface stoniness in section entitled "General Discussion of Soil Map"

4. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).

5. In regions of arid or subhumid climate, some of the finer textured soils may be rated one class better. See definitions of soil textural classes in Glossary.

Table 8. Guides for Developing Soil Interpretations for Lawns and Landscaping.

This guide applies to soils to be used for lawn turf, shrubs and trees. It is assumed that the addition of topsoil will not be needed for good establishment, and that irrigation will be provided (Olsen et al. 1971).

Table 8.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	None during growing season	May flood 1 or 2 times for short periods during growing season	Subject to flooding more than 2 times during growing season
Wetness[1] (soil drainage)	Very rapidly, rapidly, well and moderately well drained soils not subject to ponding	Moderately well drained soils subject to occasional ponding of short duration. Imperfectly drained soils	Poorly and very poorly drained soils. Imperfectly drained soils subject to ponding for periods of more than 4 weeks during growing season
Slope	0 to 9% (aA to dD)	9+ to 15% (eE)	Greater than 15% (fF to hH)
Surface stoniness[2]	0 to 1	2	3, 4 and 5
Rockiness[3]	Rock exposures more than 300 feet (100 m) apart and cover less than 2% of the surface	Rock exposures 100 to 300 feet (30 - 100 m) apart and cover about 2 to 10% of the surface	Rock exposures less than 100 feet (30 m) apart and cover more than 10% of the surface
Surface soil texture[4]	SL, FSL, VFSL, L, SiL and LS with textural B horizon. Not subject to soil blowing	CL, SCL, SiCL, LS and sand other than loose sand.	SC, SiC, C, sand and LS subject to soil blowing. Organic soils
Depth of Ah[5] horizon	Greater than 3 inches	0 to 3 inches	Lack of Ah horizon not a severe limitation by itself
Salinity of topsoil	E.C.[6] 0 to 1	E.C. 1+ to 3	E.C. greater than 3
Depth to bedrock	More than 40 inches	20 to 40 inches[7]	Less than 20 inches
Depth to sand or gravel	More than 40 inches	20 to 40 inches[7]	Less than 20 inches
Permeability[8]	Moderately slow to moderately rapid (0.2 to 6.0 inches/hour)	Slow (0.06 to 0.2 inches/hour)	Rapid and very rapid (more than 6.0 inches/hour, and very slow (less than 0.06 inches/hour)

1. See definitions of soil drainage classes in Glossary.
2. See definitions of surface stoniness in section entitled "General Discussion of Soil Map'
3. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).
4. See definitions of soil textural classes in Glossary.
5. See definition of Ah horizon in Glossary.
6. E.C. means "electrical conductivity". See explanation in Appendix.
7. May be rated "none to slight" on 0 to 2% slopes.
8. In low rainfall areas, soils may be rated one class better. See definitions of soil permeability classes in Glossary.

Table 9. Guides for Developing Soil Interpretations for Permanent Buildings

This guide provides ratings for undisturbed soils that are evaluated for single story buildings and other structures with similar foundation requirements. The emphasis in rating soils for buildings is on foundations; but slope, susceptibility to flooding, and seasonal wetness, that have effects beyond those related exclusively to foundations, are also considered (U.S.D.A. 1971). The properties affecting foundation support are those that affect bearing capacity and settlement under load, and those that affect excavation and construction costs. The properties affecting bearing strength and settlement of the natural soil are density, wetness, plasticity, texture, and shrink-swell behaviour. Shrink-swell potential and plasticity (Atterberg limits) are inferred from the Unified Soil Classification. Properties influencing the ease and amount of excavation are wetness, slope, depth to bedrock and sand or gravel, stoniness and rockiness. These properties also affect the ease of installing underground utilities. Excluded are limitations for septic tank absorption fields (see Table 10), and lawns and landscaping (see Table 8).

On-site investigations are needed for specific placement of buildings and utility lines, and for detailed design of foundations. All ratings are based on undisturbed soils to a depth of 4 to 6 feet.

Table 9.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	None	None	Subject to flooding
Wetness[1] (soil drainage)	WITH BASEMENTS: Very rapidly, rapidly and well drained soils. Water table below 60 inches WITHOUT BASEMENTS: Very rapidly, rapidly, well and moderately well drained soils. Water table below 30 inches	WITH BASEMENTS: Moderately well drained soils. Water table below 30 inches WITHOUT BASEMENTS: Imperfectly drained soils. Water table below 20 inches	WITH BASEMENTS: Imperfectly, poorly and very poorly drained soils. Water table above 30 inches one month or more during year WITHOUT BASEMENTS: Poorly and very poorly drained soils. Water table above 20 inches one month or more during year.
Slope	0 to 9% (aA to dD)	9+ to 15% (eE)	Greater than 15% (fF to hH)
Shrink-swell potential	Low - Unified Groups GW, GP, SW, SP, GM, GC, SM, SC, and CL with P.I.[2] less than 15	Moderate-Unified[3] Groups ML, and CL with P.I. > or equal to 15	High - Unified Groups CH, MH, OL, OH and Pt
Potential frost[4] action	Low (F1, F2)	Moderate (F3)[3]	High (F4)
Depth to bedrock[5]	WITH BASEMENTS: More than 60 inches WITHOUT BASEMENTS: More than 40 inches	WITH BASEMENTS: 40 to 60 inches WITHOUT BASEMENTS: 20 to 40 inches	WITH BASEMENTS: Less than 40 inches WITHOUT BASEMENTS: Less than 20 inches
Potential sulphate attack on concrete	0 to 1000 p.p.m.[6]	1000 to 2000 p.p.m.[3]	Greater than 2000 p.p.m.
Surface stoniness[7]	0 to 1	2	3, 4 and 5
Rockiness[8]	Rock exposures more than 300 feet (100 m) apart and cover less than 2% of the surface	Rock exposures 100 to 300 feet apart (30 - 100 m) and cover 2 to 10% of the surface	Rock exposures less than 100 feet (30 m) apart and cover more than 10% of the surface

1. See definitions of soil drainage classes in Glossary.

2. P.I. means Plasticity Index. See definition in Appendix.

3. These factors are limitations only where basements and underground utilities are planned.

4. The "potential frost action" classes are outlined in Table 3.

5. If bedrock is soft enough so that it can be dug out with light power equipment, such as backhoes, the soils can be rated one class better.

6. p.p.m. means parts per million.

7. See definitions of surface stoniness in section entitled "General Discussion of Soil Map

8. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).

Table 10. Guides for Developing Soil Interpretations for Septic Tank Absorption Fields.

The septic tank absorption field is a subsurface tile system laid out in such a way that effluent from the septic tank is distributed with reasonable uniformity into the natural soil (USDA 1971). When the effluent is percolated into the ground, the contained impurities are attacked by myriad biological organisms, naturally present in the soil (Plumbing Inspection Branch 1972).

Absorption fields are influenced by the ease of downward movement of effluent through the soil (Olsen et al. 1971). This guide provides ratings for undisturbed soils that are evaluated on their ability to absorb and filter the liquid or effluent passed through the tile field. Soils with slow permeability are rated severe. Clean sands and gravels with rapid permeability may constitute a hazard for groundwater contamination.

Table 10.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	Not subject to flooding	Not subject to flooding	Subject to flooding
Wetness[1] (soil drainage)	Very rapidly, rapidly, well and moderately well drained soils not subject to ponding or seepage. Water table below 72 inches	Well and moderately well drained soils subject to occasional ponding or seepage. Imperfectly drained soils not subject to ponding. Water table 48 to 72 inches	Imperfectly drained soils subject to ponding. Poorly and very poorly drained soils. Very rapidly and rapidly drained soils if groundwater contamination hazard. Water table less than 48 inches
Slope	0 to 9% (aA - dD)	9+ to 15% (eE)	Greater than 15% (fF to hH)
Permeability[2]	Moderate to very rapid (more than 0.6 inches/hour)	Moderately slow (0.2 to 0.6 inches/hour)	Slow and very slow (less than 0.2 inches/hour). Rapid and very rapid if groundwater contamination hazard (more than 6.0 inches/hour)
Depth to bedrock[3]	More than 72 inches	48 to 72 inches	Less than 48 inches
Depth to sand or gravel[3]	More than 72 inches	If less than 72 inches and a groundwater contamination hazard exists, limitation is severe	Less than 72 inches if groundwater contamination hazard exists

1. Water table depth is based on the assumption that the tile depth is 2 feet in the soil. Also, see definitions of soil drainage classes in Glossary.

2. The limitation ratings should be related to the permeability of soil layers at and below the depth of the tile line. Also, see definitions of soil permeability classes in Glossary.

3. Based on the assumption that the tile depth is 2 feet in the soil.

Table 11. Guides for Developing Soil Interpretations for Sanitary Landfills - Trench Type[1].

The trench type sanitary landfill is a dug trench in which refuse is buried (USDA 1971). The refuse is covered with at least a 6 inch layer of compacted soil material daily, or more frequently if necessary. Soil material excavated when digging the trench is used for this purpose. A final cover of soil material at least 2 feet thick is placed on the landfill when the trench is full.

This guide provides ratings for evaluating undisturbed soils on their suitability as sites for good sanitary landfills that should be usable all year, and should operate without contaminating water supplies or causing a health hazard (Olsen et al. 1971). Because routine soil investigations are normally confined to depths of about 5 or 6 feet and many landfill operations use trenches as deep as 15 feet or more, there is need for a geological investigation of the area to determine the potential for pollution of groundwater, as well as to obtain the design of the sanitary landfill (USDA 1971). The presence of hard nonrippable bedrock, creviced bedrock, sandy or gravelly strata within or immediately underlying the proposed trench bottom is undesirable from the standpoint of excavation, and from the standpoint of the potential for pollution of groundwater.

