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SOIL SURVEY
OF
PEMBINA RIVER PROVINCIAL PARK
AND
INTERPRETATION FOR RECREATIONAL USE

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CONTENTS

MAPS

LIST OF FIGURES

LIST OF TABLES

PREFACE

This report is one of a series describing detailed and semi-detailed soil surveys which have been conducted in Alberta provincial parks and recreation areas. As well as Pembina River Provincial Park, soil surveys were conducted in the following provincial parks during the summer of 1975: Gooseberry Lake, Rochon Sands, Vermilion, Big Knife, and Garner Lake. Also included were areas in the vicinities of Upper and Lower Kananaskis Lakes, Cold Lake (Lund's Point), Calling Lake, and Notikewin River. The total area mapped was approximately 11,380 ha.

A general guidebook has been prepared to accompany soil survey reports written for Alberta provincial parks and recreation areas (Greenlee, 1981). It includes general discussions of the following: soil formation; the Canadian soil classification system; soil characteristics and other factors that affect the use of soils for recreational and related purposes; Luvisolic, Organic, and Solonetzic soils; soil erosion; methodology; soil and landform maps that accompany the soil survey reports; an explanation of soil interpretations and guidelines for developing them; chemical and physical properties of soils; and the landform classification system used by Canadian soil pedologists. Also included is a glossary. Specific results and interpretations for the areas covered by this study are presented in the ensuing report.

Also in 1975, soil samples were collected from an archaeological site excavated by the Parks Planning Branch in the Cypress Hills. A detailed field soil profile description was made, laboratory analyses have been completed and a report will be prepared.

ACKNOWLEDGEMENTS

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Mrs. Kathie Skogg and Miss Ruby Wallis typed and assisted in compiling and proof reading the report. Mrs. J. Dlask drafted the soil, landform and soil limitations for recreation maps, while Mr. J. Beres determined the physical properties of the soils. The soil chemical analyses were determined by the Alberta Soil and Feed Testing Laboratory.

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

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

SUMMARY

Pembina River Park is about 205 ha in size, and is located about 90 km west of Edmonton along Highway 16. Surficial deposits throughout the upland portions of the Park consist of a very fine textured glaciolacustrine veneer overlying moderately fine textured till; and a

blanket of medium to moderately coarse textured fluvial sediments overlying moderately fine textured till occupies most of the river floodplain. The upland portions are separated from the river floodplain by steep valley banks, and mixtures of moderately fine to very coarse textured till cover these. This region has a cold snow-forest climate with humid winters, characterized by frozen ground and a snow cover of several months duration. Summers are cool and short with less than four months where the average temperature is above 10°C, and the average temperature of the coldest month is below -3°C.

The Park is situated in the mixedwood section of the boreal forest region, where the characteristic forest association of well drained uplands is a mixture in varying proportions of trembling aspen and balsam poplar; white birch, white spruce, and balsam fir.

Seven map units were recognized in Pembina River Park. The key profile types are Orthic Gray Luvisols, Dark Gray Luvisols, Orthic Eutric Brunisols, Orthic Eutric Brunisols Lithic phase, Gleyed Regosols, Rego Gleysols, and Terric Humisols. These are distributed over the landscape in relation to landform, parent material, and drainage. Map units ocnsist of series or groupings of series (complexes), and their distribution is shown on the soil map.

Soil interpretations of each map unit are made for fully serviced campgrounds, picnic areas, lawns and landscaping, paths, trails, buildings (with and without basements), road location, source of roadfill, and source of sand or gravel.

The soils in the Park best suited for recreational development are those of Map Unit 1 when found on suitable topography, and those of Map Unit 3. Map Unit 1 soils cover all of the upland portion, and Map Unit 3 soils cover nearly all of the river floodplain. Soils of these two map units have moderate limitations for recreational development, soils of most others have severe limitations, and some have very severe limitations. The soils best suited for road construction are those of Map Unit 3, and they have moderate limitations. Soils of most other map units have severe limitations, and some have very severe limitations. A good source of sand and gravel was not found in the Park. Map Unit 5 soils can provide only a fair source of sand, and Map Units 2 and 3 soils constitute only a poor source. Occasional thin gravel deposits may be found in Map Unit 3 soils. Careful study of the soil map and Tables 4 to 13 inclusive (soil limitation and suitability tables) will reveal areas suitable for particular uses.

A soil survey properly interpreted can be one of the most useful tools management has in making a proper design for a recreational area. However, all soil differences which occur in the field cannot be shown on the soil map. Thus for design and construction of specific recreational facilities, on on-site investigation is usually required.

INTRODUCTION

SIZE AND LOCATION

Pembina River Park is about 205 ha in size, and is located about 90 km west of Edmonton along Highway 16 (Figure 1). The Park is adjacent to the Pembina River on the south and north sides, is slightly less than 1 km north of Entwhistle, and slightly less than 1 km east of Evansburg. It includes the south half, northeast quarter, and part of the northwest quarter of section 29, township 53, range 7, west of the fifth meridian.

PHYSIOGRAPHY AND SURFICIAL DEPOSITS

The Park is situated in the Eastern Alberta Plains division of the Interior Plains physiographic region (Government and the University of Alberta, 1969). Green (1972) has classified the bedrock as the Scollard member of the Paleocene and Upper Cretaceous Paskapoo Formation, which is nonmarine. The land surface in the region is extremely variable, ranging from relatively level lacustrine plains to gently rolling and rolling morainic areas, and the overall elevation gradually rises from east to west (Twardy and Lindsay, 1971). The elevation in the upland portion of the Park is about 760 m, and the Pembina River valley is about 60 m deep in this vicinity. The Park is drained by the Pembina River to the north.

Surficial deposits throughout the upland portions of the Park; the southern portion, the extreme western edge, and a small portion near the northeastern corner; consist of a very fine textured glaciolacustrine veneer overlying moderately fine textured till. A blanket of medium to moderately coarse textured fluvial sediments overlying moderately fine textured till occupies most of the river floodplain. Only occasional small patches of deeper medium to very coarse textured fluvial sediments (sand) are found, and one patch of a moderately coarse textured fluvial veneer overlying sandstone occurs near the northwestern boundary on the south side of the river. The upland portions are separated from the river floodplain by steep valley banks, and mixtures of moderately fine to very coarse textured till cover these. Some sandstone and shale outcrops also occur.

CLIMATE

The climate of the mapped area is designated as humid microthermal in Koppen's climatic classification (Trewartha and Horn, 1980). This is described as a cold snow-forest climate with humid winters, characterized by frozen ground and a snow cover of several months duration. Summers are cool and short, having less than four months with an average temperature above 10°C. The average temperature of the coldest month is below -3°C.

Weather records over a recent ten year period at Edson, about 95 km west of the Park and at an elevation of 922 m, show the following values (Environment Canada, 1982): the mean annual temperature is 0.9°C. July is the warmest month of the year with a mean temperature of 14.4°C, and January is the coldest with a mean temperature of -15.4°C. The mean annual precipitation is 533 mm and 62% falls as rain. The average

