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DETAILED SOIL SURVEY

of

THE CANMORE AREA

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ALBERTA RESEARCH COUNCIL

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PREFACE

This report is one of a series describing detailed soil surveys of areas found within the jurisdiction of the Calgary Regional Planning Commission. These soil surveys are conducted at sufficiently large scale to be useful for local planning.

The report contains information that can be used to evaluate soil properties for urban and recreational development, to evaluate the engineering properties of soils for construction materials and sites and to assess the agricultural capability of the land. The suitabilities or limitations of the soils for selected uses are described in tabular form in the report. These tables can easily be used to make interpretive maps for specific land uses.

There were seven areas surveyed in this program in 1974. These areas are adjacent to the following towns:

Strathmore (5,800 acres)
Okotoks (6,000 acres)
Airdrie (6,800 acres)
Black Diamond (7,700 acres)
Cochrane (10,000 acres)
High River (11,000 acres)
Canmore (15,000 acres)

Total acreage surveyed - 62,300.

There is a separate report for each area. A standard explanatory section which is pertinent to all areas is presented at the beginning of each report. Specific results and interpretations for a particular area are presented in the second section of the report.

INTRODUCTION

Soil is one of our most important natural resources. Man bases his activities on soils and depends on their productivity. Misuse of land can have drastic environmental, economic and social effects. Soil surveys provide baseline data on the soil resources of an area. This information is essential to land characterization and evaluation which is

the natural basis for effective land use and land management policies.

Soils vary widely in their properties and as such their suitability or limitations for different uses also varies. A soil with low agricultural capability may be suitable for road construction and a soil that is unsuitable for road location due perhaps to periodic flooding hazard or high water table may be excellent pasture land. However soils often are suitable for several uses. For example, well drained, level soils that have a high capability for agriculture also are excellent locations for airports, highways and urban development. Soil surveys provide the planner with information useful for making decisions based on predicted soil performance and soil suitability for multiple uses.

USE OF THE REPORT

This report consists of a written text and a map. The written part includes introductory and background information on soils, soil mapping, and soil interpretations in the first section and descriptions of the soils, analytical results, and interpretations for various uses in the second section.

The soil map is presented on an aerial photo-mosaic base. The photo base aids in identification and location of areas, however the linear and spatial distortion inherent in a photo mosaic must be appreciated. The soil-landscape units delineated on the map are described briefly in the map legend and in greater detail in the written report. The map and the report should be used together.

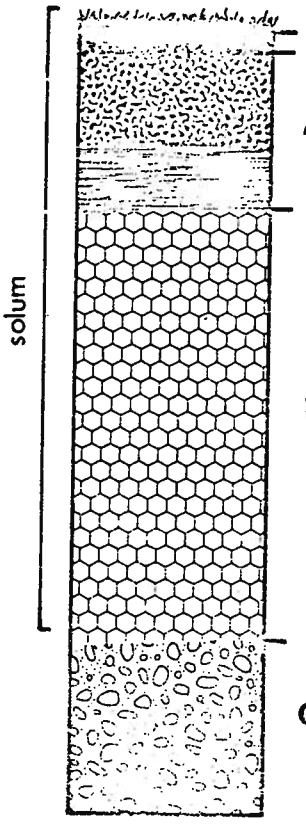
THE SOILS

Soil Formation

Soils are natural bodies present on the earth's surface that are an integral part of the environment. Soils display variation both vertically and horizontally and by examining these variations soil individuals may be recognized. Soils have evolved from their geological parent material through the action of a combination of

soil forming processes, which are controlled by environmental parameters or "soil forming factors". These soil forming factors are commonly listed as being the parent material, climate, biotic agents and topography all acting through time. The variations in relative importance or dominance of one or more of the soil forming processes such as addition and removal of organic matter, translocation of clays or iron and aluminum, and chemical and physical transformations result in the formation of horizons or layers of various kinds within the soil body. These horizons differ from one another in such properties as color, texture, structure, consistence, and chemical and biological activity. The major, or master horizons are designated O for organic layers developed mainly from mosses, rushes, and woody materials; L, F and H for organic layers developed mainly from leaves, twigs, woody materials, and a minor component of mosses; and A, B and C for mineral horizons. Subdivisions of the master horizons are denoted by suffix letters appended to the master horizon symbol (see Figure 1, Table13, and glossary).

FIGURE 1. DIAGRAM OF A SOIL PROFILE



-- Organic layer which may be subdivided into L, F, H or Of, Om, and Oh

--A mineral horizon at or near the surface. It may be a dark colored horizon in which there is an accumulation of humus (Ah), or a light colored horizon from which clay, iron, and humus have been leached (Ae).

--Mineral horizon that (1) may be altered to give a change in color or structure (Bm) or (2) may have an enrichment of clay (Bt).

--Mineral horizon comparatively unaffected by the soil forming process operative in the A and B horizons except for the process of gleying (Cg).

Through observation of soil characteristics it is possible to classify soils into taxonomic units. In this report the System of Soil Classification for Canada (Canada Soil Survey Committee, 1973) is used (see Table 10, Key to the Soils). The criteria used for making the taxonomic separations are significant for understanding soil genesis and for land use applications.

Soil Mapping

When mapping soils the fieldman examines the soil at points in the landscape to characterize landscape units. Since soil is a continuum, and adjacent soils seldom have sharp boundaries, soil map units are defined as having a certain range of properties. These soil map units are based on geologic materials and landforms, soil development, and soil moisture conditions. The soil and land attributes recognized in mapping are important for various land uses.

The notations on the soil map consist of number and letters: for example

$$\frac{1-3}{c}$$

The first digit in the number represents a geologic landform or material (for example an alluvial fan or a glacial till); the second digit denotes soil profile development, moisture conditions, and sometimes textural differences; and the letter denotes the topographical class. The topographical classes are those used by the Canada Soil Survey Committee, which are as follows:

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

The soils were mapped in the field by making observations at selected sites using available exposures or digging with a shovel or coring with a truck-mounted coring machine. These point observations are extrapolated to an area basis through the use of aerial photograph interpretation and field checking. The principal soils were sampled to depths of six feet for physical, chemical and engineering analyses.

Soil Classification

The soils have been classified according to the System of Soil Classification for Canada (Canada Soil Survey Committee, 1973). This scheme classifies the soils in their natural state and thus indicates relationships between soils and their environment.

These relationships are often important for assessing limitations of soils for various uses. The classification system is described briefly in Table 12.

Soil Texture

Throughout the report reference is made to soil texture and to soil drainage classes. Soil texture is according to the United States Department of Agriculture (USDA) textural classification which is described below. The soil drainage classes, according to the Canada Soil Survey Committee (1970) are outlined following the textural classification.

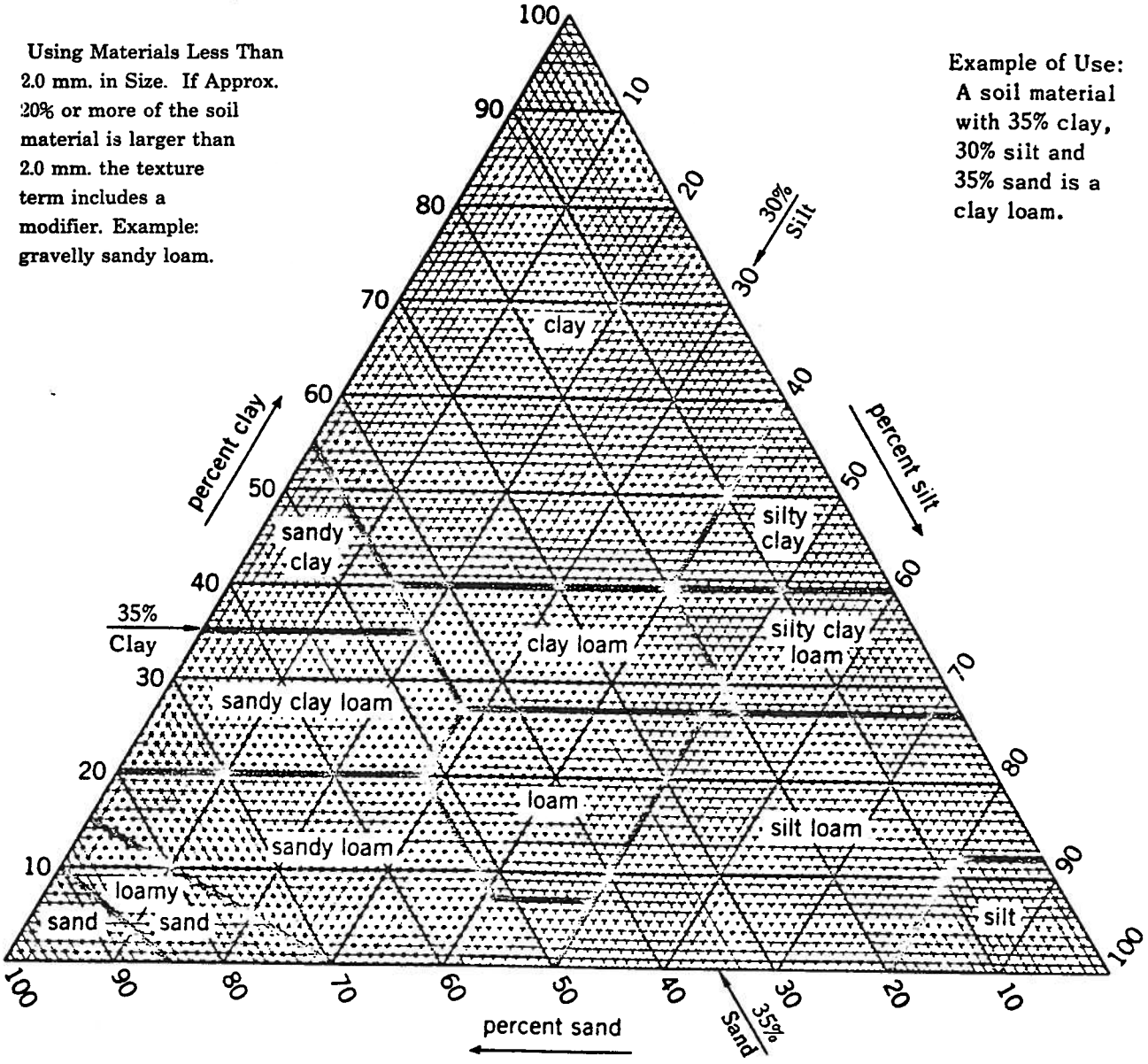
Soil Separates (Particle Size) on which Textural Classes are Based.

