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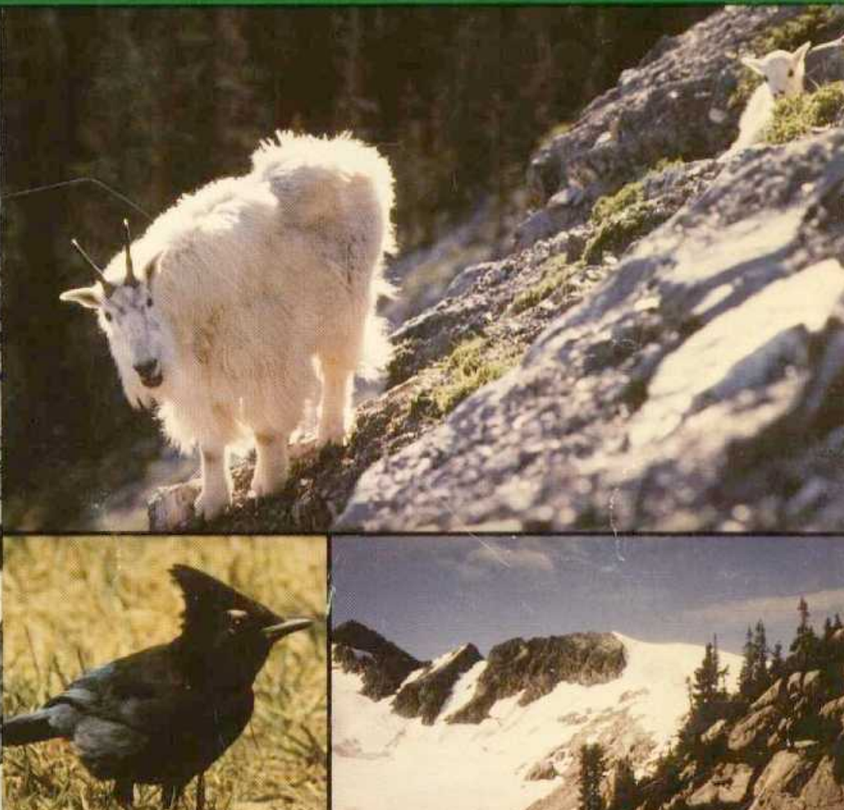
Ecological Land Classification of Mount Revelstoke and Glacier National Parks, British Columbia

Vol. I: Integrated Resource Description

Editors: P.L. Achuff, W.D. Holland, G.M. Coen, and K. Van Tighem



Canada

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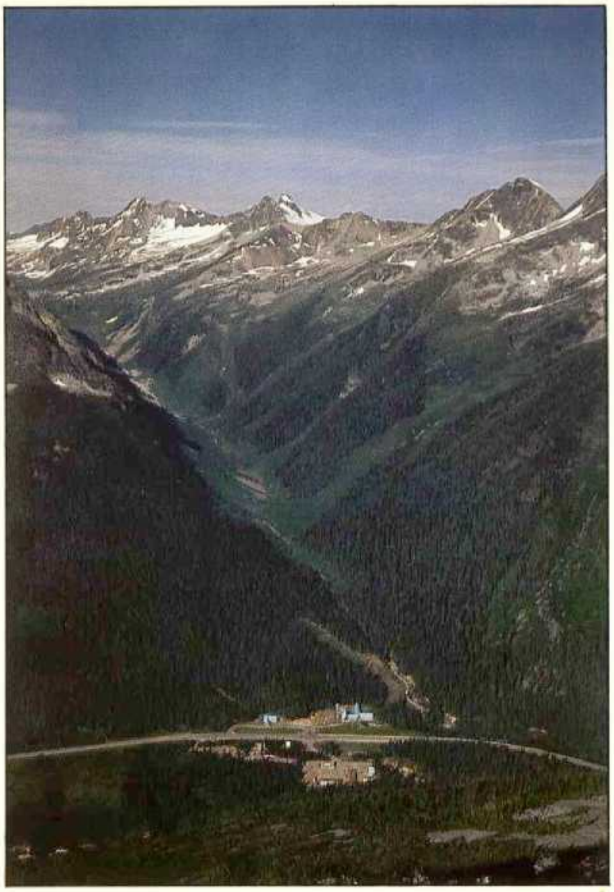

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ABSTRACT

Mount Revelstoke and Glacier National Parks are in the Columbia Mountains of southeastern British Columbia between 51° 00' and 51° 29' N and 117° 12' and 118° 13' W. The Ecological Land Classification of the parks is an integrated resource inventory of landform, soil, vegetation and wildlife information presented in both report and 1:50,000 map format. A three-level, hierarchical land classification system was developed using existing landform and soil classifications plus a classification of 34 vegetation types developed by the authors. The three levels are based on national guidelines for ecological land classification and are, from highest to lowest level of generalization, Ecoregion, Ecosection and Ecosite.

Ecoregion separations are based primarily on vegetation physiognomy and species composition which reflect macroclimate. Interior Cedar-Hemlock, Engelmann Spruce-Subalpine Fir and Alpine Ecoregions are recognized. The Engelmann Spruce-Subalpine Fir Ecoregion is divided into Lower Subalpine and Upper Subalpine portions based on vegetational characteristics reflecting macroclimatic differences.

The Ecoregions are divided into 19 Ecosections. Ecosection separations are based on landform, drainage class and soil differences. Landforms are composed of eight genetic materials which are divided into 11 genetic material units based on textural and chemical (calcareousness/reaction) differences.

The Ecosections are divided into 50 Ecosites based on bedrock, landform, soil and vegetational differences insufficient to warrant separation at the Ecosection level. Ecosites plus seven Miscellaneous Landscapes are the map units delineated. The landforms, soils, vegetation and wildlife of each Ecosection and Ecosite are described. Wildlife information includes the importance of each Ecosite for most of the common animals and descriptions of 11 breeding bird communities and 10 small mammal associations.

A total of 239 animal species is recorded in the parks, including four amphibians, three reptiles, 178 birds and 54 mammals. A total of 841 plant taxa occurs in the parks; 546 are vascular plants, 36 are liverworts, 130 are mosses and 129 are lichens.

CHAPTER I - PHYSICAL ENVIRONMENT

LOCATION, PHYSIOGRAPHY AND DRAINAGE SYSTEMS

D.T. Allan, B.D. Walker and W.S. Taylor

LOCATION

Mount Revelstoke National Park (MRNP) and Glacier National Park (GNP) are in the Columbia Mountains (Holland 1964, Bostock 1970) of southeastern British Columbia (Fig. 1). MRNP extends north to south approximately 20 km between 51°00' and 51°12' N and east to west about 22 km between 117°52' and 118°13' W. MRNP occupies 260 km² with the city of Revelstoke near the southwest boundary.

GNP extends north to south for approximately 50 km between 51°02' and 51°29' N and east to west for approximately 50 km between 117°12' and 117°55' W. It covers 1349 km² and is centered on Rogers Pass, British Columbia. The Trans-Canada Highway and Canadian Pacific Railway both transect GNP extending from the northeastern corner along the Beaver River to the western boundary along the Illecillewaet River.

PHYSIOGRAPHY

MRNP and GNP occur in the Columbia Mountains of the Southern Plateau and Mountain Area which is in the Interior System of the Canadian Cordillera (Holland 1964, Bostock 1970).

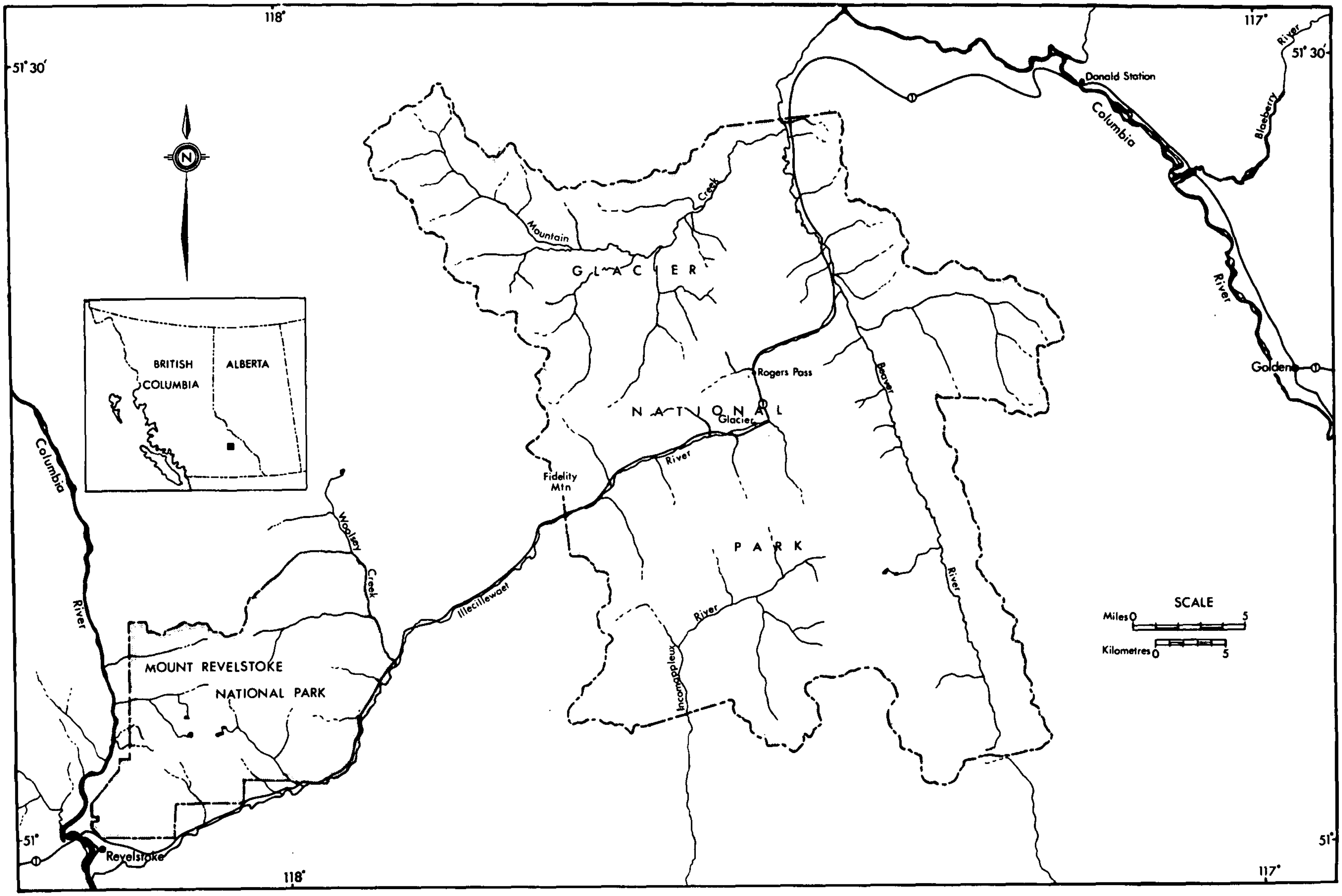
Physiography and landform in the Canadian Cordillera Region are governed by geomorphic process, bedrock character, and orogenic or structural history (Holland 1964). MRNP and GNP are underlain predominantly by folded and faulted metasedimentary rocks uplifted by orogenic deformation during the Tertiary (Holland 1964). Erosion, mainly fluvial and glacial, has operated since then. The general topography is controlled by differences in resistance to erosion. Valleys reflect softer rocks while peaks and ridges are underlain by more resistant beds. Bedrock here trends northwesterly which controls the direction of the ranges and has imposed a trellis-like pattern on the drainage systems (Holland 1964).

MRNP and GNP contain portions of the Selkirk Mountains and the northwestern flank of the Purcell Mountains, two of four major Columbia Mountain subdivisions (Holland 1964, Baird 1965, Bostock 1970). The Selkirks are composed mostly of three bedrock groups that control general topography in MRNP and GNP: Hamill Group, Lardeau Group, and Shuswap Metamorphic Complex. With the addition of the Horsethief Creek Group, which dominates the northwestern Purcells, MRNP and GNP encompass four physiographic units that reflect bedrock geology.

Easternmost GNP is in the Purcell Mountains and is separated from the more rugged Selkirks by the Beaver River valley also called the Purcell Trench (Wheeler 1963). Recessive, slate and schist bedrock in this area of the Purcells controls the general topography which is the most rounded and subdued in the two parks (Plate 1). High elevation topography, with low to moderate internal relief, includes both broad and narrow, rounded, ridge tops and poorly defined cirques and valley shoulders. Most of these landscapes show evidence of glaciation but present glaciers are few and very small. Mountain peaks are also poorly defined being little more than elevated parts of the interconnecting ridges. Most are rounded or elongated and <2600 m elevation. The highest is Moonraker Peak (2840 m). Valley floors in the northern Purcells have gentle to moderate gradients and are higher than in other physiographic units; thus, valley walls are not as steep. Internal relief in the Copperstain and East Grizzly Creek areas is about 1000 m. The greatest relief is 1200 to 1500 m and the steepest slopes mark the northwestern edge of the Purcells, rising from the Beaver River to the eastern GNP boundary on the Prairie Hills and Bald Ridge. Most Purcell landscapes in GNP are vegetated.

The central three-quarters of GNP, is dominated by Hamill Group bedrock but includes several small areas of Horsethief Creek and Lardeau Group strata, limestone, and granitic intrusive bedrock.

Fig. 1. Location and drainage systems of Mount Revelstoke and Glacier National Parks.



Massive, highly resistant lithologies, mainly quartzite, within the Hamill and granitic intrusive rocks produce the most rugged topography in MRNP and GNP (Plate 1). Massive, precipitous, mountain peaks and narrow, craggy, serrated ridges are abundant with most peaks >2700 m. Several peaks in the Hermit, Sir Donald, Dawson, Bishops, and Purity Ranges are >3200 m. The highest peaks are: Mount Dawson, consisting of Hasler Peak (3390 m), Mount Selwyn (3360 m), Feuz Peak (3350 m) and Michel Peak (3077 m); Mount Wheeler (3363 m); and Mount Sir Donald (3297 m). Long, connecting ridges are uncommon except around the northwestern boundary. Well defined cirques are abundant, particularly on northerly and easterly aspects. Glaciers and icefields occur extensively in the highest areas. Deeply incised, narrow, glaciated valleys separate most mountain ranges. These have very steep walls that often include craggy and gullied portions. Internal relief is frequently 1500 m but ranges from 1000 m above low passes to nearly 2250 m between Mount Sir Donald and the Beaver River. Vegetated landscape occupies a significantly greater proportion of this relief than does unvegetated terrain, except in areas of high peaks and extensive glaciers.

Recessive slate and schist bedrock of the Lardeau Group occupies a small area along the southwestern boundary of GNP (Plate 2). The topography is similar to the Purcells in eastern GNP but valley walls are steeper and longer, internal relief is 1100 to 1800 m, and some have craggy sections. The highest elevations (Corbin Peak, 2712 m) occur along the connecting ridges that form the southwestern park boundary. Most of the vertical relief is vegetated. The mountain ridges are steeper and narrower than in the Purcells and well defined cirque valleys extend north and east from the main ridges. Current glaciers are few and very small.

A great variety of metamorphic and granitic rocks of the Shuswap Metamorphic Complex characterizes MRNP. Thus, the variety of resistances to erosion gives more than one kind of topography. One type, occurring in Clachnacudainn Creek-Inverness Peaks and West Woolsey Creek areas, resembles the rugged topography of the Hamill area in GNP, in having narrow valleys with long, steep, often craggy walls culminating in precipitous, cliffy, narrow ridge and mountain tops. A second, more extensive type of topography occurs in the vicinity of Mount Revelstoke. Narrow valley floors (*e.g.* Illecillewaet) are bounded by long, steep slopes which grade at about mid-slope (1500-1900 m) to broad, rounded, hummocky or ridged, plateau-like shoulders or cirques. Small isolated peaks or narrow mountain ridges, well back from the valley wall, complete the profile. Valleys in MRNP are deeply incised and narrow with little benchland along floors. Vertical relief of $\geq$1800 m is common along the Illecillewaet and Columbia rivers. The maximum range is Revelstoke townsite (456 m) to Mount Revelstoke summit (1938 m), and to Mount Coursier, the highest peak in MRNP (2646 m). Most of this vertical relief is vegetated. Glaciers are extensive in MRNP, the largest occurring on the northeast side of Inverness Peaks and Mount Coursier.

DRAINAGE SYSTEMS

MRNP and GNP occur within the Columbia Initial Drainage Division (Shera and Grant 1980), also called the Columbia Basin. MRNP and GNP drain via the Columbia and Illecillewaet Major River Watersheds (Shera and Grant 1980). The Beaver River, flowing north to the Columbia River, drains the eastern and northern parts of GNP. Main tributaries in east-central GNP are Connaught, Grizzly, East Grizzly, and Copperstain creeks. The largest tributary, Mountain Creek, and its tributaries drain the northwestern quarter of GNP.

The Illecillewaet River and tributaries drain the central and southwestern portion of GNP and the majority of MRNP. Major tributaries of the Illecillewaet River in GNP include Bostock and Flat creeks, and Asulkan, Cougar, and Loop brooks. Major tributaries of the Illecillewaet River in MRNP include Maunder, West Woolsey, Woolsey, Clachnacudainn, Bridge, and Hamilton creeks. All are part of the Illecillewaet Major River Watershed which empties into the Columbia River at Revelstoke townsite. Coursier and St. Cyr creeks and other smaller tributaries on the western side of MRNP drain directly into the Columbia River.

The Incomappleux River and tributaries drain the south central and southern portion of GNP. Major tributaries in GNP include Van Horne and Bain brooks and Mitre and Black creeks.

Very few lakes occur in GNP. The only named lakes are Schuss Lake on Mount Fidelity and Marion Lake above Glacier station. A notable unnamed lake occurs at the mouth of Glacier Circle. Other small unnamed lakes and ponds occur in backwater localities along the Beaver River and Mountain Creek.

MRNP contains several high elevation lakes. The most notable include Millar, Eva, Upper and Lower Jade, Heather, and Balsam lakes. Limnological studies on lakes (Donald and Alger 1984) and streams (Alger and Donald 1984) in MRNP and GNP were done as part of the ecological inventory.

CLIMATE

B.D. Walker and P.L. Achuff

OVERVIEW AND EAST-WEST TRENDS

Climatic data for MRNP and GNP are scarce. Except for a brief brochure on the climate of MRNP and GNP (Parks Canada 1980), most climatic discussions of the area are generalized (Chapman 1952, Krajina 1965).

Mean annual temperature range (difference between mean temperatures of the warmest and coldest months, Chapman 1952) and temperature range (difference between extreme maximum and minimum temperatures, Janz and Storr 1977) have been suggested as simple measures of climatic continentality. Comparison of such data from various western Canadian stations (Table 1) shows that temperature regimes in MRNP and GNP more closely resemble those of continental climate (*e.g.* Prince George Airport, Edmonton International Airport) than of maritime climate (*e.g.* Prince Rupert). Nevertheless, winter temperatures in the two parks tend to be weakly moderated by Pacific air and usually show higher mean and extreme minima than stations in the Rockies to the east (Table 2). The moderating, maritime influence increases with increasing elevation, although inversions, which are common in mountainous areas (Chapman 1952, Janz and Storr 1977), may account for mild extreme and mean minima at Mount Fidelity (Table 2).

Precipitation in MRNP and GNP better reflects maritime influence than does temperature. Mean annual precipitation (Table 3) is about three times greater on an equal elevation basis in the Columbias when compared with the Rockies. The precipitation regime is characterized by a well defined winter maximum in December or January, with heavy snowfall, and a summer minimum. A weak secondary maximum usually occurs in June and reflects continental influence. Otherwise, 65 to 70% of total precipitation consistently occurs in the winter months (Table 3), which is comparable to Prince Rupert (63%, Atmospheric Environment n.d.a). Snow depth (Table 4), particularly for higher elevation stations, supports these precipitation trends.

The northwest-southeast orientation of the mountains exerts considerable influence on air mass movement in Western Canada. The Rocky Mountains offer considerable resistance to westward movement of dry Arctic air masses although there is occasional spillover through large passes (Chapman 1952, Janz and Storr 1977). The mountains offer less protection against cold air from the Yukon and Alaska that occasionally moves parallel to the trend of relief into the British Columbia Interior (Chapman 1952). Most often, MRNP and GNP are affected by eastward-moving, moist, mild Pacific air that lifts and cools over the Columbias where it releases much of its moisture before reaching the Rockies. Thus, the Columbias are much wetter than the Rockies or the Interior Plateau to the west.

Precipitation trends related to the west to east flow of moist Pacific air also occur within the immediate park area. Based on vegetational features, two areas were noted as being drier in MRNP and GNP. Both are at low elevations within the Interior Cedar-Hemlock Ecoregion on southwesterly aspects. The first is above Revelstoke townsite and the second on the east wall of the Beaver River valley. The Revelstoke area is dry probably because of its very low elevation (Tables 2 and 3) and possibly because of a rain shadow effect of the Monashee Mountains to the west. Aside from aspect and low elevation, the eastern wall of the Beaver River valley is drier than other parts of GNP because it occurs on the leeward side of the Columbia Mountains. Comparison of snow depth (Table 4) on an equal elevation basis suggests that total precipitation is less in leeward (Sunbeam Lake, Bugaboo Creek, and Vermont Creek stations) *vs.* windward areas of the Columbias. On an equal elevation basis, the Purcell Mountains are likely drier than the Selkirks and have decreasing total precipitation eastwards. These precipitation trends are consistent with previously delineated boundaries separating forest regions or systems (Interior Wet Belt *vs.* Dry Interior boundary follows the Purcell divide, Wittneben 1980) and climatic regions (Wet Region *vs.* Moist Region boundary follows the Beaver River, Lloyd 1983). There are few data with which to evaluate east-west temperature trends across the park area.

Table 1. Temperature (°C) ranges of selected western Canadian stations. (Atmospheric Environment n.d.a & n.d.b)

Station	Daily x̄ Warmest Month	Daily x̄ Coldest Month	Mean Annual Range	Ext. Max.	Ext. Min.	Ext. Range
Prince Rupert 52 m	13.5	1.7	11.8	32.2	-21.1	53.3
Prince George A 676 m	15.1	-12.1	27.2	34.4	-50.0	84.4
Revelstoke 456 m	19.0	-6.1	25.1	40.6	-34.4	75.0
Mount Fidelity 1875 m	11.1	-9.5	20.6	27.8	-30.5	58.3
Rogers Pass 1323 m	13.3	-10.9	24.2	32.8	-38.9	71.7
YNP Boulder Ck. 1219 m	15.3	-10.9	26.2	33.0	-35.0	68.0
Banff 1397 m	14.8	-11.5	26.3	34.4	-51.1	85.5
Edmonton Intl. A 715 m	15.8	-16.5	32.3	35.0	-48.3	83.3

CLIMATE AND ECOREGIONS

Altitude plays a major role in modifying regional climate and its effects are especially noticeable in mountainous areas (Chapman 1952). Vegetation, as a biotic component of an ecosystem, reflects elevational controls on climate. Thus, vegetational features have been used to delimit climatic units. Based primarily on vegetational physiognomy and composition, four units have been delineated: Interior Cedar-Hemlock Ecoregion, Engelmann Spruce-Subalpine Fir Ecoregion with Lower Subalpine and Upper Subalpine portions, and Alpine Ecoregion.

INTERIOR CEDAR HEMLOCK ECOREGION

Most of the climatic data for MRNP and GNP are from the Interior Cedar-Hemlock Ecoregion (Tables 2 and 3), which is warmest and driest although much wetter than its elevational counterpart (Montane Ecoregion) in the Rockies. Mean annual temperature is >1°C but the Interior Cedar--Hemlock experiences the greatest temperature range with extreme minima of -30° to -35°C and mean minima of -10° to -15°C. Mean maxima are 21° to 28°C and extreme maxima have reached 40°C at the lowest elevations (Table 2). Summer frost at Glacier is less frequent than at Banff or Radium (Atmospheric Environment 1975a), which indicates mild climate. Various inversions (Janz and Storr 1977) likely occur. The result, particularly of diurnal inversions common in summer, is cold air drainage to valley bottoms and a *thermal belt* with warmer temperatures on valley walls. Cold air drainage is likely pronounced in valleys below glaciers.

Mean annual precipitation in the Interior Cedar-Hemlock is 1000 to 1700 mm with most occurring in winter (Table 3). Minimum precipitation occurs in April or May and again in July to August or occasionally September. June precipitation is consistently greater than in other spring and summer months and often equals precipitation of late winter and early fall months. Mean annual snowfall is

Table 2. Temperature data (°C) for stations in and near MRNP and GNP.

Station and Elevation	Ecoregion	Ext. Max.	Ext. Min.	Mean Maxima					Mean Minima					Annual Mean
				May	Jun	Jul	Aug	Sep	Nov	Dec	Jan	Feb	Mar	
Revelstoke Airport 443 m	ICH	36.1	-29.4	[1]20.6 [2]19.7	23.0 22.3	26.6 26.5	25.0 25.3	19.2 19.0	-2.0 -2.0	- 6.8 - 6.2	-11.1 - 9.8	- 7.5 - 5.9	-4.4 -3.8	6.5 6.6
Revelstoke 456 m	ICH	40.6	-34.4	[1]20.6 [2]20.2	23.7 23.4	27.8 27.2	25.8 25.8	20.4 19.3	-1.8 -2.5	- 6.1 - 6.8	- 9.1 - 9.2	- 5.8 - 5.1	-3.2 -3.3	7.2 6.9
Glacier Avalanche RS 1177 m	ICH	35.0	-35.6	[2]13.3	17.5	22.1	20.3	14.6	-6.6	-10.9	-13.1	-10.1	-7.9	2.3
Glacier 1248 m	ICH	36.7	-35.6	[1]14.1	18.3	22.2	20.4	14.8	-7.1	-10.7	-14.1	-11.2	-8.4	2.1
Rogers Pass 1323 m	ICH	32.8	-38.9	[1]11.5 [2]11.4	16.9 16.6	21.8 20.9	20.2 19.7	14.8 13.6	-7.3 -7.4	-11.7 -11.4	-14.7 -13.6	-10.4 - 9.4	-9.0 -8.2	1.5 1.5
Mount Fidelity 1875 m	ESSF	27.8	-30.5	[2] 7.9	10.9	16.3	16.0	9.8	-8.4	-11.0	-11.9	- 9.1	-9.0	0.2
Golden 787 m	Montane	40.0	-46.1	[1]19.9 [2]19.2	23.3 22.7	27.1 26.1	25.1 24.8	20.0 18.8	-5.9 -6.3	-11.3 -11.5	-15.3 -15.3	-11.1 -10.6	-7.0 -6.9	4.8 4.6
YNP Boulder Creek 1219 m	Montane	33.0	-35.0	[2]15.7	19.7	23.7	22.2	16.7	-8.4	-12.0	-14.5	-10.3	-7.5	2.9

[1] Atmospheric Environment (1975a): 1941-70, 5-30 yrs. data

[2] Atmospheric Environment (n.d.a): 1951-80, 5-30 yrs. data

Table 3. Mean annual precipitation (MAP) for stations in and near MRNP and GNP.

Station	Elevation	MAP	% Oct-Mar	% as snow
ICH		$\bar{x}=1278$ mm		
Revelstoke A	443 m	947[2]	65	37
Revelstoke	456 m	1096[1]	65	36
		1064[2]	65	39
Albert Canyon	640 m	1014[3]	64	nd
Glacier Avalanche RS	1177 m	1725[2]	67	64
Glacier	1248 m	1493[1]	66	65
Rogers Pass	1323 m	1606[2]	70	68
Montane				
Golden	787 m	473[1]	57	44
		477[2]	56	44
YNP Boulder Ck.	1219 m	557[2]	47	45
Banff	1397 m	477[1]	40	43
		471[2]	40	44
ESSF		$\bar{x}=1995$ mm		
Mount Fidelity	1875 m	2169[2]	69	78
	1914 m	1821[3]	65	nd

[1] Atmospheric Environment (1975b): 1941-70, 5-30 yrs. data.
[2] Atmospheric Environment (n.d.a & n.d.b): 1951-80, 5-30 yrs. data.
[3] Atmospheric Environment (n.d.c): 1-7 yrs. data.

35 to 70% of total precipitation and the proportion increases with increasing elevation (Table 3). The Interior Cedar-Hemlock is rarely snow-free in winter. Snow course data from MRNP and GNP for February, March and April show no zero readings over a 40 to 44 year period (Inventory and Engineering Branch 1980).

The only wind records available for the MRNP and GNP area from Revelstoke and Revelstoke Airport (Atmospheric Environment 1982) suggest that winds are generally light in valleys. Mean wind speeds are fairly uniform over the year (3.5-6.0 km/hr) with the highest speeds occurring in summer. Prevailing wind direction at Revelstoke is SE from October to February and NW from March to September. Frequencies are also high for westerly and easterly winds. At Revelstoke A, prevailing wind direction is NE in all months except February (SE). Frequency is also high for SE, S and NW winds in most months. These differences show that surface wind direction is highly variable and determined by the mountain topography. Calm periods are few in summer but common in winter (13% and 22% frequency for the two stations in January, Atmospheric Environment 1982).

ENGELMANN SPRUCE-SUBALPINE FIR ECOREGION

The Engelmann Spruce-Subalpine Fir Ecoregion occurs at elevations above the Interior Cedar-Hemlock and is moister and cooler. Mean annual temperature is probably <1°C and decreases with increasing elevation. However, mean and extreme temperature ranges are narrower in the Engelmann Spruce-Subalpine Fir than the Interior Cedar-Hemlock.

Table 4. Snow depths for stations in and near MRNP and GNP.

	Mean Snow Depth (cm)			
Station and elevation	March 1	April 1	May 1	June 1
ICH				
Revelstoke 560 m	95	71	24	nd
Glacier 1250 m	185	188	155	59
New Glacier 1250 m	179	179	141	58
Montane				
Field 1280 m	65	53	10	nd
ESSF				
Mount Copeland 1700 m	358	375	360	235
Mount Revelstoke 1830 m	285	311	288	196
Mount Fidelity 1870 m	313	333	310	239
Mount Abbott 1980 m	297	337	326	265
Sunbeam Lake 2010 m	235	272	248	nd
Subalpine				
Bugaboo Creek 1510 m	128	129	78	1
Vermont Creek 1520 m	144	154	131	nd

Precipitation generally increases with increasing elevation and the Engelmann Spruce-Subalpine Fir in MRNP and GNP receives substantial amounts (1700 to >2100 mm mean annual precipitation, Table 3). Most (60-80% or more) occurs as snow and deep snowpack often lasts well into June or July (Table 4). The precipitation regime is virtually the same as the Interior Cedar-Hemlock.

Winds are generally light but increase with elevation. The windiest localities are in passes and at the highest Engelmann Spruce-Subalpine Fir elevations where stunted and krummholz open forests are prevalent.

ALPINE ECOREGION

The Alpine Ecoregion occurs at elevations above the Engelmann Spruce-Subalpine Fir Ecoregion and has the coldest, most rigorous climate as demonstrated by the lack of forest vegetation. Cool mean temperatures are inferred from temperatures at lower elevations and temperature range is probably narrowest in the Alpine. Precipitation increases with altitude but somewhere in the Alpine the trend may reverse. As in the Engelmann Spruce-Subalpine Fir, most of the precipitation probably occurs as snow.

Wind is important in the Alpine. Janz and Storr (1977) report that areas above about 2300 m in the Rockies are windy but winds may be light for several days in succession, particularly in summer. This is likely true of the Columbias as well and it appears that wind determines effective precipitation in the Alpine. Most Alpine areas are exposed and snow is probably redistributed to lower elevations or to avalanche starting zones. On Bald Mountain in eastern GNP, wind exposure may be responsible for the unusually low elevation (about 2200 m) at which Alpine occurs. Thus, with wind as a controlling factor, the Alpine in MRNP and GNP may not receive significantly more effective precipitation than Alpine areas in the Rocky Mountain parks. Within Alpine areas, complex vegetation patterns are often linked to varying topographic exposures and resultant snow depth variability.

GEOLOGY

W.S. Taylor

REGIONAL SETTING

Mount Revelstoke and Glacier National Parks lie within the Columbia Mountains which are in the southern portion of the Omineca Crystalline Belt, a central sector of the Cordilleran Orogen. The Cordilleran Orogen is a circum-Pacific orogenic belt that averages 800 km in width. It has been evolving since the mid-Proterozoic, starting at that time as the Cordilleran Geosyncline. At present, the region is tectonically quiet (Douglas *et al.* 1970).

STRATIGRAPHIC FRAMEWORK

Much of the bedrock in MRNP and GNP was once sediment of the Cordilleran Geosyncline which is now strongly altered. The metasediments have been grouped into rock-stratigraphic units (Okulitch 1949, Wheeler 1963, 1965, Baird 1965,, Ross 1968, Douglas *et al.* 1970, Price and Mountjoy 1970, Gilman 1972, Poulton and Simony 1980).

The oldest strata make up the Late Precambrian Horsethief Creek Group. It contains some quartzite, grit, metaconglomerate, and carbonate units, but most notable is the predominance of slate and schist. The Late Precambrian-Lower Cambrian Hamill Group occurs next in the sequence. It is mostly quartzite and contains minor slate, phyllite, schist, grit, and conglomerate. Grizzly Creek (GNP) contains one minor exposure of Lower Cambrian Donald Formation. The similarly aged Badshot Formation, though not extensive, outcrops in locations that are important because of the limestone content. The Nakimu Caves are developed in the Badshot Formation in upper Cougar Creek. The Lardeau Group has the youngest metasedimentary rocks, possibly Middle Cambrian. It contains argillite, phyllite, metasiltstone, carbonate, and minor quartzite and conglomerate (all generally dark colored), but most notable are the carbonaceous slate and schist.

Plutonic rocks also outcrop. Granitic rock, typically granodiorite, occurs in southwestern GNP (Wheeler 1963) and on west facing slopes above the Columbia River in MRNP (Ross 1968). Quartz monzonite is extensive in northcentral MRNP (Ross 1968). The plutons probably evolved in pulses over a long time period (Douglas *et al.* 1970), although a Cretaceous age has been given, probably for completion (Okulitch and Woodsworth 1977). A body of granitic gneiss crops out in two parallel northwest trending bands that run from southeastern to northern MRNP (Ross 1968, Gilman 1972). Though possibly plutonic, it may be a slice of Precambrian basement rock tectonically thrust into the metasediments. It was emplaced either prior to or during the regional metamorphism (Gilman 1972). Okulitch and Woodsworth (1977) give a Devonian age for the gneiss.

STRUCTURAL FRAMEWORK

Bedrock in the parks has probably experienced several orogenic episodes, starting as early as the Precambrian (Douglas *et al.* 1970). Traditionally it was held that the area was most affected by the Columbian Orogeny, a period of deformation, regional metamorphism, granitic intrusion, and uplift that lasted from Late Jurassic to earliest Upper Cretaceous (Douglas *et al.* 1970, Price and Mountjoy 1970). However, Price and Mountjoy indicate no implicit separation between the influence of the Columbian and later Laramide Orogenies on the eastern portion of the Cordilleran Geosyncline. Thus, mountain building probably occurred in successive pulses from Late Jurassic to Mid-Tertiary (Eocene). Structures produced are complex, resembling a crude anvil or mushroom shape in cross section at a gross scale (Douglas *et al.* 1970).

Within the Columbia Mountains, the Purcell (or Dogtooth) Mountains occur east of the Beaver River in GNP. The Beaver River valley, referred to as the Purcell Trench (Wheeler 1963), separates the Purcells from the Selkirk Mountains which extend west to the Columbia River at Revelstoke townsite. The Purcells in GNP are composed almost exclusively of Horsethief Creek Group strata. In the balance of GNP, the Selkirks contain nearly the entire sequence of metasedimentary strata, as well as granitic rock. MRNP occurs on the western boundary of the Selkirks and as an eastward projection of the Shuswap Metamorphic Complex, shares some similarities with the Monashee Mountains to the west. Highly metamorphosed strata of the Horsethief Creek and Hamill Groups crop out along with the granitic rock and gneiss in MRNP (Ross 1968).

The characteristics of unsorted sediments and their source bedrock are often linked. These relationships were identified for residual, colluvial, and morainal materials in MRNP and GNP. The predominant lithologic influence in Horsethief Creek Group strata is the schists and slates that generate noncalcareous, medium textured sediments. Quartzite portions of the Hamill Group give rise to noncalcareous, coarse textured deposits. However, the Hamill often consisits of interbedded quartzites, schists, and quartzitic phyllites (Okulitch 1949), so textures vary unpredictably between coarse and medium. The predominance of carbonaceous schists and slates in the Lardeau Group is reflected in its dark colored, noncalcareous, medium textured overburden. Limestone in the Badshot Formation and locally within the other Groups, especially Lardeau, produces small areas of calcareous, medium textured drift. The granitic intrusives and gneiss erode to form noncalcareous, coarse textured sediments.

Extensive areas of the major bedrock groups are shown in Fig. 2, compiled from Wheeler (1963, 1965). Source bedrock was a major criterion for separating Ecosites on colluvium and till. Fig. 2 thus predicts areas where various Ecosites will occur.

Other landscape features correlate with bedrock lithology. Quartzites and granitic rocks are more resistant than schists and slates. The most rugged topography thus occurs in a northwesterly trending band through central GNP, flanked to the east and west by more subdued peaks. Medium textured sediments from the slates and shales have a significant component of micaceous minerals, while those from quartzite or granitic rock have predominantly quartz grains. Pedogenic cementing is common in coarse tills from the latter sources, but is virtually absent from the medium textured tills derived from the slates and schists. Thus, pedogenic cementing occurs in MRNP and through the band of Hamill Group in central GNP. Other relationships between bedrock and Ecosites are identified throughout the text.

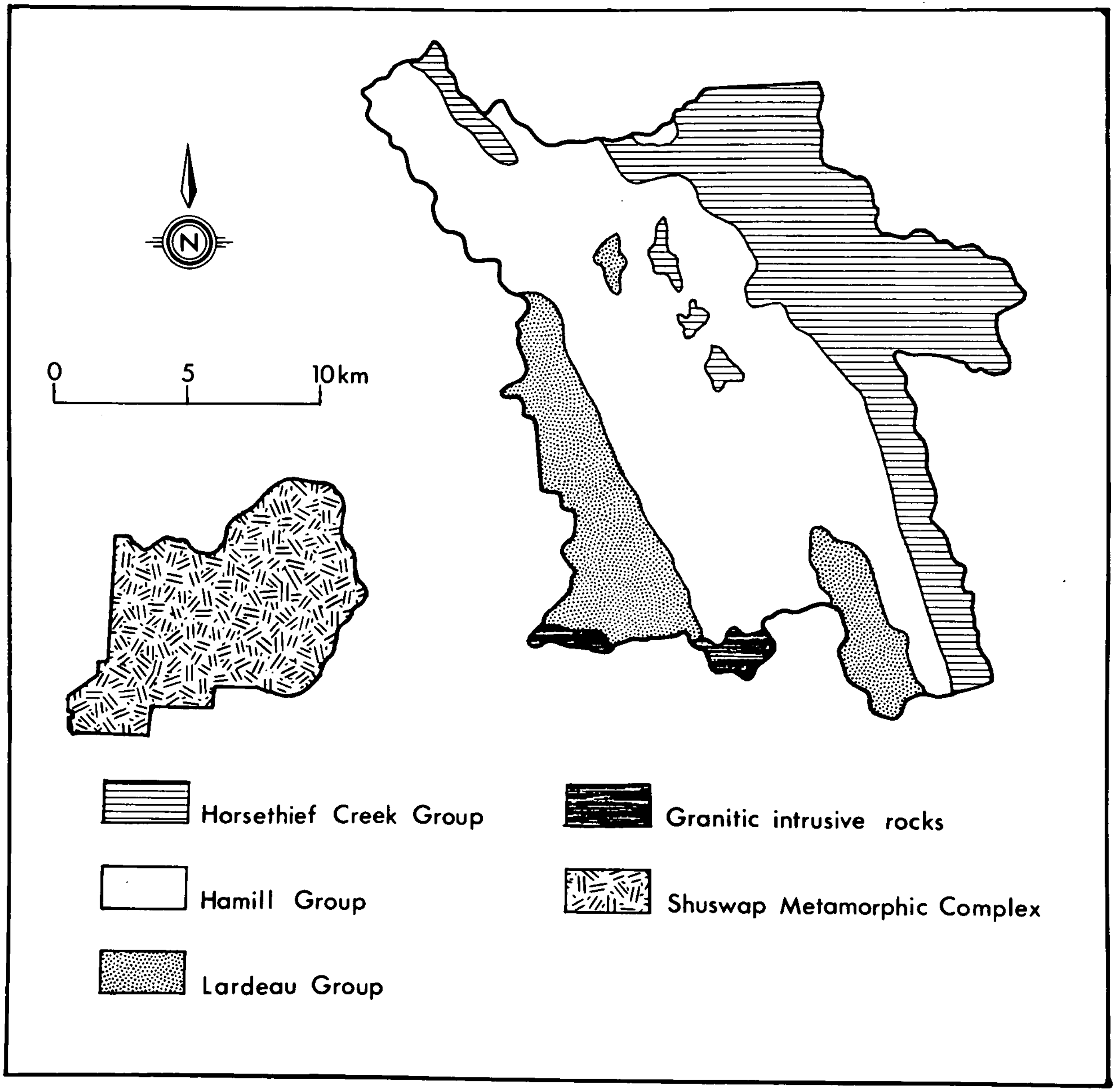
GEOMORPHOLOGY

B.D. Walker, W.S. Taylor and D.T. Allan

OVERVIEW

Soil and vegetation development is influenced by landform. Landform consists of genetic material, surface expression, and modifying processes (C.S.S.C. 1978a). Genetic materials are emphasized in this section and are defined, with slight modification, according to the C.S.S.C. (1978a) landform classification system. A similar system was used to map surficial materials of the Seymour Arm map

Fig. 2. Major bedrock groups of Mount Revelstoke and Glacier National Parks.



area (Fulton *et al.* 1984) which includes western MRNP. Genetic materials are organized into four groups: unconsolidated mineral, organic, consolidated (bedrock) and ice.

UNCONSOLIDATED MINERAL COMPONENT

The unconsolidated mineral group is divided according to mode of formation or deposition with eight genetic material classes recognized (modified from C.S.S.C. 1978a). They are in Table 5 in order of increasing source diversity, increasing influence on properties by depositional agents, and decreasing bedrock lithology influence. Seven classes are important to Ecosection/Ecosite separations in the Ecological Land Classification legend.

Genetic material classes are MRNP and GNP divided according to textural and chemical (calcareous) properites imparted either by source area lithology or modified by depositional media. Eleven genetic material units (Table 5) occur in MRNP and GNP but only ten are the basis for separations in the Ecological Land Classification. These units correspond to the genetic material units identified for the Banff-Jasper (BNP-JNP) Ecological Land Classification (Walker *et al.* 1982a).

RESIDUAL GENETIC MATERIAL

Residual material (R^U) is physically and chemically weathered bedrock and includes saprolite (C.S.S.C. 1978a). It occurs as a thin veneer conforming to the underlying inclined, ridged, and sometimes hummocky bedrock. Residual landforms occur primarily on high elevation cirque floors and ridge crests in the Alpine where they form the Heather 3 (HE3) Ecosite. Slopes are complex, generally 15 to 45%, with local variations of <15% and >45%. Exposed bedrock on ridge crests and short steep escarpments, till on parts of cirque floors, and colluvium on steep slopes, add to topographic complexity of residuum dominated landscapes. The colluvium resembles the original residuum but has moved downslope by colluviation and solifluction. Cryoturbation also occurs sporadically. Eolian material B (altered, medium textured), which is important to soil formation, often forms a thin, discontinuous veneer over the residuum on gentler slopes. Residuum occasionally occurs on colluvial and morainal landforms as a thin veneer over slaty or schistose bedrock and below a thin deposit of colluvium or till.

Bedrock from which residual material is weathered is metasedimentary and usually noncalcareous. Thus, only one genetic material unit, Residuum A (Table 6), is recognized. Its characteristics, though expanded to include some coarse textured material, are effectively the same as in BNP and JNP (Walker *et al.* 1982a). Medium textures (<60% sand and <10% clay) are prevalent, particularly on highly jointed, medium grained, recessive bedrock of the Horsethief Creek and Lardeau Groups (Fig. 2). Less often, Residuum A occurs on Hamill Group bedrock where textures are medium to coarse, the latter, usually with >60% sand and <5% clay, weathered from medium to coarse grained strata. Coarse fragments frequently constitute, by volume, 50 to 90%, occasionally 100% of Residuum A and are predominantly flat (channers, slates, and flagstones), less often angular. In a few localities, physically weathered residuum or colluvium is rubbly and fragmental with little or no fine earth. Being weathered from noncalcareous rock and part of lower sola, Residuum A is usually strongly to extremely acid pH 4.4 to 5.0. Calcareous, medium textured residuum (*cf.* Residuum B, Walker *et al.* 1982a) occurs sporadically and is weathered from localized limestone and calcareous clastic strata.

LANDSLIDE GENETIC MATERIAL

Landslide genetic material (C^A) is generated by rapid, gravity-induced movement of mineral material downslope *en masse*. Glacier House 1 Ecosite (GH1) is the only landslide mappable at 1:50,000 in MRNP and GNP. It forms a distinctive prominent landscape on the valley floor where Asulkan Brook valley meets the Illecillewaet River valley. Another landslide deposit, dissected by the Trans-Canada Highway south of Cougar Mountain, is too small to map. Colluvial landscapes affected by bedrock failure often contain small blocky and rubbly localities that resemble landslides.

The GH1 landslide likely originated after failure of Hamill Group quartzite on Avalanche Crest. Landslide textural properties reflect massive bedrock and disintegration due to cataclysmic failure. The landslide is predominantly rubbly but interspersed with blocky, fragmental localities. The rubbly material is noncalcareous (pH likely <5.5) and coarse textured with >60% sand, <5% clay, and 50

Table 5. Characteristics of modal unconsolidated mineral genetic materials in MRNP and GNP.

	Origin	Genetic Material Symbol[1]	Genetic Material Class[2]	Characteristics		Genetic Material Unit
				Calcareousness	Texture	
Genetic material derived from increasingly diverse bedrock lithology ↓	Bedrock	R^U	Residual	Noncalcareous	Medium to coarse	Residuum A
	Gravity	C^A	Landslide	Noncalcareous	Coarse to fragmental	Landslide material
		C	Colluvial	Noncalcareous	Coarse	Colluvium A
				Noncalcareous	Medium	Colluvium B
	Ice	M	Morainal	Noncalcareous	Coarse	Till A
				Noncalcareous	Medium	Till B
				Calcareous	Medium	Till C
		MF^G	Ice Contact Stratified	Noncalcareous	Variable	Ice Contact Stratified Drift C
	Flowing water	F^G	Glaciofluvial	Noncalcareous	Coarse	Glaciofluvial material A
		F	Fluvial	Non- to weak	Coarse-stratified	Fluvial material A
	Air	E	Eolian	Altered	Medium	Eolian material B

[1] Genetic material symbols are from C.S.S.C. (1978a) except for R^U, C^A and MF^G which are defined in this section.

[2] Modified from C.S.S.C. (1978a) as outlined in this section.

Table 6. Characteristics of Residuum A.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties	
			Fine Earth	Coarse Fragments
Residuum A	Noncalcareous, medium and medium to coarse grained, metasedimentary bedrock	Noncalcareous	20-90% sand, 0-20% clay	50-90%

to 90% angular coarse fragments of all sizes, including large boulders. At some sites, this rubbly material appears till-like. It may have been valley wall till that descended with the landslide or ice-modified material if the landslide fell onto a valley glacier. There is no strong evidence either way and the landslide age is either late glacial or early postglacial. Eolian material B (altered, medium textured) often mantles well vegetated, rubbly localities as a thin, discontinuous veneer among the larger coarse fragments. The ground surface remains very to exceedingly stony (C.S.S.C. 1978b) and a few boulders are as large as a house.

The subdominant, but distinctive, blocky localities consist of loosely packed boulders (fragments >256 mm) and stones interspersed with large voids. Little or no fine earth is present and the fragmental material supports only sparse plant cover.

The landslide surface is hummocky and reflects genesis rather than bedrock control. Slopes are 15 to 30%, highly complex, and of various lengths. Short, gully-like features, often occurring in blocky material, and small river-cut terraces with gentle slopes add to topographic complexity.

COLLUVIAL GENETIC MATERIAL

Colluvial genetic material (C) is generated either by gravity-induced slow mass movement or rapid downslope displacement of individual rock fragments. It is a subset of colluvial material as defined by C.S.S.C. (1978a). Soil creep, rockfall, and snow avalanching, with avalanche related fluvial activity including mudflows (Ryder 1978, 1981), are mainly responsible for colluvial material accumulation.

Colluvium is generally postglacial and mantles steep valley walls. Veneers are most abundant at high elevations (Alpine and Upper Subalpine) and the deposits often deepen downslope, if the slope does not steepen. Blankets and veneers are abundant at lower elevations (Interior Cedar-Hemlock and Lower Subalpine). Colluvial aprons are the deepest deposits and form the lower walls in several valleys. They are invariably associated with snow avalanching but rockfall and avalanche related fluvial activity have also occurred. Consolidated bedrock usually underlies colluvium but, at a few sites, weathering of the bedrock surface has been sufficient to produce veneers of Residuum A (noncalcareous, medium to coarse textured). This is more likely to occur in recessive, highly jointed, slaty to shistose strata. Small bedrock outcrops occur sporadically in most colluvial landscapes, except for aprons and craggy terrain. The former have no exposed bedrock while the latter are characterized by discontinuous colluvial veneers plus bedrock outcrops including large massive cliffs. Craggy terrain is most extensive in areas with resistant bedrock (Hamill Group and Shuswap Metamorphic Complex, Fig. 2) and increases in extent with increasing elevation.

Colluvial slopes are usually long, straight and 45 to >100% although slopes <55% are not extensive. Craggy terrain typically has the steepest (rarely <60%), most irregular slopes with cliff and sloping bench topography, especially on resistant bedrock. The few landscapes with complex slopes have pronounced topographic irregularity. These include tracts affected by bedrock failure (modifier F added to the Ecosite symbol), tracts that straddle ridge and mountain tops, and tracts that encompass a variety of local landforms, mapped as Ecosite symbol + T.

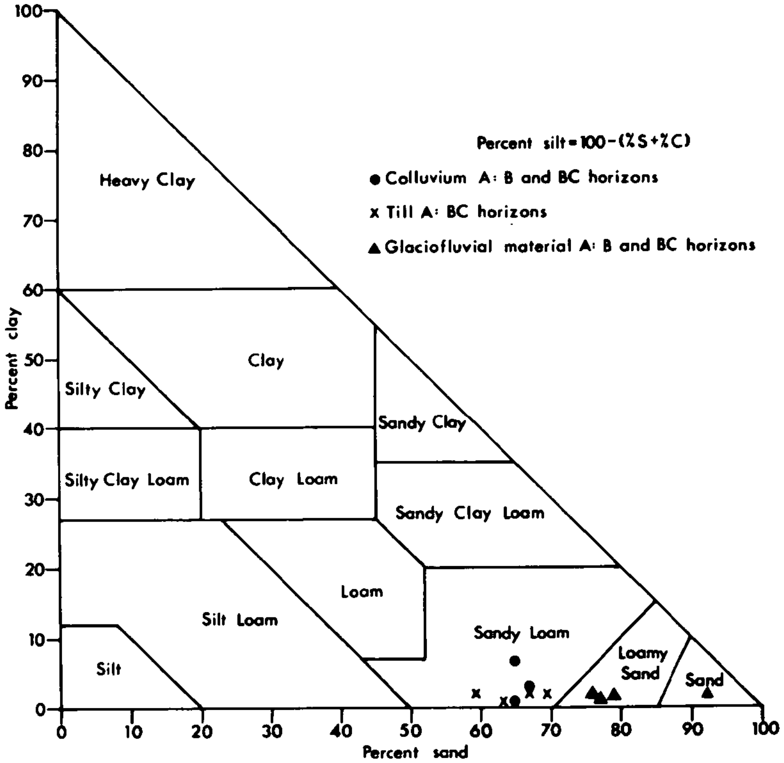
Well vegetated colluvial slopes are relatively stable and inactive, as indicated by the predominance of well developed soils. Only low intensity surficial processes such as uprooting of trees and solifluction may still be operating. Solifluncted soils are most abundant under Alpine vegetation. In contrast, sparsely vegetated and unvegetated localities, excluding most exposed bedrock and blocky, fragmental talus, are still active, being affected by both erosional and depositional processes.

Two colluvial genetic material units (Colluvium A and Colluvium B) were distinguished in MRNP and GNP primarily on textural characteristics (Table 7). Both are noncalcareous and soils developed on them usually are strongly to extremely acid (pH <5.5). Analyzed BC horizon pH values were from 4.2 to 5.1. Calcareous, medium textured colluvium (*cf.* Colluvium C, Walker *et al.* 1982a, 1984a) occurs sporadically and is weathered from limestone strata present in only a few areas.

Colluvium A

Colluvium A is coarse textured and derived from medium to coarse grained, metasedimentary (mainly quartzitic) and granitic strata of the Hamill Group, granitic intrusive and Shuswap Metamorphic Complex bedrock areas (Fig. 2). Where there is no influence from finer grained, schistose strata, the textural and coarse fragment characteristics of Colluvium A (Table 7) conform to Colluvium A of the BNP and JNP inventory (Walker *et al.* 1982a). However, such occurrences are not common in MRNP and GNP because of the lithologic variability in the bedrock. More often, schistose strata have had an influence and Colluvium A textures (Fig. 3) commonly are 60 to 70% sand and <10% clay (<5% clay in Hamill bedrock areas). Mixing also affects coarse fragment shape and volume; 35 to 70% angular and flat fragments are common, although ≤90% may occur in avalanched and craggy terrain.

Fig. 3. Textural variation among coarse textured materials.



Colluvium B

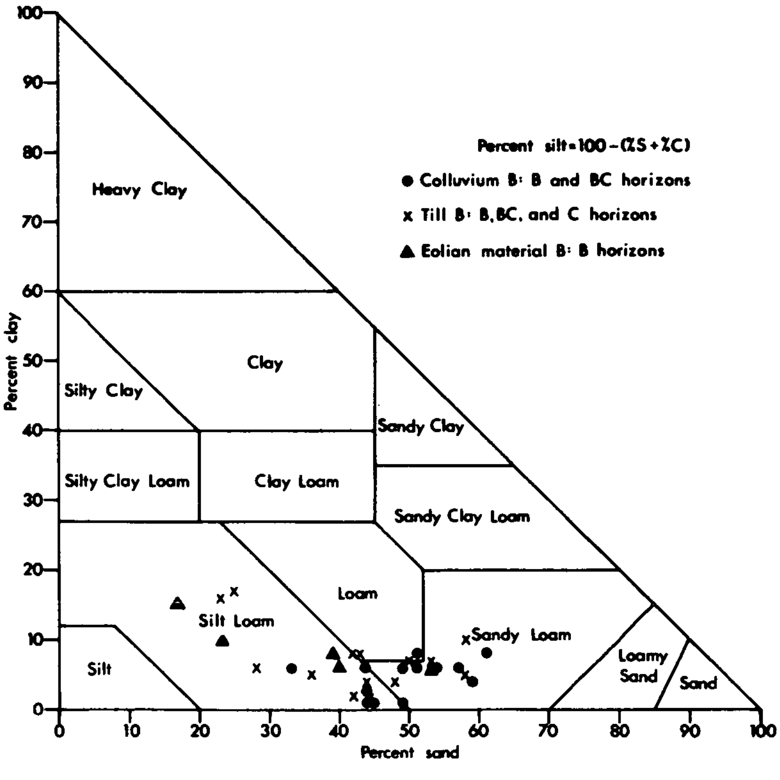
Colluvium B is medium textured and derived from medium grained, slaty and schistose strata which are common throughout both parks. The textural limits (Table 7) are similar to those of the BNP and JNP inventory (Walker *et al.* 1982a), although lower in clay content. However, low clay content is consistent in all materials in MRNP and GNP and analyzed samples contained 30-60% sand and

Table 7. Characteristics of colluvial genetic materials.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties: Fine Earth	Textural Properties: Coarse Fragments
Colluvium A	Noncalcareous, medium to coarse grained, metasedimentary and granitic bedrock	Noncalcareous	60-90% sand, 0-10% clay	50-90%
Colluvium B	Noncalcareous, medium grained, metasedimentary bedrock	Noncalcareous	20-60% sand, 0-20% clay	35-70%

<10% clay (Fig. 4). Colluvium B from the Hamill bedrock area often contains <5% clay. Coarse fragments are predominantly flat (channers, slates, flagstones, and stones), occasionally angular, and normally 35 to 70% by volume.

Fig. 4. Textural variation among medium textured materials.



MORAINAL GENETIC MATERIAL

Morainal material (till) is unsorted and unstratified drift deposited by a glacier without reworking by glacial meltwater (Gary *et al.* 1972). Till is often associated with ice contact stratified drift along the floors of major valleys. Both are glacial deposits in contrast to the proglacial glaciofluvial and glaciolacustrine materials.

Glaciation was a major factor shaping the landscapes of MRNP and GNP. Moraine (M) is extensive and frequently dominates cirque and pass floors, valley wall shoulders, and broad mountain tops. Moraine also occurs on moderately sloping valley walls and with ice contact stratified drift on benchlands of some broader valley floors.

Moraine usually occurs as blankets and veneers. On valley walls, surface form reflects inclined bedrock. Slopes are most often 45 to 65% and uncommonly up to 70%. Such long straight slopes frequently have gullies oriented perpendicular to the contour. Less often slopes of 30 to 45% occur, usually on upper and lower slopes transitional to more irregular terrain. These slopes are more characteristic of pass, cirque, and valley floors, valley shoulders, and broad mountain tops. This complex topography may be ridged and, less often, hummocky or a combination of inclined and ridged, all reflecting bedrock control. Deep, ridged and occasionally hummocky till, reflecting deposition rather than bedrock control, is virtually restricted to Neoglacial lateral and terminal moraines. Some irregular landscapes have been produced or accentuated by slope failure (modifier F) of overburden or bedrock. However, not all failed slopes have complex topography. Complex slopes are commonly 30 to 45% although tracts with 0 to 30% or 30 to 70% also occur.

Snow avalanching and solifluction also modify morainal landforms. Modification is primarily to vegetation or soils and is not sufficient to produce colluvial landforms.

Colluvial, residual, eolian, and fluvial materials occur locally or as a thin mantle in some morainal landscapes. Colluvium occurs on local, steep slopes, particularly on terrain affected by slope failure. Residual veneer underlies till at some sites and was produced by bedrock weathering. It most often occurs on gently sloping, high elevation areas with recessive, highly jointed bedrock. Discontinuous fluvial or eolian veneers often thinly mantle gently to moderately sloping, high elevation moraines. The former are associated with morainal wetlands affected by seepage, the latter occur on drier terrain. Both are important to soil formation.

The last major deglaciation in south central British Columbia was probably complete before 10,000 years ago (Fulton and Smith 1978, Ryder 1978). However, source bedrock lithology is more important to textural and chemical properites of morainal material than is glacial chronology (Wittneben 1980, Walker *et al.* 1982a). These properties were imparted by the strata and remain distinct even though the products were mixed by glaciation. The deposits are divided into three morainal genetic material units, Tills A, B, and C, on chemical and textural characteristics (Table 8).

Till A

Till A is noncalcareous, coarse textured, and derived from noncalcareous, medium to coarse grained, metasedimentary (mainly quartzitic) and granitic strata of the Hamill Group, granitic intrusive and Shuswap Metamorphic Complex bedrock areas (Fig. 2). Soils developed in Till A are normally strongly to extremely acid (pH <5.5). BC horizons range from pH 4.2 to 5.5, the latter from a Neoglacial moraine.

Where there is no contribution from finer grained schistose stata, the textural and coarse fragment characteristics of Till A (Table 8) conform to Till A of the BNP and JNP inventory (Walker *et al.* 1982a). Such occurrences are not common in MRNP and GNP because of the lithologic variability in the bedrock. More often, schistose strata have had an influence and Till A textures (Fig. 3) commonly are 60-70% sand and <5% clay. Mixing also affects coarse fragment shape and volume; 35 to 70% rounded, subrounded, and flat fragments are common.

Soils developed in Till A are distinctive in having deeply developed, acidic sola and, where conditions are favorable, thick, well developed, eluvial (Ae) horizons. They may also have pedogenically cemented B and BC horizons. The cementing ranges from patchy to continuous and weak to strong. Soils developed in Till B under comparable conditions are likewise acidic but generally have thinner sola, thinner, weaker Ae horizons, and lack pedogenic cementation unless they have high sand (near 60%) or very low clay (<5%) contents.

Table 8. Characteristics of morainal genetic materials.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties	
			Fine Earth	Coarse Fragments
Till A	Noncalcareous, medium to coarse grained, metasedimentary and granitic bedrock	Noncalcareous	60-90% sand, 0-10% clay	35-70%
Till B	Noncalcareous, medium grained, metasedimentary bedrock	Noncalcareous	20-60% sand, 0-20% clay	20-50%
Till C	Medium grained, carbonate bedrock	>15% $CaCO_3$ equivalent	20-60% sand, 0-20% clay	20-50%

Till B

Till B is noncalcareous and medium textured, being derived from noncalcareous, medium grained, slaty and schistose strata which are common throughout both parks. Soils developed in Till B are normally strongly to extremely acid (pH <5.5) although a much higher pH can occur in soils affected by seepage. The pH values of BC and C horizon samples from well drained soils were 4.3 to 5.5, whereas three samples from two poorly drained soils had pH values of 4.5, 6.1, and 6.4.

The textural limits of Till B (Table 8) are similar to those of Till B in the BNP and JNP inventory (Walker *et al.* 1982a). The main difference, low clay content (Fig. 4), is consistent with all materials in MRNP and GNP. Till B samples from the Hamill bedrock area often contained <5% clay. Coarse fragment volume is normally 20 to 50% with flat shapes predominant in Horsethief Creek and Lardeau bedrock areas. In areas where Tills A and B are codominant, rounded and subrounded fragments are also abundant and coarse fragment volume is generally 35 to 70%.

Till C

Till C is calcareous, medium textured and derived from medium grained, limestone strata present in minor amounts in a few areas of both parks. It mainly occurs with the other tills in Neoglacial moraines, mapped as Abbott 1 Ecosite (AB1) or Recent Moraine (M). These young moraines often are in proximity to the limestone strata and are only weakly weathered compared to older glacial deposits.

The texural limits of Till C (Table 8) are similar to Till C of the BNP and JNP inventory (Walker *et al.* 1982a), except for lower clay content which is typical of all materials in MRNP and GNP. Also, Neoglacial till tends to have a higher coarse fragment volume (*i.e.* 35-70%) and fragments vary considerably in size and shape.

Carbonate-bearing strata, although in only minor amounts in most source areas, contribute substantially to the chemical characteristics of nearby tills. The minimum content limit of 15% $CaCO_3$ equivalent is consistent with previous definitions of Till C (Walker *et al.* 1982a) and with the majority of calcareous tills in the Rocky Mountains. In MRNP and GNP, noncalcareous strata are far more extensive than carbonate-bearing strata and low lime (1-15% $CaCO_3$ equivalent) intergrades between Till C and the two noncalcareous tills are also common in Neoglacial moraines.

ICE CONTACT STRATIFIED GENETIC MATERIAL

Ice contact stratified drift is deposited by glacial ice with local reworking by flowing and ponded glacial meltwater. The result is extreme vertical and lateral textural variability over short distances. In essence, ice contact stratified drift is a mixture of morainal and glaciofluvial sediments individually inseparable at a scale of 1:50,000. Glaciolacustrine sediment, common in many ice contact stratified drift deposits in the Rocky Mountain national parks (Walker *et al.* 1982a, 1984a), was not found in MRNP and GNP. Ice contact stratified drift and morainal material are collectively called glacial deposits.

Ice contact stratified drift forms moraine-like landforms on benchlands and lower walls of major valleys. Hummocky and ridged surfaces, primarily depositional, are typical of benchland deposits. As benchland grades to valley wall, surface expression becomes more regular and reflects inclined bedrock. The complex slopes of hummocky and ridged topography commonly are 15 to 45% and the simple, inclined slopes are 30 to 70%. Occasionally, complex slopes of 5 to 15% occur and some ice contact stratified drift landscapes include gently sloping glaciofluvial terraces too small to map separately at the study scale of 1:50,000. The most important modifying processes are slope failure, channelling (Eroded modifer, C.S.S.C. 1978a) on benchlands, and gullying on steep slopes. Snow avalanching also modifies some tracts. All add to topographic complexity.

Thin, discontinuous, eolian veneer occasionally mantles gentle to moderately sloping ice contact stratified drift on benchlands, and is most abundant in the Revelstoke townsite area. A limited amount of hummocky to ridged landscape has poorly drained, seepy depressions in which organic and, occasionally, fluvial materials have accumulated. The organic materials are occasionally thick enough (>40 cm) to be classed as fen landforms.

Ice contact stratified drift deposits are generally downvalley from two or more source bedrock areas (Fig. 2). For example, ice contact stratified drift in the Beaver River valley was derived mainly from Horsethief Creek and Hamill Group bedrock. The deposit above Revelstoke townsite was derived from Shuswap Metamorphic Complex strata plus other rock types occurring upstream in the Columbia River valley. Deposits are lithologically complex but only one genetic material unit, Ice Contact Stratified Drift C, was recognized. Its chemical and textural characteristics (Table 9) span the constituent morainal (Tills A and B) and glaciofluvial (Glaciofluvial material A) materials. The definition is consistant with KNP (Walker *et al.* 1984a) except that weakly calcareous drift is not included. Acidic soils (usually pH <5.5) develop in the ice contact stratified drift materials in MRNP and GNP. Neoglacial moraines occasionally contain ice contact stratified drift deposits that range from noncalcareous (typical Ice Contact Stratified Drift C) to calcareous (*cf.* Ice Contact Stratified Drift B, Walker *et al.* 1982a, 1984a), including a low lime intergrade.

GLACIOFLUVIAL GENETIC MATERIAL

Glaciofluvial genetic material (F^G) is generated by flowing water in which volume and sediment load are strongly affected by melting ice. Deposition occurs where meltwater encounters a valley floor with a gentler grade. The sediment over-load is rapidly deposited, especially the coarser bed-load, producing massive bedding. Much of the silt and clay fractions either remain in suspension or are easily eroded again leaving a deposit with high coarse fragment and sand contents. Diurnal fluctuation in summer flow rate also affects aggradation. Ryder (1978) describes common glaciofluvial processes and materials in British Columbia. Recent work by Jackson *et al.* (1982) suggests that early postglacial mudflows contributed significantly to sediment loads.