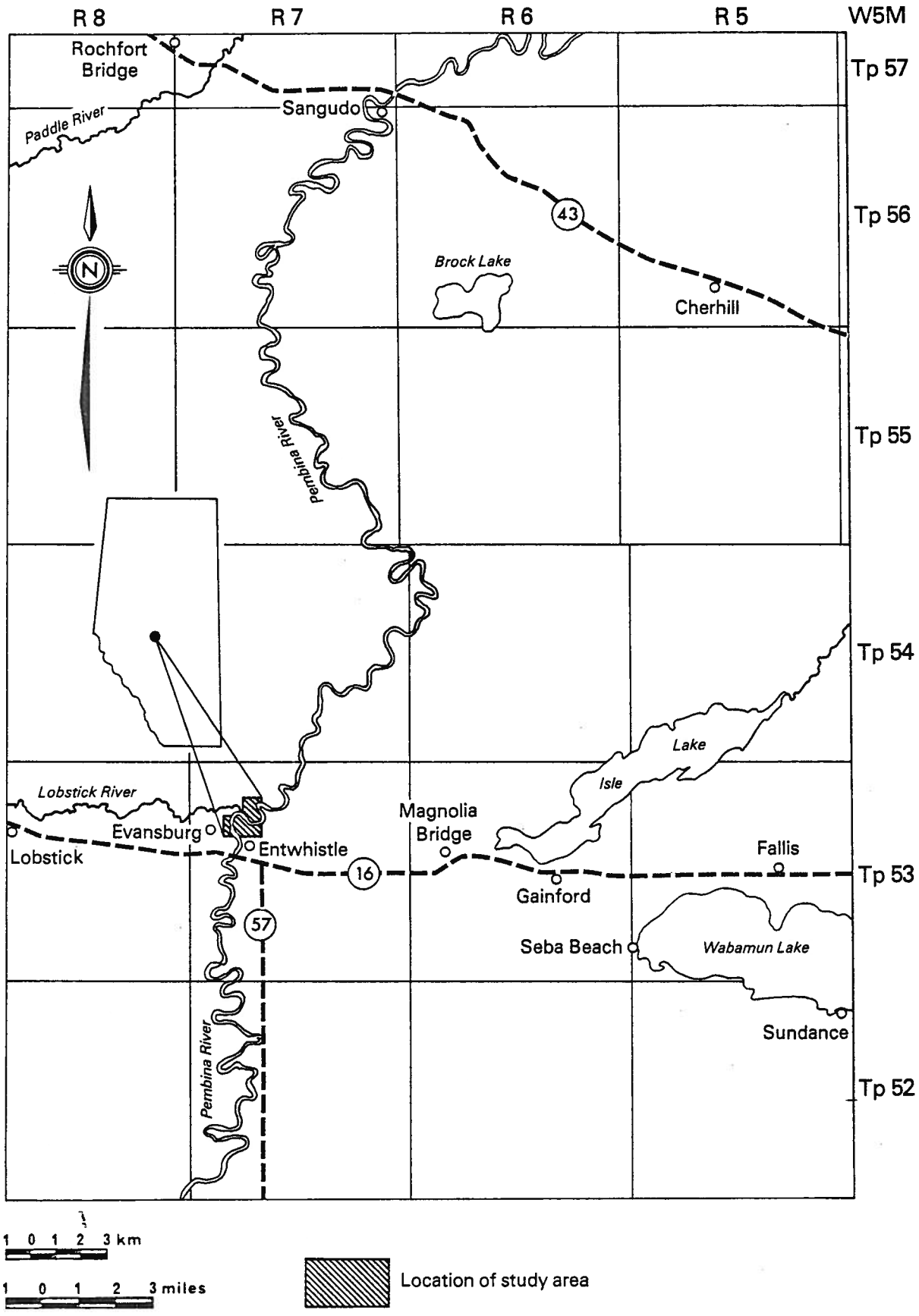


Figure 1. Map showing location of study area.

frost-free period is only 66 days. Somewhat higher average temperatures, a somewhat longer frost-free period, and somewhat lower precipitation can be expected in the Park however, since elevations are considerably lower than at Edson.

VEGETATION

The Park is situated in the mixedwood section of the boreal forest region, as classified by Rowe (1972). In the mixedwood section, the characteristic forest association of well drained uplands is a mixture in varying proportions of trembling aspen and balsam poplar; white birch, white spruce, and balsam fir. The last two species are especially prominent in old stands. However, the cover type of greatest areal extent is the trembling aspen. Jack pine is dominant on sandy areas, is part of the forest composition on the drier till soils, and is mixed with black spruce on the plateau-like tops of the higher hills. Also black spruce and tamarack muskegs develop in lower positions and the upper water catchment areas.

In the upland portions of the Park and on the steep valley banks, aspen is the dominant vegetation; and small amounts of white birch, balsam poplar, and white spruce also occur. In the river floodplain, variable combinations of aspen and balsam poplar occur; as well as patches of white birch and white spruce. Since the Outdoor Recreation Planning Branch of Alberta Recreation and Parks conducts biological studies of provincial parks and recreation areas, the vegetation is not extensively discussed in this report. However, some of the more common plants observed growing on different soils are indicated as part of the map unit descriptions, and these are listed as follows (Moss, 1959; Cormack, 1967; Conard, 1956): aspen (Populus tremuloides), balsam poplar (Populus balsamifera), white birch (Betula papyrifera), white spruce (Picea glauca), tamarack (Larix laricina), dogwood (Cornus stolonifera), low-bush cranberry (Viburnum edule), high-bush cranberry (Viburnum trilobum), beaked hazelnut (Corylus cornuta), saskatoon-berry (Amelanchier alnifolia), choke cherry (Prunus virginiana), Canadian buffalo-berry (Shepherdia canadensis), willow (Salix spp), alder (Alnus spp), wild rose (Rosa spp), snowberry (Symphoricarpos albus), wolf willow (Elaeagnus commutata), wild red respberry (Rubus strigosus), native grass (various species), slough grass (Beckmannia syzigachne), sedge (Carex spp), arrow-leaved coltsfoot (Petasites sagittatus), horsetail (Equisetum spp), other forbs, Labrador tea)Ledum groenlandicum), sphagnum moss (Sphagnum spp), and feathermoss (various species).

SOILS

Seven map units were recognized in Pembina River Park. The soils of three were classified in the Brunisolic Order; and one in each of the Luvisolic, Organic, Regosolic, and Gleysolic Orders in the Canadian soil classification system (Canada Soil Survey Committee, 1978). The system is outlined in Greenlee (1981). Pertinent features of the map units are outlined in Table 1.

Soils of the Luvisolic Order are well to imperfectly drained mineral soils characterized by an Ae horizon near the surface, and it generally

Table 1. Key to the Soils.

Map Unit	Classification	Parent Material	Surface Texture	Slope (class & gradient)	Surface Stoniness	Drainage	Comments and Limitations
1	Orthic Gray Luvisol-60% Dark Gray Luvisol-40%	very fine textured glaciolacustrine sediments, overlying moderately fine textured till	silt loam	c,d,f (> 2 to 30%)	0	well drained	Till usually slightly deeper than 120 cm. Slight to severe limitations, poor source of roadfill, unsuitable as a source of sand or gravel - slow permeability, slippery or sticky when wet, excessive slopes, erosion hazard, thin or no Ah horizon, high shrink-swell potential, susceptibility to frost heave.
2	Orthic Eutric Brunisol	moderately fine textured till containing a high proportion of weathered shale, and moderately to very coarse textured till containing a high proportion of weathered sandstone	clay loam	f,g (> 15 to 60%)	1	well to rapidly drained	(1) The two till textures are intimately and unpredictably associated. (2) Numerous slumps have occured. Moderate to very severe limitations, poor source of roadfill and sand, unsuitable as a source of gravel - excessive slopes, erosion hazard, slippery or sticky when wet, lack of Ah horizon, moderate to high shrink-swell potential, susceptibility to frost heave.
3	Orthic Eutric Brunisol	medium to very coarse textured fluvial sediments, overlying moderately fine textured till	fine sandy loam	b,c (> 0.5 to 5%)	0	well drained	(1) Bm_2 horizon is occasionally gravel. (2) Till is usually deeper than 120 cm. (3) Cca horizon occasionally occurs within 90 cm of surface. Slight to severe limitations, good source of roadfill, poor source of sand or gravel - flooding hazard (overflow), thin or no Ah horizon, moderate shrink-swell potential, susceptibility to frost heave.
4	Orthic Eutric Brunisol, Lithic phase	moderately coarse textured fluvial sediments, overlying sandstone	sandy loam	F (> 15 to 30%)	0	well drained	Moderate to severe limitations, fair source of roadfill, unsuitable as a source of sand or gravel - excessive slopes, erosion hazard, flooding hazard (overflow), lack of Ah horizon, shallow depth to bedrock.
5	Gleyed Regosol	very coarse textured fluvial sediments (sand)	very fine sandy loam	b (> 0.5 to 2%)	0	imperfect	Severe limitations, fair source of roadfill and sand, unsuitable as a source of gravel -

Table 1. Key to the Soils.

