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SOIL SURVEY

of

WOOLFORD PROVINCIAL PARK

and

INTERPRETATION FOR REACTIONAL 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, water-shed 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 (8). 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.

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Branch of the Department of Lands and Forests provided some of the aerial photographs and maps. Alberta Research published the report and compiled the soil map. The University of Alberta provided office and laboratory space.

Mrs. Pal Foster typed and assisted in compiling and 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 (4). 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

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C4 ← surface stoniness rating (Table 2)

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

SOIL CHARACTERISTICS AND INTERPRETATIONS FOR RECREATIONAL USE

Soil surveys provide for classifying, defining and delineating each kind of soil and making predictions of soil behaviour under specific management (8). 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 (8). 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 (2,8). 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 (8). Montgomery and Edminster (8) suggest one or two floodings during the season of use consitiutes 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 (8). 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 (8).

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 (8).

Slope affects the use of soils for recreation (2,8). Generally, slopes of less than 2% offer no limitations for use as playgrounds, campsites, sites for recreation buildings, roads and trails. Slopes greater than 9% constitute a severe limitation for playground areas, since levelling costs would become prohibitive. Slopes of more than 15% constitute a severe limitation for camping areas, picnic areas and some building sites for the same reason. The smaller areas required for these facilities as compared to playground areas, account for the greater tolerance. On the other hand, steeply sloping soils are essential for ski runs and are desirable for hiking areas and scenic values. Hiking trails are not limited unless slopes are greater than 30%. Of course steep, gently sloping and moderately sloping soils can be levelled for campsites, playgrounds and building sites, where the cost is justified (8). 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(8). 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 (8). Rounded gravels and stones present hazards on steeply sloping soils used for foot trails.

Surface texture is an important soil property to consider (2,8). 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 (8). 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 (8). 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 (8). 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 % soluble sulphate content are considered to have no limitations for standard concrete foundations, and soils with 0.1 to 0.2% are considered to have slight limitations. Soils with 0.2 to 0.5% soluble sulphate content are considered to have moderate limitations, and foundations may require sulphate resistant concrete. Soils with greater than 0.5% soluble sulphate are considered to have severe limitations and should be avoided (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 (8). 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 (8).

Thus we find that basic soil qualities and characteristics are closely associated with the various types of outdoor recreational activities (8). By knowing the characteristics and qualities of the different kinds of soils and their behaviours, and with the aid of a soil map, soil scientists and other specialists can develop soil interpretations for recreational uses. Interpretations for recreation can best be made locally by those familiar with the soils and conditions in the area (8).

EXPLANATION OF SOIL INTERPRETATIONS

Soil limitation or suitability ratings are for evaluating each soil for a particular use (9). 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 (8). 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 (9). 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 (9). 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 (9). 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 crosscrountry 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)(9). 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 (9). 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 (9). 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 groundwater, slope, depth to bedrock, and depth to sand and gravel. Clean sands and gravels with rapid permeability may constitute a hazard for groundwater 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 (9). 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 (9). 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 (9). 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 (9). 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 (9). 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 predominantly 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 (9). 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 (9). 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 semi-solid to a plastic state.

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

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

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

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

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

droughty soil - Sandy or very rapidly drained soil.

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

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

erodibility - Susceptibility to erosion.

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

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

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

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

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

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

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

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 colour, structure, texture, consistence, and chemical, biological and mineralogical composition.

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

soil reaction - The degree of acidity or alkalinity of a soil, usually expressed as a pH value. Descriptive terms commonly associated with certain ranges inpH 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). The textural classes can also be grouped as follows:

(a) Coarse-textured group
1) Very coarse textured: CS, S, FS, VFS, LCS, LS, LFS, LVFS.
2) Moderately coarse textured: CSL, SL, FSL, VFSL.
(b) Medium-textured group
1) Medium textured: L, SiL, Si.
2) Moderately fine textured: SCL, CL, SiCL.
(c) Fine-textured group
1) Fine textured: SC, SiC, C.
2) Very fine textured: HC (more than 60% clay).

soluble sulphate - Water-soluble sulphate found in soil.

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

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

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

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

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

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

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SOIL REPORT

C O N T E N T S

LIST OF TABLES

LOCATION AND SIZE

Woolford Park is located about five miles east of the town of Cardston, adjacent to the east side of the St. Mary River. However one must travel about 11 miles to reach the Park by road from Cardston. The Park is confined predominantly to the southeast quarter of section five, township three, range 24, west of the fourth meridian; and is only about 100 acres in size.