Glaciofluvial material grades to fluvial material with increasing distance from the glacier as flow fluctuations and sediment load are less influenced by the melting ice or as stream flow becomes restricted by landforms. The Beaver and Illecillewaet rivers and Mountain Creek, though glacier fed and sometimes bordered by early postglacial terraces, are confined to single channels. The Illecillewaet River is a high energy stream confined within a steep-sided, narrow valley and is likely eroding rather than depositing material along most of its length. The Beaver River meanders across broad, well vegetated floodplains through much of its course and deposits silt and sand, mainly during flood stages. The recent floodplain sediments are well stratified and sorted, contain few coarse fragments, and are termed fluvial. Mountain Creek has two high energy, erosional reaches, separated by a low energy,

Table 9. Characteristics of Ice Contact Stratified Drift C.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties Fine Earth	 Coarse Fragments
Ice Contact Stratified Drift C	Noncalcareous, medium and coarse grained metasedimentary bedrock	Noncalcareous	20-100% sand, 0-20% clay	5-70%

meandering reach. In contrast, the Incomappleux River is braided over much of its course in GNP. Poorly bedded, gravelly to cobbly, coarse textured, glaciofluvial material is being deposited on the braided bottomlands.

Other situations in which it is difficult to distinguish between glaciofluvial and fluvial deposits include the north half of Stoney Creek fan with a braided stream that is rapidly aggrading. Both features are typically glaciofluvial. But the near-surface sediment consists of partially sorted, well stratified layers (coarse and medium textures with strongly contrasting coarse fragment contents) and was therefore called fluvial. Mountain Creek fan was mapped as fluvial material but probably could have been equally well considered glaciofluvial.

Early postglacial, glaciofluvial deposits form terraced landforms, mapped as Kuskanax 1 (KX1), at three locations: along the Beaver River upstream of the Beaver Pit, and at the mouth of Flat Creek in GNP, and along the Trans-Canada Highway near the West Gate in MRNP. The terraces are well developed with steep, prominent, (5 to 50 m) risers adjacent to contemporary floodplains. Slopes are 0 to 15% but terrace treads, usually with slopes <5%, make up the majority of any tract. Abandoned channels (Eroded modifier, C.S.S.C. 1978a) are poorly incised and not common.

Recent glaciofluvial deposits occur on several braided floodplains along the Incomappleux River. The largest, on SN1A, occurs between Jeopardy Slide and the GNP boundary. The surface is level, with slopes commonly <2%, and dissected by numerous channels.

Glaciofluvial Material A

Only one glaciofluvial genetic material, Glaciofluvial material A, is recognized in MRNP and GNP. It is characteristically coarse textured and noncalcareous (Table 10, Fig. 3), as originally defined in the BNP and JNP inventory (Walker *et al.* 1982a). Deposits are usually massively bedded and partially sorted. In addition to high sand content, they contain abundant coarse fragments, mainly rounded gravels, cobbles and stones. These textural features reflect high energy stream deposition. Well sorted beds with textures and coarse fragment contents beyond the specified range (Table 10) occur infrequently.

The absence of calcium carbonate reflects the overwhelming predominance of noncalcareous bedrock and other source materials in MRNP and GNP. Soils developed in the early postglacial deposits are Brunisolic and Podzolic with strongly to extremely acidic sola (pH <5.5). A weakly calcareous (<5% $CaCO_3$ equivalent) phase of Glaciofluvial material A occurs in a few localities and is most extensive in recent floodplain deposits along the Incommapleux River. Here, Regosolic soils with medium acid to neutral sola (pH >5.5) are abundant. The carbonate is derived from a few, thin, limestone beds in source areas.

FLUVIAL GENETIC MATERIAL

Fluvial (alluvial) material (F) encompasses sediments deposited primarily by nonglacial flowing water and by mudflows and debris flows, collectively called mudflows. The difference between glacial and nonglacial flow regimes and deposits is often indistinct in MRNP and GNP. Included as fluvial are deposits laid down by streams with flow regimes and sediment loads at least partially controlled by glacial melt. These deposits tend to be well stratified, sometimes well sorted, and with wide textural variability. These characteristics are common in fluvial deposits (Ryder 1978).

Table 10. Characteristics of Glaciofluvial material A.

			Textural Properties	
Genetic Material Unit	**Dominant Source**	**Calcareous-ness**	**Fine Earth**	**Coarse Fragments**
Glaciofluvial material A	Noncalcareous glacial deposits	Noncalcareous	60-100% sand, 0-5% clay	35-70%

Fluvial landforms are of two types. The first is level floodplain, with simple slopes of 0 to 2%, which contains the major streams that formed it. Weak terracing with risers <1 m occurs on some floodplains. The second type consists of fans and aprons, with simple slopes of 5 to 45%, occurring along the base of steeper slopes from which the sediments originate. Radial sections suggest a subtly concave surface with steepest slopes at the apex and the gentlest slopes at the toe. Linear slopes of many fluvial landforms are subtly broken by active and abandoned channels (Eroded modifier, C.S.S.C. 1978a), including narrow, slightly elevated ridges along the banks. Tracts with complex slopes contain both types of fluvial landform or, less often, subtly terraced floodplains.

Floodplains are constructed only by processes associated with flowing water (Thornbury 1954, Leopold *et al.* 1964, Ryder 1978), whereas fan and aprons are constructed by both flowing water and mudflows (Winder 1965, Broscoe and Thomson 1969, Ryder 1971, 1981, Roed and Wasylyk 1973, Jackson 1979, Nasmith and Mercer 1979, Rachocki 1981, Jackson *et al.* 1982, Walker *et al.* 1982a, 1984a). The importance of mudflows, also called mass flow deposits (Rachocki 1981), is generally underestimated. Construction by mudflow was probably rapid and began immediately after deglaciation, a setting termed *paraglacial* (Ryder 1971). Mudflows are often shallowly buried beneath recent stream sediments (Broscoe and Thomson 1969, Roed and Wasylyk 1973). Although the current magnitude of mass movement in fan and apron construction is comparatively insignificant (Ryder 1971, Roed and Wasylyk 1973, Jackson *et al.* 1982), modern mudflow occurrences have been recorded (Sharp and Nobles 1953, Winder 1965, Broscoe and Thomson 1969, Fulton and Halstead 1972, Russell 1972, Jackson 1979, Nasmith and Mercer 1979). Several small mudflows occurred in MRNP and GNP (*e.g.* on Connaught Creek at Rogers Pass) following exceptionally heavy rainfall in July 1983.

Flowing water deposits have textural qualities which differ from those of mudflow sediments. Stream deposits are moderately to well sorted, vertically stratified, and variable across the landscape. Both sand and coarse fragments are highly variable and textural changes may be abrupt or gradual. Sediments deposited by relatively high energy streams usually have abundant rounded to subrounded clasts. Such layers are most abundant on aprons, fans, and dry, sloping floodplains. In contrast, sediments deposited by low energy streams, like those of the wet floodplains along the Beaver River, are virtually coarse fragment free and predominantly silty, occasionally resembling fluviolacustrine material (Walker *et al.* 1982a). Subdominant sandy layers occasionally replace the silty material, and humus is often incorporated in uppermost mineral layers where sedimentation has recently diminished. Where deposition has virtually ceased, peat layers mantle the mineral soil. Fen peat accumulations to >1 m occur under sedge fen vegetation. Yet nearby localities may still receive substantial amounts of sediment. Fresh silty material up to 7 cm thick was observed in 1983 on a few Beaver River floodplain sites dominated by dense, wet shrub thicket vegetation.

Mudflow beds, in contrast to stream deposits, tend to be unsorted and more uniformly textured with little or no internal stratification because each bed was usually produced by a single flow event (Sharp and Nobles 1953, Winder 1965, Ryder 1971, Roed and Wasylyk 1973, Rachocki 1981). Coarse fragments vary in size, shape, and abundance and are usually embedded in a finer grained matrix. The largest debris is often deposited near fan and apron apexes (Sharp and Nobles 1953, Rochocki 1981). Thus, mudflows are strongly influenced by source materials (*e.g.* till and colluvium) and the deposits often resemble till (Sharp and Nobles 1953, Harland *et al.* 1966, Landim and Frakes 1968, Pe and Piper 1975, Ryder 1981).

Fluvial Material A

Only one fluvial genetic material, Fluvial material A, was recognized in MRNP and GNP and is similar to Fluvial material A in BNP and JNP. Because of its polygenetic composition and wide textural range (Table 11, Fig. 5), it is termed coarse-stratified.

Fig. 5. Textural variation among Fluvial material A samples.

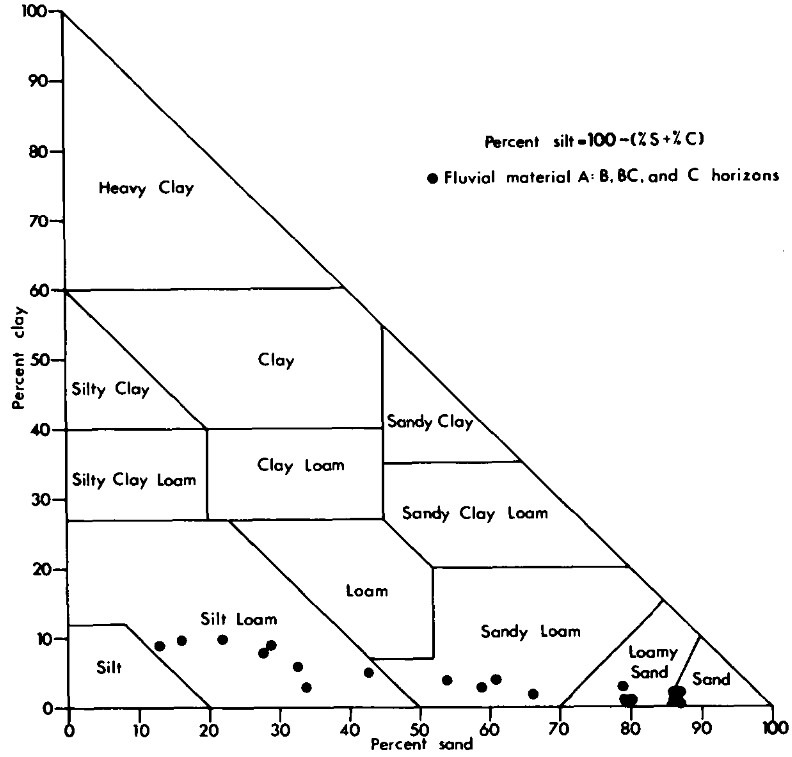


Table 11. Characteristics of Fluvial material A.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties	
			Fine Earth	Coarse Fragments
Fluvial material A	Noncalcareous, consolidated and unconsolidated deposits	<5% $CaCO_3$ equivalent	10-90% sand, 0-20% clay	0-70%

Fluvial material A is typically non- to weakly calcareous (<5% $CaCO_3$ equivalent) and reflects the overwhelming predominance of noncalcareous source materials. Small amounts of calcium carbonate often occur in unweathered recent sediments but are also present below the influence of weathering in older, stable landforms. The carbonate is derived from a few, thin, limestone beds in source areas. Soils developed in old, stable fluvial deposits are Brunisolic and Podzolic with strongly to extremely acidic sola (pH <5.5). Regosolic and Gleysolic soils with medium acid to neutral sola (pH >5.5) are characteristic of recent deposits.

EOLIAN GENETIC MATERIAL

Eolian sediment (E) is deposited by wind. Eolian deposits, also termed *loess* tend to be well sorted and rarely contain <50% silt (Fig. 4). The sand fraction is dominated by fine and very fine sand. Two eolian genetic materials occur in BNP and JNP (Walker *et al.* 1982a). However, Eolian material A (calcareous, medium textured) does not occur in MRNP and GNP.

Table 12. Characteristics of Eolian material B.

Genetic Material Unit	Dominant Source	Calcareousness	Textural Properties Fine Earth	Textural Properties Coarse Fragments
Eolian material B	Local materials and bedrock plus volcanic ash	Pedogenic alteration	0-50% sand, 0-20% clay	<5%

Eolian Material B

Eolian material B (altered, medium textured) occurs in MRNP and GNP (Table 12). It usually occurs as a thin, discontinuous veneer overlying other materials as described by Walker *et al.* (1982a) in BNP and JNP. Thus, no Ecosection or Ecosite separations were based on its occurrence. The veneers are best preserved on gentle, protected slopes in the Alpine and Upper Subalpine. It is less common on gently sloping valley benchlands, and uncommon on steep valley walls where erosion has occurred. Unusually high pH values in eolian veneers near Revelstoke townsite suggest that the calcareous floodplain along the Columbia River contributed or contributes to these veneers. Many upper sola are developed in mixtures of eolian and underlying materials. The mixing is attributed to surficial processes such as solifluction and tree throw. On most seepy sites, eolian material has been reworked by slope wash, being redeposited as a constituent of Fluvial material A.

Eolian material B usually is chemically altered because it is near the soil surface where pedogenic weathering is strongest. Weathering of the primary minerals, releasing free iron and aluminum oxides, is important to pedogenesis in the Cordillera (Pawluk and Brewer 1975, Valentine and Lavkulich 1978, Smith *et al.* 1983). Although often called volcanic ash, the eolian veneers also contain appreciable amounts of local detritus (Smith *et al.* 1981) but the proportion of each varies across the landscape. Ash and local detritus do not exist as separate strata within a veneer. Instead, Eolian material B is mineralogically uniform at any location (Smith *et al.* 1981), the constituents having been mixed by wind, tree throw, soil creep, solifluction, and other pedoturbation processes. Thus, some authors have generalized by describing the thin surface layers as eolian material (Knapik and Coen 1974), loess (Wittneben 1980), eolian fines (Ryder 1981), or silty surficial deposit (Smith *et al.* 1981).

Volcanic ash is a common constituent of many surficial and buried eolian deposits throughout southeastern British Columbia and southwestern Alberta (Westgate and Dreimanis 1967, Beke and Pawluk 1971, Ryder 1971, Pettapiece and Pawluk 1972, Sneddon *et al.* 1972b, Knapik *et al.* 1973, Roed and Wasylyk 1973, Pawluk and Brewer 1975, King and Brewster 1976, Valentine and Lavkulich 1978, Wittneben 1980, Smith *et al.* 1981, Jackson *et al.* 1982). The ash component has been traced to three major postglacial ashfalls (Powers and Wilcox 1964, Nasmith *et al.* 1967, Westgate and Dreimanis 1967, Harward and Youngberg 1969, Westgate *et al.* 1969, Westgate 1977): Mazama (6600 years B.P.), St. Helens Y (ca. 3200 years B.P.), and Bridge River (ca. 2400 years B.P.).

ORGANIC, CONSOLIDATED, AND ICE COMPONENTS

Of the four genetic material landform classification components (C.S.S.C. 1978a) Organic, Consolidated and Ice are dealt with under one heading. Variations within each of these three classes are not considered of sufficient importance, for the purpose of this inventory, to warrant their division into subclasses. The Organic component, while small in area, is a significant portion of several Ecosites. The Consolidated component is identified as *Rockland* or as an attribute of many Ecosites. The Ice component is identified as *Glacier* and is not included as an integral part of Ecosite concepts.

ORGANIC COMPONENT

The organic landform component (N) consists of peat with >30% organic matter by weight (>17% organic carbon) that may be as thin as 10 cm over bedrock but is otherwise >40 cm thick (C.S.S.C. 1978a). In MRNP and GNP, it is of very limited areal extent and thinly mantles fluvial and, less often, glacial landforms where ground water discharge and high water tables create very poor drainage and where mineral deposition has ceased. While peat depths >1 m were recorded, maximum thicknesses were not ascertained. Based on experience in the Rocky Mountains (Walker *et al.* 1982a, 1984a), modal peat depth is estimated at <1.2 m.

Organic landforms, mainly horizontal fen with slopes <2%, consist primarily of poorly decomposed, fibric, fen peat (C.S.S.C. 1978a) derived from sedges and brown mosses. In a few localities, sedge fen has succeeded to open forest. Moderately decomposed, mesic material and buried wood fragments occur occasionally. Well decomposed humic peat is rare although one Organic soil dominated by humic layers was found at Rogers Pass. Peat layers are occasionally separated by thin mineral layers indicative of episodic deposition, likely during major floods.

Fens of varying size occur mostly in CT6, GF1, and GF2 where they form subdominant to minor parts of the landscape. No Ecosections are dominated by Organic landforms.

CONSOLIDATED COMPONENT (BEDROCK)

The consolidated component (bedrock) consists of lithified materials, excluding materials indurated by pedogenic processes, that are harder than 3 on Mohs' hardness scale. Bedrock underlies all other materials and may outcrop in any area, but does so most extensively at high elevations. Massive, resistant bedrock is more prominent in the landscape than recessive bedrock.

Bedrock is the source of all unconsolidated mineral material in MRNP and GNP, except the volcanic component of Eolian material B. For purposes of this ecological land classification, four major bedrock groups (Fig. 2) are important. Although these groups strongly influence the immediate landscape, especially where unsorted sediments are derived from them, only one class of bedrock landform is established because it lacks soil and vegetation. The Miscellaneous Landscape Rockland (R) is mapped with bedrock as the principal landform.

ICE COMPONENT

The ice component forms by the compaction and recrystallization of snow that remains year-round. In MRNP and GNP, it includes glaciers, icefields, glacierettes, and firn. It occurs mainly in the Upper Subalpine and Alpine and is most extensive in the Hamill and Shuswap Metamorphic Complex bedrock areas (Fig. 2). Ice is absent in the Interior Cedar-Hemlock Ecoregion. In some localities, ice is mantled by colluvial, morainal, and landslide debris from adjacent slopes. The ice component is identified by the Miscellaneous Landscape Glacier (GL).

The Miscellaneous Landscape Rock Glacier (RG) is a mixture of ice and unconsolidated mineral components. A rock glacier is a mass of poorly sorted, angular coarse fragments and fine earth material cemented by interstitial ice a meter or so below the surface (Gary *et al.* 1972). Most RG occurs in areas of Horsethief Creek Group bedrock.

CHAPTER II - SOILS

W.S. Taylor, B.D. Walker and D.T. Allan

INTRODUCTION

Soil formation is a function of five environmental factors: climate, living organisms, topography, parent material, and time (Buol *et al.* 1973). Because these factors vary across the landscape, soil forms a continuum with varying properties. The intent of soil classification is to organize soil variability in a meaningful way. Ideally, each category is defined by criteria which are observable or measurable in the soil profile. Each classification system has certain objectives and the established criteria reflect the knowledge of the soils being classified (C.S.S.C. 1978a). The Canadian system (C.S.S.C. 1978a) was used in MRNP and GNP. The taxa are based more on properties thought to reflect genesis than on interpretations of properties for various uses.

Soil taxa are convenient in ecological land classification because they summarize information on both the properties and environment of the pedons. Taxa also facilitate the description of map units, although mapping necessitates a different type of generalization than taxonomy. Map units are designed to group landscape and soil patterns. These map units are described in terms of taxa. Thus a map unit represents a predictable spatial pattern of soil taxa which are related along pedogenic gradients, *e.g.* soils along a seepage slope may be in different taxa but are related along wetness, stability, organic matter, and geomorphic gradients. Thus, the limits of a map unit concept are broader than those of a soil taxon. The degree of generalization depends on soil complexity and predictability, and on mapping scale.

Much of the information available on soils near MRNP and GNP is about their distribution. Wittneben (1980) mapped soils of the Columbia Mountains in the Lardeau NTS area to the south, and Kowall (1980) surveyed the Seymour Arm sheet which includes the western portion of MRNP, both at 1:100,000 scale. Knapik and Coen (1974) conducted a detailed survey (1:6,000) of the Mount Revelstoke summit area.

Sneddon *et al.* (1972a, 1972b) investigated the genesis of several soils in the Alpine in British Columbia. McKeague and Sprout (1975) studied profiles with cemented subsoils, including some from the Columbia forest and Interior subalpine of British Columbia.

METHODS OF SOIL DESCRIPTION AND ANALYSIS

FIELD DESCRIPTION METHODS

Soil and site data, including geomorphic information, were collected as part of this multidisciplinary, ecological land inventory. Field crews, usually consisting of soils, vegetation, and wildlife specialists, collected data at each site. Pedon and site data as suggested by Day *et al.* (1975) were recorded on Canadian Soil Information System (CanSIS) computer coding forms (Dumanski *et al.* 1975, C.S.S.C. 1978b) developed from the CanSIS Detail Form (Field Description Input Document). Thirty-seven pedons representing various soils, Ecosites, and Ecosections were described in detail on the CanSIS Detail Form and analyzed in the laboratory.

LABORATORY METHODS

Chemical and physical analyses were done following air drying and grinding according to the routine procedures used by the Alberta Institute of Pedology (C.S.S.C. 1978c). Results were entered on a CanSIS Detail Form (Methods and Analytical Data) for each pedon. The routine procedures involved determination of:

Soil Reaction: with a pH meter using a 2:1 ratio of 0.01 m $CaCl_2$ solution to soil (Peech 1965)[3.11].[1]

Calcium Carbonate Equivalent: by the inorganic carbon manometric method of Bascombe (1961).

Organic Carbon: by difference between total carbon and inorganic carbon. Total carbon was determined by dry combustion using an induction furnace (Allison *et al.* 1965) with a gasometric detection of evolved CO_2 (Leco model CR12) [3.611].

Cation Exchange Capacity: by displacement of ammonium with sodium chloride (Chapman 1965) except that an ammonium ion electrode was used to detect the displaced ammonium ion [3.321]

Exchangeable Cations: by extraction with neutral N NH_4OAC (A.O.A.C 1955) and K, Mg, Na, and Ca determined by inductively-coupled plasma spectroscopy [3.321].

Sodium Pyrophosphate Extractable Iron, Aluminum, and Manganese: by the McKeague (1967) method. Fe, Al, and Mn were determined by inductively-coupled plasma spectroscopy [3.53]. Several C.S.S.C. reference samples were included in the analyses to check data quality. Results for them were the same to slightly lower than the tentative best values but always within the range of values (McKeague *et al.* 1978).

Particle Size Distribution: by the pipette method of Kilmer and Alexander (1949) as modified by Toogood and Peters (1953), except that carbonates were not removed prior to dispersion. Separation of sand fractions, by ultrasonic sieving, and coarse fragments, by dry sieving with 3/4 inch and No.4 sieves, was done on some samples to facilitate engineering classification.

Liquid Limit, Plastic Limit, and Plasticity Index: by the ASTM (1970) method [2.61, 2.62, 2.63].

One-third and Fifteen Bar Moisture: by the pressure plate method (U.S. Salinity Laboratory Staff 1954) [2.431].

Bulk Density: by the soil clod method using Saran (C.S.S.C. 1978c) Samples were oven dried and weighed. Calculations were based on oven dry volume. Values reported are the arithmetic mean of 2 to 4 determinations per horizon [2.21].

SOILS AND THEIR DISTRIBUTION

Five of the nine orders in the Canadian soil classification system (C.S.S.C. 1978a) occur in MRNP and GNP, *i.e.* the Brunisolic, Gleysolic, Organic, Podzolic and Regosolic Orders. Numerous great groups, subgroups, and phases within these categories are present. Soil distribution complexity often parallels increases in bedrock complexity, wetness, or geomorphic instability. A more subtle increase in diversity occurs with increasing elevation.

WELL DEVELOPED, WELL DRAINED SOILS

Most soil parent materials in MRNP and GNP are medium or coarse textured and noncalcareous. That, combined with the moist climate and predominance of coniferous forest at low elevations and heath vegetation at high elevations, makes Podzolics and strongly developed Brunisolics most common.

PODZOLIC SOILS

Podzolics are the most strongly developed of the well drained soils. Their salient feature is a thick ($\geq$10 cm) podzolic B horizon in which amorphous material, mainly humified organic matter with Fe

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[1] The number in [ ] indicates the method in C.S.S.C. (1978c).

and Al, has accumulated. Two of the three Podzolic great groups are well to moderately well drained and occur in MRNP and GNP. Humo-Ferric Podzols have podzolic Bf horizons (generally ≥0.6% pyrophosphate-extractable Fe + Al and ≤5% organic carbon) while Ferro-Humic Podzols have podzolic Bhf horizons (generally, Fe + Al as for Bf but >5% organic carbon). It is often difficult to distinguish the two great groups without laboratory data.

Humo-Ferric Podzols are the most extensive of the two great groups, occurring with codominant or dominant Dystric Brunisols under forest vegetation, with codominant Dystric and Sombric Brunisols and, less often, Humic Regosols, under avalanche vegetation, and with codominant Dystric and Sombric Brunisols under Alpine and Upper Subalpine vegetation. Well drained areas with few or no Podzolic soils are recent landscapes with incipient soils; landslides with rubbly, coarse textured and fragmental soils; Alpine colluvium derived from Lardeau Group rocks; and at low elevations in the Interior Cedar-Hemlock Ecoregion on southwesterly aspects above Revelstoke townsite and on the east wall of the Beaver River valley. The latter areas are the warmest and driest in MRNP and GNP, based on vegetational features. This mesoclimate coupled with certain parent material features — recent eolian veneers in the Revelstoke area and colluvium or till derived from Horsethief Creek Group strata in the Beaver River area — are less conducive to podzolization than elsewhere in the parks.

Orthic Humo-Ferric Podzols, the predominant subgroup, generally have friable or very friable podzolic B horizons underlain by thick, weak BC horizons that are transitional to noncalcareous C horizons which begin at depths often >1 m. Sometimes, Bm horizons occur between Bf and BC horizons. Thin (<10 cm) Bhf horizons may occur above or below Bm and/or Bf horizons. Lower sola are strongly to extremely acidic (pH <5.5). Profiles are usually deeper and more strongly developed on coarse textured, predominantly quartzitic materials than on medium textured materials dominated by sheet silicate mineralogy.

Features of the A horizons of Orthic Humo-Ferric Podzols are variable. Where pedoturbation precludes or alters development, A horizons may be absent or replaced by AB mixtures. Eluvial (Ae) horizons, are common in forested, stable landscapes and range from thin and incipient to thick (occasionally approaching 1 m) and well developed. Humus incorporation into surface mineral horizons is common under avalanche vegetation at all elevations and under herb meadow, herb and heath tundra at high elevations. The resulting organo-mineral Ah (or weakly eluviated Ahe) horizons may be 2 to ≥20 cm thick. Thus, Orthic Humo-Ferric Podzols (Ah <10 cm thick) and codominant to accessory Sombric Humo-Ferric Podzols (Ah >10 cm thick) occur in these environments. Those soils that have thick (≥10 cm) Ah horizons, likely had the horizon thickened physically by pedoturbation.

Orthic Ferro-Humic Podzols are related to the above subgroups. They occur, as codominants or accessory soils, in Alpine and Upper Subalpine landscapes under tundra and meadow vegetation and in avalanched terrain. Bhf horizons of varying thickness frequently develop under Ah and Ahe horizons and often have higher cation exchange capacity (CEC) than horizons above or below. Occasionally, a thick Ah horizon (Sombric Ferro-Humic Podzols) may occur. In some landscapes however, differentiating Ah from Bhf is difficult. Under forest, Orthic Ferro-Humic Podzols occur most often as accessory soils where soils are shallow to bedrock. Illuvial humus appears to accumulate above the bedrock contact, occasionally in sufficient amounts to be classed as a Bhf horizon. In a few shallow soils, discontinuous layers of black humus (H horizon) ≤2 cm thick lie on the bedrock surface.

Pedogenic cementing occurs in several strongly developed Podzolic and Brunisolic soils, particularly those developed in coarse textured, predominantly quartzitic till derived from Hamill Group and Shuswap Metamorphic Complex rocks. Two types of cementing occur in B and C horizons although a few unusual soils with cemented Ae horizons were found. The first, *duric tendency*, occurs in lower B and BC horizons. Though sometimes continuous, it is more often patchy. Even if continuous, the affected horizons are usually weakly to moderately cemented, which is insufficient to warrant a Duric subgroup designation (C.S.S.C. 1978a). The second is also continuous to patchy but occurs in upper and middle podzolic B horizons, usually Bf. If strongly cemented and ≥3 cm thick, the horizon is *ortstein*, labelled Bfc (occasionally Bhfc) and the soil is an Ortstein Humo-Ferric Podzol (occasionally Ortstein Ferro-Humic Podzol). Ortstein Humo-Ferric Podzols are codominant in Lower Subalpine morainal landforms derived from Hamill Group bedrock. They are subdominant on the same material in the Interior Cedar-Hemlock and on morainal landforms in the Interior Cedar-Hemlock and Lower Subalpine of MRNP (Shuswap Metamorphic Complex). In the Upper Subalpine on the same materials, Ortstein Humo-Ferric Podzols are less common, occurring as accessory soils. Cemented soils occur sporadically on stable fluvial landforms and are rare in colluvial landscapes.

BRUNISOLIC SOILS

Brunisolics occur with and are related to Podzolic soils but are more weakly developed. In MRNP and GNP, Brunisolics are predominantly acidic and characterized by thick, brownish or yellower, Bm horizons. They may also contain thin (<10 cm) Bf or Bhf horizons. Differentiating Brunisols from Podzols on field characteristics alone is often difficult. Dystric Brunisol (acidic with thin or no Ah horizon) is the most extensive great group and is the dominant or codominant soil under forest vegetation. Dystric Brunisols, Sombric Brunisols, Podzolics, and, occasionally, Regosolics are codominant under avalanche, herb meadow, and herb and heath tundra vegetation. Eutric Brunisols, with pH ≥5.5 in upper to middle sola, are common in only a few landscapes and are discussed below with other incipient soils.

Except for amounts and thickness of amorphous material accumulated in B horizons, Dystric and Sombric Brunisols are similar to Podzolics. BC horizons underlie Bm horizons and are transitional to noncalcareous C horizons which begin at depths often >1 m. As in the Podzolics, features of A horizons vary and determine Brunisolic subgroup and great group classes. Orthic Dystric Brunisols can have no A horizon or AB horizon mixtures where pedoturbation has affected the soil surface; thin, incipient eluvial (Ae) horizons; or thin, (<10 cm) Ah or weakly eluviated Ahe horizons. Orthic Sombric Brunisols, with mechanically thickened Ah horizons >10 cm thick, are closely related to Orthic Dystric Brunisols. Brunisolics with organo-mineral horizons commonly occur under avalanche vegetation at all elevations and under tundra and meadow vegetation at high elevation. In contrast, Eluviated Dystric Brunisols have thick (>2 cm), well developed eluvial (Ae) horizons and are most extensive under forest vegetation.

As with Podzolics, Dystric Brunisols may have pedogenically cemented B and BC horizons. Cementing is usually too weak for the Duric subgroup and ortstein does not apply to Bm horizons or Brunisolics (C.S.S.C. 1978a).

Some well to moderately well drained Dystric and Sombric Brunisols illustrate a common taxonomic problem among similar soils of the Canadian Cordillera. They have upper B horizons with sufficient organic carbon and pyrophosphate-extractable Fe low enough to meet the chemical criteria of a Bh horizon (C.S.S.C. 1978a). However, since color values and chroma are too high for Bh horizons they are designated as Bm horizons.

WEAKLY DEVELOPED, WELL DRAINED SOILS

Well drained soils at an early stage of development (*i.e.* some Regosolics, Brunisolics) are not extensive in MRNP and GNP. They are predominant in two Ecosections and occur sporadically elsewhere on unstable terrain. Regosolic soils normally lack pedogenic horizonation, but have thin, discontinuous organic horizons (LF), either at the surface only (Orthic Regosols), or at the surface and at depth (Cumulic Regosols). Pedogenic Ah horizons may be present, but are rare. Brunisolic soils usually have slight development of B horizons, shown by slightly browner colors (Orthic Eutric Brunisols) and a lower pH (Orthic Dystric Brunisols) both compared to parent materials.

Some Regosolic soils reflect episodic terrain instability. Orthic Regosols and Cumulic Regosols occur on fluvial and glaciofluvial landforms where flooding, channel migration or mudflow are sufficiently frequent that surfaces are buried or eroded before profiles can develop. The lime in some locations also retards weathering.

Cumulic Regosols occur on steep, snow avalanched colluvium in conjunction with Cumulic Humic Regosols (≥10 cm Ah, and buried organic matter) produced by mechanical mixing on geomorphically very active sites. Small areas of Regosolics occur on colluvium where weathering is retarded by lime in the profiles (*e.g.* parts of Jeopardy Slide, GNP). Orthic Regosols usually reflect surface erosion, and are rare.

In the Alpine, some soils on colluvium derived from Lardeau Group bedrock are classified as Orthic Regosols because horizonation was indiscernible. The inherently dark parent materials (Munsell N2 to N4) mask horizonation if it is present, and the extent of colluviation and solifluction make it likely that Regosolics are present. However, since most of the soils have acidic pHs, they could possibly be Brunisolic instead.

Some stable landscapes have weakly developed soils. Recently glaciated areas have predominantly Orthic Regosols where the till contains lime. These soils may have incipient Ah horizons and show weathering of some carbonates, especially in peripheral areas which have been ice-free longest.

Recently glaciated areas with noncalcareous till have a mosaic of Regosolic and Brunisolic soils. Neoglacial landscapes in MRNP and GNP are likely a maximum of 400 years old, based on an extrapolation of Heusser's (1956) conclusions on the Rocky Mountains. This provides an estimate of the time over which these soils have developed. Orthic Regosols with little evidence of alteration occur closest to the retreating glacier. Further away, Orthic Eutric Brunisols show weak B horizon development and a strong pH gradient within the top few tens of centimeters. They are slightly acid at depth (pH 6.1-6.5) and become strongly acid near the surface (pH 5.1-5.5). Where quartzites are predominant, there is little buffering capacity and pH rapidly becomes <5.5 (Orthic Dystric Brunisol) beyond depths of 25 cm.

WETLAND SOILS

Of the soil orders that occur in MRNP and GNP, all five have gleyed subgroups associated with wetlands, where soils are wet for a significant part of the growing season, *i.e.* drainage classes 5, 6, and 7 (C.S.S.C. 1978b). Though there is abundant rainfall, very few soils have sufficiently fine textures to impede internal drainage. Pedogenically cemented horizons may occasionally cause perched water tables. But most often, saturation occurs either from seepage and groundwater discharge on slopes, or flooding and high water tables in valley bottoms along streams.

Just as poor drainage influences vegetation, it is usually reflected in soil features. Many pedogenic processes in wetlands are related to reducing conditions caused by prolonged saturation which result in a lack of oxygen. Gleization is indicated by mottling or dull colors, and organic-rich layers which may accumulate, either at the surface or at depth. Wetlands are also often susceptible to surface modifications that influence soil genesis. Solifluction may produce turbic phases, and deposition of fluvial or slope wash material creates parent material disconformities.

Organic soils reflect the most prolonged wet conditions. Profiles are predominantly peat to depths >40 cm, and develop where shallow water that lacks mineral sediment is ponded or flows slowly across the surface for most of the growing season. They are most common in the Interior Cedar--Hemlock Ecoregion, but only because the flat, wet topography conducive to their development is scarce at higher elevations. They are most extensive on flat valley bottomland (*e.g.* Beaver River and Mountain Creek valleys) but occur locally in the troughs and depressions of hummocky glacial drift on valley floors. In both settings, development is occasionally associated with beaver dams.

The organic material is fen peat derived mainly from rushes, sedges, and mosses. The peat is mostly fibric (*i.e.* weakly decomposed), especially in the upper horizons, and Fibrisols predominate. Mesic, moderately decomposed horizons are common but Mesisols are less extensive. Humic, thoroughly decomposed horizons and Humisols are rare.

The mean thickness of peat accumulation is not well known. The Terric subgroup (thickness <1.2 m) was called modal in the Ecosite accounts, based on field observation and experience in the Rocky Mountains. However, extensive peat >1.2 m thick (Typic subgroups) may occur on the Beaver River and Mountain Creek valley floors.

Thin layers of fluvial and occasionally eolian material occur sporadically within the Organic soils. They usually have a high silt content and lack coarse fragments. Both they and the mineral materials that underlie the Organic soils are generally gleyed.

Gleysols are mineral soils with dull colors or strong mottling within 50 cm of the surface. They occur with Organics, but have a broader distribution as well. Many are as wet as Organics and some even have fen vegetation, but episodes of fluvial deposition in these preclude the buildup of thick organic layers and the development of pedogenic horizons (Rego Gleysols). Orthic Gleysols occur in both fluvial and morainal, stable landscapes. They have B horizons with dull colors or mottles (Bg), and peat or forest humus <40 cm thick at the surface.

Gleysolics are most common on flat to gently sloping topography, but also occur on steeper grades where seepage emerges on lower valley walls. They are least common in the Alpine, but only because of little suitable topography.

Gleyed Cumulic Regosols are similar to Rego Gleysols but show less evidence of reducing conditions in the upper 50 cm, *i.e.* faint mottling or little dulling of matrix colors. They are imperfectly to poorly drained, but surfaces can be quite dry at times during the growing season. Gleyed Cumulic Regosols develop on fluvial landscapes where surface organic materials which have built up for several years are rapidly buried by floods that recur infrequently. They occur on lower slopes of fans and on floodplains on transitional positions between the Gleysolics and better drained Regosolics. This limits their distribution mainly to the Interior Cedar-Hemlock Ecoregion because topography makes fluvial landforms most extensive there.

Podzolic soils occur on stable wetlands in association with the Orthic Gleysols. B horizons in these imperfectly to very poorly drained areas often have greater enrichment with humus, iron and aluminum than in adjacent uplands. Gleyed Ferro-Humic Podzols are usually similar in appearance to Orthic Gleysols, but analyses reveal $\geq$10 cm of Bhf (generally $\geq$0.6% pyrophosphate-extractable Fe + Al and $\geq$5% organic carbon). Orthic Humic Podzols have $\geq$10 cm of dark colored Bh horizon (generally, $>$1% organic carbon and $<$0.3% pyrophosphate extractable Fe) and occur sporadically. Bhf and Bh horizons usually occur in a fluvial or slope wash veneer that contains reworked eolian material and overlies till. Rapid decomposition and eluviation of surface organic material likely contributes to the genesis of these soils.

Gleyed Dystric Brunisols, Gleyed Eluviated Dystric Brunisols, and Gleyed Humo-Ferric Podzols are similar in morphology to the Orthic subgroups except the imperfect drainage is reflected by mottling, mostly at depths $>$50 cm. On till, they fringe wet depressions and troughs in benchland or occur with seepage at the base of slopes. They can be extensive on gently sloping morainal topography. They also occur on stable fluvial landscapes with seasonally high water tables, either on floodplains or on the lower margins of fans.

EXCEPTIONAL SOILS

Some mineral soils in MRNP and GNP consist almost exclusively of a few thick eluvial (Ae) horizons that extend the entire depth of the control section. They are not classifiable in a meaningful way by the Canadian system (C.S.S.C. 1978a).

These strongly eluviated soils occur on coarse textured parent materials that are almost purely quartzitic, and thus are restricted to association with portions of the Hamill Group bedrock. They occur in two distinct settings, *i.e.* within landslide materal on valley floors and in colluvial veneers on steep valley walls.

In landslide material, the soils occur on hummocky surfaces under closed to open forest with a nearly continuous moss and bryophyte cover. The drift has a till-like aspect but is loose, coarse, and has subangular and angular fragments. Eolian material is usually incorporated into the mineral surface. Typical profile features include several cm of decomposing organic matter (LFH) that is being eluviated, staining the upper mineral horizon a faint gray. Within the eluvial mineral horizons, silty cappings have accumulated above coarse fragments, while small rusty patches stain the underside. The pH is extremely acidic ($<$4.5) throughout. The outstanding aspect is that the eluvial horizons extend beyond the normal 2 m control section depth (C.S.S.C. 1978a). A profile of this type was described in detail and sampled (Table D15). Though they may occur elsewhere, these deep profiles were encountered only on the landslide near Glacier House in GNP.

When completely eluviated soils occur on steep colluvial slopes, the colluvium is usually a veneer. Bedrock terminates the control section usually at $<$1 m depth, and eluviated materials are leached away along the bedrock surface. Vegetation is most often avalanched, but is occasionally forest. Materials are loose, coarse, and angular, and eolian material is seldom present. Profiles typically include a few cm of litter and decomposing organic material (LF). The upper Ae horizon is occasionally stained light gray, but more often the entire mineral portion of the profile is bleached. Extremely acidic pHs ($<$4.5) predominate. Occasionally, a few cm of illuvial humus or iron and aluminum have accumulated at the bedrock surface, but in layers too thin to meet the Brunisolic or Podzolic classification criteria. These lithic soils occur sporadically within the belt of Hamill Group bedrock in GNP (Fig. 2) and, less commonly, in the Hamill portions of the Shuswap Metamorphic Complex in MRNP.

Because these eluviated soils are intimately associated with Brunisolics and Podzolics, it appears the critical factor for their genesis is an initially low content of weatherable primary minerals in the parent material.

CHAPTER III - VEGETATION

P.L. Achuff and H.A. Dudynsky

INTRODUCTION AND METHODS

FIELD SAMPLING

Since the prime objective of the vegetation study was to provide a vegetation classification for integration into the ecological land classification, the methods were subject to the constraints of the 1:50,000 mapping program. Polygons of homogeneous composition were initially outlined on air photos. Single sample plots (relevés) were then established in homogeneous areas representative of the predominant vegetation of selected polygons. Plots were generally 20 x 20 m in forested vegetation, 15 x 15 m in shrubby vegetation and 10 x 10 m in herbaceous and dwarf shrub vegetation. Smaller plots (5 x 5 m or 1 x 1 m) were sometimes necessary to keep plot boundaries within a homogeneous area, as in some intricately patterned Alpine areas.

Within each plot, canopy cover (Daubenmire 1959) was estimated to the nearest percent both for individual species and for each layer. Plants with <1% cover were considered to have 0.5% cover. Epiphyte cover was not estimated; species were merely noted as being present. Five layers were recognized:

1. Tree layer: woody plants >5 m tall
2. Tall Shrub layer: woody plants 2 to 5 m tall
3. Low Shrub layer: woody plants 0.5 to 2 m tall
4. Herb-Dwarf Shrub layer: woody plants <0.5 m and all herbs regardless of height
5. Bryoid layer: terrestrial lichens and bryophytes.

Cover was also estimated for ground litter, rocks and stones, bare mineral soil, deadfall and water. In forested plots, one of the largest trees was measured for height and diameter at breast height (dbh) and cored to determine its age. Average tree canopy height and the mean and range of dbh were also estimated.

Physical environmental factors noted include: elevation, slope, aspect, topographic position, relief shape, landform, soil subgroup and drainage class. Each plot was also rated on a moisture regime scale (Table 13).

Voucher collections are deposited in the herbaria of: Northern Forest Research Centre (CAFB), University of Alberta (ALTA), Agriculture Canada (DAO) and the National Museum of Canada (CAN). Nomenclature for vascular plants follows primarily (Packer 1983) and Hitchcock and Cronquist (1973), for hepatics Stotler and Crandall-Stotler (1977), for mosses Crum *et al.* (1973) and for lichens Hale and Culberson (1970) and Hawksworth *et al.* (1980).

VEGETATION CLASSIFICATION

The vegetation was classified initially into five physiognomic (structural) classes: Closed Forest (C), Open Forest (O), Shrub (S), Low Shrub-Herb (L) and Herb-Dwarf Shrub (H). In Closed Forest, the distance between tree crowns is no more than twice the mean crown diameter. This generally corresponds to a lower tree cover limit of 15 to 20%. In Open Forests, the distance between crowns is 2X to 5X mean crown diameter and tree cover is generally between 5% and 15 to 20%. Vegetation with <5% tree cover was not considered forested.

Within these physiognomic classes, the classification was based primarily on the dominant species in each layer (Whittaker 1973a) and on characteristic combinations of species. Dominance or importance was based on cover values and thus, the classification has a quantitative basis. The plots were grouped on the basis of shared characteristics into abstract units called **vegetation types** (v.t.s). V.t.s are viewed as *noda* (Poore 1962) along a vegetational gradient or *coenocline* (Whittaker 1967). The v.t. is of the same order of magnitude as the *association* of the Zurich-Montpellier approach (Westhoff and van der Maarel 1973) or the *biogeocoenose* of Sukachev (Sukachev and Dylis 1964),

Table 13. Ecological moisture regime classes (Walmsley *et al.* 1980). AWSC=available water storage capacity.

Moisture Regime Class	Soil Drainage
xeric - very dry, little precipitation or high evapotranspiration, very low AWSC	very rapid
subxeric - dry, low AWSC	rapid
mesic - moist, intermediate to high AWSC	well to moderately well
subhygric - moist to wet, variable AWSC, seasonal seepage	imperfect
hygric - wet, variable AWSC, permanent seepage	poor
subhydric - wet, variable AWSC, excess water most of the time	very poor
hydric - very wet, standing water constantly	——

although the bases and methods of recognition differ. V.t.s were delineated by tabular comparison (Mueller-Dombois and Ellenberg 1974) and by both indirect ordination (Wisconsin ordination, Cottam *et al.* 1974) and direct ordination (direct gradient analysis, Whittaker 1973b). Both seral and climax v.t.s were recognized. In v.t. names, a hyphen (-) separates species in the same layer; a virgule (/) separates layers. Appendix E lists the v.t.s of MRNP and GNP.

ECOREGIONS

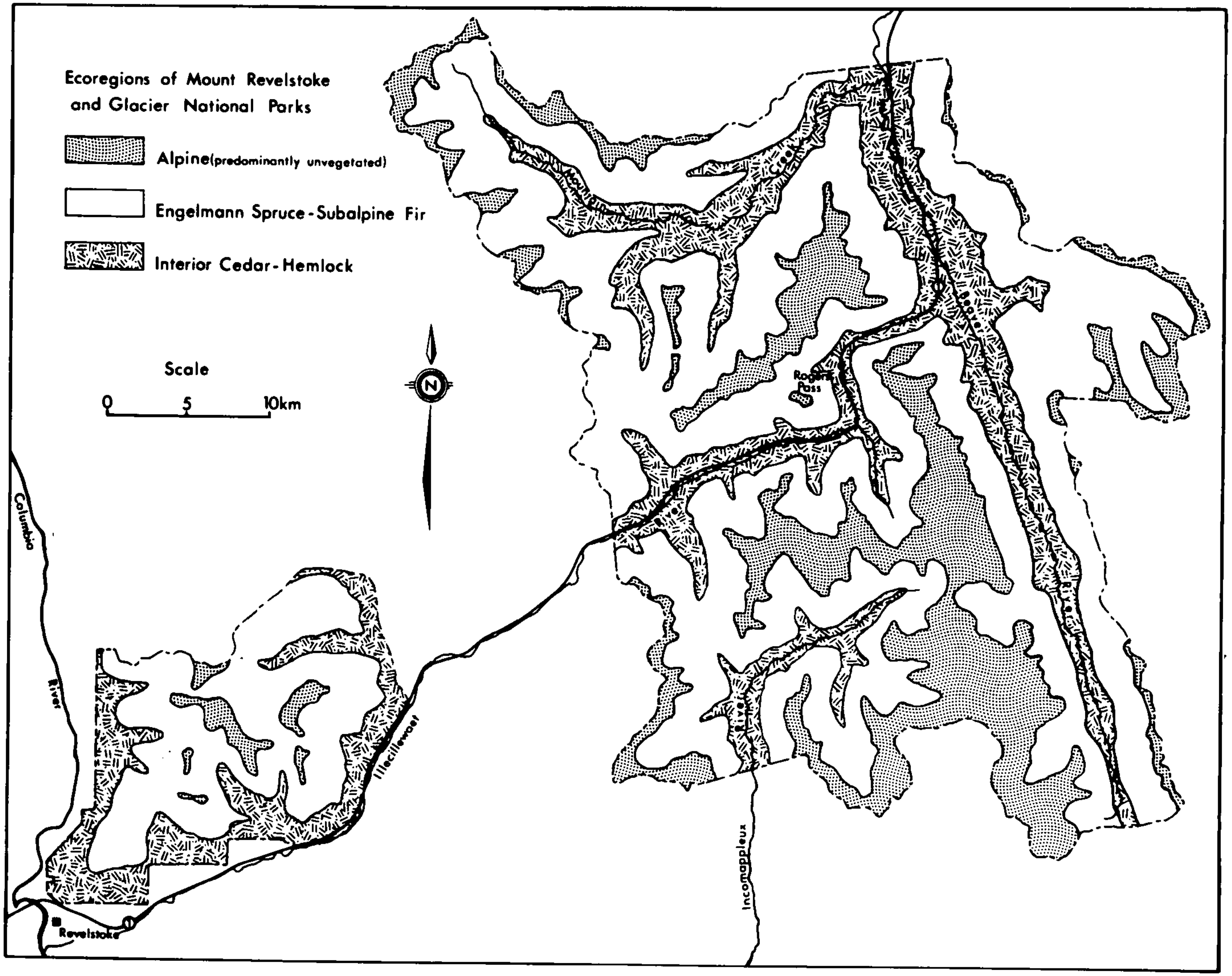
Vegetation is used as the basis for the definition of Ecoregions in the ecological land classification. Ecoregional divisions reflect macroclimate and thus, vegetational features, which primarily reflect climatic factors, rather than, for example, edaphic factors, are used to define Ecoregions. An Ecoregion is conceptually similar to the zone of Daubenmire (1968), La Roi (1975) and Lea (1980, 1983), the biogeoclimatic zone of Krajina (1965) and Utzig *et al.* (1983), the biophysical region of Lacate (1969), and the forest section of Rowe (1972). Three Ecoregions are recognized in MRNP and GNP: Interior Cedar-Hemlock, Engelmann Spruce-Subalpine Fir, Alpine (Fig. 6).

INTERIOR CEDAR-HEMLOCK ECOREGION

The Interior Cedar-Hemlock Ecoregion (ICH) is characterized by v.t.s dominated by *Tsuga heterophylla* and *Thuja plicata*. It occurs from the lowest elevations in the parks, about 550 m in MRNP and about 830 m in GNP, to approximately 1500 m in MRNP and 1450 m in GNP. The upper boundary is a bit lower on cooler, northerly and easterly aspects and a bit higher on warmer, southerly and westerly aspects. Typical v.t.s include: western hemlock-western red cedar/western yew/oak fern (C50), western red cedar-western hemlock/devil's club/oak fern (C51), western hemlock-western red cedar-(Douglas fir)/mountain lover (C52), and Douglas fir-western red cedar/mountain lover (C53). *Tsuga heterophylla* and *Thuja plicata* typically dominate mature v.t.s, while *Pseudotsuga menziesii*, *Pinus monticola*, and *Picea engelmannii* are usually seral species in the ICH. East of the Beaver River in GNP, the climate is drier than in MRNP or the rest of GNP. This is reflected in the vegetation, *e.g.* by the occurrence of *Pinus contorta*, which is absent further west and the restriction of *Thuja plicata* and *Oplopanax horridum* to wetter sites.

The Interior Cedar-Hemlock Ecoregion corresponds to the Northern Columbia Forest Section (CL.2) of Rowe (1972). The ICH west of the Beaver River in GNP and in MRNP corresponds largely to the Wet Interior Cedar-Hemlock Subzone (ICHb) of the biogeoclimatic classification of the British Columbia Ministry of Forests (Utzig *et al.* 1983). This also corresponds to the Western Wet Submontane Interior Cedar-Hemlock Subzone (ICHw) and Western Wet Montane Interior Cedar-Hemlock Subzone (ICHv) described for an area just west of MRNP (Lloyd 1983). The ICH Ecoregion in MRNP and west of the Beaver River in GNP appears somewhat drier than the ICHb Subzone. In particular, *Oplopanax horridum* is less common and *Vaccinium membranaceum* is more common than indicated by Utzig *et al.* 1983).

Fig. 6. Ecoregions of Mount Revelstoke and Glacier National Parks.



ENGELMANN SPRUCE - SUBALPINE FIR ECOREGION

The Engelmann Spruce-Subalpine Fir Ecoregion occurs at altitudes above the Interior Cedar-Hemlock Ecoregion and below the unforested Alpine Ecoregion. It is divided into Lower Subalpine and Upper Subalpine portions.

Lower Subalpine

The Lower Subalpine is characterized by closed forests dominated by *Picea engelmannii* and *Abies lasiocarpa*. *Tsuga mertensiana* is often codominant and *Tsuga heterophylla* occurs in the lower part of the Lower Subalpine. The Lower Subalpine occurs from 1500 to 1900 m in MRNP and 1450 to 2000 m in GNP. This range is slightly higher on warm aspects and lower on cooler aspects. Typical v.t.s include Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21), mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47), Engelmann spruce-mountain hemlock/rhododendron-tall bilberry (C48), mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49) and Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21). The drier climate east of the Beaver River in GNP is also reflected in the vegetation of the Lower Subalpine as in the ICH Ecoregion. *Pinus contorta* occurs here and not further west, *Tsuga mertensiana* is mostly absent, and *Pachystima myrsinites* is more common and widespread.

The Lower Subalpine corresponds to the lower part of the Interior Subalpine Forest Section (SA.2) of Rowe (1972), although his lower boundary is about 300 m lower than recognized here. The Lower Subalpine west of the Beaver River corresponds to the lower part of the Wet Forested Engelmann Spruce-Subalpine Fir Subzone (ESSFb) of the biogeoclimatic classification of the Nelson Forest Region (Utzig *et al.* 1983). It seems to correspond wholly with the Wet Central Engelmann Spruce-Subalpine Fir Subzone (ESSFw) of the Kamloops Forest Region, just to the west (Lloyd 1983). The Lower Subalpine east of the Beaver River comes closest to the Moist Southern Forested Engelmann Spruce-Subalpine Fir Subzone (ESSFc, Utzig *et al.* 1983). Since eastern GNP is clearly in the transition between the Wet and Moist Climatic Regions, it does not fit the central concept of ESSFc fully. For example, some *Tsuga heterophylla* occurs in eastern GNP, although it is typically absent in ESSFc.

Upper Subalpine

The Upper Subalpine typically has open forests dominated by *Picea engelmannii* and *Abies lasiocarpa*. Closed Engelmann spruce-subalpine fir forests occur on warm aspects and in the lower part of the Upper Subalpine, but characteristically contain *Cassiope mertensiana*, *Phyllodoce empetriformis* and *Luetkea pectinata* and lack *Menziesia glabella* or *Oplopanax horridum*. *Tsuga mertensiana* is also common, often as a codominant. The Upper Subalpine occurs from 1900 to 2200 m in MRNP and 2000 to 2300 m in GNP, the boundary being lower on cool aspects and higher on warm ones. Typical v.t.s include subalpine fir-mountain hemlock/heather-luetkea (O20), subalpine fir-whitebark pine-(Engelmann spruce)/tall bilberry-heather (O22) and mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47). The Upper Subalpine east of the Beaver River is drier but the difference is not as great as in the Lower Subalpine and Interior Cedar-Hemlock. The primary effect is a decreased amount of *Tsuga mertensiana* and more of the Engelmann spruce-subalpine fir/heather (O10) v.t. Lush herb meadows (fleabane-valerian (H16)) are also typical of the Upper Subalpine.

The upper part of the Interior Subalpine Forest Section (Rowe 1972) corresponds to the Upper Subalpine. The Upper Subalpine west of the Beaver River corresponds to the upper part of the Wet Forested Engelmann Spruce-Subalpine Fir Subzone (ESSFb) and to the Wet Parkland Engelmann Spruce-Subalpine Fir Subzone (ESSFbp) in the biogeoclimatic classification of the Nelson Forest Region (Utzig *et al.* 1983). In the Kamloops Forest Region (Lloyd 1983), the Upper Subalpine fits best the Wet Upper Engelmann Spruce-Subalpine Fir (ESSFu) and Wet Parkland Engelmann Spruce-Subalpine Fir (ESSFbp) Subzones. The Upper Subalpine east of the Beaver River is closest to the Moist Southern Parkland Engelmann Spruce-Subalpine Fir (ESSFbp) (Utzig *et al.* 1983).

ALPINE ECOREGION

The Alpine Ecoregion is treeless and occurs at elevations above the Upper Subalpine, *i.e.* above 2200 m in MRNP and above 2300 m in GNP. Alpine vegetation forms a complex, fine-scale mosaic in which marked changes in dominant species reflect microclimatic variations. Significant microclimatic factors include: aspect, wind exposure, time of snow melt, soil moisture and snow depth. Typical v.t.s are heather-everlasting (L5), black alpine sedge-everlasting (H2), everlasting-white mountain heather-red heather (H18) and, at the highest altitudes, saxicolous lichen (H12). The Alpine east of the Beaver River is drier than further west. Occurrence of the mountain avens-snow willow-moss campion (H1) v.t. only east of the Beaver River reflects the drier climate. Alpine communities in MRNP and GNP generally contain more *Luetkea pectinata* than ones in Kootenay National Park (Achuff and Dudynsky 1984) or Banff and Jasper National Parks (Corns and Achuff 1982), even though they have the same v.t. designation.

The Alpine Ecoregion corresponds to the Tundra of Rowe (1972). West of the Beaver, it presumably corresponds to the Wet Alpine Tundra Subzone (ATg) of the biogeoclimatic classification (Utzig *et al.* 1983), while east of the Beaver River, the correspondence is apparently to Moist Alpine Tundra Subzone (ATe). The correspondence can be only tentative since ATg and ATe have not been described fully.

VEGETATION TYPE DESCRIPTIONS

The v.t.s, names and symbols (*e.g.* C14) are part of a system common to BNP, JNP, KNP, MRNP and GNP. All stands of a particular v.t. belong to one conceptual entity and some v.t.s occur in all five parks (*e.g.* H16 and L5) although some occur in only one.

In the stand tables with the v.t. descriptions, stands from outside MRNP and GNP have been added in some cases to better characterize the v.t. where fewer than five stands were sampled in MRNP and GNP. The additional stands are from KNP, BNP and JNP. Species with low frequency of occurrence or low cover values have been deleted in many cases from the stand tables. Complete data can be obtained from the authors.

CLOSED FOREST VEGETATION TYPES

C14: *Picea engelmannii-Abies lasiocarpa/Menziesia glabella/Vaccinium scoparium*

(Engelmann spruce-subalpine fir/false azalea)

Environment: C14 occurs on mesic Lower Subalpine (1650-1800 m) sites with moderate to steep slopes and mostly northerly and easterly aspects. Soils are well to moderately well drained Eutric and Dystric Brunisols on morainal and colluvial landforms. The only stand sampled (PA1059) is in eastern GNP near Copperstain Creek, although it appears that much of the Copperstain burn was formerly C14 forest.

Vegetation: In the tree layer (20-45%), *Abies lasiocarpa* (5-25%) and *Picea engelmannii* (10-30%) are dominant (Table 14). *Menziesia glabella* (15-70%) dominates the shrub layer (25-80%) with *Rhododendron albiflorum* (5-10%), *Ribes lacustre* (0.5-3%) and *Abies lasiocarpa* (5-15%) often present also. The herb-dwarf shrub layer is well developed (15-50%) and commonly includes *Vaccinium membranaceum* (3-25%), *Vaccinium scoparium* (2-20%), *Abies lasiocarpa* (1-3%), *Arnica cordifolia* (1-10%), *Cornus canadensis* (1-10%), *Linnaea borealis* (1-5%), *Pyrola secunda* (1-3%) and *Lycopodium annotinum* (≤1%). The species-rich bryoid layer (45-90%) is dominated by *Pleurozium schreberi* (20-80%) along with *Dicranum scoparium* (5-10%), *Hylocomium splendens* (3-15%), *Ptilium crista-castrensis* (5-10%), *Barbilophozia lycopodioides* (5-40%) and *Peltigera aphthosa* (2-5%). Epiphytes are moderately abundant and include *Alectoria sarmentosa*, *Hypogymnia physodes*, *Letharia vulpina* and *Parmelia* spp.. In Table 14, PA1059 is from GNP; the other stands are from KNP.

Table 14. Stands of the Engelmann spruce-subalpine fir/false azalea (C14) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	BB	BB	HD	HD	HD	HD	PA	PA	PA
	10	10	10	10	11	20	10	10	20
	22	25	07	11	29	34	59	71	45
TREE LAYER									
Abies lasiocarpa	25	10	15	.5	05	--	23	05	10
Picea engelmannii	15	15	02	08	02	03	07	18	20
Pinus contorta	--	05	02	.5	--	01	--	02	.5
TALL SHRUB LAYER									
Abies lasiocarpa	04	07	--	--	02	35	04	10	.5
Alnus crispa	--	--	05	05	--	--	--	--	--
Picea engelmannii	01	03	--	.5	--	.5	--	.5	.5
SHRUB LAYER									
Abies lasiocarpa	10	05	01	--	02	05	--	10	05
Menziesia glabella	38	20	03	10	40	15	60	50	45
Rhododendron albiflorum	--	--	--	01	--	--	.5	--	20
Shepherdia canadensis	--	05	--	--	--	--	--	--	.5
Ribes spp.	.5	.5	.5	01	--	--	--	--	.5
HERB-DWARF SHRUB LAYER									
Abies lasiocarpa	01	--	02	--	--	.5	--	02	.5
Arnica cordifolia	--	03	01	01	--	--	--	03	03
Cornus canadensis	--	05	05	01	--	.5	--	--	05
Goodyera oblongifolia	--	--	.5	.5	--	--	--	--	--
Linnaea borealis	--	03	--	03	--	.5	--	--	10
Lonicera involucrata	--	01	.5	.5	--	--	--	--	--
Moneses uniflora	.5	--	.5	.5	--	--	--	--	--
Pyrola secunda	.5	--	05	.5	--	--	--	.5	.5
Pyrola virens	.5	.5	--	01	--	--	--	--	--
Spiraea lucida	--	05	--	.5	--	--	--	.5	--
Vaccinium membranaceum	08	--	--	10	01	01	10	15	--
Vaccinium scoparium	02	02	01	03	10	01	--	10	20
Lycopodium annotinum	--	.5	--	.5	--	--	--	--	.5
BRYOID LAYER									
Dicranum fuscescens	03	.5	03	--	25	.5	35	05	--
Drepanocladus uncinatus	.5	--	--	.5	--	02	--	--	--
Hylocomium splendens	10	15	--	.5	--	05	--	--	05
Pleurozium schreberi	10	20	45	.5	--	60	05	50	70
Ptilium crista-castrensis	--	20	05	07	--	.5	--	--	05
Barbilophozia lycopodioides	10	--	--	.5	25	.5	50	25	--
Cladonia carneola	--	.5	--	.5	--	.5	--	--	--
Peltigera aphthosa	05	--	.5	01	--	02	.5	--	05
EPIPHYTES									
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	.5	--	--	--	.5	.5
Bryoria spp.	.5	.5	--	.5	.5	.5	--	.5	.5
Hypogymnia enteromorpha	--	.5	--	.5	--	--	--	--	.5
Hypogymnia physodes	--	--	--	--	--	.5	--	.5	.5
Letharia vulpina	.5	--	.5	.5	.5	--	--	--	.5
Parmeliopsis ambigua	.5	.5	--	.5	--	--	--	--	.5

C14 is mature successionally with stand ages 175 to 400 years. The dominance of *Menziesia glabella* in the shrub layer differentiates C14 from most other *Picea engelmannii-Abies lasiocarpa* v.t.s. Stands with moderate *Rhododendron albiflorum* cover intergrade with C21.

Other Studies: C14 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, McLean (1970) describes an *Abies lasiocarpa -Menziesia ferruginea* type, Kujala (1945) has a *Picea engelmannii-Abies lasiocarpa/Menziesia-Vaccinium membranaceum/Tiarella trifoliata-Rubus pubescens-Rhododendron albiflorum* type, and Lea (1984) has an alpine fir-smooth Pacific menziesia-grouseberry-heart-leaved arnica type. Numerous similar types have been described in Alberta by Corns (1978 and 1983, *Picea engelmannii-Abies lasiocarpa/Menziesia glabella*) in west central Alberta and in the northern foothills, by Kondla (1978, spruce-fir/false azalea-feathermoss) in Kananaskis Provincial Park, Ogilvie (1976, Kirby and Ogilvie 1969, *Picea-Abies/Menziesia glabella-Lycopodium annotinum*). In JNP, similar types are described by Hettinger (1975, *Picea engelmannii-Abies lasiocarpa/Menziesia glabella-Vaccinium membranaceum*), La Roi (1975, *Picea engelmanniiAbies lasiocarpa/Menziesia glabella/Valeriana sitchensis/Vaccinium scoparium/Pleurozium schreberi*), and Beil (1966). In Banff, Trottier and Scotter (1973) recognize similar types (*Picea-Abies/Menziesia glabella-Vaccinium scoparium, Picea-Abies/Menziesia glabella/* moss). In other parts of Alberta, similar types are noted by Jacques and Legge (1974) in the Kananaskis area (*Picea-Abies/Menziesia ferruginea-Tiarella trifoliata, Picea-Abies/Menziesia-Lycopodium annotinum*), Kuchar (1973) in Waterton Lakes National Park (fir/spruce/menziesia), and by Cormack (1953). Shepherd (1959) describes a *Picea engelmannii-Abies/Peltigera* association in BNP, JNP and Yoho National Park in Alberta and British Columbia. In Montana, Pfister *et al.* (1977) describe an *Abies lasiocarpa/Menziesia glabella* type. Daubenmire and Daubenmire (1968), in northern Idaho and eastern Washington, have a similar *Abies lasiocarpa/Menziesia ferruginea* type, as do Steele *et al.* (1983) in eastern Idaho and eastern Wyoming, and Steele *et al.* (1981) in central Idaho.

C21: *Picea engelmannii-Abies lasiocarpa/Vaccinium membranaceum/Barbilophozia lycopodioides*

(Engelmann spruce-subalpine fir/tall bilberry/liverwort)

Environment: C21 occurs on mesic Lower Subalpine to Upper Subalpine (1370-2070 m) sites throughout both parks, although a few stands occur in the Interior Cedar-Hemlock Ecoregion. Slopes are moderate to steep with a variety of aspects.

