SOIL SURVEY OF DRY ISLAND BUFFALO JUMP PROVINCIAL PARK AND INTERPRETATION FOR RECREATIONAL USE

by

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ALBERTA RESEARCH COUNCIL

1977

Alberta Institute of Pedology
Number M - 77 - 6

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PREFACE

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

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

INTRODUCTION

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

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

ACKNOWLEDGMENTS

The Alberta Research Council provided the staff and the Parks Planning Branch of Alberta Recreation, Parks and Wildlife contributed the operating costs of 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. Pal Foster typed and assisted in compiling and proof reading the report. Mr. Z. Widtman drafted the soil and landform maps, while Mr. J. Beres determined the physical properties of the soils. The soil chemical analyses were determined by the Alberta Soil and Feed Testing Laboratory.

Mr. R. MacMillan assisted in the field and in the preparation of this report.

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

SUMMARY

Dry Island Buffalo Jump Provincial Park is located along the Red Deer River about 22 km (14 miles) northeast of Trochu. It covers an area of about 1,000 hectares (2,470 acres) mostly within the rough and steeply sloping Red Deer River valley. Moderately fine textured till is the predominant surficial material on the upland portions of the park, while within the valley eroded sediments occur as moderately fine textured colluvium and alluvium of highly variable textures. One area of aeolian deposits was noted and a considerable portion of the valley consists of exposed sandstone and shale. The climate is continental with warm summers and cold winters, though a hotter, dryer microclimate exists within the valley. The vegetation ranges from native grass to thick shrub cover and is a reflection of the degree of protection from sun and wind and the availability of water at specific sites. Xerophytic and salt tolerant vegetation inhabits dry and saline locations.

Sixteen Map Units were recognized within the park. The key profile types consist of Orthic Black, Dark Brown and Dark Gray Chernozems; Rego Dark Brown Chernozems; Brown Solonetz and Solods, Orthic and Saline Regosols, and Orthic Eutric Brunisols. These are distributed over the landscape in relation to parent material, landform and drainage. Map Units consist of single soil series or groupings of series, and their distribution is shown on the Soils Map.

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

The soils occurring within the park display a wide range of suitability for recreational development. Within the valley, soils of Map Unit 11 and to a lesser extent Map Units 10 and 13 are the most suitable for recreational uses. Map Unit 6 soils may be subject to flooding from the river but otherwise display only slight to moderate limitations. Numerous limitations are encountered within the park, but

excessive slope, erosion hazard, solonetzic soil and flooding hazard are the most prevalent. Careful study of the Soils Map and Table 17 (interpretations table) will reveal areas suitable for particular uses.

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

METHODS

Field Techniques

The areas surveyed were traversed by motor vehicle along all roads and negotiable trails, and on foot along cut lines and trails not suitable for vehicles. An outboard motor boat was utilized along lake shores and rivers in some areas of otherwise limited access, and foot traverses were made as necessary across areas lacking trails.

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

Soil areas were delineated on ozalid copies of photomosaics at a scale of 1:8000 (8 inches = 1 mile). Panchromatic black and white areal photographs of scales varying from 1:31,680 (2 inches = 1 mile) to 1:12,000 (5.25 inches = 1 mile) were also used with the aid of a pocket stereoscope, to facilitate the field mapping.

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

Chemical and Physical Analyses

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

1) Available nutrients; Available nitrogen (N) and available potassium (K) (Jackson 1962), available phosphorus (P) (Dickman and Bray 1940), and available sulphur (S) (Carson et al 1972).
2) Soil Reaction; pH was determined with a glass and calomel electrode, using a 2:1 water to soil ratio (Jackson 1962).
3) Electrical Conductivity was measured by a dip electrode procedure. The electrodes were placed in the supernatant liquid on the surface of a 2:1 water to soil mixture.

4) Soluble Sulphates (SO_4) were determined on soil samples having electrical conductivities of 1 or more. A saturated soil paste was prepared according to the procedure outlined in U.S.D.A. Handbook 60 (1954). A saturation extract was obtained by suction, and sulphates were precipitated with $BaCl_2$ crystals by the turbidimetric method and estimated by a visual inspection.

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

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

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

8) Available Aluminum (Al) and Manganese (Mn) were determined on soil samples having a pH of 5.5 or less. These nutrients were determined by atomic adsorption spectrophotometry (Hoyt and Nyborg 1971).

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

GENERAL DISCUSSION OF SOIL MAP

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

Example:

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

The Map Units indicate single soil series, groupings of series, or soil associations. A soil series consists of soils that are essentially alike in all major profile characteristics except the texture of the surface (CDA 1972). Where a Map Unit consists of a grouping

of series, they occur together in a characteristic pattern within the landscape and it is not feasible to outline each separately because of the scale of the soil map. A soil association simply consists of a sequence of soils of about the same age, derived from similar parent materials, and occurring under similar climatic conditions, but having unlike characteristics because of variations in relief and in drainage (CDA 1972).

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

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

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

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

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

Table 1. Topographic Classes and Symbols (CDA 1974)

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

Table 2. Surface Stoniness Ratings[1] (Greenlee 1971)

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

GENERAL DISCUSSION OF LANDFORM MAP

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

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

Landforms, in this system, are considered to represent two basic attributes; materials and form. The material category recognizes four groups of materials; unconsolidated mineral, organic, consolidated mineral and ice. A number of classes of unconsolidated mineral and organic materials have been established but classes of consolidated materials (bedrock) and ice have not been recognized.

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

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

Genetic Materials

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

Unconsolidated Group

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

Classes:

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

Definitions

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

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

Eolian: Sediment generally consisting of medium to fine sand and coarse silt particle sizes that is well-sorted, poorly compacted, and may show internal structures such as cross bedding or ripple laminae, or may be massive. Individual grains may be rounded

and show signs of frosting. These materials have been transported and deposited by wind action. The assumed process status is inactive. Examples: dunes, veneers and blankets of sand and coarse silt, and loess but excludes volcanic tuffs.

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

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

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

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

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

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

Organic Component

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

Classes:

B - Bog (Sphagnum peat)

N - Fen (Fen or sedge peat)

O - Organic, undifferentiated

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

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

Consolidated Component

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

Classes:

R - Bedrock, undifferentiated

Ice Component

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

Classes:

I - Ice, undifferentiated

Qualifying Descriptors

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

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

Classes:

Clastic: G - Glacial, E - Channelled

Process: A - Active, I - Inactive

Definition

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

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

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

5. Flowtills.

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

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

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

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

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

Surface Expression

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

Classes for Unconsolidated and Consolidated Components

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

Definitions

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

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

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

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

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

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

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

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

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

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

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

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

Classes for Organic Component

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

Definitions:

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

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

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

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

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

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

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

Sloping: A unidirectional peat surface with a generally constant slope not broken by marked irregularities. 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
B - Bevelled
D - Deflated
E - Eroded (Channelled)
F - Failing
H - Kettled
P - Piping
V - Gullied
W - Washed

Definitions

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. Assumed process status is active.

Examples: avalanche cones and avalanche tracks or chutes.

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. Assumed process status is inactive.

Example : river cut terrace in bedrock.

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.

Assumed process status is inactive.

Example : deflated lacustrine terrace.

Eroded (Channelled): Surface crossed by a series of abandoned channels.

The term applies to fluvial plains, terraces and fans. Assumed process status is inactive.

Examples: abandoned channels on alluvial terrace.

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. Process status is only active.

Examples: slumps.

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 glacial till materials. Kettle depressions usually have steep sides and are bound by an abrupt convex break of slope. They occur in a variety of shapes and sizes from round basins to branching valleys. Assumed process status is inactive.

Examples: pitted outwash and lacustrine; knob and kettle topography.

Piping: Surface 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. Assumed process is active.

Example : piping in silty lacustrine terrace.

Gullied: The modification of surface of fluvial erosion, resulting in the development of parallel and sub-parallel, steep-sided and narrow ravines in both consolidated and unconsolidated materials.

Assumed process status is active.

Example : gullied lacustrine terrace.

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. 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 being used:

I) Mh - indicates an area of hummocky morainal deposits

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

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

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

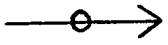
5) $\frac{Cb}{Rr - FV}$ - indicates a colluvial blanket, overlying an area of ridged rock modified by failing and gullying.

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. These 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.

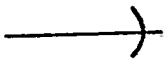
The size of the on-site symbols will vary with the type of symbol. For example, those symbols which connote an areal extent such as failing will vary in size whereas those which are point observations and have no relation to areal extent, such as fossil locality will be of a standard size. Those symbols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

Drumlin/drumlinoid ridge

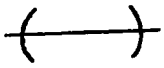


Fluting

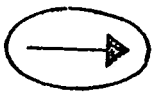
Glacial Striae, ice direction known



Glacial Striae, ice direction unknown



Failing (arrow indicates direction of failure)



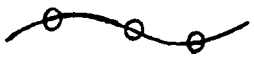
Piping

Gullied

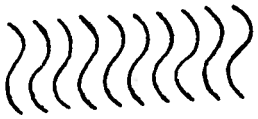
Erratic

Quaternary Fossil Locality

Moraine ridge (end moraine)

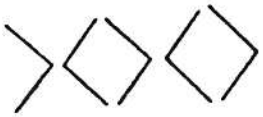


Minor Moraine Ridges



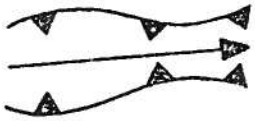
Eskers, direction known

Eskers, direction unknown

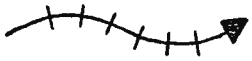


Kettled

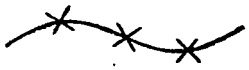
Glacial meltwater channel, large



Glacial meltwater channel, small arrow indicates direction of flow



Abandoned shoreline



Dunes, active

Dunes, inactive

Anthropogenic site

Landslide scar

Gravel location

Escarpments

Cirque

Avalanched

SOIL CHARACTERISTICS AND INTERPRETATIONS FOR RECREATIONAL USE

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

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

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

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

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

Soils that are wet all year, even if not flooded, have severe limitations for campsites, roads, hiking trails, playgrounds and picnic areas. The economic feasibility of installing subsurface drainage in these soils is questionable. Soils that are wet only part of the year or those with a water table that fluctuates without actually reaching the surface are not easily detected. These soils are considered to have moderate to severe limitations for most recreational uses, and if possible should be avoided for the more permanent facilities such as camping areas and building sites. With careful

planning, design, and management, however, these soils can be used for most recreational facilities. Soils that dry out slowly after rains also present problems where intensive use is contemplated. The soils that are dry during the season of use and have a water table greater than 3 feet from the surface are considered to have slight to no limitations for most recreational uses.

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

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

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

Permeability is an important property affecting the recreational use of soils. Since no permeability measurements were made, it has been estimated from a consideration

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

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

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

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

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

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

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

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

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

Table 3. Frost Design Soil Classification[1]

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

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

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

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

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

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

EXPLANATION OF SOIL INTERPRETATIONS

Soil limitation or suitability ratings are for evaluating each soil for a particular use (Olsen et al. 1971). Interpretations are based on evaluation of the soil to a depth of about 40 inches; however, some interpretations can be made below the 5 foot depth. These interpretations are made largely from soil descriptions and field observations made during the soil mapping program. Only surface and shallow subsurface soil samples were collected for routine chemical analyses, while only limited numbers of deeper subsurface samples were collected for engineering tests. Engineering properties of some map units sampled were extrapolated to other map units not sampled, where soils of the different map units were developed on like or very similar parent materials.

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

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

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

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

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

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

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

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

DEFINITION OF SELECTED USES AND GUIDES FOR DEVELOPING SOIL INTERPRETATIONS

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

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

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

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

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

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

Table. 4.