Separates		Diameter in Millimeters
Very Coarse Sand (V.C.S.)		2.0 - 1.0
Coarse Sand (C.S.)		1.0 - 0.5
Medium Sand (M.S.)	Sand (S)	0.5 - 0.25
Fine Sand (F.S.)		0.25 - 0.10
Very Fine Sand (V.F.S.)		0.10-0.05
Silt (Si)		0.05 - 0.002
Clay (C)		less than 0.002

FIGURE 2. GUIDE FOR USDA SOIL TEXTURAL CLASSIFICATION.

Using Materials Less Than 2.0 mm. in Size. If Approx. 20% or more of the soil material is larger than 2.0 mm. the texture term includes a modifier. Example: gravelly sandy loam.

Example of Use: A soil material with 35% clay, 30% silt and 35% sand is a clay loam.



The soil textural classes are grouped according to the Canada Soil Survey Committee as follows:

Very coarse textured: sands, loamy sands.

Moderately coarse textured: sandy loam, fine sandy loam

Medium textured: very fine sandy loam, loam, silt loam, silt.

Moderately fine textured: sandy clay loam, clay loam, silty clay loam

Fine textured: sandy clay, silty clay, clay (40 - 60% clay).

Very fine textured: heavy clay (more than 60% clay).

Soil Drainage Classes

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

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

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

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

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

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

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

Specific reference to surface drainage may be designated in terms of run-off and described as high, medium, low or ponded. Similarly, specific reference to the characteristics of horizons within the profile may be designated in terms of permeability or percolation and described as rapid, moderate, slow, very slow, and none.

SOIL AND LAND USE

Engineering Use of Pedological Information

Both the report and the map contain information of use to engineers and land use planners. A pedological soil classification, which describes the soil in its natural setting, describes not only the soil material but also the effects of soil climate, drainage, permeability and topography. When planning the construction of roads, airports, residential and other developments which are based on the soil this information can be very useful in predicting performance. Highway engineers make use of soil maps in planning materials investigations and for predicting sub-grade and pavement performance (Allemeier, 1973). A recent soil survey in the Mill Woods area of Edmonton indicated areas where concrete corosion due to sulfate attack was a potential problem (Lindsay, et al, 1973).

Several terms, such as soil, texture, structure, and consistence differ in usage between pedology and engineering. The pedological meanings are intended in this report and many of the terms are defined in the glossary.

Engineering Properties of the Soils

Engineering properties including particle size distribution, Atterberg limits, and the Unified and AASHO classification are reported for the major soils. These data are derived from laboratory testing of samples representative of the soil map unit. The philosophy of pedology is involved here in extrapolating from a site to an area. These data are not intended to be site specific and do not substitute for on-site inspection and soil testing but do provide a basis for area planning and further soil investigations.

Soils and Urban Development

In selecting sites for housing, schools, parks, shopping centres, sewage disposal and other community developments, soil suitability must be considered so as to avoid costly errors and to prevent waste, abuse and loss of valuable agricultural soils.

The soils have been evaluated for limitations to roads, buildings, and sewage lagoons and as suitability as a source of gravel, roadfill and topsoil. The soils have also been assigned ARDA capability ratings for agriculture in order to evaluate the loss of agricultural production potential.

These evaluations consider such soil properties as texture - which affects stability and bearing strength for roads and foundations, shrink-swell, risk of frost heaving, and rate of infiltration and internal drainage; soil moisture conditions - which affect location of buildings, roads, services and sewage disposal; topography - which affects drainage and site location; and flooding hazard - which affects location of buildings, roads and sewage lagoons.

Soil interpretations are included so that soils information may be more easily understood. These interpretations should be treated as evaluations of performance of soils not as recommendations for the use of soils. Many other factors are involved in the recommended use of soils. Also, because soil boundaries are not precise, soil survey interpretations do not eliminate on-site investigations. They are, however, intended as an aid in planning further investigations, to reduce the amount of investigation and minimize the cost.

For each use, the soils are rated in terms of degree of limitation - slight, moderate or severe, or in terms of suitability as a source of material - good, fair or poor.

A slight soil limitation is the rating given soils that have properties favourable for the use. Good performance and low maintenance can be expected.

A moderate soil limitation is the rating given soils that have properties moderately favourable for the use. This limitation can be overcome or modified by planning, design or maintenance.

A severe soil limitation is the rating given soils that have one or more properties that are seriously unfavourable for the use. This limitation generally requires major soil reclamation, special design or intensive maintenance. In most situations, it is difficult and costly to alter the soil or to design a structure so as to compensate for the severe degree of limitation but using these soils without employing corrective measures could result in failure.

TABLE 1. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR ROAD LOCATION

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

Soil limitation ratings do not substitute for basic soil data or for onsite investigations.

Item Affecting Use	Degree of Soil Limitation		
	NONE TO SLIGHT	MODERATE	SEVERE
Soil drainage class[1]	Rapidly[1], well and moderately well drained.	Imperfectly drained	Poorly and very poorly drained.
Flooding	None	Once in 5 years	More than once in 5 yrs
Slope	0 to 9% (AD).	9 to 15% (E).	More than 15% (> E).
Depth to Bedrock	More than 40 inches	20 to 40 inches.	Less than 20 inches.
Subgrade[2] a. AASHO Group index[3]	0 to 4.	5 to 8.	more than 8
b. Unified soil classes	GW, GP, SW, GM, SM, and GC[4] and SC[4].	CL (with PI[5] less than 15), ML, SP.	CL (with PI[5] 15 or more CH, MH, OH, OL, Pt.
Shrink-swell 6 potential	Low (PI[5] less than 15).	Moderate (PI[5] 10 to 15).	High (PI[5] greater than 2
Susceptibility to frost heave[7]	Low (F1, F2)	Moderate (F3) .	High (F4) (silty & peaty soils).
Stoniness	Stones greater than 5' apart.	Stones 2 to 5' apart.	Stones less than 2' apart.
Consolidated Bedrock exposures	Rock exposures greater than 300' apart and cover less than 2% of the surface	Rock exposures 300 to 100' apart and cover 2 to 10% of the surface.	Rock exposures less than 100' apart and cover greater than 10% surfac

1. For an explanation of soil drainage classes see page 7.
2. This item estimates the strength of a soil as it applies to roadbeds. When available, AASHO Group Index values from laboratory tests were used; otherwise the estimated Unified classes were used. On unsurfaced roads, rapidly drained, very sandy poorly graded soils may cause washboard or rough roads
3. Group Index values were estimated from information published by the Portland Cement Assn. 1962. pp 23-25.
4. Downgrade to moderate if content of fines (less than 200 mesh) is greater than about 30%.
5. PI means plasticity index.
6. Inherent swelling capacity is estimated as low when the plasticity index is less than 15, medium when the plasticity index is 10 to 15 and high when the plasticity index is greater than 20 (Terzaghi and Peck, 1967). Gravelly and stony soils may not exhibit shrink-swell as estimated by the plasticity index because of dilution of the fines with coarse fragments. In these situations decrease a severe limitation to moderate and a moderate limitation to slight.
7. Frost heave is important where frost penetrates below the hardened surface layer and moisture transportable by capillary movement is sufficient to form ice lenses at the freezing front. The susceptibility classes are taken from the United States Army Corps of Engineers (1962), pp. 5 - 8.