Vegetation: *Abies lasiocarpa* (5-30%) and *Picea engelmannii* (5-10%) dominate the closed canopy (25-30%) (Table 15, Plate 32). In the shrub layer, *Vaccinium membranaceum* (20-50%) is most important along with *Rhododendron albiflorum* (10-30%) and occasionally *Sorbus sitchensis* (2%), *Alnus crispa* (5%) and *Menziesia glabella* (3%). Species diversity in the herb-dwarf shrub layer is moderately high but cover values are low (10-30%). Common species include *Abies lasiocarpa* (2%), *Arnica latifolia* (10%), *Cassiope mertensiana* (2%), *Deschampsia atropurpurea* (<5%), *Luetkea pectinata* (5-50%), *Pyrola secunda* (1-3%), *Rubus pedatus* (5-35%), *Valeriana sitchensis* (2-15%), *Gymnocarpium dryopteris* (5%) and *Dryopteris assimilis* (5%). A few moss species with high cover value comprise most of the varied and species-rich bryoid layer: *Barbilophozia lycopodioides* (10-70%), *Dicranum scoparium* (<5-20%), *Pleurozium schreberi* (5-35%), *Ptilium crista-castrensis* (5%), *Cladonia carneola* (1%) and *Cladonia ecmocyna* (<1-3%). Epiphytes are moderately abundant and include *Alectoria sarmentosa, Hypogymnia enteromorpha, Parmeliopsis ambigua* and *Parmeliopsis hyperopta.*

C21 is successionally mature with stands 160 to >300 years old. C21 differs from C14 in having *Rhododendron albiflorum* and *Vaccinium membranaceum* dominant rather than *Menziesia glabella* and *Vaccinium scoparium.* C47, C48 and C49 differ in having *Tsuga mertensiana* codominant in the tree layer. O21 has a similar composition but physiognomically is an open forest and O22 differs both in having *Pinus albicaulis* codominant and in being open forest.

Other Studies: C21 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, a similar spruce-fir/rhododendron type is described by Kuchar (1978) in Yoho National Park, Clement (1981, alpine fir-white-flowered rhododendron-black blueberry-sitka valerian) has a similar type in the Vernon area and Lea (1984, Engelmann spruce-white-flowered rhododendron-Canadian bunchberry-moss) describes a similar type in the East Kootenays. In Alberta, similar types are described by Corns (1978) from the northern foothills (*Picea engelmannii-Abies lasiocarpa/Menziesia glabella*), Trottier and Scotter (1973) for BNP (*Picea-Abies/Rhododendron albiflorum-Vaccinium* spp.), Baig (1972) for the Alberta Rockies (*Abies-Picea-Larix/Rhododendron*), and Beil (1966) for BNP and JNP.

Table 15. Stands of the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	JD	MF	PA	PA	PA	PA	PA	SD
	10	21	10	10	20	20	30	20
	78	24	13	52	34	40	25	99
TREE LAYER								
Abies lasiocarpa	10	15	10	10	20	20	15	30
Picea engelmannii	15	--	05	.5	05	05	20	10
Tsuga mertensiana	--	--	--	--	05	10	--	20
SHRUB LAYER								
Abies lasiocarpa	04	15	01	02	05	03	--	08
Rhododendron albiflorum	04	15	.5	50	10	20	.5	.5
Vaccinium membranaceum	01	17	10	35	05	15	55	17
Vaccinium ovalifolium	--	--	15	--	--	--	--	10
Tsuga mertensiana	--	--	--	--	.5	02	--	--
HERB-DWARF SHRUB LAYER								
Arnica latifolia	10	--	--	10	--	.5	--	--
Cassiope mertensiana	--	02	--	--	--	02	--	--
Clintonia uniflora	--	--	01	--	10	--	--	--
Cornus canadensis	--	--	--	--	02	--	--	05
Deschampsia atropurpurea	.5	--	--	.5	--	.5	--	--
Erigeron peregrinus	01	--	--	02	--	--	--	--
Gaultheria humifusa	--	04	--	.5	--	--	--	--
Linnaea borealis	--	--	--	--	03	--	--	05
Luetkea pectinata	--	05	--	--	--	60	--	--
Mitella pentandra	--	--	05	--	--	.5	--	--
Pedicularis bracteosa	01	--	--	01	--	--	--	--
Phyllodoce empetriformis	--	04	--	--	--	.5	--	--
Pyrola secunda	--	--	--	01	03	--	.5	05
Rubus pedatus	01	--	05	--	40	--	--	20
Smilacina racemosa	--	--	02	--	--	--	--	02
Thalictrum occidentale	--	--	07	--	--	--	.5	--
Tiarella unifoliata	01	--	10	--	--	--	15	--
Valeriana sitchensis	40	.5	10	02	--	01	05	--
Streptopus roseus	03	--	07	--	--	--	--	--
Dryopteris assimilis	--	--	02	--	--	--	10	--
Gymnocarpium dryopteris	--	--	20	--	--	--	03	--
Lycopodium sitchense	--	12	--	.5	--	--	--	--
BRYOID LAYER								
Dicranum fuscescens	--	--	--	--	05	10	05	05
Dicranum scoparium	--	.5	--	--	--	--	--	05
Rhizomnium nudum	15	--	55	--	--	--	--	--
Pleurozium schreberi	--	--	--	--	35	--	--	10
Pohlia nutans	--	--	--	--	--	05	--	.5
Ptilium crista-castrensis	--	--	.5	--	05	--	--	05
Brachythecium sp.	30	--	--	--	--	--	03	--
Barbilophozia lycopodioides	10	03	.5	07	30	70	25	.5
Cladonia carneola	--	--	--	01	.5	.5	--	--
Cladonia chlorophaea	--	.5	--	01	.5	--	--	--
Cladonia ecmocyna	--	--	--	03	02	.5	--	--
EPIPHYTES								
Alectoria sarmentosa ssp. sarmentosa	--	.5	.5	.5	.5	--	--	.5
Hypogymnia enteromorpha	--	--	.5	.5	.5	--	--	--
Parmeliopsis ambigua	--	.5	--	--	.5	--	--	.5
Parmeliopsis hyperopta	--	.5	--	.5	.5	--	--	--

In the western Cascades of Washington, a similar type (*Picea engelmannii-Abies lasiocarpa/Vaccinium membranaceum*) is noted by del Moral and Fleming (1979) and similar vegetation occurs at Logan Pass in Glacier National Park, Montana as reported by Habeck (1969).

C25: *Picea engelmannii-Abies lasiocarpa/Alnus crispa/Vaccinium membranaceum/Dryopteris assimilis*

(Engelmann spruce-subalpine fir/green alder)

Environment: C25 occurs on mesic Lower Subalpine (1490-1750 m) sites in GNP on moderate to steep slopes and southerly and easterly aspects. Soils are well to imperfectly drained Brunisolics and Podzolics on morainal and colluvial landforms.

Vegetation: The closed tree canopy (15-50%) (Table 16) is composed mostly of *Picea engelmannii* (5-20%) and *Abies lasiocarpa* (5-15%). *Alnus crispa* (15-30%) dominates the shrub layer (40-80%). Other common shrub species are *Ribes lacustre* (3-10%) and *Abies lasiocarpa* (2-10%). The herb-dwarf shrub layer is dense (40-80%) and species-rich. Characteristic species include *Dryopteris assimilis* (1-10%), *Gymnocarpium dryopteris* (10-15%), *Cornus canadensis* (1-10%), *Streptopus roseus* (2-3%) and *Valeriana sitchensis* (1-2%). Bryoid cover is generally low (10-15%) with *Brachythecium* spp. most common.

C25 is successionally mature with stand ages 100 to >300 years. C25 is distinguished by the dominance of *Alnus crispa* in the shrub layer.

Other Studies: C25 is also described in KNP (Achuff and Dudynsky 1984). Elsewhere in British Columbia, Lea (1984, Engelmann spruce-thin-leaved mountain alder-heart-leaved arnica) describes a similar type in the East Kootenays.

C28: *Populus balsamifera/Equisetum pratense*

(balsam poplar/horsetail)

Environment: C28 occurs on subhygric Interior Cedar-Hemlock (800-1100 m) sites in the Beaver Valley of GNP. Soils are imperfectly to poorly drained Regosolics and Gleysolics on nearly level fluvial landforms.

Vegetation: *Populus balsamifera* (10-55%) is the dominant tree (Table 17). Shrub cover is variable (10-50%) with *Alnus crispa* (20-40%), *Cornus stolonifera* (5-10%) and *Rubus strigosus* (5%) most common. The herb-dwarf shrub layer has high cover (50-80%) and characteristically contains *Equisetum arvense* (5-20%), *Rubus pubescens* (1-5%) and *Galium triflorum* (<1-3%). Bryoid layer cover is generally <5% with *Brachythecium* spp. and *Mnium* spp. most frequent.

C28 is intermediate successionally with stand ages ≤100 years. It occurs on sites which are periodically disturbed by flooding. C28 is distinguished by the dominance of *Populus balsamifera*. However, in eastern British Columbia *Populus balsamifera* is difficult to separate from *Populus trichocarpa* since hybridization occurs (Brayshaw 1965) and some workers merge the two taxa (*e.g.* Packer 1983). Flowers or fruits are needed to separate the two taxa and the collections made in MRNP and GNP are closest to *Populus trichocarpa*. Thus, *Populus trichocarpa* appears in the species list in Appendix A. But since C28 was described in BNP and JNP with the name *Populus balsamifera*, that name is retained for the v.t. here also since the GNP, KNP and BNP-JNP stands are one conceptual entity.

Other Studies: C28 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). No similar types are described by other authors in British Columbia. In west central Alberta, Corns (1983) describes a similar *Populus tremuloides/Rosa acicularis/Thalictrum venulosum* type. In northwestern Alberta, Moss (1953) notes a balsam poplar consociation and in central Saskatchewan, Dix and Swan (1971) also describe balsam poplar vegetation.

C44: *Picea* spp.-*Populus tremuloides-Pinus contorta-(Betula papyrifera)/Shepherdia canadensis/Calamagrostis rubescens*

(spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass)

Table 16. Stands of the Engelmann spruce-subalpine fir/green alder (C25) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	BB	MF	MF	PA	PA	SD	SD
	10	20	20	10	30	20	30
	36	17	30	14	26	26	11
TREE LAYER							
Abies lasiocarpa	15	--	10	10	05	10	05
Picea engelmannii	--	--	30	05	05	15	05
Pinus contorta	05	05	--	--	--	--	--
Pseudotsuga menziesii	15	05	--	--	--	--	--
SHRUB LAYER							
Abies lasiocarpa	--	--	05	.5	05	20	05
Alnus crispa	15	25	35	35	02	30	05
Menziesia glabella	10	--	35	--	--	25	--
Rhododendron albiflorum	.5	--	--	--	--	05	10
Ribes lacustre	--	--	.5	03	02	.5	10
Vaccinium membranaceum	--	--	--	15	10	.5	05
HERB-DWARF SHRUB LAYER							
Actaea rubra	--	--	--	--	03	--	02
Arnica cordifolia	05	01	--	--	--	--	--
Aster conspicuus	35	02	--	--	--	--	--
Berberis repens	.5	01	--	--	--	--	--
Calamagrostis rubescens	05	04	--	--	--	--	--
Clintonia uniflora	--	--	--	02	.5	--	--
Cornus canadensis	01	01	--	--	--	.5	--
Disporum trachycarpum	--	.5	--	--	05	--	--
Epilobium angustifolium	.5	--	--	--	.5	--	02
Linnaea borealis	--	03	--	--	--	.5	--
Pyrola secunda	--	.5	--	--	--	.5	--
Rubus parviflorus	.5	--	--	.5	20	--	--
Thalictrum occidentale	--	--	--	--	05	--	02
Tiarella unifoliata	--	--	--	10	10	--	--
Valeriana sitchensis	--	--	--	02	.5	--	05
Streptopus roseus	--	--	--	05	02	--	03
Athyrium filix-femina	--	--	--	--	20	--	--
Dryopteris assimilis	--	--	--	25	--	--	10
Gymnocarpium dryopteris	--	--	--	05	10	--	15
Polystichum lonchitis	--	--	--	--	--	--	02
Dryopteris phaegopteris	--	--	--	10	--	--	--
BRYOID LAYER							
Brachythecium curtum	.5	--	--	10	05	--	05
Dicranum fuscescens	10	--	02	--	--	--	--
Hylocomium splendens	15	04	05	--	--	10	--
Pleurozium schreberi	15	70	30	--	.5	05	--
Pohlia nutans	.5	.5	.5	--	.5	--	--
Ptilium crista-castrensis	--	.5	05	--	--	--	--
Timmia austriaca	15	--	--	--	--	.5	--
Barbilophozia spp.	.5	--	--	--	--	.5	--
Ptilidium pulcherrimum	.5	.5	.5	--	--	--	--
Peltigera aphthosa	10	01	03	--	--	.5	--
EPIPHYTES							
Bryoria spp.	--	.5	.5	.5	--	--	.5
Alectoria sarmentosa ssp. sarmentosa	--	.5	--	.5	--	--	.5
Hypogymnia spp.	.5	.5	--	.5	--	.5	.5
Parmelia sulcata	--	.5	--	.5	--	--	.5
Parmeliopsis spp.	--	.5	.5	.5	--	--	.5
Platismatia glauca	--	.5	--	.5	--	--	.5

Table 17. Stands of the balsam poplar/horsetail (C28) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	IC	JC	MF	MF
	70	70	21	21
	14	01	43	35
	TREE LAYER			
Betula papyrifera	--	--	17	--
Picea glauca	--	02	21	05
Populus balsamifera	55	33	45	10
	SHRUB LAYER			
Acer glabrum	--	--	09	--
Cornus stolonifera	.5	.5	04	15
Lonicera spp.	01	--	05	--
Picea glauca	02	--	--	15
Populus balsamifera	15	--	--	--
Ribes spp.	02	--	09	--
Rosa acicularis	02	02	--	--
Symphoricarpos albus	--	08	15	--
	HERB-DWARF SHRUB LAYER			
Actaea rubra	01	--	--	--
Cornus canadensis	--	--	10	--
Elymus innovatus	--	02	--	--
Galium triflorum	.5	.5	03	06
Mertensia paniculata	01	15	--	--
Mitella nuda	01	--	05	--
Osmorhiza spp.	.5	--	04	02
Petasites palmatus	02	01	--	--
Rubus pubescens	05	01	02	03
Vicia americana	01	01	--	--
Viola rugulosa	--	.5	.5	--
Equisetum arvense	01	20	05	03
Equisetum pratense	60	15	--	--

Environment: C44 occurs on mesic to subhygric Interior Cedar-Hemlock sites (830-1040 m) in GNP mainly along the lower Beaver River. Slopes and aspects vary widely and soils are well to moderately well drained Eutric Brunisols on fluvial and morainal landforms.

Vegetation: C44 is a mixedwood forest with *Populus tremuloides* (1-25%), *Betula papyrifera* (10-35%), *Picea* spp. (5-35%) and *Pseudotsuga menziesii* (3-15%) in the tree layer (Table 18). Total shrub layer cover is 30 to 70% and dominated by *Shepherdia canadensis* (15-35%) with *Rosa acicularis* (3-5%), *Acer glabrum* (5-20%), *Lonicera utahensis* (1-5%) and *Amelanchier alnifolia* (1-5%) also important. The herb-dwarf shrub layer is dense (50-90%) and species-rich with no single species consistently dominant. Important species include *Calamagrostis rubescens* (3-15%), *Linnaea borealis* (3-15%), *Cornus canadensis* (3-10%), *Pyrola secunda* ($\leq$1%), *Spiraea lucida* (1-10%) and *Lycopodium annotinum* (2-5%). Bryoid layer cover is variable as are individual species values. Common species include *Pleurozium schreberi*, *Hylocomium splendens*, *Ptilium crista-castrensis*, *Peltigera aphthosa* and *Brachythecium* spp. Epiphytes are scarcely to moderately abundant with *Hypogymnia physodes*, *Letharia vulpina* and *Cetraria pinastri* typical.

C44 is intermediate successionally with stand ages mostly 85 to 150 years. Regeneration of *Picea* spp. suggests succession toward a climax community dominated by *Picea* spp. C44 is distinguished by its mixed deciduous - coniferous tree composition.

Other Studies: C44 is also described in KNP (Achuff and Dudynsky 1984). Eis (1980) describes a similar *Aralia-Dryopteris* site type near Prince George, British Columbia, Clement (1981) has a Rocky Mountain Douglas fir-common paper birch-birch-leaved spiraea-large-leaved rattlesnake orchid type near Vernon, and Lea (1984) has a lodgepole pine-trembling aspen-birch-leaved spirea-pinegrass-grouseberry type in the East Kootenays.

Table 18. Stands of the spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	BB	HD	HD	JD	MF	PA	MF
	10	20	30	20	20	20	21
	17	08	01	06	13	16	33
TREE LAYER							
Betula papyrifera	01	--	--	10	--	--	35
Picea spp.	--	08	05	05	--	15	06
Pinus contorta	10	03	--	10	65	15	--
Populus tremuloides	05	02	01	02	05	20	08
Pseudotsuga menziesii	--	--	.5	01	--	--	07
SHRUB LAYER							
Alnus crispa	--	--	--	20	--	05	--
Acer glabrum	--	--	--	20	--	.5	20
Amelanchier alnifolia	--	--	.5	.5	01	01	05
Lonicera utahensis	--	--	05	01	01	--	01
Menziesia glabella	--	--	01	02	--	--	--
Picea spp.	05	--	--	01	--	--	--
Populus tremuloides	.5	.5	--	--	.5	--	--
Rosa acicularis	15	01	--	01	02	05	--
Shepherdia canadensis	35	25	--	20	40	45	02
Viburnum edule	03	.5	--	02	.5	--	--
HERB-DWARF SHRUB LAYER							
Aralia nudicaulis	.5	--	--	.5	--	--	04
Arnica cordifolia	--	.5	--	01	04	15	--
Aster conspicuus	03	--	--	.5	01	20	--
Calamagrostis rubescens	10	--	--	.5	03	03	--
Clematis verticellaris	.5	--	--	.5	--	.5	--
Cornus canadensis	05	05	60	05	10	10	--
Elymus innovatus	--	--	--	01	10	05	--
Fragaria virginiana	.5	--	--	--	02	05	--
Linnaea borealis	08	03	01	02	10	10	--
Lonicera involucrata	--	--	--	01	01	.5	--
Oryzopsis asperifolia	.5	50	--	--	07	--	--
Pachystima myrsinites	--	--	--	--	--	--	18
Pyrola secunda	--	.5	.5	.5	01	--	.5
Smilacina racemosa	.5	--	--	.5	--	--	05
Spiraea lucida	01	--	--	05	.5	05	04
Vaccinium caespitosum	15	.5	--	--	08	--	--
Vaccinium membranaceum	--	--	10	08	--	--	--
Lycopodium annotinum	.5	05	.5	.5	02	--	--
BRYOID LAYER							
Dicranum polysetum	.5	--	--	--	03	.5	--
Hylocomium splendens	55	10	10	30	12	--	--
Pleurozium schreberi	15	--	45	45	30	.5	--
Ptilium crista-castrensis	05	.5	.5	05	--	--	--
Peltigera aphthosa	01	05	.5	02	.5	.5	--
EPIPHYTES							
Cetraria pinastri	.5	--	.5	.5	--	--	--
Hypogymnia physodes	.5	--	--	.5	.5	--	.5
Letharia vulpina	--	--	--	.5	.5	.5	--

C47: *Tsuga mertensiana-Abies lasiocarpa/Rhododendron albiflorum-Vaccinium membranaceum/Rubus pedatus*

(mountain hemlock-subalpine fir/rhododendron-tall bilberry)

Environment: C47 occurs on mesic to subhygric mostly Lower Subalpine (1200-2000 m) sites throughout MRNP and GNP (Plates 13 and 46). Slopes are moderate to very steep and aspects are varied. Soils are well to moderately well drained Dystric Brunisols and Podzolics on morainal and colluvial landforms.

Vegetation: *Tsuga mertensiana* (10-30%) and *Abies lasiocarpa* (2-15%) dominate the tree layer (25-60%) (Table 19). *Tsuga heterophylla* occurs in the lowest elevation stands which are in the Interior Cedar-Hemlock Ecoregion. The shrub layer (20-55%) is dominated by *Rhododendron albiflorum* (10-50%) and *Vaccinium membranaceum* (10-30%). Also common is regeneration of *Abies lasiocarpa* (1-10%) and *Tsuga mertensiana* (3-10%). Cover of the herb-dwarf shrub layer is variable (5-65%) with *Rubus pedatus* (2-10%) often dominant. Other common species include *Cassiope tetragona, Clintonia uniflora, Pyrola secunda, Valeriana sitchensis, Veratrum eschscholtzii, Streptopus roseus* and *Gymnocarpium dryopteris*. The bryoid layer (20-75%) is species-rich and species cover values vary widely. Common species include *Dicranum fuscescens, Dicranum pallidisetum, Plagiothecium laetum, Rhytidiopsis robusta, Barbilophozia lycopodioides, Barbilophozia floerkii* and *Cladonia* spp. Epiphytes are moderately abundant with *Alectoria sarmentosa* and *Parmeliopsis hyperopta* typical.

C47 is mature successionally with stand ages of 120 to >400 years. It is distinguished by the dominance of *Tsuga mertensiana* and *Abies lasiocarpa*. C48, which is dominated by *Picea engelmannii* and *Tsuga mertensiana*, is similar and intergrades occur.

Other Studies: In British Columbia, Yarie (1980, *Vaccinio-(membranacei)-Tsugetum mertensianae*) in Garibaldi Provincial Park and Clement (1981, western hemlock-alpine fir-black blueberry-sitka valerian) in the Vernon area, describe similar types.

C48: *Picea engelmannii-Tsuga mertensiana/Rhododendron albiflorum-Vaccinium membranaceum/Clintonia uniflora*

(Engelmann spruce-mountain hemlock/rhododendron-tall bilberry)

Environment: C48 occurs on mesic Lower Subalpine sites (1550-1780 m) with steep, easterly aspect slopes. Soils are Dystric Brunisols and Humo-Ferric Podzols on colluvial and morainal landforms.

Vegetation: *Picea engelmannii* (5-5%), *Abies lasiocarpa* (2-25%) and *Tsuga mertensiana* (3-20%) dominate the closed tree layer (Table 20). *Rhododendron albiflorum* (10-60%), *Vaccinium membranaceum* (15-35%) and *Tsuga mertensiana* (5-15%) are most important in the shrub layer (40-90%). The herb-dwarf shrub layer is sparse (5-25%) and includes *Clintonia uniflora* (2-10%), *Pyrola secunda* (1-5%), *Rubus pedatus* (1-5%), *Tiarella unifoliata* (1-5%), *Dryopteris assimilis* and *Gymnocarpium dryopteris* (0.5-1%). Frequent in the bryoid layer (30-65%) are *Dicranum pallidisetum* (15-20%), *Rhytidiopsis robusta* (5-10%) and *Barbilophozia* spp. (10-65%). Epiphytes are moderately abundant.

The successional status of C48 is unclear. Stand ages are 120 to 240 years. In the lower part of the Lower Subalpine, *Picea engelmannii* appears to be a seral species and the absence of *Picea engelmannii* regeneration in the understory of C48 also suggests this, although evidence from older C47 stands at these altitudes suggests that some *Picea engelmannii* continues to occur in older stands. Thus, C48 is perhaps best termed advanced to mature based on the expectation that *Picea engelmannii* will decrease with time and that *Tsuga mertensiana* and *Abies lasiocarpa* will increase. C48 is distinguished by the dominance of *Picea engelmannii* and *Tsuga mertensiana*. It is similar to C47 and intergrading stands occur.

Other Studies: No similar types are described by other authors.

C49: *Tsuga mertensiana-Pseudotsuga menziesii-Abies lasiocarpa-Picea engelmannii/Rhododendron albiflorum-Vaccinium membranaceum*

(mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry)

Table 19. Stands of the mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	JD	JD	PA	PA	PA	SD	SD
	10	10	10	10	10	10	20	20	21	21
	52	55	66	43	45	50	31	32	15	22
TREE LAYER										
Abies lasiocarpa	--	.5	02	.5	.5	.5	10	05	15	20
Picea engelmannii	--	--	12	--	--	--	.5	04	10	05
Tsuga heterophylla	08	--	01	--	--	--	--	01	40	--
Tsuga mertensiana	10	05	--	20	--	15	15	10	--	10
SHRUB LAYER										
Menziesia glabella	--	--	03	--	--	--	05	10	--	--
Rhododendron albiflorum	07	35	--	25	--	30	25	20	15	15
Thuja plicata	--	--	01	--	--	--	--	--	--	--
Vaccinium membranaceum	03	25	.5	30	05	25	20	20	10	20
HERB-DWARF SHRUB LAYER										
Cassiope mertensiana	--	--	--	--	01	--	03	--	--	10
Clintonia uniflora	--	--	15	--	--	.5	--	.5	--	--
Disporum oreganum	--	--	--	--	--	01	--	01	--	--
Luetkea pectinata	--	--	--	--	10	--	--	--	--	15
Pyrola secunda	.5	--	03	--	--	.5	--	03	--	--
Rubus pedatus	--	02	--	--	--	05	--	10	--	--
Senecio triangularis	--	--	--	--	01	--	--	--	--	02
Valeriana sitchensis	--	--	--	--	30	--	--	--	--	05
Veratrum eschscholtzii	--	--	--	--	05	--	--	--	--	02
Streptopus roseus	--	03	02	--	--	--	--	--	--	--
Gymnocarpium dryopteris	--	--	02	--	--	.5	--	--	03	--
BRYOID LAYER										
Dicranum fuscescens	45	--	.5	30	--	20	20	10	--	05
Dicranum pallidisetum	.5	--	--	35	--	20	--	.5	02	03
Dicranum scoparium	--	05	.5	--	10	--	--	--	03	--
Plagiothecium laetum	.5	--	01	--	--	.5	--	.5	.5	--
Pohlia nutans	.5	--	.5	--	--	.5	--	.5	02	--
Rhytidiopsis robusta	--	--	--	15	--	--	--	50	.5	--
Barbilophozia lycopodioides	.5	--	.5	--	--	10	35	15	03	--
Lophozia ventricosa var. ventricosa	--	--	--	--	--	--	.5	.5	.5	--
Barbilophozia floerkei	--	.5	--	.5	--	.5	.5	--	02	--
Lophozia longidens ssp. longidens	.5	.5	.5	.5	--	--	--	--	--	--
Cladonia bellidiflora	--	--	--	--	--	.5	.5	--	02	--
Cladonia ecmocyna	--	--	--	--	--	--	10	--	--	02
EPIPHYTES										
Bryoria fremontii	--	--	--	.5	--	.5	--	.5	--	--
Bryoria pseudofuscescens	--	--	--	--	--	.5	.5	.5	.5	--
Alectoria sarmentosa ssp. sarmentosa	.5	.5	--	.5	--	.5	.5	.5	.5	--
Hypogymnia physodes	--	.5	.5	--	--	.5	--	.5	.5	--
Platismatia glauca	--	.5	.5	.5	--	--	--	--	02	--

Environment: C49 occurs on mesic Interior Cedar-Hemlock to Lower Subalpine sites (870-2140 m) in both MRNP and GNP with moderate to very steep slopes and various aspects. Soils are Dystric Brunisols and Orthic Humo-Ferric Podzols on morainal and colluvial landforms.

Vegetation: *Tsuga mertensiana* (15-35%) is the dominant tree species (Table 21) although *Tsuga heterophylla* may dominate Interior Cedar-Hemlock stands. Also often present are *Abies lasiocarpa* (5-20%), *Picea engelmannii* (3-5%), *Pseudotsuga menziesii* (2-10%) and *Pinus monticola* (1-5%). The shrub layer (25-60%) is composed mostly of *Rhododendron albiflorum* (10-40%) and *Vaccinium*

Table 20. Stands of the Engelmann spruce-mountain hemlock/rhododendron-tall bilberry (C48) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	JD	JD	JD	MF	MF	PA
	10	10	10	21	21	10
	49	51	68	15	27	33
	TREE LAYER					
Abies lasiocarpa	02	06	.5	--	--	20
Picea engelmannii	15	10	05	--	--	05
Tsuga mertensiana	03	04	20	40	40	.5
	SHRUB LAYER					
Rhododendron albiflorum	10	60	50	60	60	40
Vaccinium membranaceum	60	15	15	20	20	35
Vaccinium ovalifolium	--	.5	05	--	--	--
Tsuga mertensiana	08	15	15	--	--	01
	HERB-DWARF SHRUB LAYER					
Clintonia uniflora	10	02	02	--	--	--
Pyrola secunda	--	.5	01	--	--	05
Tiarella unifoliata	05	01	.5	--	--	--
Veratrum eschscholtzii	--	.5	.5	--	--	--
Streptopus streptopoides	--	--	05	--	--	--
Athyrium filix-femina	03	--	--	--	--	--
Dryopteris assimilis	10	.5	--	--	--	--
Gymnocarpium dryopteris	01	.5	--	--	--	--
Pteridium aquilinum	05	--	--	--	--	--
	BRYOID LAYER					
Dicranum pallidisetum	--	50	15	20	.5	20
Rhytidiopsis robusta	--	--	10	--	05	--
Barbilophozia hatcheri	--	--	03	.5	65	--
Barbilophozia lycopodioides	--	10	--	67	.5	--
Lophozia sp.	--	--	--	.5	.5	--
	EPIPHYTES					
Alectoria sarmentosa ssp. sarmentosa	--	--	.5	--	--	.5
Letharia vulpina	--	--	--	.5	.5	--
Usnea sp.	.5	--	.5	--	.5	--
Parmelia sp.	.5	.5	--	--	--	--

membranaceum (3-20%) with *Abies lasiocarpa* (3-15%), *Tsuga* spp. (3-15%) and *Menziesia glabella* (1-5%) common. The herb-dwarf shrub layer (10-40%) commonly contains *Clintonia uniflora* (2-5%), *Cornus canadensis* (1-3%), *Gymnocarpium dryopteris* (1-5%) and *Pyrola secunda* (<1%). *Pleurozium schreberi, Pohlia nutans, Ptilium crista-castrensis, Rhytidiopsis robusta* and *Barbilophozia lycopodioides* are important in the bryoid layer (20-65%). Epiphytes are moderately abundant with *Alectoria sarmentosa, Letharia vulpina* and *Parmeliopsis hyperopta* most frequent.

C49 is advanced to mature successionally with stand ages 100 to >300 years. It is distinguished by the occurrence of both *Tsuga* spp. and *Pseudotsuga menziesii.* Intergrades with C47 and C48 occur.

Other Studies: No similar types are described by other authors.

C50: *Tsuga heterophylla-Thuja plicata/Taxus brevifolia/Gymnocarpium dryopteris*

(western hemlock-western red cedar/western yew/oak fern)

Environment: C50 occurs on mesic Interior Cedar-Hemlock sites (990-1450 m) on mostly moderate slopes with various aspects throughout MRNP and GNP. Soils are Dystric Brunisols and Orthic Humo-Ferric Podzols which are well drained and developed on morainal and colluvial landforms.

Table 21. Stands of the mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	JD	JD	MF	PA	PA	PA
	10	10	11	10	10	21	10	10	10
	71	99	02	58	71	25	26	39	66
TREE LAYER									
Abies lasiocarpa	07	--	02	--	--	07	10	06	01
Picea engelmannii	03	.5	03	--	--	--	.5	04	05
Pinus monticola	--	--	--	03	01	--	05	--	--
Pseudotsuga menziesii	--	02	--	02	--	--	15	--	--
Thuja plicata	--	--	--	.5	01	--	--	--	--
Tsuga mertensiana	--	--	04	35	33	--	10	--	15
SHRUB LAYER									
Abies lasiocarpa	.5	--	.5	--	--	19	--	05	--
Menziesia glabella	--	--	--	.5	10	--	01	--	.5
Rhododendron albiflorum	05	--	40	.5	--	08	--	25	10
Thuja plicata	--	.5	--	02	15	--	01	03	--
Tsuga mertensiana	--	02	03	38	25	14	04	05	05
Vaccinium membranaceum	05	01	03	05	05	20	02	15	30
Vaccinium ovalifolium	--	.5	02	--	05	--	.5	10	--
HERB-DWARF SHRUB LAYER									
Chimaphila umbellata	--	08	--	.5	.5	--	--	--	--
Clintonia uniflora	05	--	.5	--	.5	--	.5	02	05
Cornus canadensis	--	--	--	02	01	--	03	08	--
Disporum oreganum	--	--	--	--	--	--	--	--	05
Linnaea borealis	--	--	--	.5	03	--	--	--	--
Pachystima myrsinites	--	--	--	07	10	--	35	--	--
Pyrola secunda	05	--	--	.5	.5	--	.5	--	--
Rubus pedatus	--	--	25	--	--	--	--	--	20
Streptopus roseus	--	--	--	--	--	--	02	01	--
Dryopteris assimilis	--	--	--	--	--	--	--	01	.5
Gymnocarpium dryopteris	01	--	20	--	--	--	05	05	--
BRYOID LAYER									
Barbilophozia lycopodioides	05	--	.5	01	--	05	--	--	20
Brachythecium spp.	05	--	05	--	--	--	.5	05	--
Dicranum spp.	--	25	40	01	01	04	10	--	05
Peltigera aphthosa	--	.5	--	--	.5	--	.5	--	--
Pleurozium schreberi	--	--	--	80	85	--	10	--	.5
Pohlia nutans	.5	.5	--	.5	--	--	--	--	.5
Ptilium crista-castrensis	.5	--	--	02	03	--	02	--	--
Rhytidiopsis robusta	--	25	20	--	--	--	05	--	40
Rhytidium rugosum	--	--	--	01	01	--	--	--	--
Ptilidium pulcherrimum	--	--	.5	.5	--	--	--	.5	--
EPIPHYTES									
Alectoria sarmentosa ssp. sarmentosa	.5	.5	--	.5	.5	--	.5	.5	.5
Bryoria pseudofuscescens	--	.5	--	.5	--	--	--	--	.5
Hypogymnia enteromorpha	.5	.5	--	--	--	--	.5	--	--
Letharia vulpina	.5	.5	--	--	--	.5	--	--	--
Parmeliopsis spp.	.5	.5	--	.5	--	.5	--	.5	.5
Platismatia glauca	--	.5	--	.5	.5	--	.5	--	.5

Table 22. Stands of the western hemlock-western red cedar/western yew/oak fern (C50) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD 10 51	HD 10 97	HD 10 98	HD 30 02	MF 21 19	PA 10 10	PA 10 12	PA 10 17	PA 20 33	SD 21 24
TREE LAYER										
Abies lasiocarpa	--	--	--	--	20	10	--	--	--	--
Picea engelmannii	--	--	03	--	17	10	--	--	--	--
Thuja plicata	25	--	10	20	.5	03	10	05	30	40
Tsuga heterophylla	20	45	30	05	03	05	35	20	15	40
SHRUB LAYER										
Taxus brevifolia	01	--	--	--	02	--	08	05	20	10
Thuja plicata	--	--	01	06	02	.5	05	--	05	04
Tsuga heterophylla	.5	02	03	--	--	--	02	.5	05	03
Vaccinium membranaceum	--	01	--	04	05	--	05	--	--	08
HERB-DWARF SHRUB LAYER										
Clintonia uniflora	05	--	01	.5	05	--	10	05	05	03
Cornus canadensis	01	05	03	03	04	--	05	.5	.5	03
Disporum oreganum	--	--	--	--	--	05	15	.5	01	--
Oplopanax horridum	--	--	--	--	--	--	.5	.5	03	--
Pyrola secunda	.5	.5	.5	.5	.5	--	01	--	--	--
Rubus pedatus	.5	10	03	05	20	--	02	.5	02	03
Thuja plicata	--	--	--	--	--	--	.5	--	.5	.5
Tiarella unifoliata	10	.5	--	10	02	--	08	01	10	02
Vaccinium ovalifolium	--	01	--	--	--	--	03	--	--	.5
Streptopus roseus	05	--	--	04	--	02	--	--	--	--
Athyrium filix-femina	--	--	--	--	--	15	--	--	05	--
Dryopteris assimilis	55	20	--	.5	--	--	05	10	01	03
Gymnocarpium dryopteris	30	05	15	60	10	20	30	30	65	05
BRYOID LAYER										
Dicranum fuscescens	.5	10	30	.5	--	--	02	02	--	--
Mnium spinulosum	--	01	--	--	--	05	02	--	--	--
Plagiothecium laetum	.5	--	--	.5	--	.5	02	--	.5	--
Pleurozium schreberi	--	.5	15	--	25	--	.5	05	20	10
Ptilium crista-castrensis	--	10	10	.5	05	--	--	03	--	20
Rhytidiopsis robusta	.5	15	25	55	--	--	50	20	05	--
Ptilidium californicum	--	.5	.5	.5	--	--	02	.5	.5	.5
EPIPHYTES										
Alectoria sarmentosa ssp. sarmentosa	.5	--	.5	.5	--	.5	.5	.5	.5	.5
Hypogymnia enteromorpha	--	.5	--	--	--	.5	.5	.5	--	--
Parmeliopsis ambigua	.5	--	--	.5	--	--	--	.5	--	.5
Parmeliopsis hyperopta	.5	--	--	--	.5	--	--	.5	--	.5
Platismatia glauca	.5	.5	.5	.5	--	.5	--	--	--	.5

Vegetation: *Tsuga heterophylla* (10-50%) and *Thuja plicata* (5-20%) dominate the closed tree layer (30-65%) (Table 22, Plate 21). The shrub layer (3-30%) is characterized by *Taxus brevifolia* (3-10%) along with *Thuja plicata* (1-5%), *Tsuga heterophylla* (1-3%) and *Vaccinium membranaceum* (1-5%). Total cover of the herb-dwarf shrub layer varies widely (10-90%) depending on the cover of the tree and shrub layers. Species diversity is high with *Gymnocarpium dryopteris* (10-30%), *Dryopteris assimilis* (3-10%), *Tiarella unifoliata* (1-10%), *Rubus pedatus* (2-10%), *Pyrola secunda* (≤1%), *Cornus canadensis* (1-5%) and *Clintonia uniflora* (1-5%) most prominent. *Rhytidiopsis robusta* (10-50%), *Pleurozium schreberi* (5-20%) and *Pleurozium schreberi* (5-20%) most often dominate the bryoid layer (20-60%). Other common species with low cover include *Dicranum fuscescens*, *Plagiothecium laetum*, *Mnium spinulosum*, and *Ptilidium californicum*. Epiphytes are sparsely to moderately abundant with *Alectoria sarmentosa*, *Parmeliopsis hyperopta* and *Platismatia glauca* most common.

C50 is successionally mature with stand ages 90 to >400 years. It is distinguished by the dominance of *Tsuga heterophylla* and *Thuja plicata* in the tree layer and *Taxus brevifolia* in the shrub layer. Intergrades with C51 occur where *Oplopanax horridum* has moderate cover.

Other Studies: Near Vernon, British Columbia, Clement (1981) describes several similar types (western hemlock-western red cedar-western yew-bluebead clintonia, western hemlock-western red cedar-unifoliate-leaved foamflower-oak fern).

C51: *Thuja plicata-Tsuga heterophylla/Oplopanax horridum/Gymnocarpium dryopteris*

(western red cedar-western hemlock/devil's club/oak fern)

Environment: C51 occurs on subhygric Interior Cedar-Hemlock (670-1420 m) sites on moderate slopes and various aspects in both MRNP and GNP (Plate 26). Soils are imperfectly to moderately well drained Brunisolics, which are often gleyed, developed mostly on fluvial landforms.

Vegetation: C51 is dominated by *Thuja plicata* (10-40%) and *Tsuga heterophylla* (10-40%) (Table 23). Lesser amounts of *Picea engelmannii* (5-15%) occur in many stands. The shrub layer is characterized by *Oplopanax horridum* (10-70%) with *Thuja plicata* (3-10%), *Tsuga heterophylla* (1-5%), *Vaccinium membranaceum* (1-5%) and *Vaccinium ovalifolium* (2-5%) also important. The herb-dwarf shrub layer (45-85%) is usually dominated by the ferns *Dryopteris assimilis* (3-10%), *Gymnocarpium dryopteris* (10-50%) and *Athyrium filix-femina* (2-25%). Other common species, usually with <3% cover, include *Tiarella unifoliata*, *Rubus pedatus*, *Clintonia uniflora*, *Cornus canadensis*, *Streptopus amplexifolius* and *Streptopus roseus*. The bryoid layer is species-rich with *Rhizomnium nudum*, *Rhytidiopsis robusta*, *Pleurozium schreberi* and *Dicranum fuscescens* most important. *Alectoria sarmentosa* and *Platismatia glauca* are most frequent of the moderately abundant epiphytes.

C51 is mature successionally with stands 130 to >300 years. It is distinguished by the dominance of *Tsuga heterophylla* and *Thuja plicata* in the tree layer and *Oplopanax horridum* in the shrub layer. C51 is similar to C52 and intergrades occur.

Other Studies: In British Columbia, similar types are described by Clement (1981, western hemlock-western red cedar-devil's club-common lady fern) in the Vernon vicinity.

C52: *Tsuga heterophylla-Thuja plicata-(Pseudotsuga menziesii)/Pachystima myrsinites*

(western hemlock-western red cedar-(Douglas fir)/mountain lover)

Environment: C52 occurs throughout MRNP and GNP on mesic Interior Cedar-Hemlock sites (660-1530 m) with moderate to steep, southerly aspect slopes (Plate 43). Soils are well to rapidly drained Dystric Brunisols on colluvial and morainal landforms.

Vegetation: The closed tree layer (40-60%) (Table 24) is dominated by *Tsuga heterophylla* (30-50%) and *Thuja plicata* (10-20%). *Pseudotsuga menziesii* (5-15%), *Picea engelmannii* (≤1%) and *Pinus monticola* (<1%) also often occur. The shrub layer (5-25%) consists mostly of *Thuja plicata* (3-5%) and *Tsuga heterophylla* (2-20%). *Pachystima myrsinites* (5-30%) characterizes the herb-dwarf shrub layer (15-40%). Other common species include *Clintonia uniflora* (1-5%), *Chimaphila umbellata* (1-3%), *Goodyera oblongifolia* (≤1%) and *Pyrola secunda* (≤1%). Cover of the bryoid layer varies (15-60%) and *Rhytidiopsis robusta*, *Pleurozium schreberi* and *Dicranum* spp. are most important. Epiphytes are moderately abundant with *Alectoria sarmentosa* and *Hypogymnia physodes* typical.

C52 is advanced to mature successionally with stand ages of 90 to 300 years. The presence of the seral species *Pseudotsuga menziesii*, *Pinus monticola* and *Picea engelmannii* in the tree layer of many stands and the abundant regeneration of *Tsuga heterophylla* and *Thuja plicata* suggest a gradual decrease in the first three species, although they will persist for a long time on these warm, comparatively dry sites.

C52 is distinguished from other v.t.s dominated by *Tsuga heterophylla* and *Thuja plicata* by the *Pachystima myrsinites* dominated shrub layer and frequent occurrence of *Pseudotsuga menziesii* in the tree layer.

Table 23. Stands of the western red cedar-western hemlock/devil's club/oak fern (C51) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	JD	MF	MF	MF	PA	PA	SD	SD	SD
	11	10	21	21	30	10	10	21	21	21
	05	59	21	28	25	18	54	10	17	18
TREE LAYER										
Abies lasiocarpa	--	.5	--	--	--	05	--	--	--	--
Picea engelmannii	--	05	05	--	--	--	--	10	20	05
Thuja plicata	01	25	40	35	05	10	15	20	10	20
Tsuga heterophylla	35	--	40	45	60	--	10	40	15	15
SHRUB LAYER										
Acer glabrum	--	--	--	01	--	--	--	--	--	10
Oplopanax horridum	08	.5	10	.5	--	70	25	05	.5	20
Rubus parviflorus	.5	.5	02	--	--	10	--	--	10	--
Thuja plicata	01	20	02	01	02	05	03	02	--	02
Tsuga heterophylla	.5	01	03	04	06	--	02	02	--	03
Vaccinium membranaceum	02	--	01	06	02	--	--	03	.5	10
Vaccinium ovalifolium	03	15	05	02	--	10	--	03	.5	05
HERB-DWARF SHRUB LAYER										
Aralia nudicaulis	--	05	--	--	--	10	--	--	--	--
Circaea alpina	--	.5	--	--	--	.5	--	--	03	--
Clintonia uniflora	.5	.5	02	04	02	03	--	.5	--	03
Cornus canadensis	08	01	01	25	.5	05	--	02	--	.5
Galium triflorum	--	03	--	--	--	02	--	.5	03	--
Goodyera oblongifolia	--	--	01	01	--	--	--	--	--	--
Moneses uniflora	--	--	.5	--	.5	--	--	.5	--	.5
Pyrola secunda	--	.5	--	01	.5	--	--	.5	.5	--
Rubus pedatus	15	.5	03	03	04	.5	.5	02	--	02
Rubus strigosus	.5	--	--	--	--	--	--	--	02	--
Smilacina racemosa	--	02	01	.5	--	.5	--	.5	02	03
Streptopus amplexifolius	--	01	02	--	--	.5	--	.5	--	.5
Tiarella unifoliata	.5	01	04	02	02	05	--	.5	.5	02
Tsuga heterophylla	01	--	02	--	.5	.5	.5	--	--	--
Streptopus roseus	--	.5	--	05	02	01	--	--	--	--
Athyrium filix-femina	02	05	48	01	--	--	--	--	.5	--
Dryopteris assimilis	10	--	--	--	.5	10	50	03	10	10
Dryopteris spinulosa	--	--	06	32	--	--	--	--	--	--
Gymnocarpium dryopteris	05	50	14	25	04	50	10	03	20	15
BRYOID LAYER										
Dicranum fuscescens	--	--	20	20	25	--	02	--	--	10
Rhizomnium nudum	--	10	.5	--	--	35	30	--	--	03
Plagiothecium laetum	--	--	.5	--	--	.5	--	.5	--	.5
Pleurozium schreberi	25	20	--	--	--	--	.5	05	03	01
Ptilium crista-castrensis	05	15	05	--	--	--	.5	05	--	--
Rhytidiopsis robusta	10	10	05	75	25	--	--	.5	--	05
Barbilophozia lycopodioides	--	--	15	--	--	01	--	20	--	--
EPIPHYTES										
Bryoria glabra	--	--	--	.5	--	--	--	--	.5	--
Alectoria sarmentosa ssp. sarmentosa	--	--	--	--	.5	.5	--	.5	.5	.5
Parmeliopsis ambigua	--	--	--	.5	.5	--	--	--	--	--
Platismatia glauca	--	--	--	--	.5	--	--	.5	.5	.5

Table 24. Stands of the western hemlock-western red cedar-(Douglas fir)/mountain lover (C52) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	JD	MF	MF	MF	PA	PA	PA	PA
	10	10	10	21	21	30	10	10	10	20
	63	88	72	09	16	14	35	40	53	37
TREE LAYER										
Picea engelmannii	--	--	01	--	05	--	--	--	.5	--
Pinus monticola	.5	--	.5	.5	--	20	--	--	--	.5
Pseudotsuga menziesii	03	15	--	05	--	03	15	--	05	.5
Thuja plicata	12	20	02	02	--	02	12	10	09	10
Tsuga heterophylla	06	--	35	80	20	15	20	30	--	30
TALL SHRUB LAYER										
Acer glabrum	01	--	.5	--	--	04	--	--	--	--
Thuja plicata	--	05	10	02	.5	02	10	--	01	.5
Tsuga heterophylla	--	--	20	01	--	03	05	.5	--	.5
SHRUB LAYER										
Lonicera utahensis	01	--	.5	.5	02	02	.5	--	01	--
Sorbus sitchensis	--	--	--	02	02	.5	--	.5	--	--
Thuja plicata	03	03	05	--	--	01	10	03	.5	03
Tsuga heterophylla	--	--	25	04	03	02	.5	02	--	--
HERB-DWARF SHRUB LAYER										
Chimaphila umbellata	02	.5	01	03	--	07	--	--	--	.5
Clintonia uniflora	01	--	.5	05	03	05	02	03	02	--
Cornus canadensis	--	--	01	--	--	01	.5	05	--	--
Goodyera oblongifolia	--	.5	.5	01	--	01	.5	.5	.5	.5
Linnaea borealis	01	--	--	--	--	09	.5	--	--	--
Pachystima myrsinites	03	02	25	12	50	03	10	05	30	04
Pyrola secunda	.5	--	.5	01	--	.5	--	01	--	.5
Thuja plicata	--	--	--	--	--	.5	.5	--	.5	02
Tiarella unifoliata	25	--	--	--	04	--	.5	01	--	--
Tsuga heterophylla	.5	--	.5	03	--	02	.5	.5	--	--
Vaccinium membranaceum	.5	--	--	--	--	--	--	05	02	.5
Vaccinium ovalifolium	.5	--	--	--	--	--	.5	.5	--	--
Viola renifolia	--	--	--	.5	03	01	.5	--	--	--
Streptopus roseus	.5	--	--	--	--	--	.5	02	--	--
Lycopodium complanatum	--	--	.5	--	--	01	--	--	--	--
Pteridium aquilinum	02	--	--	--	--	25	.5	--	--	--
BRYOID LAYER										
Dicranum spp.	03	25	--	17	--	01	10	02	10	05
Mnium spinulosum	.5	.5	--	--	--	--	03	--	--	--
Pleurozium schreberi	05	--	40	08	--	10	--	01	--	35
Ptilium crista-castrensis	--	03	--	--	--	03	--	--	--	--
Rhytidiopsis robusta	.5	20	01	40	--	08	40	55	.5	.5
Peltigera aphthosa	--	.5	.5	--	--	.5	.5	--	--	.5
EPIPHYTES										
Alectoria sarmentosa ssp. sarmentosa	.5	.5	.5	.5	--	.5	.5	.5	.5	--
Cetraria chlorophylla	.5	--	.5	--	--	--	--	--	.5	--
Hypogymnia physodes	.5	.5	--	.5	--	--	.5	--	.5	--
Parmeliopsis hyperopta	--	--	.5	--	--	--	.5	.5	--	--

Other Studies: In British Columbia, Clement (1981) describes several types (Rocky Mountain Douglas fir-Oregon boxwood-common western pipsissewa-large-leaved rattlesnake orchid, Rocky Mountain Douglas fir-western hemlock-black blueberry-blue bead clintonia, Rocky Mountain Douglas fir-western hemlock-Oregon boxwood-northern twinflower, Rocky Mountain Douglas fir-western red cedar-Oregon boxwood-western bracken) from the Vernon area which are similar to C52. In Oregon, Binkley and Graham (1981) describe a similar "old growth" Douglas fir/western hemlock forest and in the eastern Cascades of Washington, del Moral and Fleming (1979) describe a *Tsuga heterophylla-Thuja plicata/Cornus stolonifera-Clintonia uniflora* type.

C53: *Pseudotsuga menziesii-Thuja plicata/Pachystima myrsinites*

(Douglas fir-western red cedar/mountain lover)

Environment: C53 occurs in the Interior Cedar-Hemlock Ecoregion (980-1440 m) of both MRNP and GNP on mesic sites with moderate, southerly and westerly aspect slopes. Soils are well drained Dystric Brunisols on fluvial and morainal landforms.

Vegetation: The tree layer (25-65%) (Table 25) is dominated by *Pseudotsuga menziesii* (10-30%) and *Thuja plicata* (5-15%) with *Picea engelmannii* (3-5%) and *Abies lasiocarpa* (10-20%) often present. The shrub layer is usually sparse (5-15%) with *Thuja plicata* (2-5%) and *Lonicera utahensis* (≤1%) most frequent. *Pachystima myrsinites* (10-30%) dominates the herb-dwarf shrub layer. Also usually present are *Vaccinium membranaceum* (3-10%), *Chimaphila umbellata* (1-3%), *Clintonia uniflora* (2-5%), *Pyrola secunda* (≤1%) and *Hieracium albiflorum* (≤1%). Bryoid layer cover is variable (20-50%) with *Pleurozium schreberi* (10-25%), *Dicranum scoparium* (3-15%), *Brachythecium* spp. (2-8%) and *Rhytidiopsis robusta* (1-5%) most common. Epiphytes are moderately abundant and *Hypogymnia physodes*, *Platismatia glauca* and *Bryoria pseudofuscescens* are typical.

C53 is intermediate successionally. Stands ages are 80 to 100 years, the tree canopy contains many seral species (*i.e.* *Pseudotsuga menziesii*, *Picea engelmannii*, *Pinus monticola*), and several stands show evidence of origin after fire. C53 will likely succeed to C52 as dominance shifts from *Pseudotsuga menziesii* to *Thuja plicata* and *Tsuga heterophylla*. The dominance of *Pseudotsuga menziesii* and *Pachystima myrsinites* distinguishes C53, although stands intergrading with C52 likely occur.

Other Studies: No similar types are described by other authors.

OPEN FOREST VEGETATION TYPES

O9: *Picea engelmannii-Abies lasiocarpa/Valeriana sitchensis-Erigeron peregrinus*

(Engelmann spruce-subalpine fir/valerian-fleabane)

Environment: O9 occurs on mesic to subhygric Upper Subalpine sites (1950-2000 m) on various slopes and aspects. Soil drainage varies from well to poorly drained and seepage is often present. The soils are mainly Brunisolics, often with gleying, on morainal and fluvial landforms.

Vegetation: The tree layer is open (5-20%) (Table 26) and dominated by *Picea engelmannii* (5-20%) and *Abies lasiocarpa* (5-10%). The shrub layer (5-30%) consists mainly of *Picea engelmannii* (1-5%) and *Abies lasiocarpa* (5-20%), with some *Tsuga mertensiana* (3-5%). The herb-dwarf shrub layer is species-rich with total cover 40 to 90%. Dominant species are *Valeriana sitchensis* (5-15%), *Erigeron peregrinus* (5-10%), *Trollius albiflorus* (5-10%), and *Erythronium grandiflorum* (5-15%). Other common species include *Cassiope mertensiana* (5-10%), *Pedicularis bracteosa* (1-3%), *Senecio triangularis* (1-20%), *Anemone occidentalis* (2-5%), *Arnica cordifolia* (1-3%), *Veratrum eschscholtzii* (≤1%) and *Castilleja* spp. (≤3%). Bryoid cover is variable (1-80%) with *Dicranum scoparium*, *Drepanocladus uncinatus*, *Aulacomnium palustre*, *Cladonia* spp., *Tortula norvegica* and *Polytrichum* spp. most common. Only one stand of O9 (SD2113.1) was sampled in GNP near Flat Creek Pass, although it is likely more widespread in MRNP and GNP. The other stands in Table 26 are from BNP and JNP.

O9 is generally 100 to 300 years old and is mature successionally. O9 is differentiated from other Engelmann Spruce-Subalpine Fir Ecoregion open forest v.t.s (O20, O21, O22) by the virtual absence of a shrub layer dominated by *Rhododendron albiflorum* or *Vaccinium membranaceum* and by a herb dominated herb-dwarf shrub layer, rather than one dominated by dwarf shrubs, *e.g.* *Cassiope mertensiana*, *Phyllodoce empetriformis* or *Luetkea pectinata*. O9 has many species in common with H16, but the latter lacks tree cover. Stands which intergrade with H16 occur occasionally.

Other Studies: O9 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff

Table 25. Stands of the Douglas fir-western red cedar/mountain lover (C53) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	MF	PA	PA	PA	SD	SD
	30	10	10	30	21	21
	17	34	36	06	02	03
TREE LAYER						
Abies lasiocarpa	--	10	.5	--	20	25
Betula papyrifera	08	--	--	05	--	--
Picea engelmannii	05	--	03	--	05	20
Pinus monticola	--	10	05	05	--	--
Pseudotsuga menziesii	03	15	10	10	30	05
Thuja plicata	15	15	05	10	12	03
Tsuga heterophylla	10	--	.5	.5	--	--
TALL SHRUB LAYER						
Abies lasiocarpa	--	01	--	--	04	05
Acer glabrum	03	--	01	10	--	--
Alnus crispa	03	--	--	--	03	.5
Thuja plicata	03	02	03	05	05	02
SHRUB LAYER						
Lonicera utahensis	01	01	.5	01	.5	01
Rubus parviflorus	.5	02	--	12	--	.5
Thuja plicata	02	--	01	--	03	03
Tsuga heterophylla	01	--	01	--	--	--
HERB-DWARF SHRUB LAYER						
Chimaphila umbellata	03	--	01	01	.5	.5
Clintonia uniflora	05	10	.5	--	02	05
Cornus canadensis	06	--	03	--	--	10
Goodyera oblongifolia	01	.5	.5	--	04	--
Hieracium albiflorum	.5	.5	.5	01	.5	--
Pachystima myrsinites	11	08	10	30	15	06
Pinus monticola	01	--	.5	--	--	--
Pseudotsuga menziesii	.5	.5	--	--	--	--
Pyrola secunda	.5	.5	.5	01	01	02
Spiraea lucida	01	--	01	--	.5	02
Thuja plicata	.5	--	02	.5	--	--
Vaccinium membranaceum	11	05	15	.5	03	04
Viola orbiculata	.5	--	01	--	.5	.5
Viola renifolia	--	01	.5	02	--	--
Rosa gymnocarpa	.5	.5	--	.5	--	--
Pteridium aquilinum	03	--	10	.5	--	--
BRYOID LAYER						
Dicranum scoparium	15	.5	10	--	--	--
Mnium spinulosum	01	--	.5	--	.5	--
Pleurozium schreberi	08	--	25	--	10	10
Pohlia nutans	03	.5	.5	--	.5	--
Ptilium crista-castrensis	05	--	.5	--	--	10
Rhytidiopsis robusta	05	.5	03	--	.5	--
Peltigera aphthosa	01	--	--	--	.5	.5
EPIPHYTES						
Alectoria sarmentosa ssp. sarmentosa	--	.5	.5	.5	.5	.5
Hypogymnia enteromorpha	--	.5	.5	--	.5	.5
Hypogymnia physodes	.5	.5	.5	.5	--	--
Platismatia glauca	--	.5	.5	.5	--	--

Table 26. Stands of the Engelmann spruce-subalpine fir/valerian-fleabane (O9) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	AW	IC	JM	PA	PA	SJ	SD
	60	90	70	90	90	91	21
	93	55	81	78	88	00	13
							.1
TREE LAYER							
Abies lasiocarpa	23	14	.5	10	05	06	10
Picea engelmannii	27	01	07	05	10	08	05
TALL SHRUB LAYER							
Abies lasiocarpa	16	10	04	.5	.5	05	20
Picea engelmannii	.5	--	--	--	.5	.5	02
Rhododendron albiflorum	--	--	--	--	--	02	.5
Tsuga mertensiana	--	--	--	--	--	--	08
HERB-DWARF SHRUB LAYER							
Abies lasiocarpa	--	18	--	.5	.5	--	03
Anemone occidentalis	--	05	02	30	.5	--	02
Arnica cordifolia	.5	--	--	--	03	01	03
Epilobium angustifolium	--	01	--	.5	.5	--	--
Erigeron peregrinus	.5	02	05	05	05	05	10
Fragaria virginiana	--	.5	--	--	03	05	--
Parnassia spp.	.5	--	--	--	--	01	.5
Pedicularis bracteosa	01	03	03	02	15	01	--
Phyllodoce empetriformis	.5	--	10	--	05	.5	--
Polygonum viviparum	.5	.5	--	--	.5	.5	--
Pyrola asarifolia	--	--	--	--	.5	01	--
Ranunculus spp.	.5	01	--	.5	--	--	--
Senecio triangularis	.5	--	--	01	--	--	02
Thalictrum occidentale	.5	--	--	--	--	03	--
Trollius albiflorus	.5	--	--	25	--	--	03
Vaccinium membranaceum	.5	--	.5	--	--	03	--
Vaccinium scoparium	02	--	07	--	--	--	--
Valeriana sitchensis	.5	03	07	10	--	03	10
Veratrum eschscholtzii	01	--	--	05	--	02	.5
BRYOID LAYER							
Barbilophozia lycopodioides	18	--	04	--	05	02	--
Brachythecium spp.	20	.5	--	05	--	--	--
Cladonia spp.	02	.5	.5	02	03	.5	--
Dicranum scoparium	--	--	05	--	05	--	--
Eurhynchium pulchellum	--	.5	--	--	01	--	--
Peltigera spp.	--	.5	--	03	02	--	--
Tortula norvegica	--	.5	--	05	01	--	.5

and Dudynsky 1984). In British Columbia, Clement (1981) describes a similar alpine fir-bracted lousewort-broad-leaved arnica-sitka valerian type near Vernon, Eady (1971) has an *Abies lasiocarpa-Valeriana sitchensis* type and Lea (1984) notes an alpine fir-subalpine fleabane-Sitka valerian type. In Alberta, similar types are described by Trottier and Scotter (1973, *Picea-Abies/Trollius albiflorus/Carex* spp.) in BNP and by Baig (1972, *Pinus albicaulis-Abies-Picea/Valeriana sitchensis*) in the southern Rockies. Habeck (1969) has a similar type at Logan Pass, Glacier National Park, Montana.

O10: *Picea engelmannii-Abies lasiocarpa/Phyllodoce glanduliflora-Cassiope mertensiana*

(Engelmann spruce-subalpine fir/heather)

Environment: O10 occurs on mesic Upper Subalpine (2040-2250 m) sites in both MRNP and GNP on moderate slopes with southerly and easterly aspects. Soils are well drained Dystric Brunisols on colluvial and morainal landforms.

Vegetation: The open tree layer (5-10%) (Table 27) is dominated by *Picea engelmannii* (1-6%) and *Abies lasiocarpa* (3-10%). The shrub layer is mostly *Abies lasiocarpa* (3-5%). The herb-dwarf shrub layer (30-85%) is dominated by *Cassiope mertensiana* (10-55%) and *Phyllodoce glanduliflora* (5-30%). Also common are *Antennaria lanata*, *Arnica latifolia*, *Erigeron peregrinus* and *Valeriana sitchensis*. Cover of the bryoid layer is variable (5-65%) with *Dicranum scoparium*, *Cladonia ecmocyna* and *Peltigera rufescens* most frequent. Epiphytes are scarce.

Table 27. Stands of the Engelmann spruce-subalpine fir/heather (O10) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	PA	PA	PA	SD
	11	10	20	30	20
	07	37	30	22	34
	TREE LAYER				
Abies lasiocarpa	05	03	10	06	--
Picea engelmannii	--	02	01	06	13
Pinus albicaulis	--	--	01	05	--
	HERB-DWARF SHRUB LAYER				
Anemone drummondii	.5	--	--	--	.5
Anemone occidentalis	--	.5	--	08	--
Antennaria lanata	06	10	--	.5	.5
Arnica latifolia	05	01	01	01	--
Cassiope mertensiana	08	25	55	20	--
Erigeron peregrinus	08	01	--	10	.5
Hieracium gracile	--	02	.5	--	--
Luetkea pectinata	--	15	35	--	--
Phyllodoce glanduliflora	--	30	--	05	20
Rhododendron albiflorum	.5	--	02	--	--
Sibbaldia procumbens	01	--	--	--	.5
Vaccinium membranaceum	05	--	30	10	--
Valeriana sitchensis	03	.5	--	10	.5
	BRYOID LAYER				
Dicranum scoparium	--	01	40	--	--
Rhacomitrium heterostichum	01	.5	--	--	--
Cladonia ecmocyna	--	02	.5	--	--
Peltigera rufescens	--	--	.5	01	.5

O10 is mature successionally with stand ages of 200 to 400 years. O20 differs from O10 in having *Tsuga mertensiana* codominant in the tree layer and *Luetkea pectinata* important in the herb-dwarf shrub layer. O10 is drier than O9 and is dominated by dwarf shrubs such as *Cassiope mertensiana* and *Phyllodoce glanduliflora* rather than herbs such as *Valeriana sitchensis* and *Erigeron peregrinus*. Intergrades with O20 occur.

Other Studies: O10 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, alpine fir forest, in part) describes a similar type from Yoho National Park, McLean (1970) has an *Abies lasiocarpa-Vaccinium scoparium* type, Eady (1971) has an *Abies lasiocarpa-Picea engelmannii-Vaccinium scoparium* type and Lea (1984) describes an alpine fir-grouseberry-cream mountain heather type. In Alberta, similar types are described by La Roi (1975, *Picea engelmannii/Phyllodoce* types) and Beil (1966) in JNP, by Baig (1972, *Abies-Picea/Phyllodoce*), Kirby and Ogilvie (1969, krummholz/*Vaccinium scoparium*), Ogilvie (1976, *Phyllodoce-Vaccinium scoparium*), and Johnson (1975, *Picea engelmannii-Vaccinium scoparium*).

O11: *Picea* spp./*Ledum groenlandicum*/*Tomenthypnum nitens*

(spruce/Labrador tea/brown moss)

Environment: O11 occurs in subhygric to subhydric Interior Cedar-Hemlock sites (1150-1200 m) on nearly level slopes of various aspects. The one stand sampled is in the Beaver River valley of GNP. Soils are poorly drained Gleysolics and Regosolics on fluvial landforms.

Vegetation: The tree layer is open (5-15%) (Table 28) and dominated by *Picea* spp. (5-10%). The shrub layer (20-50%) is composed mostly of *Ledum groenlandicum* (10-25%) and *Juniperus communis*. The herb-dwarf shrub layer is dense (35-80%) and diverse. Common are *Carex* spp. (3-10%), *Equisetum* spp. (1-5%), *Cornus canadensis* (1-3%), *Linnaea borealis* (1-5%) and *Mitella nuda* (<1-2%). *Tomenthypnum nitens*, *Aulacomnium palustre*, *Pleurozium schreberi*, *Peltigera aphthosa*, and *Sphagnum* spp. are typical of the bryoid layer.

O11 stands are 100 to 275 years old and successionally mature. The open forest physiognomy and dominance of *Ledum groenlandicum* in the shrub layer distinguish O11 from other v.t.s.

Other Studies: O11 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). No similar types are described in British Columbia. In Alberta, La Roi (1975, *Picea mariana*/*Ledum groenlandicum*/-*Equisetum arvense*-*Carex* spp.) and Laidlaw (1971, *Picea mariana*/-*Tomenthypnum*) both in JNP, Jacques and Legge (1974, *Picea*/*Sphagnum*-*Ledum*) in the Kananaskis area, and Ogilvie (1963, Kirby and Ogilvie 1969; *Picea*/*Sphagnum*-*Ledum*) describe similar types. Raup (1947) describes a similar muskeg forest for the southwestern Northwest Territories.

O15: *Populus tremuloides*-*Pinus monticola*/*Pachystima myrsinites*

(aspen-western white pine/mountain lover)

Environment: O15 is restricted to the lower Clachnacudainn Creek area in MRNP where it occurs in the Interior Cedar-Hemlock Ecoregion (670-910 m) on mesic, moderate to steep slopes with southerly aspects of the NC6 Ecosite. Soils are well drained Dystric Brunisols and Orthic Humo-Ferric Podzols on colluvial landforms.