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

1. See definitions of soil drainage classes in Glossary.

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

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

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

5. See definitions of soil textural classes in Glossary.

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

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

Table 5.

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

1. See definitions of soil drainage classes in Glossary.

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

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

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

5. See definitions of soil textural classes in Glossary.

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

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

Table 6.

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

1. See definitions of soil drainage classes in Glossary.

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

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

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

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

6. See definitions of soil textural classes in Glossary.

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

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

Table 7.

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

1. See definitions of soil drainage classes in Glossary.

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

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

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

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

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

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

Table 8.

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

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

Table 9. Guides for Developing Soil Interpretations for Permanent Buildings

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

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

Table 9.

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

1. See definitions of soil drainage classes in Glossary.

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

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

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

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

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

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

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

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

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

Table 10.

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

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

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

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

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

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

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

Table 11.

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

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

2. See definitions of soil drainage classes in Glossary.

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

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

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

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

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

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

Table 12.

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

1. See definitions of soil permeability classes in Glossary.

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

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

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

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

Table 13.

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

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

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

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

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

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

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

Table 14.

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

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

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

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

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

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

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

Table 15.

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

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

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GLOSSARY

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

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

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

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

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

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

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

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

droughty soil - Sandy or very rapidly drained soil.

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

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

erodibility - Susceptibility to erosion.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

soil blowing - Soil erosion by wind.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

soluble sulphate - Water-soluble sulphate found in soil.

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

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

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

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

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

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

SOIL REPORT

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LOCATION AND SIZE

Dry Island Buffalo Jump Provincial Park is located along the Red Deer River about 22 km (14 mi) northeast of Trochu and 34 km (21 mi) southeast of Delburne. The distances by road from these two centers are 32 km (20 mi) and 48 km (30 mi) respectively. The park occupies about 1000 hectares (2470 acres) and is situated mostly within the river Valley. The legal location is as follows: in Township 34, Range 21, West of the Fourth Meridian, it includes all of section 29, the south half of section 32, those portions of sections 19, 20, 28 and the south half of 33 which lie north of the river, and the southeast quarter and part of the southwest quarter of section 30. In Township 34, Range 22, West of the Fourth Meridian, it occupies the eastern 3/4's of section 24 and that portion of the southeast quarter of section 25 which is south of the road leading to the park.

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

The majority of the park lies within the rough and steeply sloping valley of the Red Deer River which has cut through soft, poorly indurated sandstone and shale to a depth of 210 m (700 ft) below the surrounding gently rolling till plain. Elevations vary from 920 m (3000 ft) on the surface of the plain to 710 m (2325 ft) on the valley floor. Drainage is rapid and generally intermittent with surface runoff contributing to the development of numerous gullies and channels. Only two of the larger streams appear to have sufficient water supply to maintain relatively continuous flow. Most of the water courses follow as straight a path as possible downslope and into the Red Deer River which flows through the park from northeast to southwest. In the upper portions of the valley, numerous small saline sloughs have formed in depressions caused by slumping.

Till covers the upland portions of the park while the surficial materials

within the valley are younger than the till plain and have been produced during its dissection. The majority of this area is covered by a colluvial blanket which has developed on the erosion surfaces left by the river as it cut its channel. The accumulated debris is composed principaIly of eroded sandstone and shale but occasionally contains remnants of the original till cover. Running water has been the main eroding agent but the deposited material has been retransported by direct gravity-induced movement and is termed colluvium. The underlying bedrock has failed due to slumping, producing linear ridges which have since been dissected by gullying. On steeper slopes, almost all of the loose material has been removed, and bedrock is widely exposed. At an elevation some 50 metres (165 ft) above the present river level, remnants of a previous valley floor exist. Here a thin veneer of fluvial sediments overlies an undulating to gently rolling erosional surface of bedrock. Gullying has dissected this plain so that only isolated 'islands' remain. Two types of fluvial material have accumulated at the level of the present valley floor. One is nonsaline and has been deposited by the Red Deer River as it changed its course of flow through the valley. This material occurs as level fluvial terrace and floodplain deposits. The second type is derived from erosion and surface runoff from the steep valley sides and accumulates as gently to moderately sloping fans and aprons at the base of these slopes. It is generally saline and is still actively accumulating. One area of aeolian deposition was encountered within the park.

CLIMATE

The climate in the vicinity of the park is characterized by moderately warm summer and relatively cold winter temperatures (Bowser 1951). Weather records kept at the Trochu-Equity meterological station about 22 km (14 mi) southwest of the park over the ten year period 1966 - 1975 show the following values (Environment Canada, 1966-75): A mean annual temperature of 2.7°C (36.8°F), mean annual precipitation of 36.3 cm (14.3 in) with 67% falling as rain and an average frost free period of 109 days. January is the coldest month of the year with a mean temperature of -16.3°C (2.7°F), while July is the warmest month with a mean temperature of 17.1°C (62.7°F). The station is located at an elevation of 888 metres (2914 ft) and

reflects the climatic conditions to be expected on the upper till plain. A hotter dryer microclimate exists in the valley but meterological records are not available to quantify this difference. Rapid surface runoff and increased absorption of solar energy due to slope aspect and bedrock exposure are responsible for this microclimate. The low amount of moisture received locally is further reduced within the valley by rapid runoff and high evapotranspiration. Though the annual rainfall is not large, 53% may be expected to fall in the four month period between May 1st and September 1st, which corresponds roughly to the tourist season.

VEGETATION

Bowser (1951) locates the park at the boundary of the long grass prairie zone and the prairie - parkland transition zone. The small portion of the park located on the till plain is dominantly grassland with isolated bluffs of trees and represents the southern limit of Rowe's (1972) aspen grove section of the boreal forest region. Within the valley the hot, dry, saline conditions favour development of xerophytic and salt tolerant vegetation which is anomalous to the above mentioned zones. The Parks Planning Branch of Alberta Recreation, Parks and Wildlife currently conducts biological studies of Provincial Parks and proposed park areas. For this reason, information regarding the vegetation is not dealt with extensively herein; however a few of the more common plant species observed growing on different soils are listed in the Map Unit descriptions. The common and scientific names of these species are as follows: aspen (Populus tremuloides), balsam poplar (Populus balsamifera), white spruce (Picea glauca), saskatoon-berry (Amelanchier alnifolia), buckbrush (Symphoricarpos occidentalis), chokecherry (Prunus virginiana), pin cherry (Prunus pennsylvanica), rose (Rosa

acicularis), wolf willow (Elaeagnus commutata), wild gooseberry (Ribes sp.), currant (Ribes sp.) high-bush cranberry (Viburnum trilobum), thorny buffalo-berry (Shepherdia argentea), Canadian buffalo-berry (Shepherdia canadensis), dogwood (Cornus stolonifera), pasture sage (Artemisia frigida), sagebrush (Artemisia sp.), ground juniper (Juniperus communis), gum weed (Grindelia squarrosa), prickly pear cactus (Opuntia sp.) cereal crops, native grass, forbs and moss.

SOILS

Sixteen Map Units were recognized within the park. Soils of the Solonetzic Order in the Canadian System of Soil Classification (CDA 1974) were dominant in six Map Units. Five were composed of soils of the Chernozemic Order, four were predominantly Regosolic, and one was Brunisolic. Pertinent features of these Map Units are summarized in Table 16. Observations on the relationships existing between these soils and other parameters (ie. vegetation, topography, land form) may be found in the comments section of the individual Map Unit descriptions.

Only slight differences are observed among some Map Units, but these are generally important enough, with respect to some recreational and/or engineering use, to justify their separation. The wide variations in horizon thickness reported in some of the following Map Unit descriptions demonstrate the extreme variability commonly found in soils. Variations in thickness of as much as 10 to 40 percent from the norm can be found in comparative horizons of the same soil series found at different points in the landscape.

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

TABLE 16. KEY TO THE SOILS

Map Unit	Classification	Parent Material	Surface Texture	Slope (class & gradient)	Surface Stoniness	Drainage	Comments & Limitations
1	Orthic Black Chernozem	moderately fine textured till	L	c,d,e (2+ to 15%)	1,2,3	well drained	slight to moderate limitations on suitable topography - surface stoniness, excessive slope erosion hazard, high clay content, moderate shrink-swell potential, and susceptibility to frost heave.
2	Dark Brown Solonetz - 60% Saline Regosol - 30% Dark Brown Chernozem - 10%	medium to fine textured colluvium derived partly from weathered sandstone and shale and partly from till 70% moderately fine textured alluvium 30%	L	d,e,f (5+ to 30%)	1	well drained	water percolation very slow on saline regosol areas. Moderate to severe limitations - excessive slope, slippery or sticky when wet, high clay content, slow permeability, high shrink-swell potential, susceptibility to frost heave, surface soil salinity, high lime content, thin Ah, possible concrete corrosion hazard, erosion hazard, solonetzic soil.
3	Orthic Dark Gray Chernozem	moderately fine textured till - may also include some colluvium derived from both weathered sandstone and shale, and till	L	f (15+to 30%)	1	well drained	soil developed on backslope of large slump. Moderate limitations for paths and trails and sanitary landfills; severe for all other uses - excessive slope, erosion hazard, moderate shrink-swell potential, susceptibility to frost heave. Small areas of more suitable topography will have less severe limitations.
4	Gray Solonetz - 80% Orthic Dark Gray Chernozem - 20%	moderately fine to fine textured colluvium derived partly from weathered sandstone and shale and partly from till	L-CL	d,e,f (5+ to 30%)	0	well drained	soils developed in bowl - shaped depressions, caused by gullying and some failing severe limitations for all uses except sanitary landfills, septic tank absorption fields and buildings without basements - excessive slope, slow permeability, slippery or sticky when wet, high clay content, high shrink-swell potential, susceptibility to frost heave, possible concrete erosion hazard, solonetzic soil, water salinization hazard.
5	Undifferentiated Regosol	exposed sandstone and shale	not determined	g(30+ to 60%)	2	rapidly drained (surface runoff)	rough, steep eroded bedrock. Gullying and failing are active, severe limitations for all uses - excessive slope, bedrock exposures, erosion hazard, slippery or sticky when wet, surface salinity, possible concrete corrosion hazard (soluble sulphate), high shrink-swell potential and water salinization hazard.