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

Woolford Park is situated in the floodplain of the St. Mary River, which traverses a large plain of level to gently rolling topography (27). The topography in the Park itself ranges from gently undulating to undulating; also present in the extreme northeastern corner is a very small area of extremely sloping topography along the valley wall of the river. The surface elevation in the Park is 3725 feet above sea level, which is about 75 feet lower than the nearby upland. The Park is drained by the St. Mary River.

Medium textured alluvial sediments comprise the surficial deposits throughout most of the Park, and gravel bars are present along the river course. The valley wall in the northeastern corner of the Park is comprised of a bedrock exposure.

CLIMATE

The climate of Woolford Park is characterized by warm summers and relatively cold winter temperatures subject to great fluctuations due to chinook winds (27). These warm winds of low relative humidity have great drying power and a distinctly moderating effect on the climate during winter. They generally come with great suddenness and may raise the temperature from sub-zero readings to well above the freezing point in a few hours. Weather records kept for the years of 1963 through 1972 at Cardston, about five miles west of the Park, show the following statistics (21): a mean annual temperature of 40.4°F., mean annual precipitation of 22.15 inches with 56% falling as rain and an average frost free period of 115 days. January is the coldest month of the year with a mean temperature of 13.2°F., and July and August are the warmest months with mean temperatures of 62.7°F. and 62.4°F. respectively.

VEGETATION

Vegetation is one of the important factors in soil formation. However since the Parks Planning Branch of Alberta Lands and Forests presently conducts biological studies of Provincial Parks and proposed park areas, the subject of vegetation is not discussed extensively herein. Only a few of the more common plant species referred to in the

Map Unit descriptions are listed as follows (23): cottonwood (Populus spp.), willow (Salix spp.), other shrubs (various species), native grasses (various species), juniper (Juniperus spp.) and sedge (Carex spp).

SOILS

In Woolford Park, only four Map Units were recognized. Two of these belong to the Gleysolic Order and one to the Regosolic Order in the Canadian System of Soil Classification (4). The remaining Map Unit is classified as "non-soil".

Differences exhibited between different soils are significant with regard to recreational or engineering uses, thus justifying the delineation of different Map Units. In the following Map Unit descriptions, average horizon thicknesses are quoted. Thickness of comparative horizons in identical profiles found at different points in the landscape often vary by as much as ten to 40% from the norm.

The dominant plant species are listed, using common names. These lists are very general, and are not attempts at complete or exhaustive species lists.

Map Unit 1

Classification: Orthic Regosol.

Parent Material: medium textured alluvial sediments containing pockets of coarse sand, overlying gravel.

Slope: gently undulating (0.5 to 2%).

Stoniness: stone free (0).

Drainage: moderately well drained.

Vegetation: cottonwood, shrubs, grass.

Profile Description: 18 inches Ck loam to silt loam, very friable consistence when moist, contains numerous pockets of coarse sand; Ckg found about 18 inches below surface, loam to silt loam, very friable consistence when moist, contains numerous pockets of coarse sand; gravel ranges between 22 and 28 inches below surface.

Limitations: slight for buildings without basements, severe for septic tank filter fields, sanitary land fills and reservoir sites; moderate for other uses. Specific limitations are seasonally high groundwater table, slippery or sticky when wet (water erosion hazard), shallow depth to gravel, rapid permeability, groundwater contamination hazard, susceptibility to frost heave, high lime content (soil nutrient imbalance), lack of Ah horizon, overburden above gravel and moderate shrink-swell potential.

Map Unit 2

Classification: Rego Gleysol.

Parent Material: gravel.

Slope: undulating (2 to 5%).

Stoniness: excessively stony (5).

Drainage: poorly drained.

Vegetation: nil.

Profile Description: profile consists of gravel; occasional overlay of coarse sand up to three feet in thickness.

Limitations: severe for all uses. Specific limitations are flooding hazard, seasonally high groundwater table or surface ponding, surface stoniness, shallow depth to gravel, rapid permeability, groundwater contamination hazard and lack of Ah horizon.

Map Unit 3

Classification: non-soil.

Parent Material: undifferentiated bedrock.

Slope: extremely sloping (more than 60%).