Vegetation: The tree layer is dominated by *Populus tremuloides* (3-10%) and *Pinus monticola* (1-10%) (Table 29, Plate 48). *Acer glabrum* (1-10%) and *Salix scouleriana* (1-5%) are most important in the tall shrub layer (5-15%). The shrub layer (15-35%) has *Pachystima myrsinites* (10-30%), *Vaccinium membranaceum* (3-15%) and *Rubus parviflorus* (<2%) most important. *Pteridium aquilinum* (5-20%) characterizes the herb-dwarf shrub layer (25-60%). Also common are *Apocynum androsaemifolium* (3-10%), *Chimaphila umbellata* (2-3%), *Epilobium angustifolium* (≤1%), *Amelanchier alnifolia* (<1%), *Berberis repens* (≤2%) and *Aster ciliolatus* (≤2%). The bryoid layer is usually sparse (10-25%) with *Rhacomitrium canescens*, *Dryptodon patens* and *Peltigera canina* typical. *Platismatia glauca* and *Hypogymnia physodes* are the most frequent epiphytes.

Stands are 55 to 60 years old since fire and O15 is intermediate successionally. O15 is distinguished by the mixed tree canopy dominated by *Populus tremuloides* and *Pinus monticola*. Closed forest phases of O15 occur occasionally.

Other Studies: No similar types are described by other authors.

O20: *Abies lasiocarpa*-*Tsuga mertensiana*/*Cassiope mertensiana*-*Phyllodoce empetriformis*-*Luetkea pectinata*

(subalpine fir-mountain hemlock/white mountain and red heather-luetkea)

Environment: O20 occurs on mesic, mostly Upper Subalpine (1900-2100 m) sites of various aspect and slope throughout both parks (Plate 8). The soils are well drained Dystric Brunisols and Humo-Ferric Podzols on morainal and colluvial landforms.

Vegetation: The open tree layer (5-15%) (Table 30) is dominated by *Abies lasiocarpa* (5-10%) and *Tsuga mertensiana* (1-3%). *Abies lasiocarpa* (5-10%) also dominates the shrub layer (10-30%), with *Tsuga mertensiana* (1-5%) and *Rhododendron albiflorum* (1-5%) occurring commonly. Total cover of the herb-dwarf shrub layer is 50 to 80% with *Cassiope mertensiana* (20-40%), *Luetkea pectinata*

Table 28. Stands of the spruce/Labrador tea/brown moss (O11) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	BB 10 26	HD 20 19	MF 20 35	MF 21 47	SD 21 04
TREE LAYER					
Abies lasiocarpa	--	--	--	01	02
Picea spp.	05	07	10	07	05
Pinus contorta	10	01	--	02	--
SHRUB LAYER					
Betula glandulosa	02	--	37	--	03
Juniperus communis	30	.5	--	11	--
Ledum groenlandicum	05	15	35	18	25
Picea spp.	02	05	10	09	05
Pinus contorta	06	--	--	03	--
Potentilla fruticosa	--	--	10	03	--
Salix glauca	.5	--	.5	05	--
HERB-DWARF SHRUB LAYER					
Aster ciliolatus	--	02	--	01	--
Calypso bulbosa	--	03	--	--	--
Carex spp.	01	20	11	09	--
Cornus canadensis	.5	03	01	.5	05
Elymus innovatus	--	35	--	--	--
Empetrum nigrum	15	--	--	03	--
Epilobium angustifolium	--	--	--	--	02
Fragaria virginiana	--	02	--	.5	02
Habenaria dilatata	01	--	--	.2	.5
Kalmia polifolia	--	--	--	02	.5
Linnaea borealis	01	05	04	02	--
Mitella nuda	.5	.5	04	01	--
Oxycoccus microcarpus	01	--	02	02	.5
Parnassia fimbriata	.5	--	--	--	03
Pedicularis bracteosa	.5	--	--	--	02
Petasites palmatus	02	--	--	02	--
Rosa acicularis	--	01	03	01	--
Rubus pubescens	--	01	.5	--	05
Equisetum spp.	05	--	01	01	05
Lycopodium annotinum	--	02	--	--	.5
BRYOID LAYER					
Aulacomnium palustre	05	--	.5	03	.5
Hylocomium splendens	--	75	--	26	--
Pleurozium schreberi	01	.5	03	01	.5
Sphagnum spp.	70	--	25	08	55
Tomenthypnum nitens	10	--	01	05	.5
Cladonia ecmocyna	.5	--	--	02	--
Peltigera aphthosa	01	.5	--	02	.5
Peltigera polydactyla	--	--	01	.5	--
EPIPHYTES					
Alectoria sarmentosa ssp. sarmentosa	.5	--	--	.5	--
Cetraria pinastri	.5	--	--	.5	--
Letharia vulpina	.5	--	--	.5	.5

(10-20%), *Vaccinium membranaceum* (10-20%) and *Phyllodoce* spp. (5-10%) dominant. Other common species with low cover include *Antennaria lanata, Hieracium gracile, Arnica* spp. and *Valeriana sitchensis*. The bryoid layer has 10 to 60% cover with *Barbilophozia lycopodioides, Dicranum*

Table 29. Stands of the aspen-western white pine/mountain lover (O15) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	PA	SD	SD	SD	MF
	30	21	21	21	30
	07	31	32	33	18
TREE LAYER					
Betula papyrifera	--	01	--	--	28
Picea engelmannii	--	01	--	02	--
Pinus monticola	10	01	04	03	01
Populus tremuloides	25	02	10	08	03
Pseudotsuga menziesii	.5	--	03	--	.5
Thuja plicata	--	--	--	02	01
TALL SHRUB LAYER					
Acer glabrum	05	01	10	.5	07
Alnus crispa	.5	--	05	05	--
Betula papyrifera	--	.5	--	.5	03
Salix scouleriana	.5	01	05	05	02
SHRUB LAYER					
Lonicera involucrata	--	02	--	--	--
Lonicera utahensis	.5	--	03	--	.5
Pachystima myrsinites	30	07	20	10	23
Rubus parviflorus	.5	.5	.5	02	02
Shepherdia canadensis	.5	.5	.5	.5	02
Vaccinium membranaceum	15	.5	03	.5	04
HERB-DWARF SHRUB LAYER					
Amelanchier alnifolia	.5	.5	.5	--	01
Apocynum androsaemifolium	10	.5	03	03	04
Aster ciliolatus	.5	05	02	--	.5
Berberis repens	.5	.5	02	05	--
Chimaphila umbellata	02	.5	03	03	02
Clintonia uniflora	.5	--	02	.5	--
Danthonia spicata	--	10	.5	--	01
Epilobium angustifolium	.5	08	.5	.5	01
Fragaria virginiana	01	05	--	--	--
Hieracium albiflorum	.5	--	.5	.5	--
Juniperus communis	.5	--	--	.5	--
Pyrola secunda	--	--	02	02	.5
Rosa acicularis	--	.5	--	.5	--
Pteridium aquilinum	20	.5	05	10	09
BRYOID LAYER					
Dryptodon patens	.5	--	.5	.5	10
Pleurozium schreberi	--	--	02	--	--
Polytrichum juniperinum	--	--	01	.5	.5
Rhacomitrium canescens	.5	.5	.5	--	03
Cladonia chlorophaea	--	.5	02	--	--
Peltigera aphthosa	--	.5	.5	.5	--
Peltigera canina	--	.5	.5	.5	.5
Peltigera rufescens	--	.5	.5	--	--
EPIPHYTES					
Hypogymnia physodes	--	.5	--	--	.5
Platismatia glauca	--	.5	--	.5	.5

Table 30. Stands of the subalpine fir-mountain hemlock/heather-luetkea (O20) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	JD	JD	MF	PA	PA	PA	PA	PA	SD
	10	10	10	21	10	10	10	10	10	20
	59	53	67	11	20	24	28	41	49	92
TREE LAYER										
Abies lasiocarpa	07	12	15	.5	13	08	05	08	05	15
Picea engelmannii	--	02	.5	--	--	--	.5	--	--	--
Tsuga mertensiana	01	02	.5	01	05	05	03	04	08	01
SHRUB LAYER										
Abies lasiocarpa	05	12	18	08	10	.5	10	02	--	10
Rhododendron albiflorum	--	--	02	--	03	--	--	01	15	05
Tsuga mertensiana	.5	03	--	02	05	05	05	--	.5	--
HERB-DWARF SHRUB LAYER										
Anemone occidentalis	.5	.5	--	--	.5	--	--	--	--	--
Antennaria lanata	--	05	01	--	.5	01	--	--	--	.5
Arnica latifolia	--	03	03	--	05	--	--	--	--	.5
Cassiope mertensiana	20	40	25	40	20	35	30	40	30	10
Deschampsia atropurpurea	15	--	.5	--	03	--	--	.5	--	--
Erythronium grandiflorum	15	05	--	--	.5	--	--	--	--	--
Hieracium gracile	.5	.5	.5	--	01	.5	.5	01	--	.5
Luetkea pectinata	50	20	35	20	10	05	01	10	10	05
Luzula parviflora	--	01	--	--	.5	--	.5	--	--	--
Phyllodoce empetriformis	12	10	02	--	01	--	--	10	--	--
Phyllodoce glanduliflora	--	--	--	07	--	10	05	.5	--	--
Vaccinium membranaceum	--	.5	30	07	10	10	10	15	20	05
Valeriana sitchensis	07	05	.5	--	.5	--	--	--	--	03
BRYOID LAYER										
Dicranum pallidisetum	--	--	30	--	--	15	--	--	--	.5
Dicranum scoparium	01	--	--	08	03	--	--	--	30	--
Rhacomitrium canescens	.5	--	10	--	.5	.5	--	.5	--	10
Barbilophozia hatcheri	25	15	--	--	30	--	--	--	--	--
Barbilophozia lycopodioides	25	--	20	.5	.5	15	.5	--	--	--
Barbilophozia floerkei	--	--	--	--	--	.5	.5	.5	10	--
Cladonia ecmocyna	.5	.5	.5	.5	.5	10	--	--	--	--
EPIPHYTES										
Bryoria fremontii	.5	--	--	--	--	--	.5	--	.5	--
Bryoria pseudofuscescens	.5	.5	.5	--	.5	--	--	--	--	--
Letharia vulpina	.5	--	--	--	.5	.5	.5	--	.5	.5

scoparium, *Rhacomitrium canescens* and *Cladonia ecmocyna* having highest cover. Epiphytes are scarce with *Letharia vulpina*, *Bryoria fremontii* and *Bryoria pseudofuscescens* most common.

Stand ages are 125 to >200 years and O20 is mature successionally. O20 is similar to O10 but differs in having *Tsuga mertensiana* important in the tree layer rather than *Picea engelmannii* and in *Luetkea pectinata* being important on the herb-dwarf shrub layer.

Other Studies: In British Columbia, Yarie (1980, *Vaccinio (membranacei)-Tsugetum mertensianae*) has a similar type.

O21: *Picea engelmannii-Abies lasiocarpa/Rhododendron albiflorum-Vaccinium membranaceum*

(Engelmann spruce-subalpine fir/rhododendron-tall bilberry)

Environment: O21 occurs throughout MRNP and GNP on mesic, mostly Lower Subalpine (1800-2000 m) sites on southerly, moderate to steep slopes. The soils are well drained Orthic Ferro-Humic Podzols and Dystric Brunisols on morainal and colluvial landforms.

Vegetation: The tree layer is open (5-10%) (Table 31, Plate 33) and dominated by *Abies lasiocarpa* (3-10%) and *Picea engelmannii* (<1-5%). The shrub layer is well developed (35-80%) with *Rhododendron albiflorum* (35-60%) dominant. *Vaccinium membranaceum* (20-55%) occurs both in this layer and the herb-dwarf shrub layer. *Abies lasiocarpa* (1-5%) usually occurs in the shrub layer also. The herb-dwarf shrub layer (55-80%) is dominated by *Vaccinium membranaceum* (20-55%), with lesser amounts of *Valeriana sitchensis* (1-10%) and *Arnica latifolia* (1-5%). *Luzula* spp., *Abies lasiocarpa* and *Pedicularis* spp. occur with low cover. Cover of the bryoid layer is variable (5-75%) with *Dicranum scoparium, Polytrichum juniperinum, Barbilophozia lycopodioides* and *Cladonia ecmocyna* most prominent. Epiphytes are sparse with *Parmeliopsis hyperopta, Parmeliopsis ambigua* and *Letharia vulpina* most common.

Stand ages are 75 to 325 years and O21 is mature successionally. Younger stands occur at lower elevations but are compositionally indistinguishable from older, higher stands. O21 is similar to C21 but differs primarily being an open forest and having lower cover values for *Rhododendron albiflorum*.

Other Studies: In eastern British Columbia, Lea (1984) describes a similar alpine fir-white-flowered rhododendron-grouseberry-Sitka valerian type. In the eastern Cascade Mountains of Washington, del Moral and Fleming (1979) describe a similar type.

O22: *Abies lasiocarpa-Pinus albicaulis-Picea engelmannii/Vaccinium membranaceum-Cassiope mertensiana*

(subalpine fir-whitebark pine-Engelmann spruce/tall bilberry-white mountain heather)

Environment: O22 occurs on mesic, Upper Subalpine (1950-2150 m) sites throughout MRNP and GNP on moderate, mostly westerly and southerly slopes. The soils are well drained Dystric Brunisols developed on colluvial and morainal landforms.

Vegetation: The open tree layer (5-15%) (Table 32) is dominated by *Abies lasiocarpa* (2-10%), *Pinus albicaulis* (2-5%) and *Picea engelmannii* (1-5%). The shrub layer is usually well developed (20-50%) with *Rhododendron albiflorum* (5-40%), *Abies lasiocarpa* (2-5%) and *Pinus albicaulis* (<1-2%) most important. The herb-dwarf shrub layer (25-75%) is dominated by *Vaccinium membranaceum* (20-40%), *Cassiope mertensiana* (5-35%) and *Phyllodoce empetriformis* (3-5%) with *Arnica latifolia, Luetkea pectinata* and *Valeriana sitchensis* also often present with low cover. Bryoid layer cover is variable (5-65%) with *Barbilophozia* spp., *Cladonia ecmocyna, Polytrichum juniperinum* and *Rhacomitrium canescens* most common. Epiphytes are generally sparse with *Letharia vulpina* and *Bryoria* spp. most common.

O22 is mature successionally with stand ages 165 to 325 years. The distinguishing characteristic of O22 is the presence of *Pinus albicaulis* in the tree layer.

Other Studies: No similar types are described by other authors.

O23: *Picea engelmannii-Populus trichocarpa/Dryas drummondii*

(Engelmann spruce-black cottonwood/yellow dryad)

Environment: O23 occurs in the Interior Cedar-Hemlock Ecoregion (970 m) at the confluence of Stony Creek and the Beaver River in GNP. The site is a gently sloping, subxeric, north facing fluvial fan. The soil is a rapidly drained Orthic Regosol.

Vegetation: The open tree layer (Table 33) has a total cover of 15 to 25% and is dominated by *Picea engelmannii* (10-15%) and *Populus trichocarpa* (5-10%). The shrub layer (5-30%) is composed mainly of young *Picea engelmannii* (3-5%) and *Populus trichocarpa* (2-20%), with <1% of *Alnus crispa* and *Salix* spp. The herb-dwarf shrub layer is composed almost entirely of *Dryas drummondii* (70-80%). The bryoid layer is sparse with *Ceratodon purpureus, Ptilium crista-castrensis, Rhacomitrium canescens* and *Cladonia cariosa* present with <1% cover.

Trees have established on the fan only 30 to 40 years ago and O23 is in an early successional stage.

Other Studies: No similar types are described by other authors.

Table 31. Stands of the Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	HD	HD	PA	PA	PA	PA
	10	10	11	11	10	10	10	20
	70	91	04	10	15	31	38	39
TREE LAYER								
Abies lasiocarpa	05	05	03	02	10	05	03	05
Picea engelmannii	01	.5	--	05	.5	.5	--	.5
SHRUB LAYER								
Abies lasiocarpa	.5	.5	01	.5	--	.5	--	10
Rhododendron albiflorum	65	03	60	35	65	40	45	55
Sorbus spp.	--	--	15	--	10	--	.5	.5
Vaccinium membranaceum	--	.5	25	25	--	--	40	--
HERB-DWARF SHRUB LAYER								
Abies lasiocarpa	--	.5	03	--	03	--	--	05
Arnica cordifolia	.5	10	04	--	--	--	--	--
Arnica latifolia	--	--	--	.5	02	.5	10	01
Cassiope mertensiana	--	--	08	--	--	10	--	--
Deschampsia atropurpurea	--	02	--	--	--	--	.5	.5
Epilobium angustifolium	--	--	--	--	02	--	--	.5
Hieracium gracile	--	.5	--	--	--	.5	--	--
Luetkea pectinata	--	--	--	--	--	15	--	35
Luzula glabrata	--	--	--	--	--	--	03	.5
Pedicularis bracteosa	--	.5	--	--	.5	.5	03	--
Phyllodoce empetriformis	--	--	03	--	--	.5	--	10
Rubus pedatus	--	01	10	20	--	--	--	--
Vaccinium membranaceum	70	10	05	--	55	40	--	45
Valeriana sitchensis	--	10	.5	03	01	.5	20	.5
Gymnocarpium dryopteris	--	--	15	05	05	--	--	--
Lycopodium spp.	--	--	.5	.5	.5	.5	.5	15
BRYOID LAYER								
Dicranum fuscescens	20	03	--	--	--	--	--	--
Dicranum pallidisetum	--	--	--	--	.5	20	--	--
Dicranum scoparium	02	10	40	--	.5	--	--	20
Polytrichum juniperinum	--	.5	--	--	.5	--	--	15
Polytrichum piliferum	--	--	--	--	--	--	01	05
Rhacomitrium canescens	--	--	--	--	--	--	--	05
Barbilophozia lycopodioides	.5	.5	.5	.5	.5	30	--	.5
Lophozia ventricosa var. ventricosa	--	05	--	.5	--	--	--	--
Barbilophozia floerkei	20	--	10	--	--	--	--	--
Cladonia cenotea	.5	.5	--	.5	--	--	--	--
Cladonia ecmocyna	--	--	.5	--	.5	05	--	.5

SHRUB VEGETATION TYPES

S2: *Abies lasiocarpa-Salix* spp./*Valeriana sitchensis*

(subalpine fir-willow)

Environment: S2 occurs in central GNP on mesic Lower Subalpine to Upper Subalpine sites (1580-1960 m) with steep slopes and mostly easterly aspects. Soils are Dystric Brunisols and Regosolics on colluvial and morainal landforms which are snow avalanched.

Table 32. Stands of the subalpine fir-whitebark pine-(Engelmann spruce)/tall bilberry-heather (O22) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	HD	HD	JD	PA	PA	SD
	10	11	10	10	30	20
	50	12	41	61	11	91
TREE LAYER						
Abies lasiocarpa	10	02	07	02	05	05
Picea engelmannii	.5	.5	05	08	--	--
Pinus albicaulis	10	03	03	05	.5	02
Tsuga mertensiana	--	.5	--	--	10	--
TALL SHRUB LAYER						
Abies lasiocarpa	02	.5	08	05	02	02
Picea engelmannii	.5	--	01	--	--	.5
Pinus albicaulis	.5	--	01	--	--	--
Tsuga mertensiana	--	--	--	.5	03	--
SHRUB LAYER						
Abies lasiocarpa	03	--	08	02	02	03
Pinus albicaulis	.5	.5	02	.5	--	02
Rhododendron albiflorum	45	40	.5	03	50	.5
Tsuga mertensiana	--	--	--	--	03	--
HERB-DWARF SHRUB LAYER						
Abies lasiocarpa	02	--	--	.5	10	--
Arenaria capillaris	--	--	.5	--	--	02
Arnica latifolia	05	--	.5	--	--	.5
Cassiope mertensiana	--	02	--	35	25	05
Hieracium gracile	01	--	--	--	--	.5
Luetkea pectinata	--	--	10	15	35	03
Luzula wahlenbergii	--	--	.5	--	--	.5
Pedicularis bracteosa	03	--	.5	--	--	--
Phyllodoce empetriformis	--	03	05	10	--	.5
Pinus albicaulis	--	02	--	--	--	--
Saxifraga ferruginea	--	--	--	.5	--	.5
Vaccinium membranaceum	40	18	30	20	50	03
Valeriana sitchensis	08	--	.5	--	--	.5
BRYOID LAYER						
Ceratodon purpureus	--	10	--	--	.5	--
Dicranum fuscescens	--	10	--	07	--	--
Dicranum scoparium	.5	--	--	08	--	--
Polytrichum juniperinum	.5	.5	--	--	--	01
Rhacomitrium canescens	.5	--	10	.5	--	--
Barbilophozia spp.	.5	.5	--	25	--	.5
Lophozia longidens ssp. longidens	55	--	--	--	--	--
Cladonia ecmocyna	.5	45	10	.5	--	.5
Solorina crocea	--	.5	.5	--	.5	.5

Vegetation: Stunted *Abies lasiocarpa* (10-50%) dominates the shrub layer (40-90%) (Table 34) with *Picea engelmannii* (3-5%) and *Salix* spp. (5-10%) also common. The herb-dwarf shrub layer (20-80%) is varied and typically contains *Epilobium angustifolium* (<1-3%), *Vaccinium scoparium* (<1-10%), *Valeriana sitchensis* (2-15%), *Fragaria virginiana* (1-5%) and *Carex* spp. (<1%). Bryoid layer cover is variable with *Dicranum scoparium*, *Tortula ruralis* and *Barbilophozia* spp. most common.

S2 is successionally mature, maintained by periodic avalanching, although it has characteristics of earlier successional stages. S2 is distinguished by the dominance of *Abies lasiocarpa* and occurrence on snow avalanche tracks. It usually occurs at higher elevations than S13, another avalanche track v.t.

Table 33. Stands of the Engelmann spruce-black cottonwood/yellow dryad (O23) v.t. Values are per cent cover except for epiphytes where 0.5 indicates the species was present.

	PA 10 44	SD 30 01
TREE LAYER		
Abies lasiocarpa	.5	.5
Picea engelmannii	10	18
Populus trichocarpa	05	12
TALL SHRUB LAYER		
Abies lasiocarpa	--	.5
Picea engelmannii	03	05
Populus trichocarpa	02	10
SHRUB LAYER		
Abies lasiocarpa	.5	--
Alnus crispa	.5	.5
Cornus stolonifera	.5	--
Picea engelmannii	02	05
Populus trichocarpa	02	15
Salix barclayi	--	10
Salix commutata	.5	--
HERB-DWARF SHRUB LAYER		
Dryas drummondii	70	80
Picea engelmannii	--	.5
Pyrola secunda	.5	--
Salix barclayi	--	10
BRYOID LAYER		
Ceratodon purpureus	.5	.5
Pleurozium schreberi	--	01
Ptilium crista-castrensis	.5	.5
Rhacomitrium canescens	.5	.5
Cladonia cariosa	.5	02
Cladonia fimbriata	.5	.5

Other Studies: S2 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, similar types are described by Kuchar (1978, deciduous avalanche scrub) in Yoho National Park. In Alberta, Trottier and Scotter (1973, *Picea-Abies/ Alnus crispa-Vaccinium scoparium/ Heracleum lanatum*) in BNP have a similar type. Butler (1979) describes a comparable type in Glacier National Park, Montana.

S13: *Alnus crispa*/fern

(green alder/fern)

Environment: S13 occurs throughout GNP on mesic to subhygric Interior Cedar-Hemlock to Lower Subalpine sites (1040-1860 m) on steep to moderate slopes and predominantly southerly and westerly aspects. Soils are well to moderately well drained Brunisolics, Regosolics and Podzolics on colluvial and fluvial landforms which are usually snow avalanched.

Table 34. Stands of the subalpine fir-willow (S2) v.t. Values are per cent cover.

	HD	HD	JD	JD	SD
	10	20	10	10	20
	34	47	73	76	97
TALL SHRUB LAYER					
Abies lasiocarpa	20	03	05	--	30
Picea engelmannii	.5	01	01	--	--
Pinus albicaulis	.5	01	.5	01	--
SHRUB LAYER					
Abies lasiocarpa	40	30	.5	50	40
Picea engelmannii	.5	05	--	--	--
Rhododendron albiflorum	--	02	--	35	--
Salix commutata	--	--	01	--	--
Salix drummondiana	--	05	10	--	--
Salix glauca	--	--	05	--	--
Salix vestita	--	25	.5	--	--
HERB-DWARF SHRUB LAYER					
Epilobium angustifolium	03	--	.5	.5	--
Fragaria virginiana	05	.5	.5	--	--
Luzula parviflora	--	--	--	.5	.5
Pyrola secunda	.5	.5	--	--	.5
Vaccinium membranaceum	--	--	--	10	02
Vaccinium scoparium	--	02	--	--	.5
BRYOID LAYER					
Dicranum scoparium	10	--	--	.5	01
Drepanocladus uncinatus	.5	30	--	--	--
Barbilophozia hatcheri	--	--	--	.5	01
Barbilophozia lycopodioides	35	05	--	--	01
Cladonia ecmocyna	--	.5	--	03	01

Vegetation: *Alnus crispa* (70-95%) (Table 35, Plates 17 and 49) dominates the shrub layer. The herb-dwarf shrub layer is varied with *Dryopteris assimilis*, *Gymnocarpium dryopteris*, *Smilacina racemosa* and *Streptopus amplexifolius* important. Bryoid layer cover is low with *Brachythecium* spp. common. S13 is mature successionally, maintained by periodic avalanches. It differs from S2 which also occurs on avalanche tracks by the dominance of *Alnus crispa* and by occurring at lower altitudes, usually in the Interior Cedar-Hemlock Ecoregion.

Other Studies: S13 is also described in KNP (Achuff and Dudynsky 1984). No similar types are described by other authors.

S14: *Salix* spp.-*Tsuga mertensiana-Abies lasiocarpa/Vaccinium membranaceum*

(willow-mountain hemlock-subalpine fir/tall bilberry)

Environment: S14 occurs in GNP on mesic sites in the upper part of the Lower Subalpine to the lower part of the Upper Subalpine (1700-2170 m) on steep to very steep slopes of various aspect. Soils are well drained Dystric Brunisols on colluvial landforms which are usually snow avalanched.

Vegetation: The shrub layer (35-75%) (Table 36) consists mostly of *Tsuga mertensiana* (5-20%), *Abies lasiocarpa* (2-10%), *Salix* spp. (8-35%) and *Rhododendron albiflorum* (5-20%). *Vaccinium membranaceum* (10-20%) usually dominates the herb-dwarf shrub layer (35-85%). Also important are *Luetkea pectinata*, *Epilobium angustifolium* and *Carex* spp. Bryoid layer cover is variable with *Cladonia* spp., *Barbilophozia* spp. and *Dicranum* spp. most common.

Table 35. Stands of the green alder/fern (S13) v.t. Values are per cent cover.

	HD	HD	JD	JD	JD	MF	MF	PA	SD	SD
	10	30	10	10	10	30	30	30	20	21
	54	23	47	48	55	31	34	04	96	19
SHRUB LAYER										
Abies lasiocarpa	--	05	--	.5	--	--	01	--	05	--
Acer glabrum	--	--	--	--	--	--	--	10	02	30
Alnus crispa	05	40	20	90	05	05	99	80	75	20
Rubus strigosus	--	--	--	--	01	--	--	.5	--	--
Sambucus pubens	--	--	--	01	--	--	--	--	--	03
Sorbus sitchensis	03	--	02	.5	--	--	--	--	--	--
Vaccinium membranaceum	30	.5	10	03	--	--	--	--	--	--
Vaccinium ovalifolium	--	03	.5	--	--	--	--	--	--	--
HERB-DWARF SHRUB LAYER										
Calamagrostis canadensis	05	--	--	--	--	--	--	.5	--	--
Elymus glaucus	.5	--	--	--	--	.5	--	--	--	--
Epilobium angustifolium	--	--	--	--	.5	--	01	--	--	--
Galium triflorum	--	--	--	--	.5	--	--	10	--	.5
Heracleum lanatum	--	--	--	--	.5	--	--	--	--	.5
Leptarrhena pyrolifolia	--	.5	--	--	--	--	02	--	--	--
Luzula parviflora	--	--	08	--	.5	--	--	--	--	--
Mitella breweri	--	--	--	.5	--	--	01	--	--	.5
Ribes lacustre	01	--	.5	--	--	--	03	--	07	--
Rubus parviflorus	--	--	--	--	--	04	--	--	--	03
Smilacina racemosa	08	--	--	--	--	--	--	05	05	02
Streptopus amplexifolius	--	--	.5	20	--	--	--	--	05	02
Thalictrum occidentale	--	--	--	--	--	01	--	--	--	.5
Tiarella unifoliata	--	--	--	--	05	--	--	--	--	05
Urtica gracilis	--	--	--	--	--	12	--	10	--	03
Veratrum eschscholtzii	--	--	--	02	.5	--	--	--	.5	--
Viola renifolia	--	--	--	--	--	02	--	03	--	--
Viola rugulosa	--	--	--	--	.5	.5	--	--	--	05
Salix sitchensis	--	04	--	--	--	--	--	--	.5	--
Streptopus roseus	--	--	--	--	10	06	.5	--	--	--
Athyrium filix-femina	--	--	--	70	--	01	13	15	--	--
Dryopteris assimilis	.5	--	--	05	--	01	--	--	20	--
Gymnocarpium dryopteris	--	--	02	.5	25	01	01	--	--	.5
Pteridium aquilinum	85	--	46	--	35	--	--	--	--	--
BRYOID LAYER										
Brachythecium curtum	--	--	15	--	--	25	--	--	--	--
Plagiothecium denticulatum	--	--	.5	--	05	--	--	--	--	--
Rhacomitrium canescens	.5	30	--	--	--	--	--	--	--	--

S14 is mature successionally due to periodic avalanching. It is distinguished by being dominated by *Tsuga mertensiana* and *Salix* spp. rather than by *Abies lasiocarpa* as in S2 or *Alnus crispa* as in S13, both of which are also avalanched. Intergrades between S14 and S13 or S2 occur.

Other Studies: No similar types are described by other authors.

S15: *Salix commutata-Salix brachycarpa*

(willow)

Environment: S15 occurs in central GNP on subhygric to subhydric Lower Subalpine (1810-1890 m) sites with gentle slopes and easterly aspects (Plate 15). Soils are poorly drained Regosolics on fluvial landforms often in the bottom of cirques.

Table 36. Stands of the willow-mountain hemlock-subalpine fir/tall bilberry (S14) v.t. Values are per cent cover.

	HD	JD	MF	PA	PA	SD
	10	10	21	10	10	21
	76	50	13	45	60	27
TALL SHRUB LAYER						
Abies lasiocarpa	02	05	10	02	--	02
Pinus albicaulis	--	--	05	--	--	--
Picea engelmannii	--	--	14	--	--	--
Tsuga mertensiana	03	25	05	01	--	--
SHRUB LAYER						
Abies lasiocarpa	12	30	30	03	--	25
Pinus albicaulis	--	--	05	.5	--	--
Rhododendron albiflorum	20	20	--	--	.5	09
Salix spp.	--	--	--	08	35	--
Vaccinium membranaceum	--	15	20	20	25	20
Vaccinium ovalifolium	30	05	--	--	--	--
Tsuga mertensiana	15	15	05	04	--	10
HERB-DWARF SHRUB LAYER						
Abies lasiocarpa	--	--	--	--	.5	03
Anaphalis margaritacea	--	--	--	.5	.5	--
Cassiope mertensiana	30	--	--	--	--	.5
Epilobium angustifolium	--	--	--	05	60	02
Hieracium gracile	--	--	--	--	.5	.5
Luetkea pectinata	15	--	10	--	--	02
Carex sp.	01	--	03	--	--	--
BRYOID LAYER						
Dicranum spp.	.5	03	07	--	--	05
Rhacomitrium heterostichum	--	--	10	--	--	--
Polytrichum sp.	--	--	--	--	40	--
Barbilophozia lycopodioides	--	02	--	--	--	05
Barbilophozia floerkei	90	--	--	--	--	.5
Marchantia sp.	--	--	--	--	15	--
Lophozia longidens ssp. longidens	--	15	--	--	--	--
Cladonia carneola	03	--	.5	--	--	.5
Cladonia ecmocyna	.5	--	--	--	--	03
Cladonia pleurota	--	.5	.5	--	--	--
Lecidea granulosa	.5	--	.5	--	--	.5

Vegetation: *Salix* spp. dominate the shrub layer (25-85%) (Table 37). The herb-dwarf shrub layer is diverse with characteristic species including *Leptarrhena pyrolifolia*, *Senecio triangularis*, *Phleum alpinum*, *Luetkea pectinata* and *Carex* spp. Bryoid layer cover is variable (10-50%) with *Aulacomnium palustre*, *Bryum pseudotriquetrum*, *Calliergon stramineum* and *Philonotis fontana* most typical.

S15 is successionally mature due to wet conditions and perhaps being in snow avalanche run-out areas. It is distinguished by the dominance of *Salix* spp.

Other Studies: No simiiar types are described by other authors.

S17: *Alnus tenuifolia/Lysichiton americanum*

(alder/skunk cabbage)

Environment: S17 occurs in both MRNP and GNP in the Interior Cedar-Hemlock Ecoregion (650-870 m) along the Beaver and Illecillewaet rivers. Sites are hydric to subhydric with very poorly drained Regosolics on level or depressional fluvial landforms.

Table 37. Stands of the willow (S15) v.t. Values are per cent cover.

	HD	JD	JD	PA	PA	SD
	10	10	10	10	10	30
	61	74	75	30	62	03
SHRUB LAYER						
Salix barclayi	--	25	--	10	--	--
Salix barrattiana	--	20	--	--	--	--
Salix brachycarpa	--	--	--	--	--	05
Salix commutata	80	40	30	25	--	10
HERB-DWARF SHRUB LAYER						
Agrostis thurberiana	--	.5	.5	01	--	--
Arnica mollis	05	01	--	--	--	.5
Caltha leptosepala	--	--	.5	15	--	.5
Carex lenticularis	.5	--	.5	--	--	--
Carex nigricans	15	--	35	20	--	02
Cassiope mertensiana	--	--	--	.5	.5	--
Deschampsia atropurpurea	--	--	.5	--	.5	.5
Epilobium alpinum	--	--	.5	--	--	.5
Erigeron peregrinus	--	01	.5	--	--	01
Eriophorum angustifolium	--	--	02	--	--	80
Juncus mertensianus	.5	--	--	02	.5	--
Leptarrhena pyrolifolia	45	--	25	01	--	05
Luetkea pectinata	--	--	01	.5	--	.5
Phleum alpinum	--	.5	.5	.5	01	--
Potentilla diversifolia	--	--	.5	--	--	.5
Senecio triangularis	--	10	.5	.5	--	10
Vaccinium membranaceum	--	--	--	--	.5	--
Valeriana sitchensis	--	30	--	--	--	.5
Veronica alpina	--	.5	.5	--	--	01
Poa sp.	--	--	.5	--	.5	--
Ligusticum canbyi	--	20	--	05	--	--
Equisetum arvense	--	--	01	.5	--	.5
BRYOID LAYER						
Aulacomnium palustre	--	--	08	03	--	05
Brachythecium turgidum	--	--	25	--	--	--
Bryum pseudotriquetrum	--	--	08	01	--	--
Calliergon stramineum	--	--	08	01	--	--
Drepanocladus uncinatus	--	--	15	--	--	--
Philonotis fontana var.fontana	--	--	--	02	15	--

Vegetation: The shrub layer (30-80%) (Table 38) is mostly *Alnus tenuifolia* (10-55%) and *Salix scouleriana* (20-70%) with *Lonicera involucrata* (5%) also frequent (Plate 25). *Lysichiton americanum* (5-65%) characterizes the herb-dwarf shrub layer. Cover of this species increases greatly through the growing season as the large leaves expand and cover estimates are likely influenced by the date of sampling. Also important are *Equisetum fluviatile* (2-15%) and *Scirpus microcarpus* (10-50%). Species with generally low cover include *Athyrium filix-femina*, *Cicuta douglasii*, *Cinna latifolia*, *Epilobium glandulosum*, *Urtica gracilis* and *Galium trifidum*. A bryoid layer is virtually absent due to frequent standing water and deposition of mineral material. Unvegetated mineral soil may occupy 50 to 70% of the ground surface.

S17 is difficult to categorize successionally. It is at an early stage of primary succession but is more or less stable and in equilibrium with periodic flooding and the high water table. It is unlikely to change substantially in the next few hundred years which is characteristic of the mature stage. Thus, it is perhaps best regarded as mature. The occurrence of *Alnus tenuifolia* and *Lysichiton americanum* are distinctive for S17.

Other Studies: No similar types are described by other authors.

Table 38. Stands of the alder/skunk cabbage (S17) v.t. Values are per cent cover.

	HD	HD	HD	HD	PA
	30	30	30	30	30
	12	13	14	25	05
SHRUB LAYER					
Alnus tenuifolia	55	45	10	25	30
Cornus stolonifera	.5	10	--	--	15
Salix scouleriana	25	20	70	05	--
Lonicera involucrata	--	05	05	.5	05
HERB-DWARF SHRUB LAYER					
Athyrium filix-femina	--	--	10	.5	03
Cicuta douglasii	.5	--	.5	.5	02
Cinna latifolia	.5	05	.5	.5	.5
Epilobium glandulosum	.5	.5	.5	--	.5
Galium trifidum	03	.5	.5	.5	.5
Poa palustris	.5	.5	--	.5	--
Scirpus microcarpus	30	50	--	50	10
Urtica dioica	--	--	50	--	.5
Aster modestus	03	01	--	03	--
Lysichiton americanum	01	05	05	.5	65
Equisetum fluviatile	15	20	.5	10	02

LOW SHRUB-HERB VEGETATION TYPES

L5: *Phyllodoce glanduliflora-Cassiope mertensiana-Antennaria lanata*

(heather-everlasting)

Environment: L5 occurs throughout MRNP and GNP on mesic Upper Subalpine to Alpine sites (2040-2500 m) with gentle to steep slopes and predominantly southerly and westerly aspects. Soils are well drained Dystric Brunisols and Orthic Humo-Ferric Podzols on morainal and colluvial landforms, often with eolian veneers. Stands on colluvium are typically snow avalanched.

Vegetation: L5 is dominated by *Cassiope mertensiana* (15-50%), *Phyllodoce glanduliflora* (10-50%) and *Antennaria lanata* (2-20%) (Table 39, Plate 30). Also important are *Phyllodoce empetriformis* (3-10%) and *Luetkea pectinata* (5-25%). Characteristic species with low cover include *Carex nigricans, Erigeron peregrinus, Hieracium gracile, Juncus drummondii, Sibbaldia procumbens* and *Valeriana sitchensis.* Bryoid layer cover is variable (3-50%) with *Dicranum scoparium, Pogonatum alpinum, Polytrichum juniperinum* and *Cladonia ecmocyna* most common.

L5 is mature successionally and characterized by the dominance of *Cassiope mertensiana, Phyllodoce glanduliflora* and *Phyllodoce empetriformis.* Intergrades with O10, O20 and O22 occur near the Alpine-Upper Subalpine boundary.

Other Studies: L5 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). Numerous other workers describe types similar to L5. In British Columbia, similar types are described by Knapik and Landals (1974, *Cassiope mertensiana*) in MRNP, by Kuchar (1978, mountain heather tundra) in Yoho National Park, by Eady (1971, *Phyllodoce empetriformis-Antennaria lanata*), and by Lea (1984, mountain heather-grouseberry-wooly pussytoes). In JNP, similar types are noted by Crack (1977, *Phyllodoce glanduliflora*), Hrapko and La Roi (1978, *Cassiope mertensiana-Phyllodoce glanduliflora*), Kuchar (1975, *Phyllodoce glanduliflora-Cassiope mertensiana*), and La Roi (1975, *Abies lasiocarpa/Cassiope mertensiana/Pseudoleskea radicosa*). Elsewhere in Alberta, Ogilvie (1976, *Phyllodoce*), Kondla (1978, everlasting-phyllodoce) , Kirby and Ogilvie (1969, *Phyllodoce*), Mortimer (1978, *Phyllodoce glanduliflora-Cassiope mertensiana*), Jacques and Legge (1974, yellow heather), and Trottier (1972, *Phyllodoce*) describe similar types.

Table 39. Stands of the heather-everlasting (L5) v.t. Values are per cent cover.

	HD	HD	HD	JD	JD	JD	MF	PA	PA	SD
	10	10	10	10	10	10	30	10	20	21
	53	79	94	44	52	62	21	56	38	20
HERB-DWARF SHRUB LAYER										
Anemone occidentalis	25	--	--	--	--	35	--	10	--	--
Antennaria lanata	02	20	05	--	--	--	06	15	10	05
Carex nigricans	--	.5	--	02	.5	--	03	--	.5	--
Carex spectabilis	10	--	02	01	.5	05	03	--	--	04
Cassiope mertensiana	10	02	.5	50	65	05	40	45	15	10
Castilleja miniata	--	05	--	--	--	.5	--	--	.5	05
Deschampsia atropurpurea	--	03	--	--	--	.5	02	01	.5	--
Epilobium alpinum	--	--	--	--	--	.5	.5	--	--	02
Erigeron peregrinus	--	.5	05	--	--	02	02	--	01	05
Hieracium gracile	--	.5	--	.5	.5	--	.5	.5	01	.5
Juncus drummondii	.5	--	.5	--	--	--	.5	.5	--	.5
Luetkea pectinata	30	--	03	20	15	--	15	05	20	40
Phyllodoce empetriformis	15	--	60	01	10	--	--	--	--	--
Phyllodoce glanduliflora	--	--	--	--	--	--	01	--	40	--
Ranunculus eschscholtzii	.5	04	--	--	--	.5	--	--	.5	--
Sibbaldia procumbens	--	.5	03	--	--	01	02	--	--	02
Trisetum spicatum	--	.5	02	--	--	.5	.5	--	--	--
Vaccinium membranaceum	.5	.5	--	.5	--	02	--	--	--	--
Valeriana sitchensis	08	10	--	--	05	10	--	--	--	--
Veronica alpina	.5	.5	--	--	--	.5	.5	--	--	.5
Poa sp.	--	45	01	.5	.5	--	--	--	--	--
Arnica sp.	--	08	01	--	.5	02	--	--	--	--
BRYOID LAYER										
Dicranum scoparium	--	--	--	--	06	--	--	20	--	--
Pogonatum alpinum	--	--	--	--	20	--	--	.5	--	--
Barbilophozia floerkei	--	--	--	20	--	--	--	15	--	--
Cetraria subalpina	--	--	--	.5	.5	--	--	--	--	--
Cladonia ecmocyna	--	--	.5	--	--	--	01	03	--	--
Lepraria neglecta	--	--	02	.5	--	.5	02	.5	--	--
Peltigera rufescens	--	.5	--	--	--	.5	--	--	--	.5
Rhizocarpon geographicum	.5	.5	50	--	--	.5	--	--	--	--
Solorina crocea	--	--	01	--	--	--	.5	.5	--	--

HERB-DWARF SHRUB VEGETATION TYPES

H1: *Dryas octopetala-Salix nivalis-Silene acaulis*

(mountain avens-snow willow-moss campion)

Environment: H1 occupies a very restricted range occurring only in easternmost GNP, principally on ridges above East Grizzly Creek especially between Dawn and Dauntless mountains. Generally, H1 occurs on mesic to subxeric Alpine sites (2300-2650 m) on various slopes and often southerly aspects. The soils are well drained Regosolics and Brunisolics on colluvial and morainal landforms. Solifluction is common.

Vegetation: H1 tundra is dominated by *Dryas octopetala* (10-50%) and *Salix nivalis* (3-20%) with total herb-dwarf shrub layer cover of 20 to 80% (Table 40). Other common species with low cover include *Saxifraga oppositifolia*, *Potentilla diversifolia*, *Oxytropis podocarpa*, *Carex scirpoidea*, *Anemone drummondii*, *Astragalus alpinus*, *Erigeron aureus*, *Antennaria lanata*, and *Salix arctica*. Bryoid cover is <10% with *Cetraria tilesii*, *Cetraria ericetorum*, *Cetraria nivalis*, *Cetraria cucullata*, *Lecidea* spp., and *Tortula* spp. most common. H1 occurs on wind-swept sites with low winter snow cover and often forms a pattern in the landscape with L5 and H2 occupying progressively deeper snow beds.

Table 40. Stands of the mountain avens-snow willow-moss campion (H1) v.t. Values are per cent cover.

	HD 20 50	HD 20 51	HD 20 96	PA 30 01	SD 20 37	SD 20 48	SD 20 81
HERB-DWARF SHRUB LAYER							
Anemone drummondii	--	05	--	--	03	.5	--
Antennaria lanata	.5	--	--	--	.5	.5	--
Astragalus alpinus	--	--	--	--	.5	05	--
Carex spp.	01	--	05	.5	02	05	05
Draba incerta	.5	--	--	--	.5	--	--
Draba lonchocarpa	--	--	--	.5	--	--	.5
Dryas octopetala	10	60	15	45	40	05	50
Erigeron aureus	.5	.5	--	.5	.5	--	--
Hedysarum sulphurescens	--	--	--	--	--	.5	02
Oxytropis podocarpa	--	--	05	--	--	--	05
Polygonum viviparum	--	--	--	--	05	--	.5
Potentilla diversifolia	.5	08	--	--	.5	--	--
Salix nivalis	03	.5	.5	15	20	20	03
Saussurea densa	.5	--	--	--	--	--	02
Saxifraga spp.	.5	03	--	--	.5	.5	--
Saxifraga oppositifolia	--	--	--	--	02	03	--
Silene acaulis	.5	--	--	05	--	--	--
Selaginella densa	.5	--	--	.5	.5	--	--
BRYOID LAYER							
Tortula norvegica	--	--	.5	--	--	--	--
Tortula ruralis	--	--	.5	--	05	02	01
Cetraria cucullata	--	--	--	.5	--	--	.5
Cetraria ericetorum	--	--	.5	.5	--	--	--
Cetraria nivalis	--	15	--	.5	--	--	.5
Cetraria tilesii	.5	--	.5	.5	--	--	.5
Lecanora spp.	--	--	--	.5	--	--	.5
Rhizocarpon geographicum	.5	15	--	.5	--	--	--
Thamnolia subuliformis	.5	--	--	.5	--	--	.5
Lecidea spp.	--	--	--	--	--	.5	--

H1 is mature successionally and is characterized by the dominance of *Dryas octopetala.*

Other Studies: H1 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, similar types are described by Kuchar (1978, white dryad tundra) in Yoho National Park and by Raup (1934) in the Mount Selwyn area in northeastern British Columbia. In Alberta, similar types are described by many workers. In JNP, these include Hettinger (1975, *Dryas octopetala-Oxytropis campestris*), Hrapko and La Roi (1978; *Dryas octopetala-Oxytropis campestris*, *Dryas octopetala-Festuca brachyphylla*, *Dryas octopetala-Salix nivalis*), La Roi (1975, *Dryas octopetala/Salix nivalis/Polytrichum piliferum-Rhizocarpon geographicum*, *Dryas octopetala/Salix nivalis/Rhacomitrium lanuginosum/Rhizocarpon geographicum*), Kuchar (1975, *Dryas octopetala*/lichen, *Dryas octopetala/Polytrichum piliferum*), and Crack (1977, *Dryas octopetala*). In BNP, similar vegetation is described by Broad (1973, *Dryas octopetala-Empetrum nigrum*), Trottier and Scotter (1973; *Dryas octopetala*, *Salix nivalis*), Beder (1967, *Dryas hookeriana-Oxytropis podocarpa-Cetraria cucullata-Cetraria nivalis*), and Knapik *et al.* (1973, *Dryas hookeriana, Dryas hookeriana-Carex scirpiformis*). Elsewhere in Alberta, similar types are described by Mortimer (1978, *Dryas integrifolia-Oxytropis podocarpa*) and See and Bliss (1980, *Dryas integrifolia-Oxytropis podocarpa-Salix myrtillifolia*) in the northern Front Ranges, in the Kananaskis area by Kirby and Ogilvie (1969, *Dryas*), Jacques and Legge (1974, *Dryas octopetala*), Kondla (1978, mountain avens), and Trottier (1972, *Dryas octopetala*), in the upper Oldman River by Jeffrey *et al.* (1968, alpine tundra), Ogilvie (1976, *Dryas hookeriana*), and by Kuchar (1973, *Dryas* tundra) in Waterton Lakes National Park. Similar types occur south in Montana as described by Bamberg and Major (1968), Choate and Habeck (1967) on fellfields on Glacier National Park, Montana, and Johnson and Billings (1962, *Dryas octopetala*) in southern Montana.

H2: *Carex nigricans-Antennaria lanata*

(black alpine sedge-everlasting)

Environment: H2 occurs throughout MRNP and GNP on mesic to subhygric Upper Subalpine to Alpine (2100-2400 m) sites with a wide range of slopes and aspects. The soils are moderately well drained Dystric Brunisols and Regosolics developed on morainal and colluvial landforms, often with a fluvial veneer.

Table 41. Stands of the black alpine sedge-everlasting (H2) v.t. Values are per cent cover.

	HD	HD	JD	JD	PA	PA
	21	30	10	10	10	30
	23	08	61	81	27	14
HERB-DWARF SHRUB LAYER						
Antennaria lanata	--	05	--	.5	.5	.5
Arnica latifolia	.5	.5	--	--	.5	--
Carex nigricans	60	60	75	98	75	70
Cassiope mertensiana	.5	.5	.5	--	05	05
Deschampsia atropurpurea	.5	--	.5	01	--	05
Epilobium alpinum	--	.5	--	.5	.5	.5
Hieracium gracile	--	--	.5	.5	.5	--
Juncus drummondii	25	--	10	.5	--	--
Juncus parryi	--	--	--	--	--	.5
Luetkea pectinata	.5	.5	.5	--	05	05
Luzula spp.	--	03	05	--	.5	10
Phyllodoce empetriformis	01	03	--	--	--	--
Phyllodoce glanduliflora	--	--	--	--	05	01
Poa cusickii	--	.5	--	--	--	--
Ranunculus eschscholtzii	--	05	--	--	--	--
Saxifraga lyallii	.5	.5	--	--	--	--
Sibbaldia procumbens	--	03	--	--	--	--
Valeriana sitchensis	--	.5	--	--	--	--
Veronica alpina	--	.5	--	--	.5	--
BRYOID LAYER						
Ceratodon purpureus	--	60	--	--	--	--
Pogonatum alpinum	--	--	--	02	.5	--
Polytrichum juniperinum	--	.5	--	05	--	--
Polytrichum piliferum	--	--	--	03	--	--
Polytrichum sexangulare	--	--	--	--	05	01
Rhacomitrium heterostichum var. hete	--	--	10	--	--	--
Pohlia sp.	--	.5	20	--	--	--
Asterella saccata	--	05	--	--	--	--
Kiaeria sp.	--	--	--	--	.5	.5
Rhizocarpon geographicum	25	.5	--	--	--	--
Stereocaulon spp.	25	--	.5	--	--	--
Alectoria sp.	--	--	10	--	--	--

Vegetation: Total cover of the herb-dwarf shrub layer (Table 41) is 75 to 95% with *Carex nigricans* (10-75%) often forming a dense turf. Other common species include *Antennaria lanata* (<1-5%), *Luetkea pectinata* (1-6%), *Phyllodoce empetriformis* (1%) and *Epilobium alpinum* (1%). *Hieracium gracile*, *Juncus drummondii* and *Luzula* spp. occur with <1% cover. Total bryoid layer cover is 10 to 15% with *Pogonatum alpinum* (<1-2%), *Polytrichum* spp. (3-5%) and *Stereocaulon* spp. (<1%) most common.

H2 is mature successionally and is distinguished by the dominance of *Carex nigricans*. It usually occurs in small patches in late snow lie areas which receive melt water until late season. H2 is usually part of a v.t. pattern in the landscape in which L5 and H1 occupy progressively shallower snow lie areas.

Other Studies: H2 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). *Carex nigricans* dominated vegetation is widespread. In British Columbia, similar types are described by Kuchar (1978, black alpine sedge types) in Yoho National Park and by Knapik and Landals (1974, *Carex nigricans*) in MRNP. In Alberta, similar vegetation is described by Kuchar (1975, *Carex nigricans*), Hrapko and La Roi (1978, *Carex nigricans-Luzula wahlenbergii*), and Crack (1977, *Carex nigricans*) in JNP, and by Trottier and Scotter (1973, *Carex nigricans* types), Broad (1973, *Carex nigricans*), Beder (1967, *Carex nigricans*), and Knapik *et al.* (1973, *Carex nigricans*) in BNP. Elsewhere in Alberta, similar types are described by Ogilvie (1976, Kirby and Ogilvie 1969; *Carex nigricans*), Jacques and Legge (1974, black sedge), Trottier (1972, *Carex nigricans*), and Kondla (1978, alpine sedge-buttercup).

H8: *Dryas drummondii-Epilobium latifolium*

(yellow dryad-willow herb)

Environment: H8 is limited to the upper Beaver River valley in GNP. It occurs on subxeric to subhygric Lower Subalpine sites (1500-1680 m) with gentle to level slopes of various aspect. Soils are rapidly to imperfectly drained Orthic Regosols on fluvial landforms.

Vegetation: The herb-dwarf shrub layer (30-65%) is dominated entirely by *Dryas drummondii* (10-50%) (Table 42). Also present are *Potentilla fruticosa* (1-7%), *Poa* spp. (2-3%), *Picea* spp. (≤1%) and *Fragaria virginiana* (<1%). Bryoid layer cover is usually <1% with unvegetated rock and mineral soil comprising 60 to 75% of the ground surface. H8 is at an early stage of primary succession occurring on recently deposited fluvial materials. The dominance of *Dryas drummondii* distinguishes it from other v.t.s.

Table 42. Stands of the yellow dryad-willow herb (H8) v.t. Values are per cent cover.

	BB	HD	HD	MF	PA
	10	11	30	20	10
	23	09	30	11	78
	HERB-DWARF SHRUB LAYER				
Dryas drummondii	10	65	40	50	30
Epilobium latifolium	--	--	--	01	--
Fragaria virginiana	.5	--	--	.5	--
Juniperus communis	--	--	--	01	--
Poa spp.	.5	05	--	02	--
Picea spp.	.5	01	--	.5	.5
Potentilla fruticosa	--	.5	--	01	.5
Primula mistassinica	01	--	--	--	--
Salix spp.	--	01	01	01	--
Saxifraga aizoides	03	--	.5	--	--
Senecio canus	05	--	--	--	--
Agropyron spp.	--	--	--	01	.5
	BRYOID LAYER				
Bryum spp.	.5	05	--	.5	--
Ceratodon purpureus	.5	--	--	.5	--
Ditrichum flexicaule	.5	05	--	--	.5
Tortella spp.	.5	--	--	--	05

Other Studies: H8 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, yellow dryad) in Yoho National Park and Raup (1934, *Dryas drummondii*) in northeastern British Columbia describe comparable types. Heusser (1956) describes a similar type in BNP and JNP. To the north in the Yukon Territory, Douglas (1974, *Dryas drummondii*) in Kluane National Park and Orloci and Stanek (1979, *Dryas drummondii*) describe similar types, and Kershaw (1981, *Dryas drummondii*) has a similar type in Nahanni National Park.

H11: *Carex aquatilis-Carex rostrata*

(water sedge-beaked sedge)

Environment: H11 fens occur on subhydric to hydric sites in the Interior Cedar-Hemlock Ecoregion (850-1330 m) of GNP. Soils are poorly to very poorly drained Rego Gleysols and Organics on nearly level fluvial landforms.

Table 43. Stands of the water sedge-beaked sedge (H11) v.t. Values are per cent cover.

	AW	JD	JD	KS	PA	PA	PA	PA
	70	60	80	60	71	81	10	10
	98	39	26	53	34	00	19	47
	HERB-DWARF SHRUB LAYER							
Arnica latifolia	--	--	--	--	--	--	--	.5
Betula glandulosa	--	05	.5	--	--	05	--	--
Calamagrostis inexpansa	--	--	--	--	--	--	.5	05
Carex aquatilis	80	38	80	50	70	80	60	80
Carex capillaris	--	--	01	--	--	--	--	--
Carex pyrenaica	--	--	--	--	--	--	--	.5
Carex rostrata	--	42	.5	10	--	--	05	--
Carex spectabilis	--	--	--	--	--	--	--	05
Deschampsia caespitosa	--	03	.5	--	--	05	--	--
Equisetum ssp.	.5	--	--	22	--	--	--	--
Epuisetum arvense	--	--	--	--	--	--	01	--
Erigeron peregrinus	--	03	--	--	--	--	--	--
Eriophorum angustifolium	--	--	--	--	01	--	--	--
Eriophorum scheuchzeri	--	--	--	--	.5	--	--	--
Hierochloe odorata	--	02	--	--	--	--	--	--
Pedicularis groenlandica	--	--	.5	--	03	--	--	--
Penstemon gracilis	--	--	--	--	--	--	01	--
Petasites sagittatus	--	01	--	06	--	--	--	--
Polygonum spp.	--	--	.5	--	--	--	03	--
Potentilla diversifolia	--	.5	--	--	.5	--	--	--
Potentilla palustris	--	--	--	--	--	--	01	--
Rubus acaulis	--	04	--	--	--	--	--	--
Salix barrattiana	--	02	02	--	--	--	--	--
Salix brachycarpa	--	--	05	--	--	--	--	--
Salix nivalis	--	--	--	--	--	05	--	--
Saxifraga ferruginea	--	--	--	--	--	--	--	.5
Senecio triangularis	--	--	--	--	--	--	--	.5
Valeriana sitchensis	--	.5	--	--	--	--	--	--
Viola palustris	--	--	--	--	--	--	.5	--
Viola sp.	--	--	--	--	--	--	--	.5
Lycopodium sitchense	--	--	--	--	--	--	--	.5
	BRYOID LAYER							
Aulacomnium palustre	--	10	--	--	05	40	--	01
Bryum pseudotriquetrum	05	02	10	--	.5	--	--	--
Calliergon giganteum	.5	--	.5	.5	--	--	--	--
Campylium stellatum	--	--	50	15	.5	10	--	--
Cinclidium stygium	.5	--	.5	--	--	--	--	--
Drepanocladus revolvens	85	--	.5	60	10	.5	10	--
Drepanocladus uncinatus	--	50	--	--	--	--	--	--
Meesia triquetra	02	--	.5	--	--	--	--	--
Myurella julacea	--	--	20	--	--	--	--	--
Philonotis fontana var.fontana	--	--	.5	--	01	--	--	--
Scorpidium spp.	--	--	--	--	.5	--	05	--
Spagnum squarrosum	--	--	--	--	--	--	--	.5
Tomenthypnum nitens	06	--	--	--	30	30	--	--

Vegetation: *Carex aquatilis* (50-80%) and *Carex rostrata* (5-60%) dominate the herb-dwarf shrub layer (Table 43). H11 is species-poor and the cover of other species is variable and usually low. These include *Equisetum* spp., *Lemna minor* and *Utricularia* spp. Bryoid layer cover varies but is usually <50%. Common species are *Bryum pseudotriquetrum*, *Tomenthypnum nitens* and *Drepanocladus revolvens*.

H11 is successionally mature in that it appears stable over perhaps several hundred years. Gradual peat accumulation may result in an increase in shrubs and trees over time. H11 is distinguished from other v.t.s by the dominance of *Carex aquatilis* and *Carex rostrata*.

Other Studies: H11 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, tall sedge meadow) in Yoho National Park and Raup (1934, *Carex rostrata*) describe similar types. Similar types are described in Alberta by Kuchar (1972, *Carex aquatilis* wet meadow) and Crack (1977, *Carex aquatilis*) both in JNP, by Lewis *et al.* (1928, *Carex aquatilis*) in northern Alberta, by Kondla (1978, *Carex aquatilis* wetland), and by Kuchar (1973, sedge meadow) in Waterton Lakes National Park. Orloci and Stanek (1979) also have a similar type (*Carex-Equisetum*) in the southern Yukon.

H12: Saxicolous lichen

(saxicolous lichen)

Environment: H12 occurs in both MRNP and GNP on subxeric to xeric Alpine sites (2400-2600 m) with various slopes and aspects, although often on ridge crests. Soils are Orthic Regosols or nonsoil on the Miscellaneous Landscapes Rockland (R), Colluvial Rubble (CR) and Talus (T).

Vegetation: H12 is very sparsely vegetated with total cover usually <20% (Table 44). Individual species typically have <1% cover. Vascular plants often have a low, cushion growth form and common species are *Saxifraga oppositifolia*, *Silene acaulis*, *Erigeron aureus*, *Cerastium beeringianum*, *Erigeron compositus*, *Draba lonchocarpa*, *Arenaria rubella*, *Saxifraga bronchialis*, *Saxifraga caespitosa* and *Draba incerta*. Important lichens are *Xanthoria elegans*, *Umbilicaria virginis*, *Umbilicaria hyperborea*, *Thamnolia subuliformis*, *Rhizocarpon geographicum*, *Cetraria tilesii*, *Acarospora chlorophana* and *Dactylina ramulosa*.

H12 is successionally mature in that its composition will change little in the next few hundred years, although it might be considered also to be in an early stage of primary succession. H12 is distinguished by very low plant cover, which is frequently dominated by lichens and by occurrence at high altitudes above most other vegetation.

Other Studies: H12 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). In British Columbia, Kuchar (1978, lichen tundra, boulder and rock tundra) in Yoho National Park and Raup (1934) describe similar types. In Alberta, similar types are described in JNP by Crack (1977, high altitude open vegetation), Hettinger (1975, rock and lichen), Hrapko and La Roi (1978, *Potentilla nivea-Silene acaulis*), Kuchar (1975, cushion-rosette, lichen tundra), and La Roi (1975, *Silene acaulis/Alectoria*) and in BNP by Beder (1967, ridge summit type). Elsewhere in Alberta, comparable types are described by Ogilvie (1976, Kirby and Ogilvie 1969, stonefield-lichen), Jacques and Legge (1974, bare rock-lichen), Bryant and Scheinberg (1970), Kuchar (1973, saxicolous lichen tundra), and Kondla (1978, lichen dominated type).

H16: *Erigeron peregrinus-Valeriana sitchensis*

(fleabane-valerian)

Environment: H16 occurs throughout MRNP and GNP on mesic to subhygric Upper Subalpine sites (1970-2200 m) with moderate to steep, southerly and westerly aspect slopes (Plates 10 and 39). Soils are well to moderately drained Dystric Brunisols and Orthic Humo-Ferric Podzols on colluvial and morainal landforms. Many of the sites are snow avalanched and most receive seasonal seepage.

Vegetation: H16 is a moist, species-rich herb meadow which often forms spectacular floral displays as on the top of Mount Revelstoke. The herb-dwarf shrub layer (60-90%) (Table 45) is dominated by *Valeriana sitchensis* (10-35%), *Erigeron peregrinus* (3-30%), *Anemone occidentalis* (10-30%),

Table 44. Stands of the saxicolous lichen (H12) v.t. Values are per cent cover.

	JE 81 17	JE 90 21	JE 91 52	PA 70 21	PA 80 08 .1	PA 80 66 .2	PA 10 05 .1	PA 20 22 .1	PA 20 22 .4	PA 20 29 .1	PA 30 21
				HERB-DWARF SHRUB LAYER							
Arenaria spp.	--	--	--	--	--	.5	.5	--	--	--	--
Carex spp.	--	.5	.5	01	--	--	--	--	--	--	02
Cassiope tetragona	--	--	--	--	--	--	--	--	--	--	.5
Cerastium beeringianum	--	--	--	--	--	.5	--	--	.5	.5	--
Draba incerta	--	--	--	.5	.5	--	.5	--	.5	--	--
Draba paysoni	--	--	--	--	--	.5	--	.5	--	--	--
Draba spp.	--	--	--	--	.5	--	.5	.5	.5	--	--
Dryas octopetala	--	--	--	--	--	--	--	--	--	--	.5
Erigeron aureus	--	--	--	--	--	--	.5	.5	.5	.5	.5
Erigeron compositus	--	--	--	--	--	--	.5	--	.5	--	--
Erigeron humilus	--	--	.5	--	--	--	--	--	--	--	--
Luzula spicata	--	--	--	--	--	--	--	--	--	--	03
Papaver kluanensis	--	--	--	--	--	.5	--	--	--	--	--
Potentilla nivea	--	--	--	--	--	03	.5	--	--	.5	.5
Salix nivalis	--	--	.5	02	--	--	--	--	--	--	--
Saussurea densa	--	--	--	.5	--	--	--	--	.5	.5	--
Saxifraga bronchialis	--	--	--	--	.5	--	.5	.5	--	--	.5
Saxifraga caespitosa	--	--	--	--	.5	--	--	--	.5	--	--
Saxifraga oppositifolia	--	.5	--	01	--	.5	.5	.5	--	.5	--
Saxifraga spp.	--	--	.5	--	.5	.5	.5	--	--	.5	--
Sedum stenopetalum	--	--	--	.5	--	--	--	--	--	--	--
Senecio fremontii	--	--	--	--	--	--	--	--	.5	--	--
Sibbaldia procumbens	--	--	--	--	--	--	--	--	--	--	01
Silene acaulis	--	.5	01	.5	--	--	--	.5	--	.5	.5
Selaginella densa	--	--	.5	.5	--	--	--	--	--	--	--
					BRYOID LAYER						
Acorospora spp.	--	--	--	--	.5	.5	--	.5	--	.5	--
Aspicilia caesiocinerea	02	--	03	--	--	--	--	--	--	--	--
Aspicilia calcarea	06	--	.5	--	--	--	--	--	--	--	--
Bryum sp.	--	--	.5	.5	--	--	--	--	--	--	--
Caloplaca elegans	--	--	--	--	.5	--	--	.5	.5	.5	--
Cetraria ericetorum	.5	.5	--	--	--	--	.5	--	--	.5	--
Cetraria nivalis	--	.5	--	.5	--	--	.5	--	--	.5	--
Cetraria tilesii	.6	03	--	01	--	--	--	--	--	--	--
Cladonia pyxidata	--	--	01	.5	--	--	--	--	--	--	--
Coelocaulon aculeatum	--	.5	--	.5	--	--	--	--	--	--	--
Dactylina ramulosa	.5	.5	--	.5	--	--	--	.5	--	--	--
Ditrichum flexicaule	--	.5	.5	.5	--	--	--	--	--	--	--
Grimmia sp.	.5	--	.5	--	--	--	--	--	--	--	--
Hypnum revolutum	.5	.5	.5	.5	--	--	--	--	--	--	--
Lecanora spp.	05	.5	.5	--	.5	--	--	.5	.5	--	--
Lecidea spp.	03	.5	.5	--	.5	.5	--	--	.5	.5	--
Omphalodiscus virginis	05	--	03	--	--	--	--	--	--	--	--
Physconia muscigena	--	01	--	.5	--	--	--	--	--	--	--
Rhacomitrium lanuginosum	--	--	--	--	--	--	--	--	--	--	.5
Rhizocarpon geographicum	03	--	08	--	.5	--	.5	.5	.5	--	10
Sporastatia testudinea	.5	--	.5	--	--	.5	--	--	--	.5	--
Thamnolia subuliformis	--	.5	--	.5	--	--	--	.5	.5	--	--
Umbilicaria spp.	02	--	01	--	--	--	.5	.5	.5	.5	--
Xanthoria elegans	04	--	.5	--	--	--	--	--	--	--	--

Table 45. Stands of the fleabane-valerian (H16) v.t. Values are per cent cover.