TABLE 16. KEY TO THE SOILS

Map Unit	Classification	Parent Material	Surface Texture	Slope (class & gradient)	Surface Stoniness	Drainage	Comments & Limitations
6	Orthic Regosol	Alluvium of highly variable texture	FSL - SiCL	b(0.5+ to 2%)	0	well drained	recent alluvial terrace. Slight to moderate limitations for most uses except severe for buildings, septic tank absorption fields, sanitary landfills and reservoir sites - flooding hazard (overflow), slippery or sticky when wet, moderate permeability, ground water contamination hazard, lack of Ah horizon, high clay content (for a source of sand), and thin deposit of sand.
7	Dark Brown Solod - 60% Orthic Dark Brown Chernozem - 40%	medium to fine textured colluvium derived partly from weathered sandstone and shale and partly from till	SL - L	f(15+ to 30%)	2	well drained	severe limitations for all uses except paths and trails and sanitary landfills - excessive slope, surface stoniness, high clay content of subsoil, solonetzic soil, moderate permeability, moderate to high shrink-swell potential, susceptibility to frost heave, thin Ah horizon, high lime content (soil nutrient imbalance), possible concrete corrosion hazard (soluble sulphate) and water salinization hazard.
8	Orthic Dark Brown Chernozem	medium to fine textured colluvium derived partly from weathered sandstone and shale and partly from till	L	f(15+ to 30%)	1	well drained	severe limitations for all uses except paths and trails and sanitary landfills - excessive slope, erosion hazard, thin Ah horizon, high lime content (soil nutrient imbalance), susceptibility to frost heave, possible concrete corrosion hazard (soluble sulphate) and water salinization hazard.
9	Dark Brown Solonetz - eroded phase	medium textured alluvium	L-SIC	B(0.5+to2%)	0	well drained	water percolation is very slow, limitations range from slight for sanitary landfills and buildings without basements to severe for majority of uses - slippery or sticky when wet, moderate to slow permeability, susceptibility to frost heave, high lime content (soil nutrient imbalance), thin Ah horizon, moderate shrink-swell potential, possible concrete corrosion hazard (soluble sulphate), solonetzic soil and water salinization hazard.
10	Dark Brown Solonetz - lithic phase 60% Orthic Dark Brown Chernozem - lithic phase 40%	medium to very coarse textured alluvium, overlying bedrock	FSL - L	c,d,f,(2+ to 30%)	1	well drained	slight to severe limitations - excessive slope, erosion hazard, moderate permeability, moderate shrink-swell potential, susceptibility to frost heave, shallow depth to bedrock, solonetzic soil, thin Ah horizon and possible concrete corrosion hazard (soluble sulphate)

TABLE 16. KEY TO THE SOILS

Map Unit	Classification	Parent Material	Surface Texture	Slope (class & gradient)	Surface Stoniness	Drainage	Comments & Limitations
11	Orthic Dark Brown Chernozem	moderately coarse to medium textured alluvium	FSL - L	C(2+ to 5%)	0	well drained	limitations are moderate for playing fields and reservoir sites and slight for all other uses - excessive slope, moderate permeability, thin Ah horizon and high clay content (for a source of sand).
12	Rego Dark Brown Chernozem	moderately coarse to very coarse textured aeolian sand	FSL	f(15+to30%)	0	rapidly drained	severe limitations for all uses - excessive slope, erosion hazard, shallow depth to sand, rapid permeability, and ground water contamination hazard.
13	Dark Brown Solod and Dark Brown Solonetz	moderately coarse to moderately fine textured alluvium	L - FSL	C,D(2+to9%)	0	well drained	similar to Map Unit 9 but thicker surface horizons, limitations are severe for reservoir sites and slight to moderate for other uses - excessive slope, solonetzic soil, erosion hazard, thin Ah horizon, moderate permeability, possible concrete corrosion hazard (soluble sulphate), water salinization hazard and high clay content.
14	Orthic Regosol	very coarse to moderately fine textured alluvium	LFS	B(0.5 +to2%)	0	well drained	slight to severe limitations - flooding hazard (overflow), sandy surface texture, lack of Ah horizon, high lime content (soil nutrient imbalance), shallow depth to sand, rapid permeability, moderate shrink-swell potential and susceptibility to frost heave of lower subsoil.
15	Orthic Regosol	moderately coarse to moderately fine textured alluvium	SIL	B(0.5+to2%)	0	well drained	surface deposit of new soil material has buried previously formed Brown Solonetz, limitations are severe for camp areas, reservoir sites and buildings, otherwise slight to moderate - flooding hazard, slippery or sticky when wet, high lime content (soil nutrient imbalance), lack of Ah horizon, possible concrete corrosion hazard (soluble sulphate) and solonetzic soil.

TABLE 16. KEY TO THE SOILS

Map Unit	Classification	Parent Material	Surface Texture	Slope (class & gradient)	Surface Stoniness	Drainage	Comments & Limitations
16	Orthic Eutric Brunisol – lithic phase	moderately fine textured colluvium derived partly from weathered sandstone and shale and partly from till, overlying bedrock	CL	G(30+to 60%)	1	well drained	severe limitations for all uses – excessive slope, erosion hazard, lack of Ah horizon, shallow depth to bedrock, high clay contents, slow permeability, moderate to high shrink-swell potential and susceptibility to frost heave.

Map Unit I

Classification: Orthic Black Chernozem

Parent Material: moderately fine textured till

Landform: undulating morainal Mu
hummocky morainal Mh
inclined morainal Mi

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

Surface stoniness: slightly stony to very stony (1 to 3)

Drainage: well drained

Vegetation: some native grass, mainly cultivated for cereal crops, (wheat, oats, barley)

Profile Description:

Orthic Black Chernozem

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah-Ap	15-25	6-10	loam	granular	soft, dry; very friable, moist
Bm	30-50	12-20	clay loam	prismatic with subangular blocky mesostructure	firm, moist; hard, dry
BC	0-30	0-12	clay loam	amorphous	slightly hard, dry; very friable, moist
Cca	at 70-95	at 28-38	clay loam	amorphous	slightly hard, dry ; very friable, moist

Comments: This soil is developed on the till plain through which the Red Deer River has incised its valley. It is an excellent agricultural soil, though slightly limited by stoniness and topography. It is also found on the 'dry island' identified in the park name. The island is a remnant of the original till plain and has been isolated by erosion. The soil on the island has a thinner Ah horizon than generally found on the till plain. This may be due to the dryer

environment created on the is land by surface runoff. In this xerophytic environment, grass vegetation is thin, and cyclical additions of organic matter are low, so Ah horizons are less strongly expressed. The limitations remain the same for the soils on the island as for those on the till plain with the exception that the 'dry island' soils are only moderately suited for lawns and landscaping. While the soils on the 'dry island' possess only slight to moderate limitations for most uses, difficult access and isolation may preclude utilization of this area.

Limitations: On suitable topography this soil has moderate limitations for playing fields, buildings with basements, sanitary landfills - trench type, reservoir sites,and road location or source of roadfill;and slight limitations for all other uses. Specific limitations are surface stoniness, excessive slope, erosion hazard, a higher clay content than suitable for some uses, moderate shrink-swell potential and susceptibility to frost heave.

Map Unit 2

Classification:	Dark Brown Solonetz	60%
	Saline Regosol	30%
	Dark Brown Chernozem	10%
Parent Material:	medium to fine textured colluvium derived partly from weathered sandstone and shale and partly from till	70%
	moderately fine textured alluvium	30%
Landform:	colluvial blanket overlying ridged rock, modified by failing and gullying Cb/Rr-FV	
Slope:	gently rolling to strongly rolling (5+ to 30%)	
Surface stoniness:	slightly stony (l)	
Drainage:	well drained	
Vegetation:	generally native grass with pasture sage, scattered sagebrush and patches of ground juniper. Gumweed occurs on the eroded Brown Solonetz soils. Patches of shrubs are found in depressions and on north and east facing slopes; these include saskatoon berry, buckbrush, rose, chokecherry, wolf willow, aspen, gooseberry and currant.	

Profile Description:

Dark Brown Solonetz

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	2.5-5	1-2	fine sandy loam	granular	very friable, moist; soft, dry
Ahe	5	2	fine sandy loam	platy	very friable, moist; slightly hard, dry
Bnt	7.5-10	3-4	silty clay to clay	columnar with subangular blocky mesostructure	very hard, dry (very dense)
Ccasa	15-20	6-8	clay loam to silty clay	subangular blocky	hard to very hard, dry; firm to very firm, moist

Saline Regosol

Aek	5	2	loam	platy	very friable, moist
AC	5	2	silty clay	columnar with subangular blocky mesostructure	very hard, dry (very dense)
Ccasa	at 10	at 4	clay loam to silty clay	subangular blocky	very firm, moist

Dark Brown Chernozem

Ah	10	4	loam	granular	very friable, moist
Bm	40	16	loam to clay loam	prismatic with subangular blocky mesostructure	slightly hard, dry
R	at 50-75	at 20-30	sandstone		

Comments: The soils of this Map Unit are highly saline and high in soluble sodium. This salinity is in part inherited from the eroded sediments which make up the bulk of the colluvial material and is enhanced by the flow of saline water through the soils. The water becomes salinized in its passage over and through the sandstone and shale.

Several factors contribute to the vegetation sparceness and type. To begin with, a low amount of precipitation falls in the area. Subsequently, much of this is lost to the soil for the following reasons: The steep eroded slopes and large exposures of bedrock create a hot dry microclimate (especially on south facing slopes) in which evapotranspiration is high and stored moisture is rapidly removed from the soil. The steep slopes and numerous gullies also contribute to rapid surface runoff thereby preventing infiltration and storage of water in the soil. High sodium levels are responsible for the formation of dense, hard, solonetzic Bnt horizons which also lessen infiltration and increase surface runoff. Furthermore, plant roots have difficulty in absorbing saline water, so that water which actually enters the soil may not be available to many types of vegetation.

The Saline Regosol has developed on low-lying, relatively flat portions of the landscape where fine textured weathered material has accumulated from surface runoff. The nature of this weathered material is such that it hardens irreversibly upon drying to form a dense impenetrable layer near the surface. Water percolation is extremely slow to nil in these areas, and vegetation is thin to absent. Where vegetation is established it generally consists of pasture sage, gumweed, and various other salt resistant forbs. The soil surface remains wet and slippery for a long time after a rain.

Limitations: On slopes less than 15%, moderate for paths and trails, septic tank absorption fields, and sanitary land fills, slight to moderate for buildings without basements and severe for all other uses. On slopes greater than 15% severe for all uses except sanitary land fills which have moderate limitations. Specific limitations are excessive slope, slippery or sticky when wet, high clay content, slow permeability, high shrink-swell potential, susceptibility to frost heave, surface soil salinity, high lime content, thin Ah horizon, possible concrete corrosion hazard, erosion hazard and solonetzic soil.

Map Unit 3

Classification: Orthic Dark Gray Chernozem

Parent Material: moderately fine textured till - may also include some colluvium derived from weathered sandstone and shale, and till.

Landform: morainal blanket overlying ridged rock modified by failing Mb/Rr-F

Slope: strongly rolling (15+to 30%)

Surface stoniness: slightly stony (I)

Drainage: well drained

Vegetation: fairly thick cover of aspen, saskatoon-berry, chokecherry, buck-brush, rose, gooseberry, high-bush cranberry, and grass and forbs. On drier south and east facing slopes wolf willow occurs.

Profile Description:

Orthic Dark Gray Chernozem

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	5	2	leaf litter		
Ahe	15-45	6-18	loam	granular	slightly hard, dry
Bm	25-35	10-14	loam to clay loam	subangular blocky	slightly hard to hard, dry
BC	to 100	to 40	sandy loam to clay loam	amphorous	soft to hard, dry (variable)

lime not encountered in profile depth, pockets of coal in BC horizon

Comments: These soils have developed on the backslope of a large continuous slump, or series of slumps, which parallel(s) the upper edge of the river valley. This slump represents a breaking away of the former edge of the till plain and a downward displacement, due to gravity. While minor disruptions occurred during movement, the surface material remained largely undistrubed. Due to the change in position of these soils to a more sheltered location where increased surface runoff is trapped they support the growth of a thicker forest cover than is characteristic of Map

Unit I soils. The thicker forest cover and resultant acidic leaf litter led to eluviation of these soils, and degradation from Black Chernozem to Dark Gray Chernozems. It is likely that this slump is of relatively recent origin as the change in soil type has not been dramatic.

Limitations: Moderate for paths and trails and sanitary land fills - trench type; severe for all other uses. Specific limitations are excessive slope and erosion hazard; as well as moderate shrink-swell potential and susceptibility to frost heave of the subsoil. Rough topography is usually the major limiting factor on these soils. On-site inspection could locate small soil areas of more suitable topography with slight to moderate limitations similar to those reported for corresponding topographic classes of Map Unit I soils.