TABLE 2. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR PERMANENT BUILDINGS[1]

This guide provides ratings for undisturbed soils evaluated for single storey buildings and other structures with similar foundation requirements. The emphasis for rating soils for buildings is on foundations; but soil slope, and susceptibility to flooding and other hydrologic conditions, such as seasonal wetness, that have effects beyond those related exclusively to foundations are considered. Also considered are soil properties, particularly depth to bedrock, which influence excavation and construction costs both for the building itself and for the installation of utility lines. Excluded are limitations for soil corrosivity, landscaping and septic tank absorption fields. On site investigations are needed for specific placement of buildings and utility lines, and for detailed design of foundations. All ratings are for undisturbed soils based on information gained from observations to a depth of 4 to 6 feet.

Item Affecting Use	Degree of Soil Limitation[2]		
	NONE TO SLIGHT	MODERATE	SEVERE
Wetness[3]	With basements: Rapidly drained and well drained. Without basements: Rapidly, well and moderately well drained.	With basements: Moderately well drained. Without basements: Imperfectly drained.	With basements: Imperfectly, poorly and very poorly drained. Without basements: Poorly and very poorly drained.
Depth to seasonal water table (seasonal means 1 month or more)	With basements: Below 60 inches Without basements: Below 30 inches	With basements: Below 30 inches Without basements: Below 30 inches	With basements: Above 30 inches Without basements: Above 20 inches
Flooding (Flood)	None.	None.	Subject to flooding.
Slope[4]	0 to 9% (AD).	9 to 15% (E).	More than 15% (>E).
Shrink-swell potential[5]	Low (PI[6] less than 15)	Moderate (PI[6] 10 to 35).	High (PI[6] greater than 20).
Unified soil group[7]	GW, GP, SW, SP, GM GC, SM, SC.	ML, CL.	CH, MH, OL, OH, Pt.
Potential frost action[8]	Low (F1, F2).	Moderate (F3).	High (F4).
Stoniness	Stones greater than 25' apart.	Stones 5 to 25' apart.	Stones less than 5' apart.
Consolidated bedrock exposures	Rock exposures greater than 300' apart and cover less than 2% of the surface.	Rock exposures 300 to 100' apart and cover 2 to 10% of the surface.	Rock exposures less than 100' apart and cover greater than 10% of the surface.
Depth to bedrock	With basements: More than 60 inches. Without basements: More than 40 inches.	With basements: 40 to 60 inches Without basements: 20 to 40 inches	With basements: Less than 40 inches Without basements: Less than 20 inches

1. By reducing the slope limits by $\frac{1}{2}$, this table can be used for evaluating soil limitations for buildings with large floor areas but with foundation requirements not exceeding those of ordinary 3-storey dwellings.
2. Some soils rated as having moderate or severe limitations may be good sites from an aesthetic or use standpoint but require more preparation or maintenance.
3. For an explanation of soil drainage classes see page 7.
4. Reduce slope limits by $\frac{1}{2}$ for those soils subject to hillside slippage.
5. Inherent swelling capacity is estimated as low when the plasticity index is less than 15, medium when the plasticity index is 10 to 35 and high when the plasticity index is greater than 20 (Terzaghi and Peck, 1967). Gravelly and stony soils may not exhibit shrink-swell as estimated by the plasticity index because of dilution of the fines with coarse fragments. In these situations decrease a severe limitation to moderate and a moderate limitation to slight.
6. PI means plasticity index.
7. This item estimates the strength of the soil, that is its ability to withstand applied loads.
8. Frost heave only applies where frost penetrates to the assumed depth of the footings and the soil is moist. The potential frost action classes are taken from the United States Army Corps of Engineers (1962), pp.5-8

TABLE 3. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR SEWAGE LAGOONS.

A sewage lagoon (aerobic) is a shallow lake used to hold sewage for the time required for bacterial decomposition. Soils have two functions, (1) as an impounding vessel and (2) as material for the impounding embankment. When the lagoon is properly constructed it must be capable of holding water with minimum seepage.

Item Affecting Use	Degree of Soil Limitation		
	SLIGHT	MODERATE	SEVERE
Depth to water table[1] (seasonal or year round)	more than 60 in.	40 - 60 in.	less than 40 in.
Flooding[2]	none	none	soils subject to flooding
Depth to Consolidated Bedrock	more than 60 in.	40 - 60 in.	less than 40 in.
Slope	less than 2%	2 - 9%	more than 9%
Organic Matter	less than 2%	2 - 15%	more than 15%
Unified Soil Group[3]	GC,SC,CL,CH	GM,ML,SM,MH	GP,GW,SW,SP, OL,OH,Pt.

1. If the floor of the lagoon is nearly impermeable material at least 2 feet thick, disregard depth to watertable.

2. Disregard flooding if it is not likely to enter or damage the lagoon (low velocity and depth less than five feet).

3. Rated mainly for the floor of the lagoon.

TABLE 4. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR CAMP AREAS.

This guide applies to soils to be used intensively for trailers and tents and the accompanying activities of outdoor living. It is assumed that little site preparation will be done other than shaping and levelling for campsites and parking areas. The soil should be suitable for heavy foot traffic and for limited vehicular traffic[1]. Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Item Affecting Use	Degree of Soil Limitation		
	NONE TO SLIGHT	MODERATE	SEVERE
Wetness	Rapidly, well and moderately well drained soils. Water table below 30" during season of use.	Moderately well and imperfectly drained soils. Water table below 20" during season of use.	Imperfectly, poorly, and very poorly drained soils. Water table above 20" during season of use.
Flooding	None.	None during season of use.	Floods during season of use.
Permeability	Very rapid to moderate.	Moderately slow and slow.	Very slow.
Slope	0 to 9% (AD).	9 to 15% (E).	Greater than 15% (greater than E).
Surface soil texture[2]	SL, FSL, VFSL, L.	SiL, CL, SCL, SiCL, LS and sand other than loose sand.	SC, SiC, C, loose sand subject to severe blowing, organic soils.
Coarse fragments on surface[3]	0 to 20%.	20 to 50%.[4]	Greater than 50%.
Stoniness[5] (stony)	Stones greater than 25' apart.	Stones 25 to 5' apart.	Stones less than 5' apart.
Rockiness[5] (rock)	no rock exposures.	Rock exposures greater than 30' apart and cover less than 25% of the area.	Rock exposures less than 30' apart & cover greater than 25% of the surface.

1. For information specific to roads and parking lots see Table 1.

2. Surface soil texture influences soil ratings as it affects foot trafficability, dust, soil permeability and erosion hazard.

3. Coarse fragments include both gravels and cobbles.

4. Some gravelly soils may be rated as slight if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix, or (b) the fragments are less than 3/4 inch in size. See the definition for gravels in the System of Soil Classification for Canada (C.S.S.C., 1970), pp 213-214.

5. Very shallow soils are rated as having a severe soil limitation for rockiness and/or stoniness. See also definitions of rockiness and stoniness in the System of Soil Classification for Canada (C.S.S.C., 1970), pp 213-214.

TABLE 5. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR PICNIC AREAS.

This guide applies to soils considered for intensive use as park-type picnic areas. It is assumed that most vehicular traffic will be confined to access roads.[1] Soil suitability for growing and maintaining vegetation is not a part of this guide, except as influenced by moisture, but is an important item to consider in the final evaluation of site.

Items Affecting Use	Degree of Soil Limitation		
	None to Slight	Moderate	Severe
Wetness	Rapidly, well and moderately well drained soils. Water table below 20" during season of use.	Moderately well and imperfectly drained soils. Water table during season of use may be less than 20" for short periods.	Poorly and very poorly drained soils. Water table above 20" and often near the surface for a month or more during season of use.
Flooding	None during season of use.	May flood once a year for short period during season of use.	Floods more than once a year during season of use.
Slope	0 to 9% (AD).	9 to 15% (E).	Greater than 15% (greater than E).
Surface soil texture[2]	SL, FSL, VFSL, L.	SiL, CL, SCL, SiCL, LS, and sand other than loose sand.	SC, SiC, C, loose sand subject to severe blowing, organic soils.
Coarse fragments on surface[3]	0 to 20%.	20 to 50%[4].	More than 50%
Stoniness[3]	Stones greater than 5' apart.	Stones 2 to 5' apart.	Stones less than 2' apart.
Rockiness[3]	Rock exposures roughly 100 to 300 or more feet apart and cover less than 10% of the surface.	Rock exposures 30 to 100' apart and cover about 10 to 25% of the surface.	Rock exposures less than 30' apart and cover greater than 25% of the surface.

1. For information specific to roads or parking lots see Table 1.

2. Surface soil texture influences soil ratings as it affects foot trafficability, dust, soil permeability and erosion hazard.

3. See also definitions for gravel, rockiness and stoniness in the System of Soil Classification for Canada (C.S.S.C., 1970), pp. 213-214. Coarse fragments include both gravels and cobbles.

4. Some gravelly soils may be rated as slight if the content of gravel exceeds 20% by only a small margin providing (a) the gravel is embedded in the soil matrix or (b) the fragments are less than 3/4 inch in size.

TABLE 6. GUIDES FOR ASSESSING SOIL LIMITATIONS FOR PLAYING FIELDS.

This guide applies to soils considered for intensive use as playing fields for organized games such as baseball or football. Soil suitability for growing and maintaining vegetation is not a direct consideration in this guide, but is an important item to consider.