Table 11.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding	Not subject to flooding	Not subject to flooding	Subject to flooding
Wetness[2] (soil drainage)	Very rapidly, rapidly, well and moderately well drained soils. Water table more than 72 inches	Imperfectly drained soils. Water table more than 72 inches	Poorly and very poorly drained soils. Water table less than 72 inches
Slope	0 to 15% (aA - eE)	15+ to 30% (fF)	Greater than 30% (gG - hH)
Permeability[3]	Moderate to very slow (less than 2.0 inches/hour)	Moderate to very slow (less than 2.0 inches/hour)	Moderately rapid to very rapid (more than 2.0 inches/hour)
Soil texture[4] (dominant to a depth of 60 inches)	SL, FSL, VFSL, L, SiL, SCL	SiCL, CL, SC, LS	SiC, C, S, gravel, peat, muck
Depth to bedrock	More than 72 inches	More than 72 inches	Less than 72 inches
Depth to sand or gravel	More than 72 inches	More than 72 inches	Less than 72 inches if groundwater contamination hazard
Surface stoniness[5]	0 to 1	2	3, 4 and 5
Rockiness[6]	Rock exposures more than 300 feet (100 m) apart and cover less than 2% of the area	Rock exposures more than 300 feet (100 m) apart and cover less than 2% of the area	Rock exposures less than 300 feet (100 m) apart and cover more than 2% of the area

1. Based on a soil depth (5 to 6 feet) commonly investigated in making soil surveys. If it is probable that the soil material to a depth of 10 to 15 feet will not alter a rating of slight or moderate, indicate that by an appropriate footnote such as "Probably slight to 12 feet", or "Probably moderate to 12 feet".

2. See definitions of soil drainage classes in Glossary.

3. Reflects ability of soil to retard movement of landfill leachate. May not be a factor in arid and semiarid areas. Also, see definitions of soil permeability classes in Glossary.

4. Reflects the ease of digging and moving soil material (workability) and trafficability in the immediate area of the trench that may not have surfaced roads. Also, see definitions of soil textural classes in Glossary.

5. See definitions of surface stoniness in section entitled "General Discussion of Soil Map

6. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).

Table 12. Guides for Developing Soil Interpretations for Reservoir Sites.

This guide provides ratings for evaluating those features and qualities of undisturbed soils that affect their suitability for water impoundments (USDA 1971). Reservoirs must be capable of holding water while allowing only a minimum amount of seepage. Another factor to consider is the suitability of the soil material for dam construction, or earth fill (see Table 13, ratings for road location and sources of roadfill). The material should be free of coarse fragments (over 10 inches in diameter) that interfere with compaction.

Table 12.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Permeability[1]	Moderately slow to very slow (less than 0.6 inches /hour)	Moderate (0.6 to 2.0 inches/hour)	Moderately rapid to very rapid (more than 2.0 inches/hour)
Slope	0 to 2% (aA - bB)	2+ to 9% (cC - dD)	Greater than 9% (eE - hH)
Unified soil group	GC,SC,CL and CH	GM,ML,SM and MH	GP,GW,SW,SP,OL, OH and Pt
Depth to bedrock	More than 72 inches	60 to 72 inches	Less than 60 inches
Depth to sand or gravel	More than 72 inches	60 to 72 inches	Less than 60 inches
Coarse fragments under 10 inches in diameter by percent volume	Less than 20	20 to 50	More than 50
Depth to water table[2]	More than 72 inches	60 to 72 inches	Less than 60 inches one month or more during year
Flooding	Not subject to flooding	Not subject to flooding	Subject to flooding

1. See definitions of soil permeability classes in Glossary.

2. Depth to water table affects the ease of excavation.

Table 13. Guides for Developing Soil Interpretations for Road Location and Sources of Roadfill.

This guide applies to soils evaluated for construction and maintenance of local roads, streets and parking areas; as well as to the suitability of soils as a source of roadfill. These are improved roads and streets having some kind of all weather surfacing, commonly asphalt or gravel, and are expected to carry automobile traffice all year (USDA 1971). They consist of: (1) underlying local soil material (either cut or fill) called the subgrade; (2) the base material of gravel, crushed rock or soil cement - stabilized soil called the subbase; and (3) the actual road surface or pavement, either flexible or rigid. They also are graded to shed water, and have ordinary provisions for drainage. With the probable exception of the hardened surface layers, the roads and streets are built mainly from the soil at hand, and cuts and fills are limited, usually less than 6 feet. Excluded from consideration in this guide are highways designed for fast moving, heavy trucks.

Properties that affect design and construction of roads and streets are: (1) those that affect the load supporting capacity and stability of the subgrade, and (2) those that affect the workability and amount of cut and fill (USDA 1971). The AASHO and Unified Classifications, and the shrink-swell potential give an indication of the traffic supporting capacity. Wetness and flooding affect stability. Slope, depth to bedrock, stoniness, rockiness, and wetness affect the ease of excavation and the amount of cut and fill required to reach an even grade.

Table 13.

Properties Affecting Use	Degree of Limitation		
	None to Slight	Moderate	Severe
Flooding[1]	None	Once in 5 years	More than once in 5 years
Wetness[2] (soil drainage)	Very rapidly, rapidly, well and moderately well drained	Imperfectly drained	Poorly and very poorly drained
Slope[1]	0 to 9% (aA - dD)	9+ to 15% (eE)	Greater than 15% (fF - hH)
Shrink-swell potential	Low - Unified groups GW, GP, SW, SP, GM GC,[3] SM, SC[3]	Moderate - Unified groups CL with P.I. less than 15. ML[4]	High - CL with P.I. 15 or more. CH, MH, OH, OL, Pt
AASHO group index	0 to 4	5 to 8	More than 8
Potential frost action[5]	Low (F1, F2)	Moderate (F3)	High (F4)
Depth to bedrock[6]	More than 40 inches	20 to 40 inches	Less than 20 inches
Surface stoniness[7]	0 to 2	3	4 and 5
Rockiness[8]	Rock exposures greater than 300 feet (100 m) apart and cover less than 2% of the surface	Rock exposures 100 to 300 feet (30 - 100 m) apart and cover about 2 to 10% of the surface	Rock exposures less than 100 feet (30 m) apart and cover more than 10% of the surface

1. Applies to road location.
2. See definitions of soil drainage classes in Glossary.
3. Downgrade to moderate if content of fines is greater than about 30 percent.
4. P.I. means Plasticity Index. See definition in Appendix.
5. Frost heave is important where frost penetrates below the paved or hardened surface layer, and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing point. The "potential frost action" classes are outlined in Table 3.
6. If bedrock is soft enough so that it can be dug with light power equipment and is rippable by machinery, reduce moderate and severe limitations by one class.
7. See definitions of surface stoniness in section entitled "General Discussion of Soil Map".
8. See definitions of rockiness in The System of Soil Classification for Canada (CDA 1974).

Table 14. Guides for Developing Suitability Ratings of Soils as Sources of Topsoil[1].

The purpose of this interpretation is to provide information for use by engineers, landscapers, nurserymen, planners and others who make decisions about selection, stockpiling, and the use of topsoil (USDA 1971).

Topsoil has several meanings, but in soil survey interpretations it refers essentially to the Ah horizon[2]. It means soil material to spread over barren surfaces, usually made barren by construction, so as to improve soil conditions for re-establishment and maintenance of adapted vegetation; and to improve soil conditions on lawns, gardens, and flower beds where vegetation may already exist. In some cases, soil material from the B and C horizons can be used for top dressing of disturbed lands.

Good topsoil has physical, chemical and biological characteristics favourable for the establishment and growth of adapted plants. It is friable, and easy to handle and spread. While a high content of plant nutrients in good balance is desirable, it is perhaps less important than responsiveness to fertilization; and to liming if pH adjustments are necessary.

A rating of "good" means that the soil provides a good source of topsoil for removal and transfer to another place, or it can be used in place. Also, after topsoil has been stripped off, the remaining soil should be reclaimable. These ratings are based on quality of the topsoil and ease of excavation. In addition to the ratings of "good, fair and poor", a rating of "unsuitable" is used.

Table 14.

Properties Affecting Use	Degree of Suitability		
	Good	Fair	Poor
Moist consistence[3]	Very friable, friable	Loose, firm	Very firm
Texture[4]	SL, FSL, VFSL, L and SiL	CL, SCL and SiCL	LS,S,SC,SiC and C. Organic soils
Thickness of Ah Horizon	More than 6 inches	3 to 6 inches	Less than 3 inches
Coarse fragments (percent by volume)	Less than 3	3 to 15	More than 15
Salinity of topsoil[5]	E.C. 0 to 1	E.C. 1+ to 3	E.C. more than 3
Surface stoniness[6]	0 to 1	2	3,4 and 5
Slope[7]	0 to 9%(aA-dD)	9+ to 15% (eE)	More than 15% (fF-hH)
Wetness[8] (soil drainage)	Drainage class not determining if better than poorly drained		Poorly and very poorly drained
Flooding	None	May flood occasionally for short periods	frequent flooding, or constantly flooded

1. See definition of topsoil in Glossary.
2. See definition of Ah horizon in Glossary.
3. See Glossary for descriptions of terms used to define soil consistence.
4. See definitions of soil textural classes in Glossary.
5. E.C. means the electrical conductivity of a saturation extract expressed in mmhos/cm. These limits are suggested by the Alberta Soil and Feed Testing Laboratory, as indicators of soluble salt concentrations that adversely affect lawn growth.
6. See definitions of surface stoniness in section entitled "General Discussion of Soil Map".
7. Influences ease of excavation, and susceptibility to soil erosion after topsoil has been removed.
8. Affects accessibility, and ease of excavation. See definitions of soil drainage classes in Glossary.

