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SOIL SURVEY

of

ENTRANCE PROVINCIAL PARK

and

INTERPRETATION FOR RECREATIONAL USE

by

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PREFACE

A standard explanatory format, beginning with the section entitled "Preface" and ending with the section entitled "Glossary" has been written. Since the same explanatory remarks will pertain to reports written for each of the Alberta Provincial Parks and other areas surveyed, the same standard format will be presented at the beginning of each report.

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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 (8). 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 (7). 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 to follow is designed to be of assistance in planning future development in various Provincial Parks within the Province of Alberta.

Detailed and semi-detailed soil surveys were conducted in the following Provincial Parks during the summer of 1972: Little Bow, Entrance, portion of Lesser Slave Lake, Beauvais Lake, Bragg Creek, Police Outpost, Woolford, and Pigeon Lake. Also included were areas adjacent to Travers Reservoir, Little Bow Lake Reservoir and Lake McGregor. Total area surveyed was approximately 27,000 acres.

ACKNOWLEDGMENTS

The Research Council of Alberta supplied the funds and staff for the field, laboratory and drafting work, and for the writing of the reports. The Parks Planning Branch of the Department of Lands and Forests provided some of the aerial photographs and maps. The Research Council of Alberta published the report and compiled the soil map. The University of Alberta provided office and laboratory space.

Mrs. A. Bembridge and Mrs. C. Novasky typed and assisted in compiling and proof reading the reports. Mr. Z. Widtman drafted the final soil map, while Mr. J. Beres and Mr. C. Veauvy determined the physical properties of the soils. The soil chemical analyses were determined by the Alberta Soil and Feed Testing Laboratory.

Able field assistance was given by Mr. J. Wasmuth, Mr. A. Wynnyk and Mr. C. Veauvy.

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METHODS

The areas surveyed were traversed by motor vehicle along all roads and negotiable trails, and on foot along cut-lines and non-negotiable trails. Soil pits were dug at frequent intervals to depths of 2 to 4 feet, to examine and describe soil horizons and classify the soils. Detailed field soil descriptions were made. Soil boundaries were drawn on aerial photographs with the aid of a pocket stereoscope.

Representative surface and shallow subsurface soil samples were collected for chemical analyses and subsurface samples were collected at depths of 4 to 6 feet for physical analyses.

GENERAL SOIL MAP

The soils were classified according to the System of Soil Classification for Canada (3). The areal extent of each different kind of soil is indicated on the soil map. An explanation of the map symbols follows:

Example:

1 ← map unit

C4 ← surface stoniness rating (Table 2)

C ← topographic class (Table 1)

The map units generally refer to single soil series or soil associations. A soil series is a grouping of all soils which are similar in the number, color, texture, structure, relative arrangement, chemical composition, and thickness of horizons, as well as in the geology of the soil parent material (3). A soil association simply consists of a number of soil series occurring together in characteristic patterns.

Where a map unit consists of a single series, other soil series may be found in close association. However, the dominant series makes up to 80 to 90 per cent 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 soil association, it was not possible to outline each separate series in the time available to complete the soil survey. However, different series in an association generally possess very similar properties. The approximate percentage of each series comprising the association is indicated in the soil report. Minor insignificant amounts of other series may be present but are not mentioned in the definition of the association.

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

The topographic classes and stoniness ratings are defined in Tables 1 and 2, which follow:

Table 1. Topographic classes and symbols (3)

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	60^+

Table 2. Stoniness ratings (5)

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 uses unless considerable clearing is done
Stony 5 (excessively stony land)	too stony to permit any recreational uses (boulder or stone pavement)

SOIL CHARACTERISTICS AND INTERPRETATIONS FOR RECREATIONAL USES

Soil surveys provide for classifying, defining and delineating each kind of soil and making predictions of soil behavior under specific management (7). The soils within an area are mapped and classified without regard for existing or expected land ownership boundaries, or types of use. 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 (7). These include soil texture; color; 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 soil 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 (2).

The soil properties affecting most recreational uses include susceptibility to flooding, wetness, slope, and surface stoniness (2). 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 (2, 7). 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 (7). Montgomery and Edminster (7) 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 (2).

Soils that are wet all year, even if not flooded, have severe limitations for campsites, roads, hiking trails, playgrounds and picnic areas (7). The economic feasibility of installing subsurface drainage in these soils is questionable (2). 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 (2).

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 (7).

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 (7).

Slope affects the use of soils for recreation (2, 7). Generally, slopes of less than 2 per cent offer no limitations for use as playgrounds, campsites, sites for recreation buildings, roads and trails. Slopes greater than 9 per cent constitute a severe limitation for playground areas since levelling costs would become prohibitive. Slopes of more than 15 per cent 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 per cent. Of course steep, gently sloping and moderately sloping soils can be levelled for campsites, playgrounds and building sites, where the cost is justified (7). 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 (2). 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 (9). Soils with very rapid to moderately rapid permeability have no limitations, and soils with slow and very slow permeability have severe limitations (7). 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 (2).

Surface stoniness limits the use of some soils for recreational facilities (2). 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 (2). 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 (7). Rounded gravels and stones present hazards on steeply sloping soils used for foot trails.

Surface texture is an important soil property to consider (2, 7). 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 (7). 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 (2). Some soils absorb septic effluent rapidly and other soils absorb it very slowly (7). 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 (2). 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 (7). These also are feasible only in soils that meet the special requirements for sewage lagoons.

Shrink-swell potential is inferred from Atterberg limits (2). 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 material 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 (2). 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. This is especially true in Alberta.

The soluble sulphate content of the underlying soil material is an important factor for buildings with concrete foundations, as well as for underground conduits (2). The U.S. Bureau of Reclamation (14) has established classes for sulphate attack on concrete. Soils with 0 to 0.1 per cent soluble sulphate content are considered to have no limitations for standard concrete foundations, and soils with 0.1 to 0.2 per cent are considered to have slight limitations. Soils with 0.2 to 0.5 per cent soluble sulphate content are considered to have moderate limitations, and foundations may require sulphate resistant concrete. Soils with greater than 0.5 per cent soluble sulphate are considered to have severe limitations and should be avoided (2).

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 (7). The ability of soils to grow sods that 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 (7).

Thus we find that basic soil qualities and characteristics are closely associated with the various types of outdoor recreational activities (7). By knowing the characteristics and qualities of the different kinds of soils and their behaviors, 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 (7).

EXPLANATION OF SOIL INTERPRETATIONS

Soil limitation or suitability ratings are for evaluating each soil for a particular use (8). 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 detailed soil descriptions obtained during the field soil mapping program. The limited time, resources and trained personnel available did not permit such determinations as bulk density and percolation rate. 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 the same or very similar parent materials.

It is important that the proper perspective be placed on the use of soil interpretations in recreation planning (7). 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 a general soil map. Thus for design and construction of specific recreational facilities, an "on-site" investigation is often needed.

The soils are grouped into 3 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 map symbol. The 3 categories of limitations are as follows:

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

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

(3) V - Severe soil 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 rated as good (G), fair (F), or poor (P) as sources of topsoil, or sand and gravel. These suitability ratings correspond to the limitations of none to slight (S), moderate (M), and severe (V) respectively and the definitions are essentially the same. The soils may also be rated "unsuitable" 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

(1) Camp Areas are considered to be used intensively for tents, truck campers and small camp trailers with the accompanying activities of outdoor living (8). It is assumed that little site preparation will be done other than shaping and levelling for tent and parking areas. The soils should be suitable for heavy foot traffic and for limited vehicular traffic. Flooding hazard, depth to water table, slope, permeability, stoniness, and surface texture affect suitability for this use. Soil suitability for growing and maintaining vegetation is not rated but is an item to consider in final evaluation of the site (see ratings for lawns and landscaping).

(2) Foundations for Low Buildings (with or without basements) - Interpretations indicate limitations for construction and maintenance of homes and small buildings (8). They are affected by soil characteristics such as flooding hazard, wetness, slope, stoniness, depth to bedrock, shrink-swell potential, sulphate content, and depth to sand and gravel. (Limitations for on-site sewage disposal is rated separately.)

(3) Play Areas for recreation apply to soils that are to be used intensively for organized games such as football, baseball, volleyball, horseshoes and other similar organized games (8). They are subject to heavy foot traffic. A level surface, good drainage, and a surface soil texture and consistence that gives a firm surface which is not slippery and sticky when wet is generally required. Soils that are sloping, very stony, very shallow, subject to blowing, subject to flooding, or have seasonally high water tables or slow permeability are rated as having severe limitations.

(4) Paths and Trails - Uses are local and crosscountry footpaths, and 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) (8). Soil features, such as surface texture and structure, that affect trafficability, dust, and design and maintenance of trafficways should be given special emphasis. Soils that flood frequently, are poorly drained or very stony, or have clay or sand surface textures or steep slopes are rated as having severe limitations.

(5) Picnic Areas are considered to be extensively used as park-type picnic grounds and are subject to heavy foot traffic (8). It is

assumed that most vehicular traffic will be confined to access roads and parking areas. Flood hazard, wetness, slope, permeability, surface stoniness and surface texture affect suitability for this use. Soil suitability for growing vegetation is not rated but is an item to consider in final evaluation of the site. (See ratings for lawns and landscaping.)

(6) Septic Tank Filter Fields - Successful operation of the system depends upon the ability of the soil to absorb and filter the liquid or effluent passed through the tile field (8). Filter fields are influenced by the ease of downward movement of effluent through the soil. Soils with slow permeability are rated severe. Other soil properties that affect septic tank filter fields are flooding hazard, seasonal high ground water, slope, depth to bedrock, and depth to sand and gravel. Clean sands and gravels with rapid permeability may constitute a hazard for ground water contamination.