Item Affecting Use	Degree of Soil Limitation		
	SLIGHT	MODERATE	SEVERE
Flooding	none during season of use	subject to occasional flooding. Not more than once in 3 years.	subject to more than occasional flooding.
Wetness	rapidly to moderately well drained.	imperfectly drained soils subject to occasional ponding.	poorly and very poorly drained.
Depth to Water table	more than 30 inches during season of use.	more than 20 inches during season of use.	less than 20 inches during season of use.
Permeability	very rapid to moderate (20 in./hr to 0.6 in./hr.)	moderately slow (0.6 - 0.2 in./hr)	slow and very slow. (less than 0.2 in/hr)
Slope	0 - 2%	2 - 5%	more than 5%
Surface Texture	SL, FSL, VFSL, L	CL, SCL, SiCL, SiL, LS and S other than loose sand.	SC, SiC, C, loose sand, organic
Depth to Bedrock	more than 40 inches	20 to 40 inches	less than 20 inches
Surface Stoniness	slightly stony	moderately stony	very to excessively stony.

TABLE 7. SUITABILITY RATINGS OF SOILS AS SOURCES OF GRAVEL

The main purpose of these ratings is to indicate local sources of gravel. The ratings are based on the probability that soils contain sizable quantities of gravel.

Item Affecting Use	Degree of Soil Suitability		
	GOOD	FAIR	POOR
Unified Soil Group	GW, GP	GP-GM GW-GM	GM, GP-GC, GW-GC (all other groups unsuited)
Flooding	none or occasional		frequent or constant
Wetness	better than poorly drained [1]		poorly and very poorly drained
Depth of overburden	less than 2 feet	2 to 5 feet	more than 5 feet

1. See page 7 for an explanation of drainage classes.

TABLE 8. SUITABILITY RATINGS OF SOILS AS SOURCES OF ROADFILL

The ratings in this table indicate the performance of a soil after it is placed in a road embankment and also the degree of difficulty in excavating the fill material. Ratings of the material are the same as for road location (Table 3) however ratings of factors governing excavation differ.

Item Affecting Use	Degree of Soil Suitability [1]		
	GOOD	FAIR	POOR
Wetness	Rapidly to moderately well drained [2]	Imperfectly drained	Poorly and very poorly drained
Engineering Groups Unified Group	GW, GP, GC, SW, SP, SM, SC	ML, CL with P.I. [3] less than 15	CH, MH, OL, OH, Pt, and CL with P.I. more than 15
AASHO Group Index	0 - 4	5 - 8	greater than 8
Stoniness	none to moderately stony	very stony	exceedingly stony
Depth to consolidated bedrock	more than 6 feet	3 to 6 feet	less than 3 feet
Slope	0 - 15%	15 - 30%	more than 30%

1. A rating of unsuited (u) is applied to land units, such as bedrock (R), where no conventional fill material is present.

2. See page 7 for an explanation of drainage classes.

3. P.I. means plasticity index.

TABLE 9. SUITABILITY RATINGS OF SOILS AS SOURCES OF TOPSOIL

Topsoil, for these ratings, refers essentially to Ah horizon material. In some cases the B, and even C horizon materials could be used for dressing disturbed land. These ratings are intended for use by engineers, landscapers, planners and others who make decisions about selecting, stockpiling and using topsoil. These ratings are based on quality of topsoil and ease of excavation. In addition to the Good, Fair, and Poor ratings described below, an Unsuited (U) rating is used.

Item Affecting Use	Degree of Suitability[1]		
	GOOD	FAIR	POOR
Texture	SL, FSL, VFSL, L, SiL	CL, SCL, SiCL	LS, S, SC, SiC, C, Organic
Depth of topsoil	more than 6 in.	3 - 6 in.	less than 3 in.
Flooding	none	may flood occasionally	frequently or constantly flooded
Wetness	Drainage class not determining if better than poorly drained		Poorly and very poorly drained
Coarse fragments % by volume	less than 3%	3 - 15%	more than 15%
Slope	less than 9%	9 - 15%	more than 15%
Stoniness	none to slightly stony	moderately stony	very to excessively stony
Salinity of topsoil	E.C.[2] 0 - 1[3]	E.C. 1 - 3	E.C. more than 3
Permeability of upper subsoil	moderate	slow	very slow

1. A rating of unsuited (U) is used for soil and land units that do not have topsoil present.
2. E.C. = electrical conductivity of a saturation extract in mmhos/cm .
3. These are the limits suggested by the Alberta Soil and Feed Testing Laboratory when considering lawn growth.

The decision as to whether or not a soil will be utilized for a specific use, regardless of the soil limitation, is beyond the scope of this report.

Agricultural Capability

The soils have been rated as to their suitability as agricultural cropland. This information is required to make sound decisions on land use where soils are being lost to agricultural production.

The ratings are made using the ARDA Canada Land Inventory, Soil Capability Classification for Agriculture. These classes and subclasses are defined in the Soil Capability Classification for Agriculture (Canada Land Inventory, 1965).

Briefly the 7 classes are:

Class 1 - Soils in this class have no significant limitations in use for crops.

Class 2 - Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.

Class 3 - Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices.

Class 4 - Soils in this class have severe limitations that restrict the range of crops.

Class 5 - Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible.

Class 6 - Soils in this class are capable of only producing perennial forage crops and improvement practices are not feasible.

Class 7 - Soils in this class have no capability for arable culture or permanent pasture.

The subclasses are as follows:

i - flooding by streams or lakes

m - low moisture holding capacity

n - salinity

p - stones interfere with tillage and harvesting

r - bedrock less than 3 feet from the surface

s - adverse soil characteristics that include one or more of the following: undesirable structure, low permeability, a restricted rooting zone, low fertility, low moisture-holding capacity, salinity.

t - adverse topography

w - excess water other than from flooding or poor drainage.

O - indicates Organic soils (not placed in capability classes)

CANMORE AREA

Location and Extent of the Study Area

The study area is located in the Bow River Valley in the vicinity of Canmore. The area, of approximately 20 square miles, extends from Banff National Park boundary down valley to where Highway 1 crosses the Bow River; and from the valley bottom to approximately 5,000 feet elevation.

Physiography of the Area

The Bow Valley is a broad U-shaped valley in the Front Ranges of the Rocky Mountains. Elevation of the valley bottom near Canmore is approximately 4,300 feet (1300 m) and the mountains on either side of the valley approach 9,000 feet (2700 m).

The mountain ridges are formed of resistant Missippian and Devonian-aged limestones and dolomites while the valleys are floored by less resistant Mesozoic shales, siltstones and sandstones. Thrusting is from the southwest and beds dip as much as 45°, with several thousand feet vertical displacement. Bedrock geology in the area has been described by Price (1971).

Surficial geology of the area was described and mapped by Rutter (1972). Surficial deposits in the map area consist of glacial till and glacio-fluvial gravels and more recent alluvial fan and floodplain materials. Rutter (1972) cites evidence for two and possibly three major Wisconsin ice advances in this section of the Bow Valley. Patches of till from the latest (Canmore) advance overlie outwash deposits associated with an earlier (Bow Valley) advance. Rutter describes the two tills as being essentially similar lithologically. They contain an average of 20% gravel-sized fragments which are predominantly dolomite and limestones. The finer fraction is a calcareous sandy clay loam textured material. The dominant clay minerals are illite and chlorite.

The glacial fluvial deposits are mostly gravels with sand and silt lenses and beds. The gravels are unconsolidated, well sorted, rounded dolomite and

limestone pebbles. These deposits, which are extensive on the northeast side of the valley, are over 100 feet thick.

Large alluvial fans are common, especially along the northeast side of the valley. The bedded materials are poorly to well sorted and vary in texture from coarse gravel to sand and silt. These materials have been used extensively for highway fill.

Modern alluvial deposits occur on the floodplain of the Bow River. These are predominantly gravels on the braided streambed above Canmore and mostly sandy loam and silt loam textured below Canmore.

Human Activity

There has been a long history of human use in the area. Indians, fur traders and explorers used the Bow Valley for hunting, trapping and access to the Columbia district. The Canadian Pacific Railway was completed in 1885 and large scale coal mining began in the Canmore area shortly thereafter. The coal mining industry is still the prime employer in the area with hydro-electric production and limestone mining being minor industries.

There has been a recent shift toward recreational development with several motels and service stations, ski runs and a golf course in operation. The mountain location, adjacent to Banff National Park, with easy access to Calgary via the Trans Canada Highway and CPR, provides a high recreational capability.

Vegetation

Vegetation patterns in the area are strongly influenced by aspect. A Douglas Fir (Pseudotsuga menziesii) - lodgepole pine (Pinus contorta) association occupies the well drained fluvial terraces along the southwest-facing valley side, while white spruce (Picea glauca) and lodgepole pine stands cover the northeast facing side. Trembling aspen (Populus tremuloides) is of minor occurrence, being most common on alluvial fans. The Bow River floodplain is a mosaic of white spruce, dwarf birch (Betula glandulosa), lodgepole pine, and willow (Salix spp.) communities. The steep, eroded banks of the terraces on the northeast side of

the valley are usually occupied by juniper (Juniperus communis) - bearberry (Arctostaphylos rubra and A. uva-ursi) communities with grasses of common abundance.