Table 15. Guides for Developing Suitability Ratings of Soils as Sources of Sand and Gravel.

The principal purpose of this interpretation is to provide guidance about where to look for sand and gravel.

Ratings are based on the probability that soils contain sizeable quantities of sand or gravel, excluding soft materials such as shale or siltstone. To qualify as either a good or fair probable source, the layer should be at least about 3 feet thick (USDA 1971). All of this however, need not be in the top 5 or 6 feet. If the approximate lowest 6 inches of this section is sand or gravel, and from observations made in deep cuts and other evidence, including geological, the sand or gravel reached at the bottom of this section is know to extend downward for several feet, the thickness requirement is satisfied.

Only the suitability as a source of sand or gravel is rated. No attempt is made to rate the quality of the sand or gravel for specific uses, such as road base, concrete, etc. The general relative quality for many uses in terms of grain size is indicated in Table 17 by classes in the Unified soil classification system (Table 19). However, quality determinations should be made at the site of the source, since both grain sizes and shapes of sand and gravel determine the suitability for specific uses (Olsen et al. 1971).

A particular area outlined on the soil map can be identified as predominantly sand or predominantly gravel, by consulting the soil report for a description of the map unit under consideration. In addition to the ratings of "good, fair and poor", a rating of "unsuitable" is used.

Table 15.

Properties Affecting Use	Degree of Suitability		
	Good	Fair	Poor
Unified soil group	SW, SP, GW, GP	SW-SM, SP-SM, GW-GM, GP-GM	SM, SW- SC, SP-SC, GM, GW-GC, GP-GC (all other groups unsuitable)
Thickness of overburden	Less than 2 feet	2 to 5 feet	More than 5 feet
Wetness[1] (soil drainage)	Drainage class not determining if better than poorly drained		Poorly and very poorly drained
Flooding	None	May flood occasionally for short periods	Frequent flooding or constantly flooded

1. Affects accessibility, and ease of excavation. See definitions of soil drainage classes in Glossary, page

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GLOSSARY

Atterberg limits - Various moisture contents of a soil at which it changes from one major physical condition to another. The Atterberg limits which are most useful for engineering purposes are liquid limit and plastic limit.

The liquid limit is the moisture content at which a soil passes from a plastic to a liquid state.

The plastic limit is the moisture content at which a soil changes from a semi-solid to a plastic state.

Plasticity index (P.I.) is defined as the numerical difference between liquid limit and plastic limit.

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

bulk density, soil - The mass of dry soil per unit bulk volume.

coarse fragments - Rock or mineral particles greater than 2.0 mm. in diameter.

consistence - (a) The resistance of a material to deformation or rupture. (b) The degree of cohesion or adhesion of the soil mass.

droughty soil - Sandy or very rapidly drained soil.

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

engineering tests - Laboratory tests made to determine the physical properties of soils that affect their uses for various types of engineering construction.

erodibility - Susceptibility to erosion.

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

fertile soil - A soil with an abundant supply of available elements necessary for plant growth.

fertilizer - Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply certain elements essential to the growth of plants.

field capacity (field moisture capacity) - The percentage of water remaining in a soil 2 or 3 days after having been saturated and after free drainage has practically ceased.

frost heave, in soil - The raising of a surface caused by ice formation in the underlying soil.

Gleysolic soil - soil developed under wet conditions resulting in reduction of iron and other elements and in gray colors and mottles.

grain size - The effective diameter of a particle measured by sedimentation, sieving, or micrometric methods.

groundwater - That portion of the total precipitation which at any particular time is either passing through or standing in the soil and the underlying strata and is free to move under the influence of gravity.

hardpan - A hardened soil layer, in the lower A or in the B horizon, caused by cementation of soil particles with organic matter or with materials such as silica, sesquioxides, or calcium carbonate.

impeding horizon - A horizon which hinders the movement of water through soils under the influence of gravity.

irrigation - The artificial application of water to the soil for the benefit of growing crops.

landform - Any physical recognizable form or feature of the earth's surface, having a characteristic shape, and produced by natural causes.

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.

pedogenic - Pertaining to the origin, morphology, genesis, distribution, and classification of soils.

permeability, soil - The ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. The classes of soil permeability are rated as follows:

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	Over 20.0 inches/hour

productive capacity, soil - The capacity of a soil, in its normal environment, for producing a specified plant or sequence of plants under a specified system of management. The "specified" limitations are necessary since no soil can produce all crops with equal success nor can a single system of management produce the same effect on all soils.

regolith - The unconsolidated mantle of weathered rock and soil material overlying solid rock.

seepage, soil - (a) The escape of water downward and laterally through the soil. (b) The emergence of water from the soil along an extensive line of surface in contrast to a spring where the water emerges from a local spot.

shrink-swell potential - Tendency of soils to undergo volume changes with changes in water content.

soil blowing - Soil erosion by wind.

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

soil drainage classes - The soil drainage classes are defined in terms of (a) actual moisture content in excess of field moisture capacity, and (b) the extent of the period during which such excess water is present in the plant-root zone. The soil drainage classes are defined as follows:

1. Rapidly drained - The soil moisture content seldom exceeds field capacity in any horizon except immediately after water additions.

2. Well drained - The soil moisture content does not normally exceed field capacity in any horizon (except possibly the C) for a significant part of the year.

3. Moderately well drained - The soil moisture in excess of field capacity remains for a small but significant period of the year.

4. Imperfectly drained - The soil moisture in excess of field capacity remains in subsurface horizons for moderately long periods during the year.

5. Poorly drained - The soil moisture in excess of field capacity remains in all horizons for a large part of the year.

6. Very poorly drained - Free water remains at or within 12 inches of the surface most of the year.

soil horizon - A layer of soil or soil material approximately parallel to the land surface; it differs from adjacent genetically related layers in properties such as colour, structure, texture, consistence, and chemical, biological and mineralogical composition.

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

soil reaction - The degree of acidity or alkalinity of a soil, usually expressed as a pH value. Descriptive terms commonly associated with certain ranges in pH are: extremely acid, < 4.5; very strongly acid, 4.5 - 5.0; strongly acid, 5.1 - 5.5; moderately acid, 5.6 - 6.0; slightly acid, 6.1 - 6.5; neutral, 6.6 - 7.3; slightly alkaline, 7.4 - 7.8; moderately alkaline, 7.9 - 8.4; strongly alkaline, 8.5 - 9.0; and very strongly alkaline > 9.0.

soil salinity - The amount of soluble salts in a soil, expressed in terms of percentage, parts per million, or other convenient units.

soil structure - The combination or arrangement of primary soil particles into secondary particles, units, or peds. The secondary units are characterized and classified on the basis of size, shape, and degree of distinctness into classes, types, and grades.

soil texture - The relative proportions of the various soil separates (sand, silt and clay) in a soil as described by textural classes. The textural classes may be modified by adding suitable adjectives when coarse fragments are present in substantial amounts; for example, "stony silt loam", or "silt loam, stony phase". The sand, loamy sand, and sandy loam classes are further subdivided on the basis of the porportions of the various sand separates present (fine, medium, coarse). The various classes and subclasses and abbreviations are listed in order from coarse to fine as follows: coarse sand (CS), sand (S), fine sand (FS), very fine sand (VFS), loamy coarse sand (LCS), loamy sand (LS), loamy fine sand (LFS), loamy very fine sand (LVFS), coarse sandy loam (CSL), sandy loam (SL), fine sandy loam (FSL), very fine sandy loam (VFSL), loam (L), silt loam (SiL), silt (Si), sandy clay loam (SCL), clay loam (CL), silty clay loam (SiCL), sandy clay (SC), silty clay (SiC), clay (C), heavy clay (HC). The textural classes can also be grouped as follows:

(a) Coarse-textured group
  1. Very coarse textured: CS, S, FS, VFS, LCS, LS, LFS, LVFS.
  2. Moderately coarse textured: CSL, SL, FSL, VFSL.

(b) Medium-textured group
  1. Medium textured: L, SiL, Si.
  2. Moderately fine textured: SCL, CL, SiCL.

(c) Fine-textured group
  1. Fine textured: SC, SiC, C.
  2. Very fine textured: HC (more than 60% clay).

soluble sulphate - Water-soluble sulphate found in soil.

solum - 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.

subsurface drainage - Removal by artificial means of excess water below the soil surface.

topsoil - (i) The layer of soil moved in cultivation. (ii) The A-horizon. (iii) The Ah-horizon. (iv) Presumably fertile soil material used to topdress roadbanks, gardens, and lawns.

trafficability - The capacity of a soil to withstand traffic by people, horses or vehicles.

watershed - A drainage area containing a few thousand acres, from which water drains toward a single channel.

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

SOIL REPORT

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LOCATION AND SIZE

Moonshine Lake Provincial Park is located about 26 km (16 miles) west and north of the town of Spirit River, but the distance is about 34 km (21 miles) by road. It occupies sections 31 and 32 and the northern halves of sections 29 and 30 in township 79, range 8, W-6. The park is about 775 hectares (1,920 acres) in size.

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

The park is situated at the margin of an upland till plain and a broad level to gently sloping lacustrine basin (Odynsky, 1961). Surface elevations range from 685 (2,250') to 730 (2,400') meters above sea level. Drainage within the park has been somewhat altered by the construction of ditches and an earth fill dam to maintain the lake as a reservoir. In the western half of the park drainage is partly directly into the lake and partly into a large slough to the southwest which is joined to the lake by a drainage channel. To the east, the lake is drained by another man-made drainage ditch which continues eastward for a considerable distance before emptying into a tributary of the Ksituan River, which shortly joins the Peace River.