(7) Road and Parking Location and Suitability for Subgrade Material - These uses are based on features that affect performance for the location of roads, streets, and parking areas (8). The main factors considered are flooding hazard, shrink-swell potential, depth to bedrock, and susceptibility to frost heave.

(8) Lawns and Landscaping - The soil is rated on the assumption that it will be used for lawn turf, shrubs and trees without need for adding topsoil for good establishment, and also that irrigation is provided (8). Soil characteristics affecting this use are flooding hazard, depth to seasonal high water table, slope, stoniness, surface soil texture, depth of topsoil, salinity, and depth to bedrock or sand and gravel.

(9) Sanitary Land Fills are disposal areas for trash and garbage. A good sanitary land fill should be usable all year and should operate without contaminating water supplies or causing a health hazard (8). Soil factors considered in rating the limitations for use are flood hazard, seasonal high water table, slope, permeability, depth to bedrock, and depth to sand and gravel.

(10) Reservoir Sites are rated on the adequacy of the soil material to prevent seepage from the reservoir (8). Soil properties most important are slope, permeability, depth to bedrock and depth to sand and gravel. Depth to water table influences the depth of water in dugouts, pits, etc. in all kinds of soil materials so is not rated for this use.

(11) Suitability as a Source of Topsoil - Topsoil is considered to be used for establishing lawns (8). A rating of "good" means the soil provides a good source of topsoil for removal and transfer to another place, or it can be used in place. Soils are rated on flooding hazard, wetness of the surface layer of undisturbed soils, slope, stoniness, surface texture, depth of topsoil, and salinity.

(12) Suitability as a Source of Sand and Gravel - A particular area outlined on the soil map can be identified as predominantely sand or predominantly gravel by consulting the soil report for a description of the map unit under consideration. Only the suitability as a source for sand and gravel is rated (8). No attempt is made to rate the quality of the sand and gravel for specific uses such as road base, concrete, etc. Quality determinations should be made at the

site of the source, since both grain sizes and shapes of sand and gravel determine suitability for specific uses (8). Soil limitations considered at the site of the source are flooding hazard, wetness, depth to bedrock (influences thickness of sand and gravel deposit), and depth to sand and gravel (determines thickness of overburden that must be removed to reach sand and gravel deposit).

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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 semisolid 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.

ground water - 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.

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.

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 color, 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 ratios.

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 proportions 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).

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 ground water or that level below which the soil is saturated with water.

SOIL REPORT

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SOILS MAP OF ENTRANCE PROVINCIAL PARK (included with report)

SIZE AND LOCATION

Entrance Provincial Park is about 6900 acres in size, including lake areas, which comprise approximately 700 acres. The park averages about 1 1/2 miles in width and is 7 miles long. It is situated in a north-south direction along the Grande Cache highway, beginning about 8 miles northwest of the town of Hinton. Most of the park is located in sections 5, 8, 17, 20, 29, and 32, and parts of sections 6, 7, 18, 19, 30, and 31, township 52, range 26, west of the fifth meridian. The extreme southern portion is located in section 32, township 51, range 26, west of the fifth.

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

Entrance Provincial Park is situated almost entirely within the Jarvis Lake valley. This is defined by Roed (22) as a partly buried bedrock valley, partly filled with glacial and fluvial deposits. Upland areas occur in the eastern portion of the park, in the extreme southern end, and in the southwest quarter of section 7, on the west side. The bottom of the valley is occupied by Jarvis Lake in the southern end of the park; Gregg Lake in the northern end; and numerous smaller lakes and Jarvis Creek between. An elevational difference of roughly 400 feet exists between the highest and lowest portions of the park. Entrance Park is drained by Jarvis Creek, which flows north from Gregg Lake.

Surficial outwash deposits are found throughout most of the park, as well as numerous small pockets of sand. The most extensive sand deposit borders the southwest corner of Jarvis Lake. Jarvis Creek is bordered by organic soils, which are most extensive between Graveyard Lake and Gregg Lake. Numerous alluvial deposits are found throughout the park, in low areas of variable size. The most substantial area is located between

Cache Lake and Gregg Lake, along the east side of Jarvis Creek. Glacial till, usually less than 10 feet in thickness (21), mantles the upland areas. A prominent bedrock outcrop occurs in the northeastern portion of the park.

CLIMATE

The climate of Entrance Park can be described as subhumid continental, with long cold winters and moderately mild summers (21). The area is subject to warm chinook winds during winter. The mean annual precipitation at Entrance, about 6 miles southeast of the park boundary, is 20 inches, with about 72 per cent falling as rain. The frost free period prior to 1950 was 42 days, but has increased to 66 days in the subsequent period. July is the warmest month, with a mean temperature of 59°F, while January is the coldest, with a mean temperature of 11°F.

VEGETATION

The most common tree species on well drained sites in the park is lodgepole pine (_Pinus contorta_ var _latifolia_), with some local inclusions of aspen poplar (_Populus tremuloides_) and balsam poplar (_Populus balsamifera_) (21). These species have assumed a dominant position over most of the landscape, as a result of fire. In certain older stands, white spruce (_Picea glauca_) and black spruce (_Picea mariana_) are common, and alpine fir (_Abies lasiocarpa_) may be present. The composition of the shrub layer varies with the density of the forest stand, and common species include buffaloberry (_Shepherdia canadensis_), alder (_Alnus_ spp.), willow (_Salix_ spp.), wild raspberry (_Rubus strigosus_), prickly rose (_Rosa acicularis_), Labrador tea (_Ledum groenlandicum_), blueberry (_Vaccinium_ spp.), bog cranberry (_Vaccinium vitis-idaea_), and bearberry (_Arctostaphylos uva-ursi_). Twinflower (_Linnaea borealis_), bunchberry (_Cornus canadensis_), Bishop's cap

(*Mitella nuda*), Indian paintbrush (*Castilleja* spp.), wintergreen (*Pyrola* spp.), wild strawberry (*Fragaria virginiana*), vetch (*Vicia americana*), and fireweed (*Epilobium angustifolium*) are common species of the forb layer. Feathermosses and plumemosses, in association with horsetail (*Equisetum arvense*) and various lichens, constitute the ground cover. Grasses (*Elymus innovatus*-hairy wild rye) are common in aspen areas and in the more open coniferous sites.

Imperfectly drained areas are usually covered by combinations of black spruce, balsam poplar, and white spruce. Occasionally lodgepole pine and birch (*Betula papyrifera*) are also present. Undergrowth is usually Labrador tea, feathermosses, various lichens and horsetails, tall larkspur (*Delphinium glaucum*), and cow parsnip (*Heracleum lanatum*).

Poorly drained, depressional, and adjacent marginal areas contain organic soils on which black spruce is the dominant species. Associated species often found are white spruce, larch (*Larix laricina*), lodgepole pine, and swamp birch (*Betula pumila* var. *glandulifera*). Undergrowth is commonly an association of feathermosses and Labrador tea, as well as minor amounts of sphagnum and some sedge (*Carex* spp.).

SOILS

Twenty-seven map units were recognized in Entrance Provincial Park. Eleven belong to the Luvisolic Order, 7 to the Regosolic Order, 4 to each of the Brunisolic and Gleysolic Orders, and 1 to the Organic Order.

Only minor differences exist among many of the map units. However, the differences are generally significant with regard to a particular recreational or engineering use, and thus warrant separation into different map units. The map units are not described in chronological order. Descriptions of similar map units are grouped so as to increase the ease in understanding differences among them.

The dominant plant species observed growing on different soils are listed, using common names. These are only general lists and are not meant to be complete or exhaustive species lists.

Map Unit 1

Map unit 1 consists primarily of well to imperfectly drained Orthic Regosols developed from medium to fine textured alluvial sediments overlying gravel. They are generally slightly gleyed, and are found on 0.5 to 5 per cent slopes. The vegetation consists mainly of willow, birch and aspen, with an understory of grass and forbs. These soils are stone free, and have an L-H horizon 3 inches in thickness. Occasionally mosses are found on the soil surface, and the L-H horizon is 6 inches in thickness. The soil profile has a texture of loam to silt loam, and a very friable consistence in the moist state. However, commencing at approximately the 10 inch depth, the subsoil texture is often silty clay loam, and the consistence in the moist state is firm. The soil has a granular structure. Sand lenses, varying from 1 to 4 inches in thickness, are often found at varying depths within the soil profile, and gravel is usually found 4 feet below the surface.

Large tracts of map unit 1 soils possess a vegetative cover of only grass and forbs. Soils in these areas possess a turfy L-H horizon 1 1/2 inches in thickness, and an Ah horizon of 1 to 2 inches. The Ah horizon has a texture of loam, a granular structure, and a very friable consistence in the moist state. Occasionally the Ah horizon is 4 to 10 inches in thickness, and thus constitutes an excellent source of topsoil for landscaping purposes. However, the occurrence of this deep Ah horizon is rare and unpredictable.

Limitations of map unit 1 soils are a seasonally high groundwater table, flooding hazard, shallow depth to sand or gravel, rapid permeability, high shrink-swell potential, and generally thin or absent Ah horizon.

Map Unit 17

Soils of map unit 17 consist dominantly of well drained Regosols developed from medium to coarse textured alluvial sediments. These soils are generally coarser textured than are map unit 1 soils, and the L-H horizon varies from 2 to 4 inches in thickness. They are found on 0.5 to 5 per cent slopes and are stone free. The vegetation consists dominantly of balsam poplar and aspen, with an understory of grass and forbs. The soil profile has a texture of loam, a granular structure, and a very friable consistence in the moist state. Numerous sand lenses, varying from 1 to 4 inches in thickness, are found in the profile and sand is often continuous below the 20 to 30 inch depth. Gravel is usually not encountered within 4 feet of the soil surface, but may be present at lower depths.

In general, these soils are very suitable for recreational uses. Limitations are lack of Ah horizon, shallow depth to sand or gravel, and rapid permeability of the subsoil.