	HD	HD	HD	JD	JD	JD	MF	MF	PA	PA	PA
	10	10	30	10	10	10	30	30	10	10	20
	73	83	09	62	66	80	05	06	16	29	41
HERB-DWARF SHRUB LAYER											
Anemone occidentalis	03	03	25	35	30	10	--	05	20	10	.5
Antennaria lanata	.5	.5	02	--	20	05	04	05	01	.5	--
Arnica latifolia	--	--	05	--	05	10	--	--	08	10	--
Carex nigricans	--	--	.5	--	--	--	--	03	--	--	--
Carex spectabilis	01	--	05	05	.5	02	01	--	--	--	--
Cassiope mertensiana	.5	--	10	05	.5	01	02	03	--	07	--
Castilleja miniata	--	--	--	.5	.5	01	--	.5	10	10	--
Castilleja occidentalis	03	--	--	.5	03	01	--	35	--	--	--
Deschampsia atropurpurea	.5	05	--	.5	05	--	--	05	--	--	02
Epilobium alpinum	--	--	03	.5	.5	.5	--	--	--	--	.5
Erigeron peregrinus	.5	35	05	02	03	30	--	15	20	15	05
Erythronium grandiflorum	--	05	.5	--	05	01	--	--	03	05	--
Luetkea pectinata	20	--	05	--	--	--	01	05	--	08	--
Luzula parviflora	--	--	--	--	--	--	04	01	--	01	.5
Mitella breweri	--	--	02	--	--	.5	--	01	--	--	02
Phleum alpinum	03	--	.5	02	--	--	--	--	--	--	--
Phyllodoce empetriformis	01	--	02	--	02	--	--	02	--	02	--
Poa spp.	05	--	.5	03	.5	02	01	21	--	--	--
Ranunculus eschscholtzii	.5	--	02	.5	--	01	--	.5	--	--	--
Salix arctica	.5	--	--	--	--	05	--	--	--	--	--
Senecio triangularis	08	--	--	15	--	--	--	--	--	--	20
Sibbaldia procumbens	--	--	.5	01	.5	02	03	01	.5	--	--
Vaccinium membranaceum	05	--	.5	02	--	--	--	--	--	--	.5
Valeriana sitchensis	35	30	30	10	--	05	--	.5	05	03	50
Veratrum eschscholtzii	01	--	.5	--	.5	.5	--	--	--	.5	40
Veronica alpina	--	--	.5	.5	--	.5	--	.5	--	--	--
BRYOID LAYER											
Dicranum spp.	--	--	.5	--	--	--	01	--	--	01	--
Pogonatum alpinum	.5	--	.5	--	--	--	--	--	--	03	--
Polytrichum spp.	--	.5	25	--	15	03	05	--	--	--	--
Pseudoleskea radicosa var. compacta	.5	--	--	--	--	--	--	--	--	01	05
Peltigera rufescens	.5	--	--	.5	--	--	--	02	--	--	--
Rhizocarpon geographicum	.5	--	--	.5	.5	--	--	--	--	--	--
Cladonia spp.	.5	--	--	--	10	01	01	.5	--	--	--

Antennaria lanata (5-20%), *Luetkea pectinata* (10-20%) and *Senecio triangularis* (8-20%). Also frequent but generally with <5% cover are *Veratrum eschscholtzii, Ranunculus eschscholtzii, Erythronium grandiflorum, Deschampsia atropurpurea, Castilleja miniata* and *Arnica* spp. Bryoid cover is variable but typically <5% with *Tortula norvegica* and *Polytrichum piliferum* most common.

H16 is mature successionally. It is characterized by the dominance of *Valeriana sitchensis, Erigeron peregrinus* and other moist herb meadow species and by occurrence in the Upper Subalpine.

Other Studies: H16 is also described in BNP and JNP (Corns and Achuff 1982) and in KNP (Achuff and Dudynsky 1984). Similar types are described in British Columbia by Kuchar (1978, moist forb meadow) in Yoho National Park, Knapik and Landals (1974, *Valeriana sitchensis-Luzula glabrata*) in MRNP, and Eady (1971, *Valeriana sitchensis-Castilleja elmeri*. In Alberta, similar types are noted in JNP by Kuchar (1975, *Artemisia norvegica/Salix arctica*) and La Roi (1975, *Artemisia norvegica/Cassiope mertensiana/Orthocaulis floerkii*) and in BNP by Broad (1973, *Anemone occidentalis-Thalictrum occidentale*) and Trottier and Scotter (1973, *Senecio triangularis-Caltha leptosepala-Trollius albiflorus-Erigeron peregrinus, Anemone occidentalis-Valeriana sitchensis-Veratrum eschscholtzii*). Jacques and Legge (1974, meadow rue), Trottier (1972, *Thalictrum occidentale*), and Kuchar (1973, moist forb meadow) describe similar types elsewhere in Alberta.

H18: *Antennaria lanata-Cassiope mertensiana-Phyllodoce empetriformis*

(everlasting-white mountain heather-red heather)

Environment: H18 occurs on mesic Upper Subalpine to Alpine (2220-2460 m) sites with a wide range of slopes and southerly and westerly aspects in GNP, mostly east of the Beaver River (Plate 41). Soils are well drained Dystric Brunisols and Podzolics on morainal and colluvial landforms.

Vegetation: The herb-dwarf shrub layer (75-90%) (Table 46) is dominated by *Antennaria lanata* (40-55%). Also important are *Cassiope mertensiana* (5-15%), *Phyllodoce glanduliflora* (10-20%), *Luetkea pectinata* (2-10%) and *Erigeron peregrinus* (≤ 5%). Frequently present but with low cover are *Hieracium gracile, Sibbaldia procumbens, Deschampsia atropurpurea, Anemone occidentalis, Phleum alpinum* and *Carex spectabilis*. Bryoid cover is low usually (1-10%) with *Cladonia ecmocyna, Cetraria islandica, Dicranum scoparium* and *Polytrichum piliferum* common.

Table 46. Stands of the everlasting-white mountain heather-red heather (H18) v.t. Values are per cent cover.

	HD	HD	HD	JD	MF	MF	PA	PA	PA	SD
	10	21	30	10	30	30	10	10	30	30
	68	22	16	40	27	28	07	57	03	06
HERB-DWARF SHRUB LAYER										
Anemone occidentalis	--	.5	--	--	--	02	01	15	--	.5
Antennaria lanata	25	40	.5	45	50	50	40	55	65	50
Carex nigricans	--	05	03	05	--	01	--	--	--	--
Carex spectabilis	.5	--	--	01	.5	--	--	--	05	01
Cassiope mertensiana	03	05	--	05	01	05	10	.5	20	15
Claytonia lanceolata	--	--	--	.5	--	--	.5	--	--	--
Deschampsia atropurpurea	.5	--	--	--	01	03	--	.5	--	.5
Erigeron aureus	--	.5	--	.5	.5	--	--	--	--	--
Erigeron peregrinus	.5	--	20	02	01	.5	05	--	--	--
Hieracium gracile	02	.5	--	.5	01	.5	.5	--	--	.5
Juncus drummondii	--	--	.5	.5	.5	--	--	.5	--	--
Luetkea pectinata	15	30	--	--	.5	12	10	.5	10	02
Luzula glabrata	--	--	--	.5	--	--	--	.5	03	--
Luzula parviflora	.5	--	05	--	01	01	.5	--	--	--
Luzula wahlenbergii	--	01	--	05	--	--	--	--	--	.5
Phleum alpinum	.5	--	05	--	01	--	--	.5	--	.5
Phyllodoce empetriformis	15	05	--	--	--	--	.5	--	--	10
Phyllodoce glanduliflora	--	05	--	20	28	08	10	--	--	20
Sibbaldia procumbens	.5	.5	.5	.5	01	.5	.5	.5	02	.5
BRYOID LAYER										
Dicranum scoparium	.5	.5	--	05	--	--	.5	05	--	--
Pogonatum alpinum	--	--	--	--	.5	--	.5	--	--	--
Polytrichum juniperinum	--	--	.5	--	--	01	10	--	--	--
Polytrichum piliferum	.5	--	--	25	02	--	.5	--	.5	--
Cetraria islandica	--	.5	--	03	.5	--	05	--	--	.5
Cetraria subalpina	02	--	--	05	--	--	.5	.5	--	--
Cladonia ecmocyna	--	.5	--	.5	.5	--	.5	10	--	.5
Rhizocarpon geographicum	--	--	.5	--	01	--	--	--	.5	.5
Solorina crocea	--	.5	--	.5	.5	--	--	--	--	08

H18 is mature successionally. It is characterized by the dominance of *Antennaria lanata* and intergrades with L5 occur where *Cassiope* spp., *Phyllodoce* spp. and *Antennaria lanata* are codominant.

Other Studies: Eady (1971) describes similar *Antennaria lanata* and *Antennaria lanata-Sibbaldia procumbens* types in central British Columbia.

H21: *Carex* spp.

(sedge)

Environment: H21 occurs on moderate to steep snow avalanche slopes of southerly aspect in MRNP and western GNP. It occurs over a wide altitudinal range (1390-2380 m) mainly in the Lower Subalpine and Upper Subalpine, but extends slightly into both the Interior Cedar-Hemlock and Alpine Ecoregions. The wide range is due to its occurrence on avalanched sites which are somewhat azonal. The soils are well drained Regosolics and Brunisolics on colluvial landforms.

Vegetation: H21 is a lush, herbaceous meadow with total herb-dwarf shrub layer cover of 90 to 100% (Table 47). It is heterogeneous but a common feature is dominance by mesic *Carex* spp., usually *Carex spectabilis*. Other leading species are *Epilobium angustifolium* (15-65%), *Senecio triangularis* (1-10%), *Valeriana sitchensis* (<1-10%), and *Veratrum eschscholtzii* (3-25%). Less common and generally with low cover, are *Castilleja miniata*, *Deschampsia atropurpurea*, *Phleum alpinum*, *Salix arctica*, *Veronica alpina*, *Heracleum lanatum*, *Erythronium grandiflorum*, and *Pedicularis bracteosa*. The bryoid layer has <5% cover and few species. They include *Bryum* spp., *Tortula norvegica*, and *Cladina* spp..

H21 is mature successionally, being maintained by avalanches. The dominance of *Carex* spp. and occurrence on avalanche paths distinguishes H21 from other v.t.s.

Other Studies: No similar types are described by other authors.

SUCCESSION AND CLIMAX

INTRODUCTION

Succession deals with directional changes over time in a plant community. Scientific thought on vegetational succession is currently in a period of flux. Most ecologists realize that the monoclimax paradigm of Clements (1916, 1936), while a valuable starting point, is now inadequate. For example, the Clementsian approach assumes that following disturbance a community regenerates itself to a climax stage through an orderly, predictable sequence of successional communities. This deterministic, single-pathway model fails to take into account, among other things, disturbance periodicity. Successional pathways may differ greatly if the period between disturbances is either very short or very long (Noble and Slatyer 1977, Cattelino *et al.* 1979). The *polyclimax* modification of Clements' ideas (Tansley 1935) helped some but still does not deal satisfactorily with succession. New ideas and ways of looking at succession recently have been put forward and are being tested and debated by ecologists (Botkin *et al.* 1972, Noble and Slatyer 1978, 1980). None seems presently suitable for this study so, while fully aware of its shortcomings, we have used a basically Clementsian scheme here. Another comparative shortcoming is that the ecological land classification focused primarily on mapping landscapes and the overriding objective of the vegetation component became a vegetation classification for the landscape classification scheme. Thus, succession was not a primary concern nor was it assessed directly. The information is only that obtained incidentally to the mapping program and permits only the description of generalized successional trends. Prediction of successional change for any specific area will require more detailed examination.

Succession is of two basic types. *Primary* succession occurs on sites without previous vegetation, such as newly deposited fluvial or morainal material. The time for primary successions to reach putative climax status is on the order of 500 to >1000 years. *Secondary* succession occurs where previous vegetation has been at least partially removed by a disturbance and generally requires <500 years to reach climax. Both types occur in MRNP and GNP, with secondary succession being most prevalent. For the most part, the successional stages described for v.t.s in this report refer to the stage in secondary succession. Those few referring to primary successional stages are so labelled.

Fire is the most frequent disturbance initiating secondary succesion in MRNP and GNP. Fires are most common in the climatically drier area east of the Beaver River, *e.g.* the Copperstain burn (Plate 61). West of the Beaver River, fires appear to be less frequent and smaller. No fire history has been compiled for MRNP and GNP so fire sizes and return intervals are not known. However, fire certainly plays are lesser role here than in the national parks to the east in the Rocky Mountains. Fires

Table 47. Stands of the sedge (H21) v.t. Values are per cent cover.

	HD	JD	MF	PA	PA
	10	10	21	10	30
	84	57	26	51	13
HERB-DWARF SHRUB LAYER					
Agropyron sp.	15	--	--	--	--
Anemone occidentalis	--	--	20	05	--
Antennaria lanata	--	--	--	01	10
Arnica spp.	02	--	--	15	--
Carex nigricans	--	--	--	--	05
Carex preslii	--	30	--	--	--
Carex raynoldsii	--	--	--	40	--
Carex spectabilis	08	30	18	--	20
Castilleja miniata	--	--	03	.5	.5
Deschampsia atropurpurea	--	--	.5	.5	05
Epilobium angustifolium	65	15	03	--	--
Erigeron peregrinus	--	--	--	01	07
Erythronium grandiflorum	05	10	--	--	--
Fragaria virginiana	--	--	04	--	--
Heracleum lanatum	.5	05	--	--	--
Hieracium gracile	--	--	--	10	.5
Luetkea pectinata	--	--	--	02	.5
Luzula parviflora	--	--	--	.5	01
Mitella spp.	02	03	02	--	--
Pedicularis bracteosa	--	05	.5	--	--
Phleum alpinum	--	--	.5	--	05
Poa spp.	--	--	.5	--	05
Ranunculus eschscholtzii	--	--	01	--	.5
Salix arctica	--	--	.5	--	05
Senecio triangularis	.5	10	04	--	01
Trisetum spicatum	--	--	.5	--	01
Valeriana sitchensis	.5	25	10	.5	.5
Veratrum eschscholtzii	10	03	25	.5	--
Veronica alpina	--	--	01	--	03
Viola spp.	--	--	02	--	--
Ligusticum canbyi	--	20	--	--	--
Selaginella densa	--	--	--	--	10
BRYOID LAYER					
Bryum spp.	.5	--	01	--	--
Pseudoleskea radicosa var. compacta	01	--	--	--	--
Tortula norvegica	01	--	04	--	--
Cladonia spp.	--	--	.5	--	05

are probably also more influential at lower elevations. Other factors which initiate secondary succession include insect and disease infestations and wind damage.

Since MRNP and GNP are predominantly forested, the successional roles of the tree species are fundamental to understanding successional dynamics. In this regard, species are either *successional* or *climax*. Successional species include *Pinus monticola*, *Pinus contorta* (east of the Beaver River), *Pseudotsuga menziesii*, *Populus tremuloides*, *Populus trichocarpa*, *Betula papyrifera* and *Picea engelmannii* (in the Interior Cedar-Hemlock and lower Lower Subalpine). Climax species are *Abies lasiocarpa*, *Tsuga heterophylla*, *Pinus albicaulis*, *Tsuga mertensiana*, *Thuja plicata* and *Picea engelmannii* (in the upper Lower Subalpine and Upper Subalpine). In the Upper Subalpine particularly, successional species are often absent and climax species may occupy disturbed sites immediately after disturbance. The distinction between climax and successional roles becomes unclear in such situations.

A four stage successional sequence is used to classify v.t.s in this report: *early*, *intermediate*, *advanced* and *mature* (climax). The early successional stage is usually heterogeneous and unstable in composition, often not referable to a v.t. and usually <50 years old since major disturbance or origin. The intermediate successional stage is moderately stable, more uniform in composition and dominated by species not climax for the site. Successionally intermediate stands typically have in the tree layer *Pinus contorta* (east of the Beaver River), *Pinus monticola* (mostly west of the Beaver River), *Populus tremuloides*, *Populus trichocarpa*, *Pseudotsuga menziesii* and *Betula papyrifera* (mostly west of the Beaver River). Regeneration in the understory of *Picea engelmannii*, *Abies lasiocarpa*, *Pinus albicaulis*, *Thuja plicata*, *Tsuga mertensiana* and *Tsuga heterophylla* indicates eventual dominance by these climax species. Forest communities in this stage are generally 50 to 100 years old although considerable variation occurs. The advanced successional stage is usually 80 to 200 years old and dominated by a mixture of successional and climax species. The duration of this stage varies but is typically 40 to 50 years. The mature (climax) stage is compositionally stable, self-perpetuating and the end point of vegetational succession. In MRNP and GNP it probably takes 100 to 300 years to reach this stage by secondary succession after fire in forest communities. The successional stage of each v.t. is indicated in the v.t. description.

INTERIOR CEDAR-HEMLOCK ECOREGION

Mature forests in the Interior Cedar-Hemlock Ecoregion are dominated mainly by *Tsuga heterophylla* and *Thuja plicata*, *e.g.* the western hemlock-western red cedar/western yew/oak fern (C50) and western red cedar-western hemlock/devil's club/oak fern (C51) v.t.s. Successional v.t.s include spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass (C44), mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49), Douglas fir-western red cedar/mountain lover (C53) and aspen-western white pine/mountain lover (O15), with *Pseudotsuga menziesii* a characteristic successional species.

ENGELMANN SPRUCE-SUBALPINE FIR ECOREGION

In the Engelmann Spruce-Subalpine Fir Ecoregion, mature forests are dominated primarily by *Picea engelmannii*, *Abies lasiocarpa*, and *Tsuga mertensiana*, *e.g.* the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21), mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47), subalpine fir-mountain hemlock/heather-luetkea (O20) and subalpine fir-whitebark pine-(Engelmann spruce)/tall bilberry-heather (O22) v.t.s. The Engelmann spruce-mountain hemlock/rhododendron-tall bilberry (C48) and mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49) v.t.s are typical successional forests in this Ecoregion. In the Upper Subalpine portion, *Pinus albicaulis* occurs as a climax species and *Pseudotsuga menziesii*, a successional species, is virtually absent. Forest succession is slower in the Upper Subalpine and may take >300 years to reach maturity. Some shrub and herb dominated v.t.s (*e.g.* subalpine fir-willow (S2), green alder/fern (S13), willow-mountain hemlock-subalpine fir/tall bilberry (S14) and fleabane-valerian (H16)) appear compositionally stable and in equilibrium with environmental factors such as snow avalanching. Since they are apparently unchanging under current conditions, they have been termed mature.

ALPINE ECOREGION

Succession in the treeless Alpine Ecoregion is more difficult to document than in forests where trees provide easily obtained evidence of stand age. Fire is infrequent in the Alpine and water erosion and cryogenic processes are the main agents of disturbance which initiate secondary succession. Succession is very slow and recovery, for example after trampling, may take hundreds of years (Willard and Marr 1970, 1971). All v.t.s in the Alpine are considered climax since they appear stable over several hundred years. Some, such as saxicolous lichen (H12), are at an earlier primary successional stage than others, but it is questionable whether substantial change will occur in H12 sites in the next few hundred years. Overall, succession is not a significant process in the Alpine Ecoregion.

WETLANDS

Succession in wetlands of all Ecoregions differs from that on uplands. Rates appear to be slower although the shrubby or herbaceous vegetation makes stand history determination difficult. Peat coring, needed to make an accurate assessment, was beyond the scope of this study. Since most wetlands appear stable over a 50 to 100 year period, they have been designated successionally mature. Landscape changes due to peat accumulation, stream aggradation and erosion, and cryoturbation are often coincident with vegetational change on these sites, thus confounding successional history determination.

SIGNIFICANT FEATURES

RARE SPECIES

The following information on rare species is based on collections made during the ecological land classification, collections in the MRNP and GNP herbarium in Revelstoke, and lists of vascular plants collected in GNP (Haber and Soper 1980) and MRNP (Soper n.d.). Rarity is derived from a list of rare plants of British Columbia (Taylor 1983). Four categories of rarity are used in that list and here also:

R1 - single or few populations
R2 - several populations, locally common
R3 - widespread or scattered distribution
R4 - restricted distribution, large populations.

This section deals only with vascular plants since insufficient information is available to evaluate nonvascular plants. The following list of rare species is alphabetical by genus and species.

Aspidotis densa: R3
Athyrium distentifolium: R3
Braya humilis: R2
Camassia quamash: R4
Carex illota: R?
Castilleja occidentalis: R3
Castilleja rhexifolia: R3
Cryptogramma stelleri: R3
Dryopteris filix-mas: R3
Eleocharis rostellata: R?
Epilobium luteum: R3
Gaultheria humifusa: R3
Heuchera richardsonii: R3
Hypericum formosum: R3
Juncus bolanderi: R?
Juncus parryi: R3
Juncus regelii: R?
Ligusticum canbyi: R3
Lilium philadelphicum: R4
Luzula arcuata: R3
Muhlenbergia glomerata: R3
Poa pattersonii: R3
Polygonum austiniae: R1
Polygonum engelmannii: R1
Potentilla hyparctica: R3
Primula mistassinica: R2
Ranunculus verecundus: R3
Romanzoffia sitchensis: R3
Salix vestita: R3
Silene drummondii: R3
Spiraea densiflora: R4
Taraxacum lyratum: R3
Vaccinium myrtillus: R2

OTHER SIGNIFICANT BOTANICAL FEATURES

Floristic composition is markedly influenced by substrate. The bedrock and soils of MRNP and GNP are predominantly acidic or noncalcareous, in contrast with KNP, BNP and JNP where basic or calcareous conditions are more common. Most bedrock units in MRNP and GNP contain small amounts of calcareous material in an unpredictable pattern. Thus in MRNP and GNP, species which occur on basic or calcareous substrates, so-called ***calciphiles***, generally have small populations and a scattered distribution. Haber and Soper (1980) cite several calcareous localities, including Fidelity Mountain, upper Cougar Creek, below the Illecillewaet Glacier, and wetlands of the lower Beaver Valley. Collections made during this study indicate a spotty distribution of calciphiles throughout GNP and to a more limited extent in MRNP. Upper Cougar Creek and the Beaver Valley wetlands are the two largest areas of this type. Conditions in upper Cougar Creek are due to limestones of the Badshot Formation in which the Nakimu Caves are developed. Dissolved materials transported by ground water flow appear to produce calcareous conditions in the Beaver Valley wetlands. In the species list for MRNP and GNP (Appendix A), calciphiles are indicated by a †.

Earlier workers in GNP (Butters 1932, Haber and Soper 1980) commented on the comparative paucity of the flora of GNP. By 1932, Butters had collected 262 vascular species and estimated the total vascular flora at <300 species. Additional collections by Soper *et al.* (Haber and Soper 1980) increased the total to about 330 species. Collections made during the ecological land classification increased this total to 533 taxa. Much of this increase is due to work in parts of GNP not visited before by collectors. However, the fieldwork was oriented to a land classification objective and focused on representative, extensive landscapes. Only limited collecting occurred in rare or unusual habitats which are more likely to contain rare or unusual species. Thus, this section and Appendix A should be regarded as a minimal account of the flora of MRNP and GNP. A more thorough effort, devoted particularly to specialized habitats, will likely yield additional species.

CHAPTER IV - WILDLIFE

L.W. Gyug and K. Van Tighem

INTRODUCTION

GENERAL DESCRIPTION OF WILDLIFE

A total of 239 wildlife species has been recorded in MRNP and GNP. These include four amphibian species, three reptiles, 178 birds and 54 mammals. Because these parks are in a mountainous area within the Big Bend of the Columbia River, a number of species characteristic of the region either do not occur or are rare in the parks. The wetlands and south aspects of the Interior Cedar-Hemlock Ecoregion are important areas in the parks for some of these species, such as northern alligator lizard, Pacific tree frog, long-toed salamander, Calliope Hummingbird, Nashville Warbler, Veery, Black-headed Grosbeak, moose and white-tailed deer.

One of the major factors affecting ungulate distribution in the mountains of western Canada is winter snow depth and the constraints it imposes on winter foraging. The Selkirk and Purcell mountains of MRNP and GNP receive heavy precipitation and accumulate deep snowpacks. Mountain goats, which use areas blown free of snow or too steep for snow accumulation, and caribou, which are adapted for travel in deep snow, are the only ungulates which have historically occurred year-round in the two parks. Elk and white-tailed and mule deer generally migrate to areas of lower snowfall during the winter. Small numbers of moose reside year-round in some of the lower valleys of the mountains, but the majority of the moose habitat in this region is outside of the parks.

Both black and grizzly bears are relatively abundant, being the most widely-distributed large mammals in both parks. Other large carnivores are uncommon, due to scarcity of prey. Cougars and wolves are recorded very rarely and are not residents of either park. Coyotes occur primarily at lower elevations and, although most leave the parks in winter, a small number winter along the highway. Martens, short-tailed weasels and wolverines are the most abundant carnivores; mink are scarce and confined to the lowest valley bottoms and there is only a single otter record.

Smaller mammals are abundant. Deep winter snow provides a sheltered environment for subnivean species such as voles and mice, and the moist climate provides abundant forage. Hoary marmots, pikas and Columbian ground squirrels are common at high elevations and locally along the highway corridor.

There have been 178 species of birds recorded in the parks, and six hypothetical species. A number of species that breed in MRNP and GNP are rare or do not occur in the Rocky Mountain parks. These include Steller's Jay, Vaux's Swift, Chestnut-backed Chickadee, Nashville Warbler and Black-headed Grosbeak. Despite heavy snowfalls, winters are sufficiently mild to support large numbers of chickadees, Red-breasted Nuthatchs, Red and White-winged Crossbills, Pine Siskins and Common Redpolls.

Important bird habitats include the vegetation mosaics along the floodplains of the larger rivers, deciduous forest on south aspects, and snow avalanche slopes. The avifauna of the Interior Cedar--Hemlock Ecoregion is protected in no other national park in Canada.

Four amphibian and three reptile species occur in MRNP and GNP. Of these, only the western toad is widespread and common. The spotted frog is common but confined to low elevations.

METHODS

Methods are described in greater detail in Van Tighem and Gyug ([1984]). Summaries of the major methods for assessing wildlife abundance on Ecosites are presented here.

SAMPLING RATIONALE

Methods were chosen to collect data on the seasonal abundance, distribution, and habitat characteristics of all species of mammals, birds, amphibians, and reptiles that occur in MRNP and GNP. The broad scope of the inventory and the large area involved necessitated a variety of methods. Some were directed specifically at relating wildlife abundance to the ecological land classification. Others surveyed the seasonal movements of selected species, to determine the actual density of some species and to locate less common species.

The wildlife inventory in MRNP and GNP, unlike that in BNP and JNP, coincided with the landform-soils-vegetation inventory. This integration of field effort necessitated the modification and streamlining of some sampling methods to be compatible in time and space with soil and vegetation sampling methods.

SYSTEMATIC SAMPLING OF ECOSITES

In order to assess the importance of 50 Ecosites to each of 239 wildlife species, sample techniques that were fast and simple, yet quantitative, were used. Because of the large area to be inventoried and the probability that wildlife use would vary on the same Ecosite from one part of the study area to another, it was necessary to be able to obtain several samples of each Ecosite in different parts of both parks.

The major constraints on developing these techniques were:

1. Each sample must fit within the boundaries of one mapped tract and one vegetation type (v.t.). The maximum area sampled was 500 m x 500 m.
2. Each method must require a limited amount of time, effort and equipment, to allow a small staff to sample numerous sites over a wide area and in rugged terrain.
3. Each method must be standardized, easily taught to new staff, and based on the best techniques in published literature at the time the project was initiated.
4. Each method must be quantitative so that indices of abundance could be compared between Ecosites.
5. Each method, where possible, should be compatible with soil and vegetation sampling methods.

The methods which fulfilled these requirements were pellet group counts, browse use transects, track count transects, circular breeding bird census plots, and snap traplines. These are briefly described below. In addition, random observations by park and inventory staff were related directly to Ecosite importance in many cases. The selection of sample locations varied. Pellet group and browse use transects were conducted almost exclusively in conjunction with soil and vegetation sampling. These samples were located in homogeneous areas representative of the predominant soil and vegetation of the map polygon. Sample locations for the other methods were chosen based on the need to sample as many Ecosite-v.t. combinations as possible in each season and major watershed. Ecosites were selected from the 1:63,360 mapped air photos provided by the land inventory team and chosen for sampling based on vegetation sample data, accessibility, size of the tract, and proximity to other suitable Ecosites. Complete coverage of all Ecosites in all drainages was not possible due to difficult terrain and seasonal hazards such as grizzly bear use or snow avalanche risk.

The major requirement for locating any sample was that it had to fall entirely within the boundaries of one Ecosite and one v.t. In some complex Ecosites, such as heavily gullied slopes, alluvial or colluvial areas, where vegetation was heterogeneous, this was not possible and the sample was considered to have been collected in the most prevalent v.t. of that tract.

FIELD SAMPLING

The relative importance of an Ecosite to each ungulate species was determined by pellet group counts. Pellet groups were counted along four 2 x 50 m transects spaced at 20 m intervals and centered around the 20 x 20 m vegetation and soil sample plot. The number of pellet groups of each species from each transect was multiplied by 100 to give pellet groups/ha and an average density was calculated for each Ecosite and v.t. On the same 50 m transects, the presence or absence of snowshoe hare pellets was determined in 1 m^2 plots spaced at 5 m intervals along each transect. An average hare pellet frequency value was calculated for each Ecosite and v.t. Ungulate and snowshoe hare use of woody browse plants was assessed using a method adapted from Cole (1959) for ungulate use and Pease *et al.* (1979) for snowshoe hare use. Shrubs were rated for ungulate and snowshoe hare use using a *nearest neighbor* selection method in 2.5 m diameter plots at 5 m intervals along two of the 50 m transects. The results were tallied for all transects within each Ecosite and v.t. This information was used to identify major browse species on each Ecosite and also in assigning importance rankings to Ecosites for ungulates.

Relative abundance of small mammals on each Ecosite was determined using traplines of 100 *Woodstream Museum Special* traps baited for two nights. The number of rodents and shrews caught was averaged for each Ecosite. The averages were used in a cluster analysis to identify Small Mammal Associations, and to determine the density ranking for each Ecosite.

Winter mammal activity was assessed by counting the number of tracks intercepted by a straight transect of 0.5 km or longer. Track counts were standardized to the mean number of tracks per ten km-day by dividing the total track count by the total distance of the transects and the number of days since the last snowfall. These figures were averaged for each Ecosite and v.t. Snow depths were measured on most transects. In addition, all birds seen or heard were recorded.

Breeding bird populations were sampled using a modification of the variable circular plot method (Reynolds *et al.* 1980). Sampling was conducted before 1000 h between June 1 and July 15. The number of birds recorded was corrected for detectibility (Emlen 1971, 1977) and density indices for each species were calculated for all circular plots in each Ecosite and v.t. Cluster analyses, based on species density and diversity in each v.t., were used to identify Breeding Bird Communities (BBC's). These were then related to each Ecosite. Red squirrel, Columbian ground squirrel and pika densities were also assessed by this method.

ECOLOGICAL INTEGRATION

ABUNDANCE RATINGS

One of the objectives of the wildlife inventory is to determine the distribution of wildlife at a scale of 1:50,000. Plotting sightings or sign would not accomplish this goal but would show only the location of the observers when they found wildlife. An alternate approach is to identify important wildlife habitat and then map the habitats. The land classification provides the map base to show the distribution of habitat as long as the criteria used to identify Ecosites also define wildlife habitats. Most wildlife habitats can be related to one or more Ecosites. Some habitats are too small to be identified at a scale of 1:50,000; other habitats are complexes of Ecosites which are difficult to identify in a classification system. Consequently, there are difficulties relating some wildlife habitats to Ecosites. However, many habitats can be readily related to Ecosites, and the classification and mapping scheme can illustrate the distribution of these habitats.

Important wildlife habitats are identified by sampling wildlife or their sign on all Ecosites and v.t.s. For each sample type and species, the results on each Ecosite were ranked as described below and a legend prepared correlating wildlife importance rankings with each Ecosite.

These methods provide data on relative abundance but in numerical form they are difficult to use in comparing Ecosites. In addition, each method has a different range of numerical values. To simplify use of the data, they have been converted into rankings that allow easy comparison of Ecosites.

ECOSITE RANKINGS

Data from the primary sample methods were computer-manipulated to produce an average quantity for each Ecosite. The quantities for the Ecosites are then ranked as **none**, **low**, **moderate**, **high** and **very high** to compare the relative degree of use of each Ecosite. The ranking was determined by dividing non-zero values into three equal groups. Ecosites having values in the lowest one-third are of **low** importance. Those in the middle one-third are **moderately** important, and those in the upper third are **highly** important. The five or ten Ecosites having the highest values are **very highly** important.

Thus, the importance of an Ecosite to a species is derived directly from the measured relative abundance of that species on the Ecosite. For groups of species (*e.g.* Small Mammal Associations and Breeding Bird Communities) the total of rankings of all species is combined with the number of species to evaluate the importance of Ecosites.

Vegetation types (v.t.s) were similarly ranked as to their importance to wildlife. *Important* habitats are Highly ranked Ecosites and v.t.s. *Critical* habitats are Very Highly ranked Ecosites and v.t.s, in addition to habitats with special functions for wildlife (*e.g.* denning, calving, staging). It should be borne in mind that **critical areas may be site-specific** and hence not predictable on the basis of habitat generalities. Assessment of the importance of a site to wildlife must be supported by field observations on that site.

This ranking of Ecosites assumes that all Ecosites were sampled equally, and that animals and their sign are equally detectable on each Ecosite. While these assumptions are true in many instances, they do not always apply. For example, in winter some moose use wetlands where their droppings end up in standing water the following spring, and are not detected in pellet group counts. All rankings were reviewed subjectively and some were adjusted because of sampling bias.

An additional method of ranking Ecosites was used for lynx and coyotes. Relatively few tracks of these species were recorded on track transects, yielding insufficient data to rank their occurrence on each Ecosite. There are, however, considerable data on the distribution of prey species on each Ecosite. From knowledge of the food habits of coyote and lynx the proportion of each prey species in the predators' diet was determined and used as a weighting factor to estimate the potential importance of each Ecosite to the predator. For each Ecosite, the rank for each prey species was assigned a value (0 for none, 1 for low, 2 for medium, 3 for high and 4 for very high). The following formula was used to derive values:

Ecosite value = (prey species' rank value) X (proportion of that species in the predator's diet)
summed for all prey.

For lynx, which depend heavily on snowshoe hare, this resulted in importance rankings being the same as those for hares. Coyote rankings compared well to the limited track count information available.

Ecosite importance for other carnivores was ranked on the basis of winter track count densities; details regarding what densities represented high, medium or low importance are presented in the species accounts in Van Tighem and Gyug ([1984]).

For other species which were poorly documented by the primary sample methods (*e.g.* non-territorial birds in the breeding season; uncommon and wide ranging carnivores such as wolverines and cougars; and larger rodents such as beavers, porcupines, hoary marmots, and Columbian ground squirrels which were not sampled by snap trap methods), random observations were used to assign Ecosite rankings.

In this volume, the importance of each Ecosite to wildlife is briefly discussed. Generally, only the species for which the Ecosite is highly or very highly important are identified. Factors that result in the importance rating, such as snow depth, forage abundance, and prey availability are discussed briefly. In addition, for ungulates and carnivores, a single rating of importance is presented for some Ecosites. This rating is derived from the sum of the individual species ratings. It is not intended to be used for site specific planning or management but only for planning at the park level or larger.

SPECIES ASSEMBLAGES

Many wildlife species occur in MRNP and GNP. Some, like ungulates and carnivores, have traditionally been important in parks because of high public interest, relatively low population densities, and significance as ecological indicators. In this report and the Map Supplement, the importance of each Ecosite is described for each of these species individually.

It is not practical to develop an extended map legend and Ecosite accounts for all wildlife species, however, and since the management of most other species is basically limited to habitat management, it may not be necessary. Consequently, we have grouped small mammals and breeding birds into assemblages of species that normally occur together because of overlapping habitat preferences. Breeding Bird Communities (BBC's) and Small Mammal Associations (SMA's) are also described in BNP and JNP (Holroyd and Van Tighem 1983) and in KNP (Poll *et al.* 1984) Similar BBC's in MRNP and GNP are included in those already defined for BNP and JNP, and KNP. All BBC's are numbered consecutively to form one system common to all the mountain parks. These assemblages are synthetic concepts; they are not meant to reflect ecological relationships among species but are purely descriptive. They integrate a great deal of wildlife information into the ecological land classification, particularly in the map legend.

Several v.t.s may occur within one Ecosite. Thus, the v.t. is the basic unit in identifying wildlife species assemblages. It is assumed that each assemblage will occur in the v.t. in which it was found, wherever that v.t. occurs. Ecosites that were not sampled by circular bird census plots or small mammal trapping are assumed to support the species that occur elsewhere in the v.t.s that characterize that Ecosite.

SMALL MAMMAL ASSOCIATIONS

Small mammal associations are groups of insectivores and small rodents that are often found together due to similar habitat preferences. The 13 species (masked shrew, dusky shrew, wandering shrew, water shrew, yellow-pine chipmunk, deer mouse, northern bog lemming, heather vole, red-backed vole, meadow vole, long-tailed vole, Richardson's water vole and western jumping mouse) considered here are those which are relatively reliably sampled by snap-trapping. The SMA's defined here are numbered consecutively with those of Banff, Jasper and Kootenay National Parks. Of the ten SMA's in MRNP and GNP, only two (SMA's 1 and 3) also occur in BNP and JNP. The results of the 47.5 snap trap lines, three pitfall trap lines and three live trap plots were grouped to form SMA's on the basis of similarities in habitat, species captured and small mammal densities. Since Ecosites and v.t.s were not completely described until after field work was finished, most trap lines were placed in habitat that appeared homogeneous. Trap lines in complex Ecosites, however, sampled several small mammal habitats since some species occur in microhabitats that are not recognizable at the 1:50,000 Ecosite level. SMA variants are described in some cases to account for minor habitat or species composition differences on a scale too small to separate from the SMA as a whole (*e.g.* stream bank habitat variants).

In the following discussion, *definitive* and *additional* species are listed for each SMA. Two numerical values follow each species name: *frequency* is the number of the trap lines on which a species was captured in an SMA, divided by the total number of traplines in that SMA, and *relative density* is the number of captures per 100 trap nights. For the yellow-pine chipmunk and western jumping mouse, frequency is based only on traplines sampled before mid-September since these hibernatory species were probably inactive later in the year.

Definitive species are those whose combined presence defines the SMA. In some SMA's, definitive species were caught on fewer than 100% of the traplines because of low overall densities of small mammals. For these SMA's, more sampling effort is needed to detect all definitive species.

Additional species are those caught rarely or at very low relative densities on trap lines in that SMA and are not essential to defining the SMA.

In the map legend and Ecosite accounts, importance rankings for small mammals were derived as follows:

V - Very High: an SMA or Ecosite in which more than one species has a relative density >5.0, and the total relative density of all species combined is >20.0
H - High: an SMA or Ecosite in which one species has a relative density >5.0, or three or more species have relative densities >2.0
M - Medium: an association or Ecosite in which the greatest relative density of only one species is between 2.0 and 5.0
L - Low: an association or Ecosite in which no species has a relative density >2.0

Ecosites that were not sampled by trapping are assumed to support SMA's that elsewhere occur in the v.t.s that typify those Ecosites. The small mammal importance ratings of these Ecosites in the map legend and Ecosite accounts are thus based on density and diversity of small mammals in the appropriate SMA.

SMALL MAMMAL ASSOCIATION 1

Shrubland and grassland

This association occurs in the Interior Cedar-Hemlock and Lower Subalpine Ecoregions.

Definitive Species	freq.	dens.		freq.	dens.
deer mouse	2/2	7.3			
Additional Species					
western jumping mouse	2/2	0.6	dusky shrew	1/2	0.6
wandering shrew	1/2	1.1			

Remarks

This association was found on only two trap lines and has been included within SMA 1 of BNP and JNP because of the clear dominance of deer mice and absence of other common species. Deer mice occur on all mesic or dry open habitats in the Interior Cedar-Hemlock and Lower Subalpine Ecoregions. Western jumping mice are present because of low herbaceous vegetation: in CE1, horsetail meadows and in CT5, a man-made grassland on the Mount Revelstoke ski hill.

Vegetation Type correlates

willow (S15)
green alder/fern (S13)
yellow dryad-willow herb (H8)

SMALL MAMMAL ASSOCIATION 3

Subalpine fir/rhododendron forest

This association occurs in the Lower Subalpine on soils derived from till or colluvial material. It occurs in mesic to subhygric closed forests of subalpine fir (*Abies lasiocarpa*) or Engelmann spruce (*Picea engelmannii*) with understories of *Rhododendron albiflorum* or *Vaccinium* spp.

Definitive Species	freq.	dens.		freq.	dens.
red-backed vole	5/5	9.1	dusky shrew	3/5	0.4
Additional Species					
heather vole	1/5	0.2	deer mouse	1/5	0.2

Remarks

Although this SMA is defined in BNP and JNP by yellow-pine chipmunks and masked shrews in addition to red-backed voles (Holroyd and Van Tighem 1983), the association was recognized in MRNP and GNP on the basis of the dominance of red-backed voles and the physiognomic similarity of the associated habitats. Northern bog lemming occur in this association in wet sedge (*Carex* spp.)

meadows within Lower Subalpine closed forests. On two trap lines that included wet sedge meadows, the average relative density of northern bog lemmings was 1.1 and of long-tailed voles, 0.25.

Vegetation Type correlates

Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21)
mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47)
Engelmann spruce-mountain hemlock/rhododendron-tall bilberry (C48)
mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49)

SMALL MAMMAL ASSOCIATION 10

Western hemlock - cedar forest

Although this association is similar to SMA 2 (Holroyd and Van Tighem 1983) in terms of species composition, it has much higher densities of deer mice and red-backed voles. This is possibly due to the longer breeding season and lusher vegetation in the Interior Cedar-Hemlock Ecoregion than in the Montane in Banff and Jasper (see sec.4.4, Van Tighem & Gyug [1984]).

SMA 10 occurs in the Interior Cedar-Hemlock Ecoregion on soils derived from till, colluvium, ice-contact stratified drift or fluvial deposits in closed mesic forests of western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*) or Douglas fir (*Pseudotsuga menziesii*) or in mixed coniferous-deciduous forests with understories of mountain lover (*Pachystima myrsinites*), Western yew (*Taxus brevifolia*) or tall bilberry (*Vaccinium membranaceum*).

Definitive Species	freq.	dens.		freq.	dens.
deer mouse	9/9	9.0	red-backed vole	9/9	9.0
Additional Species					
masked shrew	4/9	1.4	dusky shrew	2/9	0.13
heather vole	1/9	0.1	wandering shrew	1/9	0.07
yellow-pine chipmunk	1/9	0.07			

Vegetation Type correlates

western hemlock-western red cedar/western yew/oak fern (C50)
western hemlock-western red cedar-(Douglas fir)/mountain lover (C52)
Douglas fir-western red cedar/mountain lover (C53)

SMALL MAMMAL ASSOCIATION 11

Alder shrub

This association occurs in the Interior Cedar-Hemlock and the Lower Subalpine and has been divided into two SMA's based on habitat. Small mammal association 11A occurs on snow avalanche meadow-shrub-forest complexes and SMA 11B occurs in hygric valley bottom forests or forest-shrub complexes. These are further described below.

The only difference in definitive species between SMA's 11A and 11B is yellow-pine chipmunk, which rarely occurs in hygric valley bottoms. Otherwise, the species groups are too similar to justify splitting into two different SMA's. In number of species, this SMA is the most diverse and the one where any of the definitive species can show up in high densities.

SMALL MAMMAL ASSOCIATION 11A

Avalanche alder shrub

This association occurs in the Interior Cedar-Hemlock and Lower Subalpine on soils derived from colluvium or till. It occurs on snow avalanche or other non-forested or open forest slopes in all moisture classes from hygric seepage areas to subxeric and lithic sites. It is found on avalanche meadows, avalanche shrub and forest complexes and in hygric, seepage shrub slopes in recent burns, wherever there is dense shrub or herbaceous understory.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
deer mouse	6/6	6.1	red-backed vole	5/6	6.2
heather vole	5/6	1.6	western jumping mouse	4/4	1.6
yellow-pine chipmunk	3/4	1.6	long-tailed vole	5/6	1.3

Additional Species					
Richardson's water vole	2/6	2.5	masked shrew	4/6	1.5
dusky shrew	3/6	0.6	wandering shrew	1/6	0.1

Remarks

The density of red-backed voles varies from nil on subxeric avalanche shrub sites to very high on mesic, open forest avalanche sites.

Vegetation Type correlates

Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21)
Engelmann spruce-subalpine fir/valerian-fleabane (O9)
subalpine fir-willow (S2)
green alder/fern (S13)
fleabane-valerian (H16)

SMALL MAMMAL ASSOCIATION 11B

Floodplain alder shrub

This association occurs in the Interior Cedar-Hemlock Ecoregion on organic soils and soils derived from fluvial deposits. It occurs in hygric valley bottom tracts in closed western red cedar (*Thuja plicata*) or Engelmann spruce (*Picea engelmannii*) forests with understories of red-osier dogwood (*Cornus stolonifera*), devil's club (*Oplopanax horridum*) and bracted honeysuckle (*Lonicera involucrata*) and in open hygric alder (*Alnus* spp.) habitats with understories of skunk cabbage (*Lysichiton americanum*), willow (*Salix* spp.) or bracted honeysuckle.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
deer mouse	4/4	12.8	red-backed vole	4/4	7.1
heather vole	2/4	2.1	western jumping mouse	1/1	1.2
long-tailed vole	3/4	1.3			

Additional Species

Richardson's water vole	2/4	0.8	masked shrew	4/4	0.8
dusky shrew	1/4	0.3	wandering shrew	2/4	0.3
water shrew	1/4	0.2	yellow-pine chipmunk	1/4	0.2

Remarks

One variant of this SMA occurs in spruce/Labrador tea/brown moss (O11) fen forests in valley bottoms where northern bog lemmings can also be present at low densities.

Vegetation Type correlates

Engelmann spruce-subalpine fir/green alder (C25)
western red cedar-western hemlock/devil's club/oak fern (C51)
spruce/Labrador tea/brown moss (O11)
alder/skunk cabbage (S17)

SMALL MAMMAL ASSOCIATION 12

Moist Upper Subalpine open forest

This association occurs in the Interior Cedar-Hemlock and Engelmann Spruce-Subalpine Fir Ecoregions on soils derived from till and recent alluvium. It is found in open subalpine fir forests near treeline with a dominant understory of heathers and in open black cottonwood - spruce forest (***Populus trichocarpa-Picea engelmannii***) with yellow dryad (***Dryas drummondii***) understory.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
red-backed vole	3/3	2.4	yellow-pine chipmunk	2/3	1.5
deer mouse	2/3	0.8	heather vole	2/3	0.5

Additional Species

none

Remarks

Red-backed vole is the most consistent species in this SMA, being found on all traplines; the other three definitive species may or may not be found since they occur at low densities.

Vegetation Type correlates

Engelmann spruce-subalpine fir/heather (O10)
subalpine fir-mountain hemlock/heather-luetkea (O20)
Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21)
Engelmann spruce-black cottonwood/yellow dryad (O23)

SMALL MAMMAL ASSOCIATION 13

Dry Upper Subalpine open forest

This association is found in the Engelmann Spruce-Subalpine Fir and Alpine Ecoregions on soils derived from till and colluvium. It occurs in subxeric open forests, subxeric shrublands and open lithic sites. The common denominator is subxeric sites with lithic tendencies.

Definitive Species	freq.	dens.		freq.	dens.
deer mouse	6/7	1.2	heather vole	3/7	0.5
yellow-pine chipmunk	2/5	0.3			

Additional Species

long-tailed vole	2/7	0.1	wandering shrew	1/7	0.1

Remarks

Yellow-pine chipmunks are usually present and Golden-mantled ground squirrels are sometimes present in this SMA, although they are not always caught in snap traps. Both deer mice and heather voles occur at such low densities that they may not both be found on the same trap line. No small mammals were snap-trapped in heather-everlasting (L5) meadows but winter heather vole latrines were found there, indicating that densities may be low or that habitat use changes seasonally.

Vegetation Type correlates

subalpine fir-whitebark pine-(Engelmann spruce)/tall bilberry-heather (O22)
Engelmann spruce-black cottonwood/yellow dryad (O23)
willow-mountain hemlock-subalpine fir/tall bilberry (S14)
heather-everlasting (L5)
yellow dryad-willow herb (H8)
fleabane-valerian (H16) (in part)

SMALL MAMMAL ASSOCIATION 14

Aspen open forest

This association occurs in the Interior Cedar-Hemlock Ecoregion on soils derived from colluvium. It was found on only one Ecosite (NC6).

Definitive Species	freq.	dens.		freq.	dens.
deer mouse	1/1	15.0	long-tailed vole	1/1	3.4

Additional Species

red-backed vole	1/1	0.6

Remarks

This association is apparently limited to the open deciduous forests of NC6 tracts along the Clachnacudainn Cliffs in MRNP. On less xeric NC6 tracts with mixed deciduous - coniferous forest, SMA 10 is more likely to occur. This association is similar to SMA 1 because of the predominance of deer mice.

Vegetation Type correlates

aspen-western white pine/mountain lover (O15)

SMALL MAMMAL ASSOCIATION 15

Lower Subalpine burn

This association occurs only in the Lower Subalpine on soils derived from till in dry, recently burned habitats where shrub regeneration is well underway.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
heather vole	1/1	7.9			
Additional Species					
long-tailed vole	1/1	0.6			

Remarks

This association was found on only one trapline and is defined by a high density of heather voles. As vegetation succession proceeds in burned tracts, other species of mice or voles may be expected to invade and the SMA to change. This association is one of the few where heather vole reaches high densities.

Vegetation Type correlates

willow-mountain hemlock-subalpine fir/tall bilberry (S14) (revegetating burn)

SMALL MAMMAL ASSOCIATION 16

Wet meadow (ESSF)

This association occurs in the Engelmann Spruce-Subalpine Fir Ecoregion on soils derived from till. It occurs only in open, herbaceous, hygric sites (often with standing water) dominated by sedges (*Carex* spp.) or in seepage areas dominated by fleabane-valerian (H16). On more mesic sites, northern bog lemming drops out of the association. Richardson's water vole is only found in streambank habitats.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
northern bog lemming	2/3	1.1	Richardson's water vole	3/3	0.7
heather vole	2/3	0.6			
Additional Species					
western jumping mouse	2/5	0.3			

Remarks

Three of the traplines used to define this SMA were in hygric habitats and two were in more mesic habitats. Overall density of small mammals is low and on more mesic sites (fleabane-valerian (H16)) there is almost no small mammal activity.

Vegetation Type correlates

willow/horsetail (S7)
fleabane-valerian (H16)
sedge (H21)

SMALL MAMMAL ASSOCIATION 17

Wet meadow (ICH)

This association is found only in the Interior Cedar-Hemlock Ecoregion on organic soils in wet sedge (*Carex* spp.) meadows.

Definitive Species	**freq.**	**dens.**		**freq.**	**dens.**
meadow vole	2/2	4.3			

Additional Species

wandering shrew	2/2	1.1	masked shrew	1/2	0.8

Remarks

This association is defined by the presence of meadow voles. The floodplains where this SMA occurs are often complexes of sedge meadows and other habitats, so that on a single 500 m trap line other species of mouse and vole that are typical of forest and shrub habitats (*e.g.* SMA 11B) may be found.

Vegetation Type correlates

water sedge-beaked sedge (H11)

BREEDING BIRD COMMUNITIES

In MRNP and GNP, Breeding Bird Communities were defined on the basis of the data collected on 505 circular bird census plots. By the methods described above (Section 2), density indices (DI's) were calculated for each species on each of the v.t.s sampled. These DI's generally fell between 0.01 and 10.00 and are relative densities.

BBC's were derived by comparing the species present, and their DI's, among each of the various v.t.s. In order to increase the significance of presence/absence, all non-zero DI values were increased by ten and the values were then clustered by BMPD (Hartigan 1983) to find which v.t.s were most similar with regard to bird species present and the relative densities at which they occur.

BBC's were not identified solely on the basis of the cluster analysis, however, since the analysis treats all species equally. Widespread species like American Robin and Golden-crowned Kinglet are of less value in defining BBC's than are species like American Redstart and Water Pipit with more specialized habitat needs. When BBC's had been defined, the DI of each species was averaged for all the v.t.s where the BBC occurs and the averages totalled to produce a DI for that BBC. By this means, the relative density of birds in one BBC could be compared to another.

BBC's are described by a number, a name for the characteristic habitat, followed by a description of the habitat. Next is a list of species with their DI's in that BBC. Since circular bird census plots were used in MRNP and GNP rather than line transects as in BNP and JNP, DI's are not comparable to those in Holroyd and Van Tighem (1983). *Dominant species* have DI's >0.1. That is, they are the most frequent or prevailing species. *Definitive species* are dominant species which best define the BBC; they are confined to that BBC, occur in it at much higher densities than elsewhere or occur in combination with other definitive species with which they do not occur elsewhere. A species may be definitive of more than one BBC. *Additional species* are all other species recorded in that habitat with DI 's lower than 0.1.

The *Remarks* section describes the areal extent of the BBC and variability in composition, particularly as it relates to habitat variability. Last is a list of *Vegetation Types* in which the BBC occurs. These v.t.s are described in Chapter III. BBC's for each Ecosite are presented in the wildlife map legend (Map Supplement) and the Ecosite accounts in Chapter V.

BREEDING BIRD COMMUNITY 7

Upper Subalpine coniferous open forest

BBC 7 is confined to Upper Subalpine open forests with heath (*Cassiope mertensiana, Phyllodoce empetriformis*) or herbaceous meadows. At highest elevations, coniferous cover is limited to krummholz of subalpine fir, while at lowest elevations forest cover may be more closed, with only scattered openings.

Definitive Species

Water Pipit	.526	Fox Sparrow	.206
Rosy Finch	.500	Hermit Thrush	.104

Dominant Species

Dark-eyed Junco	.386	American Robin	.135
Pine Siskin	.377	Winter Wren	.108
Chipping Sparrow	.146		

Additional Species

Yellow-rumped Warbler	.098	Townsend's Warbler	.013
Ruby-crowned Kinglet	.056	Townsend's Solitaire	.012
Clark's Nutcracker	.051	Boreal Chickadee	.011
Varied Thrush	.048	White-crowned Sparrow	.011
Golden-crowned Sparrow	.043	White-winged Crossbill	.009
Mountain Chickadee	.043	Hammond's Flycatcher	.009
Golden-crowned Kinglet	.030	Wilson's Warbler	.008
Gray Jay	.029	Red-breasted Nuthatch	.102
White-tailed Ptarmigan	.027		

Remarks

The average DI is 3.1, lower than any other forest BBC but still higher than the Alpine meadow BBC.

None of the definitive species are unique to timberline; rather, they are a mix of Subalpine (Hermit Thrush, Fox Sparrow) and Alpine (Water Pipit, Rosy Finch) species that occur here in close association. Clark's Nutcracker, Townsend's Solitaire and Golden-crowned Sparrow are strongly associated with this BBC. The composition of this BBC is very similar to its composition in the Rockies (Holroyd and Van Tighem 1983, Poll and Porter 1984).

Vegetation Type correlates

Engelmann spruce-subalpine fir/valerian-fleabane (O9)
Engelmann spruce-subalpine fir/heather (O10)
subalpine fir-mountain hemlock/heather-luetkea (O20)
subalpine fir-whitebark pine-(Engelmann spruce)/tall bilberry-heather (O22)
heather-everlasting (L5)

BREEDING BIRD COMMUNITY 8

Upper Subalpine coniferous closed forest

BBC 8 is widespread and common in the coniferous forests of the Lower and Upper Subalpine. It is most typical of closed canopy forests of subalpine fir (*Abies lasiocarpa*), mountain hemlock (*Tsuga mertensiana*) and Engelmann spruce (*Picea engelmannii*) but also occurs in some open forests.

Definitive Species

Hermit Thrush	.159	Golden-crowned Kinglet	.105
Yellow-rumped Warbler	.144		

Dominant Species

Pine Siskin	.745	Red-breasted Nuthatch	.152
Dark-eyed Junco	.594	Hammond's Flycatcher	.136
Varied Thrush	.411	Fox Sparrow	.115
Townsend's Warbler	.399	Rufous Hummingbird	.113
Winter Wren	.353		

Additional Species

Chipping Sparrow	.089	MacGillivray's Warbler	.033
Swainson's Thrush	.078	Clark's Nutcracker	.029
Chestnut-backed Chickadee	.073	Pine Grosbeak	.012
Gray Jay	.068	Pileated Woodpecker	.011
American Robin	.056	White-winged Crossbill	.011
Brown Creeper	.055	Warbling Vireo	.011
Hairy Woodpecker	.052	Steller's Jay	.006
Wilson's Warbler	.052	Golden-crowned Sparrow	.006
Ruby-crowned Kinglet	.046	American Kestrel	.005
Blackpoll Warbler	.042	Song Sparrow	.005
Red Crossbill	.039	Olive-sided Flycatcher	.003
Mountain Chickadee	.034	White-crowned Sparrow	.002

Remarks

The average DI is 4.8, lower than other closed forest BBC's but higher than at timberline (BBC 7).

Most of the species in this BBC are widespread in coniferous forests. The definitive species occur more consistently and at higher densities here than elsewhere. Species strongly associated with this BBC include Gray Jay, Ruby-crowned Kinglet, White-winged Crossbill and Yellow-rumped Warbler. The long list of *Additional Species* is due to the large number of samples collected in the C46 and C47 v.t.s.

In BNP and JNP this BBC is also widespread, being defined there by several species that are less ubiquitous in the Rockies than in the Columbia Mountains, and are hence more restricted to this BBC when it occurs there.

Vegetation Type correlates

Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21)
mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47)
Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21)
Engelmann spruce-mountain hemlock/rhododendron-tall bilberry (C48)

BREEDING BIRD COMMUNITY 12

Avalanche slope

BBC 12 is common and widespread in both parks, occurring wherever regular snow avalanching maintains early successional mosaics of shrubs, lush herbaceous meadows and exposed rock. This BBC is the most diverse and sustains the highest density of breeding birds in the Interior Cedar-Hemlock Ecoregion, but also occurs as high as the Upper Subalpine. At the bases of low elevation avalanche slopes where there is considerable seepage and stands of mature poplar (*Populus trichocarpa*) and spruce (*Picea engelmannii*), BBC 12 may give way to BBC 22, while on exposed, well drained sites it may be replaced by BBC 26. Revegetating glacial moraine, such as AB1, may sustain deciduous shrubs where this BBC also occurs.

Definitive Species

Wilson's Warbler	.555	Orange-crowned Warbler	.240
MacGillivray's Warbler	.540	Yellow Warbler	.159
Brown-headed Cowbird	.505		

Dominant Species

Rufous Hummingbird	.943	Warbling Vireo	.398
Dark-eyed Junco	.663	Chipping Sparrow	.374
Golden-crowned Kinglet	.457	Swainson's Thrush	.227
Townsend's Warbler	.446	Winter Wren	.149
Pine Siskin	.440	Varied Thrush	.119

Additional Species

American Robin	.095	Olive-sided Flycatcher	.026
Dusky Flycatcher	.087	Tennessee Warbler	.025
Vaux's Swift	.084	Blue Grouse	.025
Hermit Thrush	.072	Cedar Waxwing	.025
Hammond's Flycatcher	.069	Northern Flicker	.015
Steller's Jay	.055	Northern Waterthrush	.015
Red-breasted Nuthatch	.044	Clark's Nutcracker	.015
American Redstart	.039	Solitary Vireo	.015
Yellow-rumped Warbler	.036	Ruby-crowned Kinglet	.013
Spotted Sandpiper	.029	Western Wood Pewee	.011
American Crow	.029	White-crowned Sparrow	.006
Western Tanager	.026	Willow Flycatcher	.006
Pine Grosbeak	.026		

Remarks

The average DI is 6.8, higher than coniferous forest and high elevation BBC's but lower than those of wetlands or deciduous forest.

Many species are characteristic of forest edge (*e.g.* Chipping Sparrow, Pine Siskin, Rufous Hummingbird) and are widespread in MRNP and GNP. The definitive species are all characteristic of deciduous habitats. This BBC is distinguished from other deciduous BBC's by the lack of wetland species like Common Yellowthroat and Song Sparrow, and the lack or scarcity of dry poplar forest species like Calliope Hummingbird and Nashville Warbler. Lazuli Bunting and Tennessee Warbler are of limited distribution in MRNP and GNP but strongly associated with this BBC.

Vegetation Type correlates

subalpine fir-willow (S2)
green alder/fern (S13)
willow-mountain hemlock-subalpine fir/tall bilberry (S14)
willow (S15)

BREEDING BIRD COMMUNITY 15

Dryad mat

BBC 15 is uncommon, occurring on gravelly river floodplains, glacial outwashes and recent moraines where early successional vegetation predominates. Mats of yellow dryad (*Dryas drummondii*) with scattered small Engelmann spruce (*Picea engelmannii*) and clumps of willow (*Salix* spp.) are characteristic and exposed gravel and small streams are common.

Definitive Species

Chipping Sparrow	.32	Spotted Sandpiper	.15

Dominant Species

Pine Siskin	.43	Hammond's Flycatcher	.18
Water Pipit	.32	MacGillivray's Warbler	.14
Clark's Nutcracker	.31	Ruby-crowned Kinglet	.13
Wilson's Warbler	.29	Warbling Vireo	.13

Additional Species

Wilson's Warbler	.29	Rosy Finch	.05
Townsend's Solitaire	.06		

Remarks

The DI is 2.4, lower than most other BBC's. Dominant species are those characteristic of edges and semi-open habitats. The Chipping Sparrow, which favours semi-open, well drained habitats, and the Spotted Sandpiper, which prefers gravelly and silty stream banks, together define this BBC.

The greater diversity of BBC 15 here compared to the Rocky Mountain parks (Holroyd and Van Tighem 1983, Poll and Porter 1984) is largely due to the greater abundance of shrubs and young conifers on recent floodplains in the Columbia Mountains than in the Rockies.

Vegetation Type correlates

yellow dryad-willow herb (H8)

BREEDING BIRD COMMUNITY 17

Moist Upper Subalpine and Alpine meadow

Herb meadows and dryad (*Dryas octopetala*) mats at and above timberline are uncommon in MRNP and GNP; where they occur they support BBC 17. Such sites are usually small and remain snow covered until well into June.

Definitive Species

Rosy Finch	.617	Water Pipit	.421

Dominant Species

Rufous Hummingbird	.298

Additional Species

White-tailed Ptarmigan	.079	Pine Siskin	.069
Horned Lark (Purcell Mountains)			

Remarks

The average DI is 1.5, lower than that of any other BBC.

The dominance of the Rufous Hummingbird is partly an artifact of the sampling, since hummingbirds are readily attracted to humans wearing bright clothing in the open meadows at timberline and are consequently seen at close range more often than their abundance warrants. All species also occur at timberline, and what is most characteristic is the absence of forest or shrub bird species.

Vegetation Type correlates

heather-everlasting (L5) (in part)
mountain avens-snow willow-moss campion (H1)
hairy wild rye-wild strawberry-fireweed (H5) (Achuff and Dudynsky 1984)
fleabane-valerian (H16)
everlasting-white mountain heather-red heather (H18)

BREEDING BIRD COMMUNITY 21

ESSF burn

This BBC occurs in recent burns where coniferous forest has been replaced by early successional vegetation dominated by fireweed (*Epilobium angustifolium*), hairy wild rye (*Elymus innovatus*), fire mosses (*Polytrichum* spp.) and berry producing shrubs. Most samples of this BBC were collected in the Copperstain burn in eastern GNP; other burns further west and at lower elevations (in the Interior Cedar-Hemlock Ecoregion) may have somewhat different bird communities.

Definitive Species

Dark-eyed Junco	1.25	Hermit Thrush	.14
Hairy Woodpecker	.85	Mountain Chickadee	.11
Wilson's Warbler	.21		

Dominant Species

Pine Siskin	.46	Yellow-rumped Warbler	.27
Hammond's Flycatcher	.38	Winter Wren	.18

Additional Species

Townsend's Solitaire	.09	Olive-sided Flycatcher	.05
Ruby-crowned Kinglet	.07	Varied Thrush	.05

Remarks

The average DI is 4.1.

In the middle of an extensive burn, only a few definitive species occur regularly; these include Dark-eyed Junco and Hermit Thrush. Most of the other species that characterize this BBC are commonest near the edges of burns or near unburned islands of forest. The abundance of dead, insect-infested timber in burns provides food for Northern Flicker and Hairy Woodpecker and the open vegetation, with an abundance of voles, ground squirrels and insects, allows Red-tailed Hawk and American Kestrel to hunt efficiently.

Vegetation Type correlates

There are no defined v.t.s that describe early successional vegetation in these burns. Ground cover at highest elevations is dominated by *Luetkea pectinata* and some *Vaccinium* spp. At lower elevations there is a diverse ground cover of fireweed (*Epilobium angustifolium*) *Arnica* spp. and *Polytrichum* spp., and variable shrub cover composed of tall bilberry (*Vaccinium membranaceum*), oval-leaf blueberry (*Vaccinium ovalifolium*), elderberry (*Sambucus* spp.), mountain ash (*Sorbus sitchensis*), and other berry producing shrubs.