The surficial deposits found throughout most of the park consist of moderately fine to fine textured glaciolacustrine sediments intermingled unpredictably with moderately fine textured till. The glaciolacustrine sediments contain numerous small stones and pebbles and have previously been described as lacustro-till (Odynsky, 1961). They occur as a blanket which subdues but does not mask the underlying topography. A subdued but still noticeable pattern of low steep sided knolls with doughnut shaped depressions in their crowns is noted in the southeast corner of the park. The western half of the park contains several sizeable areas of organic deposits. In the southwest corner a large portion of these are below water and thus are delineated as marsh rather than organic soil.

CLIMATE

The climate of Moonshine Lake is characterized by moderately warm summer and relatively cold winter temperatures (Odynsky, 1961). Weather records kept at

Rycroft about 20 miles (32 km) southeast of the park over a ten year period from 1965-74 show the following values (Environment Canada 1965-1974). A mean annual temperature of 0.9° C (33.6° F), mean annual precipitation of 52.1 cm (20.5 in) with 66% falling as rain, and an average frost free period of 102 days. January is the coldest month of the year with a mean temperature of -20.8° C (-5.4° F), while July is the warmest month with a mean temperature of +13.7° C (56.7° F). Weather records kept nearer the park at the Blueberry Mountain Federal Research Station for the period 1968 to 1972 agree closely with those for Rycroft over the same period. The Rycroft station is reported to provide data for a longer period of time, and therefore means more representative of the general climate. While the total annual precipitation for the area is low it should be noted that fully 31.8 cm (12½ in) or 61% of the total falls during the May through September tourist season.

VEGETATION

Vegetation is an important factor in soil formation. However, since biological studies of Provincial Parks and proposed park areas are currently carried out by the Parks Planning Branch of Alberta Recreation, Parks and Wildlife, vegetation is not discussed in detail herein. Only a few of the more common plant species referred to in the map unit descriptions are listed as follows (Moss, 1959): aspen (Populus tremuloides), balsam poplar (Populus balsamifera), white birch (Betula papyrifera), white spruce (Picea glauca), black spruce (Picea mariana), willow (Salix, spp.), Canadian buffaloberry (Shepherdia canadensis), various grasses, Labrador tea (Ledum groenlandicum), rose (Rosa, spp.), lowbush cranberry (Virburnum edule), fireweed (Epilobium angustifolium), sphagnum moss (Sphagnum, spp.) and feathermoss (Hypnum, spp.).

SOILS

Five Map Units were recognized in the park. Three of these belong to the Luvisolic Order, and one each to the Gleysolic and Organic Orders in the Canadian System of Soil Classification (CDA, 1976). Pertinent features of these Map Units are summarized in Table 16.

TABLE 16. KEY TO THE SOILS

Map Unit	Classification	Parent Material	Surface Texture	Slope (class & gradient)	Surface Stoniness	Drainage	Comments & Limitations
1	Gleyed Dark Gray Luvisol 60% Dark Gray Luvisol 30% Gleyed Gray Luvisol 10%	fine textured glaciolacustrine	L	b,c, (0.5-5%)	1	imperfectly to well drained	slightly stony lacustro-till. Moderate to severe limitations, seasonally high groundwater table, high clay content, low permeability, high shrink-swell potential, susceptibility to frost heave.
2	Orthic Gleysol peaty phase 60% Orthic Gleysol 40%	fine textured glaciolacustrine	Organic	a,b, (0-2%)	0	poorly drained	surface mat of peat varies in thickness from 0 to 40 cm (0-16 in). Severe limitations, organic surface layer, seasonally high groundwater table, high shrink-swell potential, susceptibility to frost heave, groundwater contamination hazard.
3	Dark Gray Luvisol 60% Gleyed Dark Gray Luvisol 30% Gleyed Gray Luvisol 10%	mostly fine textured glaciolacustrine some moderately fine textured till	L	c,E,(2-15%)	1	well to imperfectly drained	only slightly stony, no laminations apparent, high silt content, slight to moderate limitations, excessive slope (E), slow permeability, high clay content.
4	Gleyed Dark Gray Luvisol 60% Orthic Gleysol 30% Orthic Gray Luvisol 10%	fine textured glaciolacustrine	L	b,c, (0.5-5%) a (0-0.5%) b,c , (0 -0.5%)	1	imperfectly drained very poorly drained well drained	pattern of gleysolic soils dissects the unit in such a way as to increase the limitations of the unit as a whole. Moderate to severe limitations - seasonally high groundwater table and surface ponding, slow permeability, susceptibility to frost heave, high shrink-swell potential.
M	Mesisol	intermediately decomposed peat	Organic	a,(0-0.5%)	0	very poorly drained	thick accumulation of mesic peat thinning somewhat towards the margins of the deposits. Large portions of these organic areas are under water more or less continuously and have therefore been mapped as marsh. Severe limitations - organic soil, high groundwater table, groundwater contamination hazard, high shrink-swell potential, susceptibility to frost heave.

Only slight differences are observed among some Map Units, but these are generally important enough, with respect to some recreational or engineering use, to justify the separation. The wide variations in horizon thickness reported in the following Map Unit descriptions demonstrate the extreme variability commonly found in soils. Variations in thickness of as much as ten to forty percent from the norm can be found in comparative horizons of the same soil series found at different points in the landscape.

Common names are employed to list the dominant plant species. These are very general, and are not attempts at complete or exhaustive species lists.

Map Unit 1

Classification:	Gleyed Dark Gray Luvisol Dark Gray Luvisol Gleyed Gray Luvisol	60% 30% 10%
Parent Material:	moderately fine to fine textured lacustrine sediments containing occasional pebbles and small stones	
Landform:	$L^{G}b/Ml$ - glaciolacustrine blanket overlying level to undulating morainal	
Slope:	nearly level to undulating slopes (0.5 - 5%)	
Surface Stoniness:	slightly stony (1)	
Drainage:	Gleyed Luvisolic - imperfectly drained Luvisolic - moderately well drained	
Vegetation:	predominantly white spruce and aspen with some balsam poplar and white birch and an understory of low bush cranberry, rose and fireweed.	

Profile Description:

Gleyed Dark Gray Luvisol developed from lacustrine:

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	8-13	3-5	leaf litter		
Ahe	5-10	2-4	loam	granular	very friable, moist
Ae (Aeg)	3-10	1-4	loam	platy	friable moist
Btg	25-30	10-12	silty clay	subangular blocky	firm, moist
BCg	40-50	15-20	silty clay	amorphous	very firm, moist
Cca	at 90-125	36-44	silty clay	amorphous	very firm, moist

Dark Gray Luvisol developed from glaciolacustrine:

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	8-10	3-4	leaf litter		
Ahe (Ah)	8-13	3-5	loam	granular	very friable, moist
Ae	5-10	2-4	loam	platy	friable, very friable moist
Bt	25-35	10-14	silty clay	subangular blocky	firm, moist
BC	25-40	10-16	silty clay	amorphous	very firm moist
Cca	at 75-90	30-36	silty clay	amorphous	very firm moist

Gleyed Gray Luvisol developed from glaciolacustrine:

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	5-8	2-3	leaf litter		
Ahe	0-5	0-2	loam	granular to platy	very friable, moist
Ae (Aeg)	8-10	3-4	loam	platy	friable moist
Btg	30-35	12-14	silty clay	subangular blocky	firm, moist
BCg	30-50	12-20	silty clay	amorphous	very firm, moist
Cca	at 90-100	36-40	silty clay	amorphous	very firm, moist

Comments:

The glaciolacustrine sediments which form the parent material of the mineral soils in the park contain occasional to numerous small stones and pebbles, and have previously been described as lacustro-till (Odinsky, 1961). They blanket the till subduing but not completely masking the underlying topography. Portions of some profiles may be quite till-like and till may be exposed to the surface at some of the higher points and on the slopes. However due to the unpredictable association of the two parent materials and their marked similarity in the field it was considered impractical to try and separate them.

Limitations:

Severe for camp areas, buildings with basements, septic tanks, sanitary landfills and reservoir sites*; otherwise moderate. Specific limitations are seasonally high groundwater table, low permeability, high clay content, high shrink-swell potential and susceptibility to frost heave.

* This map unit is rated as having severe limitations for reservoir sites due to its seasonally high water table. This applies specifically to dugout type reservoirs where high water tables hinder excavation. Otherwise, only slight limitations are present to construction of dam-type reservoirs.

Map Unit 2

Classification: Orthic Gleysol - peaty phase 60%
Orthic Gleysol 40%

Parent Material: moderately fine to fine textured glaciolacustrine sediments containing occasional pebbles and small stones.

Landform: L^{G}b/Ml - glaciolacustrine blanket overlying level morainal

Slope: nearly level to gently undulating (0 - 2%)

Surface Stoniness: slightly stony (1)

Drainage: poorly drained

Vegetation: predominantly alder, willow, white birch and balsam poplar, some white spruce with an understory consisting mostly of feathermoss.

Profile Description:

Orthic Gleysol/peaty phase developed on lacustrine:

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Oh	30-35	12-14	humic peat		
Bg	at 30-35	12-14	silty clay	amorphous	very firm moist

Orthic Gleysol developed on glaciolacustrine: The description of this soil is identical to that above with the exception that the organic layer is thinner, ranging from 12 to 15 cm (5 to 6 inches).

Comments:

These soils are found in depressional areas where surface ponding is frequent and runoff and infiltration are slow. They are only somewhat less inundated than the areas delineated as marsh.

Limitations:

Severe for all uses, seasonally high groundwater table, organic surface layer more than 6 inches thick, high shrink-swell potential, susceptibility to frost heave, groundwater contamination hazard.