Map Unit	Classification	Parent Material	Surface Texture	Slope (class & gradient)	Surface Stoniness	Drainage	Comments and Limitations
5 contd							flooding hazard (overflow), seasonally high groundwater table or surface ponding, lack of Ah horizon, high lime content (soil nutrient imbalance).
6	Rego Gleysol	moderately coarse textured fluvial sediments	fine sandy loam	a (0 to 0.5%)	0	poor	Water table occurs 60 cm below soil surface. Severe limitations, poor source of roadfill, unsuitable as a source of sand or gravel - seasonally high groundwater table or surface ponding, lack of Ah horizon, high lime content (soil nutrient imbalance).
TH	Terric Humisol	predominantly humic peat, overlying very fine textured glaciolacustrine sediments	mesic peat	a (0 to 0.5%)	0	very poor	Very severe limitations, very poor source of roadfill, unsuitable as a source of sand or gravel - Organic soil, extreme wetness, lack of Ah horizon, high shrink-swell potential, susceptibility to frost heave.

varies from 7.5 to 30 cm in thickness. It is a leached gray coloured horizon, very low in organic matter (humus) content and in plant nutrients. Luvisolic soils in their natural state commonly have surface L-H and Ah horizons as well. The L-H horizon ranges from 2.5 to 12.5 cm or more in thickness; however, the Ah horizon below is usually less than 5 cm thick, and often absent altogether. When Luvisolic soils are cultivated, the L-H and Ah horizons quickly become mixed with the Ae, resulting in gray coloured fields. Also, the L-H and Ah horizons rapidly become broken down under conditions of heavy foot traffic in recreation areas, and often disappear completely from a combination of physical destruction and soil erosion. When thoroughly dried out, the Ae horizon is often baked and hard, so that plant seedlings may be unable to push up through the crust. Also, entry of moisture from rainfall may be hampered and runoff increased, thereby enhancing soil erosion. This problem is especially serious on steep slopes.

Well drained Luvisolic soils, developed on a very fine textured glaciolacustrine veneer overlying moderately fine textured till, cover the upland portions of the Park; the southern portion, the extreme western edge, and a small portion near the northeastern corner.

Soils of the Brunisolic order are rapidly to imperfectly drained mineral soils with sufficient profile development to exclude them from the Regosolic order, but that lack the degrees or kinds of horizon development specified for soils of other orders. Their common characteristic of identification is the development in situ of the prominent brownish Bm horizon with sufficient alteration by hydrolysis, oxidation or solution to produce significant changes in colour, structure and composition different from those of an A or C horizon. Because the processes of leaching and weathering are relatively weakly developed in Brunisolic soils, they tend to reflect the chemical characteristics, particularly the base status and acidity, of parent materials from which they have been derived.

Well drained Brunisolic soils, developed on a blanket of medium to moderately coarse textured fluvial sediments overlying moderately fine textured till, occur throughout most of the river floodplain; and one patch of well drained Brunisolic soils, developed on a moderately coarse textured fluvial veneer overlying sandstone, occurs near the northwestern boundary on the south side of the river. These floodplain deposits are of relatively recent deposition and insufficient time has elapsed for advanced stages of soil profile development. Well to rapidly drained Brunisolic soils, developed on mixtures of moderately fine to very coarse textured till, also occur on the steep valley banks that separate the upland and floodplain portions of the Park. Much surface moisture runs off these steep slopes, rather than percolating down through the soil profile; and thus profile development is retarded.

Soils of the Regosolic Order are rapidly to imperfectly drained mineral soils with profile development too weakly expressed to meet the requirements for classification in any other order. They lack any expression of a B horizon, and therefore, reflect essentially the characteristics of the C horizons and parent materials from which they are formed.

Only two very small patches of imperfectly drained Regosolic soils developed on very coarse textured fluvial sediments (sand) are found in the Park. Both are adjacent to the river on the north and west sides. Again, these deposits are of very recent origin so that insufficient time has elapsed for soil profile development, other than gleying. Also, the gleyed soil profile reflects a fluctuating water table, and a lack of net downward leaching.

Soils of the Gleysolic order are poorly drained mineral soils whose profiles reflect the influence of waterlogging for significant periods. Water saturation causes reducing conditions due to a lack of aeration. These conditions result in gleyed horizons having dull gray to olive, greenish or bluish-gray moist colours, frequently accompanied by prominent usually rust-coloured mottles resulting from localized oxidation and reduction of hydrated iron oxides.

Only one patch of Gleysolic soils, developed on moderately coarse textured fluvial sediments, is found in the Park, on the north side of the river.

Soils of the Organic order include all soils that have developed largely from organic deposits, contain more than 30% organic matter by weight, and meet specifications of depth and horizon thickness within a defined control section. The majority of Organic soils are either water saturated or nearly so for much of the year unless artificially drained. The organic deposits are derived primarily from the decomposition of hydrophytic or mesohydrophytic vegetation. The further classification and naming of the great groups into Fibrisols, Mesisols and Humisols depends on the occurrence and identification of three major diagnostic layers: Fibric, Mesic and Humic. Fibric layers are the least decomposed of all the organic soil materials and have large amounts of well preserved fibres, which are readily identifiable as to botanic origin. The organic matter of humic layers is in a highly decomposed state, and often has a smooth greasy feel when moist. It has the least amount of recognizable plant fibre, and is usually darker in colour than fibric or mesic materials. It is relatively stable and changes little in physical or chemical composition with time. The organic matter of mesic layers is in an intermediate stage of decomposition between that of fibric and humic layers, and is partially altered both chemically and physically. Management problems in areas of cultivated Organic soils involve the maintenance of controlled drainage, adequate fertilization, and tillage practices necessary to maintain a firm bed for seed germination and root development. Over-drainage and dessication of peat are detrimental to crop production and to the maintenance of the organic layers in a desirable physical condition. Under cultivation, many Organic soils show deficiencies in macro and micro mineral nutrients, and most require the application of phosphorus and potassium to obtain maximum productivity. Special problems also exist in using Organic soils for construction purposes. These are their low bearing strength, high shrink-swell potential and susceptibility to frost heaving.

Only one very small patch of very shallow Organic soils, overlying very fine textured glaciolacustrine sediments, is found in the southwestern

upland portion of the Park on the east side of the river.

Very minor differences exist among some map units. However, the differences are usually significant with regard to a particular recreational or engineering use, and thus justify separation of different map units. They are described in chronological order, and horizon thicknesses represent averages. Thicknesses of comparative horizons in identical soil profiles often vary as much as 10 to 40 percent from the norm at different points in the landscape.

The dominant plant species are listed using common names. These are very general lists, and not purported to be complete.

Map Unit 1

Classification: Orthic Gray Luvisol - 60%
Dark Gray Luvisol - 40% (these two subgroups are intimately and unpredictably associated).
Parent material: very fine textured glaciolacustrine sediments, overlying moderately fine textured till.
Landform: glaciolacustrine veneer, overlying hummocky morainal ($L^{G}V$/Mh); glaciolacustrine veneer, overlying undulating morainal ($L^{G}V$/Mu)
Slope: undulating to strongly rolling (>2 to 30%)
Surface stoniness: nonstony (0)
Drainage: well drained
Vegetation: predominantly aspen; with an understory of dogwood, low-bush cranberry, and wild rose; small amounts of white birch, balsam poplar, white spruce, saskatoon-berry, beaked hazelnut, Canadian buffalo-berry, willow, and snowberry.
Profile description: Orthic and Dark Gray Luvisol

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	5-8	leaf and root litter		
Ah	0-8	silt loam	granular	soft, dry
Aeg	10-20	loam	platy	slightly hard, dry
Bt	50	clay	blocky	very firm, moist; very dense
BC	5-30	clay	amorphous	very firm, moist very dense
Cca1 at	75-100	clay	amorphous	very firm, moist; very dense
IICca$_2$ at (till)	110-120+	clay loam	amorphous to subangular blocky	firm, moist

Comments:
(1) The Orthic Gray Luvisols have less than 5 cm of Ah, and the Dark Gray Luvisols have 5 cm or more. Otherwise, these two soil subgroups are identical.
(2) The till sometimes commences at 100 to 120 cm below the surface but is usually slightly deeper than 120 cm.

Limitations: Slight to severe-slight on suitable topography for buildings without basements; moderate on suitable topography for all recreational uses; severe for buildings with basements, and road location; poor source of roadfill; unsuitable as a source of sand or gravel because of unsuitable textures. Other limitations include slow permeability, slippery or sticky when wet, excessive slopes, erosion hazard, thin or no Ah horizon, high shrink-swell potential, and susceptibility to frost heave.