Map Unit 4

Soils of map unit 4 are comprised mainly of well drained Orthic Regosols developed from medium to coarse textured alluvial sediments overlying gravel. These soils are very similar to soils of map unit 17; however the dominant vegetation of map unit 4 soils is lodgepole pine. Scattered white spruce, birch, and aspen are found, and the understory consists dominantly of bearberry, grass and mosses. The L-H horizon is 1 to 2 inches in thickness and gravel is commonly found 15 to 30 inches below the soil surface. Consequently, these soils are somewhat more droughty than those of map unit 17. The soils of map unit 4 are found on 0.5 to 5 per cent slopes.

Limitations are very similar to those of map unit 17 soils.

Map Unit 14

Map unit 14 soils consist of the peaty phase of map unit 17 soils. They are somewhat poorly drained, as evidenced by the gleyed soil profile. The vegetation consists of variable proportions of aspen, balsam poplar, and willow interspersed with open areas containing a thick growth of grass and forbs. The most common forbs are tall larkspur and cow parsnip. Mosses are also common in the understory. These soils possess an L-H horizon, ranging from 10 to 16 inches in thickness, and occur on slopes of 2 to 5 per cent.

Limitations of map unit 14 soils are flooding hazard, a seasonally high groundwater table, thick organic surface layer, lack of Ah horizon, shallow depth to sand or gravel, and rapid permeability.

Map Unit 24

Soils of map unit 24 consist primarily of the shallow phase of map unit 17 soils, overlying glacial till. The till is similar to that of map unit 8 soils. The average depth to till is 20 inches, but it varies from 16 to 30 inches below the soil surface. The deeper phase of map unit 24 soils occurs on 5 to 9 per cent slopes, while the shallower phase is found on 9 to 15 per cent slopes.

These soils have slight limitations for most recreational uses when found on 5 to 9 per cent slopes. The most severe limitation is lack of Ah horizon.

Map Unit 5

Map unit 5 soils are dominantly well drained Orthic Regosols developed from gravel. They are usually overlain by alluvial sediments, varying from 6 to 15 inches in thickness, and occasionally 30 inches. The overlay has a variable texture of sandy loam to loam, a weakly granular structure, and a very friable consistence in the moist state. The L-H horizon varies from

1 to 2 inches in thickness. The vegetation consists of aspen and willow, with an understory of grass and forbs. These soils occur on 2 to 5 per cent slopes, and are generally very stony on the surface.

Soil limitations include excessive surface stoniness, shallow depth to gravel, rapid permeability, and lack of Ah horizon.

Map Unit 19

Map unit 19 consists mainly of well drained Orthic Gray Luvisols developed from medium textured alluvial sediments overlying gravel. The vegetation is dominantly lodgepole pine, with an understory of grass, shrubs, and mosses. The soils have developed on 2 to 5 per cent slopes, and the surface is stone free. The L-H horizon is 1 to 2 inches in thickness, and the Ae horizon is 4 to 8 inches. It has a texture of loam, a platy to granular structure, and a friable consistence in the moist state. The Bt horizon varies from 12 to 20 inches in thickness, has a silty clay loam texture, a fine subangular blocky structure, and a firm consistence in the moist state. Lenses of sand or fine gravel, varying from 4 to 8 inches in thickness, are often found in the Bt horizon and the lower portion of the Ae horizon. Gravel is found 20 to 30 inches below the soil surface.

Generally these soils are very well suited for most recreational uses. Limitations include shallow depth to gravel, rapid permeability, and lack of Ah horizon.

Map Unit 2

Map unit 2 consists of 80 per cent well drained Orthic Gray Luvisols developed from gravel, and 20 per cent well drained Degraded Eutric Brunisols developed from sand. The Brunisolic soils are described under map unit 16.

The Luvisolic soils have developed on slopes ranging from 2 to 60 per cent, and surface stoniness varies from very stony to excessively stony. The vegetation is composed mainly of lodgepole pine, with lesser amounts of white spruce, aspen, and balsam poplar. The understory is comprised dominantly of bearberry and grass. An L-H horizon, 1 to 2 inches in thickness, is commonly found. The Ae horizon ranges from 4 to 8 inches in thickness, has a sandy loam texture, a platy structure, and a very friable consistence in the moist state. A weak bisequa development is sometimes evident in this horizon. The 6 inch Bt horizon has a very gravelly clay loam texture, a blocky structure, and a firm consistence in the moist state. Gravel is present below the Bt horizon. A Cca horizon is sometimes found at the 2 foot depth, but is generally at least 5 feet below the soil surface. Deeper soil profiles are often found on the 2 to 9 per cent slopes; the Ae horizon ranges from 8 to 12 inches in thickness, and the Bt horizon is often 12 inches.

The main limitations of the Luvisolic soils developed from gravel, aside from steep slopes, are excessive surface stoniness, shallow depth to gravel, rapid permeability, and lack of Ah horizon.

Map Unit 3

This map unit is comprised of 70 per cent well drained Orthic Gray Luvisols, 20 per cent well drained Orthic Gray Luvisols, peaty phase, and 10 per cent Orthic Gleysols, peaty phase, all developed from gravel. The Orthic Gray Luvisols are described under map unit 2.

The Orthic Gray Luvisols and their peaty phase possess similar soil profiles. The main difference is the increased thickness (4 to 8 inches) of the L-H horizon found on the peaty phase. This is a spongy horizon, which contains a high proportion of mosses. These soils are usually found on north facing side slopes, varying from 2 to 30 per cent. The vegetation is an association of lodgepole pine and black spruce. The soils have the same limitations as the Orthic Gray Luvisols but a further limitation is the thick organic surface layer.

The Gleysolic soils are found in depressional areas and have L-H horizons about 10 inches in thickness. The vegetation is mainly black spruce, with an understory of mosses and grass. These soils have the same limitations as the Luvisolic soils developed from gravel, but further limitations are the thick organic surface layer and a high groundwater table.

Map Unit 16

Map unit 16 consists of 60 per cent well drained Degraded Eutric Brunisols and 20 per cent well drained Bisequa Gray Luvisols, both developed from sand; and 20 per cent well drained Orthic Gray Luvisols developed from gravel. The Orthic Gray Luvisols are described under map unit 2.

Soils of map unit 16 have developed on slopes ranging from 2 to 60 per cent, and the surface stoniness varies from stone free to slightly stony. The vegetation is mainly lodgepole pine with scattered aspen, balsam poplar, and white spruce. The understory consists dominantly of bearberry and grass. The L-H horizon ranges from 1 to 4 inches in thickness, but averages about 2 inches.

The Degraded Eutric Brunisols have a 2 to 3 inch Ae horizon which has a loamy sand texture, a weakly platy structure, and a very friable consistence in the moist state. The Bm horizon is 20 to 30 inches in thickness, has a texture of sand to loamy sand, a very weakly granular structure, and a very friable to loose consistence in the moist state.

The Ck horizon has a texture of coarse sand, a single grain structure, and a loose consistence in the moist state. Numerous lenses of fine gravel are found in the soil profile, usually below the 4 foot depth, but occasionally within 20 inches of the soil surface.

The Bisequa Gray Luvisols have thicker Ae horizons and thinner B horizons than the Degraded Eutric Brunisols. The Ae horizon varies from 10 to 14 inches in thickness, has a texture of sand, a weakly platy structure, and a loose consistence in the moist state. The Bt horizon ranges from 4 to 8 inches in thickness, has a sandy loam texture, a weakly subangular blocky structure, and a very friable consistence in the moist state. The Ck horizon occurs 18 to 22 inches below the soil surface, and has a texture of coarse sand.

Limitations of map unit 16 soils, other than steep slopes, are sandy surface texture, shallow depth to sand, rapid permeability, and lack of Ah horizon.

Map Unit 18

Map unit 18 is composed of 80 per cent well drained Orthic Gray Luvisols, and 20 per cent well drained Degraded Eutric Brunisols, both developed from sand.

Soils of map unit 18 are stone free, and have developed on slopes ranging from 2 to 9 per cent. The vegetation is an association of aspen, lodgepole pine, and white spruce. The depth of L-H horizon is 2 inches.

The two soil types in map unit 18 are similar. Both have Ae horizons 4 to 8 inches in thickness, with a fine sandy loam to sandy loam texture, a platy structure, and a very friable consistence in the moist state. Both soils have B horizons 6 to 12 inches in thickness. The Bt horizon of the Luvisol has a clay loam texture, a subangular blocky structure, and a firm consistence in the moist state. The Btj horizon of the Brunisol has a texture of loam, a granular structure, and a friable consistence in the moist state. Both soils have Ck horizons 20 to 30 inches below the surface, having a texture of coarse sand.

Soils of map unit 18 are very suitable for recreational uses. Limitations are shallow depth to sand, rapid permeability, and lack of Ah horizon.

Map Unit 23

This map unit is comprised of 60 per cent well drained Orthic Gray Luvisols developed from gravel; and 30 per cent well drained Degraded Eutric Brunisols, and 10 per cent well drained Orthic Gray Luvisols, both developed from sand. These soils are described under the following map units: the Luvisols developed from gravel, under map unit 2; the Brunisols developed from sand, under map unit 16; and the Luvisols developed from sand, under map unit 18.

The main limitations of this soil association are excessive surface stoniness, steep slopes, shallow depth to sand or gravel, rapid permeability, and lack of Ah horizon.

Map Unit 27

Map unit 27 is composed of 90 per cent well drained Orthic Gray Luvisols developed from gravel, and 10 per cent well drained Orthic Gray Luvisols developed from lacustrine clay overlying gravel. The Luvisols developed from gravel are described under map unit 2.