Map Unit 4

Classification:	Gray Solonetz	80%
	Dark Gray Chernozem	20%

Parent Material: moderately fine to fine textured colluvium derived partly from weathered sandstone and shale and partly from till

Landform: colluvial blanket overlying ridged rock, modified by failing and gullying Cb/Rr-FV

Slope: gently rolling to strongly rolling (5+ to 30%)

Surface stoniness: stone free (0)

Drainage: well drained

Vegetation: relatively thick cover of aspen, saskatoon-berry, chokecherry, rose, buckbrush, dogwood, pin cherry, some thorny buffaloberry and Canadian buffaloberry.

Profile Description:

Gray Solonetz

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	5	2	leaf litter		
Ae	2.5-10	1-4	loam to clay loam	platy	very friable to friable, moist
Bnt	15-35	6-14	clay	columnar with subangular blocky mesostructure	very hard, dry (very dense)
Ccasa	at 25-37.5	at 10-15	clay to silty clay	amorphous to subangular blocky	firm to very firm, moist

Orthic Dark Gray Chernozem

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	5	2	leaf litter		
Ah	15-45	6-18	loam	granular	slightly hard, dry
Bm	25-35	10-14	loam to clay loam	subangular blocky	slightly hard to hard, dry
BC	to 100	to 40	sandy loam to clay loam	amorphous	soft to hard, dry

lime not encountered in profile depth

Comments: The soils of this Map Unit have developed in bowl shaped depressions carved out by the gullying action of runoff waters and to a lesser extent by failing and other types of gravity-induced erosion. A higher percentage of trees and shrubs occur on these soils than those of Map Unit 2, because the depressions offer some protection from the sun and serve as channels for precipitation runoff. Consequently growth is enhanced by an increased moisture supply.

Limitations: Moderate for sanitary land fills, on slopes less than 9% limitations are moderate for septic tank absorption fields and slight for buildings without basements, otherwise they are severe. Specific limitations are excessive slope, slow permeability, slippery or sticky when wet, high clay content, high shrink-swell potential, susceptibility to frost heave, possible concrete corrosion hazard, solonetzic soil and water salinization hazard.

Map Unit 5

Classification: Undifferentiated Regosol

Parent Material: exposed shale and sandstone

Landform: ridged rock modified by failing and gullying Rr-FV

Slope: hilly (30+ to 60%)

Surface stoniness: moderately stony (2)

Drainage: rapidly drained (surface runoff)

Vegetation: very sparse; scattered patches of grass and forbs, numerous patches of juniper.

Profile Description: no profile development

Comments: This material can be classed as "nonsoil". The combination of steep slopes, extremely low permeability of the consolidated material, rapid surface runoff of precipitation, and lack of vegetation does not permit the process of soil formation to be initiated.

Limitations: Severe for all uses due to excessive slopes, bedrock exposures, erosion hazard, slippery or sticky when wet, surface salinity, possible concrete corrosion hazard (soluble sulphate), high shrink-swell potential and water salinization hazard.

Map Unit 6

Classification: Orthic Regosol

Parent Material: Alluvium of highly variable texture

Landform: fluvial terrace Ft

Slope: gently undulating (0.5+ to 2%)

Surface stoniness: stone free (0)

Drainage: well drained

Vegetation: commonly shrubs; saskatoon-berry, rose, buckbrush, wolf willow, chokecherry, dogwood, grass and forbs. Patches of aspen and balsam poplar occur along the edge of the river and there are some open areas of grass, pasture sage and scattered sagebrush.

Profile Description:

Orthic Regosol

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	2.5-5	1-2	leaf litter	(absent in grass areas)	
Bm	10-30	4-12	silt loam	subangular blocky	slightly hard to hard, dry
			sometimes silty clay loam or loam to fine sandy loam		hard, dry soft, dry
Cca	at 10-30	at 4-12	sandy loam to very fine sandy loam	amorphous	soft, dry
	(layers from 10 to 46 cm or 4 to 18 in. in thickness)		silt loam		slightly hard, dry

silty clay loam	amorphous	hard, dry
silty clay occasional sand lens	amorphous single grain	very firm, moist loose, dry

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Comments: The soils of this Map Unit have developed from sediments of highly variable texture deposited by the river as it incised the valley to its present level. These soils are not saline and have a more desirable physical structure than the solonetzic soils which dominate adjoining Map Units. They are therefore able to support a more varied and abundant growth of vegetation.

Limitations: Slight for road location and source of roadfill, moderate for camp and picnic areas, playing fields, paths and trails and lawns and landscaping; severe for buildings, septic tank absorption fields, sanitary landfills - trench type, and reservoir sites. Specific hazards are flooding hazard (overflow), slippery or sticky when wet, moderate permeability, groundwater contamination hazard, lack of Ah horizon, high clay content (for a source of sand), and thin deposit of sand. The severity of the flooding hazard may be overrated. If it is disregarded then these soils possess only slight to moderate limitations for most recreational uses.

Map Unit 7

Classification:

Dark Brown Solod	60%
Orthic Dark Brown Chernozem	40%

Parent Material: medium to fine textured colluvium derived partly from weathered sandstone and shale and partly from till

Landform: colluvial blanket overlying ridged rock modified by failing and gullying Cb/Rr-FV

Slope: strongly rolling (15+ to 30%)

Surface stoniness: moderately stony (2)

Drainage: well drained

Vegetation: generally native grass with pasture sage and scattered prickly pear cactus; patches of shrubs are found in depressions and on north and east facing slopes; these include saskatoon-berry, rose, buckbrush, chokecherry and aspen.

Profile Description:

Dark Brown Solod

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	10	4	loam	granular	very friable, moist
AB	20	8	loam	prismatic with subangular blocky mesostructure	hard, dry
Bnt	10	4	silty clay	subangular blocky	very hard, dry
Cca	at 40	at 16	silty clay	subangular blocky	slightly hard, dry

Orthic Dark Brown Chernozem

L-H	5	2	leaf litter (in wooded portions)		
Ah	0-5	0-2	sandy loam	granular	very friable, moist
Bm	10-25	4-10	loam	subangular blocky	slightly hard, dry
Cca	at 10-30	at 4-12	loam to clay loam	subangular blocky	slightly hard to hard, dry

Comments: The Solod soils are found on mid and lower slopes, and in depressions. The Chernozemic soils, occupying the upper slopes and knolls, have thin Ah horizon.

Limitations: Moderate for paths and trails, sanitary landfills - trench type; severe for all other uses. Specific limitations are excessive slope, surface stoniness, high clay content of subsoil, solonetzic soil, moderate permeability, moderate to high shrink-swell potential, susceptibility to frost heave, thin Ah

horizon, high lime content (soil nutrient imbalance), possible concrete corrosion hazard (soluble sulphate) and water salinization hazard.

Map Unit 8

Classification: Orthic Dark Brown Chernozem

Parent Material: medium to fine textured colluvium derived partly from weathered sandstone and shale and partly from till

Landform: colluvial blanket overlying ridged rock modified by failing and gullying Cb/Rr-FV

Slope: strongly rolling (15+ to 30%)

Drainage: well drained

Vegetation: native grass, pasture sage and numerous patches of shrubs in depressions; these include saskatoon-berry, buckbrush, rose, chokecherry, and some aspen.

Profile Description:

Orthic Dark Brown Chernozem

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	2.5-5	1-2	leaf litter	(under shrubs and trees)	
Ah	7.5-10	3-4	loam	granular	very friable, moist
Bm	30-35	12-14	clay loam	prismatic with subangular blocky mesostructure	hard, dry
Cca	at 35-45	at 14-18	loam	subangular blocky	slightly hard, dry

Comments: The Ah horizons are eroded and thinner on the upper slopes and knolls than on lower slopes and in low areas.

Limitations: Moderate for paths and trails, sanitary landfills - trench type; severe for all other uses. Specific limitations are excessive slope, erosion hazard, thin Ah horizon, high lime content (soil nutrient imbalance), moderate to high shrink-swell potential, susceptibility to frost heave, possible concrete corrosion hazard (soluble sulphate) and water salinization hazard.

Map Unit 9

Classification: Dark Brown Solonetz - eroded phase

Parent Material: medium textured alluvium

Landform: fluvial apron Fa

Slope: very gently sloping (0.5+ to 2%)

Surface stoniness: stone free (0)

Drainage: well drained

Vegetation: native grass (including blue grama), pasture sage and prickly pear cactus.

Profile Description:

Dark Brown Solonetz - eroded phase

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	0-5	0-2	loam	granular	soft, dry
Bnt	25-45	10-18	silty clay	columnar with subangular blocky mesostructure	very hard, dry
Cca	at 25-50	at 10-20	loam to silt loam	amorphous	slightly hard to hard, dry

Comments: There are frequent eroded patches where the A horizon is absent and an accumulation of lime occurs only 5–7.5 cm (2–3 in) below the surface. These soils have developed from alluvial deposits of variable texture. Considerable material has been washed down the steep valley sides by rainfall runoff. This material has a high content of sodium and other salts which have resulted in the formation of solonetzic features. Water percolation is very slow.

Limitations: Slight for sanitary landfills - trench type, and buildings without basements, moderate for road location and source of roadfill, septic tank absorption fields and buildings with basements; otherwise severe. Specific limitations are slippery or sticky when wet, moderate to slow permeability, susceptibility to frost heave, high lime content (soil nutrient imbalance), thin Ah horizon, moderate shrink-swell potential, possible concrete erosion hazard (soluble sulphate), solonetzic soil and water salinization hazard.

Map Unit 10

Classification: Dark Brown Solonetz - lithic phase 60%
Orthic Dark Brown Chernozem - lithic phase 40%

Parent Material: medium to very coarse textured alluvium (highly variable texture), overlying bedrock

Landform: fluvial veneer overlying undulating rock Fv/Ru
fluvial veneer overlying hummocky rock Fv/Rh

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

Surface stoniness: slightly stony (I)

Drainage: well drained

Vegetation: grass and pasture sage with patches of buckbrush, wolf willow and rose.

Profile Description:

Dark Brown Solonetz - lithic phase

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	2.5-5	1-2	loam to fine sandy loam	granular	soft, dry
Ahe	5-17.5	2-7	loam to fine sandy loam	platy	slightly hard to soft, dry
Bnt	10-17.5	4-7	silty clay	columnar with subangular blocky mesostructure	very hard, dry
Cca	10-55	4-22	loam to silty clay loam	amorphous	slightly hard to hard, dry
R	at 50-75	at 20-30	bedrock (sandstone or shale)		

Orthic Dark Brown Chernozem - lithic phase

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	5	2	fine sandy loam	granular	soft, dry
Bm	20	8	fine sandy loam	prismatic with a subangular blocky mesostructure	soft, dry
BC	25	10	loamy fine sand	single grain	loose, dry
Cca	0-25	0-10	loam	amorphous	slightly hard, dry
R	at 50-75	at 20-30	bedrock (sandstone or shale)		

Comments: The soils of this Map Unit have developed on the dissected remnants of a former valley bottom. A gently undulating erosional surface existed at one time at an elevation some 50 meters (165 ft) above the present valley bottom. This has since been dissected by gully erosion into numerous 'islands' of the former plain which are characterized by gently undulating to gently rolling surfaces bounded by steep eroded scarps. The sides consist of colluvium or exposed bedrock while the surfaces retain some of their original veneer of fluvial sediments. The salinization causing Solonetzic soils probably results from the uptake of salts from the shallow underlying bedrock into the fluvial sediments.

Limitations: Slight on suitable topography for camp and picnic areas, paths and trails and buildings without basements; moderate on suitable topography for playing fields, lawns and landscaping, buildings with basements, and road location and source of roadfill; severe for septic tank absorption fields, sanitary landfills - trench type and reservoir sites. Specific limitations are excessive slope, erosion hazard, moderate permeability, moderate shrink-swell potential, susceptibility to frost heave, shallow depth to bedrock, solonetzic soil, thin Ah horizon and possible concrete corrosion hazard (soluble sulphate).

