Earth Sciences Report 80-4

Soil Survey of Cypress Hills, Alberta and Interpretation for Recreational Use

by

G.M. Greenlee

Alberta RESEARCH COUNCIL

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Pg. 7 Table 2. Stony 5, the excessively stony phase should read "... (>50% of surface, stones <0.1 or 0.3 ft apart)."

Pg. 31 Table 4. The soil ratings for Map Symbols 1/G2 and 6/gO should both read "Slope/Er" under the heading "Severe."

Pg. 65 The definition for "droughty soil" should read "Sandy or very rapidly drained soil."

PREFACE

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

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

The initial phase in planning the use and development of any resource is an inventory of the nature of the resource - its kind, quality, quantity, and distribution (Pluth, 1969). A soil survey indicates how much land is available for development, as well as how and where different kinds of soil are found in the landscape. Different soils delineated on a map have different properties, and different soils have different use capacities. A soil survey can be a useful tool to management in making a proper design for a recreational area. A good design directs users away from areas unsuitable for heavy use because of factors such as coarse-textured or wet soils, steep slopes, or fragile vegetation. A design made with the use of a soil survey is more compatible with natural land features than a design made without the use of that information. Lower initial investment is required; and the amount of maintenance required after a site is developed is expected to be reduced (Stevens, 1966), thereby reducing maintenance costs.

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

This report is one of a series describing detailed and semi-detailed soil surveys being conducted in the provincial parks and recreation areas of Alberta. In addition to a separate report for each area, a standard explanatory report that is pertinent to all areas is being prepared. Portions of this report appear in the Notikewin River Soil Survey Report (Greenlee, 1979).

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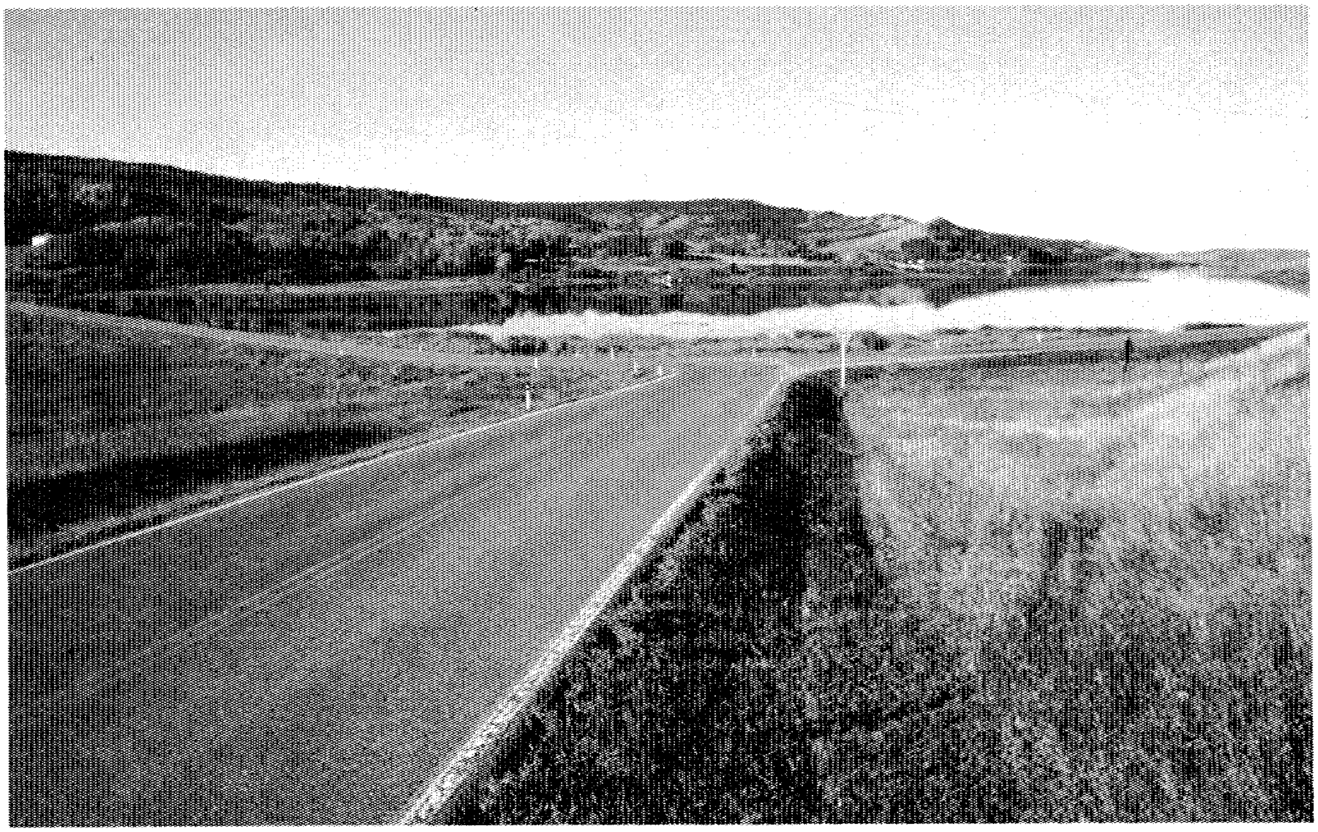


PLATE 1. Elkwater Lake, with the northern escarpment of the Cypress Hills in the background.

SUMMARY

The mapped area is in the Cypress Hills, about 26 km east and 35 km south of Medicine Hat. The area is 16 700 ha, slightly less than three townships. The Cypress Hills rise about 550 m above the surrounding plains surface. The dominating physical feature is the nearly level plateau that slopes gently to the east and south. The elevation and surface gradient of the plateau are determined by the Cypress Hills conglomerate. The gravel of the plateau is covered by a veneer of medium- to fine-textured materials with scattered pebbles, which are loess of Wisconsin age. The surficial deposits near the margins of the trough-shaped valleys, which dissect the northern and eastern parts of the Cypress Hills plateau, are coarse-textured fluvial sediments (gravel). Further to the north and east, where the valleys have been progressively widened, the surficial deposits are of morainal origin. These deposits merge with the hummocky disintegration moraine found in the northern and western portions of the mapped area. The till is predominantly moderately fine textured. Southeastern Alberta has a semi-arid climate with hot summers, and bright cold winters; however, the higher elevation of the Cypress Hills plateau results in lower temperatures and higher precipitation than in the surrounding plains region. The Cypress Hills, in general, are situated in the grassland region according to Rowe (1972); however, the forested portions belong to a small outlier of the lower foothills section, which belongs to the boreal forest region.

Twenty-two map units were recognized in the study area. The key profile types are Orthic Black and Orthic Dark Brown Chernozemics, Orthic and Dark Gray Luvisols, Orthic Eutric Brunisols, Orthic Regosols, Black Solodized Solonetz, Black Solods, and Terric Humisols. These soils are distributed over the landscape in relation to landform, parent material, and drainage. Map units consist of single soil series, groupings of series or catenas; and their distribution is shown on the soil map.

Soil interpretations are made for each map unit for primitive camping areas, fully serviced campgrounds, paths, trails, road location, source of roadfill, and source of sand or gravel. Soils of map units 1, 2, 5, 6, 11, 12, 13, 14, and 21 are the best suited for recreation when found on suitable topography. Soils of map units 1, 2, 6, and 11 are all widespread; however, most have moderate to severe limitations due to steep slopes and erosion hazard, with the exception of soils of map unit 11. Soils of other widespread map units have moderate to severe limitations. The soils of map unit 13 are the most suitable for road construction. Factors limiting soils of most others are steep slopes, high clay content, moderate to high shrink-swell potential, and susceptibility to frost heave. The soils of map units 9, 10, 11, 13, and 15 are good sources of gravel. Careful study of the soil map and tables 4 to 10 inclusive (soil limitation and suitability tables) will reveal areas suitable for particular uses.

A soil survey properly interpreted can be a very useful tool for management in making a proper design for a recreational area. All soil differences in the field cannot, however, be shown on a soil map. For design and construction of specific recreational facilities, an on-site investigation is, therefore, usually required.

ACKNOWLEDGMENTS

The Alberta Research Council provided the staff and the Parks Planning Branch of Alberta Recreation, Parks and Wildlife contributed the operating costs for the 1976-77 Provincial Parks soil survey program. The Alberta Research Council published the report and compiled the soil map. The University of Alberta provided office and laboratory space.

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

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

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

INTRODUCTION

LOCATION AND SIZE

The mapped area, 26 700 ha or slightly less than three townships, is in the Cypress Hills, about 26 km east and 35 km south of Medicine Hat (Plate 1, Figure 1). The legal description of the area is; sections 1 to 30 inclusive in township 8, and each of ranges 1 and 2; sections 1 to 16 inclusive and 21 to 26 inclusive in township 8, range 3; sections 31 to 36 inclusive in township 7, and each of ranges 2 and 3; and sections 25 to 27 inclusive as well as sections 31 to 36 inclusive in township 7, range 1; all west of the fourth meridian.

FIELD TECHNIQUES

The areas were surveyed by motor vehicle along all roads and negotiable trails, and foot traverses were made as necessary across areas lacking trails. Soil pits were dug at frequent intervals to depths of 0.6 to 1.5 m in order to examine and describe soil horizons and to classify the soils. The usual procedure was to excavate the upper 0.6 m of a soil pit with a shovel, and to examine the lower depths by sampling with a soil auger. Soil areas were delineated on panchromatic black and white aerial photographs at a scale of 1:31 680 (2 in = 1 mi), with the aid of a pocket stereoscope. Representative surface and shallow subsurface soil samples were collected for chemical analyses, and subsurface samples were collected at depths of 1 to 1.2 m for physical analyses.

CHEMICAL AND PHYSICAL ANALYSES

Chemical analyses carried out by the Alberta Soil and Feed Testing Laboratory (O.S. Longman Building, Edmonton) determined:

1. *available nutrients; available nitrogen* (N), *available potassium* (K) (Jackson, 1962), *available phosphorus* (P) (Dickman and Bray, 1940), and *available sulfur* (S) (Carson *et al.*, 1972).
2. *soil reaction;* pH was determined with a glass and calomel electrode, using a 2:1 water to soil ratio (Jackson, 1962).
3. *electrical conductivity* was measured by a dip electrode procedure; the electrodes were placed in the supernatant liquid on the surface of a 2:1 water to soil mixture.
4. *soluble sulfates* (SO_4) were determined on soil samples having electrical conductivities of one or more; a saturated soil paste was prepared according to the procedure outlined in USDA Handbook 60 (Richards, 1954); a saturation extract was obtained by suction, and sulfates were precipitated with $BaCl_2$ crystals by the turbidimetric method and estimated by a visual inspection.
5. *exchangeable sodium* (Na) was determined by flame photometry (Jackson, 1962).
6. *organic matter* was estimated by a visual inspection of the soil sample.
7. *free lime* was determined by a visual estimation of the degree of effervescence when a 10 percent solution of dilute HCl was added to a soil sample.
8. *available aluminum* (Al) and *manganese* (Mn) were determined on soil samples having a pH of 5.5 or less; these nutrients were determined by atomic adsorption spectrophotometry (Hoyt and Nyborg, 1971).

Staff at the Alberta Institute of Pedology laboratories analyzed: field moisture content, liquid limit, plastic limit, sieve analysis, and particle size (hydrometer method) (ASTM, 1970). Values for optimum moisture content and maximum dry density were obtained from charts prepared by the Alberta Transportation Laboratory of Alberta Transportation (1955).

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

The Cypress Hills rise about 550 m above the surrounding plains (Jungerius, 1969). The dominating physical feature is the nearly level plateau that slopes gently to the east and south (Westgate, 1964). At its western extremity, or "Head of the Mountain," the plateau reaches a maximum elevation of 1465 m and drops to less than 1370 m at the Alberta-Saskatchewan border, some 24 km to the east. The elevation and surface gradient of the plateau are determined by the Cypress Hills conglomerate (Westgate, 1964). The lowest elevation in the study area is 1130 m along the western boundary, a difference of some 335 m between the highest and lowest elevations. To the north and west, the plateau ends abruptly in escarpments formed in part by ice marginal meltwater flow; whereas on the south, it gradually merges into a till plain. The northern and eastern parts are dissected by trough-shaped valleys excavated into the Cypress Hills conglomerate, and to the south, broad pediments slope away from the plateau at very low gradients. The mapped area is drained by numerous, small unnamed creeks that originate on the plateau and flow in various directions. Two named creeks, the Battle and Graburn, flow to the east. The western and northern escarpments generally drain towards the north, and ultimately the water

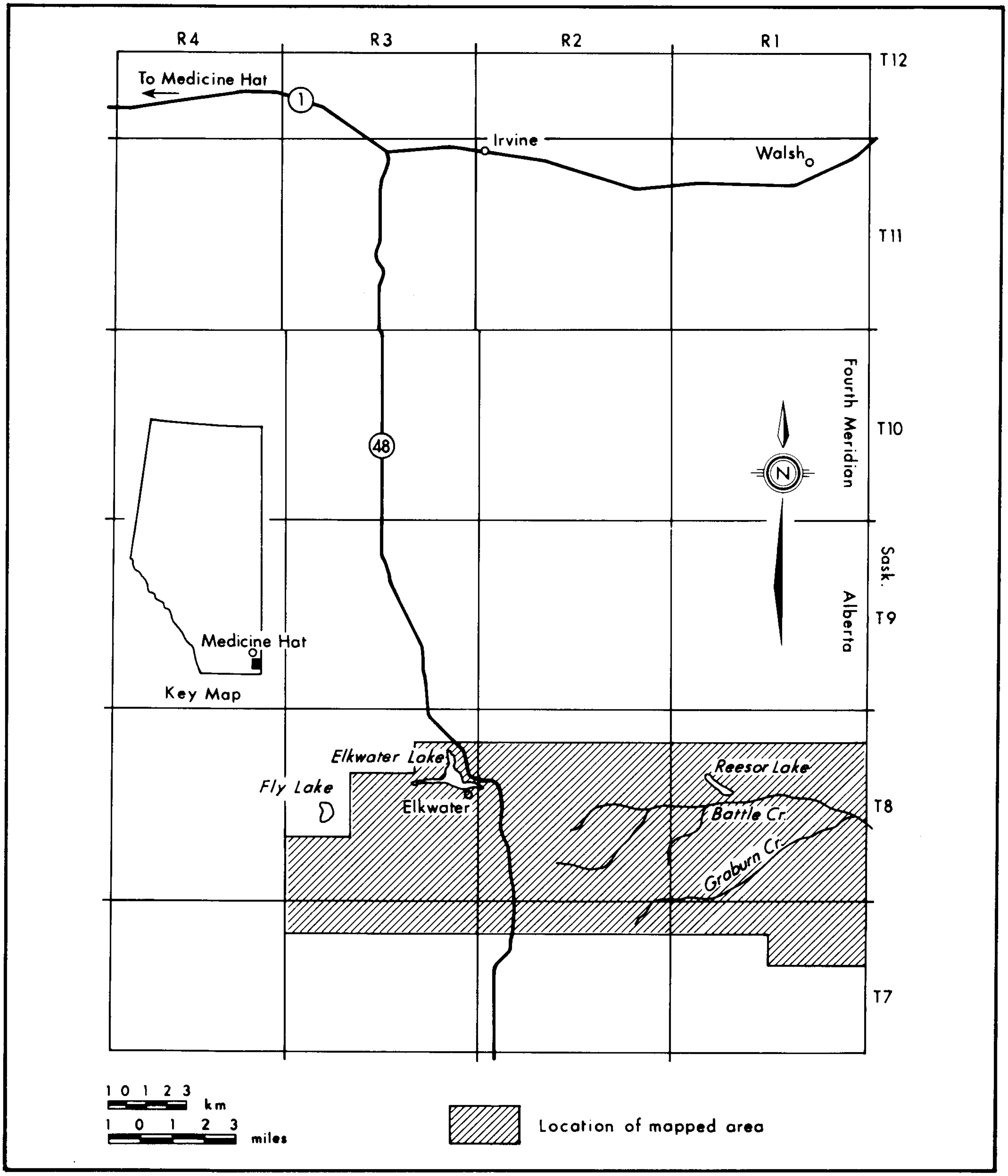


FIGURE 1. Location of mapped area.

reaches the South Saskatchewan River. The eastern and southern portions of the study area generally are drained towards the southeast, and ultimately to the Missouri River in Montana (Westgate, 1964).

The Cypress Hills plateau and most of the southern pediment remained above the limits of the Wisconsin glaciation (Jungerius, 1969). The gravel of the plateau is covered by a veneer of medium- to fine-textured materials with scattered pebbles that, according to Westgate (1964), are loess of Wisconsin age, and vary in thickness from 30 cm to 2.4 m. Heavy mineral studies carried out by Westgate verified the loessic origin of these sediments. Material with a similar texture, but derived from unconcentrated slope wash during the postglacial period, overlies the southern pediment (Jungerius, 1969).

The numerous quartzite pebbles in the loess were elevated there by frost action (Westgate, 1964). The resultant fabric of the loess resembles that of till (unsorted), but no erratic pebbles are present. The long axes of the pebbles, usually in a vertical position, indicate postdepositional changes in the loess as well as in the underlying Cypress Hills conglomerate. Deranged pebbles in the uppermost 1.8 m show that the conglomerate has also been deformed by frost action. The conglomerate ranges in thickness from 7.6 m at the western end of the Cypress Hills, to over 15 m at the Alberta-Saskatchewan border (Westgate, 1964). Outcroppings of conglomerate can be observed at various locations along the northern escarpments of the Cypress Hills plateau.

In general, the surficial deposits found in the trough-shaped valleys near their margins consist of very coarse-textured fluvial sediments (gravel). Further into the valleys, only a thin veneer (30 to 60 cm) of fluvial sediment occurs, overlying medium- to moderately fine-textured till. Further to the north and east, where the valleys have been progressively widened, the surficial deposits are of morainal origin. These deposits then merge with the hummocky disintegration moraine found in the northern and western portions of the mapped area (Westgate, 1964). The till is predominantly moderately fine textured.

Very coarse-textured fluvial sediments (gravel) are found in the floodplains of the upper reaches of numerous streams which originate within the mapped area. In the lower reaches, where the floodplains progressively broaden out, the surficial fluvial sediments are medium- to moderately fine textured. A few small areas of shallow peat deposits also occur in these locations. One relatively extensive area of a shallow peat deposit is found in the glacial meltwater channel that runs eastward from Elkwater Lake, then northward to the northern boundary of the study area.