The Luvisolic soils developed from lacustrine appear to be small isolated islands. Their occurrence and location in the landscape is unpredicatble; they support the same types of vegetation as do the Luvisolic soils developed from gravel. These soils are generally found in lower landscape positions on slopes of 0.5 to 2 per cent. The soil surface is stone free, and the L-H horizon varies from 1 to 2 inches in thickness. The Ae horizon varies from 4 to 8 inches in thickness, has a loam to sandy loam texture, a platy structure, and a very friable consistence in the moist state. The Bt horizon is approximately 20 inches in thickness, has a silty clay to clay texture, a fine subangular blocky structure, and a firm consistence in the moist state. An occasional lens of coarse sand, varying from 1 to 3 inches in thickness, is found in the Bt horizon. A Cca horizon in, gravel or coarse sand is found at depths of 24 to 30 inches below the soil surface.

Limitations of these soils are slow permeability, high shrink-swell potential, and susceptibility to frost heave in the lacustrine; shallow depth to gravel; rapid permeability of the gravel; and lack of Ah horizon.

Map Unit 6

This map unit is comprised primarily of well drained Orthic Gray Luvisols developed from glacial till. The vegetation consists of variable proportions of lodgepole pine, aspen, and balsam poplar, with an understory of grass, bearberry, Labrador tea, and mosses. These soils have developed on slopes of 15 to 30 per cent, and the soil surface is exceedingly stony. The L-H horizon varies from 3 to 5 inches in thickness. The normal Ae horizon thickness is 3 to 5 inches, has a sandy loam texture, a weakly platy structure, and a very friable consistence in the moist state. Occasionally the Ae horizon is 16 inches in thickness. Bisequa development is often evident in these thicker Ae horizons. The Bt horizon varies from 10 to 12 inches in thickness, and has a clay loam texture. The structure is subangular blocky, and the consistence in the moist state is firm. This horizon is generally very gravelly, and contains pockets that have a texture of sandy clay loam. The Cca horizon and the lower parent material are very gravelly and cobbly. They vary from sandy loam to sandy clay loam in texture, are weakly granular in structure, and have a friable consistence in the moist state.

Limitations of these soils are steep slopes, excessive surface stoniness, rapid permeability, and lack of Ah horizon.

Map Unit 8

Map unit 8 is composed of 70 per cent well drained Orthic Gray Luvisols, and 30 per cent well drained Lithic Orthic Eutric Brunisols, both developed from glacial till.

The vegetation of these soils consists of variable proportions of lodgepole pine, white spruce, balsam poplar, and aspen, with an understory of grass, forbs, mosses, and patches of Labrador tea. Slopes vary from 5 to 60 per cent, and surface stoniness ranges from moderately to exceedingly stony. The L-H horizon averages 1 to 3 inches in thickness, but is occasionally 6 inches.

The Luvisolic soils have an Ae, Bt, Cca horizon sequence, and the Brunisolic soils have a Bm, Cca horizon sequence. The Ae horizon of the Luvisolic soils varies from 3 to 5 inches in thickness, has a texture of loam, a platy structure, and a very friable consistence in the moist state. The Bt horizon varies from 18 to 22 inches in thickness, has a clay loam texture, a subangular blocky structure, and a firm consistence in the moist state. The Bm horizon of the Brunisolic soils ranges from 18 to 28 inches in thickness, and has a texture varying from loam to sandy loam. This horizon is structureless to weakly granular, and has a very friable consistence in the moist state. The Cca horizon and the lower parent material of these soils have a variable texture, ranging from sandy loam to clay loam. This is a very heterogeneous till, and pockets of the variable textured materials are randomly intermixed. Numerous small fragments of sandstone and shale are common. The Brunisolic soils are generally coarser textured than the Luvisolic soils, and soft sandstone is common at approximately the 30 inch depth. Bedrock is found at lower depths in the Luvisolic soils, and will generally be encountered at 5 to 6 feet below the surface.

Limitations of map unit 8 soils are excessive surface stoniness, steep slopes, shallow depth to bedrock, and lack of Ah horizon.

Map Unit 9

This map unit consists of 70 per cent well drained Lithic Orthic Eutric Brunisols, and 30 per cent well drained Orthic Gray Luvisols, both developed from glacial till similar to that described under map unit 8. Map unit 9 soils have developed on slopes ranging from 5 to 30 per cent, and surface stoniness varies from stone free to moderately stony. These soils are described under map unit 8, and soil limitations of both map units are similar.

Map Unit 10

Soils of map unit 10 consist mainly of imperfectly drained gleyed Orthic Gray Luvisols developed from glacial till, similar to that described under map unit 8. Soils of map unit 10 have developed on 15 to 30 per cent slopes, and the soil surface is very stony. The vegetation consists of variable proportions of aspen, balsam poplar, and white spruce, with an understory of grass and forbs. The L-H horizon varies from 2 to 4 inches in thickness, has a texture of loam, a granular structure, and a very friable consistence in the moist state. The Btg horizon is approximately 10 inches in thickness, has a silty clay loam texture, a granular structure, and a firm consistence in the moist state. A BC horizon is found 20 inches sand in texture. It has a weakly platy structure, and a slightly hard consistence in the dry state. The Bt horizon is approximately 10 inches in thickness, has a texture of loam to sandy clay loam, a weakly subangular blocky structure, and a friable consistence in the moist state. A 10 inch BC horizon, often present, has a texture varying from sandy loam to loam, a weakly granular structure, and a very friable consistence in the moist state. Soft sandstone is commonly found 14 to 24 inches below the soil surface.

Limitations of map unit 20 soils are steep slopes, excessive surface stoniness, rapid permeability, and lack of Ah horizon.

Map Unit 22

Soils of this map unit consist of 50 per cent well drained Orthic Gray Luvisols, and 30 per cent well drained Lithic Orthic Gray Luvisols, both developed from glacial till, similar to that described under map unit 8; and 20 per cent Orthic Gleysols, peaty phase, developed from undifferentiated glacial till. The Orthic Gray Luvisols are described under map unit 20; and the Gleysols under map unit 11. The Luvisolic soils of map unit 22 have developed on slopes ranging from 15 to 30 per cent, and the soil surface is very stony. The Gleysolic soils have developed in depressional areas.

Limitations of these soils are similar to those of map unit 8 soils. In addition, limitations of the Gleysolic soils are a high groundwater table, a thick organic surface layer, and moderate permeability.

Map Unit 26

Map unit 26 is composed of 80 per cent well drained Degraded Eutric Brunisols, peaty phase, developed from glacial till containing a high proportion of weathered sandstone; and 20 per cent Orthic Gleysols, peaty phase, developed from undifferentiated glacial till. The Gleysolic soils are described under map unit 11. They have developed in depressional areas.

The vegetation of the Brunisolic soils consists of lodgepole pine and white spruce, with an understory of mosses and Labrador tea. These soils have developed on 15 to 30 per cent slopes, and are stone free. The L-H horizon varies from 5 to 8 inches in thickness, and is very spongy. It is composed dominantly of mosses. The Ae horizon is 1 inch in thickness, has a texture of loam, a platy structure, and a very friable consistence in the moist state. The Btj horizon varies from 8 to 12 inches in thickness, has a texture of loam, a granular structure, and a very friable consistence in the moist state. The BC horizon is 2 feet in thickness, and the Cca horizon is found 3 feet below the soil surface. These horizons have a sandy loam texture, a weakly granular structure, and a very friable consistence in the moist state. Although bedrock was not encountered within 40 inches of the soil surface, it may occur within 5 to 6 feet.

Limitations of the Brunisolic soils are steep slopes, a thick organic surface layer, rapid permeability, lack of Ah horizon, and probably a shallow depth to bedrock. An additional limitation is a high groundwater table in the Gleysolic soils.

Map Unit 12

Map unit 12 is comprised mainly of Lithic Orthic Regosols developed from glacial till, similar to that described under map unit 8. The vegetation consists of white spruce, lodgepole pine, aspen, and balsam poplar, with an understory of bearberry, grass, forbs, Labrador tea, and mosses. These soils are found along stream banks, where slopes range from 9 to greater than 60 per cent, and the soil surface is very stony to excessively stony. The normal thickness of the L-H horizon is 1 to 2 inches; however, it is sometimes 4 to 6 inches. The soil solum varies from 14 inches to 2 feet in thickness, but is occasionally more than 30 inches. The texture varies from loam to clay loam, and sand pockets are common. The structure is granular, and the consistence varies from very friable to firm in the moist state. Sandstone occurs below the soil solum.

Limitations of these soils are steep slopes, excessive surface stoniness, shallow depth to bedrock, and lack of Ah horizon.

Map Unit 7

Map unit 7 consists of 60 per cent Orthic Gleysols, peaty phase developed from undifferentiated glacial till, and 40 per cent well drained Orthic Gray Luvisols developed from glacial till similar to that described under map unit 6. The Gleysolic soils are described under map unit 11, and the Luvisolic soils are described under map unit 6.

Soils of map unit 7 have developed in areas of 15 to 30 per cent slope, where the soil surface is very stony. The Gleysolic soils are found in poorly drained side slope positions, where slopes vary from 5 to 30 per cent. The Luvisolic soils occur on well drained steep slopes between the wet areas.

Limitations of map unit 7 soils are a high groundwater table, a thick organic surface layer, steep slopes, excessive surface stoniness, lack of Ah horizon, and moderate permeability.

Map Unit 11

This map unit consists of an association of Orthic Gleysols, peaty phase developed from undifferentiated glacial till, and Terric Humisols. These soils have developed in depressional areas, and in groundwater discharge areas, on slopes of less than 0.5 per cent to 30 per cent. The soil surface is generally stone free. Vegetation consists of variable proportions of black spruce, larch, lodgepole pine, willow, and swamp birch, with an understory of Labrador tea, mosses, grass, horsetail, and sedge.