Stoniness: very stony (3).

Drainage: well drained.

Vegetation: very sparse growth of grass and juniper.

Profile Description: This Map Unit consists of undifferentiated bedrock exposures.

Limitations: severe for all uses. Specific limitations are excessive slope, surface stoniness, shallow depth to bedrock and lack of Ah horizon.

Map Unit 4

Classification: Rego Gleysol.

Parent Material: medium textured alluvial sediments overlying very coarse textured alluvial sediments.

Slope: undulating (2 to 5%).

Stoniness: stone free (0).

Drainage: poorly drained.

Vegetation: grass, sedge.

Profile Description: Cgk1 loam, very friable consistence when moist; Cgk2 about 10 to 20 inches below surface, consists of loamy sand or gravel.

Limitations: severe for all uses. Specific limitations are seasonally high groundwater table or surface ponding, excessive slope, shallow depth to sand or gravel, rapid permeability, groundwater contamination hazard, lack of Ah horizon and overburden above gravel or sand.

MISCELLANEOUS LAND TYPES

1) – – – – – – – – – This symbol indicates a shallow drainage course or intermittent stream.

SOIL INTERPRETATIONS

Soil interpretations are predictions of soil performance under different uses, not recommendations for land use (22). They do not eliminate the need for land use planning; rather they are valuable tools that can be used to assist the planner. They indicate limitations and suitabilities of the various kinds of soil for any particular use. The planner can then predict the type and degree of problem likely to be encountered, and plan the kind and amount of on site investigation needed to determine corrective measures. However, the actual number of on site investigations can be reduced considerably by the use of a detailed soil survey map.

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

Soils of Map Unit 1 are the only ones suitable for recreational development and for use as road construction materials in the Park. However they do have moderate limitations that should be recognized and dealt with during construction. The other soils all have severe limitations and should not be used. Soils of Map Units 2 and 4 are Gleysolic or wet soils, and those of Map Unit 2 are excessively stony as well. Map Unit 3 is found on very steep slopes. It consists dominantly of bedrock exposures, and the surface is very stony.

The limitations most widespread in the Park are a seasonally high groundwater table or surface ponding, slippery or sticky when wet (water erosion hazard), shallow depth to sand or gravel, rapid permeability, groundwater contamination hazard, high lime content (soil nutrient imbalance), lack of Ah horizon, overburden above gravel or sand and moderate shrink-swell potential. Other less prevalent limitations are flooding hazard, excessive slope, surface stoniness and shallow depth to bedrock.

A source of good topsoil is not available in Woolford Park. The surface four to six inches of Map Unit 1 soils has been altered by the activity of earthworms to give the appearance of an Ah horizon. However this horizon is very weakly developed and has a high lime content. An abundant supply of gravel can be found in the Park from Map Unit 1 soils.

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 properties are 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 surface ponding.
3) Excessive slope.
4) Surface stoniness.

6) Slippery or sticky when wet (water erosion hazard).
8) Shallow depth to sand and/or gravel.
9) Rapid permeability.
12) Groundwater contamination hazard.
14) Susceptibility to frost heave.*
16) High lime content (soil nutrient imbalance).
17) Shallow depth to bedrock.
18) Thin Ah horizon.
21) Thick overburden above gravel or sand.
22) Moderate shrink-swell potential.

* 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 (22). 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 determining 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 soils are simply rated as good (G), fair (F), poor (P), and unsuitable (U).

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21. Environment Canada. Monthly Record Meteorological Observations in Canada, 1963 to 1972. Information Canada, Ottawa.

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TABLE 4. SOIL LIMITATIONS AND SUITABILITIES FOR SELECTED USES

Map Symbol	Soil Limitations For:											Suitability as a Source of	
	Camp Areas	Picnic Areas	Play Areas	Paths and Trails	Lawns & Land - scaping	Buildings with basement	Buildings without basement	Septic Tank Filter Fields	Sanitary Land Fills	Reservoir Sites	Roads, Parking, Subgrade Material	Topsoil*	Sand and/or gravel
1/bo	M6	M6	M6,8	M6	M18,16	M2	S	V8,9,12, 2	V8,9,12 2	V8,9,2	M22,14, 2	P18,16	F21
2/c5	V4,1,2	V4,1,2	V4,1,2,8	V4,1,2	V4,1,2, 18,8,9	V1,2,4	V1,2,4	V1,2,8,9 12	V1,2,8, 9,12	V8,9,1,2	V1,2,4	U	P1,2
3/H3	V3,4	V3,4	V3,4,17	V3,4	V3,4,18, 17	V3,4,17	V3,4	V3,17	V3,17	V3,17	V3,17,4	U	U
4/co	V2	V2	V2,3,8	V2	V2,18,8	V2	V2	V2,8,9, 12	V2,8,9, 12	V2,8,9	V2	U	P2,21