Map Unit 2

Classification: Orthic Eutric Brunisol
Parent material: moderately fine textured till containing a high proportion of weathered shale, and moderately to very coarse textured till containing a high proportion of weathered sandstone (these two till textures are intimately and unpredictably associated).
Landform: inclined morainal (Mi)
Slope: strongly rolling to hilly (>15 to 60%)
Surface stoniness: slightly stony (1)
Drainage: well to rapidly drained
Vegetation: predominantly aspen; understory of dogwood, low-bush cranberry, wild rose; patches of white birch, white spruce, balsam poplar, alder; some willow, and saskatoon-berry.
Profile description: Orthic Eutric Brunisol developed on moderately fine textured till containing a high proportion of weathered shale.

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	2-5	leaf and root litter		
Bm	50	clay loam	subangular blocky	very friable to firm, moist
Cca	50	clay loam	subangular blocky	very friable to firm, moist

Orthic Eutric Brunisol developed on a mixture of moderately fine textured till containing a high proportion of weathered shale, and moderately to very coarse textured till containing a high proportion of weathered sandstone.

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	2-5	leaf and root litter		
Bm1	50	clay loam	subangular blocky	very friable to firm, moist
Bm2	37-50	sandy loam to loamy sand	subangular blocky to amorphous	very friable to loose, moist
Cca	at 87-100	sandy loam to loamy sand	subangular blocky to amorphous	very friable to loose, moist

Comment: Numerous slumps have occurred, resulting in escarpments and surface exposures of till that are devoid of vegetation.
Limitations: Moderate to very severe-moderate to severe for trails; severe to very severe for all other uses; poor source of roadfill; poor source of sand due to unsuitable textures, and thin discontinuous deposits; unsuitable as a source of gravel because of unsuitable textures. Other limitations include excessive slopes, erosion hazard, slippery or sticky when wet, lack of Ah horizon, moderate to high shrink-swell potential, susceptibility to frost heave.

Map Unit 3

Classification: Orthic Eutric Brunisol
Parent material: medium to very coarse textured fluvial sediments, overlying moderately fine textured till.
Landform: fluvial terrace blanket, overlying level morainal (Ftb/Ml) fluvial terrace blanket, overlying undulating morainal (Ftb/Mu)
Slope: gently undulating to undulating (>0.5 to 5%)
Surface stoniness: nonstony (0).
Drainage: well drained
Vegetation: variable proportions of aspen, and balsam poplar; understory of dogwood, low-bush cranberry, wild rose; patches of white birch, white spruce, willow, alder, saskatoon-berry, choke cherry, beaked hazelnut, high-bush cranberry, and wild red raspberry.
Profile description: Orthic Eutric Brunisol

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	2-8	leaf and root litter		
Ah	0-8	fine sandy loam	granular	very friable, moist
Bm1	10-50	loam to fine sandy loam	subangular blocky	very friable, moist
Bm2	10-50	loamy sand to sand	amorphous	loose, moist
IIBm3 at	90 to 120+	clay loam	subangular blocky	firm, moist

Comments:
(1) The Bm1 and Bm2 horizons both consist of variable textured sediments, as indicated above, and ranging from 10 to 50 cm thick. The Bm2 horizon commences 50 cm below the surface.
(2) The Bm2 horizon is occasionally gravel.
(3) The till is sometimes found within 90 cm of the surface, but is usually deeper than 120 cm.
(4) A Cca horizon occasionally occurs within 90 cm of the surface, but is usually deeper than 120 cm.
Limitations: Slight to severe-slight for picnic areas, paths, and trails; moderate for campgrounds, lawns and landscaping, and road location; severe for buildings; good source of roadfill; poor source of sand or gravel because of unsuitable or variable textures, and thin deposits.
Other limitations include flooding harzard (overflow), thin or no Ah horizon, moderate shrink-swell potential, and susceptibility to frost heave.

Map Unit 4

Classification: Orthic Eutric Brunisol, Lithic phasee
Parent material: moderately coarse textured fluvial sediments, overlying sandstone.
Landform: fluvial veneer, overlying inclined bedrock (Fv/Ri)
Slope: steeply sloping (>15 to 30%)
Surface stoniness: nonstony (0)
Drainage: well drained
Vegetation: aspen, dogwood, low-bush cranberry, wild rose; some white birch, and white spruce
Profile description: Orthic Eutric Brunisol, Lithic phase

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	5	leaf and root litter		
Bm	50	sandy loam	subangular blocky	very friable, moist
Cca	50	fine sandy loam	platy	very friable, moist
IICca	at 100	sandstone		

Limitations: Moderate to severe-moderate for trails; severe for all other uses; fair source of roadfill, unsuitable as a source of sand or gravel because of unsuitable textures. Other limitations include excessive slopes, erosion hazard, flooding hazard (overflow), lack of Ah horizon, and shallow depth to bedrock.

Map Unit 5

Classification: Gleyed Regosol
Parent material: very coarse textured fluvial sediments (sand)
Landform: level fluvial (Fl)
Slope: gently undulating (>0.5 to 2%)
Surface stoniness: nonstony (0)
Drainage: imperfect
Vegetation: willow, grass
Profile description: Gleyed Regosol

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
Ckg1	7-10	very fine sandy loam	platy	friable, moist
Ckg2	30-33	sand	amorphous	loose, moist

Limitations: Severe for all uses; fair source of roadfill and sand; unsuitable as a source of gravel because of unsuitable textures. Other limitations include flooding hazard (overflow), seasonally high groundwater table or surface ponding, lack of Ah horizon, and high lime content (soil nutrient imbalance).

Map Unit 6

Classification: Rego Gleysol
Parent material: moderately coarse textured fluvial sediments
Landform: level fluvial (Fl)
Slope: nearly level (0 to 0.5%)

Surface stoniness: nonstony (0)
Drainage: poor
Vegetation: willow, tamarack, sphagnum moss, grass, horsetail; some white birch, white spruce, and balsam poplar (sparsely vegetated).
Profile description: Rego Gleysol

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	7-8	leaf and root litter		
Ccag	100	fine sandy loam	amorphous	friable, moist

Comment: A water table occurs 60 cm below the soil surface.
Limitations: Severe for all uses; poor source of roadfill; unsuitable as a source of sand or gravel because of unsuitable textures, and seasonally high groundwater table or surface ponding. Other limitations include lack of Ah horizon, and high lime content (soil nutrient imbalance).

TH (Organic Soil)

Classification: Terric Humisol
Parent material: predominantly humic peat, overlying very fine textured glaciolacustrine sediments.
Landform: horizontal fen (Nh)
Slope: nearly level (0 to 0.5%)
Surface stoniness: nonstony (0)
Drainage: very poor
Vegetation: willow, white birch, grass, sedge, horsetail; some white spruce, and arrow-leaved coltsfoot; occasional small patch of Labrador tea, and feathermoss.
Profile description: Terric Humisol

Horizon	Thickness (cm)	Field Description		
Om	15	predominantly mesic peat		
Oh	25-30	predominantly humic peat		
		Field Texture	Structure	Consistence
Cg	at 0+	clay	amorphous	very firm, moist (very dense)

Limitations: Very severe for all uses; very poor source of roadfill; unsuitable as a source of sand and gravel because of unsuitable textures, and extreme wetness. Other limitations include Organic soil, lack of Ah horizon, high shrink-swell potential, and susceptibility to frost heave.

Special Features

The soils in Alberta have been classified into broad general zones (Figure 2) as established by Alberta Soil Survey during the normal course of soil surveys, and correlated with temperature and precipitation records. Annual precipitation amounts change gradually from one soil zone to another, and are not abrupt changes at the point where a zone boundary has been located. Thus a zone boundary is a broad transitional belt, which can be many kilometres across. Topsoil colours reflect this gradual change. For example, in the centre of the Brown Soil Zone (annual precipitation about 30 to 33 cm), topsoil colours are brown. Similarly in the centre of the Dark Brown Soil Zone (annual precipitation about 38 cm), topsoil colours are dark brown. Between these two zones, topsoil colours are brown to dark brown, and annual precipitation is about 35 cm. The boundary between the two soil zones has been placed approximately at that midpoint.