LANDFORMS

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

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

Landforms, in this system, are considered to represent two basic attributes: materials and form. Materials fall into four categories: unconsolidated mineral, organic, consolidated mineral, and ice. Several classes of unconsolidated mineral and organic materials have been established but classes of consolidated materials (bedrock) and ice have not been recognized. Although the landform classification system is outlined in Appendix C, "A Landform Mapping System for Canadian Soil Surveys" (Acton, 1975), and the Canadian System of Soil Classification (CSSC, 1978) contain more complete descriptions.

CLIMATE

According to Westgate (1964), southeastern Alberta has a semi-arid climate with hot summers and bright cold winters. Although situated a considerable distance east of the Rocky Mountains, the area is influenced by warm chinook winds at irregular intervals throughout the year. Jungerius (1969) states that climatic variation, reflected in the vegetation and soils, is considerable within the Cypress Hills. The higher elevation of the plateau results in lower temperatures and higher precipitation than in the surrounding plains region. Mean annual temperatures range from 2°C on the plateau to 5°C near the Canada-United States boundary 65 km to the south. The average annual precipitation decreases from 46 cm on the plateau to 30 cm in the south. Most precipitation falls during the summer months. Comparing weather records kept between 1966 and 1975 at the Medicine Hat airport, about 35 km north and 26 km west of the mapped area and at an elevation of 725 m shows the following values (Environment Canada 1966-1975); a mean annual temperature of 5°C and mean annual precipitation of 35 cm with 65 percent falling as rain. July is the warmest month of the year with a mean temperature of 20°C; January is the coldest month with a mean temperature of -12.2°C. The average frost-free period is 125 days.

VEGETATION

According to Rowe (1972), the Cypress Hills are situated primarily in the grassland region; however, the forested portions belong to a small outlier of the lower foothills section, identified beyond its eastern boundary. This section belongs to the boreal forest region, and the distinctive tree species is the lodgepole pine. Fire has enabled the pine, along with trembling aspen and balsam poplar, to become dominant over much of the area.

A detailed description of the vegetation is not presented in this report because the Parks Planning Branch of Alberta Recreation, Parks and Wildlife conducts biological studies of Provincial Parks and proposed park areas. Some common plant species associated with different soil types are listed in the map unit descriptions.

These common plant species are (Moss, 1959): lodgepole pine (*Pinus contorta* var. *latifolia*), aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), white spruce (*Picea glauca*), hawthorn (*Crataegus douglasii*), saskatoonberry (*Amelanchier alnifolia*), dogwood (*Cornus stolonifera*), Canadian buffalo-berry (*Shepherdia canadensis*), wild rose (*Rosa* spp.), wild red raspberry (*Rubus strigosus*), wild gooseberry (*Ribes oxyacanthoides*), ground juniper (*Juniperus communis*), willow (*Salix* spp.), buckbrush (*Symphoricarpos occidentalis*), shrubby cinquefoil (*Potentilla fruticosa*), wolf willow (*Elaeagnus commutata*), sagebrush (*Artemisia cana*), common bearberry (*Arctostaphylos uva-ursi*), grass (various species including tame hay), venus'-slipper (*Calypso bulbosa*), cow parsnip (*Heracleum lanatum*), wild mint (*Mentha arvensis* var. *villosa*), horsetail (*Equisetum* spp.), and numerous other forbs.

SOILS

Soils were classified according to the Canadian System of Soil Classification (see Appendix B and CSSC, 1978). The extent of each soil is indicated on the soil map. An explanation of the map symbol follows:

TABLE 1
Topographic classes and symbols (CDA, 1974)

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

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

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

Where a map unit consists of a single series, other soil series may be found nearby. The dominant series, however, constitutes roughly 70 to 90 percent of the map unit; the other series are present in such minor amounts that they do not affect the use of a particular map unit for recreation.

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

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

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

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

Where a map unit consists of a catena, the approximate percentages of only the dominant members (which may also be series) are indicated. Insignificant amounts of other members often occur, but are not mentioned. Soil interpretations are for the dominant member of a catena, and interpretations for the less dominant members may or may not be different.

Twenty-two map units were recognized in the study area. Soils of the Chernozemic order are dominant in eleven of these; soils of the Brunisolic order are dominant in three; soils of the Luvisolic order are dominant in four; soils of the Solonetzic order are dominant in two; a Regosolic soil is dominant in one; and the soils of one map unit are classified in the Organic order. A minor component of this map unit is comprised of Gleysolic soils as well, which also occur adjacent to groundwater discharge areas and in small wet depressions. Soils of the Regosolic order are also minor components of four map units. Pertinent features of the map units are summarized in table 3. For a discussion of the Canadian soil classification system, refer to Appendix B.

In general, the most common and widespread soils found throughout the grassland and parkland regions of southern and central Alberta are those of the Chernozemic order, and the mapped area is no exception. Extensive areas of Luvisolic and Brunisolic soils also occur in the study area.

Soils of the Chernozemic order are well- to imperfectly drained mineral soils of good structure, with very high natural fertility and productive capacity. These soils are characterized by dark-colored surface virgin (Ah or Ahe) or cultivated (Ap) horizons, darkened by the accumulation of organic matter (humus) from the decomposition of grasses and forbs representative of grassland communities or of grassland-forest communities with associated shrubs and forbs. The A horizon, commonly referred to as "topsoil," ranges from 10 to 25 cm in thickness. In some regions, it is much thicker. Chernozemic soils are further divided into four major divisions, the Brown, Dark Brown, Black, and Dark Grey great groups. These divisions distinguish measurable differences in color of the A horizons. With other associated features such as depth, organic matter content, and structure, the divisions reflect significant differences in the climate and vegetation under which the soils developed, and which continue to influence and distinguish their characteristics and relative use capabilities.

In general, Brown Chernozemic soils found in southern and southeastern Alberta have A horizons that are lower in organic matter content, lighter in color, and thinner than those of the other Chernozemic great groups. A horizons of Black Chernozemic soils found in central and southwestern Alberta are higher in organic matter content, darker in color, and thicker than those of the other great groups. In south-central and east-central Alberta, Dark Brown Chernozemic soils have A horizons with characteristics intermediate between those of the Browns and the Blacks. A horizons of Dark Gray Chernozemic soils have variable colors, thicknesses, and modifications of structural pattern indicating degradation of the typical Chernozemic A horizon.

Under virgin conditions, the Dark Grays usually have leaf mats (L-H horizons) overlying the mineral soil, and degradation of the A horizons frequently causes a banded or "salt and pepper" effect. The organic matter content varies with the degree of degradation, from high accumulations in slightly degraded soils, comparable to that of Black soils, to significantly lower amounts in the more strongly degraded types. These latter types are intergrades to Dark Gray Luvisolic soils of the Luvisolic order.

Dark Gray Chernozemics are found primarily in transitional areas of grassland and forest in north-central Alberta and in

TABLE 3
KEY TO THE SOILS

Map Unit	Classification	Parent Material	Surface Texture	Slope (class and gradient))	Surface Stoniness	Drainage	Comments and Limitations
1.	Orthic Dark Brown Chernozemic -60% Orthic Black Chernozemic -30% Orthic Regosol -10%	medium- to moderately fine-textured till	L	d,e,f,G (>5 to 60%)	1 to 3	well drained	1. Dark Browns - south and west facing slopes, Blacks - north and east facing slopes, Regosols - eroded upper slopes and gravelly knolls; 2. Sand pockets in B and C horizons; slight to severe limitations - excessive slope, erosion hazard, susceptibility to frost heave, high clay content of subsoil, high shrink-swell potential.
2.	Orthic Black Chernozemic	moderately fine-textured till	L	b,c,D,d E,e,f, (>0.5 to 30%)	0 to 3	well drained	1. Soil solum sometimes nearly stone free; 2. occasional sand or gravel pockets in soil solum; slight to severe limitations - excessive slope, erosion hazard, susceptibility to frost heave, high clay content of subsoil, high shrink-swell potential.
3.	Gleyed Black Chernozemic	medium- to moderately fine-textured fluvial sediments	L	b,c (>0.5 to 5%)	0	imperfectly drained	Profile consists of layers of loam and clay loam textured materials, also occasional sand lenses; slight to moderate limitations - seasonally high groundwater table or surface ponding, moderate shrink-swell potential, susceptibility to frost heave.
4.	Black Solodized Solonetz-70% Orthic Black Chernozemic -30%	medium- to moderately fine-textured fluvial sediments	L	B,c,D,E (>0.5 to 15%)	0	well drained	1. Solodized Solonetz soil has good round tops; 2. Cca horizon of Chernozemic soil generally deeper than 100 cm; moderate limitations - Solonetzic soil, slow permeability excessive slope, erosion hazard, moderate shrink-swell potential, susceptibility to frost heave.
5.	Orthic Black Chernozemic	medium- to moderately fine-textured till containing a high proportion of weathered shale and sandstone	L	e,f (>9 to 30%)	0	well drained	Slight to severe limitations - excessive slope, erosion hazard, susceptibility to frost heave, high shrink-swell potential.
6.	Orthic and Dark Grey Luvisol	medium- to moderately fine-textured till containing a high proportion of weathered shale and sandstone	L	e,f,g, (>9 to 60%)	0	well drained	Occasional sand lenses occur in Cca horizon; slight to severe limitations - excessive slope, erosion hazard, susceptibility to frost heave, high shrink-swell potential.
7.	Orthic Black Chernozemic -70% Black Solodized Solonetz -30%	medium- to moderately fine-textured till containing a high proportion of weathered sandstone and shale	SL,L,SiL, CL	f (>15 to 30%)	0	well to rapidly drained	1. Pockets of fine and very coarse-textured till also occur; 2. Numerous fragments of sandstone and shale often occur in BC and Cca horizons of the Chernozemic soils; moderate to severe limitations - excessive slope, erosion hazard, susceptibility to frost heave, high shrink-swell potential, slow permeability of Bnt horizon in Solodized Solonetz soil.

TABLE 3.
KEY TO THE SOILS (CONTINUED)

Map Unit	Classification	Parent Material	Surface Texture	Slope (class and gradient)	Surface Stoniness	Drainage	Comments and Limitations
8.	Orthic Dark Brown Cherno-zemic (eroded phase) -70% Orthic Regosol -30%	very-coarse to fine-textured till containing a high proportion of of weathered shale and sandstone	LFS,L,CL, SiCL, SiC	f,G (>15 to 60%)	0	well drained	Cca horizons consist of layers and pockets of highly variable textured materials, moderate to severe limitations - excessive slope, high clay content, erosion hazard, slippery or sticky when wet, susceptibility to frost heave, high shrink-swell potential.
9.	Orthic Black Chernozemic -80% Eluviated Black Chernozemic -20%	medium- to moderately fine-textured loess overlying moderately fine to fine-textured very gravelly fluvial sediments	SiL	B,b,C,c,D E,f (>0.5 to 30%)	0 to 1	well drained	1. Average thickness of loess is 50 to 75 cm, soil profile generally somewhat gravelly for 25 to 35 cm above the fluvial sediments; 2. Depth to lime is nearly always more than 120 cm; moderate to severe limitations - slippery or sticky when wet, high clay content, slow permeability, excessive slope (in some areas), erosion hazard, susceptibility to frost heave, high shrink-swell potential.
10.	Orthic Eutric Brunisol	gravel	gravel	f,g (>15 to 60%)	5	very rapidly drained	1. L-H horizon very fragile 2. Cca horizon commonly deeper than 50 cm; moderate to severe limitations - excessive slope.
11.	Orthic Gray Luvisol	moderately coarse-textured loess overlying moderately fine to fine-textured very gravelly fluvial sediments	FSL	B,C,c,D, E,e,F (>0.5 to 30%)	1 to 2	well drained	1. Very few pebbles occur near top of Bt horizon, concentration increases with depth; 2. Lime horizon occurs deeper than 50 cm; 3. A small percentage of Dark Gray Luvisol soil is found; slight to severe limitations - excessive slope, erosion hazard, high clay content of subsoil, susceptibility to frost heave, high shrink-swell potential.
12.	Orthic Gray Luvisol - 80% Dark Gray Luvisol - 20%	moderately fine-textured till	L,FSL	D,d,f,g (>5 to 60%)	0 to 2	well drained	Slight to severe limitations - excessive slope, erosion hazard, high clay content of subsoil, susceptibility to frost heave, high shrink-swell potential.
13.	Orthic Black Chernozemic	gravel	L	c,d,F,f (>2 to 30%)	1 to 5	very rapidly drained	Lime horizon occurs deeper than 50 cm; none to slight limitations - excessive slope, erosion hazard.
14.	Black Solod -70% Orthic Black Chernozemic -30%	medium- to moderately fine-textured fluvial sediments	L	D (>5 to 9%)	0	well drained	Lime horizon of Chernozemic soil occurs deeper than 100 cm; slight to moderate limitations - moderate shrink-swell potential, susceptibility to frost heave.
15.	Gleyed Black Chernozemic -70% Gleyed Eutric Brunisol -30%	medium- to moderately fine-textured fluvial sediments overlying gravel	L	b (>0.5 to 2%)	0	imperfectly drained	Occasional sand lenses in Bmg horizon; slight to moderate limitations - seasonally high groundwater table or surface ponding.

TABLE 3.
KEY TO THE SOILS (CONTINUED)

Map Unit	Classification	Parent Material	Surface Texture	Slope (class and gradient)	Surface Stoniness	Drainage	Comments and Limitations
16.	Orthic Gray Luvisol	moderately fine-textured gravelly fluvial sediments overlying medium- to fine-textured till containing a high proportion of weathered shale and sandstone	L,FSL	D,f,g (>5 to 60%)	3 to 5	well drained	1. Occasional sand lenses occur in Cca horizon; 2. The gravelly layer usually occurs in the Bt horizon, but sometimes occurs in the BC and Cca horizons; 3. L-H horizon is very fragile; moderate to severe limitations - high clay content and slow permeability of subsoil, erosion hazard, excessive slope, susceptibility to frost heave, high shrink-swell potential.
17.	Gleyed Regosol -70% Gleyed Rego Black Chernozemic -30%	medium- to moderately fine-textured fluvial sediments	L to CL	b (>0.5 to 2%)	0	imperfectly drained	1. Occasional sand lenses occur in the soil profiles; 2. Carbonated phases of the Chernozemic soils are occasionally found; slight to moderate limitations - seasonally high groundwater table or surface ponding, moderate shrink-swell potential, susceptibility to frost heave.
18.	Orthic Dark Brown Chernozemic (eroded and lithic phases)	medium- to moderately coarse-textured till containing a high proportion of weathered sandstone, overlying sandstone	L to SL	F (>15 to 30%)	2	well to rapidly drained	Sandstone shallow near tops of slopes, deep near bases of slopes, moderate to severe limitations - excessive slope, erosion hazard, shallow depth to bedrock.
19.	Eluviated Dystric Brunisol	moderately coarse to very coarse-textured till containing a high proportion of weathered sandstone	FSL	g (>30 to 60%)	0	well to rapidly drained	Severe limitations - excessive slope, erosion hazard.
20.	Orthic Dark Brown Chernozemic (eroded phase) -60% Orthic Regosol -40%	medium- to moderately fine-textured till containing a high proportion of weathered sandstone and shale	SL, L to CL	f (>15 to 30%)	0	well drained	Occasional sand lenses occur in Cca horizon; moderate to severe limitations - excessive slope, erosion hazard, susceptibility to frost heave, high shrink-swell potential.
21.	Orthic Black Chernozemic	medium- to moderately coarse-textured fluvial sediments	L	c (>2 to 5%)	0	well drained	Slight to moderate limitations - moderate shrink-swell potential, susceptibility to frost heave.
T.H.	Terric Humisol	well-decomposed peat overlying medium- to moderately fine-textured fluvial sediments	intermediately decomposed peat (Om)	B (>0.5 to 2%)	0	very poorly drained	1. Occasional sand lenses occur in the IIC material; 2. Surface water often occurs, depth to water table ranges from above ground to 60 cm; 3. Thickness of peat gradually becomes less toward edges of these areas; severe limitations - organic soil, seasonally high groundwater table or surface ponding, susceptibility to frost heave, high shrink-swell potential.

the Peace River region. Well-drained Black Chernozemic soils predominate over most of the Cypress Hills plateau. Smaller areas occur in the hummocky disintegration moraine in the northern and western portions of the mapped area, as well as in various stream floodplains. Imperfectly drained Blacks are also found in portions of some floodplains. The soils most widespread through most of the hummocky disintegration moraine are Dark Brown Chernozemics.

Soils of the Luvisolic order are well- to imperfectly drained mineral soils characterized by an Ae horizon near the surface which generally varies from 7.5 to 30 cm in thickness. It is a leached gray colored horizon very low in organic matter (humus) content and plant nutrients. Luvisolic soils in their natural state commonly have surface L-H and Ah horizons as well. The L-H horizon ranges from 2.5 to 12.5 cm or more in thickness; however, the Ah horizon below is usually less than 5 cm thick, and is often absent altogether.

When Luvisolic soils are cultivated, the L-H and Ah horizons quickly become mixed with the Ae, resulting in gray colored fields. Also, the L-H and Ah horizons rapidly break down under heavy foot traffic in recreation areas, and often disappear completely from a combination of physical destruction and soil erosion. When thoroughly dried, the Ae horizon is often baked and hard, so that plant seedlings may be unable to push up through the crust. Also, entry of moisture from rainfall may be hampered and runoff increased, thereby enhancing soil erosion. This problem is especially serious on steep slopes. Well-drained Luvisolic soils are widespread in the valleys and on the escarpments that surround the plateau to the west, north, and east, as well as on portions of the southwestern and eastern plateau fringes, where lodgepole pine forests have encroached upon grassland areas.

Soils of the Regosolic order are well- to imperfectly drained mineral soils with profile development too weakly expressed to meet the requirements for classification in any other order. These soils lack any expression of a B horizon and, therefore, reflect essentially the characteristics of the C horizons and the parent materials from which they are formed. In the mapped area, Regosolic soils are found in the areas of hummocky disintegration moraine, associated with Chernozemic and Brunisolic soils. The Regosolic soils are found on steep south facing slopes where conditions favor high rates of moisture runoff and evaporation, coupled with low moisture infiltration and percolation rates. These conditions retard or prevent any soil profile development, and soil erosion may also be a factor.