Map Unit II

Classification: Orthic Dark Brown Chernozem

Parent Material: moderately coarse to medium textured alluvium

Landform: fluvial terrace Ft

Slope: undulating (2+ to 5%)

Surface stoniness: stone free (0)

Drainage: well drained

Vegetation: grass, pasture sage, scattered buckbrush

Profile Description:

Orthic Dark Brown Chernozem

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	10	4	loam to fine sandy loam	granular	soft, dry
Bm	40	16	loam to fine sandy loam	prismatic with subangular blocky mesostructure	slightly hard, dry
Cca	at 50	at 20	loam to fine sandy loam	amorphous	slightly hard, dry

Comments: These soils have developed on an alluvial terrace which is slightly older and more elevated than those which are occupied by the soils of Map Unit 6. The Chernozemic soils of this Map Unit are older and show greater profile development than the Regosolic soils of Map Unit 6.

Limitations: Moderate for playing fields and reservoir sites; slight for all other uses. Specific limitations are excessive slope, moderate permeability, thin Ah horizon and high clay content (for a source of sand).

Map Unit 12

Classification: Rego Dark Brown Chernozem

Parent Material: Moderately coarse to very coarse textured aeolian sand

Landform: hummocky aeolian Eh

Slope: strongly rolling (15+ to 30%)

Surface stoniness: stone free (0)

Drainage: rapidly drained

Vegetation: grass, pasture sage, scattered buckbrush and patches of wolf willow.

Profile Description:

Rego Dark Brown Chernozem

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	5	2	fine sandy loam	granular	soft, dry
Bm	5	2	fine sandy loam	prismatic with subangular blocky mesostructure	slightly hard, dry
Cca_1	50	20	fine sandy loam	amorphous	slightly hard, dry
Cca_2	at 60	at 24	sand	single grain	loose, dry

Comments: These soils are found on only one landscape unit within the park. It may once have been an island in a former stream channel but it has been enlarged by the accumulation of wind blown sand. A deep gully to the north and west funnels wind toward this site where it slows down and deposits its load of fine sand and silt. The shallow depth of soil profile development is evidence of continuing accretion of aeolian material.

Limitations: Severe for all uses. Specific limitations are excessive slope, erosion hazard, shallow depth to sand, rapid permeability and ground water contamination hazard.

Map Unit 13

Classification: Dark Brown Solod and Dark Brown Solonetz
(These two subgroups are intimately and unpredictably associated)

Parent Material: moderately coarse to moderately fine textured alluvium

Landform: fluvial apron Fa
fluvial fan Ff

Slope: gently to moderately sloping (2+ to 9%)

Surface stoniness: stone free (0)

Drainage: well drained

Vegetation: grass, pasture sage and scattered buckbrush.

Profile Description:

Dark Brown Solod

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ah	2.5	1	loam to fine sandy loam	granular	soft, dry
Ahe-AB	12.5-25	5-10	loam to fine sandy loam	platy to prismatic	slightly hard to hard, dry

Bnt	12.5–25	5–10	silty clay loam to clay loam	columnar with subangular blocky mesostructure	hard to very hard, dry
Cca	at 40	at 16	loam to fine sandy loam	amorphous	slightly hard to hard, dry

Dark Brown Solonetz

Ah	2.5	1	fine sandy loam	granular	soft, dry
Ahe	15	6	fine sandy loam	platy	slightly hard, dry
Bnt	17.5	7	silty clay	columnar with a subangular blocky mesostructure	very hard, dry
Cca	at 35	at 14	loam to silty clay loam	amorphous	slightly hard to hard, dry

Comments: These soils are very similar to those of Map Unit 9. They have developed on fans and aprons of saline debris deposited by running water at the base of the steep valley slopes. They differ from the soils of Map Unit 9 in having thick Ahe to AB horizons overlying the hard solonetzic Bnt horizon.

Limitations: Severe for reservoir sites; slight for picnic areas, paths and trails, buildings without basements and sanitary landfills - trench type; moderate for camp areas, playing fields, lawns and landscaping, buildings with basements, septic tank absorption fields, road location and source of roadfill. Specific limitations are excessive slope, solonetzic soil, erosion hazard, thin Ah horizon, high clay content, moderate permeability, possible concrete corrosion hazard (soluble sulphate), and water salinization hazard.

Map Unit 14

Classification: Orthic Regosol

Parent Material: very coarse to moderately fine textured alluvium

Landform: level fluvial Fl

Slope: very gently sloping (0.5 +to 2%)

Surface stoniness: stone free (0)

Drainage: well drained

Vegetation: grass, pasture sage; patches of buckbrush, rose, wolf willow and scattered sagebrush.

Profile Description:

Orthic Regosol

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Cca_1	60	24	loamy fine sand	amorphous	soft, dry
Cca_2	30	12	sand	single grain	loose, dry
Cca_3	at 90	at 36	silty clay loam	amorphous	hard, dry

Comments: These soils have developed under essentially the same influences as those of Map Unit 9. They have probably been inundated more frequently and have received greater amounts of sediment than Map Unit 9 soils; therefore they exhibit much less profile development.

Limitations: Severe for camp areas, buildings and reservoir sites, moderate for picnic areas, playing fields, paths and trails, lawns and landscaping,and road location and source of roadfill; slight for septic tank absorption fields and sanitary landfills - trench type. Specific limitations are flooding hazard (overflow), sandy surface texture, lack of Ah horizon,

high lime content (soil nutrient imbalance), shallow depth to sand, rapid permeability, thin deposit of sand, moderate shrink-swell potential and susceptibility to frost heave of lower subsoil.

Map Unit 15

Classification: Orthic Regosol

Parent Material: moderately coarse to moderately fine textured alluvium

Landform: level fluvial Fl

Slope: very gently sloping (0.5+ to 2%)

Surface stoniness: stone free (0)

Drainage: well drained

Vegetation: the vegetation is very sparse and consists of pasture sage, buckbrush, grass and gumweed.

Profile Description:

Orthic Regosol

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
Ck	12.5	5	silt loam	platy	very friable, moist
ABb	12.5	5	loam	subangular blocky	friable, moist
Bntb	7.5	3	silty clay loam	subangular blocky	firm, moist
Ccab	at 32.5	at 13	very fine sandy loam	amorphous	soft, dry

Comments: This soil is nearly identical to the Solod of Map Unit 13 with the exception that subsequent to the development of the soil profile, the area has been flooded and new material deposited over the surface. The buried Solod is referred to as a paleosol

and the upper 12.5 cm (5 in) of new material is regarded as a new soil. This surface material does not yet show evidence of any profile development and is therefore termed a Regosol. The cover of recent alluvium justifies delineation of this soil as it indicates that the area has recently been subject to flooding either from the river or by excessive surface runoff from the steep hillsides. The flooding and the salinity of the deposited material, have severely restricted the growth of vegetation. These factors increase the limitations of this soil for recreational development.

Limitations: Slight for septic tank absorption fields and sanitary landfills - trench type; moderate for picnic areas, playing fields, paths and trails, lawns and landscaping, and road location and source of roadfill; and severe for camp areas, reservoir sites and buildings. Specific limitations are flooding hazard, slippery or sticky when wet, high lime content (soil nutrient imbalance), lack of Ah horizon, possible concrete corrosion hazard (soluble sulphate) and solonetzic soil.

Map Unit 16

Classification: Orthic Eutric Brunisol - lithic phase

Parent Material: moderately fine textured colluvium derived partly from weathered sandstone and shale, and partly from till, overlying bedrock

Landform: colluvial veneer overlying steep rock Cv/Rs

Slope: very steeply sloping (30+ to 60%)

Drainage: well drained

Vegetation: white spruce, moss, juniper, rose, buckbrush and Canadian buffaloberry.

Profile Description:

Orthic Eutric Brunisol - lithic phase

Horizon	Thickness cm	Thickness in	Texture	Structure	Consistence
L-H	7.5	3	leaf litter		
Bm	10-75	4-30	clay loam	subangular blocky	firm, moist
R	at 10-75	at 4-30	weathered bedrock		

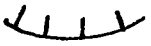
Comments: These soils are found on the steep north and east facing slopes of gullies, which act as drainage channels leading to the river. Numerous stands of white spruce have become established on these soils due to protection from the sun and wind, afforded by the gullies.

Limitations: Severe for all uses. Specific limitations are excessive slope, erosion hazard, lack of Ah horizon, shallow depth to bedrock, high clay content, slow permeability, moderate to high shrink-swell potential, and susceptibility to frost heave.

MISCELLANEOUS LAND TYPES

1)  This symbol indicates very poorly drained areas. It is used in conjunction with standard Map Unit notations to delineate areas within Map Units which periodically exhibit accumulations of up to 60 cm (24 inches) of surface water.

2)  This symbol indicates bedrock outcrops, generally sandstone and shale. These are generally very steeply sloping and therefore have severe limitations for all uses.

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

SOIL INTERPRETATIONS

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

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

The soils occurring within this park display a wide range of suitabilities for recreational development. Much of the area is too steeply sloping for most recreational uses and in general, areas of suitable topography are limited to the upper

till plain and the valley floor. Map Unit 1 soils occur on the till plain and offer only slight to moderate limitations for most uses. Within the valley, soils of Map Units 10, 11 and 13 provide the most suitable areas for recreational development. Some of the other valley floor soils are limited as follows: Map Unit 9 soils display slow water infiltration and slippery or sticky surfaces when wet due to their solonetzic structure. They may also cause concrete corrosion and are susceptible to frost heave and shrink-swell. Soils of Map Units 14 and 15 are subject to flooding from hillside runoff and accumulation of eroded saline material. Map Unit 6 soils may be subject to flooding by the river and display a slippery or sticky surface texture when wet. With the exception of seasonally high groundwater tables and organic soils, every limitation listed below Table 17 is found somewhere in the park. The most prevalent limitations are excessive slope, erosion hazard, Solonetzic soil, flooding hazard, concrete corrosion hazard, susceptibility to frost heave and high shrink-swell potential. Severe limitations don't necessarily prevent the use of certain soils for recreational purposes; however it is important to keep these limitations in mind when planning development, as careful or expensive construction procedures will likely be required to overcome them. Map Unit 1 provides a good source of top soil and Map Units 10 and 11 are fair sources. No good sources of sand and gravel occur in the park but sand may be obtained from Map Units 12 and 14.

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

It is recognized that interactions among some soil and other properties may be great enough to change the limitation ratings by one class. If a moderate or severe limitation occurs in a given map unit, lesser limitations are usually not specified. Limitations due to slope are not subdivided once the limitation becomes

severe for the specified use. It follows however, that the steeper the slope, the more severe the limitation, and this fact should be considered in using the soil interpretation tables. In Table 17 the soil limitations for various uses have been designated as slight (S), moderate (M), and severe (V). As a source of topsoil or as a source of sand or gravel the soils are simply rated as good (G), fair (F), poor (P), and unsuitable (U).