Zonal soils are soils with well developed soil characteristics that reflect the zonal or normal influences of climate and living organisms, mainly vegetation, as active factors of soil genesis. Examples are Brown, Dark Brown, or Black soils of the Brown, Dark Brown, or Black Soil Zones respectively. Intrazonal soils are soils with morphology that reflects the influence of some local factor of relief, parent material, or age; rather than of climate and vegetation. An example is Solonetzic soils, which develop as a result of salinization. This may originate internally from a saline parent material, or from saturation by external saline waters. Solonetzic soils are found across many soil zones (Figure 2). Azonal soils are soils without distinct genetic horizons, and are represented by Regosolic soils in Canada. These occur across all the soil zones in the province.

Pembina River Park is situated in the Dark Gray and Dark Gray Luvisolic soil zone, and soils in the upland portion are classified as Orthic and Dark Gray Luvisols, which are zonally normal. This soil zone is transitional in nature, and Orthic Gray Luvisols are commonly found. One small patch of Organic soils, which are intrazonal and occur in most soil zones in the Province, are also found in the upland portion. The soils on the steep valley banks, and most in the river floodplain, are classified as Brunisolic, which are intrazonal. These also occur in most soil zones in the Province. Two small patches of azonal Regosolic soils, and one patch of intrazonal Gleysolic soils also occur in the river floodplain. These occur across all the soil zones. Soils in the Park can be considered typical, both locally and regionally (Lindsay et al., 1968); Twardy and Lindsay, 1971).

Special features of soils in the Park are the inherent properties of Luvisolic soils, as found in the upland portion. Luvisolic soils in their natural state display surface leaf litter (L-H) and leached light gray coloured Ae horizons, typical of soils developed under forest vegetation. the Ae horizons are underlain by much finer textured Bt horizons of clay accumulation.

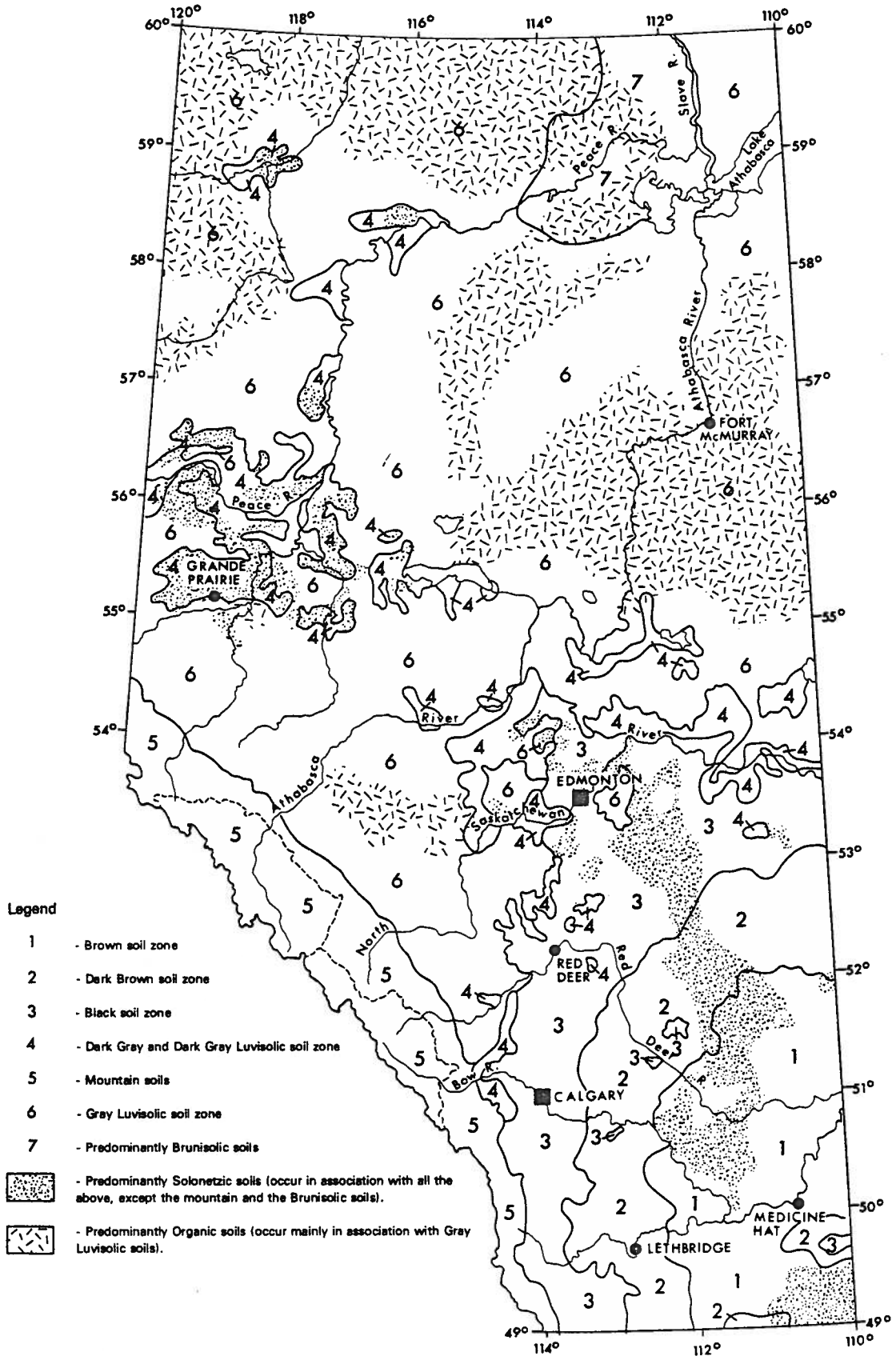
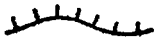


Figure 2. Map showing soil zones of Alberta. (From Soil Group Map of Alberta, Alberta Institute of Pedology, undated).

MISCELLANEOUS SYMBOLS

This symbol indicates bedrock exposures, either sandstone or shale. These usually have very steep slopes (>30 to 60%) and are devoid of vegetation. Occasional small portions have gentler slopes (greater than>5 to 15%), and a sparse cover of vegetation, including balsam poplar, dogwood, wild rose, and patches of wolf willow. These bedrock exposures commonly have very severe limitations for most uses because of the extreme slopes and the inherent properties of bedrock. Small portions may have some limited potential for trails.

B.P. This symbol indicates the location of a burrow pit.



This symbol indicates escarpments.

SR This symbol indicates a location where the soil solum has been removed by construction activities, thus exposing the soil parent material at the surface. These patches are devoid or nearly devoid of vegetation, and properties are the same as adjacent soil parent materials.

F This symbol indicates a sanitary landfill site.

This symbol indicates the location of wet depressional patches, which commonly are water-filled. They are characterized by the growth of hydrophytic vegetation, including slough grass, sedge, arrow-leaved coltsfoot, and a few willows. These depressions have severe to very severe limitations for all uses because of seasonally high groundwater tables or surface ponding.

SOIL INTERPRETATIONS

An explanation of soil interpretations and definitions of the soil limitation and suitability ratings are given in Greenlee (1981). The results of soil chemical and physical analyses are given in Tables 2 and 3.

the soils in the Park best suited for recreational development are those of Map Unit 1 when found on suitable topography, and those of Map Unit 3. Map Unit 1 soils cover all of the upland portion, and Map Unit 3 soils cover nearly all of the river floodplain. Map Unit 1 soils have moderate limitations because they have slow permeability, and they may be slippery or sticky when wet. Map Unit 3 soils have moderate limitations due to a possible flooding hazard (overflow). Soils of most other map units have severe limitations and some have very severe limitations because of various factors, including excessive slopes, erosion hazard, seasonally high groundwater tables or surface ponding, flooding hazard (overflow), and Organic soil.