Map Unit 3

Classification:	Dark Gray Luvisol 60% Gleyed Dark Gray Luvisol 30% Gleyed Gray Luvisol 10%
Parent Material:	moderately fine to fine textured lacustrine containing occasional pebbles and small stones.
Landform:	L^Gb/Mu - glaciolacustrine blanket overlying undulating morainal L^Gb/Mi - glaciolacustrine blanket overlying inclined morainal
Slope:	undulating to moderately rolling slopes (2 - 15%)
Surface Stoniness:	slightly stony (1)
Drainage:	Dark Gray Luvisol - moderately well drained Gleyed Luvisols - imperfectly drained
Vegetation:	predominantly aspen, white spruce and balsam poplar with some willow and an understory of buffaloberry, low bush cranberry and rose.
Profile Descriptions:	Same descriptions as corresponding soils of map unit 1, only the relative amounts of each type have changed.
Comments:	This unit has the best drainage of all the map units due primarily to its higher topographic position and steeper, more continuous slopes.
Limitations:	On undulating topography, moderate for playing fields, sanitary landfills and reservoir sites, otherwise slight. On strongly sloping topography, severe for playing fields and reservoir sites, slight for paths and trails and lawns and landscaping, otherwise moderate. Specific limitations are excessive slope, moderate permeability, and high clay content.

Map Unit 4

Classification: Gleyed Dark Gray Luvisol 60%
Orthic Gleysol 30%
Orthic Gray Luvisol 10%

Parent Material: moderately fine to fine textured glaciolacustrine sediments containing occasional pebbles and small stones.

Landform: $L^{G}b/Ml$ - glaciolacustrine blanket overlying level morainal
$L^{G}b/Mu$ - glaciolacustrine blanket overlying undulating morainal

Slope: nearly level to undulating (0 - 5%)

Surface stoniness: slightly stony (1)

Drainage: Luvisolic soils - imperfectly to moderately well drained
Gleysolic soils - very poorly drained

Vegetation: Luvisolic soils - aspen, balsam poplar, willow and white spruce with an understory of rose, low bush cranberry and buffaloberry. Gleysolic soils - willow, alder and grass, some sedges and cattails.

Profile Descriptions:

Gleyed Dark Gray Luvisol (same description as for Map Unit 1)

Orthic Gleysol (same description as for comparable soil in Map Unit 2)

Orthic Gray Luvisol developed from glaciolacustrine:

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	5-8	2-3	leaf litter		
Ahe	3-8	1-3	loam	granular-platy	friable, moist
Ae	3-10	1-4	loam	platy	friable, moist
Bt	30-35	12-14	silty clay	subangular blocky	firm, moist
BC	20-25	8-10	silty clay	amorphous	very firm, moist
Cca	at 90	36	silty clay	amorphous	very firm, moist

Comments: The gleysolic soils dissect the otherwise more suitable luvisolic soils in such a pattern as to severely limit the usefulness of the unit as a whole. This unit is characterized by low subdued circular hillocks with wet central depressions and margins.

Limitations: Moderate for lawns and landscaping, and buildings without basements; otherwise severe. Specific limitations are seasonally high groundwater table and surface ponding, slow permeability, susceptibility to frost heave and high shrink-swell potential.

M - Organic Soil

Classification: undifferentiated Mesisol

Parent Material: sedge and reed peat

Landform: Bh - horizontal bog

Slope: depressional to level (0 - 0.5%)

Surface Stoniness: stone free (0)

Drainage: very poorly drained

Vegetation: black spruce with an understory of labrador tea, sphagnum and feathermoss.

Profile Description:

Horizon	Thickness cm	Thickness in	Texture
Of	40-50	15-20	fibric sphagnum peat
Om	to 150	60	mesic sphagnum and fen peat

Comments: These organic deposits are uniformly more than 150 cm in depth except at their margins. They support continuous stands of black spruce. Considerable portions of the area mapped as marsh are actually inundated organic areas.

Limitations: Severe for all uses. Specific limitations are organic soil, high groundwater table, high shrink-swell potential, groundwater contamination hazard, susceptibility to frost heave and lack of Ah horizon.

MISCELLANEOUS LAND TYPES

1) S.R. Surface Removed. The soil solum has been removed by construction activities in these areas, exposing the parent material. The texture, surface stoniness and limitations of these areas are variable, but are generally similar to those of surrounding soils.

2) D.L. Disturbed Land. These are areas where man's activity has caused the disruption, burial, or removal of the original soil profile such that the remaining soil material displays no recognizable natural profile development.

3) D.O. Dugout. This is a pit excavated by man to serve as a water reservoir.

4)  This symbol is used to indicate a marshy area. These areas are usually inundated for a portion of the year and vegetation consists of grass, sedge, cattail and willow.

SOIL INTERPRETATIONS

Soil interpretations are predictions of soil performance under different uses, not recommendations for land use. They do not eliminate the need for land use planning; rather they are valuable tools that can be used to assist the planner. They indicate limitations and suitabilities of the various kinds of soil for any particular use. The planner can then predict the type and degree of problem 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 detailed soil survey map.

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

A narrow range of soils is found in the mapped area, and numerous limitations exist for recreational development. This does not mean the soils cannot be used; rather the limitations should be recognized and procedures followed to overcome them during construction. Soils most suitable for recreational development are those of map unit 3, and to a much lesser extent map unit 1, while the remaining units possess severe limitations for most uses. The most serious limitation is the seasonally high groundwater table. This combined with high clay content, low permeability and high shrink-swell potential tends to severely restrict most of the map area soils for recreational development.

The limitations and suitabilities of the various soils for selected uses are shown in Table 18. The ratings were determined on the basis of soil morphological, physical and chemical properties, as well as steepness of slope. The principal limiting properties are indicated by numerals which correspond to those listed beneath Table 17. The limiting properties are generally listed in decreasing order of importance.

It is recognized that interactions among some soil and other properties may be great enough to change the limitation ratings by one class. If a moderate or severe limitation occurs in a given map unit, lesser limitations are usually not specified. Limitations due to slope are not subdivided once the limitation becomes severe for the specified use. It follows however, that the steeper the slope, the more severe the limitation, and this fact should be considered in using the soil interpretation tables. In Table 18 the soil limitations for various uses have been designated as slight (S), moderate (M), and severe (V). As a source of topsoil or as a source of sand or gravel the soils are simply rated as good (G), fair (F), poor (P), and unsuitable (U).

TABLE 17. LIMITATIONS AND SUITABILITIES FOR SELECTED USES

Map[2] Symbol	Limitations For: Camp Areas	Picnic Areas	Playing Fields	Paths and Trails	Lawns & Land-scaping	Buildings: with basement	Buildings: without basement	Septic Tank Ab-sorption Fields	Sanitary Landfills-Trench Type	Reservoir Sites	Road Location & Source of Roadfill	Suitability as a Source of: Topsoil[1]	Sand or Gravel
1/b1	V2,11 7	M2,11	V2,11, 6,7	M2	M2,18	V2,13, 14	M2,13, 14	V2,11	V2,11	V2	M2,14, 13	F	U
1/c1	V2,11 7	M2,11	V2,11 6,3	M2	M2,18	V2,13, 14	M2,13 14	V2,11	V2	V2	M2,14, 13	F	U
2/a1	V2,1, 20	V2,1 20	V2,1, 20	V2,1, 20	V2,1, 18	V2,13, 14	V2,13, 14	V2,1	V2,1	V2,1	V2,1	U	U
3/c1	S	S	M3,11	S	S	M7,13, 14	S	S	M7,11	M3,11	S	F	U
3/E1	M3	M3	V3,11	S	S	M3,7, 13,14	M3	M3	M7,11	V3	M3	F	U
4/b1	V2,11	V2	V2,11	V2	M2	V2,13, 14	M2,13 14	V2	V2	V2	V2,14, 13	F	U
M	V19, 1,2	V19, 1,2	V19, 1,2	V19, 1,2	V19, 1,2	V19,1, 2,13	V19,1, 2,13	V19,1, 2	V19,1, 2	V19,1, 2	V19,1, 2,13	U	U

Legend: S - none to slight, M - moderate, V - severe, G - good, F - fair, P - poor, U - unsuitable

[1] Topsoil being considered here is Ah horizon or its equivalent (see Glossary)

[2] Example: Map unit ——→ 6
topography → d 3 ← surface stoniness

Note: for definitions, see section entitled "General Discussion of Soil Map"

LIMITING SOIL PROPERTIES AND HAZARDS

1. Flooding hazard (overflow)
2. Seasonally High Groundwater Table or Surface Ponding
3. Excessive slope
4. Surface Stoniness
5. Sandy Surface Texture
6. Slippery or Sticky When Wet
7. High Clay Content
8. Shallow Depth to Sand or Gravel
9. Rapid Permeability (Droughtiness)
10. Moderate Permeability
11. Slow Permeability
12. Groundwater Contamination Hazard
13. High Shrink-Swell Potential
14. Susceptibility to Frost Heave
15. Surface Soil Salinity
16. High Lime Content (Soil Nutrient Imbalance)
17. Shallow Depth to Bedrock
18. Thin Ah Horizon
19. Organic Soil
20. Organic Surface Layer More Than 6 Inches Thick
21. Thick Overburden above Gravel or Sand
22. Moderate Shrink-Swell Potential
23. Possible Concrete Corrosion Hazard (Soluble Sulphate)
24. Thin Deposit of Sand or Gravel
25. Erosion Hazard
26. Solonetzic Soil
27. Excessive Coarse Fragments

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APPENDIX

Chemical Analyses of the Soils

The chemical analyses carried out on representative soil samples are presented in Table 18 . The samples analyzed are surface and subsoil samples, taken of the map units at representative sites. Surface samples are taken from the zero to six inch depth, and the subsoil samples from the six to twelve inch depth. Each surface sample consists of five separate samples taken at random locations and bunched together into one composite sample. A brief explanation of the significance of each chemical analysis follows.

