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SOIL SURVEY OF THUNDER LAKE PROVINCIAL PARK AND INTERPRETATION FOR RECREATIONAL USE

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CONTENTS

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, Wabamun 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 30 000 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.

ACKNOWLEDGMENTS

The Alberta Research Council provided the staff, and the Outdoor Recreation Planning Branch of Alberta Recreation and Parks contributed the funds for the 1976-77 provincial parks soil survey program. Costs included field, office, laboratory, drafting, editing, and printing; as well as equipment and supplies. Office and laboratory space were provided by The University of Alberta. Mrs. Kathie Skogg typed and assisted in compiling and proofreading the report. Mrs. J. Dlask drafted the soil, landform, and soil limitations for recreation maps, while Mr. J. Beres determined the soil physical properties. The soil chemical analyses were determined by the Alberta Soil and Feed Testing Laboratory. Able field assistance was given by Mr. M. Hennie.

Special acknowledgment is given to the Park Rangers and other park employees, who cooperated by allowing soil investigations to be conducted throughout the park, and who invariably offered assistance when needed.

SUMMARY

Thunder Lake Park comprises approximately 190 ha and is located approximately 21km west of Barrhead, which in turn is approximately 120 km northwest of Edmonton. The entire Park is covered by moderately fine textured till, and occasional small organic soil deposits also occur in depressional locations. 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 suitated 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.

Only three map units were recognized in Thunder Lake Park. The key profile types are Orthic Gray Luvisols, Dark Gray Luvisols, and undifferentiated Mesisols. These are distributed over the landscape in relation to landform, parent material, and drainage. Each map unit is a soil series, and the distribution is shown on the soil map.

Soil interpretations of each map unit are made for fully serviced campgrounds, primitive camping areas, picnic areas, lawns and landscaping, paths, trails, buildings (with and without basements), septic tank adsorption fields, trench type sanitary landfills, road location, source of roadfill, and source of sand or gravel.

Map Unit 1 soils, which cover nearly all of Thunder Lake Park, have moderate limitations for recreational development because of surface stoniness, but are otherwise well suited when found on suitable topography. These soils have severe limitations for road construction because of high shrink-swell potentials, and susceptibility to frost heave. A source of sand or gravel was not found in the Park. Careful study of the soil map and Tables 4 to 16 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, an on-site investigation is usually required.

INTRODUCTION

SIZE AND LOCATION

Thunder Lake Park comprises approximately 190 ha and is located approximabely 21 km west of Barrhead (Figure 1), which in turn is approximately 120 km northwest of Edmonton. It is adjacent to the northeastern shore of Thunder Lake, and includes a small portion of the north half of Section 20, most of the southwest quarter and all of the northwest quarter of Section 29, a small portion of the southeast quarter and most of the north half of Section 30, Township 59, Range 5, 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); and the topography ranges from gently to moderately rolling in different portions. The bedrock has been classified as the Upper Cretaceous Wapiti Formation, which is nonmarine (Green, 1972). Surface elevations remain relatively constant at approximately 670 m within the Park; and a very gradual decrease occurs from the northeast to the