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

* Topsoil being considered here is Ah - horizon or its equivalent (see glossary)

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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 zero to six inch depth, and the subsoil samples are taken in 12 inch increments between the six and 18 inch depths. 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:

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

TABLE 5. CHEMICAL ANALYSES OF SELECTED MAP UNITS *

Map Unit	Sample Depth (inches)	Pounds per Acre Nitrogen (N)	Phosphorus (P)	Potassium (K)	Sodium**	Sulphur**	Soil Reaction (pH)	Conductivity (mmhos.)	Sulphate **	Organic Matter**	Free Lime ** ($CaCO_3$)	REMARKS
1	0-6	4	5	400	L-	L+	8.2	0.4	--	L+	H	campground-grass
1	6-18	68	3	135	L-	M+	8.3	0.5	--	L	H-	campground-grass
1	0-6	3	7	325	L-	L+	8.2	0.3	--	L+	H	native woodland
1	6-18	1	2	155	L-	L	8.2	0.2	--	L	H-	native woodland

* Chemical Analyses done by Alberta Soil and Feed Testing Laboratory.

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

need it in rather large amounts and it is easily lost from the soil.

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

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

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

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

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

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).

* Alberta Soil and Feed Testing Laboratory.

As phosphorus does not move appreciably in the soil, accumulations are found primarily in the first foot of soil.

Most of the total phosphorus supply is tied up chemically in a form that is not usable by plants; it is not available to the growing plant. The available soil phosphorus 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 percent 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, zero to 30; medium, 31 to 70; and high, 71 or more.

3. Potassium.

Plants need large amounts of potassium, one of the three major plant nutrients (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, zero to 150; medium, 151 to 300; and high, 301 or more.

* Alberta Soil and Feed Testing Laboratory.

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 (-). The degree within each category is indicated by a plus or minus 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;

* Alberta Soil and Feed Testing Laboratory.

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 (-). The degree within each category is indicated by a plus or minus 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 (-). The degree within each category is indicated by a plus or minus sign.*

Organic matter influences physical and chemical properties of soils far out of proportion to the small quantities contained therein (20).

* Alberta Soil and Feed Testing Laboratory.

It commonly accounts for at least half the cation exchange capacity of soils and is responsible, perhaps more than any other single factor, for the stability of soil aggregates. Furthermore, it supplies energy and body building constituents for the soil microorganisms.

Free lime is present in some soils and may reduce nutrient availability to plants in the following ways (20):

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

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

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

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

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

Engineering Properties of the Soils

Engineering test data determined on representative soil samples are presented in Table 6. The samples analyzed were taken from subsoils of Map Unit 1 at representative sites. Depth of sampling ranged between one and two 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.

TABLE 6. PHYSICAL ANALYSES OF SELECTED MAP UNITS *

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 % **	Maximum Dry Density lb/ft³ **	Classification AASHO	Unified	USDA
1	1-2	23	100	100	100	100	100	99	55	52	21	15	12	25	4	20	103	A-4 (4)	CL-ML	L
1	1-2	26	100	100	100	100	100	100	74	68	23	17	12	30	7	23	96	A-4 (8)	ML	SiL

* Map Units developed on similar parent material: 1 and 4.

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

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, waterholding capacity, shrink-swell potential, bearing value, susceptibility to frost heave, adaptability to soil cement construction, etc.

3. Plasticity.

In soil mechanics, plasticity is defined as that property of a material which allows it to be deformed rapidly, without rupture, without elastic rebound, and without volume change (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 number 40 sieve (0.42 mm.) have been used as key factors in classifying soils for structural purposes.

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

4. Moisture - Density Relationship.

The purpose of every laboratory compaction text 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 functions, using a number four 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 zero 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").