There is a history of fire and recent grazing in most of the valley.

More complete plant community descriptions accompany soil map unit descriptions.

The Soils

Soil development in the area reflects the influences of materials, climate, aspect and vegetation.

The parent materials vary in texture from coarse gravel to sandy loam and silt loam. They are usually high in carbonates, being derived from limestones and dolomites. The high carbonate content, gravelly textures, and recent ages of materials (especially alluvial fan materials) restrict soil development resulting in soils with thin sola and fairly weak morphology.

Soils on the northeast-facing valley side show the influence of cool, moist conditions. The soils are mostly Luvisolic with leached surface horizons - typical of forested soils. The soils of the southwest aspects are drier and warmer and are typically Brunisolic with organic matter accumulation in surface horizons.

TABLE 10. KEY TO THE SOILS OF THE CANMORE AREA

PARENT MATERIAL	SOIL ASSOCIATION	TEXTURE	DRAINAGE CLASS	SOILS		COMMENTS
				DOMINANT	SIGNIFICANT	
Fan Alluvium	1-1	SiL/G	well	Cumulic Regosol	Orthic Regosol	
	1-2	G-VGSL	rapidly	Cumulic Regosol		
	1-3	SL & G	rapidly-well	Cumulic Regosol		Areas of 1-1 & 1-2 together
	1-4	SL	well	Orthic Gray Luvisol	Degraded Eutric Brunisol	
Floodplain Alluvium	2-1	SiCL	well-moderately well	Cumulic Regosol	Orthic Regosol	Many of these soils have a seasonally high water table and may also be subject to flooding
	2-2	0-6" SL/G	well	Cumulic Regosol		
	2-3	6-36" SiL/G	well-moderately well	Cumulic Regosol		
	2-4	SiCL	imperfectly	Orthic Regosol		
	2-5	SL	well	Orthic Gray Luvisol	Degraded Eutric Brunisol	
	2-6	SL-SiL	well to poorly	Rego Gleysol	Cumulic Regosol	
Glaciofluvial Outwash	3-1	SCL/GSiL-VGSiL	well	Orthic Eutric Brunisol	Degraded Eutric Brunisol	thin slopewash deposits over outwash
	3-2	GSiL - VGSiL	well	Orthic Eutric Brunisol	Orthic Regosol	
	3-3	GL-VGSiL	rapidly	Orthic Regosol	Cumulic Regosol	very steeply sloping, eroded escarpments
Glacial Till	4-1	GSL	well	Orthic Gray Luvisol		
	4-2	SL/R	well	Lithic Orthic Regosol	(rock outcrops)	Bedrock close to surface or exposed
	4-3	GSL	rapidly	Orthic Regosol		very steeply sloping eroded escarpments
	4-4	SiL/GSL	poorly	peaty Rego Gleysol		Groundwater seepage areas
	4-5	GSL	well	Orthic Eutric Brunisol	Orthic Regosol	
Thin Colluvium or Drift over Bedrock	5-1	variable/R	rapidly	Lithic Orthic Regosol	(rock outcrops)	Very steep slopes and rock outcrops severely limit most uses
Organic	6-1	organic	very poorly	Terric Fibrisol		Organic (peat) soils - have severe limitations for most uses
	6-2	organic	poorly	Limno Mesisol		

Texture Symbols

G	gravel
GSiL	gravelly silt loam
GSL	gravelly sandy loam
SiCL	silty clay loam
SiL	silt loam
SL	sandy loam
SL/R	sandy loam over bedrock
VGSL	very gravelly sandy loam

Miscellaneous Land Units

DL	Disturbed Land (includes urban areas, strip mines, etc.)
CI	Cobble land (greater than 90% coarse fragments)
R	Rock Outcrops

SOIL ASSOCIATION DESCRIPTIONS

1. Soils developed on alluvial fan deposits. These are rapidly to well drained Regosols that vary considerably in texture. Cross sections of fan deposits reveal bedded, sorted materials varying from gravel to sand with occasional silty lenses.

1-1. Cumulic and Orthic Regosols that have more than 20 in. sandy loam to loamy sand over gravel. These soils are found mostly on fan margins or gently sloping fans under aspen, grass, and aspen-white spruce communities. The soils have fairly deep, black Ahk horizons overlying Ck horizons.

1-2. Rapidly drained Cumulic Regosols and minor cobbleland type on very gravelly fan deposits. Vegetation is principally aspen, lodgepole pine, and yellow dryad communities. Soils have thin L-F or Ah horizons over a gravel, or very gravelly sandy loam Ck. These materials have been used extensively for roadfill and as gravel. These soils are droughty due to low water holding capacity.

1-3. This association is a combination of 1-1 and 1-2. Areas designated 1-3 have a mixture of coarse gravelly soils and soils with 10-20" sandy fluvial materials over the gravel.

1-4. Soils of this association are developed on materials similar to those of 1-1, however a Luvisolic profile has developed. These well-drained soils have L-F, Ae, Bt, Ck horizon sequences. Association 1-4 was used on only one fan, which is on the southwest side of the Bow River. Vegetation consists of lodgepole pine-aspen stands with buffalo-berry and numerous herbs, including cow-berry, strawberry, bunchberry, raspberry and Venus' slipper.

2. Soils developed on fluvial deposits on the floodplain of the Bow River. Many of these soils are subject to flooding and may have a seasonally high water table. Textures range from gravel to sandy loam and silt loam.

2-1. These are well drained Orthic and Cumulic Regosols found on abandoned terraces and channels. Textures range from sandy loam to silt loam. The soils have thin to thick black Ahk horizons overlying Ck horizons, which may overlie a sequence of buried Ahk horizons. These Cumulic Regosols, with a series of buried A horizons are evidence of repeated flooding and deposition of sediment. Natural vegetation cover is made up of white spruce, dwarf birch, shrubby cinquefoil community with understory vegetation including bearberry, strawberry, pussytoes and sedge.

Some of these soils have been cultivated and used for forage production and pasture. The danger of flooding and a seasonally high water table make many of these soils unsuitable for residential development.

2-2. These are well to moderately well drained Orthic and Cumulic Regosols on the Bow River floodplain. They are characterized by thin (less than 6 in.) sandy loam to loamy sand deposits overlying gravel. Some of the soils have weak Degraded Eutric Brunisol profiles. The water table in the highly permeable gravels responds to the level of the Bow River and is often less than 5 feet during high water stages. Parts of these soil areas, especially incised stream channels are subject to flooding. The golf course and much of the town of Canmore are situated on these soils. The seasonally high water table causes problems for houses with basements, and the very gravelly, permeable soils probably require large amounts of water for growth of lawns or gardens. Vegetation is made up of white spruce, willow and lodgepole pine communities.

2-3. Soils of this association differ from those of 2-2 by having deeper (6" to 36") accumulations of sandy loam materials over the gravels.

2-4. Moderately fine textured Orthic Regosols were mapped in one small location near the Banff National Park boundary in what appears to be an old incised stream channel. Adjacent alluvial fans probably contribute sediment to the area. The soils are strongly calcareous; stone-free; imperfectly drained with level topography. Vegetation consists of a cinquefoil-grass community with dandelion, strawberry, and yarrow components.

2-5. This association identifies Orthic Gray Luvisols and Degraded Eutric Brunisols on sandy loam alluvial deposits. These are well drained soils located northwest of Canmore. Vegetation consists of lodgepole pine-aspen stands with buffalo berry, cowberry, strawberry, bunchberry, raspberry, and Venus' slipper present in the understory.

2-6. This unit identifies floodplain areas with poorly drained Rego Gleysols, intimately mixed with some freely drained soils. The water table is generally less than 3 feet from the surface and much of the area is subject to seasonal flooding. These areas are unsuitable for most community uses. Vegetation is predominantly willow, white spruce, and numerous hydrophytic plants.

3. Soils developed on outwash deposits described by Rutter (1972) as being overridden and ice contact glacio fluvial. The gravelly outwash often has eolian, till, and slopewash deposits on the surface.

3-1. This association is found mostly on the steps of the outwash terraces. Soils are Orthic Eutric Brunisols with significant Orthic Regosols and Degraded Eutric Brunisols. The soil profile is usually developed in finer (loam to sandy clay loam), less gravelly material than the C or IIC horizon which is usually a gravelly or very gravelly silt loam. The terraces are covered

by lodgepole pine-Douglas fir stands with bearberry common in the understory.

3-2. Soils of this association do not have the finer textured overlay deposit found in 3-1. Soil profile development and vegetation is similar to 3-1.

3-3. These soils occur on the very steeply sloping, eroded terrace risers. The Regosolic soils are rapidly drained, droughtly, and subject to soil creep. Vegetation consists mainly of juniper-bearberry communities with occasional Douglas fir.

4. Soils developed on moderately coarse textured glacial till. These soils occur above the glaciofluvial benches on the northeast valley side and on most of the southwest valley side.