The L-H horizon of the Gleysolic soils varies from 8 to 16 inches in thickness, but averages about 10 inches. The Bg horizon has a sandy clay loam texture, and contains numerous pockets of sand and gravel. The thickness of the L-H horizon of the Humisols varies from 16 to 30 inches.

Limitations of these soils are a high groundwater table, a thick organic surface layer, lack of Ah horizon, moderate permeability, and steep slopes.

Map Unit 13

Soils of map unit 13 are dominantly Orthic Gleysols, peaty phase, developed from coarse textured alluvial sediments. Vegetation consists of white spruce, balsam poplar, willow, and alder, with an understory of mosses, Labrador tea, and horsetail. These soils have developed on slopes ranging from 0.5 to 2 per cent, and the soil surface is stone free. The L-H horizon varies from 10 to 12 inches in thickness. The texture of the Bg horizon varies from fine sandy loam to loamy sand, and coarse sand is found 20 inches below the soil surface.

Soil limitations are a high groundwater table, flooding hazard, a thick organic surface layer, lack of Ah horizon, shallow depth to sand, and rapid permeability.

Map Unit 21

Map Unit 21 consists mainly of Orthic Gleysols developed from medium textured alluvial sediments overlying coarse textured alluvial sediments. The vegetation consists of willow, swamp birch, grass, forbs, and mosses. These soils have developed on slopes of 0.5 to 5 per cent, and the soil surface is stone free. The L-H horizon is 3 to 5 inches in thickness, and the upper 8 to 12 inches of the Bg horizon has a silt loam texture. The lower Bg horizon consists of alternating layers 1 to 4 inches in thickness, having textures of loam and sandy loam. Coarse sand is found 30 inches below the soil surface.

Limitations of these soils are a high groundwater table, flooding hazard, shallow depth to sand, rapid permeability, groundwater contamination hazard, and lack of Ah horizon.

Mesisol (M)

These are organic soils derived from the growth and decomposition of mosses. The vegetation is dominantly Labrador tea, mosses, and grass. Black spruce and larch are common along the margins of organic soil areas, and occasionally spread to the middle of the areas. These soils have developed in depressional areas, and are commonly saturated within a few inches of the soil surface. The thickness of organic material overlying mineral soil is commonly more than 52 inches, and it consists dominantly of semidecomposed peat. The surface few inches are usually undecomposed peat, and a few inches of highly decomposed peat are common immediately above the mineral soil.

Limitations are the inherent unstable nature of organic soils, and their permanently saturated condition.

MISCELLANEOUS LAND TYPES

1. Disturbed Land (D.L.). This is land that has been disturbed by man's activity. Examples are parking lots, roadways, and excavations. The soils were not classified in these areas.

2.  This is a symbol used to indicate bedrock outcrops. They are generally found on steeply sloping land along the crest of a ridge.

3.  This is a symbol used to indicate steep escarpments. They are generally found along lake shores in Entrance Park.

4.  This symbol is used to indicate open water.

5.  This symbol is used to indicate a marshy area. These areas are usually inundated, and vegetation consists of grass, sedge, and willow.

SOIL INTERPRETATIONS

Soil interpretations are predictions of soil performance under different uses, not recommendations for land use (23). 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 a construction material.

Soils most suitable for recreational development in Entrance Provincial Park are those of map units 1, 4, 17, 18, 19, and 24; and 8, 9 and 16 where these soils are found on suitable topography. Many of the soils, however, have severe limitations, both for recreational use and as road construction materials. The limitations most prevalent throughout the park are steep slopes, and excessive surface stoniness. This does not mean the soils cannot be used; rather the limitations should be recognized and procedures followed to overcome limitations during construction. An abundant supply of gravel can be found throughout most of the park. An extreme shortage of topsoil exists, however, since the majority of the soils of Entrance Park lack any Ah horizon whatsoever.

The limitations and suitabilities of the various soils for selected uses are shown in Table 4. The ratings were determined on the basis of soil morphological, physical, and chemical properties, as well as steepness of slope.* The principal limiting property(s) is indicated by numerals which correspond to those listed in Table 3. The limiting properties are generally listed in decreasing order of importance in Table 4.

Table 3. Limiting Soil Properties and Hazards

1. Flooding hazard (overflow).
2. Seasonally high groundwater table or ponding.
3. Excessive slope.
4. Surface stoniness.
5. Sandy surface texture.
8. Shallow depth to sand and/or gravel.
9. Rapid permeability.
10. Moderate permeability.
11. Slow permeability.
12. Groundwater contamination hazard.
13. High shrink-swell potential.
14. Susceptibility to frost heave (*)
17. Shallow depth to bedrock.
18. Thin Ah horizon.
19. Organic soil.
20. Organic surface layer more than 6 inches thick.
21. Deep overburden above gravel.

* Contingent upon an abundant supply of moisture. 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. In well drained locations, the water table is normally deep enough so that frost heaving rarely takes place. Consequently the hazard "susceptibility of soils to frost heaving" has been given only minor consideration in deter-

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

mining a soils' overall limitation for a particular use. Exceptions are soils having high or fluctuating water tables. These soils may be highly susceptible to frost heaving, depending upon texture.

In Table 4 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 and gravel the various soils are simply rated as good (G), fair (F), poor (P), and unsuitable (U).

Certain explanatory figures (in brackets) are shown in Table 4 to assist with the understanding of the contents. A brief explanation of these figures is given below:

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

[2] Soils of map unit 1 occasionally possess an Ah horizon, varying from 4 to 10 inches in thickness. Soils possessing this Ah horizon are not widespread however and their occurrence is unpredictable.

[3] These ratings are for the Luvisolic soils developed from gravel. See map unit 16 for ratings of the Brunisolic soils developed from sand.

[4] These ratings are for the Luvisolic soils developed from gravel. Ratings for the peaty phase and the Gleysols developed from gravel are the same with regard to surface stoniness. Otherwise, ratings for the peaty phase would be similar to ratings for map unit 14 soils, except that the limitations of flooding hazard and seasonally high groundwater table would not apply. Ratings for the Gleysols would be similar to ratings for map unit 13 soils.

[5] Map unit 7 has been assigned the rating of the Gleysolic soils since they comprise 60 per cent of the map unit. Patches of well drained Luvisolic soils developed from till are interspersed with the Gleysolic soil areas. See map unit 6 for ratings of the Luvisolic soils.

[6] The ratings for the Luvisolic and Brunisolic soils of map unit 8 and 9 are nearly identical.

[7] These ratings pertain to both the Brunisolic and the Luvisolic soils of map unit 16.

[8] These ratings pertain to both the Luvisolic and the Brunisolic soils of map unit 18.

[9] These ratings are for the Orthic Luvisolic soils of map unit 20. Ratings for the Lithic Orthic Luvisolic soils will be almost identical to ratings for map unit 9 soils.

[10] These ratings are for the Orthic Luvisolic soils of map unit 22. However ratings for the Lithic Orthic Luvisolic soils will be almost identical. See map unit 11 for ratings of the Gleysolic soils.

[11] These ratings are for the Luvisolic soils developed from gravel. See map unit 16 for ratings of the Brunisolic soils developed from sand. The soils of map unit 16, developed on 5+ to 9 per cent slopes and rated S, will be rated M on 9+ to 15 per cent slopes. See map unit 18 for ratings of the Luvisolic soils developed from sand. The soils of map unit 18, developed on 5+ to 9 per cent slopes and rated S, will be rated M on 9+ to 15 per cent slopes.

[12] These ratings are for the Brunisolic soils of map unit 26. See map unit 11 for ratings of the Gleysolic soils.

[13] These ratings pertain to the Luvisolic soils developed from lacustrine on 0.5+ to 2 per cent slopes, where the stoniness class is 0. Ratings for the majority of map unit 27 soils will be the same as those of map unit 2 soils.

Table 4. Soil Limitations and Suitabilities for Selected Uses

Map Symbol	Soil Limitation For: Camp Areas	Picnic Areas	Play Areas	Paths and Trails	Lawns and Landscaping	Buildings with Basement	Buildings without Basement	Septic Tank Filter Fills	Sanitary Land Fills	Reservoir Sites	Roads, Parking, Subgrade Material	Suitability as a Source of: Topsoil [1]	Sand and Gravel
1/bo	M2	S	S	S	V18 [2]	V1,2	V1,2	V9,12,1	V9,18,1,8	V9,8	M13	P18 [2]	F21,[illegible] 1
1/co	M2	S	V8,3	S	V18 [2]	V1,2	V1,2	V9,12,1	V9,12,1,8	V9,8	M13	P18 [2]	F21,[illegible] 1
2/c3 [3]	V4	M4	M4,8	M4	V18,4,8	V4	V4	S	V8	V9,8	M4	P18,4	G
2/c5 [3]	V4	V4	V4,8	V4	V4,18,8	V4	V4	S	V8	V9,8	V4	P4,18	G
2/D5 [3]	V4	V4	V4,3,8	V4	V4,18,8	V4	V4	S	V8	V9,8	V4	P4,18	G
2/d5 [3]	V4	V4	V4,3,8	V4	V4,18,8	V4	V4	S	V8	V9,8	V4	P4,18	G
2/f5 [3]	V3,4	V3,4	V3,4,8	V4,3	V4,18,8,3	V4,3	V4,3	V3	V8,3	V9,8,3	V4,3	P4,18,3	G
2/g5 [3]	V3,4	V3,4	V3,4,8	V3,4	V3,4,18,8	V3,4	V3,4	V3	V3,8	V9,8,3	V3,4	P4,18,3	G
3/e5 [4]	V4,3	V4,3	V3,4,8	V4	V4,18,8	V4	V4	M3	V8	V9,8,3	V4	P4,18,3	G
3/f5 [4]	V3,4	V3,4	V3,4,8	V4,3	V4,18,8,3	V4,3	V4,3	V3	V8,3	V9,8,3	V4,3	P4,18,3	G
3/g5 [4]	V3,4	V3,4	V3,4,8	V3,4	V3,4,18,8	V3,4	V3,4	V3	V3,8	V9,8,3	V3,4	P4,18,3	G
4/bo	S	S	M8	S	V18,8	S	S	V9,12	V9,12,8	V9,8	S	P18	F21
4/[illegible]	S	S	V8,3	S	V18,8	S	S	V9,12	V9,12,8	V9,8	S	P18	F21