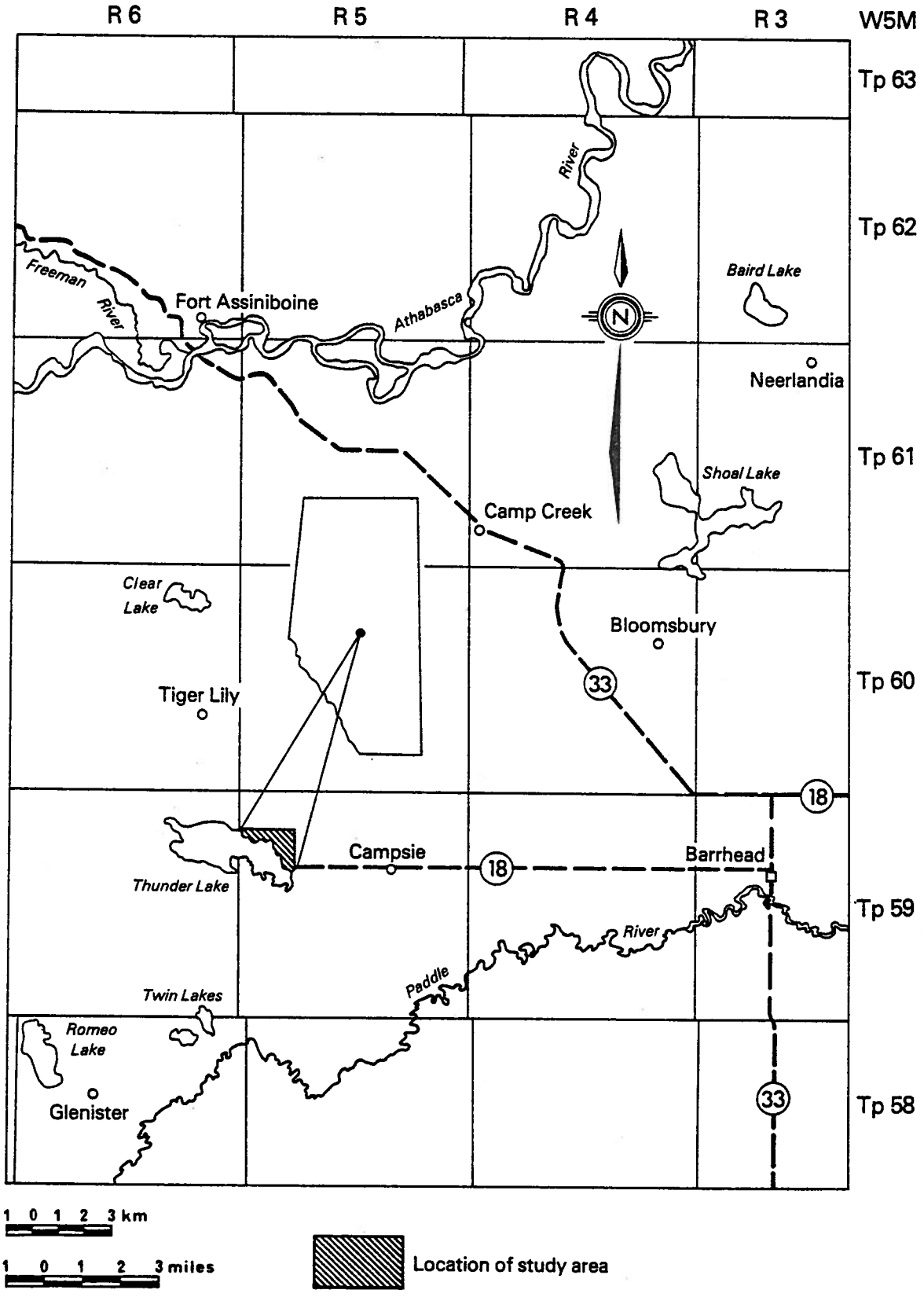

Figure 1. Map showing location of study area.

southwest, toward the lake. The Park is drained by a creek that flows into the Paddle River to the southeast. The Paddle River flows into the Pembina to the east, and this in turn flows into the Athabasca River to the north.

The entire Park is covered by moderately fine textured till, and occasional small organic soil deposits also occur in depressional locations.

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 for 1951 through 1980 from the Namao Airport approximately 120 km southeast of the Park, and at an elevation of 688 m, were used to compile the following information (Environment Canada, 1982): the mean annual temperature is 2.4°C. July is the warmest month of the year with a mean temperature of 16.9°C, and January is the coldest with a mean temperature of -15.6°C. The mean annual precipitation is 451 mm and 71% falls as rain. The average frost-free period is 129 days. Considerably lower average temperatures can be expected in the Park than at Namao Airport. According to the agro-climatic map of Alberta (Bowser, 1967) the Park is situated approximately on the boundary between agro-climatic areas 2H and 3H, while Namao Airport is situated in agro-climatic area 1. The average frost free period in agro-climatic area 1 is greater than 90 days; in agro-climatic area 2H it is between 75 and 90 days; and in agro-climatic area 3H it is only 60 to 75 days.

VEGETATION

The study area is situated in the mixedwood section of the boreal forest region, as classified by Rowe (1972). The characteristic forest association of well drained uplands ia 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. In addition to its usual dominance in sandy areas, jack pine is found in the forest composition on the drier till soils, and is mixed with black spruce on plateau-like tops of the higher hills. Black spruce and larch muskeg have developed in lower positions and the upper water catchment areas.