TABLE 17. LIMITATIONS AND SUITABILITIES FOR SELECTED USES

Map[2] Symbol	Limitations For:											Suitability as a Source of	
	Camp Areas	Picnic Areas	Playing Fields	Paths and Trails	Lawns & Landscaping	Buildings with basement	Buildings without basement	Septic Tank Absorption Fields	Sanitary Landfills-Trench Type	Reservoir Sites	Road Location & Source of Roadfill	Topsoil[1]	Sand or Gravel
1/c1	S	S	M3	S	S	M22, 14,7	S	S	M7	M3	M22, 14,7	G	U
1/c2	M4	S	M3,4	S	M4	M22, 14,4	M4	S	M7,4	M3	M22 14,7	F4	U
1/d1	S	S	V3	S	S	M22, 14,7	S	S	M7	M3	M22, 14,7	G	U
1/d2	M4	S	V3,4	S	M4	M22, 14,4	M4	S	M7,4	M3	M22, 14,7	F4	U
1/e2	M3, 4,25	M3, 25	V3,4 25	S	M3, 4,25	M3, 22,14	M3, 4	M3	M7,4	V3	M22, 14,3	F3, 4,25	U
1/e3	V4, 3,25	V3, 4,25	V3, 4,25	M4	V4, 3,25	V4, 3,22	V4,3	M3	V4,7	V3	M22, 14,3	P4, 3,25	U
1/F3	V3, 4,25	V3, 4,25	V3, 4,25	M4, 3,25	V4, 3,25	M4, 3,22	V4,3	V3	V4, 7,3	V3	V3,22, 14	P4, 3,25	U
2/d1	V26, 11,25	V26, 11,25	V3, 26,25	M26, 25,6	V26, 15,16	V23, 22,14	S	M10, 23	M7	V28, 26,3	V13, 14,7	P15, 16,18	U
2/e1	V26, 3,25	V26, 3,25	V3, 26,25	M26, 25,6	V26, 15,16	V23, 22,14	M3	M3, 10,23	M7	V3, 28,26	V13, 14,3	P15, 16,18	U
2/f1	V3, 26,25	V3, 26,25	V3, 26,25	V3, 26,25	V3, 26,15	V3, 23,22	V3	M3, 10,23	M3,7	V3, 28,26	V3, 13,14	P3, 15,16	U
3/f1	V3, 25	V3, 25	V3, 25	M3, 25	V3, 25	V3, 22,14	V3	V3	M3	V3	V3, 22,14	P3, 25	U
4/do	V26, 11,25	V26, 11,25	V3, 26,25	V26, 25,6	V26, 11,7	V23, 22,14	S	M10, 23	M7	V28, 26,3	V13, 14,7	P18, 26,25	U
4/fo	V3, 26,25	V3, 26,25	V3, 26,25	V3, 26,25	V3, 26,11	V3, 23,22	V3	V3, 10,23	M3,7	V3, 28,26	V3, 13,14	P3, 18,26	U
5/f2	V3, 17,6	V3, 17,6	V3, 17,6	V6, 3,17	V3, 17,15	V3, 17,23	V3, 17,4	V3, 17,11	V17, 3,7	V3, 17,28	V3, 17,13	U	U

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

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

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

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

LIMITING SOIL PROPERTIES AND HAZARDS

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

TABLE 17. LIMITATIONS AND SUITABILITIES FOR SELECTED USES

Map[2] Symbol	Limitations For:											Suitability as a Source of	
	Camp Areas	Picnic Areas	Playing Fields	Paths and Trails	Lawns & Landscaping	Buildings with basement	Buildings without basement	Septic Tank Absorption Fields	Sanitary Landfills-Trench Type	Reservoir Sites	Road Location & Source of Roadfill	Topsoil[1]	Sand or Gravel
5/g2	V3, 17,6	V3, 17,6	V3, 17,6	V3, 17,6	V3, 17,15	V3, 17,23	V3, 17,4	V3, 17,11	V3, 17,7	V3, 17,28	V3, 17,13	U	U
6/bo	M6	M6	M6	M6	MI8	VI	VI	VI	VI	VI	S	PI8	P7,24
7/f2	V3, 4	V3, 25	V3,4 25	M3, 25	V3, 16,4	V3, 23,22	V3	V3, 10,23	M3, 7	V3, 28,26	V3, 13,14	P3, 16,18	U
8/fl	V3, 25	V3, 25	V3, 25	M3, 25	V3, 16,25	V3, 23,22	V3	V3, 11,23	M3, 7	V3, 28	V3, 13,14	P3, 16,18	U
9/Bo	V26, 11,6	V26, 11,6	V26, 11,6	V26, 11,6	V26, 18,16	M23, 22,14	S	M23	S	V28, 26,10	M22, 14	PI8, 26,16	U
10/cl	S	S	M3, 17	S	MI8, 17	MI7, 22,23	S	VI7	VI7	VI7, 10,3	M22, 14	FI8, 26	U
10/dl	S	S	V3, 17	S	MI8, 17	MI7, 22,23	S	VI7	VI7	VI7, 10,3	M22, 14	FI8, 26	U
10/fl	V3, 25	V3, 25	V3, 17,25	M3, 25	V3, 18,17	V3, 17,22	V3	V3, 17,	VI7, 3	VI7, 3,10	V3, 22,14	P3, 18,26	U
13/co	S	S	M3	S	S	S	S	S	S	M 10, 3	S	FI8	P7
12/fo	V3, 25	V3, 25	V3, 25,8	M3, 25	V3, 8,9	V3	V3	V3, 9,12	V8, 9,12	V3, 8,9	V3	PI8, 3,25	F2I
13/co	M26, 10,25	S	M3, 10,25	S	MI8	M26, 23	S	M26, 23	S	V28, 10,3	M26, 7	FI8, 26	P7
13/Co	M26, 10,25	S	M3, 10,25	S	MI8	M26, 23	S	M26, 23	S	V28, 10,3	M26, 7	FI8, 26	P7
13/Do	M26, 10,25	S	V3, 10,25	S	MI8	M26, 23	S	M26, 23	S	V28, 10,3	M26, 7	FI8, 26	P7
14/Bo	VI,5	MI,5	MI,5	MI,5	M5, 18,16	VI	VI	S	S	V8, 9,1	M22, 14,1	U	F24

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

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

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

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

LIMITING SOIL PROPERTIES AND HAZARDS

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

TABLE 17. LIMITATIONS AND SUITABILITIES FOR SELECTED USES

Map[2] Symbol	Limitations For: Camp Areas	Picnic Areas	Playing Fields	Paths and Trails	Lawns & Landscaping	Buildings with basement	Buildings without basement	Septic Tank Absorption Fields	Sanitary Landfills-Trench Type	Reservoir Sites	Road Location & Source of Roadfill	Suitability as a Source of: Topsoil[1]	Sand or Gravel
15/Bo	VI,6	MI,6	MI,6	M6	MI8, 16,1	VI, 26,23	VI	S	S	VI, 10	MI	U	P7
16/GI	V3, 7,25	V3, 7,25	V3, 7,25	V3, 7,25	V3, 25,18	V3, 22,14	V3	V3, 17,11	V3, 17,7	V3, 17	V3, 13,14	U	U

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

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

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

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

LIMITING SOIL PROPERTIES AND HAZARDS

1. Flooding hazard (overflow)
2. Seasonally High Groundwater Table or Surface Ponding
3. Excessive slope
4. Surface Stoniness
5. Sandy Surface Texture
6. Slippery or Sticky When Wet
7. High Clay Content
8. Shallow Depth to Sand or Gravel
9. Rapid Permeability (Droughtiness)
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11. Slow Permeability
12. Groundwater Contamination Hazard
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14. Susceptibility to Frost Heave
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16. High Lime Content (Soil Nutrient Imbalance)
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20. Organic Surface Layer More Than 6 Inches Thick
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24. Thin Deposit of Sand or Gravel
25. Erosion Hazard
26. Solonetzic Soil
27. Excessive Coarse Fragments
28. Water Salinization Hazard

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APPENDIX

Chemical Analyses of the Soils

The chemical analyses carried out on representative soil samples are presented in Table 18 . The samples analyzed are surface and subsoil samples, taken of the Map Units at representative sites. Surface samples are taken from the 0 to 6 inch depth, and the subsoil samples from the 6 to 12 inch depth. Each surface sample consists of five separate samples taken at random locations and bunched together into one composite sample. A brief explanation of the significance of each chemical analysis follows.

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 aeriation and less leaching favour the retention of nitrogen in the finer textured soils.

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

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

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

[1] Alberta Soil and Feed Testing Laboratory

TABLE 18. CHEMICAL ANALYSES OF SELECTED MAP UNITS *

Map Unit	Sample Depth (in.)	Pounds per Acre			Sodium **	Sulphate **	Soil Reaction (pH)	Cond. (mmhos/cm.)	Organic Matter**	Free ** Lime ($CaCO_3$)	REMARKS
		Nitrogen (N)	Phosphorus (P)	Potassium (K)							
1	0-6	0	16	461	L		8.5	0.2	M-		cultivated (wheat, oats, ley), some native grass.
	6-12	0	16	458	L		5.5	0.3	M-		
2	0-6	1	8	796	H+	H+	7.3	6.0	M-	L+	native grass, pasture sage sagebrush, ground juniper gumweed, saskatoon-berr buckbrush, rose, chokech wolf willow, aspen, goos berry, currant
	6-12	1	1	319	H+		8.8	0.7	M-	M-	
3	0-6	0	81	708	L		6.1	0.3	M-		aspen, saskatoon-berry, c cherry, buckbrush, rose, berry, high-bush cranberr grass, forbs, wolf willow
	6-12	1	18	609	L		6.1	0.1	M-		
4	0-6	0	87	444	H+		7.4	0.7	M-		aspen, saskatoon-berry, ch cherry, rose, buckbrush, d wood, pincherry, thorny b lo berry, Can. buffalo ber
	6-12	1	24	325	L		7.8	0.4	M-	M	
6	0-6	0	19	554	L		5.8	0.2	M-		saskatoon-berry, rose, buckbrush, wolf willow, chokecherry, dogwood,
	6-12	0	3	431	L		5.9	0.1	M-		
6	0-6	0	35	577	M-		6.5	0.4	M-		grass, forbs, aspen, bals poplar, pasture sage, sagebrush.
	6-12	1	1	385	L		6.9	0.3	M-		

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

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

TABLE 18. CHEMICAL ANALYSES OF SELECTED MAP UNITS *

Map Unit	Sample Depth (in.)	Pounds per Acre			** Sodium	** Sulphate	Soil Reaction (pH)	Cond. (mmhos/ cm.)	Organic Matter**	Free ** Lime ($CaCO_3$)	REMARKS
		Nitrogen (N)	Phosphorus (P)	Potassium (K)							
7	0-6	0	13	465	H+		7.5	0.7	M-	L	native grass, pasture sage, prickly pear cactus, saskatoon-berry, rose, buckbrush chokecherry, aspen.
	6-12	1	0	215	L		8.0	0.3	M-	H+	
8	0-6	1	22	580	M+		7.5	0.4	M-	L	native grass, pasture sage, saskatoon-berry, buckbrush rose, chokecherry, aspen.
	6-12	1	3	358	M		8.3	0.3	M-	H-	
9	0-6	1	13	365	H+		8.0	0.8	M	L-	native grass, pasture sage, prickly pear cactus.
	6-12	1	3	376	H+		8.1	0.8	M-	L	
10	0-6	1	29	502	H+		7.4	0.9	M-		grass, pasture sage, buckbrush, wolf willow, rose.
	6-12	1	2	367	H+		6.5	0.2	M-		
11	0-6	1	21	530	L		6.4	0.3	M-		grass, pasture sage, buckbrush.
	6-12	1	3	320	L		6.4	0.1	M-		
12	0-6	1	13	299	L		7.3	0.4	M-	L+	grass, pasture sage, wolf willow.
	6-12	1	4	202	L		7.4	0.4	M-	M-	
13	0-6	1	8	476	M		7.3	0.4	M-		grass, pasture sage, buckbrush
	6-12	1	1	371	H+		8.5	0.5	M-	M	

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

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

TABLE 18. CHEMICAL ANALYSES OF SELECTED MAP UNITS *

Map Unit	Sample Depth (in.)	Pounds per Acre			Sodium **	Sulphate **	Soil Reaction (pH)	Cond. (mmhos/ cm.)	Organic Matter**	Free ** Lime ($CaCO_3$)	REMARKS
		Nitrogen (N)	Phosphorus (P)	Potassium (K)							
14	0-6	1	5	301	M		7.9	0.3	M-	L+	grass, pasture sage, buckbrush, wolf willow, sagebrush.
	6-12	1	2	162	H		8.4	0.3	M-	M+	
15	0-6	3	3	507	H+		8.4	0.9	M-	L	mostly bare - some pastur sage, buckbrush, grass, gumweed
	6-12	38	3	464	H+	L-	8.8	1.0	M-	L+	

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

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

2. Phosphorus.

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

Most of the total phosphorus supply is tied up chemically in a form that is not usable by plants; it is not available to the growing plant. The available soil phosphorus originates from the breakdown of soil minerals and soil organic matter or from the addition of phosphate fertilizer. The available soil phosphorus is usually only about 1% of the total soil phosphorus.