5. Soil Classification.

In order that soils may be evaluated, it is necessary to devise systems or methods for identifying soils with similar properties and then to follow this identification with a grouping or classification of soils that perform in a similar manner when their densities, moisture contents, textures, etc. are similar (11). A brief description of three widely used soil classification systems follows.

(a) AASHO Classification System.

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

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

(b) Unified Soil Classification System.

In this system, the soils are identified according to their textures and plasticities, and are grouped according to their performance as engineering construction materials. Soil materials are divided into coarse grained soils, fine grained soils, and highly organic soils. The coarse grained soils are subdivided into eight classes; the fine grained soils into six classes; and there is one class of highly organic soils. Coarse grained soils are those that have 50% or less of material passing the number 200 sieve; fine grained soils have more than 50% of material passing the number 200 sieve. The letters G, S, C, M and O stand for gravel, sand, clay, silt, and organic 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 W and P, meaning well graded and poorly graded, respectively. Additional letters used in the secondary divisions of the fine grained soils are L and H, meaning relatively low liquid limit and relatively high liquid limit, respectively.

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

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

The system of textural soil classification, used by Canadian soil scientists, is known as the USDA system. It is defined under "soil texture" in the glossary. There is some variation in the particle size limits between the USDA system and the two engineering systems just described, but the differences are not great. A comparison of the different systems is given in the PCA Soil Primer (11).

GLOSSARY

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

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

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 adsorbed 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.

bedrock - Any solid rock exposed at the surface, or underlying soil, sand or any type of mantle-rock.

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.

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

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.

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

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

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.

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

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

mantle-rock - Unconsolidated rock debris that overlies the bedrock surface.

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

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

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.

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

Rego - A modifying adjective used to indicate a soil that lacks a B horizon.

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.

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

shrub - A woody plant, smaller than a tree, usually with several stems.

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

soil horizon - A layer of soil or soil material approximately parallel to the land surface; it differs from adjacent genetically related layers in physical properties such as color, structure, texture, and consistence; and chemical, biological, and mineralalogical composition. A layer refers primarily to organic strata (layers) that may be found in organic soils, at the surface of mineral soils, or at any depth beneath the surface in buried soils, or overlying geological deposits. Soil horizons and layers are designated by letters according to the following definitions:

1) Organic Layers - These contain more than 17% organic carbon by weight. Organic layers designated as L-F-H, commonly abbreviated to L-H, have developed primarily from leaves, twigs, woody materials and a minor component of mosses. They are defined as follows:

L - An accumulation of organic matter in which the original structures are easily discernible.
F - An accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize.
H - An accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F layer by its greater humification chiefly through the action of organisms.

2) Mineral Horizons and Layers - These contain less organic carbon than that specified for organic layers. They are defined as follows:

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

B - A mineral horizon characterized by enrichment in organic carbon, sesquioxides, or clay, or by the development of soil structure or by a change of color denoting hydrolysis, reduction, or oxidation.

C - A mineral horizon comparatively unaffected by the pedogenic processes operative in A and B, except gleying, and the accumulation of carbonates and more soluble salts. Roman numerals are prefixed to horizon designations to indicate unconsolidated lithologic discontinuities in the profile. Roman numeral I is understood for the uppermost material and therefore is not written. Subsequent contrasting materials are numbered consecutively in the order in which they are encountered downward, that is II, III and so on.

3) Lowercase Suffixes:

g - A horizon characterized by gray colors, or prominent mottling indicative of permanent or periodic intense reduction, or both, and caused by conditions of imperfect or poor drainage. Examples are Aeg, Btg, Eg, and Cg.

h - A horizon enriched with organic matter.

Ah - A horizon that is either darker than the underlying horizon, or contains 0.5% more organic carbon than the IC, or both. It contains less than 17% organic carbon by weight.

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

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.