Aspen is the predominant vegetation throughout most of the Park, and some balsam poplar also occurs. A mixture of white birch and balsam poplar, as well as some white spruce, are found on the two larger islands. Black spruce and tamarack predominate in organic soil areas. 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 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), black spruce (Picea mariana), tamarack (Larix laricina), saskatoon-berry (Amelanchier alnifolia), dogwood (Cornus stolonifera), beaked hazelnut (Corylus cornuta), low-bush cranberry (Viburnum edule), choke cherry (Prunus virginiana), pin cherry (Prunus pensylvanica), willow (Salix spp), alder (Alnus spp), swamp birch (Betula pumila var glandulifera), wild rose (Rosa spp), wild gooseberry (Ribes spp), wild currant (Ribes spp), alsike clover (Trifolium hybridum), grass (various species), slough grass (Beckmannia syzigachne), wild mint (Mentha arvensis var villosa), arrow-leaved coltsfoot (Petasites sagittatus), Labrador tea (Ledum groenlandicum), cloudberry (Rubus chamaemorus), and sphagnum moss (Sphagnum spp).

SOILS

Only three map units were recognized in Thunder Lake Park. The soils of two were classified in the Luvisolic Order, and one in the Organic Order of 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 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.

Virtually the entire park is covered by well drained Luvisolic soils developed on moderately fine textured till.

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 furhter 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

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	moderately fine textured till	fine sandy loam to very fine sandy loam	d,e (> 5 to 15%)	2	well drained	Slight to severe limitations, poor source of roadfill, unsuitable as a source of sand or gravel - surface stoniness, excessive slopes, erosion hazard, lack of Ah horizon, high clay content, slow permeability of subsoil, moderate to high shrink-swell potential, susceptibility to frost heave.
2	Dark Gray Luvisol	moderately fine textured till	loam	d,f (> 5 to 30%)	2 to 3	well drained	Occasional pockets of coarse sand occur in Cca horizon. Moderate to severe limitations, poor source of roadfill, unsuitable as a source of sand or gravel - surface stoniness, excessive slopes, erosion hazard, thin Ah horizon, high clay content, slow permeability of subsoil, moderate to high shrink-swell potential, susceptibility to frost heave.
M	undifferentiated Mesisol	predominantly mesic peat	fibric peat	a (0 to 0.5%)	0	very poor	Very severe limitations, poor source of roadfill, unsuitable as a source of sand or gravel - Organic soil, extreme wetness, lack of Ah horizon, high shrink-swell potential, groundwater contamination hazard.

readilly 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 c omposition 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 cvhemically 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 deficiences 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 heave.

Only three small patches of Organic soils were mapped in Thunder Lake Park.

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% 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.
Parent material:	moderately fine textured till.
Landform:	hummocky morainal (Mh).
Slope:	gently to moderately rolling (>5 to 15%).
Surface stoniness:	moderately stony (2).
Drainage:	well drained.
Vegetation:	predominantly aspen; some balsam poplar; understory consists of saskatoon-berry, dogwood, beaked hazelnut, low-bush cranberry, choke cherry, pin cherry, and wild rose.
Profile description:	Orthic Gray Luvisol.

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	5-8	leaf and root litter		
Ae	10-20	fine sandy loam to very fine sandy loam	platy	soft, dry; very friable, moist
Bt	40-50	clay loam	subangular blocky	very firm, moist
BC	15-38	clay loam	amorphous	very firm, moist
Cca	at 75-100	clay loam	amorphous	very firm, moist

Limitations: Slight to severe-slight on suitable topography for picnic areas and trails; moderate because of surface stoniness but otherwise slight on suitable topography for campgrounds, paths, and buildings without basements; moderate for lawns and landscaping, buildings with basements, and trench type sanitary landfills; severe for septic tank absorption fields, and road location; poor source of roadfill; unsuitable as a source of sand or gravel due to unsuitable textures. Other limitations include excessive slopes, erosion hazard, lack of Ah horizon, high clay content, slow permeability (of subsoil), moderate to high shrink-swell potential, and susceptibility to frost heave.

Map Unit 2

Classification: Dark Gray Luvisol.

Parent material: moderately fine textured till.

Landform: hummocky morainal (Mh).

Slope: gently to strongly rolling (>5 to 30%).

Surface stoniness: moderately to very stony (2 to 3).

Drainage: well drained.

Vegetation: white birch, balsam poplar; some white spruce; understory consists of dogwood, willow, beaked

hazelnut, saskatoon-berry, choke cherry, pin cherry, wild rose, wild gooseberry, and wild currant.