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

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

3. Potassium.

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

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

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

4. Sulphur.

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

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

[1] Alberta Soil and Feed Testing Laboratory

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

5. Soil Reaction (pH).

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

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

6. Soil Salinity and Conductivity Test.

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

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

0 to 1, negligible salt effects.

1.1 to 3, lawn growth noticeably restricted.

3.1 or more, lawn growth considerably restricted.

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

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

[1]Alberta Soil and Feed Testing Laboratory

7. Organic Matter and Free Lime.

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

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

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

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

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

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

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

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

Engineering Properties of the Soils

Engineering test data determined on a representative soil sample are presented in Table 19. The sample analyzed was taken from the subsoil of Map Unit I at a representative site. Depth of sampling was between 1 and 4 feet below the surface. A brief description of the significance of each analytical parameter follows:

1. Field Moisture Percentage.

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

For any potential borrow material, it is essential to know in advance of con-

TABLE 19. PHYSICAL ANALYSES OF SELECTED MAP UNITS

	Depth (feet)		Mechanical Analysis: Percentage Passing Sieve: 1 inch	3/4 inch	5/8 inch	#4 (4.7 mm.)	#10 (2.0 mm.)	#40 (0.42 mm.)	#200 (0.074 mm.)	Percentage Smaller than: 0.05 mm.	0.005 mm.	0.002 mm.	0.001 mm.	Liquid Limit	Plasticity Index	Optimum Moisture % **	Maximum Dry Density lb/ft^3 **	Classification: AASHO	Unified	USDA
1 *	3-4		100	100	100	100	100	94	62	58	37	30	24	29	15	13	120	A-6(7)	CL	CL
2 *	1-2		100	100	100	100	100	100	80	71	40	28	20	43	18	26	93	A-7-6(12)	CL	CL

Map Units developed on similar parent material a) 1,3
b) 2,4,7,8,16

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

– materials not sampled due to highly variable texture 6,9,10,11,12,13,14,15

struction 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 (PCA 1962). The amounts of the gravel and sand fractions are determined by sieving, while the silt and clay contents are determined by sedimentation techniques. The amount of each soil separate contained in a soil determines its texture.

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

3. Plasticity.

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

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

The tests used for estimating plasticity are plastic limit, liquid limit, and plasticity index. The plastic limit is the moisture content at which the soil passes from a semisolid to a plastic state. The liquid limit is the moisture content at which the soil passes from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid and plastic limits. This parameter gives the range in moisture content at which a soil is in a plastic condition. A small plasticity index, such as 5, indicates that a small change in moisture content will change the soil from a semisolid to a liquid condition. A large plasticity index, such as 20, shows that a considerable amount of water can be added before a soil changes to a liquid condition.

4. Moisture - Density Relationships.

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

5. Soil Classification.

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

(a) AASHO Soil Classification System.

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

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 0 for the best subgrades, to 20 for the poorest.

(b) Unified Soil Classification System.

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

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

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

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

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

GLOSSARY

accretion - The gradual addition of new land to old by the deposition of sediment carried by a stream.

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.

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

Black Chernozem - A great group of soils in the Chernozemic order. The soils occur in the cool to cold subhumid grassland and parkland regions. They have a very dark surface (Ah or Ap) horizon and ordinarily a brownish B (Bm, Btj or Bt) horizon, which may be absent, over a highly base-saturated, usually calcareous C horizon.

Brown Chernozem - A great group of soils in the Chernozemic order. The soils occur in the cool, subarid to semiarid grassland regions, and consist of a brown (dry) surface (Ah or Ap) horizon and ordinarily a lighter-colored brownish B (Bm, Btj or Bt) horizon, which may be absent, over a highly base-saturated, usually calcareous, C horizon.

Brunisolic - An order of soils whose horizons are developed sufficiently to exclude the soils from the Regosolic order, but that lack the degrees or kinds of horizon development specified for soils of the other orders. These soils, which occur under a wide variety of climatic and vegetative conditions, all have Bm or Btj horizons.

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.

Chernozemic - An order of soils that have developed under xerophytic or mesophytic grasses and forbs, or under grassland-forest transition vegetation, in cool to cold, subarid to subhumid climates. The soils have a dark-colored surface (Ah, Ahe or Ap) horizon and a B or C horizon, or both of high base saturation.

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:

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

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

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.

loose - Consistence at which dry or moist soil material is noncoherent.

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

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

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

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

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.

Dark Brown Chernozem - A great group of soils in the Chernozemic order. The soils occur in the cool to cold, semiarid grassland regions and have a dark brown surface (Ah or Ap) horizon and a lighter colored brownish B (Bm, Btj or Bt) horizon, which may be absent, over a highly base saturated, usually calcareous C horizon.

Dark Gray Chernozem - A great group of soils in the Chernozemic order. The soils occur in the cool to cold, subhumid grassland-forest transitional regions, and have a dark gray partially eluviated surface (Ahe or Ap) horizon and

a brownish B (Bm, Btj or Bt) horizon, which may be absent, over a highly base saturated, usually calcareous C horizon.

degradation - The changing of a soil to a more highly leached and weathered state, usually accompanied by morphological changes such as the development of an eluviated, light colored A (Ae) horizon.

detrital - Rock and minerals occurring in sedimentary rocks that were derived from pre-existing igneous, sedimentary or metamorphic rocks.

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

escarpment - A steep face or ridge of high land.

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

evapotranspiration - The combined loss of water from a given area and during a specific period of time, by evaporation from the soil surface and by transpiration from plants.

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.

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.

horizon, soil - A layer of mineral or organic soil or soil material, approximately parallel to the land surface, with characteristics affected by processes of soil formation. It differs from adjacent layers in properties such as color, structure, texture, consistence; and chemical, biological and mineralogical composition. A list of the designations and some of the properties of soil horizons and layers follows.

Mineral horizons and layers contain less than 17% organic carbon (about 30% organic matter) by weight.

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

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

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

R - This is a consolidated bedrock layer that is too hard to break with the hands (>3 on Mohs scale) or to dig with a spade when moist, and that does not meet the requirements of a C horizon.

Roman numerals are prefixed to horizon and layer designations to indicate parent material discontinuities in the profile. Roman numeral I is understood for the uppermost material, and therefore is not written. Subsequently contrasting materials are numbered consecutively in the order in which they are encountered downward, that is, II, III and so on.

For transitional horizons, designations such as AB or BC are used if the transition is gradual; and A and B or B and C if the horizons are interfingered. Dominance of horizons may be shown by order, such as AB or BA, etc.

Organic horizons contain more than 17% organic carbon (approximately 30% organic matter) by weight. Two groups are recognized; O horizons, and L, F and H horizons.

O - This is an organic horizon developed mainly from mosses, rushes and woody materials. It is divided into the following subhorizons:

Of - This is the least decomposed organic horizon, consisting dominantly of well-preserved fibers that are readily identifiable as to botanical origin, and called the fibric horizon.

Om - This is an organic horizon at a stage of decomposition intermediate between fibric and humic materials, and called the mesic horizon. The material is partly altered both physically and biochemically.

Oh - This is the most decomposed organic horizon, containing the lowest amount of raw fiber and called the humic horizon.

L,F and H (commonly abbreviated to L-H) - These are organic horizons developed primarily from the accumulation of leaves, twigs and woody materials with or without a minor component of mosses.

L - The original structures of the organic material are easily discernible.

F - The accumulated organic material is partly decomposed, and some of the original structures are difficult to recognize.

H - An accumulation of decomposed organic material in which the original structures are indiscernible.

Lowercase Suffixes - These are used to designate subhorizons of the major horizons.

b - A buried soil horizon.

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

e - An A horizon characterized by the eluviation of clay, iron, aluminum or organic matter alone or in combination; and usually lighter colored when dry than an underlying B horizon.

h - An A or B horizon enriched with organic matter.

k - Denotes the presence of carbonate, as indicated by visible effervescence when dilute HCl is added.

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

n - A B horizon in which the ratio of exchangeable Ca to exchangeable Na is 10 or less. It must also have the following distinctive morphological characteristics: prismatic or columnar structure, dark coatings on ped surfaces and hard to very hard consistence when dry.

p - A horizon disturbed by mans activities; such as cultivation, logging, habitation, etc.

sa - A horizon with secondary enrichment of salts more soluble than calcium and magnesium carbonates, in which the concentration of salts exceeds that present in the unenriched parent material.

t - A B horizon enriched with silicate clay.

indurated layer - A soil layer that has become hardened, generally by cementation of soil particles.

infiltration - The downward entry of water into the soil.

lithic phase (of soil) - Any mineral soil having bedrock within the control section.

macrostructure (primary structure) - Refers to the larger peds of soil horizons that break down to smaller peds.

mesostructure (secondary structure) - Refers to the smaller peds of soil horizons that result from the break down of larger peds.

nonsoil - The aggregate of surficial materials that do not meet the definition of soil.

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

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.

paleosol (fossil soil) - A soil of the geologic past that was buried subsequent to its formation.

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

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

rego - A subgroup referring to soils that lack a B horizon, in various great groups of the Chernozemic and Regosolic orders in the Canadian system of soil classification.

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

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.

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.

scarp - An escarpment or a cliff.

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.

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

slumping - A landslide characterized by a shearing and rotary movement of a generally independent mass of rock or earth along a curved slip surface (concave upward) and about an axis parallel to the slope from which it descends, and by backward tilting of the mass with respect to that slope so that the slump surface often exhibits a reversed slope facing uphill.

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

Solod - A great group of soils in the Solonetzic order occurring most commonly in the grassland and parkland regions. The soils have a dark colored surface (Ah) horizon, a prominent eluvial (Ahe or Ae) horizon at least 5 cm (2 inches) thick, a prominent transitional (AB) horizon that breaks readily into blocky aggregates, and a darkly stained B (Bnt) horizon over a C horizon that is saline and usually calcareous.

Solonetz - A great group of soils in the Solonetzic order, occurring most commonly in the grass land and parkland regions and consisting of soils with a variable surface (Ah, Ahe or Ae) horizon that breaks abruptly into a hard, compact prismatic or columnar B (Bnt, rarely a Bn) horizon underlain by one or more saline and usually calcareous (Bs, Cs, Csa, Csk, Cca) horizons. They lack a continuous Ae horizon 2.5 cm (1 inch) or more thick.

Solonetzic - An order of soils developed mainly under grass or grass-forest vegetative cover in semiarid to subhumid climates. The soils have a stained brownish solonetzic B (Bnt or Bn) horizon and a saline C horizon. The surface may be one or more of Ap, Ah or Ae horizons.

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

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

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).

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

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

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

single grain - Loose, incoherent mass of individual particles, as in sands.