Map Symbol	Soil Limitation For: Camp Areas	Picnic Areas	Play Areas	Paths and Trails	Lawns and Landscaping	Buildings with Basement	Buildings without Basement	Septic Tank Filter Fills	Sanitary Land Fills	Reservoir Sites	Roads, Parking, Subgrade Material	Suitability as a Source of: Topsoil [1]	San and/ Grav
4/Do	S	S	V3,8	S	V18,8	S	S	V9,12	V9,12,8	V9,8	S	P18	F21
5/c3	V4	M4	V4,8,3	M4	V18,4,8	V4	V4	V9,12	V9,12,8	V9,8	M4	P18,4	G
6/f4	V3,4	V3,4	V3,4	V4,3	V3,4,18	V3,4	V3,4	V3	V3	V3,9	V3,4	P4,3,18	U
[5] 7/f3	V2,20,3,4	V2,20,3	V2,20,3,4	V2,20,3	V2,20,18,4,3	V2,3,4	V2,3,4	V2,3	V2,3	V3,10	V2,20,3,4	P2,18,20,3,4	U
[6] 8/d2	M4	S	V3	S	V18	M4,17	M4	M17	V17	V17	S	P18	U
[6] 8/f2	V3	V3	V3	M3	V18,3	V3,17,4	V3	V3,17	V3,17	V3,17	V3	P18,3	U
[6] 8/f3	V3,4	V3	V3,4	M3,4	V18,3,4	V3,4,17	V3,4	V3,17	V3,17	V3,17	V3,4	P18,3,4	U
[6] 8/f4	V4,3	V3,4	V4,3	V4,3	V18,4,3	V3,4,17	V4,3	V3,17	V3,17	V3,17	V3,4	P18,4,3	U
[6] 8/g3	V3,4	V3,4	V3,4	V3	V3,18,4	V3,17,4	V3,4	V3,17	V3,17	V3,17	V3,4,17	P3,18,4	U
[6] 9/do	S	S	V3,17	S	V18	V17	S	V17	V17	V17,3	M17	P18,3	U
[6] 9/f2	V3,4	V3	V3,17,4	M3	V18,3,4	V17,3,4	V3,4	V17,3	V17,3	V17,3	V3,17	P18,3	U
10/f3	V3,4,2	V3,2	V3,4,2	M3,4,2	V18,3,4	V3,4,17,2	V3,4	V3,17,2	V3,17,2	V3,17	V3,4,2	P18,3,4,2	U

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Map Symbol	Soil Limitation For: Camp Areas	Picnic Areas	Play Areas	Paths and Trails	Lawns and Land-scaping	Buildings with Basement	Buildings without Basement	Septic Tank Filter Fills	Sani-tary Land Fills	Reser-voir Sites	Roads, Parking, Subgrade Material	Suitability a a Source of: Topsoil [1]	Sa and Gra
11 ao	V2,20	V2,20	V2,20	V2,20	V2,20,18	V2	V2	V2	V2	M10	V2,20	P2,18,20	U
11 bo	V2,20	V2,20	V2,20	V2,20	V2,20,18	V2	V2	V2	V2	M10	V2,20	P2,18,20	U
11 co	V2,20	V2,20	V2,20, 3	V2,20	V2,20,18	V2	V2	V2	V2	M10	V2,20	P2,18,20	U
11 Do	V2,20	V2,20	V2,20, 3	V2,20	V2,20,18	V2	V2	V2	V2	M10,3	V2,20	P2,18,20, 3	U
11 do	V2,20	V2,20	V2,20, 3	V2,20	V2,20,18	V2	V2	V2	V2	M10,3	V2,20	P2,18,20, 3	U
11 eo	V2,20 3	V2,20, 3	V2,20, 3	V2,20	V2,20,18, 3	V2,3	V2,3	V2,3	V2,3	V3,10	V2,20,3	P2,18,20 3	U
11 fo	V2,20, 3	V2,20, 3	V2,20 3	V2,20, 3	V2,20,18, 3	V2,3	V2,3	V2,3	V2,3	V3,10	V2,20,3	P2,18,20, 3	U
12 e3	V4,3	M3,4	M3,4, 17	M4	V4,18,3, 17	V17,4, 3	V4,3	V17,3	V17,3	V3,17,10	M3,4,17	P18,4,3	U
12 g3	V3,4	V3,4	V3,4, 17	V3,4	V3,18,4, 17	V3,17,4	V3,4	V3,17	V3,17	V3,17,10	V3,4,17	P3,18,4	U
12 g4	V3,4	V3,4	V3,4, 17	V3,4	V3,4,18, 17	V3,17,4	V3,4	V3,17	V3,17	V3,17,10	V3,4,17	P3,4,18	U
12 h5	V3,4	V3,4	V3,4, 17	V3,4	V3,4,18, 17	V3,17,4	V3,4	V3,17	V3,17	V3,17,10	V3,4,17	P3,4,18	U
13 bo	V2,1 20	V2,1, 20	V2,1, 20	V2,1, 20	V2,1,20, 18	V2,1	V2,1	V2,1,9, 12	V2,1,9, 12	V9,8	V2,1	P2,1,18, 20	P2,

CONTINUED Tal[illegible] 4. Soi[illegible]mi[illegible]ons [illegible] S[illegible]bil[illegible]s f[illegible] Sel[illegible]d U[illegible]

Map Symbol	Soil Limitation For:											Suitability a[illegible] Source [illegible]	
	Camp Areas	Picnic Areas	Play Areas	Paths and Trails	Lawns and Landscaping	Buildings with Basement	Buildings without Basement	Septic Tank Filter Fills	Sanitary Land Fills	Reservoir Sites	Roads, Parking, Subgrade Material	Topsoil [1]	San[illegible] and Gra[illegible]
14 co	V20,2,1	V20,2,1	V20,2,3	V20	V20,18	V1,2	V1,2	V1,2,9,12	V1,8,9,12	V8,9	M2	P18,20	F2,1[illegible]
15 g4	V3,4	V3,4	V3,4	V3,4	V3,4,18	V3,4	V3,4	V3	V3	V3,9	V3,4	P3,4,18	U
[7] 16 co	M5	M5	V8,5,3	M5	V18,8,5	S	S	S	V8	V9,8	S	P5,18	G
[7] 16 do	M5	M5	V5,3,8	M5	V18,8,5	S	S	S	V8	V9,8	S	P5,18,3	G
[7] 16 dl	M5	M5	V5,3,8	M5	V18,8,5	S	S	S	V8	V9,8	S	P5,18,3	G
[7] 16 fl	V3,5	V3,5	V3,5,8	M3,5	V3,18,8,5	V3	V3	V3	V8,3	V9,8,3	V3	P5,18,3	G
[7] 16 gl	V3,5	V3,5	V3,5,8	M3,5	V3,18,8,5	V3	V3	V3	V3,8	V9,8,3	V3	P5,18,3	G
17 bo	S	S	S	S	V18	S	S	V9,12	V9,12,8	V9,8	S	P18	P21
17 co	S	S	M3	S	V18	S	S	V9,12	V9,12,8	V9,8	S	P18	P21
[8] 18 co	S	S	V8,3	S	V18,8	S	S	M12	V8	V9,8	S	P18	F21
[8] 18 do	S	S	V3,8	S	V18,8	S	S	M12	V8	V9,8	S	P18,3	F2[illegible]
19 co	S	S	V8,3	S	V18,8	S	S	V9,12	V9,12,8	V9,8	S	P18	F21

CONTINUED Table 4. Soil Limitations and Suitabilities for Selected Uses

Map Symbol	Soil Limitation For:											Suitability as a Source of:	
	Camp Areas	Picnic Areas	Play Areas	Paths and Trails	Lawns and Landscaping	Buildings with Basement	Buildings without Basement	Septic Tank Filter Fills	Sanitary Land Fills	Reservoir Sites	Roads, Parking, Subgrade Material	Topsoil [1]	Sand and/ Grav
[9] 20/f3	V3,4	V3,4	V3,4	M3,4	V3,4,18	V3,4	V3,4	V3	V3	V3,9	V3,4	P3,4,18	U
21/ao	V2,1	V2,1	V2,1	V2,1	V2,1,18	V2,1	V2,1	V2,1,9,12	V2,1,8,9,12	V8,9	V2,1	P2,1,18	P2,1
21/bo	V2,1	V2,1	V2,1	V2,1	V2,1,18	V2,1	V2,1	V2,1,9,12	V2,1,8,9,12	V8,9	V2,1	P2,1,18	P2,1
21/co	V2,1	V2,1	V2,1,8,3	V2,1	V2,1,18	V2,1	V2,1	V2,1,9,12	V2,1,8,9,12	V8,9	V2,1	P2,1,18	P2,1
[10] 22/f3	V3,4	V3	V3,4	M3,4	V18,3,4	V3,4,17	V3,4	V3,17	V3,17	V3,17	V3,4	P18,3,4	U
[11] 23/e4	V4,3	V4,3	V3,4,8	V4	V4,18,8,3	V4,3	V4,3	M3	V8,3	V9,8,3	V4,3	P4,18,3	G
24/do	S	S	V3	S	V18	S	S	S	S	M3,10	S	P18	U
24/eo	M3	M3	V3	S	V18,3	M3	M3	M3	M3	V3,10	M3	P18,3	U
[12] 26/fo	V3,20	V3,20	V3,20	V20,3	V3,20,18	V3	V3	V3	V3	V3,9	V3	P3,18,20	U
[13] 27/c5	V11	M11	V11	S	V18	M13	S	S	V8	V9,8	M13,14	P18	F21
M	V19,2	V19,2	V19,2	V19,2	V19,2	V19,2	V19,2	V19,2	V19,2	V19	V19,2	P19,2	U

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APPENDIX

Chemical Analyses of the Soils

The chemical analyses carried out on representative soil samples are presented in Table 5. The samples analyzed are surface and subsoil samples, taken of the map units at representative sites. Surface samples are taken from the 0 to 6 inch depth, and the subsoil samples are taken in 6 inch increments between the 6 and 24 inch depth. Each surface sample consists of 5 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 5.