The soils best suited for road construction are those of Map Unit 3, and

TABLE 2. Chemical Analyses of Selected Map Units[1]

MAP UNIT	DEPTH cm	pH H20	[2] EC	[3] Na	[3] SO_4	[3] OM	[3] $CaCO_3$
1	0-15	6.0	0.3	L-	[4] nd	L+	-
	15-30	4.8	0.1	L	nd	L+	-
2	0-15	6.8	0.4	L-	nd	M-	-
	15-30	6.3	0.3	L	nd	M-	-
3	0-15	6.2	0.2	L-	nd	M-	-
	15-30	6.5	0.2	L	nd	L+	-
4	0-15	6.3	0.3	L-	nd	L+	-
	15-30	6.0	0.2	L-	nd	M-	-

[1]Chemical Analyses done by Alberta Soil and Feed Testing Laboratory, [2]EC - electrical conductivity, millimhos/cm, [3]These tests are rated into 4 categories: High (H), Medium (M), Low (L), and none (-). The degree within each category is indicated by a + or - sign. The tests for OM (organic matter) and $CaCO_3$ (free lime) are visual estimates only, [4]nd - not determined.

Table 3. Physical Analyses of Selected Map Units (1)

Map Unit	Depth cm	Field Moisture %	Mechanical Analysis											Liquid Limit	Plasticity Index	Optimum Moisture %(2)	Maximum Dry Density lb/ft.^{3} (2)	Classification		
			Percentage Passing Sieve							Percentage Smaller Than										
			1 inch	3/4 inch	5/8 inch	#4 (4.7 mm.)	#10 (2.0 mm.)	#40 0.42 mm.)	#200 (0.074 mm.)	0.05 mm.	0.005 mm.	0.002 mm.	0.001 mm.					AASHO	Unified	USDA
1	60-90	24	100	100	100	100	100	100	98	97	90	77	59	71	38	nd[3]	nd	A-7-5 (20)	CH	HC
2	120-150	22	100	100	100	100	100	99	85	82	56	39	30	46	21	26	93.5	A-7-6 (13)	CL	SiCL

(1) Map Units developed on similar parent material: 1, and 3 (the underlying till)

(2) These values are obtained from charts worked out by the Highways Testing Laboratory, Alberta Transportation.

(3) nd - not determined

they have moderate limitations because of a possible flooding hazard (overflow). Soils of most other map units have severe limitations and some have very severe limitations because of various factors, including high shrink-swell potential, susceptibility to frost heave, excessive slopes, erosion hazard, flooding hazard (overflow), shallow depth to bedrock, and seasonally high groundwater table or surface ponding.

A good source of sand and gravel was not found in the Park. Map Unit 5 soils can provide only a fair source of sand because of seasonally high groundwater tables or surface ponding, and flooding hazard (overflow). Map Units 2 and 3 soils constitute only a poor source of sand because of unsuitable textures and thin deposits. Also, occasional thin gravel deposits may be found in Map Unit 3 soils. Soils of other map units are unsuitable because of unsuitable textures.

Specific limitations and suitabilities of the various soils for selected uses are shown in Tables 4 to 13 inclusive. The ratings were determined on the basis of morphological, physical, and chemical properties of the soils, as well as steepness of slope. The principal limiting properties are indicated, and are generally listed in decreasing order of importance. In Tables 4 to 11 inclusive, the soil limitations for various uses have been designated as none to slight, moderate, severe, and very severe. In Tables 12 and 13, the suitability of soils as sources of roadfill and as sources of sand and gravel respectively, have been designated as good, fair, poor and very poor.

TABLE 4. Soil Limitations for Fully Serviced Campgrounds

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	M - Sl Perm, Slip	5/b0	S - Flood, Wet
1/f0	S - Slope, Er, Sl Perm	6/a0	S - Wet
2/f1	S - Slope, Er, Slip	TH/a0	VS - Org, Wet
2/g1	VS - Slope, Er, Slip		
3/b0 3/c0	M - Flood		
4/F0	S - Slope, Er, Flood		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Org - Organic soil
Org Surf - Organic surface layer > 15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Sl Perm - Slow permeability
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 5. Soil Limitations for Picnic Areas

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	M - Sl Perm, Slip	5/b0	S - Wet, Flood
1/f0	S - Slope, Er, Sl Perm	6/a0	S - Wet
2/f1	S - Slope, Er, Slip	TH/a0	VS - Org, Wet
2/g1	VS - Slope, Er, Slip		
3/b0 3/c0	SL		
4/F0	S - Slope, Er		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Org - Organic soil
Org Surf - Organic surface layer > 15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Sl Perm - Slow permeability
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 6. Soil Limitations for Lawns and Landscaping

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	M - Sl Perm, Thin Ah	5/b0	S - Wet, Thin Ah, Lime
1/f0	S - Slope, Er, Sl Perm	6/a0	S -Wet, Thin Ah, Lime
2/f1	S - Slope, Er, Thin Ah	TH/a0	VS - Wet, Org, Thin Ah
2/g1	VS - Slope, Er, Thin Ah		
3/b0 3/c0	M - Thin Ah		
4/F0	S - Slope, Er, Thin Ah		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Lime - High lime content (soil nutrient imbalance)
Org - Organic soil
Org Surf - Organic surface layer > 15 cm thick
R Perm - Rapid permeability (droughtiness)
Saline - Surface soil salinity
Sandy - Sandy surface texture
Slope - Excessive slope
Sl Perm - Slow permeability
Solz - Solonetzic soil
Stony - Surface stoniness
Thin Ah - Thin or no Ah horizon
Wet - Seasonally high groundwater or surface ponding

TABLE 7. Soil Limitations for Paths

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	M - Slip	5/b0	S - Wet, Flood
1/f0	S - Slope, Er, Slip	6/a0	S - Wet
2/f1	S - Slope, Er, Slip	TH/a0	VS - Org, Wet
2/g1	VS - Slope, Er, Slip		
3/b0 3/c0	SL		
4/F0	S - Slope, Er		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Org - Organic soil
Org Surf - Organic surface layer > 15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 8. Soil Limitations for Trails

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	M - Slip	5/b0	S - Wet, Flood
1/f0	M - Slope, Er, Slip	6/a0	S - Wet
2/f1	M - Slope, Er, Slip	TH/a0	VS - Org, Wet
2/g1	S - Slope, Er, Slip		
3/b0 3/c0	SL		
4/F0	M - Slope, Er,		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Org - Organic soil
Org Surf - Organic surface layer > 15 cm thick
Sandy - Sandy surface texture
Slip - Slippery or sticky when wet
Slope - Excessive slope
Solz - Solonetzic soil
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 9. Soil Limitations for Buildings with Basements

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	S - Sh-Sw, Frost	5/b0	S - Flood, Wet
1/f0	S - Slope, Sh-Sw, Frost	6/a0	S - Wet
2/f1	S - Slope, M Sh-Sw, Frost	TH/a0	VS - Wet, Sh-Sw, Frost
2/g1	VS - Slope, M Sh-Sw, Frost		
3/b0 3/c0	S - Flood, M Sh-Sw, Frost		
4/F0	S - Slope, BR, Flood		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

BR - Shallow depth to bedrock
Clay - High clay content
Flood - Flooding hazard (overflow)
Frost - Susceptibility to frost heave
M Sh-Sw - Moderate shrink-swell potential
Org - Organic soil
Sh-Sw - High shrink-swell potential
Slope - Excessive slope
Stony - Surface stoniness
Sulfate - Possible concrete corrosion hazard (soluble sulfate)
Wet - Seasonally high groundwater table or surface ponding

TABLE 10. Soil Limitations for Buildings Without Basements

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	SL	6/a0	S - Wet
1/f0	S - Slope	TH/a0	VS - Wet, Org
2/f1	S - Slope		
2/g1	VS - Slope		
3/b0 3/c0	S - Flood		
4/F0	S - Slope, Flood, BR		
5/b0	S - Flood, Wet		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

BR - Shallow depth to bedrock
Flood - Flooding hazard (overflow)
Org - Organic soil
Slope - Excessive slope
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 11. Soil Limitations for Road Location

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/c0 1/d0	S - Sh-Sw, Frost	5/b0	S - Flood, Wet
1/f0	S - Slope, Er, Sh-Sw	6/a0	S - Wet
2/f1	S - Slope, Er, Sh-Sw	TH/a0	VS - Wet, Sh-Sw, Frost
2/g1	VS - Slope, Er, Sh-Sw		
3/b0 3/c0	M - Flood		
4/F0	S - Slope, Er, BR		