Soils of the Brunisolic order are well- to imperfectly drained mineral soils with sufficient profile development to exclude them from the Regosolic order, but lack the degrees or kinds of horizon development specified for soils of other orders. They are commonly identified by *in situ* development of the prominent brownish-Bm horizon with sufficient alteration by hydrolysis, oxidation, or solution to produce changes in color, structure, and composition significantly different from those of an A or C horizon. Since the processes of leaching and weathering are relatively weakly developed in Brunisolic soils, they tend to reflect the chemical characteristics, particularly the base status and acidity, of parent materials from which they derive.

Very rapidly drained Brunisolic soils are commonly found on the fluvial gravels of the trough-shaped valleys that dissect the northern and eastern parts of the Cypress Hills plateau. The high percolation rates of these materials result in droughty conditions and very little profile development, except for the removal of lime by leaching. A few other small patches of Brunisolic soils are found on steep slopes, mostly in areas of hummocky disintegration moraine in the northwestern, western, and eastern portions of the mapped area. Two other small patches occur on steep slopes near Elkwater Lake on the southern side. The high rates of moisture runoff result in low moisture infiltration and percolation rates and promote only minimal soil profile development.

Soils of the Solonetzic order are well- to imperfectly drained mineral soils having Solonetzic B horizons and saline C horizons. A Solonetzic B is characterized by a columnar (round or flat-topped) or prismatic macrostructure that can usually be broken into a blocky mesostructure. These blocks, which have hard to very hard consistence when dry and are relatively impermeable, usually show dark surface stains or coatings. Chemically, the Solonetzic B horizons show evidence of alkalinization and have ratios of exchangeable calcium to exchangeable sodium of 10 or less, which is significantly lower than that for other, non-Solonetzic B horizons. The C horizons are generally saline and usually show an accumulation of salts.

Solonetzic soils are further divided into three major divisions, the Solonetz, Solodized Solonetz, and Solod great groups. Solonetz and Solodized Solonetz soils have Solonetzic B horizons that are essentially intact and have not undergone significant breakdown. Generally, an abrupt break appears between the A and B horizons, and the A horizon is usually thin in relation to the B. Solodized Solonetz soils are characterized by the presence of an acidic Ae horizon, which is lacking in Solonetz soils. Solod soils are characterized by a greater development of this acidic Ae horizon and an AB transitional horizon in which the former Solonetzic B structure is in the process of physical disintegration. A horizons are generally thicker in relation to B horizons than in associated Solonetz and Solodized Solonetz soils. The contact bewteen the AB and Solonetzic B horizons is not well defined, and the remnant B horizons are more easily broken into darkly stained aggregates than in Solonetz and Solodized Solonetz soils. Structural limitations of Solonetzic B horizons, which tend to become sticky and plastic when wet and very hard when dry, restrict moisture penetration and root development. Rainwater usually remains at or near the surface, and much is lost by evaporation.

The proximity of saline and alkaline subsoils and periodic salinization of surface horizons present further limitations to healthy plant growth and to water availability. Consequently, Solonetzic soils are usually distinctly inferior in productivity to other associated soils. Another limitation of Solonetzic soils is their high erodibility, due to unstable soil aggregates caused by high sodium contents. In Solod soils, the limitations of structure and salinity are moderate in comparison to those for Solonetz and Solodized Solonetz soils. Solods, although somewhat inferior, more closely approach the associated Chernozemic soils in general productivity. Management problems in the cultivation of Solonetzic soils involve the timely use of tillage equipment to conserve moisture, and to prevent caking of surface clods and dessication of the underlying B horizon. Only a few small areas of Solonetzic soils occur in hummocky disintegration moraine and stream floodplains, in the extreme western portions of the study area.

The Organic order includes all soils that have developed largely from organic deposits, contain more than 30 percent organic matter by weight, and meet minimum specifications of depth and thickness within a defined control section. Most Organic soils are either water saturated or nearly so for much of the year, unless artificially drained. The organic deposits are derived primarily from decomposing hydrophytic or mesohydrophytic plants.

The further classification and naming of the great groups into Fibrisols, Mesisols, and Humisols depends on the occurrence and identification of three major diagnostic layers: Fibric, Mesic, and Humic. Fibric layers, the least decomposed of all the organic soil materials, have large amounts of well-preserved fibres, whose botanical origins can be readily identified. The highly decomposed organic matter of humic layers, often has a smooth, greasy feel when moist, has the least amount of recognizable plant fibre, and is usually darker in color than fibric or mesic materials. Humic layers are relatively stable and change little in physical or chemical composition with time. The organic matter of mesic layers, in an intermediate stage of decomposition between that of fibric and humic layers, is partially altered both chemically and physically.

In areas where Organic soils are cultivated, management problems include controlled drainage, adequate fertilization, and tillage practices that ensure a firm bed for seed germination and root development. Overdrainage and dessication of peat are detrimental to crop production and to maintaining organic layers in a desirable physical condition. When cultivated, many Organic soils show deficiencies in macro and micro mineral nutrients, and most need additions of phosphorus and potassium for maximum productivity. Special problems using Organic soils for construction include their low bearing strength, high shrink-swell potential, and susceptibility to frost heaving. Organic soils in the mapped area are confined mainly to the floodplains of streams and glacial meltwater channels, with the most extensive area in the channel that runs eastward from Elkwater Lake, then northward to the northern boundary.

Soils of the Gleysolic order are poorly drained mineral soils whose profiles reflect the influence of waterlogging for significant periods. Water saturation causes reducing conditions from lack of aeration, so gleyed horizons are dull gray to olive, greenish or bluish-gray, frequently accompanied by prominent, usually rust-colored mottles, that result from localized oxidation and reduction of hydrated iron oxides. In the study area, Gleysolic soils are found along the margins of Organic soil areas, where the peat is too shallow to be classified as Organic soils. Gleysolic soils are also found adjacent to groundwater discharge areas, and in a few, scattered, small, wet depressions.

Although some map units exhibit only slight differences, they are usually significant for some recreational or engineering use and warrant their separation. The extreme variability common to soils is demonstrated by the wide variations in horizon thicknesses reported in some of the following map unit descriptions. Comparative soil horizons of the same series found at different points in the landscape can vary in thickness by as much as 10 to 40 percent from the norm.

Map Unit 1

Classification: Orthic Dark Brown Chernozemic - 60 percent; Orthic Black Chernozemic - 30 percent; Orthic Regosol - 10 percent
Landform: inclined morainal (Mi), rolling morainal (Mm), and hummocky morainal (Mh)
Parent Material: medium- to moderately fine-textured till
Slope: gently to strongly rolling (>9 to 30 percent)
Surface Stoniness: slightly to very stony (1 to 3)
Estimated Drainage: well drained
Vegetation: generally grass; patches of shrubs and trees in lower, more moist areas and on north and east-facing slopes: hawthorn, wild rose, wild gooseberry, buckbrush, aspen, some white spruce
Profile Description:

Orthic Dark Brown Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	8 - 15	loam	granular	very friable, moist
Bm	40 - 65	loam to clay loam	prismatic, breaking to subangular blocky	very friable to firm, moist
BC or Cca	at 50 - 75	clay loam	amorphous	friable to very firm, moist

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	2.5 - 7.5	leaf litter	(occurs under aspen)	
Ah	20 - 30	loam	granular	very friable, moist
Bm	50	loam to clay loam	prismatic, breaking to subangular blocky	very friable to firm, moist
BC or Cca	at 75	loam to clay loam	amorphous	very friable to very firm, moist

Orthic Regosol

Horizon	Thickness cm	Field Texture	Structure	Consistence
Cca	not determined	loam	subangular blocky	very friable, moist

Comments: (1) In general, the Orthic Dark Browns are predominantly on south and west-facing slopes, while the Orthic Blacks are on the north and east-facing slopes and in the lower, more moist areas, especially under clumps of shrubs and trees.

(2) Occasionally the Cca horizon of the Chernozemic soils starts below the depth of 120 cm.

(3) Sand pockets are sometimes found in the B and C horizons of the Chernozemic soils.

(4) The Regosolic soils are found on eroded upper slopes (usually south-facing), and very gravelly knolls (surface stoniness 4).
Limitations: None to slight on suitable topography for primitive camping areas, fully serviced campgrounds, paths, and trails; moderate to severe for road location; fair to poor source of roadfill. Specific limitations are excessive slope, hazard of erosion, susceptibility to frost heave, high clay content of subsoil and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 2

Classification: Orthic Black Chernozemic
Landform: level morainal (Ml), undulating morainal (Mu), inclined morainal (Mi), rolling morainal (Mm), and hummocky morainal (Mh)
Parent Material: moderately fine-textured till
Slope: gently undulating to strongly rolling (>0.5 to 30 percent)
Surface Stoniness: non stony to very stony (0 to 3)
Estimated Drainage: well drained
Vegetation: grass, forbs; patches of wild rose, shrubby cinquefoil, and buckbrush
Profile Description:

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10 - 15	loam	granular	very friable, moist; soft, dry
Bm	15 - 25	loam to clay loam	prismatic, breaking to subangular blocky	friable, moist
BC	6 - 60	clay loam	amorphous	firm to very firm, moist
Cca	at 30 - 100	clay loam	amorphous	firm to very firm, moist

Comments: (1) the soil solum sometimes is nearly stone-free.
(2) Occasional sand or gravel pockets are found in the soil solum.
Limitations: None to slight on suitable topography for primitive camping areas, fully serviced campgrounds, paths, and trails; moderate to severe for road location; fair to poor source of roadfill. Specific limitations are excessive slope, hazard of erosion, susceptibility to frost heave, high clay content of subsoil, and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 3

Classification: Gleyed Black Chernozemic
Landform: level fluvial (Fl) and undulating fluvial (Fu)
Parent Material: medium- to moderately fine-textured fluvial sediments
Slope: gently undulating to undulating (>0.5 to 5 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: imperfectly drained
Vegetation: grass, forested patches; aspen, wild rose, wild gooseberry, buckbrush, some balsam poplar
Profile Description:

Gleyed Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	5	leaf litter	(occurs under forest)	

Map Unit 3 (continued)

Ah	15 - 25	loam	granular	very friable, moist
Bmg	50 - 85	loam to clay loam	amorphous to subangular blocky	very friable to firm, moist
Ccag	at 65 - 100	loam to clay loam	amorphous	friable to firm, moist

Comments: The Bmg horizon consists of layers of loam and clay loam textured materials, varying from 10 to 30 cm thick. Also one or two sand lenses (sand to loamy sand) often occur; these are 8 to 10 cm thick and have amorphous structure and loose consistence when moist.
Limitations: None to slight for paths and trails; moderate for primitive camping areas, fully serviced campgrounds, and road location; fair to poor source of roadfill. Specific limitations are seasonally high groundwater table or surface ponding, susceptibility to frost heave, and moderate shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 4

Classification: Black Solodized Solonetz - 70 percent; Orthic Black Chernozemic - 30 percent (These two soils are intimately and unpredictably associated.)
Landform: level fluvial (Fl), undulating fluvial (Fu), and inclined fluvial (Fi)
Parent Material: medium- to moderately fine-textured fluvial sediments
Slope: gently undulating to strongly sloping (>0.5 to 15 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well drained
Vegetation: grass
Profile Description:

Black Solodized Solonetz

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10 - 15	loam	granular	soft to slightly hard, dry
Ahe	0 - 15	loam	platy	soft to slightly hard, dry
AB	0 - 15	clay loam	subangular blocky	friable, moist
Bnt	30 - 50	clay loam	columnar, breaking to blocky	very firm, moist; very dense
Ccas	at 65 - 75	clay loam	amorphous	firm to very firm, moist

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10 - 15	loam	granular	slightly hard, dry
AB	8 - 18	loam	prismatic, breaking to subangular blocky	slightly hard to hard, dry
Bm	25 - 30	loam to clay loam	prismatic, breaking to subangular blocky	hard, dry

Map Unit 4 (continued)

BC	at 43 - 60+	loam to clay loam	amorphous, breaking to subangular blocky	slightly hard to hard, dry

Comments: (1) The Bnt horizon of the Solodized Solonetz soil exhibits well-formed round tops.
(2) The Cca horizon of the Black Chernozemic soil generally occurs below a depth of 100 cm.

Limitations: (for the Solodized Solonetz soil): Moderate for all uses; fair source of roadfill. Specific limitations are Solonetzic soil, slow permeability (of Bnt horizon), excessive slope, hazard of erosion, moderate shrink-swell potential, and susceptibility to frost heave. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 5

Classification: Orthic Black Chernozemic
Landform: hummocky morainal (Mh)
Parent Material: medium- to moderately fine-textured till containing a high proportion of weathered shale and sandstone
Slope: moderately to strongly rolling (>9 to 30 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well drained
Vegetation: grass; clumps of shrubs in lower, more moist areas: buckbrush, wild rose, saskatoon-berry, wild gooseberry, and hawthorn
Profile Description:

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	12 - 20	loam to clay loam	granular	very friable, moist
Bm	30 - 45	clay loam to silty clay loam	prismatic, breaking to subangular blocky	friable to firm, moist
BC	0 - 35	loam to clay loam or silty clay loam	amorphous	friable to very firm, moist; slightly hard to hard, dry
Cca	at 60 - 100	loam to clay loam or silty clay loam	amorphous	friable to very firm, moist; slightly hard to hard, dry

Limitations: None to slight on suitable topography for primitive camping areas and trails; moderate on suitable topography for fully serviced campgrounds and paths; moderate to severe for road location; fair to poor source of road fill. Specific limitations are excessive slope, erosion hazard, susceptibility to frost heave, and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 6

Classification: Orthic and Dark Gray Luvisol (These two soils are intimately and unpredictably associated.)
Landform: inclined morainal (Mi) and hummocky morainal (Mh)
Parent Material: medium- to moderately fine-textured till containing a high proportion of weathered shale and sandstone
Slope: moderately rolling to hilly (>9 to 60 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well drained
Vegetation: aspen; or mixed forest with aspen, white spruce, and some balsam poplar; understorey consists of wild rose, hawthorn, saskatoon-berry, willow, wild gooseberry, wild red raspberry, and some dogwood

Map Unit 6 (continued)

Profile Description:

Orthic and Dark Gray Luvisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	5 - 8	leaf litter		
Ae or Ahe	7 - 13	loam	platy	very friable, moist
Bt	30 - 50	clay loam	subangular blocky to blocky	firm, moist
BC	0 - 82	loam to clay loam or silty clay loam	amorphous	very friable to very firm, moist
Cca	at 60 - 120	loam to clay loam or silty clay loam	amorphous	very friable to very firm, moist

Comments: (1) The soils with Ahe horizons more than 5 cm thick are classified as Dark Gray Luvisols, while those with Ahe horizons 5 cm or less in thickness are classified as Orthic Gray Luvisols.

(2) Occasional sand lenses (loamy fine sand) are found in the Cca horizon and are generally about 15 cm thick, have amorphous structure, and loose consistence when moist.

Limitations: None to slight on suitable topography for primitive camping areas and trails; moderate on suitable topography for fully serviced campgrounds and paths; moderate to severe for road location; fair to poor source of roadfill. Specific limitations are excessive slope, erosion hazard, susceptibility to frost heave, and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 7

Classification: Orthic Black Chernozemic - 70 percent; Black Solodized Solonetz - 30 percent (These two soils are intimately and unpredictably associated.)
Landform: hummocky morainal (Mh)
Parent Material: till containing a high proportion of weathered sandstone and shale; predominantly medium- to moderately fine-textured, also pockets of moderately fine to fine-textured and very coarse-textured
Slope: strongly rolling (>15 to 30 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: predominantly well drained, pockets of rapidly drained
Vegetation: grass, sagebrush; also in numerous low areas and coulees clumps of hawthorn, saskatoon-berry, wild rose, buck-brush, wild gooseberry, and some wolf willow
Profile Description:

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	13	loam or silty loam to clay loam	granular	very friable, moist
Bm	18 - 38	loam to clay loam or silty clay loam	prismatic, breaking to subangular blocky	very friable to firm, moist
BC	0 - 20	loam to clay loam or silty clay loam	subangular blocky	friable to firm, moist

Map Unit 7 (continued)

Cca	at 50	loam to clay loam or silty clay loam	amorphous, breaking to subangular blocky	friable to very firm, moist; slightly hard to hard, dry

Orthic Black Chernozemic (sandy phase)

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10	loam to sandy loam	granular	very friable, moist
Bm	15 - 50	loam to sandy loam	prismatic, breaking to subangular blocky	very friable to firm, moist
BC	at 25 - 60	loamy sand to sand	amorphous	loose, dry or moist

Black Solodized Solonetz (eroded phase)

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	0 - 13	loam	granular	very friable, moist
Ae or AB	0 - 25	loam to silty clay loam	platy to sub-angular blocky	very friable, moist; slightly hard, dry
Bnt	13	clay loam to silty clay	blocky	very firm, moist; very hard, dry; very dense
Ccasa	at 13 - 50	clay loam to silty clay	amorphous	soft, dry to very firm, moist

Comments: (1) The BC and Cca horizons of the Orthic Black Chernozemics often contain numerous fragments of sandstone and shale.

(2) The sandy phases of Orthic Black Chernozemics are found on sandy mounds or hills, which occur sporadically. The Cca horizons in these soils are found at depths of more than 120 cm.

Limitations: (for the Orthic Black Chernozemics): Moderate for primitive camping areas and trails; severe for fully serviced campgrounds and paths; moderate to severe for road location; fair to poor source of roadfill. Specific limitations are excessive slope, erosion hazard, susceptibility to frost heave, and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture. The Black Solodized Solonetz soils have the same limitations, along with the additional limitations attributable to Solonetzic soils of a higher susceptibility to erosion and the slow permeability of the Bnt horizon.

Map Unit 8

Classification: Orthic Dark Brown Chernozemic (eroded phase) - 70 percent; Orthic Regosol - 30 percent
Landform: inclined morainal (Mi) and hummocky morainal (Mh)
Parent Material: very coarse to fine-textured till containing a high proportion of weathered shale and sandstone
Slope: strongly rolling to very steeply sloping (>15 to 60 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well drained
Vegetation: grass, scattered sagebrush; clumps of hawthorn, saskatoon-berry, wild rose, and wild gooseberry in lower more moist areas

Map Unit 8 (continued)

Profile Description:

Orthic Dark Brown Chernozemic (eroded phase)

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	2 - 5	loam to clay loam or silty clay loam	granular	very friable, moist; slightly hard, dry
Bm	10 - 20	loam to silty clay	subangular blocky	slightly hard, dry to very firm, moist
Cca	at 15 - 25	loamy fine sand to silty clay	amorphous to subangular blocky	loose, dry or moist to soft and slightly hard, dry and very firm, moist

Orthic Regosol

Horizon	Thickness cm	Field Texture	Structure	Consistence
Cca	0+	loamy fine sand to silty clay	amorphous to subangular blocky	loose, dry or moist to soft and slightly hard, dry and very firm, moist

Comments: (1) The Orthic Regosol soils are found mainly on dry, steep eroded, south-facing slopes.
(2) The Cca horizons are layers and pockets of highly variable textured materials.