BREEDING BIRD COMMUNITY 22

Floodplain complex

BBC 22 occurs at low elevations in the Interior Cedar-Hemlock and, locally, the Lower Subalpine where rivers and large streams meander through wide, low-gradient valley bottoms, creating a diverse mosaic of habitats. This habitat mosaic falls mostly within the GF and LR Ecosections. Much of the vegetation is alder (*Alnus crispa*) thickets, frequently with skunk cabbage (*Lysichiton americanum*) and seasonally wet understories. Beaver ponds occur locally. Sedge (*Carex* spp.) meadows and fens occur in poorly drained sites, and spruce-cedar (*Picea engelmannii-Thuja plicata*) forest - frequently with a strong black cottonwood (*Populus trichocarpa*) component - occurs on better drained sites. The complexity of the vegetation does not allow separation of BBC's for each vegetation type at our sampling scale.

Definitive Species

Brown-headed Cowbird	6.857
Common Yellowthroat	1.417
Black-headed Grosbeak	.796
American Redstart	.749
MacGillivray's Warbler	.642
Lincoln's Sparrow	.622
Red-winged Blackbird	.497
Song Sparrow	.474
Solitary Sandpiper	.444
Northern Waterthrush	.425
American Crow	.298
Cedar Waxwing	.159
Western Wood Pewee	.138

Dominant Species

Rufous Hummingbird	3.349
Yellow Warbler	1.031
Steller's Jay	1.024
Hammond's Flycatcher	.556
Pine Siskin	.402
American Robin	.316
Chipping Sparrow	.304
Warbling Vireo	.236
Orange-crowned Warbler	.191
Wilson's Warbler	.179
Townsend's Warbler	.172

Additional Species

Red-breasted Nuthatch	.097	Dark-eyed Junco	.047
Northern Flicker	.096	Spotted Sandpiper	.047
Varied Thrush	.078	Veery	.039
Willow Flycatcher	.078	Black-capped Chickadee	.039
Common Snipe	.078	Solitary Vireo	.020
Swainson's Thrush	.078	Townsend's Solitaire	.019
Evening Grosbeak	.063	Western Tanager	.019
Mountain Chickadee	.050	Fox Sparrow	.019
Golden-crowned Kinglet	.049	Savannah Sparrow	.019

Remarks

The average DI is 22.4, considerably higher than that of any other BBC in MRNP and GNP.

The diversity of species reflects the prevalence of habitat edge and variety of v.t.s. The definitive species are primarily those associated with productive wetlands. Many occur only rarely elsewhere in MRNP and GNP and their presence alone distinguishes this from other BBC's. Examples include American Redstart, Black-headed Grosbeak, Solitary Sandpiper and Song Sparrow. Common Snipe, Magnolia Warbler, Savannah Sparrow, Veery, and Violet-green and Tree Swallows are species of limited distribution in MRNP and GNP that are strongly associated with this BBC. There is considerable similarity between this BBC and BBC 9 (Holroyd and Van Tighem 1983), but the prevalence of tall shrubs in MRNP and GNP wetlands results in species like American Redstart and MacGillivray's Warbler being more abundant and species like Steller's Jay and Black-headed Grosbeak, which are rare in the Rockies, occur here in the Columbia Mountains.

Vegetation Type correlates

Engelmann spruce-black cottonwood/yellow dryad (O23) (in part)
willow/horsetail (S7) (Corns and Achuff 1982)
alder/skunk cabbage (S17)
water sedge-beaked sedge (H11) (in part)

BREEDING BIRD COMMUNITY 23

Wet forest

BBC 23 is prevalent in Interior Cedar-Hemlock and Lower Subalpine wetlands where vegetation is less diverse and conifers are more predominant than in those areas where BBC 22 occurs. Wet sedge (*Carex* spp.) meadows bordered by alder (*Alnus* spp.) thickets with scattered spruce (*Picea engelmannii*), and wet coniferous forests with abundant seepage support this BBC.

Definitive Species

Common Yellowthroat	.867	Boreal Chickadee	.231
Blackpoll Warbler	.257	Yellow Warbler	.228
Northern Waterthrush	.253	Wilson's Warbler	.210

Dominant Species

Townsend's Warbler	.885	American Robin	.337
Dark-eyed Junco	.773	Chestnut-backed Chickadee	.182
Golden-crowned Kinglet	.665	Red-breasted Nuthatch	.154
Chipping Sparrow	.486	Yellow-rumped Warbler	.130
Varied Thrush	.477	Brown Creeper	.105
Winter Wren	.448	Pine Siskin	.105
Hammond's Flycatcher	.356		

Additional Species

Hermit Thrush	.095	Savannah Sparrow	.064
Willow Flycatcher	.067	Townsend's Solitaire	.035
Swainson's Thrush	.064	Olive-sided Flycatcher	.032

Remarks

The average DI is 7.5, much lower than BBC 22 but higher than coniferous forest BBC's.

Many species that occur here are also present in hemlock-cedar (*Tsuga heterophylla-Thuja plicata*) and other coniferous forests. The definitive species include Blackpoll Warbler, which is confined to this BBC, and species characteristic of wetlands (Common Yellowthroat and Northern Waterthrush), deciduous shrubbery (Yellow Warbler), dense coniferous forest (Boreal Chickadee) and coniferous shrubbery and forest edges (Wilson's Warbler). This unique assemblage, and the presence of Blackpoll Warbler, distinguishes this BBC from others in MRNP and GNP. It is similar to BBC 6, which occurs in the Rocky Mountains (Holroyd and Van Tighem 1983), but the greater prevalence of tall shrubs in MRNP and GNP wetlands increases the densities of species like Yellow Warbler and Common Yellowthroat.

Vegetation Type correlates

water sedge-beaked sedge (H11) (in part)
spruce/Labrador tea/brown moss (O11)
Engelmann spruce-subalpine fir/green alder (C25)

BREEDING BIRD COMMUNITY 24

Hemlock-cedar forest

BBC 24 occurs primarily in the mature hemlock-cedar (*Tsuga heterophylla-Thuja plicata*) forests of the Interior Cedar-Hemlock Ecoregion, but also occurs locally in the Lower Subalpine. Where deciduous trees form a significant part of the canopy, it gives way to BBC 25.

Definitive Species

Golden-crowned Kinglet	.898	Vaux's Swift	.259
Townsend's Warbler	.584	Brown Creeper	.170
Chestnut-backed Chickadee	.533	Evening Grosbeak	.158

Dominant Species

Pine Siskin	.675	Hammond's Flycatcher	.180
Varied Thrush	.270	Swainson's Thrush	.105
Winter Wren	.267	Three-toed Woodpecker	.103
Red-breasted Nuthatch	.197		

Additional Species

Dark-eyed Junco	.094	Boreal Chickadee	.019
Hermit Thrush	.087	Chipping Sparrow	.019
Hairy Woodpecker	.065	Mountain Chickadee	.017
Red Crossbill	.061	Warbling Vireo	.016
American Robin	.060	Solitary Vireo	.011
MacGillivray's Warbler	.055	Western Tanager	.010
Steller's Jay	.040	Northern Flicker	.010

Gray Jay	.032	Orange-crowned Warbler	.006
Yellow-rumped Warbler	.028	White-winged Crossbill	.005
Pine Grosbeak	.023	Black-capped Chickadee	.005
Pileated Woodpecker	.021	Fox Sparrow	.003
		Townsend's Solitaire	.002

Remarks

The average DI is 5.1, reflecting the low productivity of the uniform, coniferous habitat. Density and diversity increase at openings and forest edges due to the concentration of both edge species and species from other habitats.

Most species in BBC 24 also occur in other coniferous habitats. Chestnut-backed Chickadee and Vaux's Swift are largely limited to this BBC and species like Brown Creeper, Evening Grosbeak, Golden-crowned Kinglet and Townsend's Warbler occur at much higher densities here than elsewhere. The Red Crossbill is also strongly associated with this BBC, but occurs at low densities.

Vegetation Type correlates

mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49)
western hemlock-western red cedar/western yew/oak fern (C50)
western red cedar-western hemlock/devil's club/oak fern (C51)
western hemlock-western red cedar-(Douglas fir)/mountain lover (C52)

BREEDING BIRD COMMUNITY 25

ICH mixed forest

Particularly in MRNP above the Trans-Canada Highway and along the lower slopes of Mount Revelstoke, and locally in the Beaver valley of GNP, a diverse forest comprised of both deciduous species, *e.g.* aspen (*Populus tremuloides*), black cottonwood (*Populus trichocarpa*), paper birch (*Betula papyrifera*), and mountain maple (*Acer glabrum*) and coniferous species, *e.g.* western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), western white pine (*Pinus monticola*) and Douglas fir (*Pseudotsuga menziesii*), covers much of the landscape. This vegetation is fire successional and may succeed eventually to closed hemlock-cedar forest, but it is likely to persist for many years. Because of its diversity and location on low southerly aspects in the Interior Cedar-Hemlock Ecoregion, it sustains a high diversity of birds.

Definitive Species

Golden-crowned Kinglet	.812	Chestnut-backed Chickadee	.227
Warbling Vireo	.417	MacGillivray's Warbler	.219

Dominant Species

Pine Siskin	1.245	Yellow-rumped Warbler	.185
Townsend's Warbler	.542	Swainson's Thrush	.178
Red-breasted Nuthatch	.247	Dark-eyed Junco	.165
Varied Thrush	.211	Chipping Sparrow	.146
Hammond's Flycatcher	.186	American Robin	.133

Additional Species

Winter Wren	.086	Hermit Thrush	.045
Red Crossbill	.083	Solitary Vireo	.045

Brown Creeper	.073	Nashville Warbler	.038
Gray Jay	.062	Wilson's Warbler	.037
Orange-crowned Warbler	.059	Ruby-crowned Kinglet	.032
Western Tanager	.054	Blue Grouse	.032
Pileated Woodpecker	.052	Evening Grosbeak	.022
Pine Grosbeak	.046	Dusky Flycatcher	.019
Three-toed Woodpecker	.045	Mountain Chickadee	.018
Black-capped Chickadee	.045	Townsend's Solitaire	.007

Remarks

The average DI is 5.8, higher than any coniferous forest BBC and lower than the deciduous forest BBC.

Most of the dominant species are widespread, common species that occur in most forests or forest edges. The definitive species include both coniferous forest birds (Chestnut-backed Chickadee, Golden-crowned Kinglet) and deciduous forest birds (Orange-crowned Warbler, Warbling Vireo) that do not occur together in other BBC's. The disturbed area at the Mount Revelstoke ski hill has stronger affinities to BBC 26 (Calliope Hummingbird, Dusky Flycatcher, Lazuli Bunting) than to this BBC. The Pileated Woodpecker and Western Tanager are strongly associated with this BBC.

Vegetation Type correlates

western hemlock-western red cedar-(Douglas fir)/mountain lover (C52) (in part)
Douglas fir-western red cedar/mountain lover (C53)
mixed forest (unclassified)

BREEDING BIRD COMMUNITY 26

ICH deciduous forest

This BBC is rare and local in MRNP and the Illecillewaet valley of GNP. It occurs only in well drained forests of aspen (*Populus tremuloides*) and paper birch (*Betula papyrifera*) on NC6, particularly above the west gate of MRNP, and in the disturbed area dominated by deciduous vegetation at the base of Mount Revelstoke. The relatively dry, semi-open structure of the vegetation appears to be as important as its deciduous nature.

Definitive Species

Nashville Warbler	.382	Cedar Waxwing	.266
Calliope Hummingbird	.373	Dusky Flycatcher	.187
MacGillivray's Warbler	.359		

Dominant Species

Rufous Hummingbird	2.348	Black-capped Chickadee	.169
Dark-eyed Junco	1.158	Swainson's Thrush	.153
Warbling Vireo	.925	Solitary Vireo	.147
Hammond's Flycatcher	.889	Golden-crowned Kinglet	.136
Western Tanager	.825	Chipping Sparrow	.131
Orange-crowned Warbler	.426	Yellow Warbler	.118
Wilson's Warbler	.228	Townsend's Warbler	.111
American Robin	.177	Pine Siskin	.101
Yellow-rumped Warbler	.169		

Additional Species

Chestnut-backed Chickadee	.084	Spotted Sandpiper	.039
White-winged Crossbill	.081	Steller's Jay	.037
Yellow-rumped Warbler	.066	Song Sparrow	.033
Western Wood Pewee	.059	White-crowned Sparrow	.017
Evening Grosbeak	.052	Hermit Thrush	.015
Fox Sparrow	.052	Alder Flycatcher	.015
Red-breasted Nuthatch	.041	Townsend's Solitaire	.015

Remarks

The average DI is 10.4. Only BBC 22 has a higher DI.

As with most other BBC's, the dominant species here are widespread and common in a variety of habitats. The definitive species, however, are largely confined to this BBC. The Calliope Hummingbird, Dusky Flycatcher and Nashville Warbler rarely occur in other habitats. The Cedar Waxwing and MacGillivray's Warbler occur here at higher densities than elsewhere.

Although this BBC is similar to BBC 2, which occurs in the Rocky Mountains, it contains a number of species, like the Nashville Warbler and Calliope Hummingbird, that are rare or absent in the Rockies.

Vegetation Type correlates

aspen-western white pine/mountain lover (O15)
Engelmann spruce-black cottonwood/yellow dryad (O23) (in part)

CHAPTER V - ECOLOGICAL INTEGRATION OF LANDFORMS, SOILS, VEGETATION AND WILDLIFE

ECOLOGICAL LAND CLASSIFICATION METHODOLOGY

B.D. Walker, W.S. Taylor and G.M. Coen

PHILOSOPHICAL PRINCIPLES

There have been various approaches to natural resource inventories in Canadian national parks. Experience has shown that, for ease of use, all resource sectors should be linked to one set of map polygons of appropriate scale (1:50,000 was chosen for MRNP and GNP) and the legend should describe holistic, repeating, ecological map unit concepts. For the mountain national parks, this mapping approach was developed during the Lake Louise pilot study (Holland 1976, Walker *et al.* 1978) and further refined in the BNP-JNP and KNP Ecological Land Classifications (Coen *et al.* 1982, Walker *et al.* 1982b, 1984c). The MRNP and GNP Ecological Land Classification is based on design principles and concepts developed in the BNP, JNP and KNP projects and uses a few of the same Ecosection concepts.

Three guidelines were used to develop the mapping procedure for ecological land classification in the mountain national parks:

1. Map, legend, and report should be easily interpretable.
2. Map unit concepts should be repetitive and holistic.
3. Map information should be uniform in reliability and intensity.

These guidelines were met by using a controlled legend (Mapping Systems Working Group 1981) and a simple map symbol that encompasses a holistic ecological concept comprising landform, soil, and vegetation. Only the slope and selected landscape modifying processes vary independently of the concept as applied to map polygons. This allows the development of an ecological map unit concept (Jurdant *et al.* 1975, Rowe 1979), limits the number of concepts, permits legend interpretation followed by mechanical labelling of repetitive map polygons, and encompasses many landscape features in an easily remembered symbol. It also allows transfer of experience from a familiar area to an unfamiliar but similarly labelled area, without reference to the many specific landscape components such as texture or calcareousness.

Map delineations were chosen to correspond with changes in landscape features, usually landform. Such changes usually can be correlated with soil and vegetation changes, which allows reliable extrapolation of Ecosite boundaries on aerial photographs. At scale 1:50,000, the smallest practical map polygon, about 0.5 to 1.0 cm^2, represents 10 to 25 ha. Thus, these were the smallest contrasting polygons delineated. Survey intensity corresponds to Level 3 of the Soil Mapping System for Canada (Mapping Systems Working Group 1981). The legend is organized hierarchically, *i.e.* the taxonomic units Ecoregion, Ecosection, and Ecosite are conceptually hierarchical. Attempts have been made elsewhere to map polygons named by hierarchical level and then to subdivide these large polygons, naming the smaller units by a lower category in the hierarchical taxonomy (Airphoto Analysis Associates 1975). This hierarchical or nested mapping method was not used in the BNP and JNP (Coen *et al.* 1982), KNP or MRNP and GNP inventories.

MAPPING METHODOLOGY

METHODOLOGY OF LEGEND DEVELOPMENT

No nationally acceptable taxonomic system for Ecological Land Classification presently exists. There are guidelines (Lacate 1969, Jurdant *et al.* 1975, Wiken 1980) useful for developing Ecological Land Classifications, but they are oriented more towards landscape mapping than to landscape taxonomy. They recommend utilizing, as building blocks, taxonomies developed for single components of the landscape, *e.g.* a soil or vegetation classification. Ecological Land Classification in the mountain national parks, as initiated by the BNP-JNP inventory, uses a conceptual taxonomy based on other taxonomies. A vegetation *community type* taxonomy was developed (Achuff 1982, Corns and Achuff 1982) and an existing landform classification was slightly modified (C.S.S.C. 1978a, Walker *et al.* 1982a). These were combined with an existing soil taxonomy (C.S.S.C. 1978a) to form a legend that defined the mapping units (Ecosites). In MRNP and GNP bedrock categories (Fig. 2), were added to differentiate map units. However, the three legends covering the five mountain national parks are comparable.

An iterative process, involving large amounts of data, was used to develop the component taxonomies and the Ecological Land Classification legend. Pretyping of probable map unit boundaries was done on 1:63,360 scale, black and white aerial photographs. During the next phase, landform, soil, vegetation, and some wildlife data were collected simultaneously along common transects and at common observation sites in the field. Traverses were selected for optimal coverage of different landscapes, particularly over an altitudinal range. Observation sites were selected to represent the most common landform-soil-vegetation-wildlife condition within each map delineation. Occasionally, sites were chosen to examine some special but less common set of conditions. Site locations were noted on the 1:63,360 photos. The data were computer coded and analyzed to develop the component taxonomies and Ecological Land Classification legend.

The pretyped map unit boundaries were corrected and refined as the field work progressed and the legend was refined. Also used were 1:25,000 scale, black and white and color IR photographs. Completed photo mapping was transferred to 1:50,000 base maps and then drafted and digitized by the Cartography Section, Land Resource Research Institute, Ottawa.

In keeping with the holistic approach of the inventory, wildlife data were used to develop Ecosite importance ratings for selected species (see methodologies in Chapter IV and Van Tighem and Gyug [1984]). In addition, wildlife data identified as critical by the wildlife team, influenced decisions about Ecosite separations and about assignment of vegetation types (v.t.s) to Ecosites. Thus, the Ecosite concepts are defined in terms of bedrock, landform, soil, and vegetation components, some of which were chosen for their usefulness in identifying wildlife habitat.

DESIGN OF THE MAP LEGEND

The current Ecological Land Classification guidelines (Wiken 1980) were the starting point for developing the map legend used for the BNP-JNP, KNP, and MRNP and GNP ecological inventories. To develop the taxonomy, class limits should have been defined for each of the hierarchical levels and taxa. This would have resulted in a matrix of *pigeon holes* into which the ecological universe could be partitioned. Since only a small portion of the ecological universe is present in MRNP and GNP, it was possible to develop credible taxon limits for only portions of the taxonomy. Thus, a map legend was developed which separates mapping concepts coincident with probable taxon limits wherever possible. Extending the ecological inventory from the Rocky Mountain parks to MRNP and GNP resulted in expansion of knowledge about the southeastern Canadian Cordillera. Consequently in MRNP and GNP there is some use of BNP-JNP and KNP Ecosections, although new Ecosite concepts were developed.

The following discussion of Ecoregions, Ecosections, and Ecosites show how the hierarchical taxonomic levels influenced the mapping legend. Ecodistrict separations (Wiken 1980) were not made.

Ecoregions

Three Ecoregions (ecological zones) occur in MRNP and GNP: Interior Cedar-Hemlock, Engelmann Spruce-Subalpine Fir, and Alpine (Fig. 6). The Engelmann Spruce-Subalpine Fir Ecoregion was further divided into Lower Subalpine and Upper Subalpine portions. The Ecoregion is the broadest level of ecosystem classification used in this study and is based primarily upon differences in vegetation physiognomy and species composition which reflect differences in macroclimate. Because greatest ecological similarity occurs at high elevations, Alpine is the only Ecoregion common to both Rocky Mountain and Columbia Mountain national parks. An Ecoregion, as used here, is conceptually similar to the zone of Daubenmire (1968), La Roi (1975), and Lea (1980, 1983), the biogeoclimatic zone of Krajina (1965) and Utzig *et al.* (1983), the biophysical region of Lacate (1969), and the Forest Section of Rowe (1972). Climatic, soil, and vegetational characteristics of each Ecoregion are described in Chapters I to III of this report.

Ecosections

Ecoregions are conceptually divided into 19 Ecosections based on broad genetic material and drainage class differences. Ecosections are named after geographic features and assigned a two letter connotative symbol. A few Alpine Ecosections established for the BNP-JNP inventory (Walker *et al.* 1982d) are used in MRNP and GNP.

Six genetic material classes were used in the establishment of Ecosections (Table 48). They are: glacial (including morainal and ice contact stratified drift), glaciofluvial, fluvial, colluvial, landslide, and residual. These six groups were divided into two moisture regimes: *wet* terrain with poorly and very poorly drained soils (C.S.S.C. 1978a) and *non-wet* terrain with moderately well drained and drier soils. Imperfectly drained areas are considered wet or non-wet depending on their spatial and conceptual associates. Wet terrain is not divided further at the Ecosection level. Non-wet terrain is divided further according to two soil-vegetation classes that reflect geomorphic activity:

1. Land areas dominated by Regosolic soils and other soils with weak profile development on young and active landforms. A variety of seral and pioneer v.t.s are associated with these incipient soils.
2. Land areas dominated by Brunisolic and Podzolic soils and a variety of v.t.s types on older, more stable landforms.

Classes 1 and 2 differentiate glacial and fluvial (including glaciofluvial) landforms with current or recent geomorphic activity (AB and SN Ecosections) from those with much older surfaces (BU and LR Ecosections). Soils on steep colluvial slopes also show differences related to the degree of geomorphic activity but these are much more localized and are emphasized at the Ecosite level.

Noncalcareous bedrock and genetic materials characterize MRNP and GNP. Contributions by the few limestone and calcareous clastic strata are localized or diluted and are virtually unmappable. Likewise, textural influence of the coarsest grained bedrock, being localized and diluted, cannot be mapped separately from that of the finer grained strata which predomiante. Genetic materials in MRNP and GNP are chemically and texturally more uniform than those in the Rocky Mountain national parks. Additionally, mesoclimatic differences producing contrasting soils and vegetation were not recognized in the classification of MRNP and GNP. Thus, Ecosection separations based on parent material and mesoclimate in BNP and JNP (Walker *et al.* 1982b) and KNP (Walker *et al.* 1984c) were not necessary in MRNP and GNP. Instead, more subtle differences were expressed by separations at the Ecosite level in MRNP and GNP.

Ecosites

The 19 Ecosections are further separated into 50 Ecosites. Ecosites are named as numerical subdivisions of the Ecosection name, *e.g.* the Balu (BU) Ecosection is divided in to BU1, BU2, BU3, *etc.*. There are one to six Ecosites per Ecosection. Ecosites are separated on bedrock and vegetational differences as well as differences in soil and landform. Factors controlling the choice of the following criteria include scale of mapping, reliability of photographic interpretation, and areal extent.

Physiognomic/habitat groupings not previously separated at the Ecoregion and Ecosection levels were used to separate Ecosites as follows:

1. Land areas dominated by avalanche complex vegetation (shrubs and herbs) were separated from those dominated by forest (*e.g.* HR5 *vs.* other HR Ecosites, LR2 *vs.* LR1).
2. Wetland areas dominated by shrub and fen vegetation were separated from wetland areas dominated by forest (*e.g.* GF1 *vs.* GF2).
3. Land areas dominated by coniferous open forest or open mixedwood were separated from land areas dominated by coniferous closed forest (*e.g.* HR6 *vs.* HR1 to 4, NC6 *vs.* NC1 to 4).

These groupings are useful in identifying wildlife habitat and sometimes correlate with soils and landform differences.

Table 48. Organization of Ecosections by Ecoregion and genetic material.

Genetic Material	Interior Cedar-Hemlock	Engelmann Spruce-Subalpine Fir		Alpine
		Lower Subalpine	Upper Subalpine	
Residual	—	—	—	HE
Landslide	GH	—	—	—
Colluvial	NC	HR	AK	RD
Glacial (morainal + ice contact stratified)	CT	AB,BU,LK*	JD,WR*	JN
Glaciofluvial	KX,(SN)†	—	—	—
Fluvial	GF*,LR,(SN)†	CE*,CM	—	—

* Dominantly wet terrain.
† SN is associated with two genetic material classes.

Complex mapping units include land areas comprising two or more distinct but cartographically inseparable soil-vegetation or genetic material components and were separated as follows:

1. Land areas characterized by abundant bedrock outcrops and lithic soils were separated from land areas with continuous soil cover (*e.g.* AK6 *vs.* AK1 to 4). Rocky landscapes with lithic soils are dominated by coniferous open forest but landscapes with continuous soil cover can have open or closed forests.
2. Land areas dominated by ice contact stratified drift were separated from land areas dominated by morainal deposits (*e.g.* CT5 and CT6 *vs.* other CT Ecosites).
3. Land areas comprised of a distinct *dry* and *wet* pattern of soils and vegetation were separated from land areas comprised mainly of either end member (*e.g.* CT6 *vs.* CT5).

Four bedrock groupings (Fig. 2) were used to separate forested and tundra landscapes occurring on unsorted genetic materials. The four groupings and their derivative genetic materials are:

1. Horsethief Creek Group from which medium textured materials are derived (*e.g.* HR1, JD1, RD3).
2. Hamill Group from which medium and coarse textured materials are derived (*e.g.* HR2, JD2, RD4). Because of limited areal extent, materials derived from granitic intrusive rocks are included with those of Hamill lithologies in GNP.
3. Lardeau Group from which medium textured, often dark gray to black materials are derived (*e.g.* HR3, JD3, RD5).
4. Shuswap Metamorphic Complex from which medium and coarse textured materials are derived (*e.g.* HR4, JD4, RD6).

Minor differences in soil and vegetation often correspond to different textural and, possibly, mineralogical characteristics imparted by the bedrock types.

Soil and vegetation differences used to define Ecosites were considered insufficient in magnitude or kind to warrant separations at the Ecosection level. An attempt was made to define repeating natural Ecosite concepts so that differences among central concepts are of equal magnitude.

As with any criteria defining cartographic concepts, individuals falling close to class boundaries may be more like each other than like the different central concepts with which they are classed. Thus, cartographic separations of a continuum always necessitate some arbitrary decisions as to which class an individual may belong. The guidelines above are reasonably precise with regard to the central concepts of the classes and the guidelines have resulted in a useful organization of the natural phenomena being mapped.

ECOLOGICAL (BIOPHYSICAL) LEGEND CORRELATION

Soil and terrain inventories of the Seymour Arm Area (Kowall 1980) and Lardeau Map Area (Wittneben 1980) utilized varying degrees of ecological integration in their approaches. The former area (N.T.S. map Sheet 82M) lies to the northwest and includes part of MRNP. The latter area (N.T.S. Map Sheet 82K) lies to the south of MRNP and GNP. The mapping units of the two inventories and of the MRNP and GNP Ecological Land Classification are correlated in Appendix C.

The two British Columbia Ministry of Environment studies are basically soil inventories (1:100,000 scale) with Ecological Land Classification overtones, since the legends use forest zonation among the higher levels of generalization. The zonation classes correspond conceptually to the Ecoregions and Ecoregion subdivisions in the MRNP and GNP Ecological Land Classification but boundaries often differ significantly and the Seymour Arm inventory (Kowall 1980) utilizes more zonation classes than the other two inventories. Physiographic Regions, the first level of generalization, of the Seymour Arm Area were divided into major bedrock types before forest zonation was applied, which proliferated the number of mapping units and differs significantly from approaches in the other two inventories.

Forest zones and subzones were divided into soil associations which form the basis of the soil mapping and are identified by geographic names. Soil association criteria in the Seymour Arm inventory are genetic material/surface form classes (6 mineral, 1 organic), dominant soil development (soil subgroups) and, sometimes, elevation and soil association location. In the Lardeau inventory, criteria include genetic material classes (5 mineral, 1 organic), deep *vs.* shallow colluvial deposits, bedrock lithology or genetic material texture, fluvial landform surface expression, and dominant soil development (soil subgroup). Soil associations, therefore, correspond approximately to Ecosections in the MRNP and GNP ecological inventory but the criteria differ significantly for many landscapes. Some criteria are applied in MRNP and GNP at the Ecosite level (*e.g.* parent material thickness, subgroup classification) or as modifiers and slope class on individual tracts, (*e.g.* slope class indicates level *vs.* fan forms of fluvial deposits). Limits for soil association separations appear to be broader for high elevation landscapes (*e.g.* Alpine tundra) than for lower elevation zones and subzones. Differences in soil taxonomy are due to differing interpretations of field characteristics and, more importantly, use of older versions of the Canadian System of Soil Classification (C.S.S.C. 1978a).

Soil associations were divided into soil association components (soil association name plus a number) which are the basic mapping units. These are differentiated according to the proportions of subgroups within the soil association. The subgroups are related but differ due to local variations in *e.g.* soil depth, drainage, texture or aspect. These criteria and those which differentiate Ecosites in the MRNP and GNP inventory differ considerably.

Another major difference between the British Columbia soil surveys and the MRNP and GNP inventory is in legend form and mapping procedure. The two soil surveys utilized an uncontrolled legend (Mapping Systems Working Group 1981) and each map delineation was identified with up to three soil association components resulting in a compound map unit. The number of possible combinations is very high and many delineations may be unique. The MRNP and GNP inventory uses a controlled legend (Mapping Systems Working Group 1981) and a simple map symbol.

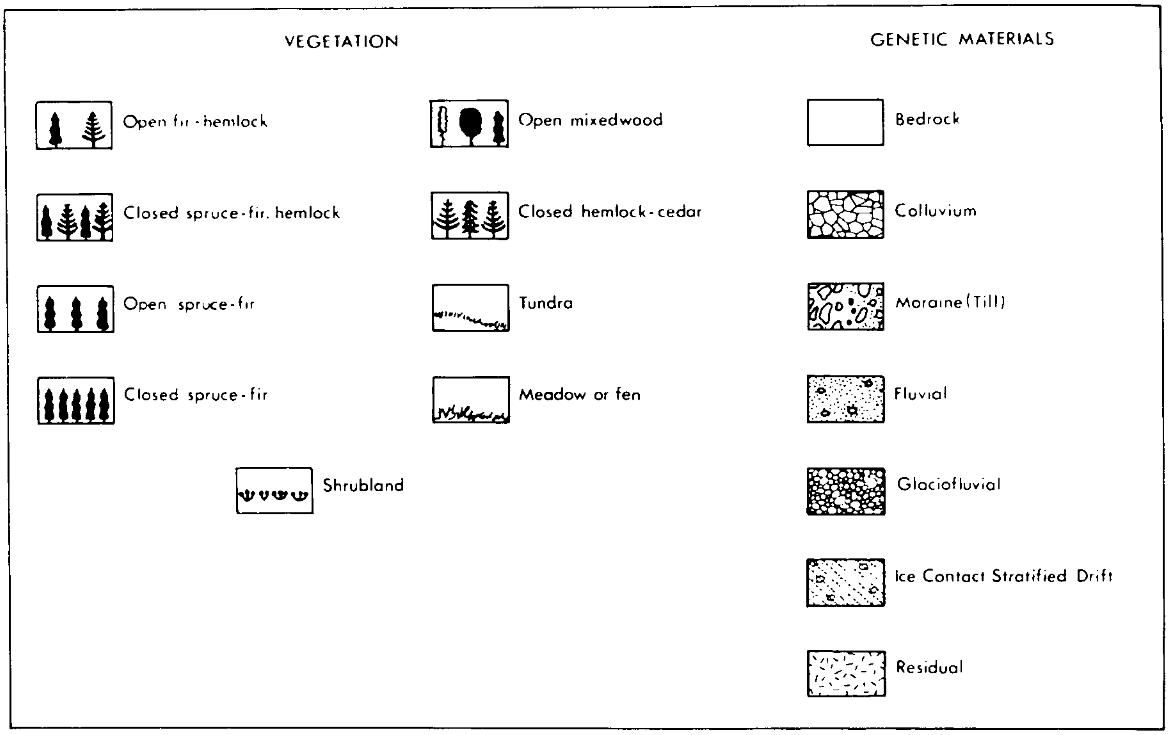
DESCRIPTION OF ECOSECTIONS/ECOSITES

W.S. Taylor, D.T. Allan, P.L. Achuff, L.W. Gyug, B.D. Walker and K. Van Tighem

INTRODUCTION

A comprehensive discussion of each mapping concept used in the MRNP and GNP Ecological Land Classification is provided in this section. The descriptions are arranged alphabetically by Ecosection symbol. Fig. 7 provides a legend for the schematic, cross-sectional diagrams. Appendix D contains pedon descriptions cited in the following Ecosection descriptions as, for example, Table D1.

Fig. 7. Legend for landscape schematics.



A *Discussion and Management Considerations* section for each Ecosection deals with mapping concept similarities between the MRNP and GNP and BNP and JNP inventories, distinguishes similar landscapes within MRNP and GNP, and highlights important features that may affect park uses. The statements are intended to broadly indicate potential suitability or limitation. Due to scale and local variation, each tract should be evaluated in detail for specific proposed uses.

AB - ABBOTT ECOSECTION

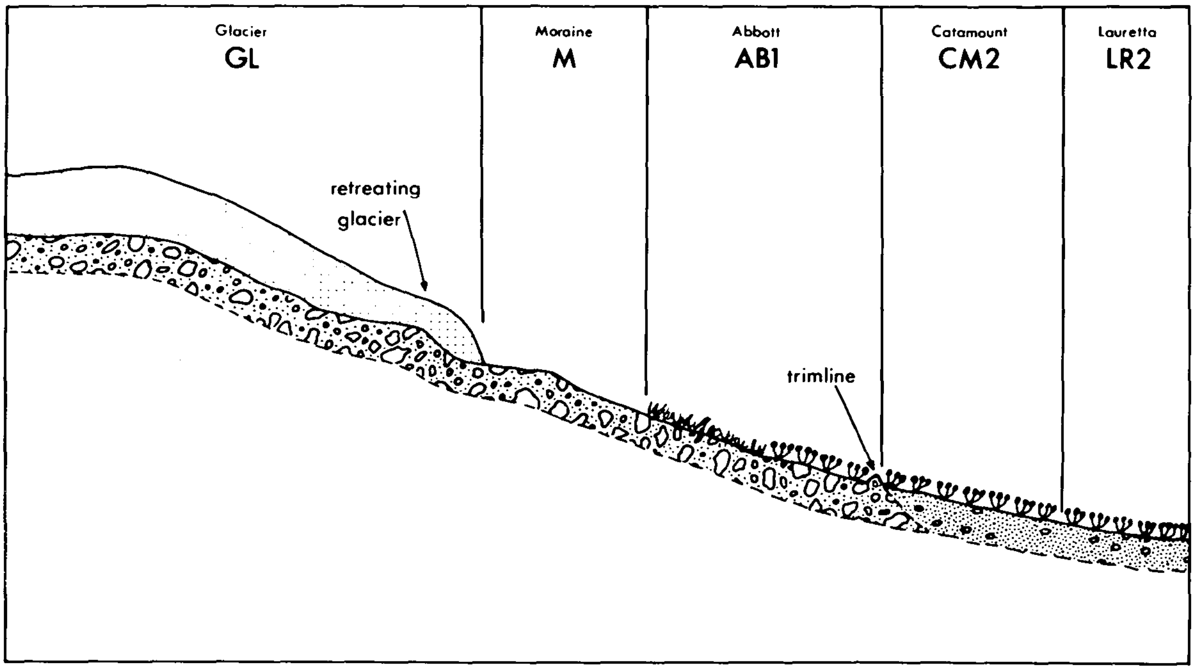
The AB Ecosection occurs in the Lower Subalpine portion of the Engelmann spruce-subalpine fir Ecoregion and incorporates landforms of recently deposited till, well drained Regosolic and Brunisolic soils, and both herb mat and shrub thicket vegetation. Only one Ecosite (AB1) is recognized (Table 49).

Table 49. Definitive features of the Abbott (AB) Ecosection.

Ecosite	**Bedrock**	**Landform**	**Soils**	**Vegetation**
AB1	Various	Tills A, B, C; ridged or blanket & veneer over inclined & hummocky bedrock	Orthic Eutric Brunisol, Orthic Dystric Brunisol, Orthic Regosol	herb mat (H8), shrub thicket (S13)

AB1 occurs on lower slopes and floors of cirques and tributary valleys in areas with extensive valley glaciers and icefields. Since AB1 is a vegetated landscape recently exposed by glacial retreat, landscape ages range from a few tens to a few hundreds of years. Age gradients exist within AB1 tracts, the oldest landscape generally being farthest from the ice front. Because of scale, AB1 is only mappable within the Selkirk Mountains of GNP (*i.e.* west of the Beaver River). Figs. 8 and 12 show AB1 in diagrammatic landscape settings.

Fig. 8. Landscape schematic of topographic relationships among AB1 and other Ecosites.



GEOMORPHOLOGY

The predominant genetic material in AB1 is glacial till. All three till units (Table 8) occur extensively; their distribution being related to the bedrock lithologies in the source area. Till A (noncalcareous, coarse textured) occurs where bedrock is predominantly quartzitic or granitic. Till B (noncalcareous, medium textured) reflects a moderate to majority percentage of schistose source bedrock. Carbonate-bearing strata are most influential, creating Till C (calcareous, medium textured) if they have occupied as little as 15% of the till source area. Also present are low lime intergrades between Till C and the two noncalcareous tills.

The till most often occurs on cirque or valley walls as blankets or veneers over inclined bedrock. On floor positions, till mantles ridged bedrock to various depths. Bedrock often crops out extensively where it is especially resistant. Ridged lateral and terminal moraines that mark the position of maximum ice advance often indicate the down valley boundary of AB1 (Plate 3).

Ice Contact Stratified Drift C (noncalcareous, variably textured) occurs locally in hummocks and ridges on valley and cirque floors. Calcareous exposures of this mixture of materials were observed near Grand Glacier (GNP). Glacial meltwater flowing through AB1 often has deposited Glaciofluvial material, either calcareous or noncalcareous, in terraces adjacent to present streams.

Slopes are generally complex overall, although the valley wall portions often have linear slopes. Slope angle varies markedly within tracts. Valley walls and morainal ridges have slopes $\leq 70\%$, while floor slopes may average $<15\%$.

Snow avalanching is common on AB1, especially on cirque and valley walls. Gullying also has modified the inclined slopes of morainal ridges and valley walls. Small areas of slope wash occur downslope from the gullies.

SOILS

Most AB1 soils are moderately well to well drained Regosolics or Brunisolics (Table 49). Brunisolics occur in noncalcareous areas where they do not differ greatly from Regosolics. They have weakly colored, poorly differentiated sola that generally lack A horizons. B horizons contain little organic carbon or organically complexed Fe and Al. The pH's of lower sola are >5.5 (Orthic Eutric Brunisols) except on older portions of tracts where textures are coarse and there is little buffering capacity. Table D1 presents data on an Orthic Dystric Brunisol (pH<5.5) from a steep, lateral moraine of the Illecillewaet Glacier (Plates 4 and 5). The pH is marginally low enough for a Dystric Brunisol although field evidence initially indicated the pedon was Eutric. The high sand and very low clay contents are typical of till derived predominantly from Hamill Group quartzites.

Calcareous areas have predominantly Regosolic soils. There is little soil development beyond the accumulation of a litter mat or thin Ah horizon on the surface where vegetation is well established. Time since glacial retreat is the strongest factor controlling soil development on calcareous till.

Lithic soil phases are common on wall or floor positions where bedrock is resistant. Youngest AB1 landscapes often have mineral soil exposed to wind erosion. In areas with Lardeau Group bedrock, profile colors are often inherently dark, making horizon differentiation difficult.

VEGETATION

The characteristic v.t.s of AB1 (Table 49) occur predictably in association with landforms and soils. The yellow dryad-willow herb (H8) v.t. pioneers on calcareous drift and grades to a variant of Engelmann spruce-black cottonwood/yellow dryad (O23) that contains buffaloberry (*Shepherdia canadensis*) on older sites further from the glacier. The green alder/fern (S13) v.t. occurs on noncalcareous till and also on avalanched till regardless of lime content.

Noncalcareous till near the Upper Subalpine boundary often has heather-everlasting (L5) or subalpine fir-mountain hemlock/heather-luetkea (O20) variants with sparse cover. Unvegetated areas (<20% cover) occur with increasing frequency closer to the glacier.

WILDLIFE

AB1 Wildlife Features

Ungulates: In the Beaver watershed, AB1 receives moderate use by elk in summer and, throughout the parks, receives moderate use by goats all year. The successional herbaceous vegetation of AB1 provides forage. Elk use the more level areas on glacial outwash plains and goats use steep lateral moraines.

Carnivores: Because of a lack of winter prey, AB1 is of low importance to carnivores.

Small Mammals: Association 13.
AB1 is important to pikas and golden-mantled ground squirrels. It is of moderate importance to the red squirrels where trees have become established. In general, it provides little cover or forage for small mammals.

Breeding Birds: Communities 12 and 11
A low density of birds was recorded. The sparse vegetation and exposed position of AB1 make it unimportant to birds, with the possible exception of Spotted Sandpiper. The only park record of a Rock Wren is from AB1 near Glacier Circle.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

AB1 accounts for 1.4% of MRNP and GNP. It resembles the Lauretta 2 (LR2) Ecosite, but the latter occurs above the trimline on recent fluvial materials. The Miscellaneous Landscape Recent Moraine (M) often is adjacent to AB1 but is unvegetated.

Table 50. Wildlife features of AB Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
AB1	high		low		medium	pika golden-m. gr. squirrel	low

Use is limited by irregular topography and avalanching on tracts where slopes are >30%. Locally, stony surfaces, coarse textures, and shallow soils may also limit use.

AK - ASULKAN ECOSECTION

The Asulkan (AK) Ecosection concept incorporates colluvial landforms composed of noncalcareous colluvium and dominated by Upper Subalpine vegetation. Dystric Brunisols and Humo-Ferric Podzols are the characteristic soils. Five AK Ecosites (Table 51) were differentiated. AK1, AK2, and AK4 all have fir-hemlock vegetation but different bedrock and soils. AK5 is dominated by vegetation indicative of frequent snow avalanching and AK6 is characterized by very steep, rugged, rocky terrain with lithic phase soils. All occur high on valley walls, although AK5 occasionally extends across high elevation valley floors. Figs. 9 and 12 show topographic relationship among several AK Ecosites.

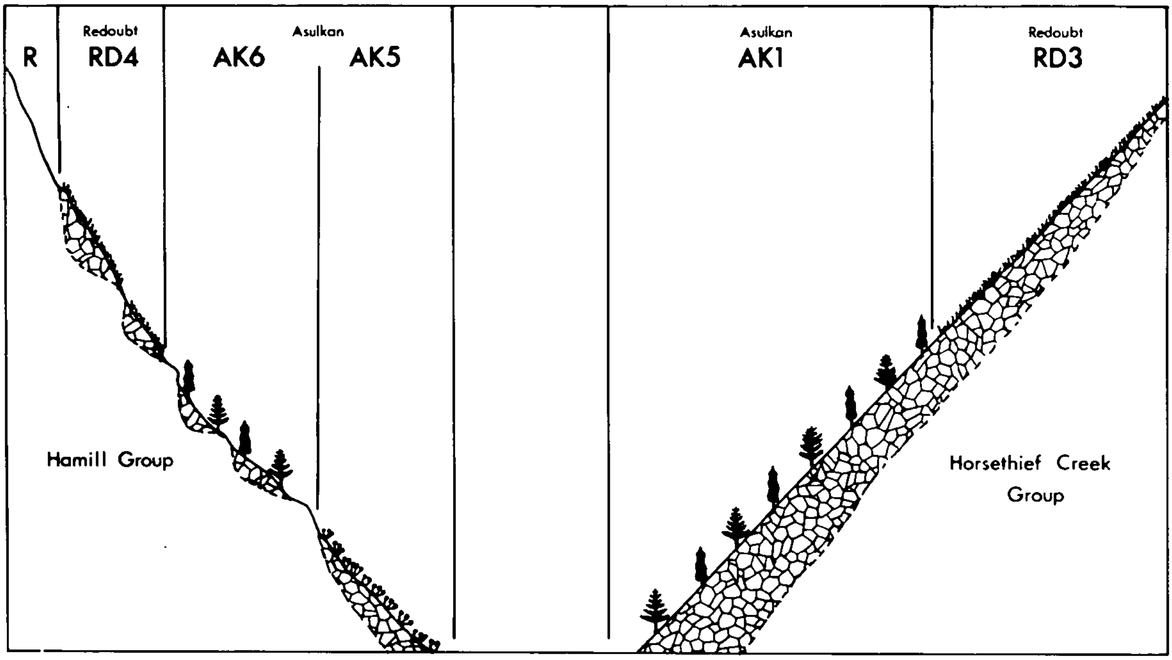
Table 51. Definitive features of Asulkan (AK) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
AK1	Horsethief Ck. Group	Colluvium B; veneer over inclined bedrock	Orthic & Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzol	subalpine fir-mountain hemlock open forest (O20)
AK2	Hamill Group	Colluvium B & A; veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	subalpine fir-mountain hemlock open forest (O20)
AK4	Shuswap Metam. Complex	Colluvium B & A; veneer over inclined bedrock	Orthic Humo-Ferric Podzol	subalpine fir-mountain hemlock open forest (O20)
AK5	Various	Colluvium B & A; veneer over inclined bedrock; avalanched	Lithic phases: Orthic & Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzol	Avalanche complex 4 > subalpine fir-mountain hemlock open forest (O20)
AK6	Various	Colluvium B & A; veneer over inclined bedrock + exposed bedrock	Lithic phases: Orthic & Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzol; + nonsoil	subalpine fir-mountain hemlock open forest (O20), subalpine fir-whitebark pine open forest (O22)

GEOMORPHOLOGY

AK is geomorphically characterized by colluvial landforms comprised of Colluvium B (non- to weakly calcareous, medium textured) and Colluvium A (noncalcareous, coarse textured). Colluvium B is predominant and characterizes AK1 on Horsethief Creek Group bedrock (Fig. 2). Colluvium A is codominant in areas underlain by Hamill Group (AK2) and Shuswap Metamorphic Complex bedrock (AK4). The former includes an area of granitic, intrusive bedrock. AK5 and AK6 on all bedrock types, are dominated by Colluvium B or an unpredictable combination of Colluvial materials A and B. Limestone occurs locally in most areas, thus calcareous, medium textured colluvium (*cf.*

Fig. 9. Landscape schematic of topographic relationships among AK and RD Ecosites.



Colluvium C, Walker *et al.* 1982a) is a minor constituent in a few AK tracts. Consolidated bedrock usually underlies the colluvium at shallow depths but, at a few sites, sufficent weathering of the bedrock produced veneers of Residuum A (noncalcareous, medium to coarse textured). These are more likely to occur in recessive, highly jointed, slaty to schistose strata. Thin, discrete veneers of Eolian material B (altered, medium textured) are uncommon in AK. Intact eolian veneers occur only on the most stable sites under forest vegetation.

The colluvium most often occurs as a nearly continuous veneer over steeply inclined bedrock on valley walls. Discontinuous colluvial veneer plus exposed bedrock is the norm for AK6 but also characterizes about 50% of the AK5 tracts. Deeper colluvial blankets occur as accessory features in all AK Ecosites. The deepest deposits are colluvial aprons which occur occasionally in AK5 and have been constructed by avalanching and rockfall, below very steep, often rocky slopes. Couloirs channel meltwater streams and mudflows onto the aprons. Thus, the aprons are often intercalated colluvial, fluvial, and mudflow deposits.

AK slopes are 55 to <100% simple and usually long, although some slopes may be as low as 45%. AK6 typically has the steepest (rarely <60%), most irregular slopes with cliffs and sloping benches, especially where it occurs on resistant bedrock of the Hamill Group and Shuswap Metamorphic Complex strata. Cliff and bench topography is not as well expressed in recessive bedrock areas with Horsethief Creek and Lardeau Groups. Many high elevation AK5 tracts associated with resistant bedrock are steep and rugged like AK6. AK tracts with complex slopes are of two types. The first includes several tracts with the modifier F (*e.g.* AK6FB above Beaver Meadows) where bedrock failure has produced a subdued, hummocky to ridged, bench-like topography on an inclined slope. Tension cracks and short slip scars are often evident although not all F tracts have complex slopes. The second type, mapped as AK6+T and AK5+T (*e.g.* AK6F+T tract around Miller Lake), has an unusual landform assemblage ranging from cliffs and knobs of exposed bedrock to colluvial aprons, encompassing several slope classes. The processes forming this distinctive, complex terrain are not known although localized bedrock failure appears contributory.

Snow avalanching (A) is the most common Ecosite modifier in AK and is a characteristic feature of AK5. However, ≤20% of any other AK tract may be avalanched. Narrow, channeled paths are a consistent, common feature of AK6 but generally occupy <20% of the area. Forested tracts, 20-50% avalanched, have the modifier A (*e.g.* AK6A).

Current landform construction is very slow and has virtually ceased under forest vegetation (AK1, AK2 and AK4), except on recently burned areas (*e.g.* upper Copperstain Creek valley) where surface modification by soil creep, slope wash and fluvial or mudflow erosion has occurred. Low intensity modification on forested terrain includes uprooting of trees and solifluction, although turbic phase soils are uncommon. In contrast, colluvial activity on avalanched (AK5) and craggy (AK6) landscapes is more diverse. Vegetated portions, which are usually most common, are stable as indicated by the predominance of well developed soils, even though low intensity processes may still be operating. Sparsely vegetated and unvegetated erosional and depositional sites ($\leq$50% of any AK5 or AK6 tract) are generally localized. Material eroded from high cliffs, very steep slopes and couloirs is deposited immediately below by rockfall, avalanching, fluvial and mudflow processes, slope wash and soil creep. Some tracts are complexes of an AK Ecosite plus T (Talus) or **CR** (Colluvial Rubble) (*e.g.* AK6F+T, AK1A+CR) because of unusually high proportions of unvegetated localities (50-80% for AK5 and AK6+T or CR, 20-80% for AK1+T or CR). These include active sites, massive bedrock cliffs and blocky talus with little or no fine earth material.

SOILS

Well to rapidly drained Dystric Brunisols and Humo-Ferric Podzols characterize the soils of AK (Table 51). B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils), even under avalanche vegetation. Two sampled pedons, a lithic Orthic Humo-Ferric Podzol (Table D2, Plate 6) from AK1A in the Prairie Hills and an Orthic Humo-Ferric Podzol (Table D3, Plate 7) from AK5 on Cheops Mountain, are typical of AK soils. Both have brownish B horizons. Brunisols have brownish or yellower B horizons, but distinguishing Podzols from Brunisols on field characteristics alone is often difficult. AK landscapes also contain soils with distinctly redder B horizons.

The two pedons also illustrate differences in A horizon development. Well developed Ae horizons (Table D2) occur at the most stable sites. Little or no A horizon or A mixed with B (AB or A+B) develop where low intensity processes are operating and Ah horizons, sometimes with minor eluviation as in the latter pedon (Table D3), develop in humus-rich environments under avalanche vegetation. Classification of Eluviated *vs.* Orthic Dystric Brunisols is based on Ae horizon thickness.

Two Podzolic subgroups, other than the characteristic Orthic Humo-Ferric Podzols, occur occasionally in AK and without laboratory data, are often difficult to distinguish from typical soils. Sombric Humo-Ferric Podzols with >10 cm of Ah horizon are accessory soils of AK5 and AK6. These soils likely also occur occasionally in the other AK Ecosites. In AK5, their development is probably related to mechanical incorporation of humus into surface horizons. Under such conditions, Sombric Ferro-Humic Podzols, with podzolic Bhf and thick Ah horizons, may also occur. Where very shallow soils are the norm, as in AK6, illuvial humus appears to accumulate above the bedrock contact, as in the Hermit 6 (HR6) pedon (Table D19).

In strong contrast to the comparatively stable Brunisolics and Podzolics, Regosolic soils occur at sites that have recently been intensely active geomorphically so that B horizon development has been inhibited. They are most abundant in avalanche terrain (accessory soils of AK5) although they likely occur in minor amounts in other AK Ecosites. Cumulic and Cumulic Humic Regosols are most common and occur in depositional localities. The variable organic matter content and color is related to mechanical incorporation of humus into surface horizons. Morphologically more uniform Orthic Regosols occur sporadically, particularly in erosional sites on AK5 and AK6. The variety of Brunisolic, Podzolic, and Regosolic soils on AK5 demonstrate the complex interactions of geomorphic activity and pedogenic weathering on avalanche terrain, among the most complex landscapes in MRNP and GNP.

Lithic phase soils are common accessory soils in any AK Ecosite, but are characteristic of AK6 and about half of AK5 tracts. Nonsoil areas occupy $\leq$80% of these very steep, rugged landscapes, occurring as exposed bedrock or where there is <10 cm of overburden. Lithic phases are interspersed with nonsoil and the proportion varies among tracts. Deeper soils, with >1 m of overburden, occur in minor amounts on craggy terrain.

VEGETATION

AK1, AK2, and AK4 have similar vegetation (Table 51) characterized by fir-hemlock open forest, mainly the subalpine fir-mountain hemlock/heather-luetkea (O20) v.t. (Plate 8). Accessory v.t.s in AK1, AK2, and AK4 are Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21) occurring at low elevations within the Upper Subalpine, and subalpine fir-whitebark pine-(Engelmann spruce)/ tall bilberry-heather (O22), occuring on relatively dry, slightly disturbed sites (Plate 9). Near the Upper Subalpine-Lower Subalpine boundary, the forest canopy occasionally becomes closed and resembles the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) or mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) v.t.s.

AK6 has similar, more open forest, although it contains ≤50% unvegetated localities associated with exposed bedrock and very active sites which add to its distinctiveness and complexity. O20 and O22 are codominant, with O22 occurring on drier, geomorphically slightly more active and rocky sites. O21 is an accessory v.t. occurring occasionally at low elevations. Avalanche v.t.s such as subalpine fir-willow (S2), willow-mountain hemlock-subalpine fir/tall bilberry (S14), and heather-everlasting (L5) are commonly associated with channeled paths in couloirs but their areal extent is low.

The geomorphic-soil diversity of avalanched terrain also applies to vegetation. Avalanched segments dominate AK5 and are characterized by a heterogeneous complex of v.t.s, Avalanche complex 4, that includes subalpine fir-willow (S2), willow-mountain hemlock-subalpine fir/tall bilberry (S14), heather-everlasting (L5), fleabane-valerian (H16), everlasting-white mountain heather-red heather (H18), plus intergrades and other unidentified assemblages. L5 and H16 (Plates 10, 34 and 55) are most abundant. S2 and S14 occur at low elevations of the Upper Subalpine and the latter is most common on rocky terrain with shallow soils and exposed bedrock. Forested portions, virtually unaffected by avalanching, usually constitute significantly <50% of any AK5 tract. They fringe avalanche runout zones and form strips between avalanche paths. The most common forest v.t. is O20, although O21 and O22 also occur occasionally as accessory v.t.s. Unvegetated localities on exposed bedrock and intensely active sites, occasionally constitute ≤50% of AK5 tracts.

Avalanche complex 4 also occurs in minor amounts on AK1, AK2, AK4, and AK6 but occupies 20 to 50% of tracts with the modifier A (*e.g.* AK6A on the south slope of Mount Tupper). Several tracts have the modifier **B** (*e.g.* an AK1B tract in upper Copperstain Creek valley) and are dominated by vegetation at an early stage of post-fire succession. Standing snags at some localities indicate a pre-fire, open forest vegetation. A few tracts containing unusually high proportions of unvegetated localities, including exposed bedrock and rubbly to blocky colluvium, were mapped as complexes of AK plus T (Talus) or **CR** (Colluvial Rubble). Generally, unvegetated portions comprise 50 to 80% of AK5 and AK6+T or CR tracts and 20 to 80% of AK1+T or CR tracts. These often include inactive blocky talus with so little fine earth that few plants other than epilithic lichens have become established.

WILDLIFE

AK1 Wildlife Features

Ungulates: In summer, AK1 is moderately important to mule deer where scattered krummholz and meadow provide forage and cover. AK1 is mountain goat winter range, except for the avalanched tracts along the summit of the Prairie Hills.

Carnivores: AK1 is of low importance to carnivores.

Small Mammals: Association 13.

The talus components of AK1 are highly important to pikas. The herb meadows are of high importance to Columbian ground squirrels and forested portions are of low importance to red squirrels.

Breeding Birds: Communities 7 and 17

A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to American Robin, Golden-crowned Sparrow and Rosy Finch. Burned AK1 tracts support BBC 21.

Table 52. Wildlife features of AK Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
AK1	medium		low		medium	pika Columbian gr. squirrel golden-m. gr. squirrel	medium
AK2	low				low		medium
AK4	low				low		medium
AK5	very high	goat caribou (s)	low		very high	pika marmot Columbian gr. squirrel	medium
AK6	high	goat			low		low

AK2 Wildlife Features

Ungulates: No ungulate use was recorded.
Carnivores: No carnivore use was recorded.
Small Mammals: Association 13.
AK2 is of moderate importance to porcupines.
Breeding Birds: Communities 7 and 17
A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Clark's Nutcracker, Hermit Thrush and Varied Thrush.

AK4 Wildlife Features

AK4 occurs only as two small, relatively inaccessible tracts in MRNP which were not sampled for wildlife use. Use is likely similar to that of AK2.

AK5 Wildlife Features

Ungulates: This steep Ecosite is very highly important in summer to goats and highly important in winter on south-facing tracts that are blown free of snow. AK5 receives high summer and low winter use by caribou.
Carnivores: AK5 is of low importance to martens and wolverines, probably due to the diversity of prey.
Small Mammals: Association 13.
The varied terrain of AK5 provides highly important habitat for several species including pika on talus slopes near meadows, hoary marmot in boulder fields near meadows and Columbian ground squirrel in open meadows. AK5 is of medium importance to snowshoe hares and porcupines.
Breeding Birds:
A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Rosy Finch.

AK6 Wildlife Features

Ungulates: The steep rockfaces of AK6 are highly important to mountain goats year round. AK6 is of low importance to caribou in summer.
Carnivores: No carnivore use was recorded, probably because of steep slopes and low prey density.
Small Mammals: Association 13.
The talus slopes, boulder fields and cliff faces of AK6 are of medium importance to hoary marmots and low importance to pikas.

Breeding Birds: Communities 7 and 17

A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Clark's Nutcracker and Townsend's Solitaire. Burned tracts of AK6 support BBC 8.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

AK is an extensive Ecosection, accounting for 11.3% of MRNP and GNP. Most is AK5 (6.3%) and AK6 (3.8%). The remaining three, AK1 (1.0%), AK2 (0.2%), and AK4 (<0.1%), are of small areal extent. AK is the Upper Subalpine counterpart of the Lower Subalpine Hermit (HR), Interior Cedar-Hemlock Nordic (NC), and Alpine Redoubt (RD) Ecosections. No other Upper Subalpine landscapes resemble AK.

Steepness and colluviation are major limitations. The Ecosites from most to least active are: AK5 (avalanched), AK6 (craggy), and the others (forested). Removal of vegetation may increase erosion. Locally, coarse textures, stony surfaces and shallow soils limit use.

The open cliffs of AK are highly important to mountain goats. Goats may be killed or stressed where their winter ranges are in avalanche control zones.

BU - BALU ECOSECTION

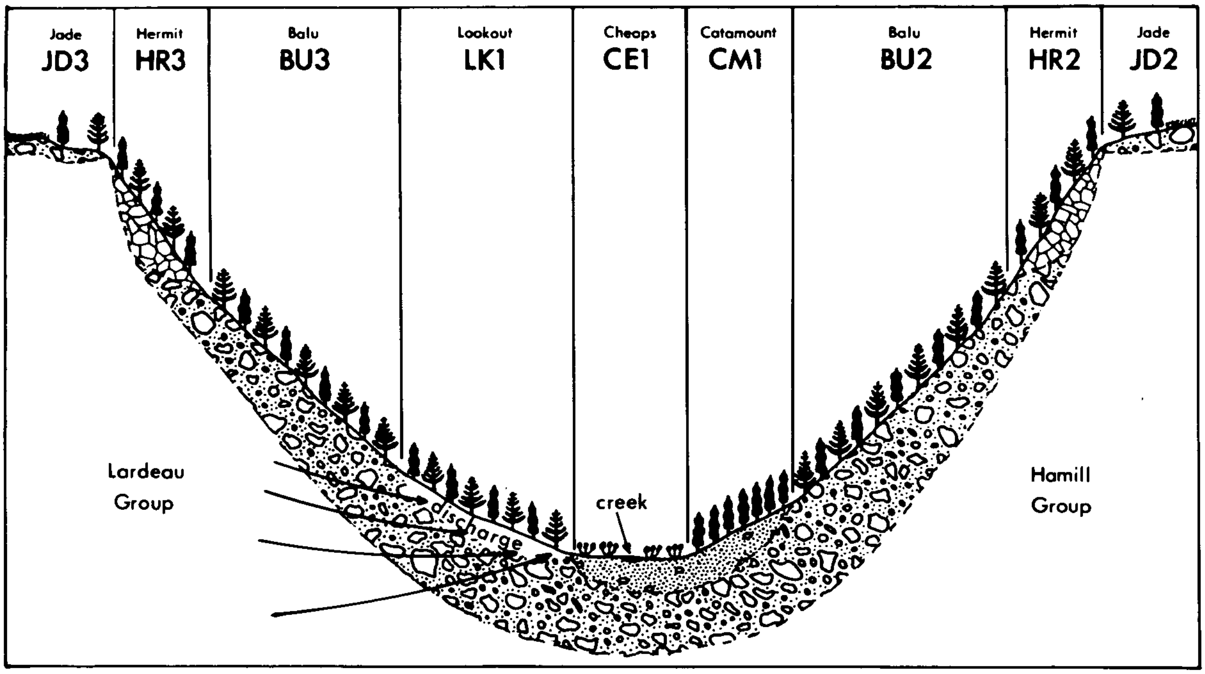
The BU Ecosection concept incorporates landforms composed of noncalcareous till, well to moderately well drained Brunisolic and Podzolic soils, and Lower Subalpine coniferous closed forest vegetation. Four BU Ecosites have been differentiated (Table 53).

Table 53. Definitive features of Balu (BU) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
BU1	Horsethief Ck. Group	Till B; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	mountain hemlock forest (C47) > Engelmann spruce-subalpine fir forest (C21)
BU2	Hamill Group	Till B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Ortstein Humo-Ferric Podzol	mountain hemlock forest (C47) > Engelmann spruce-subalpine fir forest (C21)
BU3	Lardeau Group	Till B; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	mountain hemlock forest (C47) > Engelmann spruce-subalpine fir forest (C21)
BU4	Shuswap Metam. Complex	Till B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol > Ortstein Humo-Ferric Podzol	mountain hemlock forest (C47) > Engelmann spruce-subalpine fir forest (C21)

BU mainly occupies valley wall middle slopes and less commonly mountain shoulders, cirque floors, and passes. Distribution of each Ecosite corresponds closely with bedrock type distribution (Table 53, Fig. 2). BU is shown in diagrammatic landscapes in Figs. 10, 11, 13 and 14.

Fig. 10. Landscape schematic of topographic relationships among BU, HR, JD and other Ecosites.



GEOMORPHOLOGY

The predominant genetic material in BU (Table 53) is Till B (noncalcareous, medium textured). Coarser textured Till A is codominant in areas underlain either by Hamill Group bedrock (BU2, GNP) or Shuswap Metamorphic Complex bedrock (BU4, MRNP).

The till is most frequently blankets or veneers which mask inclined bedrock. Eolian material B (noncalcareous, medium textured) seldom forms discrete surface veneers in BU. Where present, it is normally mixed into upper sola.

Slopes are predominantly linear on valley walls but were mapped with complex slopes where they include benches or cirque mouths and ravines. Valley wall tracts in which the till or bedrock has failed also have complex slopes. Linear slopes are commonly 50 to 65%, but may be 30 to 70%. Complex slopes, common on shoulders, cirque floors, and in passes, are 5 to 45%.

Gullying has modified many strongly sloping valley walls. Seepage is common in the bottom of some gullies. Bedrock is occasionally exposed in gully floors as well. Snow avalanching rarely initiates on BU, but tracts downslope from starting zones often contain avalanche tracks or runout zones.

SOILS

Most BU soils are moderately well to well drained Brunisolics or Podzolics (Table 53). Eluviated Dystric Brunisols are common in both parks. They have eluvial surface horizons (>2 cm Ae), thick B horizons (20-50 cm) in which <10 cm are strongly developed, the balance having moderate development, and thick, weakly developed BC horizons that are transitional to noncalcareous C horizons which begin at depths often >1 m. Lower sola are strongly to extremely acidic (pH <5.5).

Other characteristic soils are interspersed with and genetically related to Eluviated Dystric Brunisols. They differ by having less surface eluviation (Orthic Dystric Brunisols with <2 cm of Ae), or more strongly developed B horizons (Orthic Humo-Ferric Podzols with >10 cm Bf). Ortstein Humo-Ferric Podzols have >10 cm of Bf, of which >3 cm have pedogenic cementing. Many BU soils have thin, dark upper Bhf horizons, but Orthic Ferro-Humic Podzols (Bhf >10 cm) are rare. Soil distribution in BU is a function of these A and B horizons. Data in Table D4 are from an Orthic Humo-Ferric Podzol from BU1 east of the Beaver River below the Prairie Hills which is typical of profiles developed on till from Horsethief Creek Group bedrock (Plate 11).

Soil development in BU is related to genetic materials and bedrock. Profiles are usually deeper and more strongly developed on coarse textured, predominantly quartzitic drift than on medium textures with sheet silicate mineralogy. Pedogenic cementing is distinctive of many coarse textured profiles. In BU2 and BU4, a duric tendency is often present in lower B and BC horizons. Though sometimes continuous, it is more often patchy. Continuous to patchy cementing of upper B horizons (Ortstein Humo-Ferric Podzol) occurs in the coarsest BU soils, and is characteristic of BU2 and BU4. Tables D5 and D6 illustrate two pedons with cementing in the upper and lower sola. The first is an Ortstein Humo-Ferric Podzol sampled from BU2 at Rogers Pass (Plate 12). The second is called an Orthic Humo-Ferric Podzol because the cementing in the Bf horizon is insufficient for the Ortstein subgroup. It was sampled from BU4 near the MRNP summit road.

Lithic phase soils occur occasionally in BU but are sometimes difficult to identify because of lush vegetation. Some turbic phases occur, usually related to uprooting of trees. Gleyed soils occur in small areas associated with seepage.