TABLE 18. CHEMICAL ANALYSES OF SELECTED MAP UNITS *

Map Unit	Sample Depth (inches)	Pounds per Acre			Sodium**	Sulphur	Soil Reaction (pH)	Cond. (mmhos/ cm.)	Sulphate **	Organic Matter**	Free Lime ** ($CaCO_3$)	REMARKS
		Nitrogen (N)	Phosphorus (P)	Potassium (K)								
Mu 1	0-6	1	21	304	L	L+	5.2	0.1		M-		w.spruce,aspen, balsam poplar,
Mu 1	6-12	1	4	351	L+	L	5.2	0.1		M-		w.birch,rose, lowbush cranberry
Mu 3	0-6	1	103	508	L	M	5.3	0.2		M-		aspen,balsam poplar,willow,
Mu 3	6-12	1	20	140	L	L	5.2	0.1		M-		w.spruce,buffalo berry,rose
Mu 4	0-6	1	25	432	L	M-	5.3	0.1		M-		aspen, w.spruce, balsam willow,
Mu 4	6-12	1	6	281	L+	L	4.7	0.1		M-		buffaloberry, rose

Chemical Analyses done by Alberta Soil and Feed Testing Laboratory.

* These tests are rated into four categories: high (H), medium (M), low (L), and none (-). The degree within each category is indicated by a plus or minus sign. The tests for organic matter and free lime are estimates only.

1. Nitrogen

Plant growth in regions where rainfall is adequate is determined more by soil nitrogen than by any other mineral element supplied by the soil (USDA, 1957). Nitrogen is of special importance because plants need it in rather large amounts and it is easily lost from the soil.

Soil nitrogen supply can be markedly affected by climatic conditions, native vegetation, and soil texture.

In humid areas, where forests predominate, the higher rainfall causes much leaching and the removal of most soil nitrogen from upper horizons. In contrast, in areas of somewhat limited rainfall where grass predominates, much more nitrogen remains near the soil surface.

A clay or clay loam soil commonly contains two to three times as much nitrogen as does a very sandy soil under the same type of climatic conditions. Poorer aeration and less leaching favour the retention of nitrogen in the finer textured soils.

In general, low soil nitrogen levels will likely occur in virgin soils, in soils low in organic matter, and in soils that are cold or poorly drained.

General soil test ratings for supplies of available nitrogen, expressed in pounds per acre, are: low, zero to 20; medium, 21 to 50; and high 51 or more.[1]

The primary natural source of soil nitrogen is air. Important artificial sources are fertilizers, animal manures, green manures, and various crop residues.

2. Phosphorus

Phosphorus is present in all living tissue. It is particularly concentrated in the younger parts of the plant, and in the flowers and seeds (USDA, 1957). As phosphorus does not move appreciably in the soil, accumulations are found primarily in the first foot of soil.

Most of the total phosphorus supply is tied up chemically in a form that is not usable by plants; it is not available to the growing plant. The available soil phosphorus

[1] Alberta Soil and Feed Testing Laboratory

originates from the breakdown of soil minerals and soil organic matter or from the addition of phosphate fertilizer. The available soil phosphorus is usually only about 1% of the total soil phosphorus.

Soil tests show that a majority of Alberta soils are low in available phosphorus.[1] Plants respond markedly to phosphate fertilizer on deficient soils.

General soil test ratings for supplies of available phosphorus, expressed in pounds per acre, are: low, zero to 30; medium, 31 to 70; and high, 71 or more.

3. Potassium

Plants need large amounts of potassium, one of the three major plant nutrients (USDA, 1957). It is supplied to roots by soil minerals, artificial fertilizers, manures and crop residues.

Most Alberta soils contain adequate amounts of potassium.[1] Deficiencies occur most frequently on peat soils or poorly drained soils.

General soil test ratings for supplies of available potassium, expressed in pounds per acre, are: low, zero to 150; medium, 151 to 300; and high, 301 or more.

4. Sulphur

Sulphur is essential to life (USDA, 1957). Many plants use about as much sulphur as they do phosphorus. Plants obtain sulphur from the soil, rain and irrigation water, artificial fertilizers, and the atmosphere.

General soil test ratings for supplies of available sulphur are: low (L), medium (M), high (H), and none (nil). The degree within each category is indicated by a + or a - sign[1].

The soil test determines whether adequate amounts of sulphur are available for normal plant growth. Where the sulphur test is low, a sulphur containing fertilizer should be applied; where it is medium, a field test using sulphur and non-sulphur fertilizers should be conducted. Plant responses to sulphur fertilizer can vary considerably within very small areas.

[1] Alberta Soil and Feed Testing Laboratory

5. Soil Reaction (pH)

This test measures soil acidity or alkalinity. Acid soils have pH values of less than 6.6; decreasing pH values indicate increasing soil acidity. Neutral soils have pH values of 6.6 to 7.3; alkaline soils have pH values of more than 7.3. Increasing pH values indicate increasing soil alkalinity.

The best pH range for most crops in Alberta is 5.5 to 7.5.[1]

6. Soil Salinity and Conductivity Test

Conductivity is a measure of the total soluble salt concentration in a soil. Soluble salts are present in soils at all times; however, when the salt concentration is high, plant growth is reduced and the soil is considered "saline". Sulphates and sodium are determined to identify specific salts commonly causing salinity.

In general, lawn growth is affected on soils having conductivity readings as follows:[1]

0 to 1 - negligible salt effects

1.1 to 3 - lawn growth noticeably restricted

3.1 or more - lawn growth considerably restricted.

The sulphate and sodium tests are rated in four categories; high (H), medium (M), low (L), and none (nil). The degree within each category is indicated by a + or a - sign.

A high sodium test may indicate a solonetzic soil which is characterized by poor physical structure and requires special management. A high sulphate test may indicate a hazard of sulphate attack on concrete, indicating a need for sulphate resistant concrete to be used in constructing foundations and underground conduits.

7. Organic Matter and Free Lime

These tests are estimates of the amounts contained in the soil. Results are rated into four categories: high (H), medium (M), low (L), and none (nil). The degree within each category is indicated by a + or a - sign.[1]

[1] Alberta Soil and Feed Testing Laboratory

Organic matter influences physical and chemical properties of soils far out of proportion to the small quantities contained therein (Brady, 1974). It commonly accounts for at least half the cation exchange capacity of soils and is responsible, perhaps more than any other single factor, for the stability of soil aggregates. Furthermore it supplies energy and body building constituents for the soil microorganisms.

Free lime is present in some soils and may reduce nutrient availability to plants in the following ways:

a) Deficiencies of available iron, manganese, copper or zinc may be induced.

b) Phosphate availability may decrease due to the formation of complex and insoluble calcium phosphates.

c) The uptake and utilization of boron may be hindered.

d) The high pH, in itself, may be detrimental.

Free lime cannot be readily removed from the soil. The only practical way to counteract its effect is to increase soil organic matter content.

Engineering Properties of the Soils

Engineering test data determined on representative soil samples are presented in Table 19. The samples analyzed were taken from the subsoils of Map Unit 1 at a representative site. A brief description of the significance of each analytical parameter follows.

1. Field Moisture Percentage.

This is a determination of the natural moisture content of the soil as it occurs in the field.

For any potential borrow material, it is essential to know in advance of construction whether, for the compaction procedure likely to be specified, the moisture content in the field is excessive or deficient with respect to the optimum value for that procedure (Terzaghi and Peck, 1967).

TABLE 19. PHYSICAL ANALYSES OF SELECTED MAP UNITS

			Mechanical Analysis																	
			Percentage Passing Sieve							Percentage Smaller than								Classification		
	Depth (feet)	Field moisture (%)	1 inch	3/4 inch	5/8 inch	#4 (4.7 mm.)	#10 (2.0 mm.)	#40 (0.42 mm.)	#200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.	0.001 mm.	Liquid Limit	Plasticity Index	Optimum Moisture % **	Maximum Dry Density lb/ft^3 **	AASHO	Unified	USDA
1	3-5	22	100	97	97	97	97	96	88	88	62	52	44	51	26	26	94	A7-6(16)	CH	C

Map Units developed on similar parent material: 1, 2, 3, & 4.

These values are obtained from charts worked out by the Highways Testing Laboratory, Alberta Department of Highways.

2. Particle Size Analysis.

The particle size distribution within a soil is determined by laboratory tests, usually referred to as the particle size analysis of the soil (PCA 1962). The amounts of the gravel and sand fractions are determined by sieving, while the silt and clay contents are determined by sedimentation techniques. The amount of each soil separate contained in a soil determines its texture.

Where soil texture is known, approximations and estimates can be made of soil properties, such as permeability, water holding capacity, shrink-swell potential, bearing value, susceptibility to frost heave, adaptability to soil cement construction, etc.

3. Plasticity.

In soil mechanics, plasticity is defined as that property of a material which allows it to be deformed rapidly, without rupture, without elastic rebound, and without volume change (Means and Parcher 1964).

Tests have been devised to determine the moisture content of a soil at which it changes from one major physical condition to another (PCA 1962). These tests, conducted on the material passing the number 40 sieve (0.42 mm), have been used as key factors in classifying soils for structural purposes.