Limitations: Moderate to severe for all uses; fair to poor source of roadfill. Specific limitations are excessive slope, high clay content, erosion hazard, slippery or sticky when wet, susceptibility to frost heave, and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 9

Classification: Orthic Black Chernozemic - 80 percent; Eluviated Black Chernozemic - 20 percent. (These two soils are intimately and unpredictably associated. The Orthic Blacks, however, predominate throughout the map unit 9 soil areas, whereas the Eluviated Blacks are only occasionally found.)
Landform: eolian veneer overlying level fluvial (Ev/Fl), eolian veneer overlying undulating fluvial (Ev/Fu), and eolian veneer overlying inclined fluvial (Ev/Fi)
Parent Material: medium- to moderately fine-textured loess overlying moderately fine- to fine-textured, very gravelly fluvial sediments
Slope: very gently sloping and gently undulating to steeply sloping (>0.5 to 30 percent)
Surface Stoniness: non stony to slightly stony (0 to 1)
Estimated Drainage: well drained
Vegetation: grass, shrubby cinquefoil, wild rose, buckbrush, abundant forbs; also some scattered small clumps of aspen, wild rose, and wild red raspberry (These are generally found near the boundaries of map unit 9 soil areas.)
Profile Description:

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	2 -5	leaf litter	(occurs under aspen)	
Ah	15 - 25	silt loam	granular	very friable, moist; slightly hard, dry

Map Unit 9 (continued)

Bm1	10 - 35	silt loam	prismatic, breaking to subangular blocky	very friable, moist; slightly hard, dry
Bm2	20 - 40	silt loam to clay loam (often gravelly to very gravelly)	prismatic, breaking to subangular blocky	friable to firm, moist
BC	at 55 - 90	very gravelly clay loam to clay	amorphous	very firm, moist

Eluviated Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	2 - 5	leaf litter	(occurs under aspen)	
Ah	15 - 25	silt loam	granular	very friable moist; slightly hard, dry
Ahe	10 - 35	silt loam	prismatic, breaking to platy	very friable, moist; slightly hard, dry
Bt	20 - 40	clay loam (often gravelly to very gravelly)	subangular blocky	firm to very firm, moist
BC	at 55 - 90	very gravelly clay loam to clay	amorphous	very firm, moist

Comments: (1) The average thickness of loess overlying the fluvial sediments is 50 to 75 cm and the soil profile is generally somewhat gravelly with small rounded pebbles, for about 25 to 35 cm above the fluvial sediments. Occasionally, the fluvial sediments begin only a few centimetres below the surface, and in some areas are 90 to 120 cm or even more below the surface.
(2) The depth to lime (Cca horizon) is nearly always greater than 120 cm.

Limitations: Moderate on suitable topography for primitive camping areas, fully serviced campgrounds, paths and trails; moderate to severe for road location. Fair to poor source of roadfill. Specific limitations are slippery or sticky when wet, high clay content, slow permeability, excessive slope (in some areas), erosion hazard, susceptibility to frost heave, and high shrink-swell potential. Good source of gravel in areas where the gravel is not cemented.

Map Unit 10

Classification: Orthic Eutric Brunisol
Landform: inclined fluvial (Fi) and hummocky fluvial (Fh)
Parent Material: very coarse-textured fluvial sediments (gravel)
Slope: strongly rolling to hilly (>15 to 60 percent)
Surface Stoniness: exceedingly stony (5)
Estimated Drainage: very rapidly drained
Vegetation: lodgepole pine, occasional white spruce; sparse understorey consisting of ground juniper, common bearberry, wild rose, Canadian buffaloberry, and venus' slipper

Map Unit 10 (continued)

Profile Description:

Orthic Eutric Brunisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	2 - 5	leaf litter	(predominantly pine needles)	
Bm	40 - 50+	gravel	amorphous	loose, dry or moist
Cca	at 40 - 50+	gravel	amorphous	loose, dry or moist

Comments: (1) The L-H horizon is very fragile, and readily broken down and destroyed under foot traffic.
(2) The Cca horizon is commonly 50 cm or deeper.

Limitations: Moderate to severe for primitive camping areas and trails; severe for fully serviced campgrounds, paths, and road location; fair to poor source of roadfill. Specific limitation is excessive slope. Good source of gravel.

Map Unit 11

Classification: Orthic Gray Luvisol
Landform: eolian veneer overlying level fluvial (Ev/Fl), eolian veneer overlying undulating fluvial (Ev/Fu), eolian veneer overlying inclined fluvial (Ev/Fi), and eolian veneer overlying hummocky fluvial (Ev/Fh)
Parent Material: moderately coarse-textured loess overlying moderately fine- to fine-textured very gravelly fluvial sediments
Slope: very gently sloping to moderately rolling and steeply sloping (>0.5 to 30 percent)
Surface Stoniness: slightly to moderately stony (1 to 2)
Estimated Drainage: well drained
Vegetation: lodgepole pine; very sparse understorey consisting of common bearberry, grass, and wild rose
Profile Description:

Orthic Gray Luvisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	1 - 3	leaf litter	(predominatly pine needles)	
Ae	10 - 25	fine sandy loam	platy	very friable, moist; slightly hard, dry
Bt	25 - 40+	clay loam in gravel	subangular blocky	firm, moist

Comments: (1) Very few rounded pebbles occur in the upper Bt horizon; however, the concentration increases with increasing depth, and it is seldom possible to dig deeper than 50 cm, because of the gravelly nature of the parent material.
(2) Lime (Cca horizon) is not found within the 50 cm depth in the soil profile.
(3) A small percentage of Dark Gray Luvisol soils is found associated with map unit 11 soils in which an Ah horizon, from 2.5 to 7.5 cm thick, is found. These soils are usually found in transitional areas between areas of map units 9 and 11.

Map Unit 12

Classification: Orthic Gray Luvisol - 80 percent; Dark Gray Luvisol - 20 percent (These two soils are intimately and unpredictably associated.)
Landform: inclined morainal (Mi) and hummocky morainal (Mh)
Parent Material: moderately fine-textured till
Slope: moderately sloping and gently rolling to hilly (>5 to 60 percent)
Surface Stoniness: non stony to moderately stony (0 to 2)
Estimated Drainage: well drained
Vegetation: mostly aspen and white spruce, patches of lodgepole pine; understorey consists of wild rose, wild red raspberry, Canadian buffaloberry, and saskatoon-berry

Map Unit 12 (continued)

Profile Description:

Orthic Gray Luvisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	2 - 5	leaf litter		
Ae	7 - 10	loam to fine sandy loam	platy	very friable, moist
Bt	30 - 40	clay loam	subangular blocky to blocky	firm, moist
BC	12 - 88	clay loam	amorphous	firm to very firm, moist
Cca	at 50 - 125	clay loam	amorphous	firm to very firm, moist

Dark Gray Luvisol

Comments: This soil has the same profile description as the Orthic Gray Luvisol soil except that an Ah horizon is present (2.5 to 7.5 cm thick, loam texture, granular structure, and very friable consistence when moist), and the Ae horizon immediately below is only 2.5 to 5 cm thick; or instead of Ah and Ae horizons, an Ahe horizon is found (10 cm in thickness, loam texture, platy structure, and very friable consistence when moist).
Limitations: None to slight on suitable topography for primitive camping areas, fully serviced campgrounds, paths, and trails; moderate to severe for road location; fair to poor source of roadfill. Specific limitations are excessive slope, erosion hazard, high clay content of subsoil, susceptibility to frost heave, and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 13

Classification: Orthic Black Chernozemic
Landform: undulating fluvial (Fu), inclined fluvial (Fi), rolling fluvial (Fm), and hummocky fluvial (Fh)
Parent Material: very coarse-textured fluvial sediments (gravel)
Slope: undulating to strongly rolling ($>$2 to 30 percent)
Surface Stoniness: slightly to excessively stony (1 to 5)
Estimated Drainage: very rapidly drained
Vegetation: grass, forbs, shrubby cinquefoil, wild rose
Profile Description:

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10 - 15	loam	granular	very friable, moist; slightly hard, dry
Bm	10 - 20	gravelly loam	prismatic, breaking to subangular blocky	very friable, moist; slightly hard, dry
BC	at 20 - 30	gravel	amorphous	loose, moist or dry

Comments: Lime (Cca horizon) does not occur within 50 cm of the soil surface, and it is extremely difficult to dig any deeper.
Limitations: None to slight on suitable topography for all uses; good source of roadfill and gravel. Specific limitations are excessive slope and erosion hazard.

Map Unit 14

Classification: Black Solod - 70 percent; Orthic Black Chernozemic - 30 percent
Landform: inclined fluvial (Fi)
Parent Material: medium- to moderately fine-textured fluvial sediments
Slope: moderately sloping (>5 to 9 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well drained
Vegetation: grass, scattered sagebrush
Profile Description:

Black Solod

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	15	loam	granular	slightly hard, dry
AB	20	loam	prismatic, breaking to subangular blocky	hard, dry
Bnt	35	clay loam	columnar, breaking to blocky	very hard, dry; very firm, moist
Cca	at 70	clay loam	amorphous	very firm, moist

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10 - 15	loam	granular	slightly hard, dry
AB	8 - 18	loam	prismatic, breaking to subangular blocky	slightly hard to hard, dry
Bm	25 - 30	loam to clay loam	prismatic, breaking to subangular blocky	hard, dry
BC	at 43 - 60+	loam to clay loam	amorphous, breaking to subangular blocky	slightly hard to hard, dry

Comments: The Cca horizon of the Black Chernozemic soils generally occurs below a depth of 100 cm.
Limitations: None to slight for primitive camping areas, fully serviced campgrounds, paths, and trails; moderate for road location; fair source of roadfill. Specific limitations are moderate shrink-swell potential and susceptibility to frost heave. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 15

Classification: Gleyed Black Chernozemic - 70 percent; Gleyed Eutric Brunisol - 30 percent
Landform: level fluvial (Fl)
Parent Material: medium- to moderately fine-textured fluvial sediments overlying gravel
Slope: gently undulating (>0.5 to 2 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: imperfectly drained

Map Unit 15 (continued)

Vegetation: grass with patches of shrubs and trees; shrubs include shrubby cinquefoil, wolf willow and buckbrush; forest clumps include aspen, balsam poplar, white spruce, hawthorn, saskatoon-berry, willow, wild gooseberry, wild rose, wild mint, and horsetail
Profile Description:

Gleyed Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10 - 20	loam	granular	very friable, moist
Bmg	30 - 70	loam to clay loam	amorphous to subangular blocky	very friable to firm, moist
Ccag	at 40 - 90	gravel	amorphous	loose, dry or moist

Gleyed Eutric Brunisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	2 - 5	leaf litter	(under forest)	
Ah	2 - 5	loam	granular	very friable, moist
Bmg	38 - 85	loam to clay loam	amorphous to subangular blocky	very friable to firm, moist
Ccag	at 40 - 90	gravel	amorphous	loose, dry or moist

Comments: Sand lenses (sand to loamy sand) occasionally found in the Bmg horizons of these soils are 2 to 8 cm thick, have amorphous structure, and have loose consistence when dry or moist.
Limitations: None to slight for paths and trails; moderate for primitive camping areas, fully serviced campgrounds, and road location; high groundwater table or surface ponding. Good source of gravel.

Map Unit 16

Classification: Orthic Gray Luvisol
Landform: fluvial veneer overlying inclined morainal (Fv/Mi), and fluvial veneer overlying hummocky morainal (Fv/Mh)
Parent Material: moderately fine-textured gravelly fluvial sediments overlying medium- to fine-textured till containing a high proportion of weathered shale and sandstone
Slope: moderately sloping to hilly (>5 to 60 percent)
Surface Stoniness: very stony to exceedingly stony (3 to 5)
Estimated Drainage: well drained
Vegetation: mainly lodgepole pine, a few aspen and white spruce; sparse understorey of grass and wild rose
Profile Description:

Orthic Gray Luvisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	2 - 5	leaf litter	(mostly pine needles)	
Ae	5 - 15	loam to fine sandy loam	platy	very friable, moist
Bt	25 - 40	clay loam to clay in gravel	subangular blocky	firm, moist

Map Unit 16 (continued)

BC	35 - 70	clay loam to silty clay	amorphous, breaking to subangular blocky	very firm, moist; very hard, dry
Cca	at 52 - 125+	loam to silty clay loam or clay loam	amorphous	very friable to very firm, moist

Comments: (1) The occasional sand lense (loamy fine sand) found in the Cca horizon is generally about 15 cm thick, has an amorphous structure, and has loose consistence when moist.

(2) The gravelly layer occasionally is found in the BC and Cca horizons beginning about 25 to 50 cm below the surface and ranging from 20 to 50 cm in thickness. In these instances, the Bt horizon is generally somewhat finer textured (silty clay to clay), while the gravelly layer generally has the same texture as indicated for the Bt horizon in the preceding profile description.

(3) The L-H horizon is very fragile and readily broken down and destroyed under foot traffic.

Limitations: Moderate on suitable topography for primitive camping areas, fully serviced campgrounds, paths, and trails; moderate to severe for road location; fair to poor source of roadfill. Specific limitations are high clay content and slow permeability of subsoil, erosion hazard, excessive slope, susceptibility to frost heave, and high shrink-swell potential. Poor source of gravel because of a thin deposit of gravel having an undesirable texture, and also because of the unsuitable texture of the remainder of the parent material.

Map Unit 17

Classification: Gleyed Regosol - 70 percent; Gleyed Rego Black Chernozemic - 30 percent (These two soils are intimately and unpredictably associated.)
Landform: level fluvial (Fl)
Parent Material: medium- to moderately fine-textured fluvial sediments
Slope: gently undulating (>0.5 to 2 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: imperfectly drained
Vegetation: predominantly grass; clumps of forest consisting of white spruce, balsam poplar, aspen, willow, wild rose, wild gooseberry, and cow parsnip
Profile Description:

Gleyed Regosol

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ccag	at 0+	loam to clay loam	amorphous to subangular blocky	very friable to firm, moist

Gleyed Rego Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	25	loam	granular	very friable, moist
Ccag	at 25	loam to clay loam	amorphous, breaking to subangular blocky	very friable to firm, moist

Comments: (1) Occasional sand lenses (loamy sand) found in the soil profiles are from 5 to 13 cm thick, have amorphous structure, and a loose consistence when dry or moist.

(2) Carbonated phases of the Chernozemic soils are occasionally found with Ahk horizons (lime to the surface).

Limitations: None to slight for paths and trails; moderate for primitive camping areas, fully serviced campgrounds, and road location; fair source of roadfill. Specific limitations are seasonally high groundwater table or surface ponding, moderate shrink-swell potential, and susceptibility to frost heave. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 18

Classification: Orthic Dark Brown Chernozemic (eroded and lithic phases)
Landform: morainal veneer and blanket overlying inclined rock (Mvb/Ri)
Parent Material: medium- to moderately coarse-textured till containing a high proportion of weathered sandstone, overlying sandstone
Slope: steeply sloping (>15 to 30 percent)
Surface Stoniness: moderately stony (2)
Estimated Drainage: well to rapidly drained
Vegetation: grass, forbs, scattered wolf willow, and buckbrush, patches of wild rose and saskatoon-berry in lower, more moist areas
Profile Description:

Orthic Dark Brown Chernozemic
(eroded and lithic phases)

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	5 - 8	loam to sandy loam	granular	very friable, moist
Bm	7 - 40	loam to sandy loam	prismatic, breaking to subangular blocky; or amorphous	very friable to loose, moist slightly hard to loose, dry
BC	0 - 75	sandy loam	amorphous	very friable, moist
Cca	at 15 - 125	loam to sandy loam	amorphous	very friable, moist
II Cca	at 45 - 125	sandstone		

Comments: Sandstone occurs near the soil surface at the tops of slopes and much deeper at the bases of slopes.
Limitations: Moderate for trails; moderate to severe for primitive camping areas; severe for fully serviced campgrounds, paths, and road location; fair source of roadfill. Specific limitations are excessive slope, erosion hazard, and shallow depth to bedrock. Unsuitable as a source of gravel because of unsuitable texture.

Map Unit 19

Classification: Eluviated Dystric Brunisol
Landform: inclined morainal (Mi) and hummocky morainal (Mh)
Parent Material: moderately coarse -to very coarse-textured till containing a high proportion of weathered sandstone
Slope: hilly (>30 to 60 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well to rapidly drained
Vegetation: predominantly aspen and white spruce, some lodgepole pine; understorey consists of wild rose, wild gooseberry, grass and forbs
Profile Description:

Eluviated Dystric Brunisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
L-H	5	leaf litter		
Ae	2 - 8	fine sandy loam	platy	very friable, moist

Map Unit 19 (continued)

Btj	40	loam to sandy clay loam	subangular blocky	friable to firm, moist
BC	at 45 - 120	sandy loam to loamy sand	amorphous	very friable to loose moist

Limitations: Severe for all uses; poor source of roadfill. Specific limitations are excessive slope and erosion hazard. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 20

Classification: Orthic Dark Brown Chernozemic (eroded phase) - 60 percent; Orthic Regosol - 40 percent
Landform: hummocky morainal (Mh)
Parent Material: medium- to moderately fine-textured till containing a high proportion of weathered sandstone and shale
Slope: strongly rolling (>15 to 30 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well drained
Vegetation: mainly grass; and in lower more moist areas a few clumps of buckbrush, wild rose, saskatoon-berry, wild gooseberry, hawthorn, and sometimes aspen and white spruce
Profile Description:

Orthic Dark Brown Chernozemic
(eroded phase)

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	5 - 8	loam to sandy loam	granular	very friable, moist
Bm	25	clay loam	prismatic, breaking to subangular blocky	friable to firm, moist
Cca	at 30	loam to clay loam	amorphous	very friable to very firm, moist; slightly hard to very hard, dry

Orthic Regosol

Horizon	Thickness cm	Field Texture	Structure	Consistence
Cca	at 0	loam to clay loam	amorphous	very friable to very firm, moist; slightly hard to very hard, dry

Comments: (1) Occasional sand lenses (loamy fine sand) found in the Cca horizons of both these soils are generally about 15 cm thick, have amorphous structure, and a loose consistence when moist.
(2) The Regosolic soils are found on severely eroded upper slopes and knolls.
Limitations: Moderate for primitive camping areas and trails; severe for fully serviced campgrounds and paths; moderate to severe for road location; fair to poor source of roadfill. Specific limitations are excessive slope, erosion hazard, susceptibility to frost heave, and high shrink-swell potential. Unsuitable as a source of sand or gravel because of unsuitable texture.