4-1. This association is made up of well drained Orthic Gray Luvisols with L-F, Ae, Bt, Ck profile on gravelly sandy loam till. These soils are found along the southwest valley side under white spruce and lodgepole pine forests.

4-2. Areas of thin till over bedrock with lithic Orthic Regosols and numerous bedrock outcrops comprise this association. These soils are usually associated with the 4-1 soils, with the same white spruce and lodgepole pine cover. The bedrock causes limitations for most uses.

4-3. These soils occur on very steeply sloping, eroded slopes (analogous to the 3-3 association on outwash) on the northeast valley side. The soils are very dry and subject to creep. Sparse vegetation cover includes common juniper and bearberry as dominants, with occasional Douglas fir.

4-4. Poorly drained peaty Rego Gleysols occur in groundwater seepage areas. These soils are saturated throughout the year and thus are severely limited for all uses. Vegetation consists of sedges, dwarf birch and white spruce.

4-5. This association consists of Orthic Eutric Brunisols and Orthic Regosols on the till deposits on the northeast valley side. Topography varies from almost level on some small terraces at approximately 5,000 feet elevation to steeply sloping. Vegetation on the terraces is mostly grass (heavily grazed by horses) with fairly open white spruce - lodgepole pine stands on the slopes.

5. Association 5 includes soils developed on thin colluvium or drift over bedrock. These are lithic soils with abundant bedrock outcrops mapped at high elevations on the northeast side of the valley. Due to very steep slopes and the bedrock outcrops, these areas have severe limitations for most uses.

6. Soils developed on organic (peat) deposits. The 6-1 association identifies very poorly drained Terric Fibrisol soils which have the water table at the surface throughout the year and have approximately 3 to 6 feet of peat accumulation. The Limno Mesisols of association 6-2 have layers of marl (calcareous sediments and shells) at or below the surface or intermixed with mesic forest peat. There is evidence of mining of these mesic peats, probably for mixing with mineral soils for gardens and landscaping.

SOIL INTERPRETATIONS

Ratings of soil performance for certain selected uses are shown in Table 11. These interpretations are made using the guidelines defined in Tables 1 to 9. Further interpretations of soil properties for uses such as playing fields, septic tank filter fields and paths and trails could also be made. These ratings can easily be transformed from table to map form by coloring or digitizing the map units according to the indicated rating.

The soils on the floodplain of the Bow River generally have severe limitations for community development due to flooding hazard and high water table. The soils on the till and outwash deposits on the valley sides are limited mostly by steep slopes. The most suitable soils for location of buildings and related services are located on the alluvial fans that occur along the northeast side of the valley.

Soil capability for Agriculture is limited at best to class 6, which is suitable for use as unimproved pasture. The agro-climate of the area is classed as 5H by Bowser (1967) which means the best soil that could theoretically be in the area would be 5C. Limitations due to stoniness, droughtiness, high lime, and topography restrict the best soils to class 6.

LIMITING SOIL PROPERTIES & HAZARDS

1. Flooding Hazard
2. Seasonally high groundwater table
3. Excessive slope
4. High stone content
5. High clay content (sticky when wet)
6. Slow permeability
7. Rapid permeability, droughtiness
8. Groundwater contamination hazard
9. High lime content (nutrient imbalance)
10. Shallow depth to bedrock
11. Thin Ah (topsoil) horizon
12. Organic soil
13. Water erosion hazard
14. Shifting stream channels
15. Wetness (ponding, groundwater seepage)
16. Gravelly surface

TABLE 11. LIMITATIONS AND SUITABILITY OF THE SOILS FOR SELECTED USES.

	Degree of Limitation for:				Suitability as a Source of:			Capability for
Map Unit	Buildings	Roads	Sewage Lagoons	Camp Areas	Topsoil	Gravel	Roadfill	Agriculture
1-1/A-D	M14	S14	V7,8	S14	F	G	G	6M
1-2/C-D	M14	S14	V7,8	M16	U	G	G	7^{P}_{M}
1-2/E	M3,14	M3,14	V7,8	M3,16	U	G	G	7^{P}_{M}
1-2/F	S3,14	S3,14	V3,7,8	V3	U	G	G	7^{T}_{P}
2-1/AC	S	S	M8	S	F	U	P	6M
2-2/AC	M1,2	S	V1,2,8	M1	U-P	G	P	7M + 6M P
2-3/AC	V1,2	V1,2	V1[a],2,8	V1	F	P	P	6S
2-4/AC	V1	M1	M1,8	V1,6	P	P	P	6S
2-5/A-C	M1,2	M1,2	M1,8	M1	P	P	P	6M
2-6/A-C	V1,2	V1,2	V1,2,3	V1,15	U	U	U	7W
3-1/C-D	S3	S3	V7	S	P	G	G	6^{M}_{P}
3-1/e	M3	M3	V7	M3	P	G	G	6^{M}_{P}
3-1/f	V3	V3	V3,7	V3	U	G	G	6T
3-2/b	S	S	V7	S	P	G	G	6^{M}_{P}
3-2/G	V3	V3	V3,7	V3	U	G	G	7T
3-3/G	V3	V3	V3	V3	U	G	G	7T
4-1/A-D	S	S	M7	S	U	P	G	7T
4-1/E	M3	M3	V3,7	M3	U	P	G	7T
4-1/F-G	V3	V3	V3,7	V3	U	P	G	7T
4-2/F-G	V3,10	V3,10	V3,10	V3	U	U	U	7^{R}_{T}
4-3/G	V3	V3	V3	V3	U	U	G	7T
4-4/A-C	V15	V15	V15	V15	U	U	U	7W
4-5/C	S			S	P	U	G	6M
4-5/G	V3	V3	V3	V3	U	U	G	7T
5-1/G	V3,10	V3,10	V10	V3	U	U	U	7R
6-1/B	V12	V12	V12	V12	U	U	U	O
6-2/C	V12	V12	V12	V12	P[b]	U	U	O

S- slight, M- moderate, V- severe, U- unsuited, P- poor, F - fair, G- good.

a - Limitations may be lessened if lagoon is made of impermeable materials and embankments are sufficiently high to prevent entrance of floodwater.

b - This material may be useful as a soil amendment.

LIMITING SOIL PROPERTIES & HAZARDS

1. Flooding hazard
2. Seasonally high groundwater table
3. Excessive slope
4. High stone content
5. High clay content (sticky when wet)
6. Slow permeability
7. Rapid permeability, droughtiness
8. Groundwater contamination hazard
9. High lime content (nutrient imbalance)
10. Shallow depth to bedrock
11. Thin Ah (topsoil) horizon
12. Organic soil.
13. Water erosion hazard
14. Shifting stream channels
15. Wetness (ponding, groundwater seepage)
16. Gravelly surface

GLOSSARY

This is included to define terms commonly used in the report; it is not a comprehensive soil glossary.

Aeolian (eolian) deposit - material deposited by wind, includes both loess and dune sand.

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

alluvial deposit - material deposited by moving water.

aspect - orientation of the land surface with respect to compass direction.

Atterberg limits - see plastic limit, liquid limit.

available plant nutrients - that portion of any element or compound in the soil that can be readily absorbed and assimilated by growing plants.

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

cation-exchange capacity (C.E.C.) - a measure of the total amount of exchangeable cations that can be held by the soil. It is expressed in terms of milliequivalents per 100 grams of soil.

coarse fragments - rock or mineral particles greater than 2 mm in diameter.

colluvium - a heterogeneous mixture of material that has been deposited mainly by gravitational action.

creep - slow mass movement of soil material down rather steep slopes primarily under the influence of gravity, but aided by saturation with water and alternate freezing and thawing.

edaphic - (i) of or pertaining to the soil, (ii) resulting from, or influenced by, factors inherent in the soil or other substrate rather than by climatic factors.

eluviation - the removal of soil material in suspension or in solution from a layer or layers of the soil.

erosion - the wearing away of the land surface by running water, wind, or other erosive agents. It includes both normal and accelerated soil erosion. The latter is brought about by changes in the natural cover or ground conditions and includes those due to human activity.

gley - gleying is a reduction process that takes place in soils that are saturated with water for long periods of time. The horizon of most intense reduction is characterized by a gray, commonly mottled appearance, which on drying shows numerous rusty brown iron stains or streaks. Those horizons in which gleying is intense are designated with the subscript g.