The tests used for estimating plasticity are plastic limit, liquid limit, and plasticity index. The plastic limit is the moisture content at which the soil passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid and plastic limits. This parameter gives the range in moisture content at which a soil is in a plastic condition. A small plasticity index, such as five, indicates that a small change in moisture content will change the soil from a semisolid to a liquid condition. A large plasticity index, such as 20, shows that a considerable amount of water can be added before a soil changes to a liquid condition.

4. Moisture-Density Relationships.

The purpose of every laboratory compaction test is to determine a moisture density curve comparable to that for the same material when compacted in the field by means of the equipment and procedures likely to be used (Terzaghi and Peck 1967). Most of the current methods are derived from the procedure known as the "Standard Proctor Test". The "optimum moisture content", according to the Standard Proctor Test, is the water content at which the dry density is a maximum ("maximum dry density").

5. Soil Classification.

In order that soils may be evaluated, it is necessary to devise systems or methods for identifying soils with similar properties and then to follow this identification with a grouping or classification of soils that perform in a similar manner when their densities, moisture contents, textures, etc. are similar (PCA 1962). A brief description of three widely used soil classification systems follows.

(a) AASHO Classification System.

The American Association of State Highway Officials system is an engineering property classification based on field performance of highways. In the AASHO system, soil material is classified into seven basic groups with each group having about the same general load carrying capacity and service. The groups are designated A-1 to A-7; the best soils for road subgrades are classified as A-1, the next best A-2, etc., with the poorest soils being classified as A-7.

These seven basic groups are further divided into subgroups with a group index that was devised to approximate within group evaluations. Group indexes range from zero for the best subgrades to 20 for the poorest.

(b) Unified Soil Classification System.

In this system, the soils are identified according to their textures and plasticities, and are grouped according to their performance as engineering construction materials. Soil materials are divided into coarse grained soils, fine grained soils, and highly organic soils. The coarse grained soils are subdivided into eight classes; the fine grained soils into six classes; and there is one class of highly organic soils.

Coarse grained soils are those that have 50% or less of material passing the number 200 sieve; fine grained soils have more than 50% of material passing the number 200 sieve. The letters G, S, C, M, and O stand for gravel, sand, clay, silt, and organic materials respectively. The highly organic soils are designated by the symbol "pt". Additional letters used in the secondary divisions of the fine grained soils are L and H, meaning relatively low liquid limit and relatively high liquid limit, respectively.

The designation CL for example, indicates inorganic clays of low to medium plasticity; SW indicates well graded sands; and SC indicates clayey sands and sand-clay mixtures.

(c) United States Department of Agriculture Soil Classification System.

The system of textural soil classification, used by Canadian soil scientists, is known as the USDA system. It is defined under 'soil texture' in the glossary. There is some variation in the particle size limits between the USDA system and the two engineering systems just described, but the differences are not great. A comparison of the different systems is given in the PCA Soil Primer (1962).

GLOSSARY

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

aeration, soil - The process by which air in the soil is replaced by air from the atmosphere.

amorphous structure - A coherent soil mass showing no evidence of any distinct arrangement of soil particles.

available nutrient - The portion of any element or compound in the soil that can be readily adsorbed and assimilated by growing plants.

blocky structure - Soil particles arranged around a point and bounded by rectangular and flattened surfaces, vertices sharply angular.

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.

firm consistence - The consistence at which a moist soil offers distinctly noticeable resistance to crushing, but can be crushed with moderate pressure between the thumb and forefinger.

friable consistence - Consistence at which a moist soil crushes easily under gentle to moderate pressure between the thumb and forefinger, and coheres when pressed together.

Gleysolic - An order of soils that are saturated with water and are under reducing conditions continuously or during some period of the year, unless they are artificially drained. They have developed under hydrophytic vegetation and may be expected to support hydrophytic vegetation if left undisturbed.

granular structure - A coherent mass of soil particles arranged around a point in a spheroidal shape, and characterized by rounded vertices.

gravel - Rounded and subrounded rock or mineral fragments greater than 2 mm and up to 7.6 cm (3 inches) in diameter.

Gray Luvisol - A Luvisolic soil in which the Ah horizon, if present, is less than 5 cm (2 inches) thick.

great group - The fifth category in the Canadian system of soil classification. It is a taxonomic group of soils having certain morphological features in common, and a similar pedogenic environment.

green manure - Plant material incorporated with the soil, while the plant material is still green. The purpose is to improve the soil.

humic - Composed of highly decomposed organic soil material containing little fiber.

humus - (1) The fraction of the soil organic matter that remains after most of the added plant and animal residues have been decomposed. It is usually dark coloured. (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 a continuous breakdown, change and synthesis.

illuvial horizon - A soil horizon in which material carried from an overlying layer has been precipitated from solution or deposited from suspension as a layer of accumulation.

leaching - The removal from the soil of materials in solution.

lime (in soil) - A soil constituent consisting principally of calcium carbonate, and including magnesium carbonate and perhaps other materials.

Luvisolic - An order of soils that have developed under climatic conditions ranging from mild humid to very cold humid. The soils have developed under deciduous, mixed deciduous-coniferous, or boreal forests, or under mixed forest in the forest-grassland transitional zones. These soils have eluviated light coloured surface (Ae) horizons, brownish illuvial B (Bt) horizons in which silicate clay is the main accumulation product, and parent materials that are generally neutral to alkaline in reaction.

mesic - Composed of organic soil material at a stage of decomposition between that of fibric and humic materials.

order, soil - The highest category in the Canadian system of soil classification. All the soils within an order have one or more characteristics in common.

Organic - An order of soils that have developed dominantly from organic deposits that are saturated for most of the year, or are artificially drained, and contain 30% or more organic matter to certain specified depths.

orthic - Refers to the modal or central concept in the definition of a soil order.

particle size distribution - The amounts of the various soil separates in a soil sample, usually expressed as weight percentages.

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

peaty phase (of soil) - Soil having 6 to 16 inches (15 to 40 cm) of mixed peat or 6 to 24 inches (15 to 60 cm) of fibric moss peat on the surface.

platy structure - Soil particles arranged around more or less developed horizontal planes, and generally bounded by relatively flat horizontal surfaces.

sediment - Deposition by such agents as running water, wind, and glacial ice, of material resulting from the decomposition and disintegration of solid rocks under the combined effects of atmospheric agents and processes.

soil horizon - A layer of soil or soil material approximately parallel to the land surface; it differs from adjacent genetically related layers in physical properties such as colour, structure, texture and consistence; and chemical, biological, and mineralogical composition. Soil horizons are designated by letters according to the following definitions:

1) <u>Organic Layers</u> - These contain more than 30% organic matter. Two groups are recognized:

O - An organic layer developed under poorly drained conditions, or under conditions of being saturated most of the year, or on wet soils that have been artificially drained.

Of - The least decomposed organic layer, containing large amounts of well preserved fiber whose botanical origin is readily identifiable, and called the fibric layer.

Om - An intermediately decomposed organic layer containing less fiber than an Of layer, and called the mesic layer.

Oh - The most decomposed organic layer, containing only small amounts of raw fiber, and called the humic layer.

L-F-H - Organic layers developed under imperfectly to well drained conditions, often forest litter (commonly abbreviated to L-H). They are defined as follows:

L - The original structures of the organic material are easily recognized.
F - The accumulated organic material is partly decomposed.
H - The original structures of the organic material are unrecognizable.

2) <u>Master Mineral Horizons</u> - These are mineral soil layers containing less than 30% organic matter. They are defined as follows:

A - A mineral horizon formed at or near the surface in the zone of removal of materials in solution and suspension or maximum in situ accumulations of organic matter, or both.

B - A mineral horizon characterized by one or more of the following:
a) An enrichment in silicate clay, iron, aluminum, or humus.
b) A prismatic or columnar structure that exhibits pronounced coatings or staining associated with significant amount of exchangeable sodium.
c) An alteration by hydrolysis, reduction, or oxidation to give a change in colour or structure from horizons above or below, or both.

C - A mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, except gleying, and the accumulation of carbonates and more soluble salts.

3) Lowercase Suffixes - These indicate a secondary or subordinate feature or features, in addition to those characteristic of the defined master horizon. They are defined as follows:

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

e - A horizon characterized by removal of clay, iron, aluminum, or organic matter, alone or in combination, and lighter coloured when dry than an underlying B horizon.

f - A horizon enriched with hydrated iron.

h - A horizon enriched with organic matter. Ah - An A horizon of organic matter accumulation. It contains less than 30% organic matter. It is darker than the layer immediately below, or has at least 1% more organic matter than the 1C or both. Ahe - This horizon has been degraded, as evidenced by streaks and splotches of light and dark material and often by platy structure.

k - Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added. Most often it is used with B and m (Bmk) or C (Ck), and occasionally with Ah (Ahk).

m - A horizon slightly altered by hydrolysis, oxidation, or solution, or all three to give a change in colour, structure or both. This suffix can be used as Bm, Bmgj, Bmk, and Bms.

t - A horizon enriched with silicate clay as indicated by a higher clay content (by specified amounts) than the overlying eluvial horizon, a thickness of at least 2 inches (5 cm), and usually a higher ration of fine (less than 0.2 micron) to total clay than the IC horizon.

soil morphology - The colour, structural, and textural characteristics of the soil or any of its parts.

soil ped - A unit of soil structure such as a prism, block or granule, which is formed by natural processes.

soil profile - A vertical section of the soil through all its horizons and extending into the parent material.

soil separate - Mineral particles, less than 2.0 mm in equivalent diameter, ranging between specified size limits. The names and size limits of separates recognized in Canada and the United States are very coarse san, 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.

subangular blocky structure - Soil particles arranged around a point and bounded by subrectangular surfaces, vertices mostly oblique, or subrounded.

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

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

very firm consistence - Consistence at which moist soil material crushes under strong pressure, and is barely crushable between the thumb and forefinger.