1. For explanation, see Soil Map.
2. SL - None to slight, M - Moderate, S - Severe, VS - Very severe.

ABBREVIATIONS

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Frost - Susceptibility to frost heave
M Sh-Sw - Moderate shrink-swell potential
Org - Organic soil
Sh-Sw - High shrink-swell potential
Slope - Excessive slope
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 12. Soil Suitability for Source of Roadfill

MAP SYMBOL [1]	DEGREE OF SUITABILITY [2]	MAP SYMBOL	DEGREE OF SUITABILITY
1/c0 1/d0	P - Sh-Sw, Frost	6/a0	P - Wet
1/f0	P - Sh-Sw, Slope, Frost	TH/a0	VP - Wet, Sh-Sw, Frost
2/f1	P - Sh-Sw, Slope, Er		
2/g1	P - Slope, Er, Sh-Sw		
3/b0 3/c0	G		
4/F0	F - Slope, Er, BR		
5/b0	F - Wet, Flood		

1. For explanation, see Soil Map.
2. G - Good, F - Fair, P - Poor, VP - Very poor.

ABBREVIATIONS

BR - Shallow depth to bedrock
Clay - High clay content
Er - Erosion hazard
Flood - Flooding hazard (overflow)
Frost - Susceptibility to frost heave
M Sh-Sw - Moderate shrink-swell potential
Org - Organic soil
Sh-Sw - High shrink-swell potential
Slope - Excessive slope
Stony - Surface stoniness
Wet - Seasonally high groundwater table or surface ponding

TABLE 13. Soil Suitability for Source of Sand or Gravel

MAP SYMBOL [1]	DEGREE OF SUITABILITY [2]	MAP SYMBOL	DEGREE OF SUITABILITY
1/c0 1/d0 1/f0	VP - Text		
2/f1 2/g1	P - Text, Thin		
3/b0 3/c0	P - Text, Thin		
4/F0	Vp - Text		
5/b0	F - Wet, Flood		
6/a0	VP - Text, Wet		
TH/a0	VP - Text, Wet		

1. For explanation, see Soil Map.
2. G - Good, F - Fair, P - Poor, VP - Very poor.

ABBREVIATIONS

Flood - Flooding hazard (overflow)
OB - Excessive overburden
Org - Organic soil
Text - Unsuitable texture
Thin - Thin deposit of sand of gravel
Wet - Seasonally high groundwater table or surface ponding

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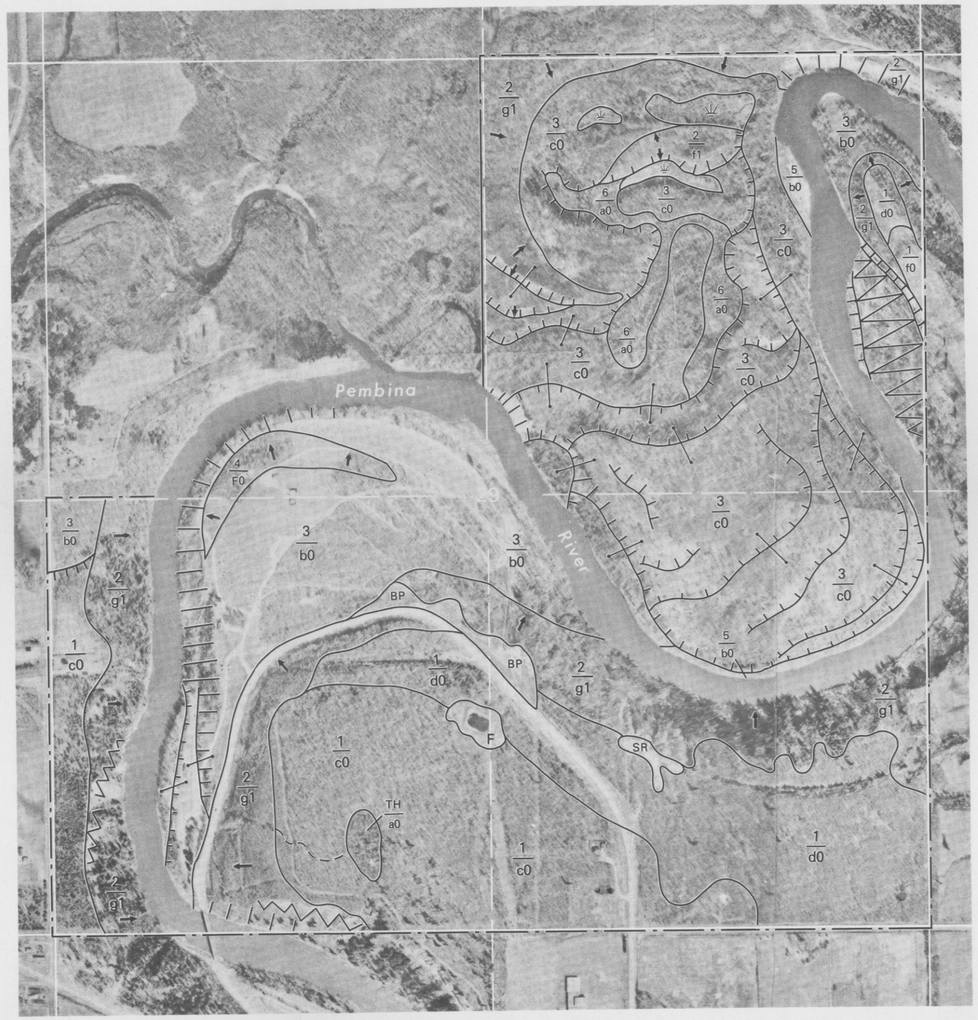


Soil Map, Pembina River Provincial Park

Tp 53 R 7 W5M

G.M. Greenlee

Published 1984
Fieldwork conducted in 1975

Cartography by Alberta Research Council, Graphic Services, J. Dlask

ALBERTA RESEARCH COUNCIL
Natural Resources Division
Terrain Sciences Department

APPROXIMATE SCALE 1:8000

666 0 666 1332 1998 Feet

160 0 160 320 480 Metres

N

SOIL CLASSIFICATION			
MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Luvisolic	Orthic Gray Luvisol-60% Dark Gray Luvisol-40%	very fine textured glaciolacustrine sediments, overlying moderately fine textured till
2	Brunisolic	Orthic Eutric Brunisol	moderately fine textured till containing a high proportion of weathered shale, and moderately to very coarse textured till containing a high proportion of weathered sandstone
3	Brunisolic	Orthic Eutric Brunsol	medium to very coarse textured fluvial sediments, overlying moderately fine textured till
4	Brunisolic	Orthic Eutric Brunisol, Lithic Phase	moderately coarse textured fluvial sediments, overlying sandstone
5	Regosolic	Gleyed Regosol	very coarse textured fluvial sediments (sand)
6	Gleysolic	Rego Gleysol	moderately coarse textured fluvial sediments
TH	Organic	Terric Humisol	predominantly humic peat, overlying very fine textured glaciolacustrine sediments