BU3 soils often have dark profiles with much of the color inherited from parent material of the Lardeau Group, making identification of horizons difficult.

Knapik and Coen (1974) conducted a detailed soil survey in MRNP. A small portion of their study area is BU4 near the Mount Revelstoke summit. Kowall (1980) reported soil information at a scale of 1:100,000 on the western portion of MRNP.

VEGETATION

The characteristic v.t.s of BU occur in a consistent pattern (Table 53). Mostly, the mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) v.t. (Plate 13) is interspersed with lesser amounts of Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21). The Engelmann spruce-mountain hemlock/rhododendron-tall bilberry (C48) and mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49) v.t.s are accessory on all four BU Ecosites. BU1 occurs chiefly in eastern GNP and has a distinctive accessory v.t., lodgepole pine/false azalea/grouseberry (C20) (Achuff and Dudynsky 1984). BU3 and BU4 both have some areas of Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21) which may be related to the fire history and regeneration. Avalanched areas have Avalanche complex 5 vegetation which includes subalpine fir-willow (S2), green alder/fern (S13), willow-mountain hemlock-subalpine fir/tall bilberry (S14), and sedge (H21), plus intergrades.

WILDLIFE

In BU overall, red-backed voles occur at high densities and provide a prey base for martens.

BU1 Wildlife Features

Ungulates: BU1 is of low importance to moose year round and to mule deer and caribou in summer.
Carnivores: BU1 is highly important to martens and of low importance to weasels.
Small Mammals: Association 3.
The mature closed forests are highly important to snowshoe hares and of low importance to red squirrels and porcupines. Pikas occur in talus slopes.
Breeding Birds: Community 8
A moderate density of birds was recorded. BU1 is not highly important to any bird species. Burned tracts support BBC 21.

Table 54. Wildlife features of BU Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
BU1	medium		high	marten lynx	high	hare red-b. vole heather vole	medium
BU2	low		medium		high	red squirrel red-b. vole	medium
BU3	medium	caribou (s)	high	marten	medium	red squirrel red-b. vole	medium
BU4	medium	mule deer	medium		low	red-b. vole	medium

BU2 Wildlife Features

Ungulates: BU2 is of low importance to ungulates. Open, rocky tracts are of low importance to mountain goats during the summer.
Carnivores: BU2 is of medium importance to martens and low importance to weasels.
Small Mammals: Association 2.
BU2 is of high importance to red squirrels, and of low importance to porcupines and snowshoe hares. Pikas and hoary marmots occur on open talus slopes or boulder fields within BU2, but are of low importance overall.
Breeding Birds: Community 7
A moderate density of birds was recorded. BU2 is not highly important to any bird species.

BU3 Wildlife Features

Ungulates: Burned, avalanched or otherwise open tracts of BU3 are highly important summer caribou range.
Carnivores: The mature, closed forests are highly important to martens and of medium importance to weasels, possibly due to the abundance of voles for prey.
Small Mammals: Association 3.
The mature closed forests are highly important to red squirrels and red-backed voles.
Breeding Birds: Community 8
A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Boreal Chickadee, Red-breasted Nuthatch and Varied Thrush. Burned tracts support BBC 21.

BU4 Wildlife Features

Ungulates: BU4 is highly important to mule deer during summer and of medium importance to caribou in winter.
Carnivores: BU4 is of medium importance to both martens and weasels, possibly due to the abundance of red-backed voles.
Small Mammals: Association 3.
Winter tracking indicate BU4 is of low importance to red squirrels although in other seasons densities of red squirrels appear high. It is of high importance to red-backed voles.
Breeding Birds: Community 8
A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Boreal Chickadee, Hermit Thrush and White-winged Crossbill. Burned tracts support BBC 21.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The BU Ecosite accounts for 13.7% of MRNP and GNP (BU1 5.3%, BU2 3.9%, BU3 1.9%, BU4 2.5%). The Jade (JD) Ecosite is the Upper Subalpine counterpart of BU, while Cutbank (CT) occurs on till in the Interior Cedar-Hemlock Ecoregion. Gently sloping areas of BU resemble the Lookout (LK) Ecosite, but soils on the latter are poorly drained.

Irregular topography and slopes >30% limit use. Locally, use may be limited by stony surfaces and coarse textures (BU2, BU4), avalanching (all), cemented soils (BU2, BU4), and seasonal seepage (BU3, BU4). Removal of vegetation may increase erosion on steep slopes.

CE - CHEOPS ECOSECTION

The Cheops (CE) Ecosection occurs in the Lower Subalpine portion of Engelmann Spruce-Subalpine Fir Ecoregion and includes fan and level landforms of non-to weakly calcareous fluvial material, poorly to very poorly drained Gleysolic soils, and shrub thicket vegetation. Only one Ecosite (CE1) is recognized (Table 55). CE1 occurs along streams in valley and cirque floors and is usually close to glaciers or icefields. Fig. 10 shows the topographic position of CE1.

Table 55. Definitive features of the Cheops (CE) Ecosection.

Ecosite	Bedrock	Landform	Soils	Vegetation
CE1	Various	Fluvial material A; fan, level	Rego Gleysol	wet shrub thicket (S15)

GEOMORPHOLOGY

Fluvial material A (non- to weakly calcareous, stratified) is the main constituent of CE1 landforms. Modification by snow avalanching (A) and channeling (Eroded modifier, C.S.S.C. 1978a) is common. High water tables and groundwater discharge account for its wetness.

Topographically, CE1 has gentle linear slopes on fans and level plains. Slopes are 0 to 15%. A tract near Woolsey Glacier in MRNP is mapped as CE1 + M because >50% is Recent Moraine (M).

SOILS

Imperfectly to poorly drained Rego Gleysols are typical of CE1. Prolonged periods of saturation plus recent deposition inhibit pedogenic development other than gleization. Thin peat and humus-rich layers may be present both at the surface and buried within the profile, as in the sampled Rego Gleysol (Table D7, Plate 14). These layers indicate episodic deposition. The organic material accumulates at the surface when deposition is inactive. Gleyed Cumulic Regosols occur as accessory soils on imperfectly drained sites.

VEGETATION

CE1 is dominated by the willow (S15) v.t. (Plate 15). Variants of S15 also occur. Small ponded localities support the cottongrass/moss (H10) (Achuff and Dudynsky 1984) v.t. CE1 at upper elevations of the Lower Subalpine may have species more typical of the Upper Subalpine.

Table 56. Wildlife features of CE Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
CE1	low				low	bog lemming	low

WILDLIFE

CE1 Wildlife Features

Ungulates: In the eastern half of GNP, CE1 with lush meadows is moderately important feeding habitat for elk in summer; elsewhere, CE1 is of low importance.

Carnivores: No carnivore sign was recorded, partly due to drifting snow which quickly obscures winter tracks, but also due to lack of cover. During winter, CE is completely and heavily snow-covered.

Small Mammals: Associations 1 and 16.

Where H16 or H21 meadows occur, Association 16 occurs at medium densities and such tracts are highly important to northern bog lemmings. Where alder predominates, Association 1 occurs at high density.

Breeding Birds: Community 12

A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Spotted Sandpiper and White-crowned Sparrow. CE1 is important to wintering White-tailed Ptarmigan.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

CE1 occupies 0.1% of MRNP and GNP. The Griffith (GF) Ecosite is the Interior Cedar-Hemlock equivalent of CE.

Imperfect to very poor drainage due to high water tables and flooding severely limits most uses. Also, fluvial deposition occurs on some tracts. Major construction (*e.g.* roads) may change hydrologic patterns.

CM - CATAMOUNT ECOSECTION

The Catamount (CM) Ecosection occurs in the Lower Subalpine portion of the Engelmann Spruce--Subalpine Fir Ecoregion. CM includes fan and apron landforms of non- to weakly calcareous fluvial material, well to moderately well drained Brunisolic, Podzolic, and Regosolic soils, and both closed coniferous forest and shrub thicket vegetation. CM1 and CM2 occur on valley floors of tributary valleys. Figs. 8 and 10 show the topographic position of both Ecosites. The two CM Ecosites differ in both vegetation and soils (Table 57).

GEOMORPHOLOGY

Fluvial material A (non- to weakly calcareous, stratified) is the main constituent of CM landforms. Glaciofluvial material A (noncalcareous, coarse textured) is an accessory genetic material of CM2. Slope continuity on both Ecosites is often subtly broken by stream channels (Eroded modifier, C.S.S.C. 1978a).

CM2 is modified by frequent snow avalanches (A). Avalanched material is distributed downslope to gentler runout zones. Layers in fans and aprons are a poorly sorted, till-like diamicton, usually indicative of mudflow, which are thought to be important in fan and apron construction.

Table 57. Definitive f· ıtures of Catamount (CM) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
CM1	Various	Fluvial material A; fan, apron	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C21)
CM2	Various	Fluvial material A; fan, apron	Orthic Dystric & Sombric Brunisols, Orthic Humo-Ferric Podzol, Cumulic Humic Regosol	moist shrub thicket (S13)

Topographically, CM displays linear slopes on fans and aprons. Slopes are 0 to 45%, with gentler slopes confined to apron and fan toes on valley floors and to the less prevalent level floodplains and glaciofluvial terraces. Some tracts have complex slopes because they contain both fan-apron and level fluvial landforms.

SOILS

CM is characterized by well to moderately well drained soils, but has accessory imperfectly drained soils. Eluviated Dystric Brunisols and Orthic Humo-Ferric Podzols are typical of CM1. These soils have B horizon development that is moderate to strong and ranges from Bm and thin Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Well developed (>2 cm) Ae horizons are usually present. Accessory Orthic Eutric Brunisols occur where calcium carbonate content results in lower sola pH >5.5. Ortstein Humo-Ferric Podzols, with strongly cemented podzolic Bfc horizons, occur sporadically in CM1 associated with Hamill Group bedrock (*e.g.* CM1A along Mitre Brook).

Orthic Dystric Brunisols, Orthic Sombric Brunisols, Orthic Humo-Ferric Podzols, and Cumulic Humic Regosols are characteristic of CM2. The upper sola in these soils reflect both humus incorporation and modification by fluvial accretion. This physical accretion thickens surface Ah horizons of Orthic Sombric Brunisols and Cumulic Humic Regosols. Orthic Dystric Brunisols occur where Ae horizon development is masked by humus incorporation or inhibited by surface disturbance. B horizon development is moderate to strong and ranges from Bm to thin Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Accessory soils on CM2 include Cumulic Regosols, Gleyed Dystric Brunisols, and Orthic Ferro-Humic Podzols. Cumulic Regosols occur where erosion or deposition is frequent and intense. Gleyed Dystric Brunisols occur where water tables are high along the lower margins of fans and aprons and on floodplains. Orthic Ferro-Humic Podzols (Table D8, Plate 16) have podzolic Bhf horizons and, without laboratory data, are difficult to distinguish from typical soils. Their development in CM2 is probably related to mechanical humus incorporation. The pedon in Table D8 was sampled in the Connaught Creek valley (GNP).

VEGETATION

Forest vegetation of CM1 separates it from CM2 which has shrub thicket vegetation. CM1 is characterized by spruce-fir and hemlock forests, chiefly the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t. The mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) v.t. is an accessory.

CM2 vegetation is indicative of frequent snow avalanche activity. Green alder/fern (S13) is most extensive. Other v.t.s of Avalanche complex 5, including subalpine fir-willow (S2), willow-mountain hemlock-subalpine fir/tall bilberry (S14), and sedge (H21), also occur occasionally. S2 and S14 occupy steep tract fringes where materials are shallow. H21 occurs as small patches associated with S13 (Plate 17). Intergrades and variants of these v.t.s also occur.

Table 58. Wildlife features of CM Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
CM1	low		high	marten wolverine	medium		low
CM2	low		medium		medium	marmot	low

WILDLIFE

CM1 Wildlife Features

Ungulates: CM1 is of no more than low importance to any ungulate, being most important in the eastern half of GNP where elk and mule deer use Lower Subalpine valleys in summer.

Carnivores: CM1 is highly important to martens because of its prey base. It is highly important to wolverines for long-distance travel, due to its position along Lower Subalpine valley bottoms.

Small Mammals: Association 3.

These Lower Subalpine forests are highly important to red-backed voles and of medium importance to snowshoe hares.

Breeding Birds: Community 8

A moderate density of birds was recorded. CM1 is highly important to Three-toed Woodpecker. Burned tracts support BBC 21.

CM2 Wildlife Features

Ungulates: Herb meadows at the base of avalanche paths are of low importance to elk in summer in the Purcell Mountains.

Carnivores: CM2 is of medium importance to weasels in winter, since the terrain is usually deeply snow covered. Wolverines use CM2 as a travel route.

Small Mammals: Association 11A and 1.

Tracts where boulders have collected from the surrounding colluvial slopes are highly important to hoary marmots. No traplines were set in this Ecosite but SMA 11A is expected at high densities in avalanche complexes and SMA 1 in tracts where alder predominates on talus.

Breeding Birds: Community 12

A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Chipping Sparrow. CM2 is also important winter habitat for White-tailed Ptarmigan.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

CM accounts for 0.5% of Mount Revelstoke and Glacier National Parks. CM1 accounts for 0.1% and CM2 for 0.4%. CM is the Lower Subalpine counterpart of the Interior Cedar-Hemlock Lauretta (LR) Ecosection. CM2 may resemble some HR5 tracts but the latter occur on steeper colluvial slopes.

Use may be limited where slopes are >30%. CM2 is frequently avalanched and some tracts are locally aggrading. Locally occurring coarse textures and high water tables may present problems for sewage disposal. The gravelly coarse textured material is suitable aggregate for construction except where stony. Most tracts have streams that are suitable domestic water supplies. Exceptional floods and mudflows may occur, although soil development on CM1 indicates it is less likely to be disturbed than CM2. Cemented soils in CM1 may limit some uses.

CT - CUTBANK ECOSECTION

The CT Ecosection concept incorporates landforms composed of noncalcareous glacial materials (till and ice contact stratified drift), well to moderately well drained Brunisolic and Podzolic soils, and Interior Cedar-Hemlock coniferous closed forests. Six CT Ecosites have been differentiated (Table 59) including one with a dry > wet landscape pattern (CT6).

Table 59. Definitive features of Cutbank (CT) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
CT1	Horsethief Ck. Group	Till B; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol	western hemlock-western red cedar forest (C50, C52)
CT2	Hamill Group	Till B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol > Ortstein Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)
CT3	Lardeau Group	Till B; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)
CT4	Shuswap Metam. Complex	Till B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)
CT5	Various	Ice Contact Stratified Drift C; ridged, hummocky & blanket over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)
CT6	Various	Ice Contact Stratified Drift C; ridged & hummocky	Dry^{70}: Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol Wet^{30}: Rego Gleysol, Gleyed Ferro-Humic Podzol, Terric Fibrisol	western hemlock-western red cedar forest (C50, C52) wet spruce open forest (O11)

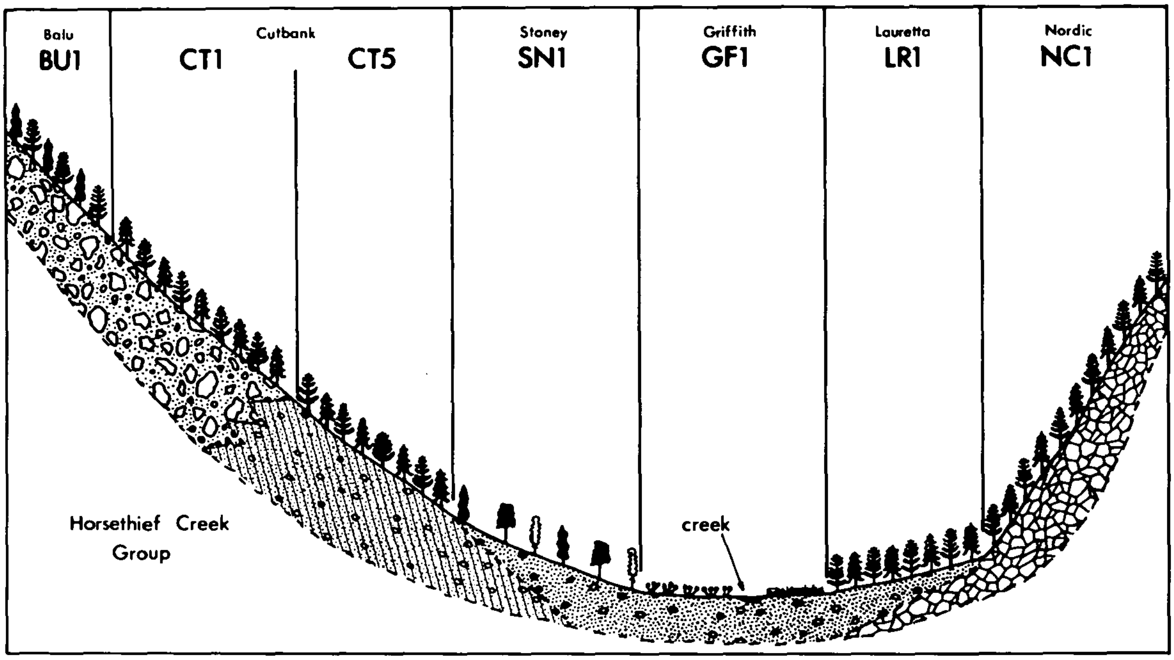
CT mainly occupies valley wall lower slopes and benchland. Distribution of CT1, 2, 3, and 4 corresponds closely with distribution of the associated bedrock (Table 59, Fig. 2). Two CT Ecosites are shown in a diagrammatic landscape in Fig. 11.

GEOMORPHOLOGY

The predominant genetic material in CT (Table 59) is Till B (noncalcareous, medium textured). Coarser textured Till A is codominant in areas underlain by Hamill Group bedrock (CT2, GNP) or Shuswap Metamorphic Complex bedrock (CT4, MRNP). Till B is a major component of the ice contact stratified drift (ICSD) in CT5 and CT6.

The till occurs most frequently as blankets or veneers which mask inclined bedrock (CT1, 2, 3, 4). Where the ice contact stratified drift (CT5, 6) is ridged or hummocky, bedrock seldom influences surface expression. Eolian material B (noncalcareous, medium textured) seldom forms discrete surface veneers, although a few were observed adjacent to the Columbia River (MRNP). Where present, eolian material is normally mixed into upper sola. Fens occur in some poorly drained depressions in CT6.

Fig. 11. Landscape schematic of topographic relationships among CT and other Ecosites.



Slopes are predominantly linear on valley walls but, because of scale, tracts were occasionally mapped with complex slopes if benches were included. Valley wall tracts in which the till or bedrock has failed also have complex slopes. Linear slopes are most commonly 50 to 65% but may be 30 to 70%. Complex slopes, common on the benchland, are 5 to 45%.

Gullying has modified many strongly sloping valley walls. Seepage is common in the bottom of some gullies. Bedrock is occasionally exposed in gully floors as well. Snow avalanching is rarely initiated in CT landscape, but tracts downslope from starting areas often contain avalanche tracks or runout zones.

SOILS

Most CT soils are moderately well to well drained Brunisolics or Podzolics (Table 59). Eluviated Dystric Brunisols are common in both parks. They have eluvial surface horizons (>2 cm Ae), thick B horizons (20-50 cm) in which <10 cm are strongly developed, the balance having moderate development and thick, weakly expressed BC horizons that are transitional to noncalcareous C horizons which begin at depths often >1 m. Lower sola are strongly to extremely acidic (pH <5.5). Data in Table D9 represent an Eluviated Dystric Brunisol from CT1 facing the Beaver River between Avalanche and Connaught creeks (Plate 18). It is typical of CT profiles developed on till derived from Horsethief Creek Group bedrock.

Other characteristic, well drained soils are interspersed with and genetically related to Eluviated Dystric Brunisols. They differ by having less surface eluviation (Orthic Dystric Brunisols with ≤2 cm of Ae), or more strongly developed B horizons (Orthic Humo-Ferric Podzols with ≥10 cm Bf). Ortstein Humo-Ferric Podzols have ≥10 cm of Bf, of which ≥3 cm have pedogenic cementing. CT soils occasionally have thin, dark upper Bhf horizons, but Orthic Ferro-Humic Podzols (Bhf ≥10 cm) are rare. Soil distribution in the upland portions of CT is a function of these A and B horizons.

Data in Table D10 represent an Orthic Humo-Ferric Podzol from CT3 adjacent to Flat Creek and is typical of CT profiles developed on till derived from Lardeau Group bedrock (Plate 19). The dark horizon colors were inherited from the parent material. Table D11 illustrates soils with Bhf horizons, the pedon being one of the few with sufficient development to be an Orthic Ferro-Humic Podzol. It was sampled from the CT4 tract near the MRNP summit road.

Soil development in the well drained portions of CT is related to genetic materials and bedrock. Profiles are usually deeper and more strongly developed on coarse textured, predominantly quartzitic drift than on medium textures with a sheet silicate mineralogy. Pedogenic cementing is distinctive of many coarse textured profiles. In CT2 and CT4, a duric tendency is often present in lower B and BC horizons. Though sometimes continuous, it is more often patchy. Continuous to patchy cementing of upper B horizons (Ortstein Humo-Ferric Podzol) occurs in the coarsest CT soils, frequently enough to be characteristic in CT2 and an accessory in CT4. Table D12 presents data on an Eluviated Dystric Brunisol with cementing in the lower solum (Plate 20). The pH's of the eolian veneer are above average suggesting that lime may have been received from the nearby Columbia River floodplain. Stratification below the veneer is typical of ice contact stratified drift. The pedon was sampled on the CT5 tract close to the gate on the MRNP summit road. The pedon in Table D11 also shows cementation.

A variety of soils (Table 59) occurs in the imperfectly to very poorly drained portions of CT6. Imperfectly drained margins have gleyed subgroups (Gleyed Dystric Brunisols, Gleyed Eluviated Dystric Brunisols, Gleyed Humo-Ferric Podzols) of the surrounding well drained soils. Poorly drained soils with pedogenic development include Orthic Gleysols, Gleyed Ferro-Humic Podzols and Orthic Humic Podzols. Rego Gleysols occur where flowing water redistributes surface materials. Organic soils (Terric Fibrisol, Terric Mesisol) occur where there is ponding.

Lithic phase soils occur occasionally in CT but are sometimes difficult to identify because of lush vegetation. Some turbic phases occur, usually related to uprooting of trees. Gleyed soils occur in small areas associated with seepage.

Kowall (1980) reported soil information at a map scale of 1:100,000 on the western portion of MRNP.

VEGETATION

The characteristic v.t.s on well drained portions of CT (Table 59) occur consistently on each Ecosite. Western hemlock-western red cedar/western yew/oak fern (C50) (Plate 21) and western hemlock-western red cedar-(Douglas fir)/mountain lover (C52) are most abundant.

The lodgepole pine/false azalea/grouseberry (C20) v.t. (Achuff and Dudynsky 1984) is a distinctive accessory of CT1 and of CT5 and CT6 in eastern GNP. Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) is another notable v.t. on CT5 and CT6 in eastern GNP. The Douglas fir-western red cedar/mountain lover (C53) v.t. occurs as an accessory of CT4 (MRNP). Seepage on lower valley wall slopes is often reflected by the western red cedar-western hemlock/devil's club/oak fern (C51) v.t.

Poorly drained portions of CT6 are characterized by the spruce/Labrador tea/brown moss (O11) v.t. Imperfectly drained margins or areas with fluvial activity may have closed forests like C51. The water sedge-beaked sedge (H11) v.t. usually occurs with ponding.

Snow avalanche areas have Avalanche complex 6 vegetation which includes green alder/fern (S13) and sedge (H21) plus variants.

WILDLIFE

The forested slopes of CT are generally of high importance to both small mammals and their predators. All CT Ecosites are of high potential importance to lynx because of the high densities of snowshoe hares. Porcupines also occur at low densities in all Ecosites. The mixed deciduous-coniferous forests which occur occasionally in CT sustain moderate to high densities o0 breeding birds.

CT1 Wildlife Features

Ungulates: CT1 is used by a variety of species and is of medium importance overall, but it is of no more than low importance to any species in any season.

Carnivores: CT1 is of medium importance to weasels and of low importance to martens.

Small Mammals: Association 10.
CT1 is of high importance to snowshoe hares, masked shrews, red-backed voles and deer mice.

Table 60. Wildlife features of CT Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
CT1	medium		medium	lynx	high	hare masked- shrew red-b. vole deer mouse	high
CT2	medium		high	lynx marten	high	hare red-b. vole deer mouse	high
CT3	low		high	lynx marten	high	hare red squirrel red-b. vole deer mouse	high
CT4	medium	caribou (w)	high	lynx marten	high	hare red-b. vole deer mouse	high
CT5	high	w.t. deer	high	lynx	high	hare red squirrel red-b. vole deer mouse	high
CT6	medium		high	lynx marten	medium	hare red-b. vole deer mouse	medium

Breeding Birds: Community 24

A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Chestnut-backed Chickadee, Golden-crowned Kinglet and Townsend's Warbler.

CT2 Wildlife Features

Ungulates: CT2 is used by a variety of species and is of medium importance overall. CT2 is of no more than low importance to any species in any season.

Carnivores: CT2 is of high importance to both martens and weasels.

Small Mammals: Association 10.

CT2 is of high importance to snowshoe hares, red-backed voles and deer mice. Pikas are plentiful on tracts where scree slopes occur,

Breeding Birds: Community 24

A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Chestnut-backed Chickadee and Brown Creeper.

CT3 Wildlife Features

Ungulates: CT3 is of low importance although moose recently have been recorded in low densities in winter in the Bostock Valley. Mule deer may be expected in the summer. Along Bostock Creek, CT3 may have been formerly used as a caribou migration route. CT3 may be potentially important as winter range for caribou on the western edge of GNP.

Carnivores: CT3 is of high importance to martens and weasels.

Small Mammals: Association 10.

CT3 is of high importance to snowshoe hares, red squirrels, red-backed voles and deer mice.

Breeding Birds:

CT3 was not sampled for breeding birds but, based on its similar vegetation and physical features, the birds appear to be similar to CT1 and CT2.

CT4 Wildlife Features

Ungulates: CT4 is of medium importance overall. It is of high importance to caribou in winter on Mount Revelstoke and of medium importance to mule deer in summer.

Carnivores: CT4 is of high importance to martens. The only recorded fisher track in MRNP during the inventory was on a CT4 tract in March 1982.

Small Mammals: Association 10.
CT4 is of high importance to snowshoe hares, red-backed voles and deer mice.

Breeding Birds: Communities 24 and 25
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Brown Creeper. Burned tracts are expected to support BBC 21.

CT5 Wildlife Features

Ungulates: CT5 is of high importance because of its regular, easily-traversed slopes and its position near valley bottoms. It is of high importance to white-tailed deer during the summer and of medium importance to mule deer in summer and to moose in winter.

Carnivores: CT5 is used by a variety of species and is of high importance overall. It is moderately important to martens and of low importance to other carnivores.

Small Mammals: Association 10.
CT5 is of high importance to snowshoe hares, red squirrels, deer mice and red-backed voles. The *Beaver* small mammal live-trap plot was on this Ecosite (see sec. 3.11, Van Tighem and Gyug [1984]).

Breeding Birds: Communities 24 and 25
A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Pileated Woodpecker, also Northern Pygmy-Owl and Barred Owl have been recorded here.

CT6 Wildlife Features

Ungulates: CT6 is of medium importance overall. It is of moderate importance to white-tailed deer in summer and of low importance to other ungulates. The wet, open forests (O11) showed more browsing by ungulates than the other v.t. in CT6 but still not as much browsing as in the similar forests of the GF Ecosection.

Carnivores: CT6 is of high importance to martens.

Small Mammals: Associations 10 and 11B.
CT6 closed forests are of high importance to snowshoe hares, deer mice and red-backed voles and SMA 10. The wet open forests are of high importance to northern bog lemmings (SMA 11B).

Breeding Birds: Communities 23 and 24
A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Kinglet, Red-breasted Nuthatch and Townsend's Warbler.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The CT Ecosection accounts for 12.8% of MRNP and GNP (CT1 2.9%, CT2 2.8%, CT3 0.5%, CT4 3.3%, CT5 3.0%, CT6 0.3%). The Balu (BU) Ecosection is the Lower Subalpine counterpart of CT. Areas with glaciofluvial materials that resemble the Kuskanax (KX) Ecosection are mapped as CT5 and CT6; they are not separated because of their small areal extent. Wet areas with fluvial activity that resemble the Griffith (GF) Ecosite, but are too small to separate at a scale of 1:50,000, are included in CT6.

Irregular topography and slopes >30% limit use. Locally, use may be limited by wet depressions (CT6), stony surfaces and coarse textures (CT2, CT4), gravelly coarse textures of ice contact deposits (CT5, CT6), avalanching (CT1 to CT5), cemented soils (CT2, CT4), and seasonal seepage (all). Removal of vegetation may increase erosion on steep slopes.

GF - GRIFFITH ECOSECTION

The Griffith (GF) Ecosection concept incorporates wetland soils and vegetation on fluvial landforms in the Interior Cedar-Hemlock Ecoregion. Various water-laid deposits may occur but the prevalent feature is wetness generated primarily by high water tables and surface water collection. Two GF Ecosites (Table 61) were differentiated, primarily by vegetational features. They occur on valley bottoms along the Beaver and Illecillewaet rivers, Mountain Creek, and at Rogers Pass (Plate 22). Most GF terrain occurs where surface water drainage has been impeded by downstream and surrounding landforms. Fig. 11 shows GF1 relative to several other Ecosites.

Table 61. Definitive features of Griffith (GF) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
GF1	Various	Fluvial material A; level > horizontal fen	Orthic & Rego Gleysols, Terric Fibrisol	wet shrub thicket (S17), sedge fen (H11) > western hemlock-western red cedar forest (C51)
GF2	Various	Fluvial material A; level	Orthic & Rego Gleysols, Gleyed Dystric Brunisol	western hemlock-western red cedar forest (C51) > wet shrub thicket (S17)

GEOMORPHOLOGY

Fluvial material A (non- to weakly calcareous, coarse-stratified) is the characteristic constituent of GF landforms. Because of GF distribution in MRNP and GNP, all bedrock types except granitic intrusive (Fig. 2) contribute material to the fluvial sediment which is therefore predominantly noncalcareous. However, weakly calcareous localities reflect contributions from small limestone source areas.

Textural diversity of GF sediments reflects depositional environments. Textural changes may be abrupt or gradual and occur vertically or laterally. Glaciofluvial material A (noncalcareous, coarse textured) may extensively underlie fluvial material on major floodplains but usually occurs below the control section (*i.e.* >1 or 2 m from the ground surface). Its texture, including abundant coarse fragments, indicates deposition by high energy, unrestricted, stream flow. Exposures of gravelly glaciofluvial material are rare on current GF surfaces although it can be argued that the overlying, finer textured, fluvial sediments are glaciofluvial because stream volume and sediment loads are controlled primarily by glacial melt. Textures within the fluvial sediment usually become finer (siltier with fewer coarse fragments) upwards and reflect a change to low energy fluvial deposition as stream flow became restricted. Upper mineral deposits on the broad floodplains tend to be silty with virtually no coarse fragments and resemble fluviolacustrine material (Walker *et al.* 1982a). On or adjacent to fan and apron landforms and on sites near stream channels, silty deposits may be locally replaced by sandier layers, some with coarse fragments.

Incorporation of humus in upper mineral layers indicates that organic layers developed as sedimentation diminished. Where deposition has virtually ceased, peat layers mantle the mineral soil. Thickness of peat in GF soils ranges from zero, where mineral accretion is still active, to >1 m. Maximum depths were not ascertained. Horizonal fen landforms occur where the peat is >40 cm thick and are the subdominant landform of GF1 and accessory in GF2. The peat is predominantly fibric, occasionally mesic, rarely humic (C.S.S.C. 1978a), and occasionally contains wood fragments. Localities with peat, although wet and often inundated, are protected from mineral deposition, likely by entrapment of sediments in dense vegetation nearer the major stream channels. Fresh silty material $\leq$7 cm thick was observed in 1983 on a few Beaver River floodplain sites dominated by the alder/skunk cabbage (S17) v.t.

Landform surface expression for both GF Ecosites is predominantly level floodplain but often grades to gently sloping fans and aprons near tract boundaries, particularly adjacent to Lauretta (LR) landscapes. Slopes commonly are 0 to 5% but may locally exceed 5%. Both simple and complex slopes occur, the latter including some subtly terraced terrain or floodplain plus apron and fan. Slope continuity on GF2 is often subtly broken stream channels (Eroded modifier, C.S.S.C. 1978b), including narrow, slightly elevated ridges along the banks.

SOILS

GF is characterized by imperfectly to very poorly drained soils of the Brunisolic, Gleysolic, and Organic orders. GF1 is consistently wetter (poorly to very poorly drained) than GF2 (imperfectly to poorly drained) but there is substantial overlap of soil taxa (Table 61). The combination of wetness and mineral accretion has precluded pedogenic horizonation in the Rego Gleysols. They are usually strongly gleyed and may have buried humus-rich layers indicative of intermittent deposition. Some contain buried wood, likely alder (*Alnus* spp.).

The other mineral soils, Orthic Gleysols and Gleyed Dystric Brunisols, have escaped mineral deposition long enough for B horizons, mainly Bm or Bg, to develop. Orthic Gleysols, the wetter of the two subgroups, are strongly gleyed within 50 cm of the mineral surface and are common in both GF Ecosites. A sampled Orthic Gleysol (Table D14, Plate 23), from a GF2 tract at the Beaver River-Connaught Creek confluence, is strongly gleyed but has both a Bm and a Bg indicating that the upper solum is periodically oxidized. It also contains a sequence of buried pedogenic horizons, demonstrating that episodic deposition has occurred. The Cg horizons illustrate textural stratification common to fluvial deposits. Gleyed Dystric Brunisols resemble this pedon but do not have Bg and well developed Ae horizons and are not as strongly gleyed in the upper 50 cm of mineral soil. These imperfectly drained soils are codominant in GF2, accessory in GF1, and occupy slightly elevated sites, particularly sloping tract fringes.

Thin organic layers may mantle any of the mineral soils. These may be forest litter (LFH horizons) where surface drainage is relatively good or fen peat (O horizons) under wetter conditions. Thick peat deposits have accumulated under fen vegetation in very poorly drained localities that have long been protected from sedimentation. Where the peat is >40 cm thick, the landform is horizonal fen and the soils are Organic. The peat is predominantly fibric (Of horizons), giving Fibrisols, although mesic material (moderately decomposed Om horizons) and Mesisols also occur occasionally. Humisols, with humic peat (Oh horizons), are likely rare, although a Terric Humisol was found on a small, sloping, artificially drained fen at the base of an avalanched slope near Rogers Pass. Depths of fen peat were not ascertained. Based on experience in the Rocky Mountains, it is estimated that modal peat depth is <1.2 m and the main Organic subgroup is Terric (C.S.S.C. 1978a). Thus, Terric Fibrisols are among the codominant soils of GF1 and accessory soils of GF2. Terric Mesisols are accessory soils of GF1. A sampled Terric Fibrisol (Table D13, Plate 24), from GF1 near the East Gate of GNP typifies the Fibrisol great group but may not be Terric if the depth of peat exceeds 1.2 m. Since the attainable sampling depth is near this taxonomic limit, Typic Fibrisols also likely occur on GF. The thin, multiple Cg layers in the sampled pedon coincide with episodic mineral deposition, likely major floods. The surface O+C horizon indicates a recent increase in sedimentation. Such stratification of organic and mineral materials is probably common in GF soils. Organic soils with >5 cm cumulative depth of mineral layers in the middle and bottom tiers belong to Cumulo subgroups (C.S.S.C. 1978a). Thus, Cumulo Fibrisols also likely occur in GF.

VEGETATION

GF1 and GF2 are characterized by similar v.t.s but they are arranged in different patterns (Table 61). GF1 is wettest and characterized by wet shrub thicket and sedge fen interspersed with strips of hemlock-cedar forest. The alder/skunk cabbage (S17) (Plate 25) and water sedge-beaked sedge (H11) v.t.s are dominant and the proportion of each varies. Western red cedar-western hemlock/devil's club/oak fern (C51) is subdominant and occupies sloping tract margins, especially where fan and apron landforms are included, and the narrow, slightly elevated ridges bordering stream channels. Balsam poplar/horsetail (C28), an accessory v.t. of GF1, often replaces C51 along stream banks.

GF2 is drier than GF1 and is characterized by hemlock-cedar forest (C51) (Plate 26) interspersed with patches of wet shrub thicket (S17). C28, in patches along stream banks, and H11, in ponded localities are accessory v.t.s of GF2.

WILDLIFE

GF is the most important to wildlife of all the Ecosections in MRNP and GNP. By far the highest number of wildlife species occurs here and many species are either confined to this Ecosection or occur here at greater densities than elsewhere. Abundant moisture, a long snow-free season and a diverse mosaic of productive vegetation types contribute to the value of GF1 and GF2 to wildlife. The bulk of the parks' wetlands and ponds occur here. Because of the complex patterns of ponds, fens, wetlands, shrublands and forest comprising this Ecosection, many distinct wildlife habitats cannot be adequately mapped or defined at the mapping scale of 1:50,000 map scale.

The wet fens and ponds of GF are very highly important to amphibians and it is the only Ecosection where all four species of amphibians have been found to breed in both MRNP and GNP.

GF1 Wildlife Features

Ungulates: The fens, shrublands and meadows of GF1 are very highly important, being highly important to moose all year round and moderately important to mule and white-tailed deer in summer. GF1 is also highly important to the small numbers of elk that winter in the Beaver Valley. The most important GF1 tracts are in the Beaver River and Mountain Creek watersheds. Shrubs heavily browsed by moose here are red-osier dogwood (*Cornus stolonifera*), bracted honeysuckle (*Lonicera involucrata*) and willows (*Salix* spp.).

Carnivores: GF1 is of very high importance due to the high diversity and density of prey. The only recent wolf records were from this Ecosite and it is also highly important to coyotes, weasels and mink. It is moderately important to martens and lynx. Fish and muskrat populations adequate to sustain populations of mink occur here but are rare elsewhere. The only record of an otter in either park is in GF1.

Small Mammals: Associations 11B and 17.
H11 fens of GF1 are highly important to meadow vole, a species of limited distribution in these parks. GF1 wetlands are highly important to beavers and muskrats, and the shrublands and open forests are highly important to deer mice and long-tailed voles.

Breeding Birds: Communities 22 and 23
A very high density of birds was recorded. The bulk of breeding and migrant waterfowl in both parks rely on this Ecosite. Based on density indices derived from circular census plots, this Ecosite is highly important to Canada Goose, Mallard, Green-winged Teal, Barrow's Goldeneye, Belted Kingfisher, Barred Owl, American Kestrel, Alder Flycatcher, American Redstart, American Robin, Black-headed Grosbeak, Blackpoll Warbler, Brown-headed Cowbird, Cedar Waxwing, American Crow, Northern Flicker, Common Snipe, Common Yellowthroat, Lincoln's Sparrow, Northern Waterthrush, Red-winged Blackbird, Rufous Hummingbird, Savannah Sparrow, Song Sparrow, Steller's Jay, Veery, Violet-green Swallow, Western Wood Pewee, Willow Flycatcher and Yellow Warbler. The *Mixed Mountain Bottomland* breeding bird census plot was in this Ecosite (sec. 3.3, Van Tighem and Gyug [1984]).

GF2 Wildlife Features

Ungulates: GF2 is very highly important to ungulates, being highly important to the small number of elk that winter in the Beaver Valley, to moose all year round and to white-tailed deer in summer. Tracts in the western half of GNP and in MRNP are less important than tracts in the Beaver River and Mountain Creek watersheds. Shrubs showing heavy browsing by moose are red-osier dogwood (*Cornus stolonifera*), bracted honeysuckle (*Lonicera involucrata*) and willows (*Salix* spp.).

Carnivores: GF2 is of very high importance because of the high density and diversity of prey. It is highly important to coyotes, martens, weasels and lynx and of medium importance to mink.

Small Mammals: Association 11B.
The ponds, fens and shrublands of GF2 are of high importance to beavers and muskrats. The forests are of high importance to porcupines. Shrublands and open forests are of high importance to snowshoe hares, heather voles, red-backed voles and long-tailed voles.

Breeding Birds: Communities 22 and 23
A high density of birds was recorded. Based on density indices derived from circular

Table 62. Wildlife features of GF Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
GF1	very high	moose elk (w)	very high	coyote weasel mink	high	beaver deer mouse meadow vole long-t. vole	very high
GF2	very high	moose elk (w) w.t. deer	very high	coyote weasel marten lynx	very high	beaver porcupine hare heather vole red-b. vole long-t. vole	very high

census plots, this Ecosite is highly important to Black-headed Grosbeak, Northern Flicker, Common Snipe, Common Yellowthroat, Lincoln's Sparrow, Northern Waterthrush, Olive-sided Flycatcher, Solitary Vireo, Steller's Jay, Vaux's Swift, Western Wood Pewee, Western Tanager and Wilson's Warbler. With LR1, this is the most important Ecosite in MRNP and GNP for Barred Owl.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

GF is not extensive, accounting for only 1.3% of MRNP and GNP, but is important because of its topographic position. GF1 and GF2 account for 0.6% and 0.7%, respectively.

GF is the Interior Cedar-Hemlock counterpart of the Lower Subalpine Cheops (CE) Ecosection. The compound Ecosite Cutbank 6 (CT6) is a dry > wet pattern on glacial landforms. The wetlands, which are too small to map at 1:50,000, occasionally resemble GF2 although spruce-fir open forest and a diverse range of wet soils are more characteristic of the glacial materials. The Lauretta 1 (LR1) Ecosite has parent material and vegetation similar to GF2 but is characterized by drier soils and often occurs on steeper slopes. A catenary soil sequence marks the boundary between GF2 and LR1 which are often adjacent to one another.

Imperfect to very poor drainage, due to high water tables and flooding, severely limits most uses. Also, fluvial deposition occurs on some tracts. Construction may change hydrologic patterns. Organic soil in some tracts also limits use.

GF wetlands are unique in the national parks system and contain the highest density and diversity of wildlife of any Ecosection in MRNP and GNP. Pond systems are maintained by beavers. Destruction of beaver dams may significantly decrease the potential of this Ecosection for wildlife.

GH - GLACIER HOUSE ECOSECTION

The Glacier House (GH) Ecosection concept incorporates landslide deposits dominated by Interior Cedar-Hemlock vegetation. Only one GH Ecosite (GH1, Table 63) was recognized and only one tract was mapped. It is a distinctive, prominent landscape on the valley floor where Asulkan Brook valley meets the Illecillewaet River valley. Another landslide deposit similar to GH, dissected by the Trans-Canada Highway south of Cougar Mountain, is too small to delineate at 1:50,000. Other predominantly colluvial landscapes affected by bedrock failure often contain small blocky and rubbly localities that resemble GH1.

Table 63. Definitive features of the Glacier House (GH) Ecosection.

Ecosite	Bedrock	Landform	Soils	Vegetation
GH1	Hamill Group	Landslide material; hummocky	Eluviated Dystric Brunisol, undefined soils, nonsoil	mountain hemlock forest (C47)

GEOMORPHOLOGY

The hummocky landslide deposit that forms GH1 likely originated after failure of Hamill Group quartzite on the slope of Glacier Crest. The textural properties reflect the massive bedrock and its cataclysmic failure. Noncalcareous, coarse textured, rubbly (about 70% coarse fragments) material is predominant but blocky (coarse fragments >256 mm), fragmental localities are also common. Eolian material B (altered, medium textured) often mantles well vegetated, rubbly localities as a thin, discontinuous veneer among the larger coarse fragments. The ground surface remains very to exceedingly stony (C.S.S.C. 1978b). At some sites, the rubbly material appears till-like. It may have been valley wall till that descended with the landslide or ice-modified material if the landslide fell onto a valley glacier. There is no strong evidence either way and the landslide age is either late glacial or early postglacial.

The hummocky surface expression reflects the landslide genesis rather than bedrock control. Slopes are highly complex, of various length, and 15 to 30%. Short, gully-like features, often occurring in blocky material, and small river-cut terraces with gentle slopes add to topographic complexity.

SOILS

A variety of rapidly to well drained soils and nonsoil occur on GH1 (Table 63). Rubbly areas, with sufficient fine earth material for soil formation, are dominated by Eluviated Dystric Brunisols or undefined soils, depending on thickness of Eolian material B veneer. Eluviated Dystric Brunisols occur where the eolian veneer is sufficiently thick for B horizon development. They generally have well developed Ae horizons and moderately to strongly developed Bm horizons. Thin Bf horizons may be present and related Orthic Humo-Ferric Podzols occur in minor amounts.

Undefined soils (Table D15, Plate 27) occur where the eolian veneer is very thin or absent. This pedon is an extremely acid, strongly weathered, base-poor, silica-dominated, soil material of relatively uniform light gray to white color. It could be mistaken for fresh parent material except for the very low pH and weakly colored, silty cappings on the tops of coarse fragments. All characteristics imply that this profile is strongly leached. There is no category for such pedons in either the Canadian (C.S.S.C. 1978a) or most other soil taxonomic systems because B horizons are not present within the 2 m control section.

Blocky localities are dominated by nonsoil because they contain little if any fine earths for soil development. They are accumulations of fragmental, angular boulders and stones interspersed with large voids.

VEGETATION

GH1 is characterized by western hemlock (*Tsuga heterophylla*) forest, best described as a mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) v.t. variant in which western hemlock replaces mountain hemlock (*Tsuga mertensiana*) as the dominant or codominant of an atypically open canopy (Plate 28). This v.t. variant is virtually restricted to GH1. The landslide position, in the upper part of the Interior Cedar-Hemlock Ecoregion, in the shade of steep mountains to the south and west, and downstream from two large glaciers has resulted in vegetation that has affinities with both the Interior Cedar-Hemlock and Lower Subalpine. Further, the stone and boulder strewn, hummocky landscape of GH1 has inhibited the development of closed forest canopies. Blocky, fragmental localities are sparsely vegetated and irregularly distributed across the landscape, adding to the overall vegetational complexity. A small portion along the eastern margin of the landslide has avalanche vegetation, mainly green alder/fern (S13).

Table 64. Wildlife features of GH Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
GH1	low		medium	weasel	medium	red squirrel deer mouse	low

WILDLIFE

GH1 Wildlife Features

Ungulates: No ungulate use was recorded. Based on historical records GH1 may be potentially important to caribou, particularly tracts with old-growth forests.
Carnivores: GH1 is of high importance to weasels and low importance to martens.
Small Mammals: Association 1.
GH1 is highly important to red squirrels. In blocky areas with sparse forest cover, GH1 is also of high importance to pikas. Deer mice occur here in very high densities.
Breeding Birds: Community 24
A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Evening Grosbeak, Mountain Chickadee and Winter Wren.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

GH1 is of very low areal extent, accounting for <0.1% of MRNP and GNP. There are no counterparts in other Ecoregions and no other mappable Interior Cedar-Hemlock landscapes that resemble GH.

Use is limited by rubbly, blocky surfaces and irregular topography. Vegetation will recover only slowly from disturbance.

HE - HEATHER ECOSECTION

The Heather (HE) Ecosection concept incorporates residual and bedrock landforms in the Alpine Ecoregion. Lithic phases of Brunisolic and Podzolic soils occurring under tundra vegetation characterize HE. Only one Ecosite (HE3, Table 65) was recognized. It occurs on high elevation cirque floors and ridge crests in GNP. Fig. 13 shows HE3 in a diagrammatic landscape setting in the Purcell Mountains.

Table 65. Definitive features of the Heather (HE) Ecosection.

Ecosite	Bedrock	Landform	Soils	Vegetation
HE3	Various	Residuum A; veneer over inclined & ridged bedrock	Lithic phases: Orthic Dystric & Sombric Brunisols, Orthic Humo-Ferric & Ferro-Humic Podzols	heath tundra (L5)

GEOMORPHOLOGY

HE3 is geomorphically characterized by veneers of Residuum A (noncalcareous, medium to coarse textured) overlying inclined and ridged bedrock. Medium textures are prevalent, particularly on the highly jointed, medium grained, recessive bedrock of the Horsethief Creek and Lardeau Groups (Fig. 2). HE3 on Hamill Group bedrock includes medium and coarse textured materials, the latter weathered from medium to coarse grained strata. In a few localities, physically weathered residuum or colluvium is rubbly and fragmental with little or no fine earth. Limestone and calcareous clastics occur locally in most bedrock areas, thus calcareous, medium textured residuum (*cf.* Residuum B, Walker *et al.* 1982a) is a minor constituent in a few HE tracts. Eolian material B (altered, medium textured), which is important to soil formation, often forms a thin, discontinuous veneer over the residuum and is generally restricted to gentler slopes.

Some, if not all, HE3 tracts were at least partially glaciated and contain till occurring locally or mixed with the residuum. Because of a wide variety of slopes and relief, many tracts include colluvium on the steepest slopes. It resembles the original residuum but has moved downslope by colluviation and solifluction. Sites affected by cryoturbation also occur sporadically. Exposed bedrock outcrops on ridge crests and short steep escarpments add to the topographic complexity. In most tracts, exposed bedrock is minor but may constitute 20 to 50% of a few, steeper HE3 landscapes.

All tracts have complex topography consisting of either ridged and sometimes hummocky slopes or long, straight slopes culminating in ridges. A few tracts have ridged bedrock oriented perpendicular to the contour and on inclined slopes. Surface expression is bedrock controlled. Slopes generally are 15 to 45%, but locally slopes <15% and >45% also occur.

SOILS

Well drained, moderately to well developed, lithic phase soils characterize HE3. The soils although belonging to two taxa (Table 65) are related and have characteristics grouped around taxonomic boundaries. B horizon development ranges from Bm and thin Bf or Bhf (Brunisolic soils) to podzolic Bf or Bhf (Podzolic soils), with Bf and Bhf horizons usually developed in Eolian material B veneer. Thus, Podzolics, such as the Orthic Ferro-Humic Podzol (Table D16, Plate 29) from HE3 in upper East Grizzly Creek, occur where Eolian material B is thickest. This pedon has unusually thin residual veneer compared to most HE3 soils and, like many Alpine, Upper Subalpine, and avalanched soils, the lower Ah horizon is difficult to distinguish from Bhf.

A horizons of HE soils are usually humus rich (Ah), may be weakly eluviated (Ahe), and vary in thickness. Most of the codominant soils (Table 65) have thin Ah or Ahe horizons but Orthic Sombric Brunisols have >10 cm of Ah. Podzolic soils occasionally have >10 cm of Ah. Sombric Humo-Ferric Podzols are accessory soils, although Sombric Ferro-Humic Podzols also likely occur sporadically. Given the range of parent material depth and horizon characteristics, it is likely that Ah horizons resting on bedrock (lithic Orthic Humic Regosol) may also occur sporadically. Nonsoil, occurring as fragmental rubble, exposed bedrock, or where there is <10 cm of overburden, constitutes a minor amount of most HE3 tracts but is ≤50% of a few steep, rocky HE3 landscapes. Turbic phases, produced by solifluction and cryoturbation, occur as accessory features.

VEGETATION

HE3 is characterized by a mosaic of tundra v.t.s in which heather-everlasting (L5) is predominant (Plate 30). Everlasting-white mountain heather-red heather (H18) is similar to L5 but occurs less extensively, as an accessory v.t. Black alpine sedge-everlasting (H2), another accessory v.t., is most abundant on Lardeau Group bedrock. HE3 soils under H2 are drier than normally associated with this v.t. Mountain avens-snow willow-moss campion (H1) is present in minor amounts on a few tracts and is restricted to high elevation ridge crests with neutral to alkaline soils, an uncommon combination of site conditions. Exposed bedrock and rubbly, fragmental localities are virtually unvegetated except for saxicolous lichen (H12). Such sites are a minor proportion of most tracts but may constitute ≤50% of rocky HE3 tracts.

Table 66. Wildlife features of HE Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
HE3	high	goat (s)	low		low	chipmunk	

WILDLIFE

HE3 Wildlife Features

Ungulates: HE3 is of high importance overall to ungulates. It is of high importance to mountain goats, and medium importance to mountain caribou in summer. Tracts in the Purcell Mountains are used in summer by mule deer and elk.

Carnivores: Martens and weasels occur at low densities in winter. At this season, prey is limited to White-tailed Ptarmigan and some snowshoe hares.

Small Mammals: Association 13.

HE3 is of low importance. The snowshoe hare was recorded at low densities in winter where forage on ridge tops is blown free of snow. Yellow-pine chipmunks occur on most HE3 tracts. Pikas and hoary marmots occur near scree slopes and boulders.

Breeding Birds: Community 17

A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Water Pipit and White-tailed Ptarmigan.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The HE Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and extended to KNP (Walker *et al.* 1984b) and MRNP and GNP to accommodate similar landscape (0.3% of MRNP and GNP). HE3, established for the Columbia Mountains, differs from HE1 of the Rocky Mountains in having more Podzolic and fewer Regosolic soils, as well as heath tundra instead of avens tundra.

No counterparts of HE occur in other Ecoregions. Jonas 2 (JN2) resembles HE3 but is characterized by morainal material overlying bedrock and nonlithic soils.

Shallow soil and occasional outcrops limit use. Vegetation will recover only slowly from disturbance. Removal of vegetation will increase erosion, especially by wind.

HR - HERMIT ECOSECTION

The Hermit (HR) Ecosection concept incorporates colluvial landforms comprised of noncalcareous colluvium and dominated by Lower Subalpine vegetation. Dystric Brunisols and Humo-Ferric Podzols are the characteristic soils. Six HR Ecosites (Table 67) were differentiated. HR1, HR2, HR3, and HR4 have the same spruce-fir-hemlock vegetation but different bedrock groups with concomitant soils differences. In contrast, HR5 is dominated by vegetation indicative of frequent snow avalanching and HR6 is characterized by very steep, rugged rocky terrain with lithic phase soils. All occur high on valley walls, although HR5 often extends across valley floors. Figs. 10, 12 and 14 show topographic relationships among several HR Ecosites and a few others.

Table 67. Definitive features of Hermit (HR) Ecosites.

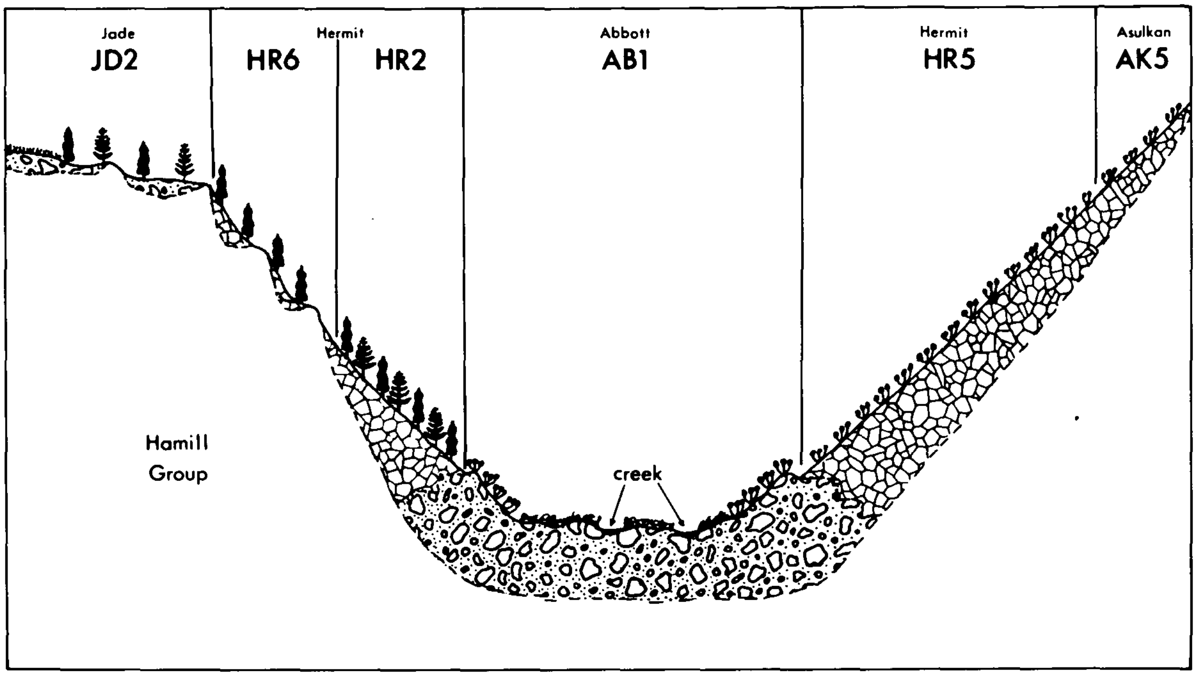
Ecosite	Bedrock	Landform	Soils	Vegetation
HR1	Horsethief Ck. Group	Colluvium B; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol > Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C21), mountain hemlock forest (C47)
HR2	Hamill Group	Colluvium B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C21), mountain hemlock forest (C47)
HR3	Lardeau Group	Colluvium B; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C21), mountain hemlock forest (C47)
HR4	Shuswap Metam. Complex	Colluvium B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	Engelmann spruce-subalpine fir forest (C21), mountain hemlock forest (C47)
HR5	Various	Colluvium B & A; blanket & veneer over inclined bedrock, apron; avalanched	Orthic & Eluviated Dystric Brunisols, Orthic Sombric Brunisol, Orthic Humo-Ferric Podzol	Avalanche complex 5 > Engelmann spruce-subalpine fir forest (C21), mountain hemlock forest (C47)
HR6	Various	Colluvium B & A; veneer over inclined bedrock + exposed bedrock	Lithic phases: Eluviated & Orthic Dystric Brunisols, Orthic Humo-Ferric Podzol; + nonsoil	Engelmann spruce-subalpine fir open forest (O21)

GEOMORPHOLOGY

HR is geomorphically characterized by colluvial landforms comprised of Colluvium B (non- to weakly calcareous, medium textured) and Colluvium A (noncalcareous, coarse textured). Colluvium B is predominant and characterizes HR1 and HR3 on Horsethief Creek and Lardeau Group bedrock types (Fig. 2), respectively. Colluvium A is codominant in areas underlain by Hamill Group (HR2) and Shuswap Metamorphic Complex (HR4) bedrock. The former includes an area of granitic, intrusive bedrock. HR5 and HR6 on all bedrock types, contain mostly Colluvium B or an unpredictable combination of Colluvial materials A and B. Limestone occurs locally in most bedrock areas, thus calcareous, medium textured colluvium (*cf.* Colluvium C, Walker *et al.* 1982a) is a minor constituent in a few HR tracts. Consolidated bedrock usually underlies the colluvium but, at a few sites, weathering of the bedrock surface has been sufficient to produce veneers of Residuum A (noncalcareous, medium to coarse textured). These are more likely to occur in recessive, highly jointed, slaty to schistose strata. Discrete veneers of Eolian material B (altered, medium textured) thinly mantling the colluvial surface are uncommon in HR. Intact eolian veneers occur only on the oldest, most stable sites under forest vegetation.

The colluvium most often occurs as nearly continuous blankets and veneers mantling steeply inclined bedrock on valley walls. Discontinuous colluvial veneer plus exposed bedrock is the norm for HR6 but also characterizes the few HR5X tracts. The X modifier, meaning lithic soils are dominant, is also occasionally applied to polygons of the other HR Ecosites, except HR6 where lithic soils are the norm. The deepest deposits are colluvial aprons, which occur only in HR5 where they have been constructed by avalanching and rockfall below very steep, often rocky slopes. Couloirs cut into the

Fig. 12. Landscape schematic of topographic relationships among HR and other Ecosites.



source slopes channel meltwater streams and mudflows onto the aprons. Thus, the apron landforms are often a mixture of intercalated colluvial, fluvial and mudflow deposits.

HR slopes are usually long, straight, and 55 to >100%, although there are some slopes as low as 45%. HR6 typically has the steepest (rarely <60%), most irregular slopes with cliff and sloping bench topography, especially where it occurs on resistant bedrock. This is most abundant in areas with Hamill Group and Shuswap Metamorphic Complex strata. Cliff and bench topography is not as well expressed in the recessive bedrock of the Horsethief Creek and Lardeau Groups where exposed bedrock normally blends into the overall slope. A few HR tracts were mapped with complex slopes. One type applies to several tracts mapped with the modifier F (*e.g.* HR1FB south of Grizzly Creek) where partial failure of the underlying bedrock has produced a subdued, hummocky to ridged, bench-like topography superimposed on an inclined slope. Tension cracks and short slip scars are often evident although not all F modified tracts have complex slopes. The second type, HR4+T and HR5+T (*e.g.* HR4F+T tract below Eva Lake), has an unusual assemblage of local landforms, ranging from cliffs and knobs of exposed bedrock to colluvial aprons, encompassing several slope classes. All the processes that formed this distinctive, complex terrain are not known although localized bedrock failure appears to be contributory.

Snow avalanching (A) is the most common Ecosite modifier in HR and characterizes (>50%) HR5. However, ≤20% of any other HR tract may have avalanche paths. Narrow, channeled paths are a consistent, common feature of HR6 but generally are of low extent (<20%). Forested tracts with more extensive avalanching (20-50%) were mapped with the modifier A (*e.g.* HR1A).

Current landform construction is very slow and has virtually ceased under forest vegetation (HR1, HR2, HR3, and HR4), except on recently burned areas (*e.g.* upper Copperstain Creek valley) where surficial modification processes such as soil creep, slope wash, and fluvial or mudflow erosion have rejuvenated the landform construction process. Other low intensity modification processes operating on forested terrain include uprooting of trees and solifluction although disturbed (turbic phase) soils are not common. In contrast, colluvial activity on avalanched (HR5) and craggy (HR6) landscapes is more diverse. Vegetated portions, which are typical and usually predominant, are relatively stable, as indicated by the predominance of well developed soils, even though low intensity processes may still be operating. Sparsely vegetated and unvegetated erosional and depositional sites (up to ≤50% of any HR5 or HR6 tract) are generally localized. Material eroded from high cliffs, very steep slopes, and couloirs is deposited immediately below by rockfall, avalanching, fluvial and mudflow processes, slope wash and soil creep. A few tracts are complexes of an HR Ecosite + 𝕋 (Talus) or ℂℝ (colluvial rubble) (*e.g.* HR4F+T) because of unusually high proportions of unvegetated localities. These include (50-80% for HR5 and HR6+T or CR; 20-80% for HR4+T) active sites, massive bedrock cliffs and blocky talus with little or no fine earth material.

SOILS

Well to rapidly drained Dystric Brunisols and Humo-Ferric Podzols characterize the soil component of HR. Soils, even though classed in different taxa (Table 67), are similar and have characteristics grouped around taxonomic boundaries. B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils), even under avalanche vegetation. Two lithic Orthic Humo-Ferric Podzol pedons, one (Table D18) from HR4 near Jade Lakes and the other (Table D19, Plate 31) from HR6 below Balu Pass, have dark reddish brown B horizons and typify well developed Podzolic soils of HR. A third pedon, an Orthic Humo-Ferric Podzol (Table D17) from HR3AB on the south slope of Mount Fidelity, has dark brown B horizons although the colors reflect, in part, the black parent material derived from Lardeau Group slate. It also appears to have inherently high organic carbon and pyrophosphate-extractable Fe and Al contents. Thus, the degree of pedogenic development, implied by the Podzolic classification, is in doubt. Dystric Brunisols are defined as having brownish or yellower B horizons; distinguishing Podzolics from Brunisolics on field characteristics alone is often difficult.

Whether Brunisolic or Podzolic, the soils have a similar range of A horizon characteristics that reflect various geomorphic-vegetational environments. Acidic Brunisols are classified according to kind and thickness of A horizon. Eluviated Dystric Brunisols have >2 cm of Ae horizon and are dominant or codominant in all HR Ecosites. Most forested soils have well developed Ae horizons (Tables D18 and D19). Orthic Dystric Brunisols and some Podzols can have little or no A horizon, A mixed with B (AB or A+B horizons), or thin (<10 cm) Ah horizon at the mineral surface. Any of these implies low intensity surficial, geomorphic activity, sometimes in conjunction with high humus input. Orthic Dystric Brunisols are codominant in HR5 and HR6, accessory soils in HR3 and HR4. Soils with Ah horizons most often develop in the humus-rich environments of avalanche vegetation. Most common are Orthic Sombric Brunisols which have Ah horizons >10 cm thick. Orthic Sombric Brunisols are codominant in HR5 where closely related Sombric Humo-Ferric Podzols occur occasionally.

Two Podzolic subgroups, other than the characteristic Orthic Humo-Ferric Podzols, occur occasionally in HR and without laboratory data are often difficult to distinguish from typical soils. Sombric Humo-Ferric Podzols with >10 cm of Ah horizon, are accessory soils of HR5; Orthic Ferro-Humic Podzols, with podzolic Bhf horizons, are accessory soils of HR5 and HR6. These soils likely also occur occasionally in the other HR Ecosites. In HR5, their development is probably related to mechanical incorporation of humus into surface horizons. Under such conditions, Sombric Ferro-Humic Podzols, with podzolic Bhf and thick Ah horizons, may also occur. Where very shallow soils are the norm, as in HR6, illuvial humus appears to accumulate above the bedrock contact as in Table D19.

In strong contrast to the comparatively stable Brunisolic and Podzolic soils, Regosolic soils occur at sites that are or have recently been subjected to intense geomorphic activity so that B horizon development has been inhibited. They are most abundant in avalanched terrain (accessory soils of HR5) although they likely occur in minor amounts in other HR Ecosites. Cumulic and Cumulic Humic Regosols are most common and occur in depositional localities. Their variable organic matter content and color is related to mechanical incorporation of humus into surface horizons. The morphologically more uniform Orthic Regosols occur sporadically, particularly in erosional sites on HR5 and HR6. The variety of Brunisolic, Podzolic, and Regosolic soils on HR5 demonstrates the diverse and complex interactions of geomorphic activity and pedogenic weathering on avalanched terrain, among the most complex landscapes in MRNP and GNP.

Lithic phase soils are common as accessory soils in any HR Ecosite, but are characteristic and distinctive of HR6. Nonsoil areas are also extensive (up to 80%) on these very steep, rugged, craggy landscapes, occurring as exposed bedrock or where there is <10 cm of overburden. Lithic soils are interspersed with nonsoil and the proportion of each varies. Deeper soils (>1 m of overburden) occur in minor amounts on craggy terrain. Tracts of HR5X often have a similar lithic soil plus nonsoil pattern. In contrast, HR2X, HR3X, and HR4X tracts are dominated by lithic soils and usually have only minor amounts of nonsoil.