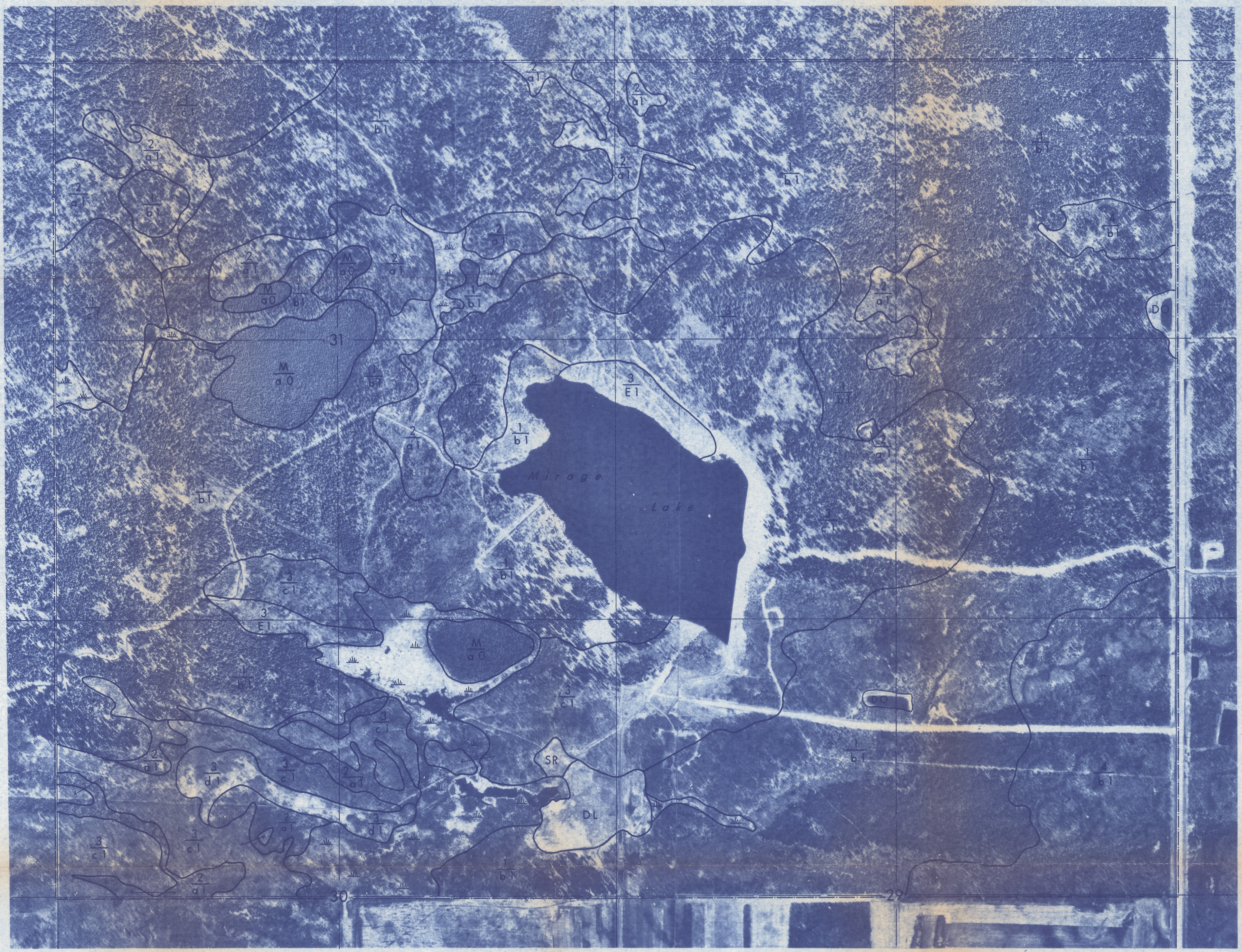
very friable consistence - Consistence at which moist soil material is crushed under very gentle pressure, but coheres when pressed together.

water table - The upper surface of the zone of saturation.

OFR 1977-1

SOILS MAP OF MOONSHINE LAKE PROVINCIAL PARK

Tp. 79, R. 8, W. 6.



Soil Classification:

MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Luvisolic	Gleyed Dark Gray Luvisol 60% Dark Gray Luvisol 30% Gleyed Gray Luvisol 10%	fine textured slightly stony glaciolacustrine
2	Gleysolic	Orthic Gleysol - peaty phase 60% Orthic Gleysol 40%	fine textured slightly stony glaciolacustrine
3	Luvisolic	Dark Gray Luvisol 60% Gleyed Dark Gray Luvisol 30% Gleyed Gray Luvisol 10%	mostly fine textured slightly stony glaciolacustrine some moderately fine textured till
4	Luvisolic	Gleyed Dark Gray Luvisol 60% Orthic Gray Luvisol 10%	fine textured slightly stony glaciolacustrine
	Gleysolic	Orthic Gleysol 30%	
M	Organic	Mesisol	intermediately decomposed peat

APPROXIMATE SCALE

660 0 660 1320 1980

FEET

Compiled from uncontrolled mosaic

Mapped and Compiled by: R.A. MacMillan and G.M. Greenlee

Soils Division

1977

D.O. Dugout

D.L. Disturbed Land

S.R. Surface Removed

Map Symbol

3 ← map unit

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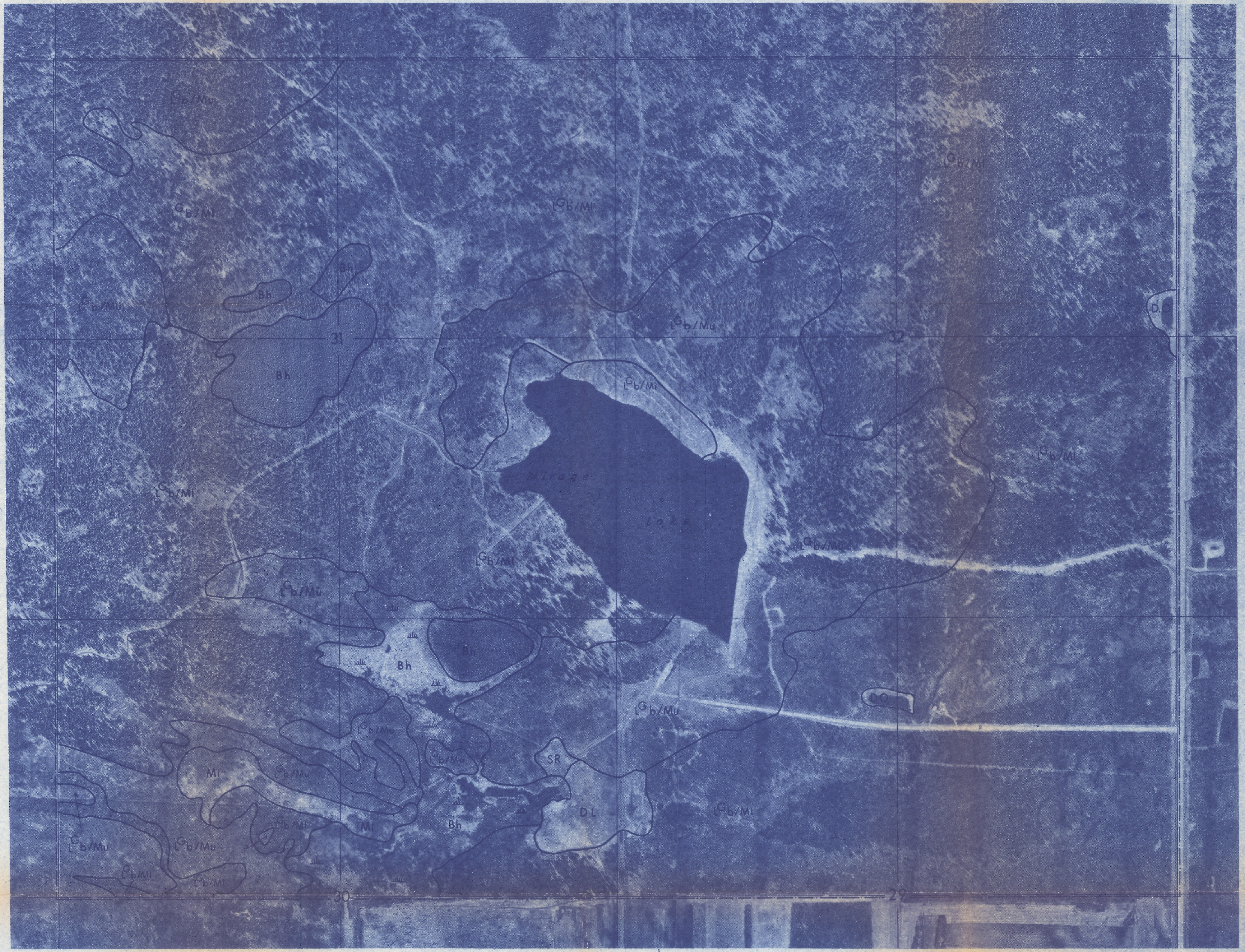
LANDFORM MAP OF MOONSHINE LAKE PROVINCIAL PARK

Tp. 79, R. 8, W 6.



LEGEND

M - morainal
    Ml - level morainal
    Mu - undulating morainal
    Mi - inclined morainal

B - bog
    Bh - horizontal bog (flat bog)

L - lacustrine
    $L^{G}b$ - glaciolacustrine blanket

D.O. Dugout

D.L. Disturbed Land

S.R. Surface Removed

Landform Line

Park Boundary

Very Poorly Drained

APPROXIMATE SCALE

660 0 660 1320 1980

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