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

horizon - a layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil forming processes. Soil horizons may be organic or mineral.

illuviation - the process of deposition of soil material removed from one horizon to another in the soil, usually from an upper to a lower horizon in the soil profile. Illuviated compounds include silicate clay, iron and aluminum hydrous oxides and organic matter.

infiltration - the downward entry of water into the soil.

lacustrine deposit - material deposited in lake water and later exposed either by a lowering of the water or by uplift of the land.

liquid limit (upper plastic limit) - the water content at which a pat of soil, cut by a groove of standard dimensions, will flow together for a distance of 12 mm under the impact of 25 blows in a standard liquid limit apparatus.

lithic - a soil subgroup modifier that indicates a bedrock contact within 50 cm (20 in.) of the soil surface.

morphology, soil - the makeup of the soil, including the texture, structure, consistence, colour, and other physical, mineralogical and biological properties of the various horizons of the soil profile.

mottles - spots or blotches of different color or shades of color interspersed with the dominant color. Mottling in soils usually indicates poor aeration and drainage.

organic matter - the decomposition residues of plant material derived from: (i) plant materials deposited on the surface of the soil, and (ii) roots that decay beneath the surface of the soil.

parent material - unconsolidated mineral material or peat from which the soil profile develops.

peat - unconsolidated soil material consisting largely of undecomposed to partially decomposed organic matter accumulated under conditions of excessive moisture.

pedology - those aspects of soil science involving the constitution, distribution, genesis and classification of soils.

percolation, soil water - the downward movement of water through soil. Especially the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.

permeability - the ease with which gases, liquids, or plant roots penetrate or pass through a bulk mass of soil or a layer of soil. Since different horizons of soil vary in permeability, the particular horizon under question should be designated.

pH - a notation used to designate the relative acidity or alkalinity of soils and other materials. A pH of 7.0 indicates neutrality, higher values indicate alkalinity, and lower values acidity.

phase, soil - a subdivision of a taxonomic class based on soil characteristics or combinations thereof which are considered to be potentially significant to man's use or management of the land.

plastic limit - water content at which a soil will just begin to crumble when rolled into a thread approximately 3 mm in diameter.

plasticity index - the numerical difference between the liquid and the plastic limit.

profile - a vertical section of the soil throughout all its horizons and extending into the parent material.

relief - the elevations or inequalities of the land surface when considered collectively. Minor configurations are referred to as "microrelief".

seepage (groundwater) - the emergence of water from the soil over an extensive area in contrast to a spring where it emerges from a local spot.

solum (plural - sola) - the part of the soil profile that is above the parent material and in which the processes of soil formation are active. It comprises the A and B horizons.

texture (soil) - the relative proportions of the various sized soil separates in a soil as described by the textural class names.

till - unstratified glacial drift deposited directly by ice and consisting of non-sorted clay, silt, sand, and boulders.

watertable - the upper limit of the part of the soil or underlying rock material that is wholly saturated with water.

TABLE 12. CANADIAN SOIL CLASSIFICATION SYSTEM

ORDER	GREAT GROUP	DISTINGUISHING CHARACTERISTICS
1. Chernozemic (Developed under grassland and transitional grassland-forest communities)	Brown Dark Brown Black Dark Gray	Light Brown Ah horizon Dark Brown Ah horizon Black Ah horizon Have L-H surface horizons typical of forest vegetation
2. Solonetzic (Columnar or prismatic B horizon and a saline C horizon; Ca/Na ration of B horizon is less than 10)	Solonetz Solodized Solonetz Solod	Ah horizon—Bnt horizon Ah——Ae——Bnt Ah——Ae——AB——Bnt
3. Luvisolic (Developed in forest areas; accumulation of clay in the B horizon)	Gray Brown Luvisol Gray Luvisol	(L-H)——Ah——Ae——Bt; Mull-like Ah horizon L-H——(Ah)——Ae——Bt
4. Podzolic (Accumulation of Fe+Al and/or organic matter in the B horizon)	Humic Podzol Ferro-Humic Podzol Humo-Ferric Podzol	Bh > 4" which contains > 1% O.C. < 0.3% Fe Bhf > 4" which contains > 5% O.C. > 0.6% Fe+Al Bf > 2" which contains < 5% O.C. > 0.6% Fe+Al
5. Brunisolic (Generally weakly developed B horizons)	Melanic Brunisol Eutric Brunisol Sombric Brunisol Dystric Brunisol	Ah > 2", Bm > 2"; pH > 5.5 Ah < 2", Bm > 2"; pH > 5.5 Ah > 2", Bm > 2"; pH < 5.5 Ah < 2", Bm > 2"; pH < 5.5
6. Regosolic (Weakly developed or young soils; no B horizon)	Regosol	(L-H)——Ah——C; no B horizon
7. Gleysolic (Poorly drained and show mottling and gleying)	Humic Gleysol Gleysol Luvic Gleysol	Ah > 3" Ah < 3" Have Aeg and Btg horizons
8. Organic (Contains > 30% organic matter; are > 24" in depth if dominantly fibric or > 16" if dominantly mesic or humic)	Fibrisol Mesisol Humisol Follisol	Large amount of well preserved fiber Partially decomposed fiber Well decomposed fiber (Black)

TABLE 13. DEFINITION OF SOIL HORIZON SYMBOLS (after C.S.S.C., 1973)

Organic Layers

Organic layers are found at the surface of some mineral soils, and may occur at any depth beneath the surface in buried soils, or overlying geologic deposits. They contain more than 17% organic carbon by weight. Two groups of these layers are recognized.

O -This is an organic layer developed mainly from mosses, rushes, and woody materials.

Of -The fibric layer is the least decomposed of all the organic soil materials. It has large amounts of well-preserved fibre that are readily identifiable as to botanical origin.

Om -The mesic layer is the intermediate stage of decomposition with intermediate amounts of fibre, bulk density and water-holding capacity. The material is partly altered both physically and biochemically. A mesic layer is one that fails to meet the requirements of fibric or of humic.

Oh -The humic layer is the most highly decomposed of the organic soil materials. It has the least amount of fibre, the highest bulk density, and the lowest saturated water-holding capacity. It is very stable and changes very little physically or chemically with time unless it is drained.

L-F-H- These organic layers develop primarily from leaves, twigs, woody materials, and a minor component of mosses.

L -This is an organic layer characterized by an accumulation of organic matter in which the original structures are easily discernible.

F -This is an organic layer characterized by an accumulation of partly decomposed organic matter. The original structures in part are difficult to recognize. The layer may be partly comminuted by soil fauna, as in moder[1], or it may be a partly decomposed mat permeated by fungal hyphae, as in mor[1].

H -This is an organic layer characterized by an accumulation of decomposed organic matter in which the original structures are indiscernible. This material differs from the F layer by its greater humification chiefly through the action of organisms. This layer is a zoogenous humus form consisting mainly of spherical or cylindrical droppings of microarthropods. It is frequently intermixed with mineral grains, especially near the junction with a mineral layer.

Master Mineral Horizons and Layers

Mineral horizons are those that contain less organic matter than that specified for organic layers.

A -This is a mineral horizon or horizons formed at or near the surface in the zone of removal of materials in solution and suspension, or of maximum in situ accumulation of organic matter, or both. Included are:
(1) horizons in which organic matter has accumulated as a result of biological activity (Ah);
(2) horizons that have been eluviated of clay, iron, aluminum, or organic matter, or all of these (Ae).

B -This is a mineral horizon or horizons characterized by one or more of the following:
(1) an enrichment in silicate clay (Bt).
(2) an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from horizons above or below (Bm and Bg).

C -This is a mineral horizon or horizons comparitively unaffected by the pedogenic processes operative in A and B, excepting the process of gleying.

R -This is consolidated bedrock that is too hard to break with the hands or dig with a spade when moist, and that does not meet the requirements of a C horizon. The boundary between the R layer and any overlying unconsolidated material is called a lithic contact.

Lowercase Suffixes

b -A buried soil horizon.

e -A horizon characterized by the removal of clay, iron, aluminum, or organic matter alone, or in combination. When dry, it is higher in color value by 1 or more units than an underlying B horizon. It is used with A (Ae, Ahe).

g -A horizon characterized by gray colors, or prominent mottling, or both, indicative of permanent or periodic intense reduction. Chromas of the matrix are generally 1 or less.

h -A horizon enriched with organic matter. When used with A it must show one Munsell unit of value darker than the horizon below, or have 0.5% more organic matter than the IC. It contains less than 17% organic carbon by weight.

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

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

t -A horizon enriched with silicate clay. It is used with B (Bt, Btg).