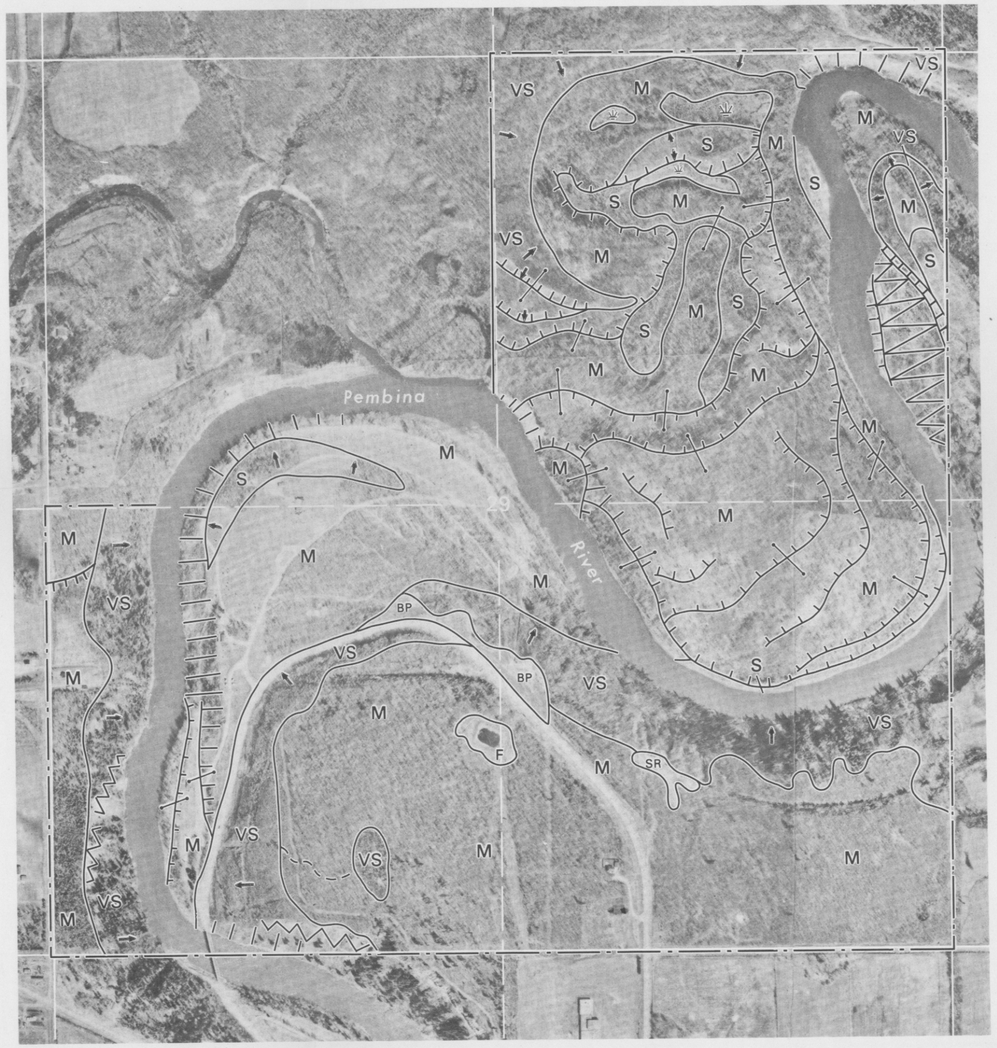
LEGEND:

Map Symbol:

3/b0 ← map unit
surface stoniness rating
topographic class

- soil line
- boundary of mapped area
- direction of slope
- bedrock exposures
- BP - burrow pit
- escarpment
- small drainage channel
- wet depression
- SR - surface removed
- F - sanitary landfill site

OFR 1984-40



Soil Limitations for Recreation, Pembina River Provincial Park

Tp 53 R 7 W5M

G.M. Greenlee

Published 1984
Fieldwork conducted in 1975

Cartography by Alberta Research Council, Graphic Services, J. Dlask

ALBERTA RESEARCH COUNCIL
Natural Resources Division
Terrain Sciences Department

APPROXIMATE SCALE 1:8000

666 0 666 1332 1998 Feet

160 0 160 320 480 Metres

LEGEND:

SL - none to slight soil limitations

M - moderate soil limitations

S - severe soil limitations

VS - very severe soil limitations

LEGEND:

- soil limitation line
- boundary of mapped area
- direction of slope
- bedrock exposures

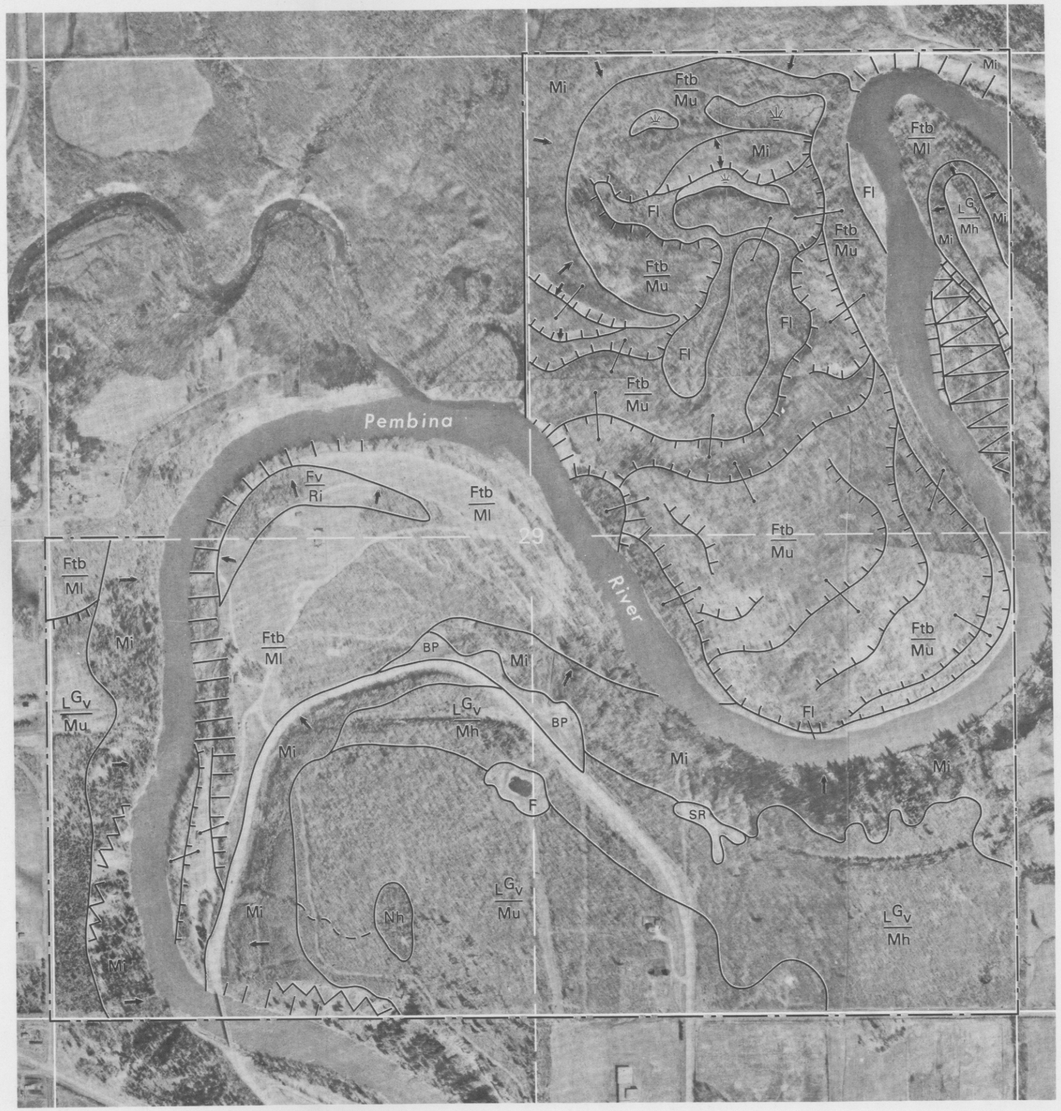
BP - burrow pit

- escarpment
- small drainage channel
- wet depression

SR - surface removed

F - sanitary landfill site

OFR 1984-40



Landform Map, Pembina River Provincial Park

Tp 53 R 7 W5M

G.M. Greenlee

Published 1984
Fieldwork conducted in 1975

Cartography by Alberta Research Council, Graphic Services, J. Dlask

ALBERTA RESEARCH COUNCIL
Natural Resources Division
Terrain Sciences Department

APPROXIMATE SCALE 1:8000

666 0 666 1332 1998 Feet

160 0 160 320 480 Metres

LEGEND:

F - Fluvial

- Fl - level fluvial
- $\frac{Ftb}{Ml}$ - fluvial terrace blanket, overlying level morainal
- $\frac{Ftb}{Mu}$ - fluvial terrace blanket, overlying undulating morainal
- $\frac{Fv}{Ri}$ - fluvial veneer, overlying inclined bedrock

L - Lacustrine

- $\frac{LGv}{Mh}$ - glaciolacustrine veneer, overlying hummocky morainal
- $\frac{LGv}{Mu}$ - glaciolacustrine veneer, overlying undulating morainal

M - Morainal

- Mi - inclined morainal

N - Fen

- Nh - horizontal fen

LEGEND:

- landform line
- boundary of mapped area
- direction of slope
- bedrock exposures
- BP - burrow pit
- escarpment
- small drainage channel
- wet depression
- SR - surface removed
- F - sanitary landfill site