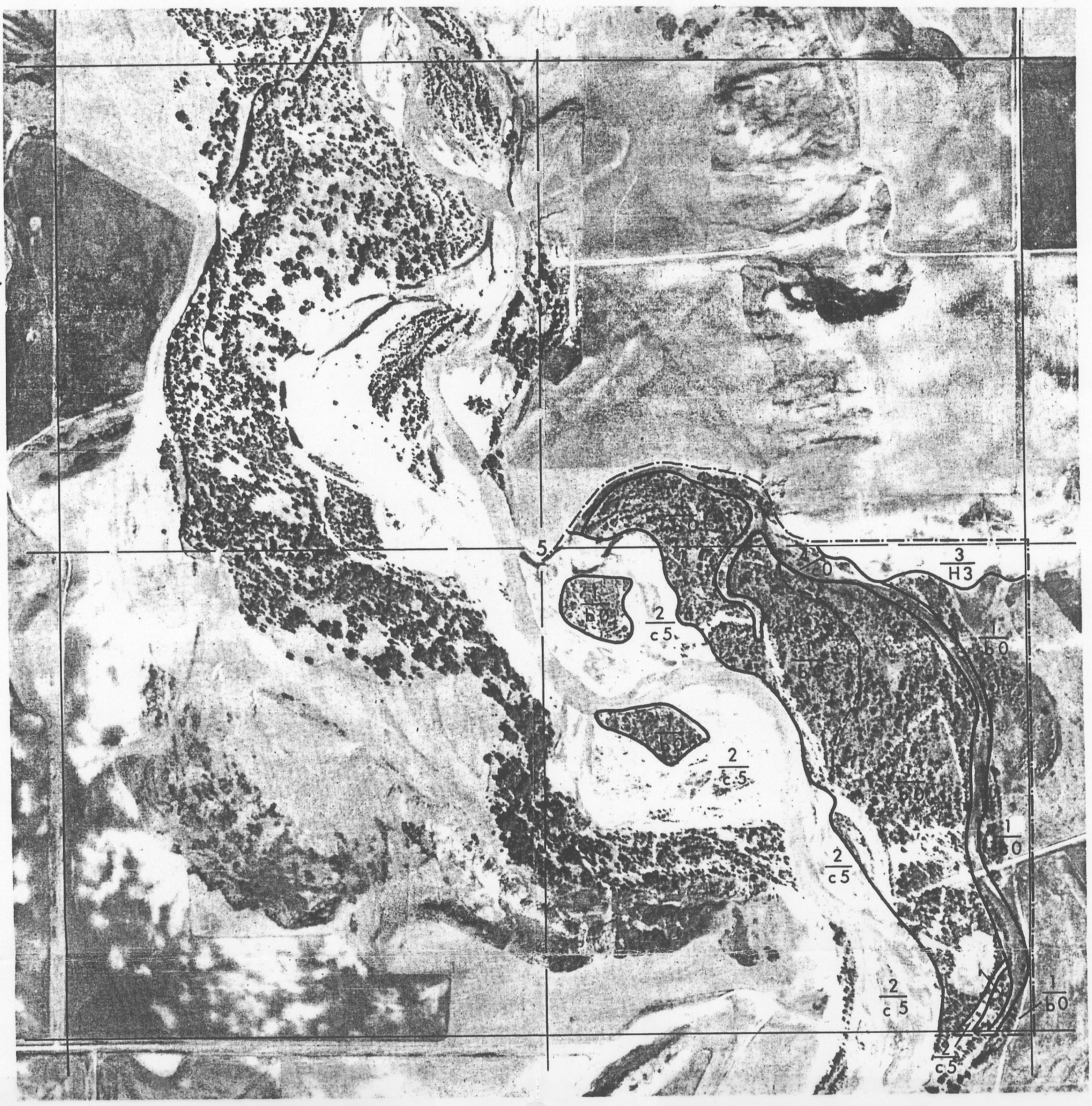
soil structure - The combination or arrangement of primary soil particles into secondary particles, units, or peds. The secondary units are characterized and classified on the basis of size, shape, and degree of distinctness.

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.

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

SOILS MAP OF WOOLFORD PROVINCIAL PARK

Tp. 3, R. 24, W. 4



Soil Classification:

MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Regosolic	Orthic Regosol	medium textured alluvial sediments containing pockets of coarse sand, overlying gravel
2	Gleysolic	Rego Gleysol	gravel
3	non-soil		undifferentiated bedrock
4	Gleysolic	Rego Gleysol	medium textured alluvial sediments overlying very coarse textured alluvial sediments

Legend:

Map Symbol

1 ← map unit
b 0 ← surface stoniness rating
← topographic class

- - - drainage course
—·—·— park boundary
——— soil line

Compiled from uncontrolled mosaic.

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

Alberta
RESEARCH COUNCIL
1974

APPROXIMATE SCALE:

660 0 660 1320 1980 2640 3300

FEET