CONTINUED

Table 5. Chemical Analyses of Selected Map Units [1]

Map Unit	Sample Depth (inches)	Pounds Per Acre Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sodium [2]	Sulphur %	Soil Reaction pH	Conductivity (mmhos)	Sulphate [2]	Organic Matter [2]	Free Lime ($CaCO_3$) [2]	Remarks
10	0-6	1	4	210	L-	M-	7.3	0.2	-	L+	-	native forest
10	6-12	4	6	230	L-	M-	7.5	0.2	-	L+	-	native forest
12	0-6	0	4	1155	L-	L+	7.4	0.4	-	L+	L+	native forest
12	6-24	1	6	450	L-	L-	8.1	0.2	-	L+	L-	native forest
16	0-6	0	55	140	L-	L	6.7	0.2	-	L	-	native forest
16	6-18	1	42	50	L-	L-	6.8	0.1	-	L-	-	native forest
17	0-6	1	5	245	L-	M-	6.6	0.2	-	H-	-	native forest
17	6-12	1	4	115	L-	L	7.0	0.1	-	L+	-	native forest
17	0-6	1	35	260	L-	H	6.3	0.2	-	L+	-	campground-heavy use
18	0-6	0	27	220	L-	M-	6.3	0.2	-	L	-	native forest
18	6-12	0	7	155	L-	L-	6.7	0.1	-	L	-	native forest
19	0-6	0	24	230	L-	L	6.3	0.1	-	L	-	native forest
19	12-24	1	37	140	L-	L	7.6	0.3	-	L	-	native forest
27	0-6	0	36	155	L-	L-	5.7	0.1	-	L	-	native forest
27	6-18	1	15	220	L-	M	6.1	0.1	-	L	-	native forest

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

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

Table 5. Chemical Analyses of Selected Map Units [1]

Map Unit	Sample Depth (inches)	Pounds Per Acre			Sodium [2]	Sulphur %	Soil Reaction pH	Conductivity (mmhos)	Sulphate [2]	Organic Matter [2]	Free Lime ($CaCO_3$) [2]	Remarks
		Nitrogen (N)	Phosphorus (P)	Potassium (K)								
1	0-6	0	6	195	L-	L+	6.2	0.2	-	L+	-	virgin area
1	6-12	1	6	110	L-	L	6.6	0.1	-	L	-	virgin area
1	0-6	0	0	215	L-	L+	6.8	0.2	-	L+	-	campground
2	0-6	0	22	220	L-	L	5.9	0.1	-	L	-	campground
2	0-6	0	33	125	L-	L	5.5	0.1	-	L	-	native forest
2	6-12	1	17	90	L-	M	5.8	0.1	-	L	-	native forest
2	0-6	0	20	150	L-	L	6.1	0.1	-	L	-	native forest
4	0-6	0	22	345	L-	L	6.4	0.2	-	L+	-	native forest
4	0-6	0	16	250	L-	L	6.4	0.1	-	L	-	native forest
4	6-12	1	6	120	L-	L	6.5	0.1	-	L	-	native forest
5	0-6	2	19	345	L-	M	6.1	0.2	-	L+	-	native forest
5	6-18	0	5	140	L-	L-	5.7	0.1	-	L	-	native forest
6	0-6	0	17	235	L-	L	6.4	0.2	-	L	-	native forest
6	6-12	1	4	150	L-	L-	6.4	0.1	-	L	-	native forest
8	0-6	1	3	410	L-	L	6.6	0.1	-	L+	-	native forest
8	6-12	1	6	785	L-	M-	6.6	0.2	-	L	-	native forest
8	0-6	0	41	650	L-	L+	6.3	0.1	-	L+	-	native forest
8	6-12	2	7	1755	L	L-	6.4	0.1	-	L+	-	native forest

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 (25). 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 2 to 3 times as much nitrogen as does a very sandy soil under the same type of climatic conditions. Poorer aeration and less leaching favor 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 - 0 to 20; medium - 21 to 50; and high - 51 or more.

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 seed (25).

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 usuable by plants; it is not available to the growing plant. The available soil phosphorus 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 one per cent of the total soil phosphorus.

Soil tests show that a majority of Alberta soils are low in available phosphorus. 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 - 0 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 (25). It is supplied to roots by soil minerals, artificial fertilizers, manures, and crop residues.

Most Alberta soils contain adequate amounts of potassium. 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 - 0 to 150; medium - 150 to 300; and high - 301 or more.

4. Sulphur

Sulphur is essential to life (25). 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 - sign.

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.

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.

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:

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 - 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 - sign.

Organic matter influences physical and chemical properties of soils far out of proportion to the small quantities contained therein (20). 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. 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 6. The samples analyzed were taken from subsoils of the map units at representative sites. Depth of sampling generally ranged between 2 and 6 feet below the surface. 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 (24).

2. Mechanical Analysis

The particle size distribution within a soil is determined by laboratory tests, usually referred to as the mechanical analysis of the soil (11). 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.

Table 6. Physical Analyses of Selected Map Units [1]

Map Unit	Depth (feet)	Field Moisture %	Mechanical Analysis: Percentage Passing Sieve: 1 inch	3/4 inch	5/8 inch	# 4 (4.7 mm.)	# 10 (2.0 mm.)	# 40 (0.42 mm.)	# 200 (0.074 mm.)	Percentage Smaller Than: 0.05 mm.	0.005 mm.	0.002 mm.	0.001 mm.	Liquid Limit	Plasticity Index	Optimum Moisture % [2]	Maximum Dry Density lb./ft.^{3} [2]	Classification: AASHO	Unified	USDA
1	3-4	29	100	100	100	100	100	100	88	85	43	32	27	40	11	-	-	A-6(8)	ML	SiCL
6	4-5	7	93	93	92	79	73	63	20	19	16	13	13	NL	NP	-	-	A-2-4 (0)	SMd	SL
8	4-5	18	89	86	85	77	72	68	43	41	25	17	15	31	8	23	96.5	A-4(2)	SC-SM	SL
17	4-5	15	100	100	99	97	95	89	32	31	23	19	18	22	4	15	110	A-2-4 (0)	SC-SM	SL
27	2-3	21	100	100	100	100	100	100	96	95	78	58	49	48	17	-	-	A-7-5 (13)	ML	C

[1] Map units developed on similar parent material: 6,15, and 20; 8, 9, 10, 12, and 22; 17,4, and 14.

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

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 (7).

Tests have been devised to determine the moisture content of a soil at which it changes from one major physical condition to another (11). These tests, conducted on the material passing the numer 40 sieve (0.42mm), 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 5, 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.

3. 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 (24). Most of the current methods are derived from the procedure known as the "Standard Proctor Test". A sample of soil is dried, pulverized, and separated into two size fractions, using a number 4 sieve. The finer fraction is divided into six or eight equal portions. Each portion is mixed thoroughly with a different quantity of water so that each has a different water content, ranging from nearly 0 to about midway between the liquid and plastic limits. Each portion is compacted in a container with exactly the same compactive effort; its water content and weight of solids per cubic foot of compacted soils, usually termed the "dry density", are determined. The dry density after compaction decreases conspicuously with increasing water content and a curve is plotted showing the relation between dry density and water content. 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").

4. 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 (11). A brief description of three widely used soil classification systems follows.

(a) AASHO Soil 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.

In recent years these seven basic groups have been divided into subgroups with a group index that was devised to approximate within group evaluations. Group indexes range from 0 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 per cent or less of material passing the number 200 sieve; fine grained soils have more than 50 per cent of material passing the number 200 sieve. The letters G, S, C, M and O stand for gravel, sand, clay, silt and organic material respectively. The highly organic soils are designated by the symbol "Pt". Additional letters used in the secondary divisions of the coarse 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 (11).

GLOSSARY

adsorption complex - The group of substances in the soil capable of adsorbing other materials.

Ae horizon - An A horizon characterized by removal (leaching) of clay, iron, aluminum, or organic matter alone or in combination.

Aeg horizon - An Ae horizon characterized by gray colors, or prominent mottling indicative of permanent or periodic reducing conditions, or both.

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

Ah horizon - An A horizon of organic matter accumulation containing less than 30 per cent organic matter.

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

alluvial sediment - Material such as clay, silt, sand, and gravel deposited by modern rivers and streams.

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

base saturation percentage - The extent to which the adsorption complex of a soil is saturated with exchangeable cations other than hydrogen and aluminum.

BC horizon - A transitional horizon, occurring between the B and C horizons.

Bg horizon - A B horizon characterized by gray colors, or prominent mottling indicative of permanent or periodic reducing conditions, or both.

B horizon - A mineral horizon characterized by one or more of the following:

(1) An enrichment in silicate clay, iron, aluminum, or humus.
(2) A prismatic or columnar structure that exhibits pronounced coatings or stainings associated with significant amounts of exchangeable sodium.

(3) An alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below, or both.

bisequa - Two sequa in one soil; that is, two sequences of an eluvial horizon and its related illuvial horizon.