Profile description: Dark Gray Luvisol.

Horizon	Thickness (cm)	Field Texture	Structure	Consistence
L-H	5-8	leaf and root litter		
Ahe	5-25	loam	amorphous	soft, dry
Ae	20-40	loam	amorphous	soft, dry
Bt	25-35	clay loam	subangular blocky	hard, dry
Cca	25-40	clay loam	amorphous	slightly hard to hard, dry

Comment: Occasional pockets of coarse sand occur in the Cca horizon.

Limitations: Moderate to severe-moderate due to surface stoniness but otherwise slight on suitable topography for picnic areas, and trails; severe due to surface stoniness but otherwise slight on suitable topography for camping areas, paths, and buildings without basements; severe due to surface stoniness but otherwise moderate on suitable topography for lawns and landscaping, buildings with basements, and trench type sanitary landfills; severe for septic tank absorption fields, and road location; poor source of roadfill; unsuitable as a source of sand or gravel because of unsuitable textures. Other limitations include excessive slopes, erosion hazard, thin Ah horizon, high clay content, slow permeability (of subsoil), moderate to high shrink-swell potential, and susceptibility to frost heave.

M (Organic soil)

Classification: undifferentiated Mesisol.

Parent material: predominantly mesic peat.

Landform: horizontal bog (Bh).

Slope: nearly level (0 to 0.5%).

Surface stoniness: nonstony (0).

Drainage: very poor.

Vegetation: black spruce, tamarack, Labrador tea, cloudberry, sphagnum moss; patches of swamp birch, willow, white birch, white spruce, slough grass, arrow-leaved coltsfoot.

Profile description: Mesisol.

Horizon	Thickness (cm)	Field Description
Of	25-60	predominantly fibric peat
Om	90+	predominantly mesic peat.

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

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 frome 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 approximately 38 cm) topsoil colours are dark brown. Between these two zones, topsoil colours are brown to dark brown, and annual precipitation is approximately 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.