Map Unit 21

Classification: Orthic Black Chernozemic
Landform: undulating fluvial (Fu)
Parent Material: medium- to moderately coarse-textured fluvial sediments
Slope: undulating (>2 to 5 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: well drained
Vegetation: grass
Profile Description:

Orthic Black Chernozemic

Horizon	Thickness cm	Field Texture	Structure	Consistence
Ah	10 - 15	loam	granular	slightly hard, dry
AB	8 - 18	loam	prismatic, breaking to subangular blocky	slightly hard to hard, dry
Bm	25 - 30	loam to clay loam	prismatic, breaking to subangular blocky	hard, dry
BC	at 43 - 60	loam to clay loam	amorphous, breaking to subangular blocky	slightly hard to hard, dry

Limitations: None to slight for primitive camping areas, fully serviced campgrounds, paths, and trails; moderate for road location; fair source of roadfill. Specific limitations are moderate shrink-swell potential and susceptibility to frost heave. Unsuitable as a source of sand or gravel because of unsuitable texture.

TH (Organic Soil)

Classification: Terric Humisol
Landform: horizontal fen overlying level fluvial (Nh/Fl)
Parent Material: well-decomposed peat overlying medium- to moderately fine-textured fluvial sediments
Slope: very gently sloping (>0.5 to 2 percent)
Surface Stoniness: non stony (0)
Estimated Drainage: very poorly drained
Vegetation: mainly slough grass; numerous clumps of willow and horsetail; occasional patch of white spruce, willow, and swamp birch
Profile Description:

Terric Humisol

Horizon	Thickness cm	Field Texture	Structure	Consistence
Om	20	intermediately decomposed peat		
Oh	100 - 125	predominantly well-decomposed peat		
II C	at 120 - 145	loam to clay loam	amorphous	very friable to firm, moist

Comments: (1) Occasional sand lenses (sand to loamy sand) found in the II C material are 8 to 10 cm thick, have amorphous structure, and have loose consistence when moist.

(2) Surface water often occurs in these soil areas because the depth to water table ranges from above ground level to 60 cm below the surface.

(3) The peat gradually becomes thinner towards the boundaries of these soil areas and may be as little as 5 cm near the boundaries. The soils are then classified as Rego Gleysols developed on fluvial sediments (Ccag horizon), as described for the II C horizon in the preceding profile description.

Limitations: Severe for all uses; unsuitable as a source of roadfill, sand, or gravel. Specific limitations are Organic soil, seasonally high groundwater table or surface ponding, susceptibility to frost heave, and high shrink-swell potential.

MISCELLANEOUS LAND TYPES

 This symbol indicates small wet or water-filled depressions, characterized by the growth of hydrophytic vegetation, mainly slough grass. The soils were not classified in these areas; however, Gleysols generally are found, and they usually have thin organic surface layers about 5 to 15 cm thick. These soils have severe limitations for all uses due to seasonally high groundwater tables and surface ponding.

G This symbol indicates groundwater discharge areas. They are very small localized wet areas which may range from 30 to 100 m in diameter. The water table is at or slightly below the soil surface and the vegetation is hydrophytic, mainly slough grass and willow. The soils were not classified in these areas; however, Gleysols may be expected. They have severe limitations for all uses because of their extreme wetness.

 This symbol indicates escarpments. They have severe limitations for all uses because of extreme slopes.

SOIL INTERPRETATIONS

Soil interpretations, which predict soil performance under different uses, are based on evaluation of the soil to a depth of about 100 cm, although some interpretations can be made below the 150 cm depth. These interpretations are made largely from soil descriptions and observations made during the field soil mapping program. Only surface and shallow subsurface soil samples were collected for routine chemical analyses, and only limited numbers of deeper subsurface samples were collected for engineering tests. Engineering properties of some map units sampled were extrapolated to other map units not sampled, where soils of the different map units were developed on like or very similar parent materials.

It is important that these soil interpretations be viewed in the proper perspective. Other factors, such as location, aesthetic values, and nearness to population centres are not considered. A soil survey properly interpreted is a useful guide for general recreation planning and in site selection; however, all soil differences found in the field cannot be shown on the soil map. Thus, before designing and constructing specific recreational facilities, on-site investigation is usually required.

Soil interpretations are not recommendations for land-use, and do not eliminate the need for land-use planning. The interpretations are, however, valuable tools that indicate to the planner limitations and suitabilities of various soils for particular uses. The planner can use the interpretations to help predict the type and degree of problems likely to be encountered, and can plan appropriate on-site investigations to determine corrective measures. By using a soil survey map and accompanying soil interpretations, the planner can considerably reduce the number of on-site investigations.

From the basic soil survey data of an area, performance predictions can be made based on field soil morphology and the laboratory determined soil physical and chemical properties. Soils in the provincial parks are used mainly for recreational pursuits and building sites, and as road construction materials.

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

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

2. A *moderate* soil limitation is the rating given soils that have properties moderately favorable for the rated use. This degree of limitation can be overcome or modified by special planning, design, or maintenance. During some part of the year, the performance of the planned use is somewhat less desirable than for soils rated slight. For soils rated moderate, a treatment, such as artificial drainage, runoff control to reduce erosion, extended sewage absorption fields, extra excavation, or some modification, is needed for construction plans generally used for soils of slight limitation. Modification may include special foundations, extra reinforcement of structures, sump pumps, and the like.

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

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

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

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

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

Soils in the Cypress Hills well suited for recreational use include those of map units 1, 2, 5, 6, 11, 12, 13, 14, and 21 when found on suitable topography. Soils of map units 1, 2, 6, and 11 are all widespread; however, with the exception of soils of map unit 11, most have moderate to severe limitations because of steep slopes and a soil erosion hazard. More extensive areas of map unit 11 soils occur on suitable topography. Soils of other widespread map units have moderate to severe limitations for recreational use. Those of map unit 9, which cover most of the Cypress Hills plateau, are slippery and sticky when wet, have a high clay content, and are slowly permeable. The main limitation of map unit 10 soils, aside from stoniness, is steep slopes. Limitations of map unit 16 soils are steep slopes, high clay content, slow permeability, and erosion hazard.

The soils most suitable for road construction purposes are those of map unit 13. Factors limiting soils of most other map units are steep slopes, high clay content, moderate to high shrink-swell potential, and susceptibility to frost heave. The soils of map units 9, 10, 11, 13, and 15 constitute good sources of gravel. Unsuitable textures render most others unsuitable.

The most prevalent limitations throughout the Cypress Hills, with the exception of the plateau, are steep slopes and erosion hazard. Other limitations not already mentioned, which affect the suitabilities of various soils, are seasonally high groundwater table or surface ponding, Solonetzic soils, shallow depth to bedrock; and one map unit is comprised of Organic soils.

Details of limitations and suitabilities are outlined in the map unit descriptions, as well as in tables 4 to 10. 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 and are generally listed in decreasing order of importance.

Once the slope becomes steep enough to render a severe limitation for a specified use, that limitation is not further subdivided. The steeper the slope, however, the more severe the limitation - something to consider when using the soil interpretation tables. In tables 4 to 8, the soil limitations for various uses have been designated as none to slight, moderate, and severe. In tables 9 and 10, the soil suitabilities as sources of roadfill and as sources of sand or gravel respectively, have been designated as good, fair, poor, and unsuitable.

TABLE 4
Soil limitations for primitive camping areas[1]

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
1/d3, 1/e1, 1/e3	NL		
1/f2, 1/f3		Slope Er	
1/G2			
2/b1, 2/c1, 2/D0, 2/d0, 2/D1, 2/d1, 2/E1, 2/e1, 2/e2	NL		
2/f2, 2/f3		Slope Er	
3/b0, 3/c0		Wet	
4/B0, 4/c0, 4/D0, 4/E0		Solz S1 Perm Er	
5/e0	NL		
5/f0		Slope Er	

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
6/e0	NL		
6/f0		Slope Er	
6/g0			
7/f0		Slope Er	
8/f0		Slope Clay Er	
8/G0		Clay	Slope Er
9/B0, 9/b0, 9/C0, 9/c0, 9/D0, 9/E0, 9/E1		Slip Clay S1 Perm	
9/F0		Slope Slip Clay	
10/f5		Slope	
10/g5			Slope

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

[2]For explanation, see section entitled SOILS.

TABLE 4
Soil limitations for primitive camping areas[1] (continued)

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
11/B2, 11/C1, 11/C2, 11/c2, 11/D1, 11/E1, 11/e1	NL		
11/F1		Slope, Er	
12/D2, 12/d2	NL		
12/f1, 12/f2		Slope, Er	
12/g0			Slope, Er
13/c1, 13/c3, 13/c5, 13/d3	NL		
13/F1, 13/f3, 13/f4, 13/f5		Slope, Er	
14/D0	NL		
15/b0		Wet	
16/D3		S1 Perm, Er, Clay	
16/f3, 16/f4, 16/f5		Slope, S1 Perm, Er	
16/g3, 16/g4, 16/g5			Slope, S1 Perm, Er
17/b0		Wet	
18/F2		Slope, Er	BR
19/g0			Slope, Er
20/f0		Slope, Er	
21/c0	NL		
Th/B0			Org, Wet

ABBREVIATIONS

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
NL - No limitations
Org - Organic soil
Slip - Slippery or sticky when wet
Slope - Excessive slope
S1 Perm - Slow permeability
Solz - solonetzic soil
Wet - Seasonally high groundwater table or surface ponding

TABLE 5
Soil limitations for fully serviced campgrounds[1]

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
1/d3	NL		
1/e1, 1/e3		Slope Er	
1/f2, 1/f3, 1/G2			Slope Er
2/b1, 2/c1, 2/D0 2/d0, 2/D1, 2/d1	NL		
2/E1, 2/e1, 2/e2		Slope Er	
2/f2, 2/f3			Slope Er
3/b0, 3/c0		Wet	
4/B0, 4/c0, 4/D0		Solz S1 Perm Er	
4/E0		Slope Solz Er	
5/e0		Slope Er	
5/f0			Slope Er
6/e0		Slope Er	
6/f0, 6/g0			Slope Er
7/f0			Slope Er
8/f0, 8/G0		Clay	Slope Er
9/B0, 9/b0, 9/C0 9/c0, 9/D0		Slip Clay S1 Perm	
9/E0, 9/E1		Slope Slip Clay	
9/F0		Clay	Slope Slip
10/f5, 10/g5			Slope
11/B2, 11/C1, 11/C2 11/c2, 11/D1	NL		
11/E1, 11/e1		Slope Er	
11/F1			Slope Er
12/D2, 12/d2	NL		
12/f1, 12/f2, 12/g0			Slope Er
13/c1, 13/c3, 13/c5 13/d3	NL		
13/F1, 13/f3, 13/f4 13/f5			Slope Er

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

[2]For explanation, see section entitled SOILS.

TABLE 5
Soil limitations for fully serviced campgrounds[1] (continued)

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
14/D0	NL		
15/b0		Wet	
16/D3		S1 Perm Er Clay	
16/f3 16/f4 16/f5 16/g3 16/g4 16/g5			Slope S1 Perm Er
17/b0		Wet	
18/F2			Slope BR Er
19/g0			Slope Er
20/f0			Slope Er
21/c0	NL		
TH/B0			Org Wet

ABBREVIATIONS
BR - Shallow depth of Bedrock
Clay - High clay content
Er - Erosion hazard
NL - No limitations
Org - Organic soil
Slip - Slippery or sticky when wet
Slope - Excessive slope
S1 Perm - Slow permeability
Solz - Solonetzic Soil
Wet - Seasonally high groundwater table or surface ponding

TABLE 6
Soil limitations for paths[1]

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
1/d3	NL		
1/e1 1/e3		Slope Er	
1/f2 1/f3 1/G2			Slope Er
2/b1 2/c1 2/D0 2/d0 2/D1 2/d1	NL		
2/E1 2/e1 2/e2		Slope Er	
2/f2 2/f3			Slope Er
3/b0 3/c0	NL		
4/B0 4/c0 4/D0		Solz Er	
4/E0		Slope Solz Er	
5/e0		Slope Er	
5/f0			Slope Er
6/e0		Slope Er	
6/f0 6/g0			Slope Er
7/f0			Slope Er
8/f0 8/G0		Clay	Slope Slip

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

[2]For explanation, see section entitled SOILS.

TABLE 6
Soil limitations for paths[1] (continued)

Map Symbol[2]	None to Slight	Moderate	Severe
9/B0 9/b0 9/C0 9/c0 9/D0		Slip Clay Er	
9/E0 9/E1		Slope Slip Clay	
9/F0		Clay	Slope Slip
10/f5 10/g5			Slope
11/B2 11/C1 11/C2 11/c2 11/D1	NL		
11/E1 11/e1		Slope Er	
11/F1			Slope Er
12/D2 12/d2	NL		
12/f1 12/f2 12/g0			Slope Er
13/c1 13/c3 13/c5 13/d3	NL		

Map Symbol[2]	None to Slight	Moderate	Severe
13/F1 13/f3 13/f4 13/f5			Slope Er
14/D0	NL		
15/b0	NL		
16/D3		Er Clay	
16/f3 16/f4 16/f5 16/g3 16/g4 16/g5			Slope Er Clay
17/b0	NL		
18/F2			Slope Er
19/g0			Slope Er
20/f0			Slope Er
21/c0	NL		
TH/B0			Org Wet

ABBREVIATIONS
Clay - High clay content
Er - Erosion Hazard
NL - No limitations
Org - Organic Soil
Slip - Slippery or sticky when wet
Slope - Excessive slope
Solz - Solonetzic soil
Wet - Seasonally high groundwater table or surface ponding.

TABLE 7
Soil limitations for trails[1]

Map Symbol[2]	None to Slight	Moderate	Severe
1/d3, 1/e1, 1/e3	NL		
1/f2, 1/f3		Slope Er	
1/G2			Slope Er
2/b1, 2/c1, 2/D0, 2/d0, 2/D1, 2/d1, 2/E1, 2/e1, 2/e2	NL		
2/f2, 2/f3		Slope Er	
3/b0, 3/c0	NL		
4/B0, 4/c0, 4/D0, 4/E0		Solz Er	
5/e0	NL		
5/f0		Slope Er	
6/e0	NL		
6/f0		Slope Er	
6/g0			Slope Er
7/f0		Slope Er	
8/f0		Slope Clay Slip	
8/G0		Clay	Slope Slip
9/B0, 9/b0, 9/C0, 9/c0, 9/D0, 9/E0, 9/E1		Slip Clay Er	
9/F0		Slope Slip Clay	
10/f5		Slope	
10/g5			Slope
11/B2, 11/C1, 11/C2, 11/c2, 11/D1, 11/E1, 11/e1	NL		
11/F1		Slope Er	
12/D2, 12/d2	NL		
12/f1, 12/f2		Slope Er	
12/g0			Slope Er
13/c1, 13/c3, 13/c5, 13/d3	NL		

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

[2]For explanation, see section entitled SOILS.

TABLE 7
Soil limitations for trails[1] (continued)

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
13/F1 13/f1 13/f4 13/f5		Slope Er	
14/D0	NL		
15/b0	NL		
16/D3		Er Clay	
16/f3 16/f4 16/f5		Slope Er Clay	
16/g3 16/g4 16/g5			Slope Er Clay
17/b0	NL		
18/F2		Slope Er	
19/g0			Slope Er
20/f0		Slope Er	
21/c0	NL		
TH/B0			Org Wet

ABBREVIATIONS

Clay - High clay content
Er - Erosion hazard
NL - No limitations
Org - Organic soil
Slip - slippery or sticky when wet
Slope - Excessive slope
Solz - Solonetzic soil
Wet - Seasonally high groundwater table or surface ponding

TABLE 8
Soil limitations for road location[1]

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
1/d3		Frost Clay	Sh-Sw
1/e1 1/e3		Frost Slope	Sh-Sw
1/f2 1/f3 1/G2		Frost	Slope Sh-Sw
2/b1 2/c1 2/D0 2/d0 2/D1 2/d1		Frost Clay	Sh-Sw
2/E1 2/e1 2/e2		Frost Slope	Sh-Sw
2/f2 2/f3		Frost	Slope Sh-Sw
3/b0 3/c0		M. Sh-Sw Frost	
4/B0 4/c0 4/D0		M. Sh-Sw Frost	
4/E0		Slope M. Sh-Sw Frost	
5/e0		Slope Frost	Sh-Sw
5/f0		Frost	Slope Sh-Sw

TABLE 8
Soil limitations for road location[1] (continued)

Map Symbol[2]	Degree of Limitation: None to Slight	Moderate	Severe
6/e0		Slope, Frost	Sh-Sw
6/f0, 6/g0		Frost	Slope, Sh-Sw
7/f0		Frost	Slope, Sh-Sw
8/f0, 8/G0		Frost	Slope, Sh-Sw
9/B0, 9/b0, 9/C0, 9/c0, 9/D0		Frost	Sh-Sw, Clay
9/E0, 9/E1		Slope, Frost	Sh-Sw
9/F0		Frost	Slope, Sh-Sw
10/f5, 10/g5			Slope
11/B2, 11/C1, 11/C2, 11/c2, 11/D1		Frost	Sh-Sw, Clay
11/E1, 11/e1		Slope, Frost	Sh-Sw
11/F1		Frost	Slope, Sh-Sw
12/D2, 12/d2		Frost, Clay	Sh-Sw
12/f1, 12/f2, 12/g0		Frost	Slope, Sh-Sw
13/c1, 13/c3, 13/c5, 13/d3	NL		
13/F1, 13/f3, 13/f4, 13/f5			Slope, Er
14/D0		M. Sh-Sw, Frost	
15/b0		Wet	
16/D3		Frost	Sh-Sw, Clay
16/f3, 16/f4, 16/f5, 16/g3, 16/g4, 16/g5		Frost	Slope, Sh-Sw
17/b0		Wet, M. Sh-Sw, Frost	
18/F2			Slope, Er
19/g0			Slope, Er
20/f0		Frost	Slope, Sh-Sw
21/c0		M. Sh-Sw, Frost	
TH/B0			Org, Wet, Frost, Sh-Sw

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

[2]For explanation, see section entitled SOILS.