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

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

Brunisolic - An order of soils whose horizons are developed sufficiently to exclude the soils from the Regosolic Order, but that lack the degrees or kinds of horizon development specified for soils of the other Orders.

Btg horizon - A Bt horizon characterized by gray colors, or prominent mottling indicative of permanent or periodic reducing conditions, or both.

Bt horizon - A B horizon enriched with silicate clay, as indicated by a higher clay content than the overlying eluvial horizon, a thickness of at east 5 cm., and other parameters determined by laboratory procedures.

Btj horizon - A horizon that resembles but fails to meet the specied limits of a Bt horizon.

Cca horizon - A C horizon of secondary carbonate enrichment where the concentration of lime exceeds that in the unenriched parent material.

C horizon - 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.

Ck horizon - A C horizon containing carbonate.

coarse texture - The texture exhibited by sands, loamy sands, and sandy loams except very fine sandy loam.

concretion - A mass or concentration of a chemical compound, such as calcium carbonate or iron oxide, in the form of a grain or nodule of varying size, shape, hardness, and color, found in soil and in rock.

degraded - A leached and weathered state of a soil, usually indicated by morphological features such as an eluviated, light-colored A (Ae) horizon.

deposition - Material being left in a new position by a natural transporting agent such as water, wind, ice, or gravity, or by the activity of man.

eluvial horizon - A soil horizon that has been formed by the process of eluviation.

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

escarpment - A steep slope or cliff separating gently sloping areas.

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.

Eutric Brunisol - A great group of soils in the Brunisolic Order. The soils may have Ah horizons less than 5 cm (2 inches) thick, and they have Bm horizons in which the base saturation is 100 per cent.

fibric - Composed of organic soil material containing large amounts of weakly decomposed fiber whose botanical origin is readily identifiable.

fine texture - Consisting of or containing large quantities of the fine fractions, particularly of silt and clay. It includes all the textural classes of clay loams and clays: clay loam, sandy clay loam, silty clay loam, sandy clay, silty clay, and clay.

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.

forb - A broadleaf seed producing plant, other than grass, that does not develop persistent woody tissue, but dies down at the end of a growing season.

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.

glacial till - Unsorted and unstratified materials deposited by glacial ice.

gleying (of soil) - Characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic reducing conditions.

granular structure - Soil particles arranged around a point and bounded by rounded surfaces, characterized by rounded vertices.

Gray Luvisol - A great group of soils in the Luvisolic Order occurring in moderately cool climates, where the mean annual temperature is usually lower than 42°F. The soils have developed under deciduous and coniferous forest cover, and have an eluviated light colored surface (Ae) horizon, a brownish illuvial (Bt) B horizon, and usually a calcareous C horizon. The solum is base saturated. 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.

Humisol - A great group of soils in the Organic Order. The diagnostic layer is composed dominantly of humic material.

humus - (i) The fraction of the soil organic matter that remains after most of the added plant and animal residues have decomposed. It is usually dark colored. (ii) Humus is also used in a broader sense to designate the humus forms referred to as forest humus. (iii) 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.

lacustrine - Material deposited in the water and later exposed either by lowering of the water level or by uplifting of the land. These sediments range in texture from sands to clays.

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

L-H horizon - Organic layer developed under imperfectly to well drained conditions, often forest litter.

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

lithic - Having bedrock under the control section of a soil.

loose consistence - Consistence at which a moist soil is noncoherent.

Luvisolic - An order of soils that have eluvial (Ae) horizons, and illuvial (Bt) horizons in which silicate clay is the main accumulation product. The soils are developed under forest or forest-grassland transition in a moderate to cool climate.

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

matrix (of soil) - The soil material that encloses other soil features, for example, concretions embedded in a fine grained matrix.

medium texture - Intermediate between fine textured and coarse textured soils. It includes the following textural classes: very fine sandy loam, loam, silt loam, and silt.

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

Mesisol - A great group of soils in the Organic Order. The diagnostic layer is composed dominantly of mesic material.

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

nodule - A rounded unit within the soil matrix, that differs from the surrounding material because of the concentration of some constituent.

Order, soil - The highest category in the Canadian system of soil classificiation. 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 artifically drained, and contain 30 per cent or more organic matter to certain specified depths.

Orthic - Refers to the modal or central concept in the definition of a soil Order.

outcrop - That part of a rock formation which appears at the surface.

outwash - Stratified drift deposited by melt water streams beyond the margin of glaciers. The particle size may vary from boulders to silt.

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 aggregates developed predominantly along the horizontal axes.

Regosolic - An Order of soils having no horizon development or development of the A and B horizons insufficient to meet the requirements of the other Orders.

sandstone - A sedimentary rock composed of sand sized grains of minerals and rock fragments cemented together.

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.

sedimentary rock - Rock derived from the waste products of older rocks.

shale - A sedimentary rock in which the particles are predominantly of clay size.

single grain structure - Soil particles occur almost completely as individual or primary particles; secondary particles or aggregates are seldom present. This structure is usually found only in extremely coarse textured soils.

slightly hard consistence - Consistence of a dry soil at which it is weakly resistant to pressure, and easily broken between the thumb and forefinger.

soil aggregate - A group of soil particles cohering so as to behave mechanically as a unit.

soil morphology - The color, 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 sand, 2.0 to 1.0 mm; coarse sand, 1.0 to 0.5 mm; medium sand, 0.5 to 0.25 mm; fine sand, 0.25 to 0.10 mm; very fine sand, 0.10 to 0.05 mm; silt, 0.05 to 0.002 mm; and clay, less than 0.002 mm.

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.

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

subgroup, soil - The fourth category in the Canadian soil classification system. These soils are subdivisions of the Great Groups, and therefore each soil is defined more specifically.

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

turfy - Grassy with matted roots.

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

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

Map 1

SOILS MAP OF ENTRANCE PROVINCIAL PARK

Tp. 51-52, R. 26, W. 5

Soil Classification:

MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Regosolic	Orthic Regosol	medium to fine textured alluvial sediment overlying gravel
2	Luvisolic	Orthic Gray Luvisol - 80 %	gravel
	Brunisolic	Degraded Eutric Brunisol - 20 %	sand
3	Luvisolic	Orthic Gray Luvisol - 70 %	gravel
		Orthic Gray Luvisol, peaty phase - 20 %	
	Gleysolic	Orthic Gleysol - 10 %	
4	Regosolic	Orthic Regosol	medium to coarse textured alluvial sediment overlying gravel
5	Regosolic	Orthic Regosol	gravel
6	Luvisolic	Orthic Gray Luvisol	medium textured cobbly till
7	Gleysolic	Orthic Gleysol, peaty phase - 60 %	undifferentiated till
	Luvisolic	Orthic Gray Luvisol - 40 %	medium textured cobbly till
8	Luvisolic	Orthic Gray Luvisol - 70 %	medium textured till
	Brunisolic	Lithic Orthic Eutric Brunisol - 30 %	
9	Brunisolic	Lithic Orthic Eutric Brunisol - 70 %	medium textured till
	Luvisolic	Orthic Gray Luvisol - 30 %	
10	Luvisolic	Gleyed Orthic Gray Luvisol	medium textured till
11	Gleysolic	Orthic Gleysol, peaty phase	undifferentiated till
	Organic	Terric Humisol	
12	Regosolic	Lithic Orthic Regosol	medium textured till
13	Gleysolic	Orthic Gleysol, peaty phase	coarse textured alluvial sediment
14	Regosolic	Orthic Regosol, peaty phase	medium to coarse textured alluvial sediment
15	Brunisolic	Orthic Eutric Brunisol	medium textured cobbly till
16	Brunisolic	Degraded Eutric Brunisol - 60 %	sand
	Luvisolic	Bisequa Gray Luvisol - 20 %	
		Orthic Gray Luvisol - 20 %	gravel
17	Regosolic	Orthic Regosol	medium to coarse textured alluvial sediment
18	Luvisolic	Orthic Gray Luvisol - 80 %	sand
	Brunisolic	Degraded Eutric Brunisol - 20 %	
19	Luvisolic	Orthic Gray Luvisol	medium textured alluvial sediment overlying gravel
20	Luvisolic	Orthic Gray Luvisol - 70 %	medium textured cobbly till
		Lithic Orthic Gray Luvisol - 30 %	medium textured till
21	Gleysolic	Orthic Gleysol	medium textured alluvial sediment overlying coarse textured alluvial sediment
22	Luvisolic	Orthic Gray Luvisol - 50 %	medium textured till
		Lithic Orthic Gray Luvisol - 30 %	
	Gleysolic	Orthic Gleysol, peaty phase - 20 %	undifferentiated till
23	Luvisolic	Orthic Gray Luvisol - 60 %	gravel
	Brunisolic	Degraded Eutric Brunisol - 30 %	sand
	Luvisolic	Orthic Gray Luvisol - 10 %	
24	Regosolic	Orthic Regosol	medium to coarse textured alluvial sediment overlying medium textured till
26	Brunisolic	Degraded Eutric Brunisol - 80 %	residual sandstone till
	Gleysolic	Orthic Gleysol, peaty phase - 20 %	undifferentiated till
27	Luvisolic	Orthic Gray Luvisol - 90 %	gravel
		Orthic Gray Luvisol - 10 %	lacustrine over gravel
M	Organic	Undifferentiated Mesisol	peat

Legend:

Map Symbol

2 ← map unit
f 5 ← surface stoniness rating
← topographic class

DL – Disturbed Land

WWWW bedrock outcrop

steep escarpment

Ω open water

marshy area

soil line

park boundary

APPROXIMATE SCALE:

510 0 510 1020 1530 2040 2550 FEET

Compiled from uncontrolled mosaic.

Mapped and Compiled by: G.M. Greenlee
Soils Division

Alberta
RESEARCH COUNCIL
1973

OFR 1973-8 1/2

Map 2

Entrance Provincial Park

OFR 1975-8 2/2