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

subgroup, soil - A category in the Canadian system of soil classification. These soils are subdivisions of the great groups, and therefore each soil is defined more specifically.

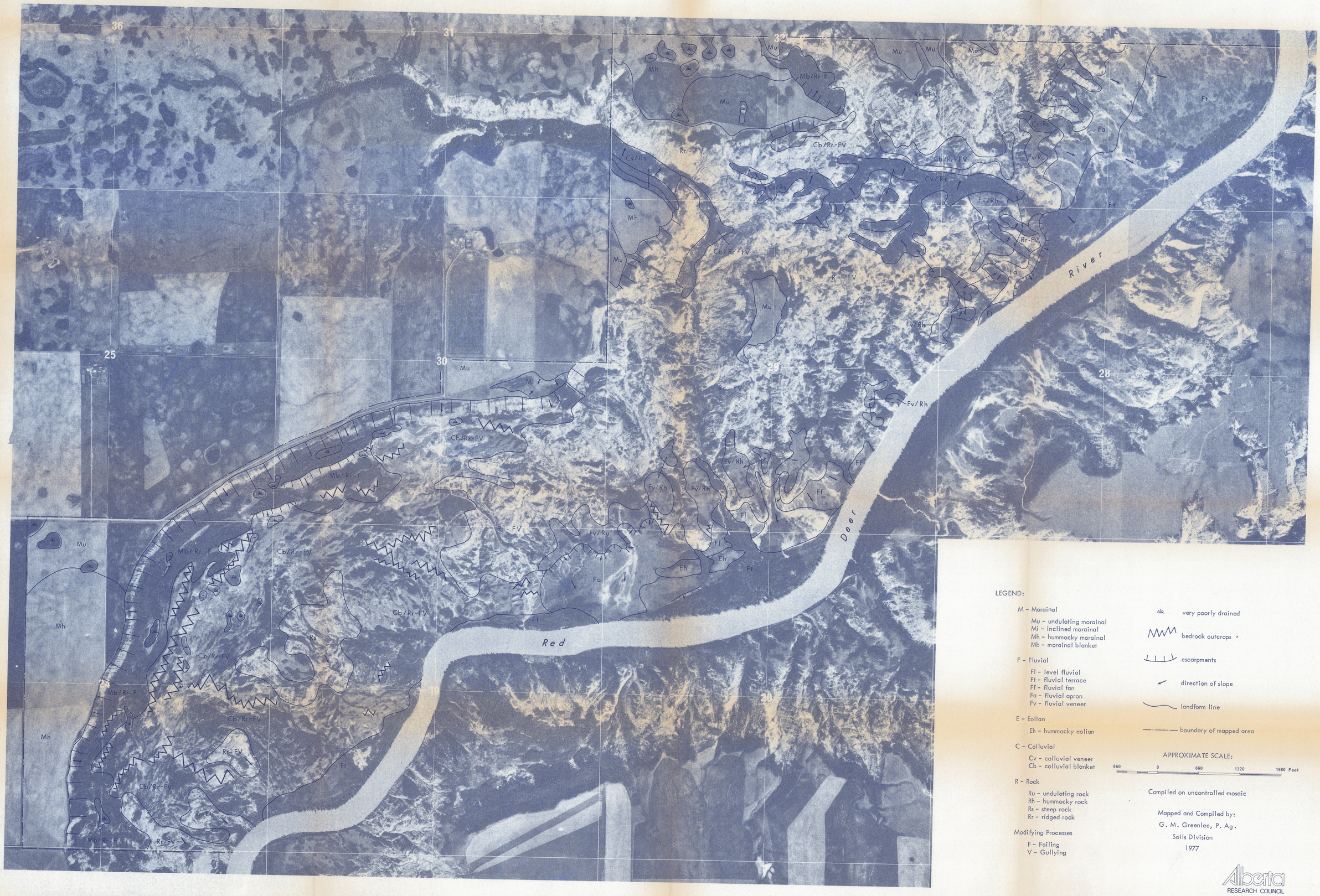
terrace - A narrow, relatively level or gently inclined surface, bounded along one edge by a steeper descending slope and along the other by a steeper ascending slope.

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

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

LANDFORM MAP OF DRY ISLAND BUFFALO JUMP PROVINCIAL PARK

Tp. 34, R. 21, 22, W 4



LEGEND:

M – Morainal
- Mu – undulating morainal
- Mi – inclined morainal
- Mh – hummocky morainal
- Mb – morainal blanket

F – Fluvial
- Fl – level fluvial
- Ft – fluvial terrace
- Ff – fluvial fan
- Fa – fluvial apron
- Fv – fluvial veneer

E – Eolian
- Eh – hummocky eolian

C – Colluvial
- Cv – colluvial veneer
- Cb – colluvial blanket

R – Rock
- Ru – undulating rock
- Rh – hummocky rock
- Rs – steep rock
- Rr – ridged rock

Modifying Processes
- F – Failing
- V – Gullying

very poorly drained

bedrock outcrops

escarpments

direction of slope

landform line

boundary of mapped area

APPROXIMATE SCALE:

660 0 660 1320 1980 Feet

Compiled on uncontrolled mosaic

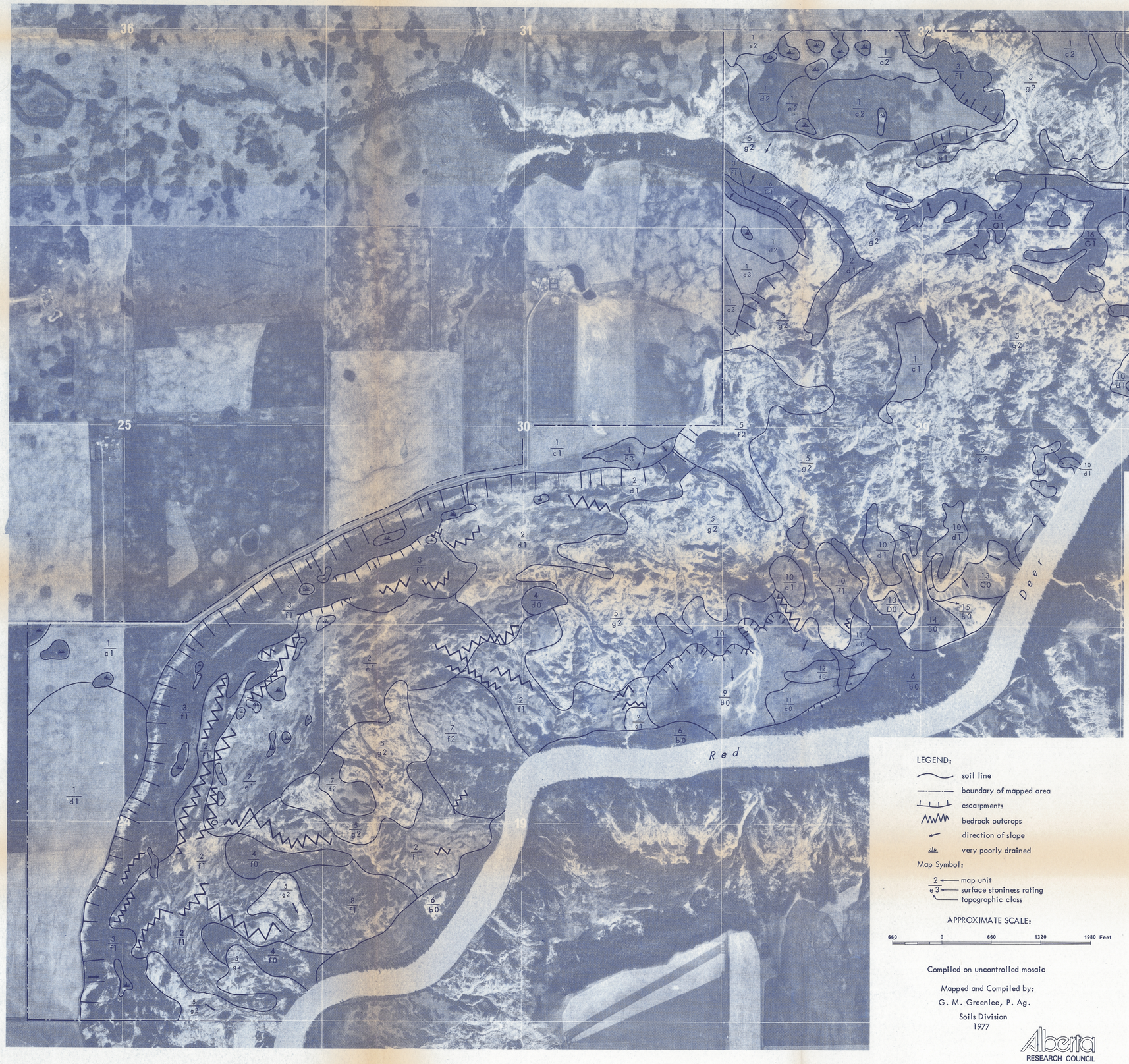
Mapped and Compiled by:
G. M. Greenlee, P. Ag.
Soils Division
1977

Alberta RESEARCH COUNCIL

OFR 1977-17

SOIL MAP OF DRY ISLAND BUFFALO JUMP PROVINCIAL PARK

Tp. 34; R. 21, 22; W 4



LEGEND:

- soil line
- boundary of mapped area
- escarpments
- bedrock outcrops
- direction of slope
- very poorly drained

Map Symbol:

2 — map unit
e3 — surface stoniness rating
topographic class

APPROXIMATE SCALE:

660 0 660 1320 1980 Feet

Compiled on uncontrolled mosaic

Mapped and Compiled by:
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1977

Alberta RESEARCH COUNCIL

SOIL CLASSIFICATION

MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Chernozemic	Orthic Black	moderately fine textured till
2	Solonetzic 60% Regosolic 30% Chernozemic 10%	Dark Brown Solonetz Saline Regosol Orthic Dark Brown	medium to fine textured colluvium derived partly from weathered sandstone and shale and partly from till 70%. moderately fine textured alluvium 30%.
3	Chernozemic	Orthic Dark Gray	moderately fine textured till, may also include some colluvium derived partly from weathered sandstone and shale, and partly from till.
4	Solonetzic 80% Chernozemic 20%	Gray Solonetz Orthic Dark Gray	moderately fine to fine textured colluvium derived partly from weathered sandstone and shale, and partly from till.
5	Regosolic	Undifferentiated Regosol	exposed shale and sandstone
6	Regosolic	Orthic Regosol	alluvium of highly variable texture
7	Solonetzic 60% Chernozemic 40%	Dark Brown Solod Orthic Dark Brown	medium to fine textured colluvium derived partly from weathered sandstone and shale, and partly from till.
8	Chernozemic	Orthic Dark Brown	medium to fine textured colluvium derived partly from weathered sandstone and shale, and partly from till.
9	Solonetzic	Dark Brown Solonetz - eroded phase	medium textured alluvium
10	Solonetzic 60% Chernozemic 40%	Dark Brown Solonetz - lithic phase Orthic Dark Brown - lithic phase	medium to very coarse textured alluvium overlying bedrock
11	Chernozemic	Orthic Dark Brown	moderately coarse to medium textured alluvium
12	Chernozemic	Rego Dark Brown	moderately coarse to very coarse textured eolian sediments.
13	Solonetzic	Dark Brown Solod and Dark Brown Solonetz	moderately coarse to moderately fine textured alluvium.
14	Regosolic	Orthic Regosol	very coarse to moderately fine textured alluvium.
15	Regosolic	Orthic Regosol	moderately coarse to moderately fine textured alluvium.
16	Brunisolic	Orthic Eutric Brunisol - lithic phase	moderately fine textured colluvium derived partly from weathered sandstone and shale and partly from till, overlying bedrock.