[1] Bernier, B. 1968. Soils under forest. Proceedings of the Seventh Meeting of the National Soil

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TABLE 14. CHARACTERIZATION ANALYSES OF SELECTED SOILS

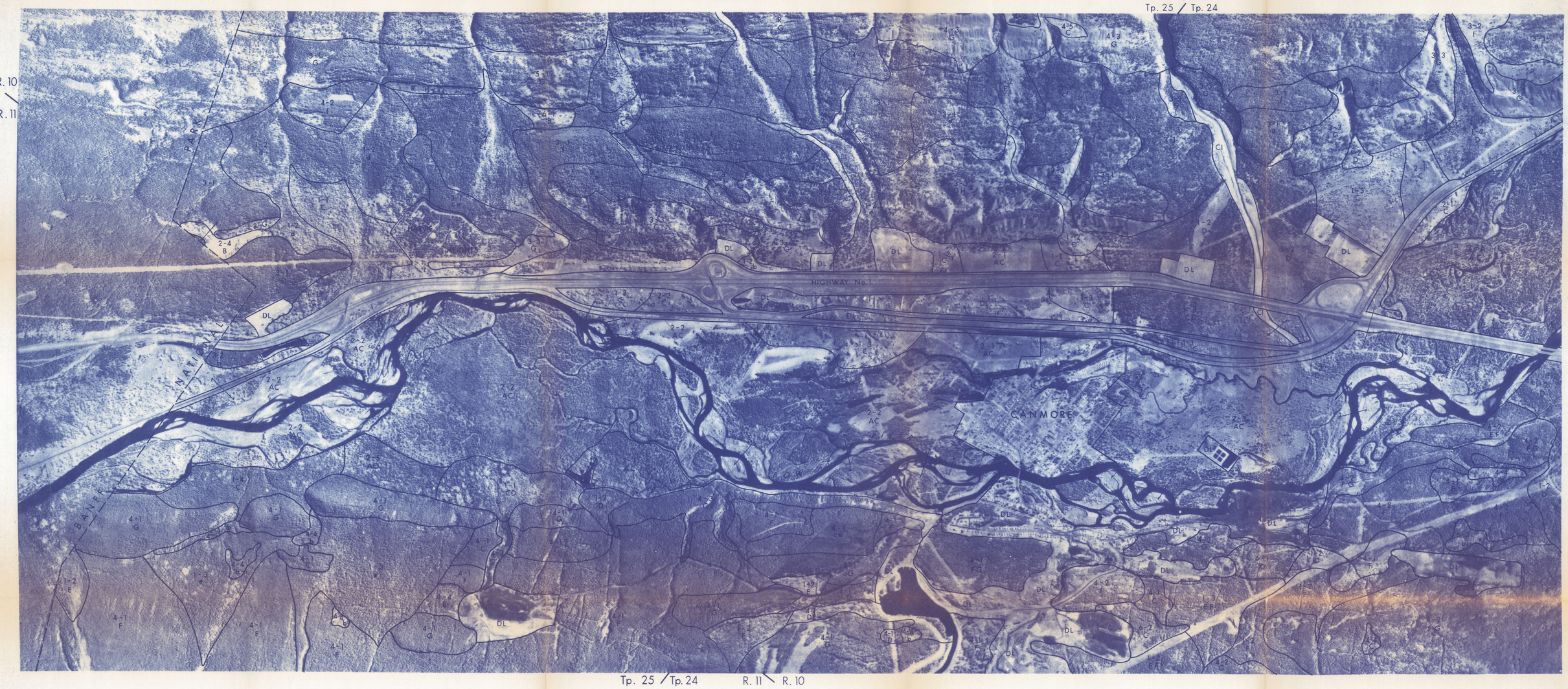
Soil Association	Horizon	Sample Depth (inches)	Reaction[1] pH	N[2] %	O.M.[3] %	C/N[4]	$CaCO_3$[5] equiv.%	C.F.[6] %	% of less than 2 mm. Sand	Silt	Clay	Textural Class USDA	Unified[7]
1-1	Ck_1	0-8	6.7	0.29	6.9	14	38.1	0	3	76	21	SiL	ML-CL
	Ck_2	25-30	6.9	0.12	3.1	15	45.6	0	-	-	-	SiL	-
2-1	Apk	0-6	6.8	-	-	-	27.6	0	8	56	36	SiCL	ML-CL
	Ck_2	10-15	7.0	-	-	-	27.6	0	7	61	32	SiCL	ML-CL
	Ck_3	15-30	7.2	-	-	-	43.1	0	9	57	34	SiCL	ML-CL
2-2	Bm	1-6	6.6	-	-	-	-	0	26	61	13	SiL	ML
	IICk	12-30	7.0	-	-	-	42.2	60	66	30	4	VGSL	GM
2-3	Ahk	0-2	7.1	-	14.8	-	31.4	0	0	70	30	SiCL	MH
	Ck_5	20-30	7.0	-	-	-	45.1	0	5	86	9	Si	ML
2-4	Ck_1	0-20	7.0	0.16	13.0		49.9	0	1	75	24	SiL	ML-CL
3-1	L-F	0-1	5.3	-	-	-	-	0	-	-	-	Organic	-
	Bm	1-6	6.8	0.09	2.63	17	-	15	29	44	27	CL	CL-ML
	IICk	6-30	7.1	-	-	-	56.5	20	-	-	-	GSL	SM
3-3	Ck_1	0-8	7.1	0.22	6.0	16	21.3	5	42	42	16	L	ML-CL
	Ck_2	8-20	7.2	-	-	-	47.1	10	40	40	20	L	ML-CL
	Ck_3	20-35	7.1	-	-	-	50.2	25	42	41	17	GL	ML-CL
4-1	L-F	0-1	6.9	-	-	-	-	0	-	-	-	Organic	-
	Ae	1-3	6.3	0.06	2.6	26	-	0	30	59	11	SiL	ML-CL
	Bt	3-10	6.6	-	-	-	-	5	23	42	35	CL	CL-ML
	$IICk_1$	10-15	6.9	-	-	-	31.8	20	41	42	17	GL	ML-CL
	$IICk_2$	15-30	7.0	-	-	-	60.4	30	47	41	12	GL	ML-CL
6-2	Marl Oh	0-20	7.0	0.89	22.7	15	55.1	0	-	-	-	Organic	Pt
	Om	20-30	7.1	1.95	50.9	15	1.25	0	-	-	-	Organic	Pt

1. pH determined on 2:1 solution:soil ratio using 0.01 M $CaCl_2$.
2. % total Nitrogen by Kjeldahl - Wilfarth - Gunning method.
3. % organic matter.
4. Organic Carbon:Nitrogen ratio.
5. % $CaCO_3$ equivalent by weight.
6. % coarse (greater than 2 mm diameter) fragments.
7. Unified classification estimated from guides published by U.S.D.A. (1971).

SOILS OF THE CANMORE AREA

Tp. 25 / Tp. 24

R. 10 \ R. 11



Tp. 25 / Tp. 24 R. 11 \ R. 10

LEGEND:

PARENT MATERIAL	SOIL ASSOCIATION	TEXTURE	DRAINAGE CLASSES	SOILS DOMINANT	SOILS SIGNIFICANT
Fan Alluvium	1-1	SiL/G	well	Cumulic Regosol	Orthic Regosol
	1-2	G-VGSL	rapidly	Cumulic Regosol	
	1-3	SL & G	rapidly - well	Cumulic Regosol	
	1-4	SL	well	Orthic Gray Luvisol	Degraded Eutric Brunisol
Floodplain Alluvium	2-1	SiCL	well - moderately well	Cumulic Regosol	Orthic Regosol
	2-2	0-6" SL/G	well	Cumulic Regosol	
	2-3	6-36" SiL/G	well - moderately well	Cumulic Regosol	
	2-4	SiCL	imperfectly	Orthic Regosol	
	2-5	SL	well	Orthic Gray Luvisol	Degraded Eutric Brunisol
	2-6	SL-SiL	well to poorly	Rego Gleysol	Cumulic Regosol
Glaciofluvial Outwash	3-1	SCL/GSiL - VGSiL	well	Orthic Eutric Brunisol	Degraded Eutric Brunisol
	3-2	GSiL - VGSiL	well	Orthic Eutric Brunisol	Orthic Regosol
	3-3	GL - VGSiL	rapidly	Orthic Regosol	Cumulic Regosol
Glacial Till	4-1	GSL	well	Orthic Gray Luvisol	
	4-2	SL/R	well	Lithic Orthic Regosol	(rock outcrops)
	4-3	GSL	rapidly	Orthic Regosol	
	4-4	SiL/GSL	poorly	peaty Rego Gleysol	
	4-5	GSL	well	Orthic Eutric Brunisol	Orthic Regosol
Thin Colluvium or Drift over Bedrock	5-1	variable/R	rapidly	Lithic Orthic Regosol	(rock outcrops)
Organic	6-1	organic	very poorly	Terric Fibrisol	
	6-2	organic	poorly	Limno Mesisol	

Simple topography
Single slopes
(regular surface)

		Slope %
A	depressional to level	0 to 0.5
B	very gently sloping	0.5+ to 2
C	gently sloping	2+ to 5
D	moderately sloping	5+ to 9
E	strongly sloping	9+ to 15
F	steeply sloping	15+ to 30
G	very steeply sloping	30+ to 60
H	extremely sloping	over 60

Complex topography
Multiple slopes
(irregular surface)

a	nearly level
b	gently undulating
c	undulating
d	gently rolling
e	moderately rolling
f	strongly rolling
g	hilly
h	very hilly

Miscellaneous Land Units

DL	Disturbed Land (includes urban areas, strip mines, etc.)
CL	Cobble land (greater than 90% coarse fragments)
R	Rock Outcrops

Texture Symbols

G	gravel
GSiL	gravelly silt loam
GSL	gravelly sandy loam
SiCL	silty clay loam
SiL	silt loam
SL	sandy loam
SL/R	sandy loam over bedrock
VGSL	very gravelly sandy loam

Compiled from uncontrolled mosaic.

Mapped and Compiled by: L. J. Knapik
Soils Division
Alberta
RESEARCH COUNCIL
1974

APPROXIMATE SCALE 1:12,000

1000 0 1000 2000 3000 4000 5000
FEET