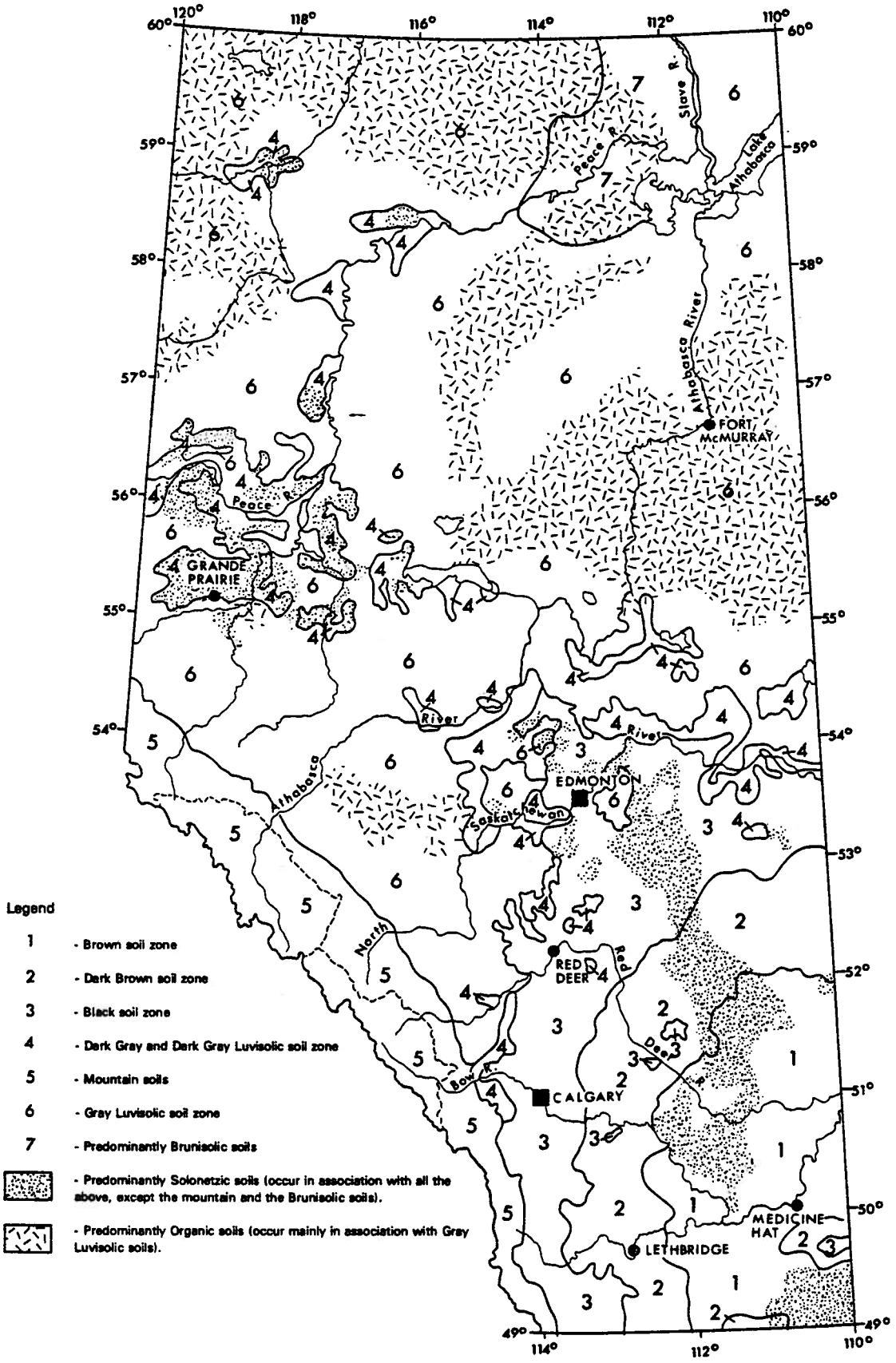

Figure 2. Map showing soil zones of Alberta (From Soil Group Map of Alberta, Alberta Institute of Pedology, undated).

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.

According to the Soil Group Map of Alberta (Alberta Institute of Pedology, undated), Thunder Lake Park is situated in the Dark Gray and Dark Gray Luvisolic soil zone, only a few kilometers southeast of the Gray Luvisolic soil zone boundary. The soils have been classified as Orthic Gray Luvisols throughout virtually the entire Park, and these can be considered as zonally normal. The Dark Gray and Dark Gray Luvisolic soil zone is typically transitional in nature, and patches of Orthic Gray Luvisols are commonly found. Soils on the two larger islands in the Park were classified as Dark Gray Luvisols. The Organic soils are intrazonal, and they occur in most of the soil zones. Soils in the Park can be considered typical, both locally and regionally (Wynnyk et al, 1969).

Special features of soils in the Park are the inherent properties of Luvisolic and Organic soils. The 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. The Organic soils are soft and spongy to walk on, and hold vast quantities of water. These soil profiles do not display well developed distinctive horizons that depict mineral soils. The soil materials resemble sponges and readily absorb water, which can easily be squeezed out in the hand.

MISCELLANEOUS SYMBOLS

B. This symbol indicates a beach, which is comprised of sand. The beach in Thunder Lake Park appears to be man-made, whereby sand has been hauled in from another location, and spread over the original soil surface along the lakeshore.

D.L. This symbol indicates disturbed land, where the soil solum has been removed by construction activities, exposing the C horizon or soil parent material at the surface. The soil characteristics are generally similar to soil properties of C horizons of adjacent soils. These areas are generally level, have slight limitations for picnic areas, and trails; moderate limitations due to surface stoniness but otherwise slight limitations for campgrounds, paths, and buildings without basements; moderate limitations for lawns and landscaping, buildings with basements, and trench type sanitary landfills; severe limitations for septic tank absorption fields, and road location; are poor sources of roadfill; and unsuitable as sources of sand or gravel due to unsuitable textures. Other limitations include lack of Ah horizon, high clay content, slow permeability, moderae to high shrink-swell potential, and susceptibility to frost heave.

 This symbol indicates escarpments.

F. This symbol indicates an area of fill. It appears that the

natural landscape has been altered by removing the highs and filling in the lows to create a relatively flat area adjacent to the beach and a portion of the lakeshore. The current vegetation is a mixture of grass and alsike clover. This area has moderate limitations for recreational uses because of a possible slippery or sticky surface when wet if vegetation is removed. An additional moderate limitation for lawns and landscaping is high lime content (soil nutrient imbalance). The area has moderate limitations due to surface stoniness but otherwise slight limitations for buildings without basements; moderate limitations for buildings with basements, and trench type sanitary landfilles; severe limitations for septic tank absorption fields, and road location; is a poor source of roadfill; and is unsuitable as a source of sand or gravel because of unsuitable textures. Other limitations include high clay content, slow permeability, moderate to high shirnk-swell potential, and susceptibility to frost heave.