ABBREVIATIONS
Clay - High clay content
Frost - Susceptibility to frost heave
M. Sh-Sw - Moderate shrink-swell potential
NL - No limitations
Org - Organic Soil
Sh-Sw - High shrink-swell potential
Slope - Excessive slope
Wet - Seasonally high ground-water table or surface ponding

TABLE 9

Soil suitability as a source of roadfill[1]

Map Symbol[2]	Degree of Suitability: Good	Fair	Poor
1/d3, 1/e1, 1/e3		Frost Clay	Sh-Sw
1/f2, 1/f3		Frost Slope	Sh-Sw
1/G2		Frost	Slope Sh-Sw
2/b1, 2/c1, 2/D0 2/d0, 2/D1, 2/d1 2/E1, 2/e1, 2/e2		Frost Clay	Sh-Sw
2/f2, 2/f3		Frost Slope	Sh-Sw
3/b0, 3/c0		M. Sh-Sw Frost	
4/B0, 4/c0 4/D0, 4/E0		M. Sh-Sw Frost	
5/e0		Frost	Sh-Sw
5/f0		Slope Frost	Sh-Sw
6/e0		Frost	Sh-Sw
6/f0		Slope Frost	Sh-Sw
6/g0		Frost	Slope Sh-Sw
7/f0		Slope Frost	Sh-Sw
8/f0		Slope Frost	Sh-Sw
8/G0		Frost	Slope Sh-sw
9/B0, 9/b0, 9/C0 9/c0, 9/D0, 9/E0 9/E1		Frost	Sh-Sw Clay
9/F0		Slope Frost	Sh-Sw
10/f5		Slope	
10/g5			Slope

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

[2]For explanation, see section entitled SOILS.

TABLE 9
Soil suitability as source of roadfill[1] (continued)

Map Symbol[2]	Good	Degree of Suitability Fair	Poor	Unsuitable
11/B2 11/C1 11/C2 11/c2 11/D1 11/E1 11/e1		Frost	Sh-Sw Clay	
12/D2 12/d2		Frost Clay	Sh-Sw	
12/f1 12/f2		Slope Frost	Sh-Sw	
12/g0		Frost	Slope Sh-Sw	
13/c1 13/c3 13/c5 13/d3	NL			
13/F1 13/f3 13/f4 13/f5		Slope Er		
14/D0		M. Sh-Sw Frost		
15/b0		Wet		
16/D3		Frost	Sh-Sw Clay	
16/f3 16/f4 16/f5		Slope Frost	Sh-Sw	
16/g3 16/g4 16/g5		Frost	Slope Sh-Sw	
17/b0		Wet M. Sh-Sw Frost		
18/F2		Slope Er		
19/g0			Slope Er	
20/f0		Slope Frost	Sh-Sw	
21/c0		M. Sh-Sw Frost		
TH/B0				Org Wet Frost Sh-Sw

ABBREVIATIONS

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

TABLE 10
Soil suitability as a source of sand or gravel

Map Symbol[1]	Good	Degree of Suitability Fair	Poor	Unsuitable
1/d3 1/e1 1/e3 1/f2 1/f3 1/G2				Text
2/b1 2/c1 2/D0 2/d0 2/D1 2/d1 2/E1 2/e1 2/e2 2/f2 2/f3				Text

[1]For explanation, see section entitled SOILS.

TABLE 10
Soil suitability as source of sand or gravel (continued)

Map Symbol[2]	Good	Fair	Poor	Unsuitable
3/b0, 3/c0				Text
4/B0, 4/c0, 4/D0, 4/E0				Text
5/e0, 5/f0				Text
6/e0, 6/f0, 6/g0				Text
7/f0				Text
8/f0, 8/G0				Text
9/B0, 9/b0, 9/C0, 9/c0, 9/D0, 9/E0, 9/E1, 9/F0	NL			
10/f5, 10/g5	NL			
11/B2, 11/C1, 11/C2, 11/c2, 11/D1, 11/E1, 11/e1, 11/F1	NL			
12/D2, 12/d2, 12/f1, 12/f2, 12/g0				Text

Map Symbol[1]	Good	Fair	Poor	Unsuitable
13/c1, 13/c3, 13/c5, 13/d3, 13/F1, 13/f3, 13/f4, 13/f5	NL			
14/D0				Text
15/b0	NL			
16/D3, 16/f3, 16/f4, 16/f5, 16/g3, 16/g4, 16/g5			Thin Text	
17/b0				Text
18/F2				Text
19/g0				Text
20/f0				Text
21/c0				Text
TH/B0				Org Wet

ABBREVIATIONS
Org - Organic Soil
Text - Unsuitable texture
Thin - Thin deposit of sand or gravel
Wet - Seasonally high ground-water table or surface ponding

REFERENCES

Acton, D.F. (1975): A. Landform Mapping System for Canadian Soil Surveys, Saskatchewan Institute of Pedology, Publication, M26, Saskatoon, Canada, 19 pp.

Alberta Transportation (1955): Plots of Plasticity Index vs. Liquid Limit showing Standard Proctor Optimum Moisture Content in Percent and Maximum Density in Pounds per per cu. ft. Highway Testing Laboratory, Edmonton, Canada.

American Society for Testing and Materials (1970): Annual Book of ASTM standards, Part II, Philadelphia, 982 pp.

Bohart, C.V. (1968): Good Recreation Area Design Helps Prevent Site Deterioration, Journal of Soil and Water Conservation, 23:21-22.

Brady, N.C. (1974): The Nature and Properties of Soils, 8th edition, MacMillan, New York, 639 pp.

Canada Department of Agricuture (1974): The System of Soil Classification for Canada, Queen's printer, Ottawa, 255 pp.

Canada Department of Agriculture (1976): Glossary of Terms in Soil Science, Publication 1459, Information Division, Ottawa, 44 pp.

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

Canada Soil Survey Committee (1978): The Canadian System of Soil Classification, Canada Department of Agriculture Publication 1646, Ottawa, 164 pp.

Carson, J.A., Crepin, J.M. and Nemunis-Siugzdinis, P. (1972): A Sulfate-Sulfur Method Used to Delineate the Sulfur Status of Soil, Canadian Journal of Soil Science, 52:278-281.

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

Conard, H.S. (1956): How to Know the Mosses and Liverworts, Wm. C. Brown Co., Dubuque, Iowa, USA, 226 pp.

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

Densmore, J. and Dahlstrand, N.P. (1965): Erosion Control on Recreation Land, Journal of Soil and Water Conservation, 20: 261-262.

Dickman, S.R. and Bray, R.H. (1940): Colorimetric Determination of Phosphate, Industrial and Engineering Chemistry, Analytical Edition. 12: 665-668.

Dooling, P.J. (1969): Soils, Carrying Capacity and Resource Based Recreation Systems, Report of 4th Annual British Columbia Soil Science Workshop, British Columbia Department of Agriculture, Victoria, Canada.

Dotzenko, A.D., Papamichos, N.T. and Romine, D.S. (1967): Effect of Recreational Use on Soil and Moisture Conditions in Rocky Mountain National Park, Journal of Soil and Water Conservation, 22:196-197.

Emmons, W.H., Allison, I.S., Stauffer, C.R. and Theil, G.A. (1960): Geology; Principles and Processes, 5th Edition, McGraw-Hill, New York, 491 pp.

Environment Canada. Monthly Record Meteorological Observations in Canada, 1966 to 1975, Information Canada, Ottawa.

Epp, P.F. (1977): Guidelines for Assessing Soil Limitations for Trails in the Southern Canadian Rockies, Unpublished M. Sc. Thesis, Department of Soil Science, Edmonton, Canada, 164 pp.

Frissel, S.S. and Duncan, D.P. (1965): Campsite Preference and Deterioration in the Quetico-Superior Canoe Country, J. For. 63: 256-260.

Gary, M., McAfee, R. Jr. and Wolf, C.L. (Editors) (1972): Glossary of Geology, American Geological Institute, Washington, D.C., 805 pp.

Greenlee, G.M. (1979) Soil Survey and Interpretations for Recreational Use, of an Area at the Junction of the Notikewin and Peace Rivers, Earth Sciences Report 78-4, Alberta Research Council, Edmonton, Canada, 45 pp.

Hale, M.E. (1969): How to Know the Lichens, Wm. C. Brown Co., Duguque, Iowa, USA, 226 pp.

Hoyt, P.B. and Nyborg, M. (1971): Toxic Metals in Acid Soils; I. Estimation of Plant-Available Aluminum, Soil Science Society of America, Proceedings, 35: 236-240.

Hoyt, P.B. and Nyborg, M. (1971): Toxic Metals in Acid Soils; II. Estimation of Plant-Available Manganese, Soil Science Society of America Proceedings. 35: 241-244.

Jackson, M.L. (1962): Soil Chemical Analysis, Prentice-Hall, Englewood Cliffs, New Jersey, USA, 498 pp.

Jungerius, P.D. 1969: Soil Evidence of Postglacial Tree Line Fluctuations in the Cypress Hills Area, Alberta, Canada, Arctic and Alpine Research, I: 235-245.

Means, R.E. and Parcher, J.V. (1964): Physical Properties of Soils, Charles E. Merrill, Columbus, Ohio, USA, 464 pp.

Montgomery, P.H. and Edminster, F.C. (1966): The Use of Soil Surveys in Planning and Recreation, In; Soil Surveys and Land Use Planning, Bartelli et al. (editors) Soil Science Society of America and American Society of Agronomy, Madison, Wisconsin, USA, pp. 104-112.

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

Pluth, D. (1969): Soil Classification and Soil Survey as a Basis for Land Use Planning, Report of the 4th Annual British Columbia Soil Science Workshop, British Columbia Department of Agriculture, Victoria, Canada.

Portland Cement Association (1962): PCA Soil Primer, Portland Cement Association, Chicago, Illinois, USA, 52 pp.

Richards, L.A. (Editor). (1954): Diagnosis and Improvement of Saline and Alkali Soils, Handbook 60, United Stated Department of Agriculture, Washington, D.C. 160 pp.

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

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

Soil Conservation Society of America (1976): Resource Conservation Glossary, 2nd Edition, Ankeny, Iowa, USA, 63 pp.

Stevens, M.E. (1966): Soil Surveys as Applied to Recreation Site Planning, Journal of Forestry. 64: 314-316.

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

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

United States Department of Agriculture (Undated): Procedure Guide, Section 400 - Application of Soil Survey Information, 403 - Rating Soils for Selected Uses, Soil Conservation Service, Unpublished Guide for Interim Use.

Westgate, J.A. (1964): The Surficial Geology of the Foremost - Cypress Hills area, Alberta, Canada, Unpublished Ph. D. Thesis, University of Alberta, Edmonton, Canada, 208 pp.

APPENDIX A

CHEMICAL ANALYSES OF THE SOILS

The chemical analyses carried out on representative soil samples are presented in Table 11. The samples analyzed are surface and subsoil samples, taken of the map units at representative sites. Surface samples are taken from the zero to 15 cm depth, and the subsoil samples from the 15 to 60 cm depth. Each surface sample consists of five separate samples taken at random locations and bunched together into one composite sample. A brief explanation of the significance of each chemical analysis follows:

1. Nitrogen

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

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

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

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

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

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

[1]Alberta Soil and Feed Testing Laboratory, O.S. Longman Building, Edmonton.

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

2. Phosphorus

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

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.[1] Plants respond remarkedly to phosphate fertilizer on deficient soils.

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

3. Potassium

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

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

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

4. Sulfur

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

TABLE 11
Chemical analyses of selected map units[1]

Map Unit	Sample Depth (cm)	Nitrogen (N) Pounds per acre	Phosphorous (P)	Potassium (K)	Sodium[2]	Sulfur[2]	Soil Reaction (pH)	Aluminum ppm[3]	Manganese ppm[3]
1	0-15	2	17	627	L-	--	6.1	nd[4]	nd
	15-30	1	1	338	L-	--	6.3	nd	nd
2	0-15	1	15	410	L-	--	7.1	nd	nd
	15-30	1	13	321	L	--	6.6	nd	nd
3	0-15	4	31	797	L	--	7.3	nd	nd
	15-30	3	11	674	L	--	7.7	nd	nd
4	0-15	2	18	300	L	--	7.8	nd	nd
	15-30	5	1	217	L-	--	7.8	nd	nd
	30-60	5	1	298	L	--	8.0	nd	nd
5	0-15	2	22	763	L	--	6.9	nd	nd
	15-30	1	3	628	L-	--	6.0	nd	nd
6	0-15	1	69	573	L-	--	6.7	nd	nd
	15-30	1	50	647	L	--	5.8	nd	nd
7	0-15	1	21	777	L	--	6.5	nd	nd
	15-30	1	1	608	L	--	8.1	nd	nd
8	0-15	5	6	654	L	--	7.6	nd	nd
	15-30	2	4	494	L	--	6.5	nd	nd
9	0-15	3	7	487	L-	--	5.3	0.8	12.0
	15-30	1	4	288	L	--	5.3	1.0	4.4
11	0-15	1	63	367	L-	--	5.1	4.8	29.0
	15-30	1	15	147	L	--	5.0	4.8	16.2
12	0-15	1	97	393	L-	--	5.5	0.6	22.6
	15-30	1	88	473	L	--	5.9	nd	nd
13	0-15	2	43	937	L	--	6.1	nd	nd
	15-30	1	4	874	L-	--	5.4	nd	nd
14	0-15	1	27	633	L	--	5.9	nd[4]	nd
	15-30	7	8	411	L	--	6.6	nd	nd
	30-60	6	3	353	L	--	7.8	nd	nd

Conduct-ivity (mmhos/cm)	Sulfate[2]	Organic Matter[2]	Free Lime[2] ($CaCO_3$)	Remarks
0.1	--	M-	--	native grass (prairie)
0.1	--	M-	--	
0.3	--	M-	--	hay-fescue, brome, alfalfa
0.1	--	M-	--	
0.4	--	M-	--	picnic area and playground-lawn grass
0.3	--	M-	--	
0.2	--	M-	--	hay-alfalfa, fescue, crested wheat, brome
0.2	--	M-	L-	
0.3	--	M-	L+	
0.3	--	M-	--	native grass (prairie)
0.2	--	M-	--	
0.3	--	M-	--	aspen, white spurce
0.1	--	M-	--	
0.2	--	M-	--	native grass (prairie)
0.6	--	M-	H-	
0.4	--	M-	M-	native grass (prairie)
0.1	--	M-	--	
0.1	--	M-	--	native grass, shrubby cinquefoil (prairie)
0.1	--	M-	--	
0.1	--	M-	--	lodgepole pine
0.1	--	M-	--	
0.1	--	M-	--	white spruce, lodgepole pine, aspen
0.1	--	M-	--	
0.2	--	M	--	native grass, shrubby cinquefoil (prairie)
0.1	--	M-	--	
0.1	--	M-	--	summerfallow, heavy weed cover-stinkweed,
0.2	--	M-	--	tansy mustard, lambs, quarters
0.4	--	M-	L-	

TABLE 11
Chemical analyses of selected map units[1] (continued)

Map Unit	Sample Depth (cm)	Nitrogen (N)	Pounds per acre Phosphourous (P)	Potassium (K)	Sodium[2]	Sulfur[2]	Soil Reaction (pH)	Aluminum ppm[3]	Manganese ppm[3]
15	0-15	14	31	433	L-	--	7.5	nd[4]	nd[4]
	15-30	2	1	159	L-	--	7.6	nd	nd
16	0-15	1	22	384	L-	--	5.1	2.6	17.4
	15-30	1	23	585	L	--	5.2	1.4	6.8
17	0-15	11	48	758	L	--	7.4	nd	nd
	15-30	9	6	421	L	--	6.9	nd	nd
18	0-15	1	21	477	L-	--	6.7	nd	nd
	15-30	1	11	371	L	--	6.5	nd	nd
19	0-15	1	68	558	L-	--	5.9	nd	nd
	15-30	1	86	495	L-	--	5.9	nd	nd

[1]Chemical Analyses done by Alberta Soil and Feed Testing Laboratory, O.S. Longman Building, Edmonton.

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

[3]ppm = parts per million

[4]nd = not determined.

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

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

5. Soil Reaction (pH)

This test measures soil acidity or alkalinity. Acid soils have pH values of 5.5 or less; decreasing pH values indicate increasing soil acidity. Neutral soils have pH values of between 5.5 and 7.4: alkaline soils have pH values of 7.4 or more. Increasing pH values indicate increasing soil alkalinity.

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

6. Soil Salinity and Conductivity Test

Conductivity is a measure of the total water-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." Sulfates and sodium are determined to identify specific salts commonly causing salinity.

Conductivity (mmhos/cm)	Sulfate[2]	Organic Matter[2]	Free Lime[2] ($CaCO_3$)	Remarks
0.2	--	M-	--	willow, white spruce, balsam, poplar, grass, forbs
0.2	--	M-	--	
0.1	--	M-	--	lodgepole pine
0.1	--	M-	--	
0.4	--	M-	--	brome grass
0.2	--	M-	--	
0.2	--	M-	--	native grass (prairie)
0.1	--	M-	--	
0.2	--	M-	--	white spruce, aspen
0.1	--	M-	--	

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

0 to 1 - negligible salt effects.
1.1 to 3 - lawn growth noticeably restricted.
3.1 or more - lawn growth considerably restricted.

The sulfate 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 sulfate test may indicate a hazard of sulfate attack on concrete, indicating a need for sulfate resistant concrete to be used in constructing foundations and underground conduits.

7. Organic Matter and Free Lime

These tests are visual estimates of the amounts contained in the soil. Results 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.[1]

[1]Alberta Soil and Feed Testing Laboratory, O.S. Longman Building, Edmonton.

Organic matter influences physical and chemical properties of soils far out o1 proportion to the small quantities contained therein (Brady, 1974). It commonly accounts for at least half the cation exchange capacity of soils and is responsible, perhaps more than any other single factor, for the stability of soil aggregates. Furthermore, it supplies energy and body building constituents for the soil microorganisms.

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

a) Deficiencies of available iron, manganese, copper or zinc may occur.
b) Phosphate availability may be low 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.

TABLE 12
Physical analyses of selected map units[1]

									Mechanical analysis		
		Field				Percentage passing sieve					
Map Unit	Depth (cm)	Moisture (%)	1 inch	3/4 inch	5/8 inch	#4 (4.7 mm)	#10 (2.0 mm)	#40 (0.42 mm)	#200 (0.074 mm)	0.05 mm
1	90-120	13	100	100	100	100	100	88	66	59
6	60-90	20	100	100	100	100	100	100	82	73
6	90-120	18	100	100	100	100	100	100	69	59
9	90-120	21	100	100	98	90	90	86	77	71
16	60-90	26	100	100	100	100	100	94	93	87
16	90-120	20	100	100	100	100	100	100	93	84

[1]Map Units developed on similar parent material: 1, 2 and 12; 6, 5, 7, 8, 16 and 20; 9 and 11.
[2]These values are obtained from charts worked out by the Highways Testing Laboratory, Alberta Transportation, Edmonton.