P. This symbol indicates the location of a paved parking lot.

SLF. This symbol indicates the location of a sanitary landfill site.

This symbol indicates wet or water-filled depressions. They are characterized by the growth of hydrophytic vegetation including slough grass, wild mint, and others; as well as some willow, alder, white birch, white spruce, and tamarack. These depressions have very severe limitations for all uses and are very poor sources of roadfill because of extreme wetness and flooding hazard (overflow). They are unsuitable as sources of sand or gravel for the same reasons, and also because they have unsuitable textures.

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.

Map unit 1 soils, which cover nearly all of Thunder Lake Park, have moderate limitations for recreational development because of surface stoniness, but are otherwise well suited when found on suitable topography. These soils have severe limitations for road construction because of high shrink-swell potentials, and susceptibility to frost heave. A source of sand or gravel was not found in the Park.

Specific limitations and suitabilities of the various soils for selected uses are shown in Tables 4 to 16 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 14 inclusive, the soil limitations for various uses have been designated as none to slight, moderate, severe, and very severe. In Tables 15 and 16, 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 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	0.2	L-	[4] nd	M-	-
	15-30	5.6	0.1	L-	nd	M-	-
2	0-15	5.8	0.3	L+	nd	M-	-
	15-30	6.5	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								AASHO	Unified	USDA
			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.							
1	90-120	14	100	100	100	100	100	95	67	64	41	36	30	39	18	21	100.0	A-6 (9)	CL	CL

(1) Map Units developed on similar parent material: 1 and 2.

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

TABLE 4. Soil Limitations for Fully Serviced Campgrounds

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/d2	M - Stony, otherwise SL		
1/e2	M - Slope, Er, Stony		
2/d3	S - Stony, otherwise SL		
2/f2	S - Slope, Er, Stony		
M/a0	VS - Org, 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
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 Primitive Camping Areas

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
$\frac{1}{d2}$ $\frac{1}{e2}$	M - Stony, otherwise SL		
$\frac{2}{d3}$	S - Stony, otherwise SL		
$\frac{2}{f2}$	M - Slope, Er, Stony		
$\frac{M}{a0}$	VS - Org, 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
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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 Picnic Areas

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/d2	SL		
1/e2	M - Slope, Er		
2/d3	M - Stony, otherwise SL		
2/f2	S - Slope, Er, Stony		
M/a0	VS - Org, 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
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 7. Soil Limitations for Lawns and Landscaping

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/d2	M - Thin Ah, Stony		
1/e2	M - Slope, Er, Thin Ah		
2/d3	M - Thin Ah S - Stony		
2/f2	S - Slope, Er, Thin Ah		
M/a0	VS - Wet, Org, 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 table or surface ponding

TABLE 8. Soil Limitations for Paths

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/d2	M - Stony, otherwise SL		
1/e2	M - Slope, Er, Stony		
2/d3	S - Stony, otherwise SL		
2/f2	S - Slope, Er, Stony		
M/a0	VS - Org, Wet		

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 Trails

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
$\frac{1}{d2}$ $\frac{1}{e2}$	SL		
$\frac{2}{d3}$	M - Stony, otherwise SL		
$\frac{2}{f2}$	M - Slope, Er		
$\frac{M}{a0}$	VS - Org, Wet		

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 10. Soil Limitations for Buildings with Basements

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/d2	M - M Sh-Sw, Frost, Stony		
1/e2	M - Slope, M Sh-Sw, Frost		
2/d3	M - M Sh-Sw, Frost S - Stony		
2/f2	S - Slope, M Sh-sw, Frost		
M/a0	VS - Org, Wet, Sh-Sw		

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)
Forst - 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 11. Soil Limitations for Buildings Without Basements

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
$\frac{1}{d2}$	M - Stony, otherwise SL		
$\frac{1}{e2}$	M - Slope, Stony		
$\frac{2}{d3}$	S - Stony, otherwise SL		
$\frac{2}{f2}$	S - Slope, Stony		
$\frac{M}{a0}$	VS - Org, 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 12. Soil Limitations for Septic Tank Absorption Fields