ENGINEERING PROPERTIES OF THE SOILS

Engineering test data determined on representative soil samples are presented in Table 12. The samples analysed were taken from the subsoils of map units 1, 6, 9, and 16 at representative sites. A brief description of the significance of each analytical parameter follows.

1. Field Moisture Percentage

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

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

2. Particle Size Analysis

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

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

3. Plasticity

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

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

The tests used for estimating plasticity are plastic limit, liquid limit, and plasticity index; collectively referred to as "Atterberg limits". 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.

Percentage smaller than			Liquid Limit	Plasticity Index	Optimum Moisture (%)[2]	Maximum Dry Density[2] (lb/ft^3)	Classification		
0.005 mm	0.002 mm	0.001 mm					AASHO	Unified	USDA
37	31	29	34	17	16	110	A-6 (9)	CL	CL
46	38	33	41	28	14	118	A-7-6 (15)	CL	CL
34	27	23	34	14	20	103	A-6 (9)	CL	L
46	40	37	55	29	27	92.5	A-7-6 (19)	CH	C
55	47	42	56	28	29	91	A-7-6 (18)	CH	SiC
47	39	34	50	23	28	91.5	A-7-6 (15)	CL	SiCL

4. Moisture Density Relationships

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

5. Soil Classification

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

(a) AASHO Classification System

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

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

(b) Unified Soil Classification System

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

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

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

(c) United States Department of Agriculture Soil Classification System

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

APPENDIX B

SOIL FORMATION

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

IDENTIFICATION OF SOIL PROFILES AND HORIZONS

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

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

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

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

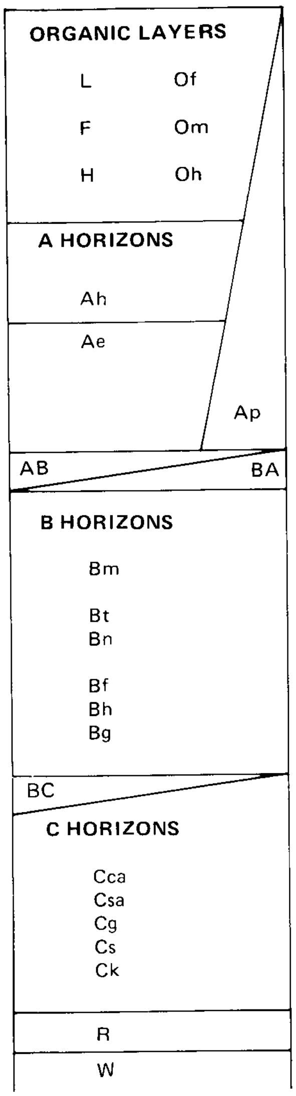
A particular soil is recognized by identifying the various layers or horizons that make up its profile, and a system has been devised to facilitate this recognition (Clatyon *et al.*, 1977). It involves the recognition of major organic layers, master mineral horizons and layers, and further subdivision of these horizons by designation of features secondary or subordinate to those characteristic of the main horizons. See the Canadian System of Soil Classification (CSSC, 1978) for the comprehensive outline of the classification scheme, the official criteria for identification of horizons and layers, and for conventions regarding their use. Figure 2 gives more generalized definitions of the soil horizons, and the symbols used to designate them in profile descriptions. Table 13 gives a generalized outline of the Canadian soil classification system. Figure 3 gives diagrammatic horizon patterns of some representative soil profiles from the various orders.

TABLE 13
Outline of Canadian Soil Classification System (Canada Soil Survey Committee 1978)

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

[1]MAST - mean annual soil temperature

[2]OC - organic carbon



NOTE: The lower case letters shown above in the A, B and C horizons are sometimes combined to express combinations of characteristics. Other lower case letters not listed above are:

b - a buried soil horizon

j - a modifier of suffixes e, f, g, n and t to denote expression of, but failure to meet, the specified limits of the suffix it modifies.

u - a horizon markedly disrupted by physical or faunal processes other than cryoturbation.

y - a horizon affected by cryoturbation.

z - a perennially frozen layer.

L-F-H	well drained decomposing plant litter, primarily leaves, twigs, woody materials. L - slightly decomposed, F - partly decomposed, H - well decomposed.
O	poorly drained decomposing peat, mainly mosses, rushes, woody materials. Of - fibric - least decomposed; Om - mesic - moderately decomposed; Oh - humic - most highly decomposed.
A	Organic-mineral horizons at or near the surface. Ah - dark colored, humus-rich horizon. Ae - light colored, eluviated horizon, characterized by removal of clay, iron, aluminium or organic matter, alone or in combination. Ap - horizons disturbed by man's activities, that is, by cultivation, or pasturing, or both.
AB, BA	horizons transitional to A and B.
B	a mineral horizon differing from A and C by the following characteristics: m - slightly altered by hydrolysis, oxidation, or solution or all three, to give a change in color, or structure or both. t - a significant accumulation of silicate clay. n - a columnar or prismatic structure, hard consistence when dry and significantly high exchangeable sodium. f - a significant accumulation of Fe + Al combined with organic matter. h - a significant accumulation of illuvial organic matter. g - a significant expression of gleying.[2]
BC	a horizon transitional to B and C.
C	a horizon comparatively unaffected by soil forming processes, except for: ca - an accumulation of lime. sa - an accumulation of water-soluble salts. g - a significant expression of gleying.[2] s - denotes the presence of salts, including gypsum ($CaSO_4$). k - denotes the presence of lime.
R	a consolidated bedrock layer.
W	a layer of water.

[1]Diagram copied from the National Atlas of Canada (Energy, Mines and Resources, 1973).

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

FIGURE 2. Diagram[1] of a soil profile and definitions of soil horizon symbols (Canada Soil Survey Committee, 1978).

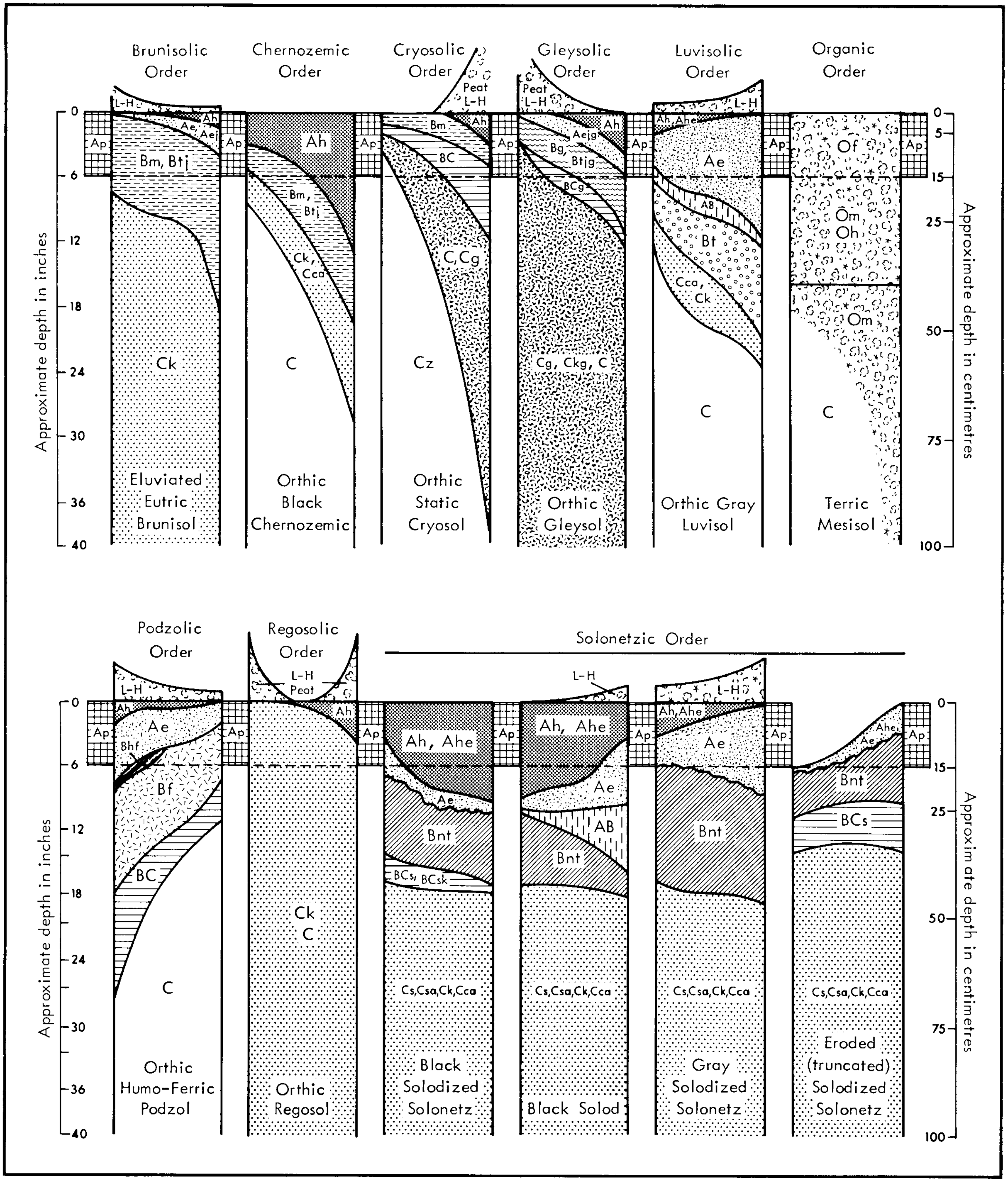


FIGURE 3. Diagrammatic horizon pattern of some representative soil profiles (Canada Department of Agriculture, 1974).

APPENDIX C
LANDFORM CLASSIFICATION SYSTEM

GENETIC MATERIALS

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

1. Unconsolidated Group

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

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

Definitions:

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

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

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

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

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

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

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

(h) Volcanic. These are unconsolidated pyroclastic sediments of volcanic origin. Assumed process status is inactive. Examples: volcanic dust, ash, cinders and pumice.

2. Organic Component

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

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

Definitions:

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

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

3. Consolidated Component

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

Classes:
R - Bedrock, undifferentiated

4. Ice Component

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

Classes:
I - Ice, undifferentiated

QUALIFYING DESCRIPTORS

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

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

Classes:
Clastic: G - Glacial, E - Channelled
Process: A - Active, I - Inactive

Definitions:

1. Glacial

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

(a) Glaciofluvial. This term is used only where fluvial materials show clear evidence of having been deposited either directly in front of, or in contact with, glacier ice.

At least one of the following characteristics must be present:

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

(b) Glaciolacustrine: This term is to be used where there is evidence that the lacustrine materials were deposited in contact with glacial ice. One of the following characteristics must be present:

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

2. Channelled

This term is used to indicate the presence of glacial meltwater channels in a unit where they are too small and/or too numerous to show individually by an on-site symbol.

3. Active

This term is used to indicate any evidence of the recurrent nature of a modifying process or of the contemporary nature of the process forming a genetic material.

4. Inactive

This term is used to indicate no evidence that the modifying process is recurrent, and also that the processes of formation of the genetic materials have ceased.

SURFACE EXPRESSION

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

Classes for Unconsolidated and Consolidated Mineral Components:

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

Definitions:

1. Apron

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

2. Blanket

This is a mantle of unconsolidated materials thick enough to mask minor irregularities in the underlying unit but which still conforms to the general underlying topography. Example: lacustrine blanket overlying hummocky moraine.

3. Fan

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

4. Hummocky

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

5. Inclined

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

6. Level

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

7. Rolling

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

8. Ridged

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

9. Steep

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

10. Terraced

This is a scarp face and the horizontal or gently inclined surface (tread) above it. Example: alluvial terrace.

11. Undulating

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

12. Veneer

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

Classes for Organic Component:

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

Definitions:

1. Blanket

This is a mantle of organic materials thick enough to mask minor irregularities in the underlying unit, but which still conforms to the general underlying topography. Example: blanket bog.

2. Bowl

This is a bog or fen occupying concave-shaped depressions. Example bowl bog.

3. **Domed**

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

4. **Floating**

This is a level or flat organic surface associated with a pond or lake and not anchored to the lake bottom. Example: floating fen.

5. **Horizontal**

This is a flat peat surface not broken by marked elevations and depressions. Examples: flat bog, horizontal fen.

6. **Plateau**

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

7. **Ribbed**

This is a pattern of parallel or reticulate low ridges associated with fens. Examples: string fen, net fen, water track fen.

8. **Sloping**

This is a unidirectional peat surface with a generally constant slope not broken by marked irregularities. Example: sloping fen.

MODIFYING PROCESSES

Terms which describe those geological processes that have modified or are currently modifying genetic materials and their surface expression are considered within the modifying processes category of the system.

These modifiers are to be used where a relatively large portion of the map unit is modified. On-site symbols can be used to indicate modification of a relatively small portion of a map unit.

The assumed common process status (active, inactive) is specified in the definition of each modifier. Where this status varies from the assumed state, it must be qualified in the description.

Classes:

A - Avalanched	H - Kettled
B - Bevelled	P - Piping
D - Deflated	V - Gullied
E - Eroded (Channelled)	W - Washed
F - Failing	

Definitions:

1. **Avalanched:**

Slopes modified by frequent avalanche activity. An avalanche is defined as a large mass of snow, ice, soil or rock or mixtures of these materials, falling or sliding very rapidly under the force of gravity. The assumed process status is active. Examples: avalanche cones and avalanche tracks or chutes.

2. **Bevelled:**

Surface cut or planed by running water but not underlain by fluvial materials. Bevelled applies to river-cut terraces in bedrock, river terraces cut into till or lacustrine silts. The assumed process status is inactive. Example: river cut terrace in bedrock.

3. **Deflated:**

The modification by the sorting out, lifting and removal of loose, dry, fine-grained particles (clay and silt sizes) by the turbulent, eddy action of the wind. The assumed process status is inactive. Example: deflated lacustrine terrace.

4. **Eroded (Channelled):**

Surface crossed by a series of abandoned channels. The term applies to fluvial plains, terraces and fans. The assumed process status is inactive. Examples: abandoned channels on alluvial terrace.

5. **Failing:**

Modification of surfaces by the formation of tension fractures or by large consolidated or unconsolidated masses moving slowly downslope. Colluvial processes resulting in shallow surface movements are not described as failing. The process status is only active. Example: slumps.

6. **Kettled:**

Deposit or feature modified by depressions left by melting ice blocks. Depressions can be formed by the melting blocks of ice buried in glaciofluvial, glaciolacustrine or till materials. Kettle depressions usually have steep sides and are bounded by an abrupt convex break in slope. They occur in a variety of shapes and sizes from round basins to branching valleys. The assumed process status is inactive. Examples: pitted outwash and lacustrine; knob and kettle topography.

7. **Piping:**

Suface modified by small hollows, commonly aligned along routes of subsurface drainage, and resulting from the subsurface removal of particulate matter in unconsolidated materials. It occurs most commonly in lake silts but may also affect alluvium, loess and volcanic ash. The assumed process is active. Example: piping in silty lacustrine terrace.

8. **Gullied:**

The modification of surface by fluvial erosion, resulting in the development of parallel and sub-parallel, steep-sided and narrow ravines in both consolidated and unconsolidated materials. The assumed process status is active. Example: gullied lacustrine terrace.

9. **Washed:**

Modification of a deposit or feature by wave action in a body of standing water, resulting in lag deposits, beaches or lag materials and wave-cut platforms. It occurs most commonly in areas of former marine inundation or glacial lakes. Active washing occurs along present shorelines. The assumed process status is inactive. Examples: terrace or beach cut or deposited on morainal blanket.

MAPPING CONVENTIONS

The following examples illustrate the mapping conventions that are used:

1. Mh - indicates an area of hummocky morainal deposits.

2. F^{G}_{u} - indicates an area of undulating glaciofluvial materials.

3. $\frac{\overset{G}{Lv}}{Mu}$ - indicates an area of glaciolacustrine veneer overlying undulating morainal materials.

4. Rr-FV-indicates an area of ridged rock modified by failing and gullying.

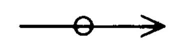
5. $\frac{Cb}{Rr\text{-}FV}$ indicates a colluvial blanket, overlying an area of ridged rock modified by failing and gullying.

ON-SITE SYMBOLS

On-site symbols or map symbols are used to describe features or processes in the terrain which express either a limited (by scale) areal function or are simply point observations. They may be linear features such as eskers or moraine ridges; site specific information such as gravel locations or kettle holes; or to add details of Quaternary history such as striae, glacial meltwater channels or abandoned shorelines.

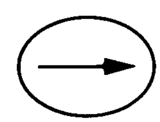
The size of the on-site symbols will vary with the type of symbol. For example, those symbols which connote an areal extent such as failing will vary in size whereas those which are point observations and have no relation to areal extent, such as fossil locality will be of a standard size. Those symbols which have linear connotations such as eskers, gullying or end moraines will vary in length but will be of standard width.

Drumlin/drumlinoid ridge



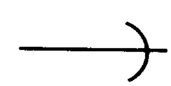
Fluting

Failing (arrow indicates direction of failure)

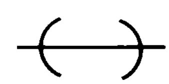


Piping

Glacial Striae, ice direction known

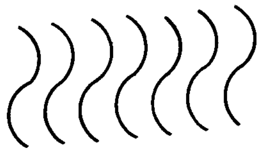


Glacial Striae, ice direction unknown

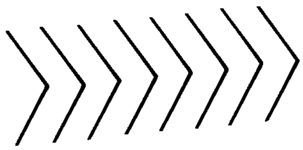


Moraine ridge (end moraine)

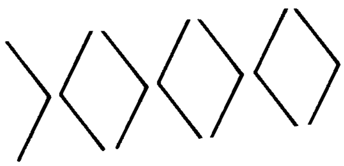
Minor Moraine Ridges



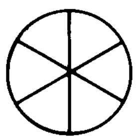
Eskers, direction known



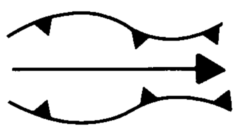
Eskers, direction unknown



Kettled



Glacial meltwater channel, large



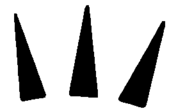
Glacial meltwater channel, small arrow indicates direction of flow

Abandoned shoreline

Dunes, active

Dunes, inactive

Gullied

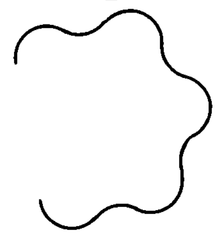


Erratic

Quaternary Fossil Locality

Anthropogenic site

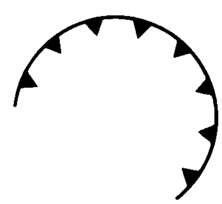
Landslide scar



Gravel location

Escarpments

Cirque



Avalanched

GLOSSARY

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

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

alkaline soil Any soil that has a pH greater than 7.0.

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

amorphous Without definite form or shape.

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

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

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

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

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

clod A compact, coherent mass of soil produced artificially, usually by the activity of man by plowing, digging, etc., especially when these operations are performed on soils that are too wet or too dry for normal tillage operations.

conglomerate The consolidated equivalent of gravel in size range and in the essential roundness and sorting of its constituent particles.

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

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

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

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

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

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

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

(f) nonplastic - consistence of wet soil material at which a roll 4 cm long and 4 mm thick cannot be formed.

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

(h) plastic - consistence of wet soil material at which a roll 4 cm long and 2 mm thick can be formed but will not support its own weight.

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

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

(k) slightly plastic - consistence of wet soil material at which a roll 4 cm long and 4 mm thick can be formed but will not support its own weight.

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

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

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

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

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

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

(r) very plastic - consistence of wet soil material at which a roll 4 cm long and 2 mm thick can be formed and will support its own weight.

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

control section, soil The vertical section upon which the taxonomic classification of soil is based. The control section usually extends to a depth of 100 cm in mineral materials and to 160 cm in organic materials.

crevasse fillings Ridges or hummocks formed from glacial sediments that were deposited by water in the cracks and crevasses of the ice.

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

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

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

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

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

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

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

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

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

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

droughty soil Sand or very rapidly drained soil.

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

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

erratic A rock fragment carried by glacier ice or by floating ice, and deposited when the ice melted at some distance from the outcrop from which the fragment was derived.

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

escarpment A steep face or ridge of high land.

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

fabric The physical nature of a geologic material according to the spatial arrangement of its particles.

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

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

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

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

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

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

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

gravel Rock fragments 2 mm to 7.5 cm in diameter.

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

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

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

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

hydrophyte A plant that grows in water, or in wet or saturated soils.

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

infiltration The downward entry of water into the soil.

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

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

lithic phase (of soil) Any mineral soil having consolidated bedrock within the control section below a depth of 10 cm.

loess Material transported and deposited by wind, and consisting of predominantly silt-sized particles.

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.

mesophyte A plant that grows under intermediate moisture conditions.

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

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

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

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

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

orthic A subgroup referring to the modal or central concept of various great groups in the Brunisolic, Chernozemic, Cryosolic, Gleysolic, Luvisolic, Podzolic and Regosolic orders of the Canadian System of Soil Classification.

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

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

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

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

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

pediment A broad, flat or gently sloping erosion surface or plain of low relief, typically developed by subaerial agents (including running water) in an arid or semi-arid region at the base of an abrupt and receding mountain front or plateau escarpment, and underlain by bedrock (occasionally by older alluvial deposits) that may be bare but more often partly mantled with a thin and discontinuous veneer of alluvium derived from the upland masses and in transit across the surface.

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

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

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

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

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

saline soil A soil that contains enough water-soluble salts to interfere with the growth of most crop plants. The electrical conductivity of the saturation extract is greater than 4 mmhos/cm.

salinization The process of salt accumulation in soil.

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

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

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

separates, soil Mineral particles, less than 2.0 mm is equivalent diameter, ranging between specified size limits. The names and size limits of separates recognized by soil pedologists in Canada and 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.

shale A laminated, detrital sedimentary rock in which the particles are predominantly of clay size.

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

shrub A woody perennial plant differing from a tree by its low stature and by generally producing several basal shoots instead of a single trunk.

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

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

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

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

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

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

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

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

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

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

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

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

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

terric layer An unconsolidated mineral substratum underlying organic soil material.

texture, soil The relative proportions of the various soil separates in a soil, as described by the classes of soil texture shown in Figure 4. The sand, loamy sand and sandy loam classes are further subdivided on the basis of the proportions of the various sand separates present.

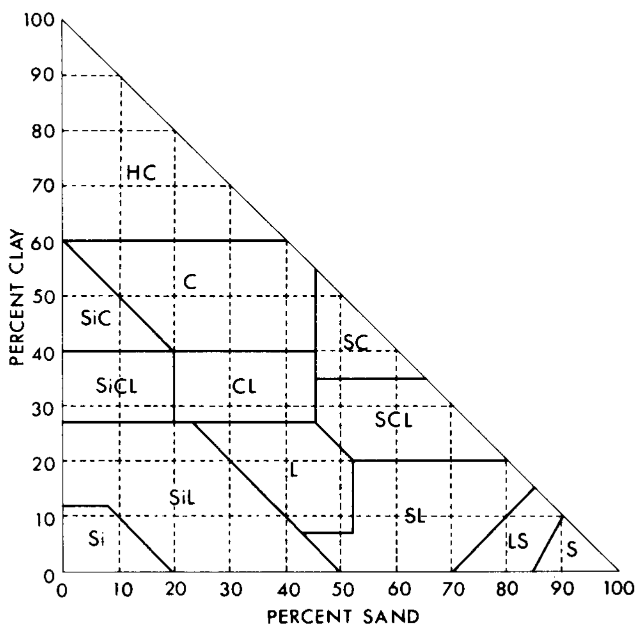


FIGURE 4. Soil textural classes. Percentages of clay and sand in the main textural classes of soils; the remainder of each class is silt.

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

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

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

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

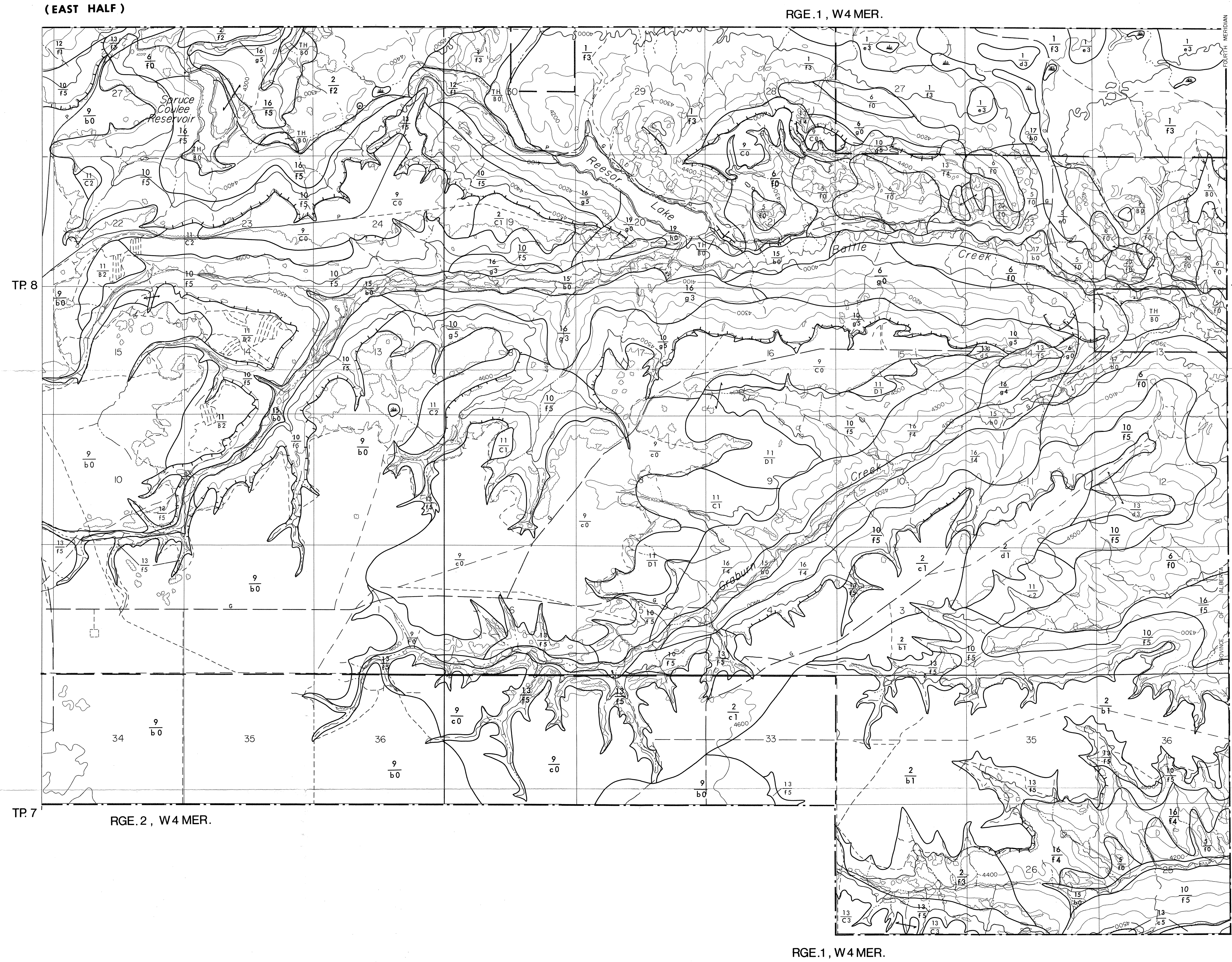
xerophyte A plant capable of surviving periods of prolonged moisture deficiency.

Legend

S - sand CS - coarse sand S - sand FS - fine sand VFS - very fine sand LS - loamy sand LCS - loamy coarse sand LS - loamy sand LFS - loamy fine sand LVFS - loamy very fine sand	very coarse textured
SL - sandy loam CSL - coarse sandy loam SL - sandy loam FSL - fine sandy loam	moderately coarse textured
VFSL - very fine sandy loam L - loam SiL - silt loam Si - silt	medium textured
SCL - sandy clay loam CL - clay loam SiCL - silty clay loam	moderately fine textured
SC - sandy clay SiC - silty clay C - clay	fine textured
HC - heavy	very fine textured

SOIL MAP OF CYPRESS HILLS PROVINCIAL PARK AND ADJACENT AREA

(EAST HALF)



SOIL CLASSIFICATION:

MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Chernozemic 90% Regosolic 10%	Orthic Dark Brown 60% Orthic Black 30% Orthic Regosol 10%	medium to moderately fine textured till
2	Chernozemic	Orthic Black	moderately fine textured till
3	Chernozemic	Gleyed Black	medium to moderately fine textured fluvial sediments
4	Solonetzic 70% Chernozemic 30%	Black Solodized Solonetz 70% Orthic Black 30%	medium to moderately fine textured fluvial sediments
5	Chernozemic	Orthic Black	medium to moderately fine textured till containing a high proportion of weathered shale and sandstone
6	Luvisolic	Orthic and Dark Gray Luvisol	medium to moderately fine textured till containing a high proportion of weathered shale and sandstone
7	Chernozemic 70% Solonetzic 30%	Orthic Black 70% Black Solodized Solonetz 30%	till containing a high proportion of weathered sandstone and shale; predominantly medium to moderately fine textured, also pockets of moderately fine to fine textured and very coarse textured
8	Chernozemic 70% Regosolic 30%	Orthic Dark Brown – eroded phase 70% Orthic Regosol 30%	very coarse to fine textured till containing a high proportion of weathered shale and sandstone
9	Chernozemic	Orthic Black 80% Eluviated Black 20%	medium to moderately fine textured loess overlying moderately fine to fine textured conglomerate
10	Brunisolic	Orthic Eutric Brunisol	very coarse textured fluvial sediments (gravel)
11	Luvisolic	Orthic Gray Luvisol	moderately coarse textured loess overlying moderately fine to fine textured conglomerate
12	Luvisolic	Orthic Gray Luvisol 80% Dark Gray Luvisol 20%	moderately fine textured till
13	Chernozemic	Orthic Black	very coarse textured fluvial sediments (gravel)
14	Solonetzic 70% Chernozemic 30%	Black Solod 70% Orthic Black 30%	medium to moderately fine textured fluvial sediments
15	Chernozemic 70% Brunisolic 30%	Gleyed Black 70% Gleyed Eutric Brunisol 30%	medium to moderately fine textured fluvial sediments overlying gravel
16	Luvisolic	Orthic Gray Luvisol	moderately fine textured gravelly fluvial sediments overlying medium to fine textured till containing a high proportion of weathered shale and sandstone
17	Regosolic 70% Chernozemic 30%	Gleyed Regosol 70% Gleyed Rego Black 30%	medium to moderately fine textured fluvial sediments
18	Chernozemic	Orthic Dark Brown – eroded and lithic phases	medium to moderately coarse textured till containing a high proportion of weathered sandstone, overlying sandstone
19	Brunisolic	Eluviated Dystric Brunisol	moderately coarse to very coarse textured till containing a high proportion of weathered sandstone
20	Chernozemic 60% Regosolic 40%	Orthic Dark Brown – eroded phases 60% Orthic Regosol 40%	medium to moderately fine textured till containing a high proportion of weathered sandstone and shale
21	Chernozemic	Orthic Black	medium to moderately coarse textured fluvial sediments
TH	Organic	undifferentiated Terric Humisol	well decomposed peat overlying medium to moderately fine textured fluvial sediments.

LEGEND:

Map Symbol:

- 9 ← map unit
- b0 ← surface stoniness rating
- topographic class

- small wet depression
- G — groundwater discharge area
- escarpment
- soil line
- boundary of mapped area
- present park boundary
- section line
- township line
- (47) P — paved highway
- (47) G — gravelled highway
- P, G (Paved, Gravelled) — well travelled road
- not well travelled road
- trail or cut line
- building
- lookout tower
- gravel pit
- bridge
- dam
- 4000 — contours
- depression contours
- lake
- stream
- ditch, canal
- fence
- wooded area

Mapped and Compiled by:
G. M. Greenlee, P. Ag.
Soils Division
1978

SCALE 1 : 24,000 CONTOUR INTERVAL : 100'
1" = 2,000'

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AERIAL SURVEYS SECTION
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DEPARTMENT OF LANDS AND FORESTS
PROVINCE OF ALBERTA

BY PHOTOGRAMMETRIC METHODS

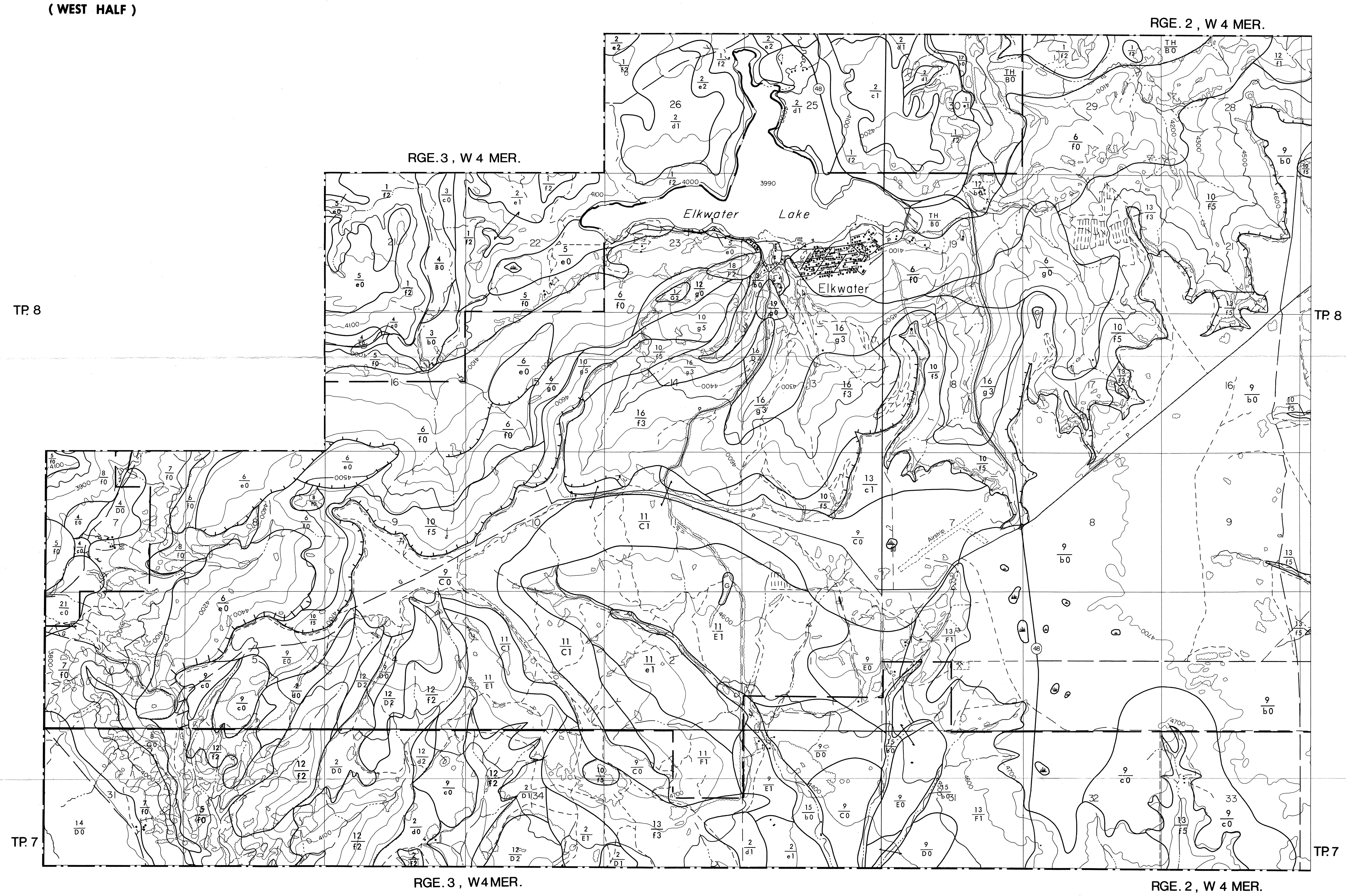
A.S. PROJECT NO. 471

CANADIAN GEODETIC DATUM

Alberta
RESEARCH COUNCIL

SOIL MAP OF CYPRESS HILLS PROVINCIAL PARK AND ADJACENT AREA

(WEST HALF)



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