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/d2	S - Sl Perm		
1/e2	S - Sl Perm, Slope		
2/d3	S - Sl Perm		
2/f2	S - Slope, Sl Perm		
M/a0	VS - Org, Wet, GW		

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)
GW - Groundwater contamination hazard
Org - Organic soil
R Perm - Rapid permeability
Slope - Excessive slope
Sl Perm - Slow permeability
Wet - Seasonally high groundwater table or surface ponding

TABLE 13. Soil Limitations for Trench Type Sanitary Landfills

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
$\frac{1}{d2}$ $\frac{1}{e2}$	M - Clay, Stony		
$\frac{2}{d3}$	M - Clay S - Stony		
$\frac{2}{f2}$	M - Slope, Clay, Stony		
$\frac{M}{a0}$	VS - Org, Wet, GW		

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)
GW - Groundwater contamination hazard
Org - Organic soil
R Perm - Rapid permeability
Slip - Slippery or sticky when wet
Slope - Excessive slope
Stony - Surface stoniness
Text - Unsuitable texture
Wet - Seasonally high groundwater table or surface ponding

TABLE 14. Soil Limitations for Road Location

MAP SYMBOL [1]	DEGREE OF LIMITATION [2]	MAP SYMBOL	DEGREE OF LIMITATION
1/d2	S - Sh-Sw, Frost		
1/e2	S - Sh-Sw, Slope, Frost		
2/d3	S - Sh-Sw, Frost, Stony		
2/f2	S - Slope, Sh-Sw, Frost		
M/a0	VS - Org, Wet, Sh-Sw		

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

ABBREVIATONS

BR - Shallow depth to bedrock
Caly - 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 15. Soil Suitability for Source of Roadfill

MAP SYMBOL [1]	DEGREE OF SUITABILITY [2]	MAP SYMBOL	DEGREE OF SUITABILITY
1/d2 1/e2	P - Sh-Sw, Frost		
2/d3	P - Sh-Sw, Frost, Stony		
2/f2	P - Sh-Sw, Slope, Frost		
M/a0	VP - Org, Wet, Sh-Sw		

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 16. Soil Suitability for Source of Sand or Gravel

MAP SYMBOL[1]	DEGREE OF SUITABILITY[2]	MAP SYMBOL	DEGREE OF SUITABILITY
1/d2 1/e2	VP - Text		
2/d3 2/f2	VP - Text		
M/a0	VP - Text, Org, 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 or gravel
Wet - Seasonally high groundwater table or surface ponding

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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
- escarpment

B - beach

DL - disturbed land

F - fill

P - paved parking lot

SLF - sanitary landfill site

ⱶ - wet or water-filled depression

N

APPROXIMATE SCALE 1:8000

666 0 666 1332 1998 Feet

160 0 160 320 480 Metres

Soil Limitations for Recreation, Thunder Lake Provincial Park

Tp 59 R 5 W5M

G.M. Greenlee

Published 1984
Fieldwork conducted in 1975

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

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SOIL CLASSIFICATION			
MAP UNIT	SOIL ORDER	SOIL SUBGROUP	SOIL PARENT MATERIAL
1	Luvisolic	Orthic Gray Luvisol	moderately fine textured till
2	Luvisolic	Dark Gray Luvisol	moderately fine textured till
M	Organic	Undifferentiated Mesisol	predominantly mesic peat

LEGEND:

Map Symbol:

1 ← map unit
e2 ← surface stoniness rating
topographic class

- soil line
- boundary of mapped area
- escarpment
- B - beach
- DL - disturbed land
- F - fill
- P - paved parking lot
- SLF - sanitary landfill site
- wet or water-filled depression

APPROXIMATE SCALE 1:8000

666 0 666 1332 1998 Feet

160 0 160 320 480 Metres

Soil Map, Thunder Lake Provincial Park

Tp 59 R 5 W5M

G.M. Greenlee

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LEGEND:

M - Morainal

Mh - hummocky morainal

B - Bog

Bh - horizonal bog

LEGEND:

- landform line
- boundary of mapped area
- escarpment

B - beach

DL - disturbed land

F - fill

P - paved parking lot

SLF - sanitary landfill site

- wet or water-filled depression

APPROXIMATE SCALE 1:8000

666 0 666 1332 1998 Feet

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Landform Map, Thunder Lake Provincial Park

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