VEGETATION

The well forested HR Ecosites (HR1, HR2, HR3, HR4) have similar vegetation (Table 67) characterized by spruce-fir and hemlock forests, mainly the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) (Plate 32) and mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) v.t.s. Although the two v.t.s are similar, there is a gradient with C21 most abundant in the east (HR1 in the Purcells) and C47 most abundant in the west (HR4 in MRNP). Two similar v.t.s, mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49) occurring at low elevations within the Lower Subalpine, and Engelmann spruce-mountain hemlock/rhododendron-tall bilberry (C48), are accessory v.t.s in these four Ecosites. At a few sites, the forest canopy is more open than normal and the vegetation resembles the Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21) v.t.

O21 characterizes HR6 (Plate 33). Unvegetated bedrock and very active sites occupy ≤50% of HR6 and add to its distinctiveness and complexity. C47, subalpine fir-mountain hemlock/heather-luetkea (O20), and avalanche v.t.s, such as subalpine fir-willow (S2) and willow-mountain hemlock-subalpine fir/tall bilberry (S14), are accessory v.t.s on HR6. C47 occurs patchily on relatively inactive sites with deeper than normal soils. O20 occasionally replaces O21 at upper elevations of the Lower Subalpine. Avalanche v.t.s occur on channeled paths in couloirs but the areal extent is low.

The geomorphic-soil diversity of avalanched terrain also applies to vegetation. Avalanched segments dominate HR5 and are characterized by a heterogeneous complex of v.t.s, Avalanche complex 5, that includes subalpine fir-willow (S2), green alder/fern (S13), willow-mountain hemlock-subalpine fir/tall bilberry (S14), sedge (H21), plus intergrades and other unidentified assemblages (Plate 34). S13 is most abundant, particularly on deeper soils. S2 and S14 occur at upper elevations of the Lower Subalpine and the latter occurs often on rocky terrain with shallow soils plus exposed bedrock. H21 occurs as small patches, usually in avalanche runout zones on colluvial aprons. Forested localities, virtually unaffected by avalanching, usually constitute significantly <50% of any HR5 tract. They fringe snow avalanche runout zones and form strips between avalanche paths. The most common forest v.t.s are C21 and C47, although O21 also occurs occasionally as an accessory v.t. Unvegetated localities, on exposed bedrock and geomorphically intensely active sites, occasionally constitute up to 50% of HR5 tracts.

Avalanche complex 5 also occurs in minor amounts on HR1, HR2, HR3, HR4, and HR6 but occupies 20-50% of tracts with the modifier A (*e.g.* HR6A on the south slope of Mount Tupper). Several tracts have the modifier **B** (*e.g.* HR1B above Beaver Meadows) and are dominated by vegetation at an early stage of post-fire succession. A few tracts containing unusually high proportions of unvegetated localities, including exposed bedrock and rubbly to blocky colluvium, were mapped as complexes of HR Ecosites plus T (Talus) or **CR** (colluvial rubble). Generally, unvegetated portions comprise 50 to 80% of tracts mapped as HR5 and HR6+T or CR, and 20 to 80% of HR4+T. Such tracts often include inactive blocky talus with so little fine earth that plants other than lichens (*e.g.* saxicolous lichen, H12) are unable to grow.

WILDLIFE

HR1 Wildlife Features

Ungulates: HR1 is of medium importance to goats in winter, due to its steep terrain, combined with sheltering forest and forage.

Carnivores: HR1 is of low importance to martens, wolverines and lynx.

Small Mammals: Association 3.

HR1 is of medium importance to small mammals overall. It is of high importance to red-backed voles and of medium importance to pikas which occur on scree slopes in many tracts.

Breeding Birds: Community 8

A low density of birds was recorded. On burned tracts, HR1 supports BBC 21.

Table 68. Wildlife features of HR Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
HR1	low		low		medium	red-b. vole	low
HR2	low		low		medium	red-b. vole	low
HR3	low		medium	marten	low	red-b. vole	low
HR4	low		low		low	red-b. vole	low
HR5	high	goat	medium		high	pika marmot long-t. vole	medium
HR6	high	goat (w)	low		medium	pika	medium

HR2 Wildlife Features

Ungulates: HR2 is of medium importance to goats in winter, due to its steep terrain, combined with sheltering forest and forage.
Carnivores: HR2 is of low importance to martens and lynx. Wolverines are recorded here.
Small Mammals: Association 3.
HR2 is of high importance to red-backed voles and of medium importance to red squirrels.
Breeding Birds: Community 8
A moderate density of birds was recorded. Burned tracts support BBC 21. Based on density indices derived from circular census plots, this Ecosite is highly important to Winter Wren.

HR3 Wildlife Features

Ungulates: HR3 is of low importance as summer range for goats.
Carnivores: HR3 is of high importance to martens but of only moderate importance to carnivores overall.
Small Mammals: Association 3.
HR3 is of low importance to small mammals overall but of high importance to red-backed voles.
Breeding Birds:
HR3 was not sampled for breeding birds, but based on similar vegetation and physical characteristics, it appears similar to HR2.

HR4 Wildlife Features

Ungulates: HR4 is of low importance to mountain caribou in winter and to goats in summer.
Carnivores: HR4 is of low importance.
Small Mammals: Association 3.
HR4 is highly important to red-backed voles but of low importance to small mammals otherwise.
Breeding Birds:
HR4 was not sampled for breeding birds, but based on similar vegetation and physical characteristics, the birds appear similar to those of HR2.

HR5 Wildlife Features

Ungulates: The cliffs and rock faces typical of HR5X tracts, are of high importance as goat range throughout the year.
Carnivores: HR5 is of medium importance overall. It is of medium importance to martens and of low importance to weasels, wolverines and lynx.

Small Mammals: Association 11A.
HR5 supports a high density of mice and voles because of its habitat diversity. It is highly important to long-tailed voles and, where open meadows abut talus slopes and boulder-fields, to pikas and hoary marmots.

Breeding Birds: Communities 12 and 8
A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Golden-crowned Sparrow and Wilson's Warbler. It is also important winter White-tailed Ptarmigan habitat and potentially important for foraging Golden Eagles.

HR6 Wildlife Features

Ungulates: HR6 is very highly important as winter range for goats and of medium importance as summer range.

Carnivores: HR6 is of medium importance to weasels but of low importance to carnivores overall.

Small Mammals: Association 11A.
HR6 is of medium importance to small mammals, supporting a diversity of species. It is highly important to pikas, due to its combination of rocky terrain and herbaceous vegetation.

Breeding Birds: Communities 12 and 8
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Chipping Sparrow, Dusky Flycatcher, MacGillivray's Warbler, Olive-sided Flycatcher, Pine Grosbeak, Pine Siskin, Red Crossbill, Rufous Hummingbird and Yellow-rumped Warbler. Most of these species are confined to snow avalanched tracts. Burned tracts support BBC 8.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

HR is an extensive Ecosection, accounting for 16.4% of MRNP and GNP. Each of the six Ecosites are fairly extensive with HR1 accounting for 2.9%, HR2 2.3%, HR3 1.1%, HR4 1.4%, HR5 6.0%, and HR6 2.7%. HR is the Lower Subalpine counterpart of the Interior Cedar-Hemlock Nordic (NC), Upper Subalpine Asulkan (AK), and Alpine Redoubt (RD) Ecosections. Few other Lower Subalpine landscapes resemble HR. An exception is Catamount 2 (CM2) which resembles parts of some HR5 tracts. CM2 occurs on more gently sloping fluvial fans and aprons on or adjacent to valley floors, often below HR.

Steepness and colluviation are major limitations. The Ecosites from most to least active are: HR5 (avalanched), HR6 (craggy), and the others (forested). Removal of vegetation may increase erosion. Locally, coarse textures, stony surfaces and shallow soils limit use.

The open cliffs of HR6 are highly important to mountain goats. Goats may abandon critical ranges or sustain mortality where they occupy avalanche control zones. Avalanched HR tracts are important grizzly bear habitats; recreational developments on such sites will lead to bear/human conflicts.

JD - JADE ECOSECTION

The Jade (JD) Ecosection concept incorporates landforms composed of noncalcareous till, well to moderately well drained Brunisolic and Podzolic soils, and Upper Subalpine coniferous open forest, heath tundra, and herb meadow vegetation. Four JD Ecosites have been differentiated (Table 69). JD usually occupies mountain shoulders and high cirque floors and less frequently, valley wall upper slopes. Distribution of each Ecosite corresponds closely with bedrock type distribution (Table 69, Figs. 2, 10, 12 and 13).

GEOMORPHOLOGY

The predominant genetic material in JD (Table 69) is Till B (noncalcareous, medium textured). Coarser textured Till A is codominant in areas underlain by Hamill Group bedrock (JD2, GNP) or Shuswap Metamorphic Complex bedrock (JD4, MRNP).

Table 69. Definitive features of Jade (JD) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
JD1	Horsethief Ck. Group	Till B; blanket & veneer over inclined & ridged bedrock	Orthic & Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzol	subalpine fir-mountain hemlock open forest (O20) + heath tundra (L5)
JD2	Hamill Group	Till B & A; veneer over inclined & ridged bedrock	Lithic phases: Orthic & Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzol	subalpine fir-mountain hemlock open forest (O20) + heath tundra (L5)
JD3	Lardeau Group	Till B; blanket & veneer over inclined & ridged bedrock	Orthic & Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzol	subalpine fir-mountain hemlock open forest (O20) + heath tundra (L5)
JD4	Shuswap Metam. Complex	Till B & A; blanket & veneer over inclined & ridged bedrock	Orthic Sombric Brunisol, Orthic & Sombric Humo-Ferric Podzols	subalpine fir-mountain hemlock open forest (O20) + heath tundra (L5), herb meadow (H16)

The till is most frequently blankets or veneers which subtly mask inclined or ridged bedrock. Bedrock crops out occasionally and does so most consistently in JD2, in which morainal veneers are the rule. Eolian material B (altered, medium textured) veneers sporadically mantle JD.

Slopes are complex on the cirque floor and mountain shoulder positions and linear on valley walls. Slopes are commonly 30 to 45%, and range from 5 to 70%.

Solifluction often modifies strong slopes especially under meadow or tundra vegetation. Some cryoturbation occurs in meadows and tundra, regardless of slope, mainly near the Alpine boundary. Both processes are best expressed where textures are medium. Snow avalanche runout zones occur near steep cirque walls, a situation common where resistant bedrock predominates.

SOILS

Most JD soils are moderately well to well drained Brunisols or Podzols (Table 69). Orthic Dystric Brunisols are common throughout GNP but are only an accessory feature in MRNP. They usually have restricted A horizons (<2 cm if Ae, <10 cm if Ah), thick B horizons (20-50 cm) in which <10 cm are strongly developed, the balance having moderate development, and thick, weakly developed BC horizons that are transitional to noncalcareous C horizons which begin at depths often >1 m. Lower sola are strongly to extremely acidic (pH <5.5).

Other characteristic soils are interspersed with and genetically related to Orthic Dystric Brunisols. They differ by having more strongly developed A horizons (Eluviated Dystric Brunisols with >2 cm Ae, Orthic Sombric Brunisols with >10 cm Ah), more strongly developed B horizons (Orthic Humo-Ferric Podzols with >10 cm Bf), or both (Sombric Humo-Ferric Podzol with >10 cm Ah and >10 cm Bf). Many JD soils have thin, dark upper Bhf horizons. Orthic Ferro-Humic Podzols (Bhf ≥10 cm) are accessory soils in JD4 (MRNP).

Soil distribution in JD is a function of these A and B horizons and several trends exist. Under forest, soils may lack A horizons or have a thin Ah, but tend to develop thick Ae horizons (Orthic Dystric Brunisols, Eluviated Dystric Brunisols, Orthic Humo-Ferric Podzols). Moderately developed Ah horizons (2-10 cm) are the rule under tundra (Orthic Dystric Brunisols, Orthic Humo-Ferric Podzols). Accessory turbic phase soils are usually among these. A wide range of Ah thicknesses occur under meadow vegetation (Orthic Sombric Brunisol, Orthic Humo-Ferric Podzol, Sombric Humo-Ferric Podzol, occasionally Orthic Dystric Brunisol).

Soil development is also related to genetic materials and bedrock. Other factors being equal, sola are usually deeper and more strongly developed on coarse textured, predominantly quartzitic drift than on medium textures with sheet silicate mineralogy. Pedogenic cementing is distinctive of some coarser textured profiles. In JD2 and JD4, a duric tendency is occasionally continuous in lower B and BC horizons but is more often patchy. Continuous to patchy cementing of upper B horizons (Ortstein Humo-Ferric Podzol) occurs in the coarsest soils and is an accessory in JD2. Both types of cementing occur more under forest than under meadow or tundra vegetation and in deeper rather than lithic soils. Table D22 presents data on a Orthic Humo-Ferric Podzol with cementing from JD4 (Plate 35).

Lithic phase soils may occur in any JD tract, but are common in JD2. Some JD2 tracts are 20 to 50% nonsoil (bedrock outcrop and veneers <10 cm thick). Forested portions are usually rare on these tracts. Table D20 illustrates a lithic phase Orthic Dystric Brunisol from JD2 (Plate 36).

JD3 soils often have dark profiles with much of the color inherited from parent material of the Lardeau Group, making identification of horizons difficult. Table D21 illustrates an Orthic Humo-Ferric Podzol with dark colors, from JD3 (Plate 37).

Knapik and Coen (1974) conducted a detailed soil survey in MRNP. Much of their study area is in the JD4 tract around the Mount Revelstoke summit. Kowall (1980) reported soil information at a map scale of 1:100,000 on the western portion of MRNP.

VEGETATION

The characteristic v.t. pattern of JD (Table 69) is one of both open forest and tundra (or meadow, JD4) interspersed in various proportions (Plate 38). The heather-everlasting (L5) v.t. is more prevalent near the Alpine boundary. L5 is occasionally replaced by the accessory everlasting-white mountain heather-red heather (H18) v.t. The subalpine fir-mountain hemlock/heather-luetkea (O20) v.t. is more prevalent near the Lower Subalpine boundary. Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21) is accessory in JD4.

Meadow vegetation occurs infrequently on JD in GNP, being accessory in JD3 only. It is an integral part of JD4 (MRNP). The fleabane-valerian (H16) v.t. predominates in meadows (Plate 39), occasionally intergrading with L5 or black alpine sedge-everlasting (H2). The latter is accessory in JD3. Patches of meadow in JD1 or JD2 usually correspond with poor drainage, but drainage appears to be moderate to good under most meadows in JD3 and JD4. Meadows on steep slopes often correlate with either surface creep or solifluction. Late snow lie may contribute to the maintenance of meadow on well drained positions.

Avalanched areas have Avalanche complex 4 vegetation which includes subalpine fir-willow (S2), willow-mountain hemlock-subalpine fir/tall bilberry (S14), heather-everlasting (L5), fleabane-valerian (H16) and everlasting-white mountain heather-red heather (H18), plus intergrades.

WILDLIFE

JD1 Wildlife Features

Ungulates: JD1 is highly important summer range for caribou, mule deer and elk.

Carnivores: JD1 is of medium importance to martens and lynx, and of low importance to weasels. Weasels were recorded abundantly in the vicinity of the small Upper Subalpine lakes on Bald Mountain where they were probably hunting voles.

Small Mammals: Associations 12 and 16.

JD1 is of medium importance overall to small mammals and of high importance to Columbian ground squirrels. Wet meadows surrounding small Upper Subalpine lakes are of high importance to northern bog lemmings and Richardson's water voles. Snowshoe hares occur at medium densities here.

Breeding Birds: Community 7

A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Ruby-crowned Kinglet. Red-tailed Hawks that nest in the Copperstain burn hunt in this Ecosite. High densities of Columbian ground squirrels make JD1 potentially important for Golden Eagles. Burned tracts support BBC 21.

Table 70. Wildlife features of JD Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
JD1	high	caribou (s) mule deer elk (s)	medium		medium	Columbian gr. squirrel	medium
JD2	low		medium		high	Columbian gr. squirrel porcupine marmot	medium
JD3	high	caribou	medium		medium	Columbian gr. squirrel	medium
JD4	high	caribou	medium		medium	Columbian gr. squirrel marmot	medium

JD2 Wildlife Features

Ungulates: JD2 is of low importance to ungulates overall. It is of low importance to goats year round. It is potentially important to mountain caribou since it is similar to their habitat outside the parks, but caribou densities are too low to assess its present importance.
Carnivores: JD2 is of medium importance overall, since it is used by most species, but it is only of low importance to any single species.
Small Mammals: Association 12.
This diverse Ecosite is of high importance to porcupines, hoary marmots and Columbian ground squirrels and of medium importance to pikas.
Breeding Birds: Community 7
A low density of birds was recorded.

JD3 Wildlife Features

Ungulates: JD3 is of high importance to caribou in winter and summer, and of medium importance to mountain goats in summer.
Carnivores: JD3 is of medium importance to carnivores, particularly to martens.
Small Mammals: Associations 12 and 16.
JD3 meadows are of high importance to Columbian ground squirrels and the open forests are of medium importance to porcupines. Wet meadows surrounding small lakes are of high importance to northern bog lemmings and Richardson's water voles.
Breeding Birds: Communities 7 and 17
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Fox Sparrow, Gray Jay and Pine Siskin.

JD4 Wildlife Features

Ungulates: JD4 is of high importance to caribou in both winter and summer and of low importance to mule deer and goats in summer.
Carnivores: JD4 is of medium importance to martens and weasels.
Small Mammals: Associations 12 and 16.
JD4 meadows are of high importance to Columbian ground squirrels and the open forests are of high importance to porcupines. Wet meadows near lakes and streams are highly important to SMA16. The *Mount Revelstoke* small mammal live-trap plot was in this Ecosite (see sec. 3.11, Van Tighem and Gyug [1984]).
Breeding Birds: Communities 7 and 17
A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Dark-eyed Junco, Fox Sparrow, Gray Jay

and Hermit Thrush. The abundance of prey and open vegetation make this an important habitat for Golden Eagles and Red-tailed Hawks, and for Northern Hawk-Owls which have been observed frequently and may breed here. A breeding bird census plot was in this Ecosite (see sec. 3.3, Van Tighem and Gyug [1984]).

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The JD Ecosection accounts for 6.1% of MRNP and GNP (JD1 2.4%, JD2 2.0%, JD3 0.7%, JD4 1.0%). The Balu (BU) Ecosection is the Lower Subalpine counterpart while Jonas (JN) occurs on till in the Alpine. JD2 and JD3 were locally extended into the normal range of Alpine because no JN Ecosites were established for tills derived from Hamill or Lardeau Group bedrock in the Alpine. Areas of JD with meadow vegetation resemble Witch Tower (WR), but soils are poorly drained on the latter.

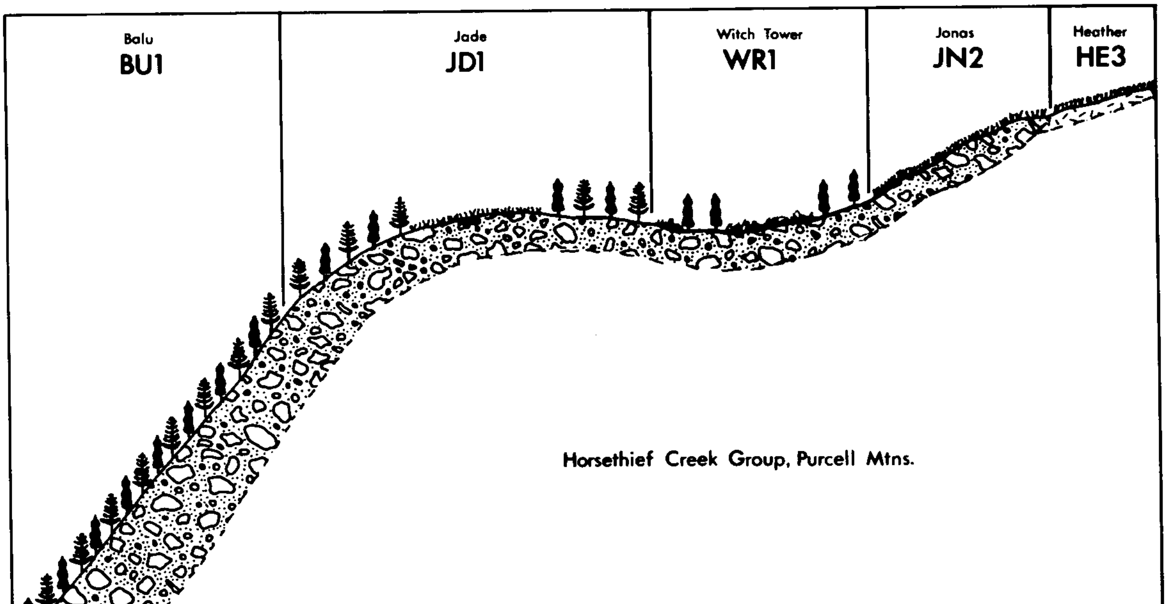
Irregular topography and slopes >30% limit use. Locally, use may be limited by stony surfaces and coarse textures (JD2, JD4), snow avalanching (all), shallow soils and outcrops (JD2), cemented soils (JD2, JD4), and seasonal seepage (all). Removal of vegetation may increase erosion on steep slopes. Revegetation following disturbance may be slow.

JD is highly important to caribou in MRNP. Disturbance in winter and early spring by humans or aircraft may result in stress or abandonment of ranges. Disturbance of Columbian ground squirrel and hoary marmot colonies may harm an important prey for eagles, or other raptors and carnivores.

JN - JONAS ECOSECTION

The Jonas (JN) Ecosite concept incorporates Alpine tundra vegetation, morainal landforms composed of noncalcareous, medium textured till (Till B), and well to moderately well drained, acidic, Brunisolic and Podzolic soils. Only one JN Ecosite (JN2, Table 71) was recognized. It occupies broad mountain tops and high cirque floors among the subdued topography of the Purcell Mountains in eastern GNP. Fig. 13 shows JN2 in a diagrammatic landscape setting in the Purcell Mountains.

Fig. 13. Landscape schematic of topographic relationships among JD1, JN1 and other Ecosites.



GEOMORPHOLOGY

The predominant genetic material in JN2 is Till B (noncalcareous, medium textured) derived from Horsethief Creek strata. Thin, Eolian material B (altered, medium textured) veneers over till are important to soil formation. Consolidated, recessive bedrock usually underlies the till but, at several sites, bedrock weathering has produced veneers of Residuum A (noncalcareous, medium to coarse textured).

The till occurs most frequently as either blankets or veneers which subtly mask inclined and ridged bedrock. Small bedrock outcrops occur sporadically and are most abundant on JN2X below Copperstain Mountain where morainal veneer is dominant.

All tracts have complex topography consisting of either ridged and sometimes hummocky slopes or ridged apexes flanked by long, straight, gentle slopes. Surface expression is bedrock controlled even in JN2F below Dawn Mountain where bedrock failure has produced an irregular, hummocky topography, including steep slopes mantled with colluvium. Slopes are 5 to 45%, with 5 to 30% most common and slopes <5% and >45% occurring locally. Solifluction and, less often, cryoturbation occasionally modify steep slopes to produce turbic soil phases.

SOILS

Well to moderately well drained, moderately to well developed soils characterize JN2. The soil taxa (Table 71) are related and have characteristics grouped around taxonomic boundaries. B horizon development ranges from Bm and thin Bf or Bhf (Brunisolic soils) to podzolic Bf or Bhf (Podzolic soils), with Bf and Bhf horizons usually developed in Eolian material B veneer. Thus, Podzolics, such as the Orthic Ferro-Humic Podzol pedon (Table D23, Plate 40) from JN2 in upper East Grizzly Creek, occur where Eolian material B is thickest. The upper three mineral horizons in this pedon are developed in a mixture of till and eolian material. As in many Alpine, Upper Subalpine, and avalanched soils, the upper Bhf horizon is difficult to distinguish from Ah.

Table 71. Definitive features of the Jonas (JN) Ecosection.

Ecosite	Bedrock	Landform	Soils	Vegetation
JN2	Horsethief Ck. Group	Till B; blanket & veneer over inclined & ridged bedrock	Orthic Dystric & Sombric Brunisols, Orthic Humo-Ferric & Ferro-Humic Podzols	heath tundra (L5), herb tundra (H18)

A horizons of JN soils are usually humus rich (Ah), may be weakly eluviated (Ahe), and vary in thickness. Most of the codominant soils (Table 71) have thin Ah or Ahe horizons but Orthic Sombric Brunisols have >10 cm of Ah. Podzolic soils occasionally have >10 cm of Ah. Sombric Humo-Ferric Podzols are accessory soils, although Sombric Ferro-Humic Podzols also likely occur sporadically. Soils with strongly eluviated A horizons (*e.g.* Eluviated Dystric Brunisols) occur infrequently.

Lithic phases are common as accessory soils in JN2 but characterize JN2X below Copperstain Mountain. This tract also contains more than the usual low proportion of nonsoil, which occurs on exposed bedrock and <10 cm of veneer over bedrock. Turbic phases, with disrupted horizons produced by solifluction and cryoturbation, also occur as accessory features, particularly if the tract is wetter than normal. Marginally wet soils, usually imperfectly drained and seepy, occur in minor amounts as Gleyed subgroups of the codominant and accessory soils. They occur in small depressions and on the fringe of the Upper Subalpine Witch Tower 1 (WR1) Ecosite.

VEGETATION

JN2 is characterized by a mosaic of tundra v.t.s, mainly heather-everlasting (L5) and everlasting-white mountain heather-red heather (H18). H18 (Plate 41) is more extensive than L5. Black alpine sedge-everlasting (H2) is an accessory v.t. that occurs frequently but not extensively. It occurs in late lying snow beds and seepy depressions. Fleabane-valerian (H16) occurs in minor amounts, usually bordering Upper Subalpine wetland of the Witch Tower 1 (WR1) Ecosite.

JN2 on Bald Mountain extends to an unusually low elevation of about 2200 m. This is likely due to wind exposure on the broad, smooth, gently sloping, mountain top. Small patches and strips of krummholz, usually subalpine fir (*Abies lasiocarpa*) or Engelmann spruce (*Picea engelmannii*), are scattered around ridge crests on the Bald Mountain JN2 tracts, but account for <5% cover overall. Soils are shallowest and exposed bedrock most abundant on these prominent ridge crests.

WILDLIFE

JN2 Wildlife Features

Ungulates: JN2 is of high importance to caribou and of medium importance to elk during summer.
Carnivores: Because of low prey densities and deep snow cover, JN2 is of very low importance in winter.
Small Mammals: .
Columbian ground squirrels and hoary marmots are common on JN2. No small mammals were trapped on JN2, but heather voles, yellow-pine chipmunks and deer mice may occur at low densities.
Breeding Birds: Community 17
A low density of birds was recorded. JN2 is of high importance to Horned Lark, Water Pipit and White-tailed Ptarmigan. Columbian ground squirrel and hoary marmot colonies make it an important foraging habitat for Golden Eagles, Red-tailed Hawks and other raptors.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The JN Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d) and extended to KNP (Walker *et al.* 1984b) and MRNP and GNP to accommodate similar landscape (0.3% of MRNP and GNP). Minor differences in soil and vegetation warranted the separation of a new JN Ecosite for the Columbia Mountains.

Jade (JD) is the Upper Subalpine counterpart of JN, and JD1 and JN2 often have common boundaries. Witch Tower 1 (WR1), with Upper Subalpine wetland soils and vegetation, also often abuts JN2. No JN Ecosites were established for the limited occurrences of Alpine till derived from Hamill or Lardeau Group bedrock. These were included in a few JD2 and JD3 tracts. Heather 3 (HE3) resembles JN2 but differs by having residual veneer over bedrock and lithic soils.

Irregular topography and slopes >30% limit use. Removal of vegetation may increase erosion on steep slopes. Revegetation following disturbance may be slow. Locally, use may be limited by solifluction, shallow soils, and seepage.

Large populations of Columbian ground squirrels in JN form an important prey for both breeding and migrating raptors in GNP and disturbance should be minimized.

Table 72. Wildlife features of JN Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
JN2	medium	caribou (s)	low		medium	Columbian gr. squirrel	medium

KX - KUSKANAX ECOSECTION

The Kuskanax (KX) Ecosection concept incorporates Interior Cedar-Hemlock forest vegetation occurring on terraced landforms composed of Glaciofluvial material A (noncalcareous, coarse textured). Dystric Brunisols and Humo-Ferric Podzols are the characteristic soils. Only KX1 (Table 73) was recognized and only three tracts were mapped. All three are on the floors of major valleys: along the Beaver River upstream of the Beaver Pit and at the mouth of Flat Creek in GNP, and along the Trans-Canada Highway near the West Gate in MRNP. Fig. 14 shows topographic relationships among KX1 and some other landscapes.

Table 73. Definitive features of the Kuskanax (KX) Ecosection.

Ecosite	Bedrock	Landform	Soils	Vegetation
KX1	Various	Glaciofluvial material B; terraced	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)

GEOMORPHOLOGY

KX1 is geomorphically characterized by proglacial, terraced landforms composed of glaciofluvial material A (noncalcareous, coarse textured). A thin, discontinuous, surficial veneer of Eolian material B (altered, medium textured) is occasionally present, particularly on the oldest and highest terrace levels. The terraces are well developed with steep, prominent (5 to 50 m relief) risers adjacent to contemporary floodplains and between terrace levels. Slopes are 0 to 15% but terrace treads, usually with slopes <5%, make up the majority of any tract. Abandoned channels (Eroded modifier, C.S.S.C. 1978a) are not common and are poorly incised.

SOILS

Well drained Eluviated Dystric Brunisols and Orthic Humo-Ferric Podzols characterize the soils of KX1. Soils, even though classed in different taxa, are similar and have characteristics grouped around taxonomic boundaries. B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Well developed, thick (>2 cm) Ae horizons are usually present and are thickest and best developed in the absence of Eolian material B veneers.

The sampled Eluviated Dystric Brunisol (Table D24, Plate 42), from KX1 adjacent to Beaver Pit, exemplifies weakly developed KX1 soils. It illustrates a common taxonomic problem in similar soils of the Canadian Cordillera. The organic carbon and pyrophosphate-extractable Fe values of the upper B horizon meet the chemical criteria of a Bh horizon (C.S.S.C. 1978a). However, the color value and chroma are too high for Bh and the horizon was labelled Bm.

VEGETATION

KX1 is characterized by western hemlock-western red cedar forest with western hemlock-western red cedar/western yew/oak fern (C50) and western hemlock-western red cedar-(Douglas fir)/mountain lover (C52) (Plate 43) the predominant v.t.s. Mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49) occurs as an accessory v.t. on the two higher elevation tracts in GNP.

Table 74. Wildlife features of KX Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
KX1	high	w.t. deer	high		high	red squirrel red-b. vole	low

WILDLIFE

KX1 Wildlife Features

Ungulates: KX1 is of high importance to ungulates, and is highly important to white-tailed deer. All ungulates occurring in the parks, except mountain goats, have been recorded in KX1. Moose in the Beaver Valley appear to use KX1 only as an easy travel corridor, whereas elk and deer appear to use it for feeding in early summer. In MRNP, it is highly important winter habitat for mule deer and elk, when they remain in the park. The tract at Flat Creek was historically used by caribou in autumn.

Carnivores: KX1 is of medium importance to martens, weasels and lynx, and of low importance to coyotes.

Small Mammals: Association 10.

KX1 is highly important to red squirrels and red-backed voles.

Breeding Birds: Community 24

A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Vaux's Swift. A breeding bird census plot is situated in a KX1 tract in the Beaver River valley (see sec. 3.3, Van Tighem and Gyug [1984]).

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The KX Ecosection (0.2%) correlates with the Kuskanax (KX) Soil Association (Kowall 1980, Wittneben 1980) of British Columbia soil surveys in and around MRNP and GNP. The soil component of the Ecosection concept, by including both Humo-Ferric Podzols and Dystric Brunisols, is broader than Humo-Ferric Podzols of the Soil Association as used by Kowall or Wittneben.

Level topography and valley floor positions are conducive to many uses. Gravelly coarse textures provide extensive aggregate supplies but are poor for sewage disposal due to poor ion filtration.

KX is highly important to ungulates. Because it occurs in valley bottoms and at only three sites in MRNP and GNP, it is sensitive to disturbance. Vegetation removal may reduce its value to ungulates, particularly in winter. Each of the three tracts has already been partially disturbed and their use should be reviewed.

LK - LOOKOUT ECOSECTION

The Lookout (LK) Ecosection concept incorporates: Lower Subalpine vegetation of the Engelmann Spruce-Subalpine Fir Ecoregion; morainal blankets and veneers of noncalcareous, medium textured till (Till B) overlying inclined and ridged bedrock; and imperfectly to poorly drained Orthic Gleysols, Gleyed Dystric Brunisols, and Gleyed Ferro-Humic Podzols. Only one Ecosite (LK1) is recognized (Table 75). The salient feature of LK1 is wetness from seepage and high water tables. Landscape positions include valley floors and adjacent lower slopes in valleys and cirques (Fig. 10).

Table 75. Definitive features of the Lookout (LK) Ecosection.

Ecosite	Bedrock	Landform	Soils	Vegetation
LK1	Various	Till B; blanket & veneer over inclined & ridged bedrock	Orthic Gleysol, Gleyed Dystric Brunisol, Gleyed Ferro-Humic Podzol	Engelmann spruce-subalpine fir forest (C21, C25), mountain hemlock forest (C47)

GEOMORPHOLOGY

LK1 is characterized by morainal blankets and veneers of Till B (noncalcareous, medium textured) overlying inclined and ridged bedrock. Thin, discontinuous veneers of Fluvial material A (non- to weakly calcareous, stratified) often overlie the till. They are a product of slope wash from adjacent slopes. Intact veneers of Eolian material B (altered, medium textured) occur occasionally. Eolian material has often been reworked by slope wash and is likely a significant constituent of the fluvial veneers.

Topographically, LK1 has linear, inclined slopes on lower valley walls and irregular, ridged slopes on valley and cirque floors. Slopes are 15 to 45%. Inclined slopes generally reflect the underlying bedrock. Ridged surfaces reflect underlying bedrock or glacial deposition.

SOILS

Soils of LK1 reflect different degrees of gleying and periods of saturation. The Orthic Gleysol, Gleyed Dystric Brunisol, and Gleyed Ferro-Humic Podzol subgroups with imperfect to poor drainage are typical. Gleying is variable in these soils but B horizons indicate that upper sola are periodically oxidized. B horizons range from Bg, Bm, and thin Bf, Bhf, and Bh (Gleysolic and Brunisolic) to $\geq$10 cm of podzolic Bf, Bhf, and Bh (Podzolic). The latter iron, aluminum, and humus enriched horizons usually develop in a silty veneer over glacial materials. Gleyed Ferro-Humic Podzols are characteristic, while Humo-Ferric and Humic Podzols are accessory soils. Gleyed Sombric Brunisols and Gleyed Eluviated Dystric Brunisols occur occasionally. A few Organic soils occur in Glacier Circle (GNP).

A Gleyed Humo-Ferric Podzol pedon (Table D25, Plate 44) from Glacier Circle illustrates soils of LK1. The organic carbon content varies irregularly with depth because episodic deposition has buried surface organic matter.

VEGETATION

LK1 vegetation (Table 75) is characterized by spruce-fir and hemlock forests, mainly the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) (Plate 45), Engelmann spruce-subalpine fir/green alder (C25), and mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) v.t.s. Fleabane-valerian (H16) is an accessory v.t. at elevations close to the Upper Subalpine boundary.

WILDLIFE

LK1 Wildlife Features

Ungulates: LK1 is of low importance to ungulates overall except where the forests have been burned, as at Copperstain Creek where the regenerating vegetation is of low importance to elk and mule deer in summer.

Carnivores: LK1 is highly important to martens and weasels.

Small Mammals: Association 3 and 11A.

LK1 is of medium importance to small mammals overall. The forests are of medium importance to porcupines, snowshoe hares and red-backed voles (SMA 3). Where the

Table 76. Wildlife features of LK Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
LK1	low		high	marten weasel	medium		medium

forests have been burned and are regenerating as at Copperstain Creek, SMA 3 is replaced by SMA 11A; these tracts are also important to Columbian ground squirrels.

Breeding Birds: Communities 23 and 8

A moderate density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Mountain Chickadee and Winter Wren. The only park record of a Gray-cheeked Thrush was from this Ecosite (see sec. 4.3, Van Tighem and Gyug [1984]).

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The LK1 Ecosite accounts for 0.4% of MRNP and GNP. LK1 is the counterpart of the Upper Subalpine Witch Tower (WR) Ecosection.

Imperfect to poor drainage due to ground water discharge severely limits most uses. Locally, LK may play a role in regulating streamflow. Construction may change hydrologic patterns.

LR - LAURETTA ECOSECTION

The Lauretta (LR) Ecosection concept incorporates: Interior Cedar-Hemlock forest and shrub thicket vegetation; fan, level, and apron landforms of non- to weakly calcareous fluvial material; and well to moderately well drained Brunisolic, Podzolic, and Regosolic soils. The two LR Ecosites (Table 77) differ in vegetation and soils. LR1 and LR2 occur on valley floors of most major and tributary valleys (Figs. 8, 11 and 14).

Table 77. Definitive features of Lauretta (LR) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
LR1	Various	Fluvial material A; fan, apron, level	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest > mountain hemlock forest (C51 > C50, C47)
LR2	Various	Fluvial material A; fan, apron	Orthic Dystric & Sombric Brunisols, Orthic Humo-Ferric Podzol, Cumulic Humic Regosol	moist shrub thicket (S13)

GEOMORPHOLOGY

Fluvial material A (non- to weakly calcareous, stratified) is the main constituent of LR landforms. Glaciofluvial material A (noncalcareous, coarse textured) is an accessory genetic material of LR2 and occurs as an inclusion in LR1. Slope continuity on both Ecosites is often subtly broken by stream channels (Eroded modifier, C.S.S.C. 1978a). LR2 is modified by frequent snow avalanche activity (A). Avalanche material is distributed downslope to gentler runout zones on LR2. Layers in fans and aprons are a poorly sorted, till-like diamicton, usually indicative of mudflows, which are also important in fan and apron construction.

Landform surfaces range from fans and aprons with straight to concave slopes, to level or subtly terraced terrain bordering streams. Most slopes are 0 to 30%, but complex slopes occur where tracts contain both level and fan or apron fluvial landforms.

SOILS

LR is characterized by well to moderately well drained soils and accessory imperfectly drained soils. Eluviated Dystric Brunisols and Orthic Humo-Ferric Podzols are typical of LR1. These soils are genetically related but are separated taxonomically. B horizon development is moderate to strong and ranges from Bm and thin Bf (Brunisolic soils) to ≥10 cm of podzolic Bf (Podzolic soils). Well developed (>2 cm) Ae horizons are usually present. Orthic Eutric Brunisols and Gleyed Dystric Brunisols are accessory soils of LR1. Orthic Eutric Brunisols occur where calcium carbonate content results in lower sola pH's >5.5. Gleyed Dystric Brunisols occur where water tables are high along the lower margins of fans and aprons and on floodplains.

Orthic Dystric Brunisols, Orthic Sombric Brunisols, Orthic Humo-Ferric Podzols, and Cumulic Humic Regosols characterize LR2. The upper sola reflect both humus incorporation and modification by fluvial accretion. Physical accretion thickens surface Ah horizons of Orthic Sombric Brunisols and Cumulic Humic Regosols. Orthic Dystric Brunisols occur where Ae horizon development is masked by humus incorporation or inhibited by surface disturbance. B horizon development is moderate to strong and ranges from Bm to thin Bf (Brunisolic soils) to ≥10 cm of podzolic Bf (Podzolic soils). Accessory Cumulic Regosols occur where erosion or deposition is frequent and intense. Orthic Ferro-Humic Podzols (≥10 cm Bhf) and imperfectly drained Gleyed Dystric Brunisols are also accessory soils on LR2.

The sampled Eluviated Dystric Brunisol pedon (Table D26), from LR1 on the Mountain Creek Campground fan, exemplifies weakly developed LR soils. The pedon illustrates a common taxonomic problem in soils of the Canadian Cordillera. The organic carbon and pyrophosphate-extractable Fe values of the upper B horizon are low but meet the chemical criteria of Bh horizon (C.S.S.C. 1978a). Because the color value and chroma are too high for Bh, the horizon was labelled Bm.

VEGETATION

LR1 is dominated by the western red cedar-western hemlock/devil's club/oak fern (C51), western hemlock-western red cedar/western yew/oak fern (C50), and mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) (Plate 46) v.t.s. C51 occurs more often than C50 or C47. Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) is an accessory v.t. on LR1.

LR2 vegetation is indicative of frequent snow avalanching and is dominated by the green alder/fern (S13) v.t. S13 variants also occur, including stands that resemble the willow (S15) v.t. because of abundant willow (*Salix* spp.) and grassy stands with abnormally low alder (*Alnus* spp.) cover. These variants can be extensive, as on LR2 opposite the new west tunnel portal on the Illecillewaet River. Avalanche vegetation also occupies 20 to 50% of LR1A.

WILDLIFE

LR1 Wildlife Features

Ungulates: LR1 is of very high importance to ungulates overall. It is of high importance to mule deer, white-tailed deer and moose in summer and to caribou, moose and elk in winter.

Carnivores: LR1 is very highly important to carnivores overall and to weasels, in particular. Carnivore diversity is high.

Small Mammals: Associations 10 and 11B.

LR1 is highly important to masked shrews in dry C51 forests and Richardson's water voles in wet C51 forests. It is of medium importance to snowshoe hares, beavers and red squirrels. The *Lauretta* small mammal live-trap plot was in an LR1 tract (see sec. 3.11, Van Tighem and Gyug [1984]).

Table 78. Wildlife features of LR Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
LR1	very high	caribou (w) moose elk (w) mule deer w.t. deer	very high	weasel	high	masked- shrew water vole deer mouse	high
LR2	medium		high	weasel	high		high

Breeding Birds: Communities 22 and 24
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Blackpoll Warbler, Evening Grosbeak, Hammond's Flycatcher and Veery. Beaver ponds in LR1 are important breeding and staging habitats for park waterfowl. LR1 is highly important to Barred Owl, Northern Pygmy-Owl, Red-tailed Hawk, American Kestrel and other raptors.

LR2 Wildlife Features

Ungulates: LR2 is of medium importance overall. It is of medium importance to moose and caribou in winter.
Carnivores: LR2 is highly important to carnivores overall and to weasels in particular.
Small Mammals: Associations 11A and 11B.
SMA 11A occurs in alder-covered snow avalanche paths and SMA 11B in wet, open forests. LR2 is of medium importance to beavers and porcupines. Where colluvial rubble has collected in narrow valley bottoms (*e.g.* along Asulkan Brook) it is highly important to hoary marmots.
Breeding Birds: Communities 12 and 22
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Dark-eyed Junco, MacGillivray's Warbler, Swainson's Thrush and Varied Thrush. LR2 is important in winter for White-tailed Ptarmigan and wintering Redpolls.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The LR Ecosection accounts for 3.1% of MRNP and GNP. LR1 occupies 2.5% and LR2 0.6%. LR is the Interior Cedar-Hemlock counterpart of the Lower Subalpine Catamount (CM) Ecosection.

Use may be limited where slopes are >30%. LR2 is frequently avalanched and some tracts are locally aggrading. Locally occurring coarse textures and high water tables may present problems for sewage disposal. The gravelly coarse textured material is suitable aggregate for construction except where stony. Most tracts have streams that are suitable domestic water supplies. Exceptional floods and mudflows may occur, although soil development on LR1 indicates stability.

LR is highly important to ungulates and because it occurs in valley bottoms is highly prone to disturbance. Undisturbed forest may be critical to wintering moose and other ungulates. Barred Owl, Northern Pygmy-Owl and Pileated Woodpecker depend on LR1 and breed in large dead trees. Removal of dead trees would be detrimental.

NC - NORDIC ECOSECTION

The Nordic (NC) Ecosection concept incorporates colluvial landforms comprised of noncalcareous colluvium and dominated by Interior Cedar-Hemlock vegetation. Dystric Brunisols and Humo-Ferric Podzols are the characteristic soils. Six NC Ecosites (Table 79) were differentiated. NC1, NC2, NC3, and NC4 have the same hemlock-cedar vegetation but are differentiated on the basis of bedrock groups with concomitant soil differences. In contrast, NC5 is dominated by vegetation indicative of frequent snow avalanching and NC6 is characterized by open mixedwood. All occur on valley walls although NC5 often extends across valley floors. Figs. 11 and 14 shows topographic relationships among several NC Ecosites and a few others.

Table 79. Definitive features of Nordic (NC) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
NC1	Horsethief Ck. Group	Colluvium B; blanket & veneer over inclined bedrock	Eluviated & Orthic Dystric Brunisols	western hemlock-western red cedar forest (C50, C52)
NC2	Hamill Group	Colluvium B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)
NC3	Lardeau Group	Colluvium B; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)
NC4	Shuswap Metam. Complex	Colluvium B & A; blanket & veneer over inclined bedrock	Eluviated Dystric Brunisol, Orthic Humo-Ferric Podzol	western hemlock-western red cedar forest (C50, C52)
NC5	Various	Colluvium B & A; blanket & veneer over inclined bedrock, apron; avalanched	Orthic & Eluviated Dystric Brunisols, Orthic Sombric Brunisol, Orthic Humo-Ferric Podzol	Avalanche complex 6 > western hemlock-western red cedar forest (C50, C52)
NC6	Shuswap Metam. Complex	Colluvium B & A; veneer & blanket over inclined bedrock	Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	mixed open forest (O15)

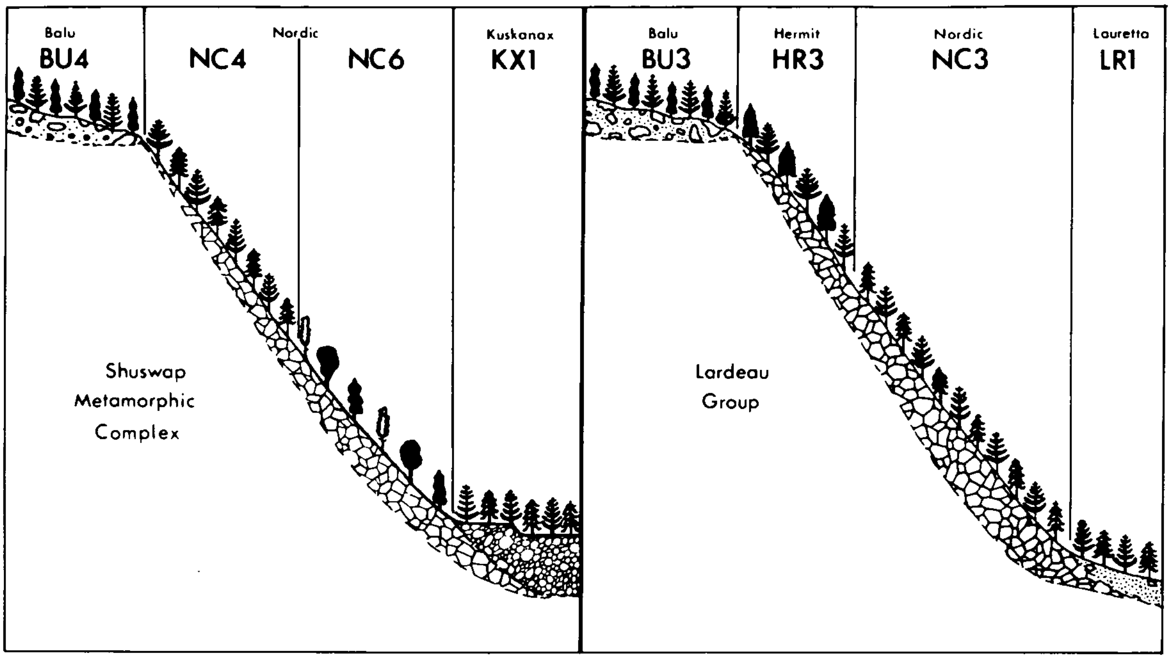
GEOMORPHOLOGY

NC is geomorphically characterized by colluvial landforms comprised of Colluvium B (non- to weakly calcareous, medium textured) and Colluvium A (noncalcareous, coarse textured). Colluvium B is predominant and characterizes NC1 and NC3 which occur on Horsethief Creek and Lardeau Group bedrock types (Fig. 2), respectively. Colluvium A is codominant in areas underlain by Hamill Group (NC2) and Shuswap Metamorphic Complex (NC4) bedrock types. NC5, mapped on all bedrock types, contains mostly Colluvium B or an unpredictable combination of Colluvial materials A and B. NC6 occurs principally on Shuswap Metamorphic Complex bedrock and is thus most extensive in MRNP. Two NC6 tracts occur in western GNP, one on Lardeau Group and the other on Hamill Group bedrock.

Limestone occurs locally in most areas, thus calcareous, medium textured colluvium (*cf.* Colluvium C, Walker *et al.* 1982a) is a minor landform constituent in a few NC tracts. Consolidated bedrock usually underlies the colluvium but, at a few sites, weathering of the bedrock surface has been sufficient to produce veneers of Residuum A (noncalcareous, medium to coarse textured). These are more likely to occur in recessive, highly jointed, slaty to schistose strata. Discrete veneers of Eolian material B (altered, medium textured) thinly mantling the colluvial surface are uncommon in NC. Intact eolian veneers occur only on the oldest, most stable sites under forest vegetation.

The colluvium most often occurs as nearly continuous blankets and veneers over steeply inclined bedrock on valley walls. The Ecosite Modifier X, meaning lithic phases are dominant, occurs in any NC Ecosite (*e.g.* NC6X above the MRNP east gate) and indicates that colluvial veneer is the dominant landform. Some such tracts have discontinuous, colluvial veneer plus exposed bedrock. The deepest deposits are colluvial aprons which occur occasionally in NC5 and have been constructed by snow

Fig. 14. Landscape schematic of topographic relationships among NC and other Ecosites.



avalanching and rockfall below steep slopes. Couloirs channel meltwater streams and mudflows onto the aprons. Thus, the apron landforms are often a mixture of intercalated colluvial, fluvial and mudflow deposits.

NC slopes are usually long, straight (simple) and 55 to >100%, with occasional slopes as low as 45% A few tracts with the modifier F (*e.g.* NC4F above the MRNP east gate) have a subdued, hummocky to ridged, bench-like topography on an inclined slope. This subtly irregular topography is produced by bedrock failure. Tension cracks and short slip scars may be evident, particularly where the overburden is shallow.

Snow avalanching (A) is the most common Ecosite modifier in NC and characterizes (>50%) NC5. However, <20% of any other NC tract may have avalanche paths. Forested tracts with more extensive avalanching, (20-50%) were mapped with the modifier A (*e.g.* NC2A).

Current landform construction is very slow and has virtually ceased under forest vegetation (NC1, NC2, NC3, and NC4), except on NC6 and more recently burned areas (*e.g.* NC4B in Coursier Creek valley) where surface modification such as soil creep, slope wash, and fluvial or mudflow erosion has rejuvenated the geomorphic process. Other low intensity processes operating on forested terrain include uprooting of trees and solifluction, although disturbed (turbic phase) soils are not common. In contrast, colluvial activity on avalanched (NC5) landscapes is more diverse. Related to snow avalanching are rockfall, fluvial and mudflow processes, slope wash, and soil creep. Virtually all NC5 tracts are extensively vegetated and usually are <20% unvegetated, due to intense erosion and deposition which preclude vegetation development. One exception, a small NC5F tract in Loop Brook valley, is about 70% unvegetated to sparsely vegetated colluvial rubble and talus. Vegetated portions of NC5 are relatively stable, as indicated by well developed soils, even though low intensity surficial processes may still be operating. A few vegetated localities have only recently stabilized as indicated by the lack of pedogenic horizonation within the soils.

SOILS

Well to rapidly drained Dystric Brunisols and Humo-Ferric Podzols characterize the soil component of NC. The soils, even though classed in different taxa (Table 79), are similar and have characteristics grouped around taxonomic boundaries. B horizon development is moderate to strong and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils), even under avalanche vegetation. Three sampled pedons, a lithic Orthic Dystric Brunisol (Table D27) from NC1 near the East Gate of GNP, an Eluviated Dystric Brunisol (Table D28) from NC2A on the south slope of Cougar Mountain, and an Orthic Dystric Brunisol (Table D30, Plate 47) from NC6 southwest of Lauretta picnic site, illustrate the range of Dystric Brunisols in NC. All three pedons have brownish B horizons as do many Podzolic soils, *e.g.* a Sombric Humo-Ferric Podzol (Table D29) above Illecillewaet campsite. When classifying such similarly colored soils on field characteristics alone, it is often difficult to distinguish Brunisols from Podzols. NC also contains soils with distinctly redder B horizons than those of the sampled pedons.

Sombric Humo-Ferric Podzols (Table D29) are among accessory soils of NC5. Chemical characteristics place the pedon very near the taxonomic boundary with Orthic Sombric Brunisols, which are more common under avalanche vegetation. Another accessory soil of NC5, Orthic Ferro-Humic Podzol, is also difficult to distinguish without laboratory data. This latter group has podzolic Bhf horizons and likely occurs occasionally in other NC Ecosites. In NC5, development of these two Podzolic groups is probably related to mechanical incorporation of humus into surface horizons. Under such conditions, Sombric Ferro-Humic Podzols, with podzolic Bhf and thick Ah horizons, may also occur. The NC6 pedon (Table D30) illustrates a common taxonomic problem in similar Brunisolic-Podzolic soils of the Canadian Cordillera. Organic carbon and pyrophosphate-extractable Fe values of the upper B horizon meet the chemical criteria of Bh horizon (C.S.S.C. 1978a). However, the color value and chroma are too high for the morphological criteria. Thus, the horizon was labelled Bm and the pedon, Orthic Dystric Brunisol.

The four sampled pedons illustrate nearly the complete range of A horizons in NC soils, whether Brunisolic or Podzolic. However, the acidic Brunisolic soils are classified according to kind and thickness of A horizon. Eluviated Dystric Brunisols have >2 cm of Ae horizon and are dominant or codominant in all NC Ecosites. Most forested soils have well developed Ae horizons. Orthic Dystric Brunisols and some Podzolics, can have little or no A horizon, A mixed with B (AB or A+B horizons), or thin (<10 cm) Ah horizon at the mineral surface. Any of these conditions implies low intensity, surficial geomorphic activity, sometimes in conjunction with high humus input. Orthic Dystric Brunisols are codominant in NC5 and NC6, accessory soils in NC3 and NC4. Soils with Ah most often develop in the humus-rich environments associated with avalanche vegetation. The third group, Orthic Sombric Brunisols, has Ah horizons >10 cm thick and is codominant in NC5.

In strong contrast to the comparatively stable Brunisolic and Podzolic soils, Regosolic soils occur at sites that are or have recently been intensely active geomorphically so that B horizon development has been inhibited. They are most abundant in snow avalanche terrain (accessory soils of NC5) although they likely occur in minor amounts in other NC Ecosites. Cumulic and Cumulic Humic Regosols are most common and occur in depositional localities. The variable organic matter content and color is related to mechanical incorporation of humus into surface horizons. The morphologically more uniform Orthic Regosols occur sporadically, particularly in erosional sites on NC5. The variety of Brunisolic, Podzolic, and Regosolic soils on NC5 demonstrates the diverse and complex interactions of geomorphic activity and pedogenic weathering on avalanched terrain, among the most complex landscapes in MRNP and GNP.

Lithic phases occur often as accessory soils in any NC Ecosite, but are dominant on tracts with the Ecosite Modifier X (*e.g.* NC6X). Nonsoil localities, occurring as exposed bedrock or where there is <10 cm of overburden, occur sporadically in all Ecosites except NC6, where they are common accessory features of low areal extent. Some X tracts have an abnormally high proportion of nonsoil, mostly exposed bedrock.

VEGETATION

NC1, NC2, NC3, and NC4 have similar hemlock-cedar forest (Table 79), mainly the western hemlock-western red cedar/western yew/oak fern (C50) and western hemlock-western red cedar-(Douglas fir)/mountain lover (C52) v.t.s. C52 occurs on drier localities than C50 and is most abundant on NC1 in the Purcells and on southerly aspects. The closely related western red cedar-western hemlock/devil's club/oak fern (C51) v.t. occurs sporadically in small amounts on all four Ecosites but is associated with moist, often seepy, sites such as at major slope breaks immediately above valley floors. Douglas fir-western red cedar/mountain lover (C53) is an accessory v.t. of NC4 and occurs on dry, southerly aspects. Mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry (C49) occurs sporadically in all four Ecosites, generally near the Interior Cedar-Hemlock-Lower Subalpine boundary.

NC6 is characterized by open mixedwood, mainly aspen-western white pine/mountain lover (O15) (Plate 48), a seral v.t. that occurs on steep, sometimes rocky, colluvial slopes that were burned about 60 years ago. The tree layer is predominantly open, although a closed variant is common in some localities. A variant of C53, with minor amounts of paper birch (*Betula papyrifera*) and aspen (*Populus tremuloides*), occurs occasionally and is extensive in a few places. NC6 occurs predominantly on southerly aspects and is rapidly to well drained.

The geomorphic-soil diversity of avalanched terrain also applies to vegetation. Avalanched segments dominate NC5 and are characterized by a heterogeneous complex of v.t.s; Avalanche complex 6, that includes green alder/fern (S13) (Plate 49), sedge (H21), and variants plus other unidentified assemblages. S13 is most extensive. S13 variants, in which mountain maple (*Acer glabrum*) or western red cedar (*Thuja plicata*) are abundant in the tall shrub layer, occur occasionally. H21 occurs as small patches, usually in avalanche runout zones on colluvial aprons. Forested localities, virtually unaffected by avalanching, usually constitute significantly <50% of any NC5 tract. They fringe avalanche runout zones and form strips between avalanche paths. The most common forest v.t.s are C50 and C52. Unvegetated localities, associated with exposed bedrock and geomorphically intensely active sites, occasionally constitute ≤20% of NC5 tracts, and in one case nearly 70% of NC5F in Loop Brook valley.

The avalanche v.t.s also occur in minor amounts on NC1, NC2, NC3, and NC4 but occupy 20 to 50% of tracts with the modifier **A** (*e.g.* NC2A on the south slope of Cougar Mountain). Several tracts have the modifier **B** (*e.g.* NC4B in Coursier Creek valley) and are dominated by vegetation at an early stage of post-fire succession.

WILDLIFE

NC1 Wildlife Features

Ungulates: The mixed forests of NC1 on the east slope of the Beaver Valley are of medium importance overall and are of high importance to elk in winter. One lithic tract on the east slope of the Beaver Valley opposite Mountain Creek sustains a small population of mountain goats in winter.

Carnivores: NC1 is of medium importance.

Small Mammals: Association 10.
NC1 is of high importance to deer mice and red-backed voles and medium importance to red squirrels and snowshoe hares.

Breeding Birds: Communities 24 and 25
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Pileated Woodpecker, Red Crossbill and Western Tanager. NC1 is also important to Northern Pygmy-Owl. In the Beaver Valley, Red-tailed Hawks that hunt in the GF Ecosection and along the highway appear to nest in this Ecosite.

NC2 Wildlife Features

Ungulates: NC2 is of low importance overall but tracts with steep, broken rock outcrops (NC2X) are of medium importance to mountain goats.

Carnivores: NC2 is of medium importance, particularly to weasels and lynx.

Small Mammals: Association 10.
NC2 forests are of high importance to deer mice and red-backed voles and of medium importance to red squirrels and snowshoe hares. It is of medium importance overall to hoary marmots but tracts with colluvial rubble are highly important.

Breeding Birds:
NC2 was not sampled for breeding birds. Based on its similar vegetation and physical features, bird use is likely very similar to that of NC1 and NC4.

Table 80. Wildlife features of NC Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
NC1	medium	elk (w)	medium		medium	deer mouse red-b. vole	high
NC2	low		medium		medium	deer mouse red-b. vole	high
NC3	low		medium		high	deer mouse red-b. vole	high
NC4	low		low		low	deer mouse red-b. vole	high
NC5	high	goat (w)	low		high	pika marmot deer mouse jumping-mouse water vole chipmunk masked- shrew	high
NC6	medium	goat (w)	low		medium	deer mouse long-t. vole	very high

NC3 Wildlife Features

Ungulates: NC3 is of low importance overall and is of low importance to mountain goats in winter.
Carnivores: NC3 is of medium importance.
Small Mammals: Association 1.
NC3 is of high importance to deer mice and red-backed voles, and of medium importance to snowshoe hares.
Breeding Birds:
NC3 was not sampled for breeding birds. Based on its similar vegetation and physical characteristics, bird use is likely very similar to that of NC1 and NC4.

NC4 Wildlife Features

Ungulates: NC4 is of low importance both overall and to mountain goats in winter.
Carnivores: NC4 is of low importance.
Small Mammals: Association 10.
NC4 is highly important to deer mice and red-backed voles but of low importance to small mammals overall.
Breeding Birds: Community 24
A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Warbling Vireo. Burned tracts support BBC 21.

NC5 Wildlife Features

Ungulates: This avalanched Ecosite is of very high importance to mountain goats in winter and of medium importance to mountain goats in summer.
Carnivores: NC5 is of low importance in winter because of frequent avalanching and deep snow cover. Data are not available for the summer but it is probably important because of the diverse and dense prey base.
Small Mammals: Association 11A.
NC5 is highly important, particularly to pikas on talus or scree slopes, hoary marmots in

boulder fields, deer mice, western jumping mice, yellow-pine chipmunks and masked shrews in avalanche vegetation, and Richardson's water voles along streams and in wet areas.

Breeding Birds: Communities 12 and 25

A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Brown-headed Cowbird, Lazuli Bunting, Orange-crowned Warbler and Swainson's Thrush. Avalanched tracts support BBC 12. Burned tracts support BBC 21.

NC6 Wildlife Features

NC6 is important to reptiles in MRNP, particularly northern alligator lizards and wandering garter snakes.

Ungulates: NC6 is of low overall importance but is highly important to goats in winter on the Clachnacudainn Cliffs and lower reaches of Cougar Mountain. It is of medium importance to mule deer in summer, particularly along the Clachnacudainn Cliffs.

Carnivores: No winter tracking samples were done here. It is likely of low importance overall. Coyotes apparently denned here in 1982 and 1983.

Small Mammals: Association 14.

SMA14 is unique to NC6 and, while of low importance to small mammals overall, NC6 is highly important to deer mice and long-tailed voles.

Breeding Birds: Community 26

A high density of birds was recorded. NC6 is very highly important because it sustains a unique bird community of several species rare elsewhere in the parks. Based on density indices derived from circular census plots, this Ecosite is highly important to Black-capped Chickadee, Calliope Hummingbird, Dusky Flycatcher, Hammond's Flycatcher, Nashville Warbler, Orange-crowned Warbler, Solitary Vireo, and Warbling Vireo. Lewis' Woodpecker has been observed here.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

NC is a moderately extensive Ecosection, accounting for 6.0% of MRNP and GNP. NC1 accounts for 0.9%, NC2 0.9%, NC3 0.7%, NC4 1.1%, NC5 2.1%, and NC6 0.5%. NC is the Interior Cedar--Hemlock counterpart of the Lower Subalpine Hermit (HR), Upper Subalpine Asulkan (AK), and Alpine Redoubt (RD) Ecosections. Few other Interior Cedar-Hemlock landscapes resemble NC, the main exception being resemblance between Lauretta 2 (LR2) and some NC5 tracts. LR2, however, occurs on gentler sloping fluvial fans and aprons on and adjacent to valley floors, often below the colluvial NC tracts.

Steepness and colluviation are major limitations. The Ecosites from most to least active are: NC5 (avalanched), NC6 (craggy and recently burned), and the others (forested). Removal of vegetation may increase erosion. Locally, coarse textures, stony surfaces and shallow soils limit use.

NC contains critical grizzly bear habitat. Recreational developments in or near NC will lead to bear/human conflicts. NC6 has a unique v.t. (O15), BBC (26) and SMA (14) and is one of only two sites where northern alligator lizards occur in MRNP and GNP.

RD - REDOUBT ECOSECTION

The Redoubt (RD) Ecosection concept incorporates colluvial landforms composed of noncalcareous colluvium and dominated by Alpine vegetation. Dystric Brunisols and Humo-Ferric Podzols are characteristic. Four RD Ecosites (Table 81) were differentiated according to bedrock groups, occasionally with minor soil differences. All occur high on valley walls and a few tracts straddle mountain ridges and peaks. Fig. 9 shows topographic relationships among several RD and Asulkan (AK) Ecosites.

Table 81. Definitive features of Redoubt (RD) Ecosites.

Ecosite	Bedrock	Landform	Soils	Vegetation
RD3	Horsethief Ck. Group	Colluvium B; veneer over inclined bedrock	Orthic Dystric Brunisol > Orthic Humo-Ferric Podzol	heath tundra (L5), herb tundra (H18)
RD4	Hamill Group	Colluvium B & A; veneer over inclined bedrock	Lithic phases: Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	heath tundra (L5), herb tundra (H18)
RD5	Lardeau Group	Colluvium B; veneer over inclined bedrock	Orthic Dystric Brunisol, Orthic Regosol	heath tundra (L5), herb meadow (H2), herb tundra (H18)
RD6	Shuswap Metam. Complex	Colluvium B & A; veneer over inclined bedrock	Lithic phases: Orthic Dystric Brunisol, Orthic Humo-Ferric Podzol	heath tundra (L5), herb tundra (H18)

GEOMORPHOLOGY

RD is geomorphically characterized by colluvial landforms comprised of Colluvium B (non- to weakly calcareous, medium textured) and Colluvium A (noncalcareous, coarse textured). Colluvium B is predominant and characterizes RD3 and RD5 on Horsethief Creek and Lardeau Group bedrock (Fig. 2). Colluvium A is codominant in areas underlain by Hamill Group (RD4) and Shuswap Metamorphic Complex (RD6) bedrock. The former includes an area of granitic intrusive bedrock. Limestone occurs locally in most bedrock areas, thus calcareous, medium textured colluvium (*cf.* Colluvium C, Walker *et al.* 1982a) is a minor landform constituent in a few RD tracts. Consolidated bedrock usually shallowly underlies the colluvium but, at a few sites, sufficent weathering of the bedrock surface has produced veneers of Residuum A (noncalcareous, medium to coarse textured). Residual veneer most often develops in recessive, highly jointed, slaty to schistose strata and is an accessory feature of RD3 and RD5. Thin, discrete veneers of Eolian material B (altered, medium textured) are uncommon in all RD Ecosites except RD3 were they are an accessory feature.

The colluvium most often occurs as a nearly continuous veneer over steeply inclined bedrock on valley walls. Discontinuous colluvial veneer plus exposed bedrock characterizes about 50% of RD4 and RD6 tracts, including the few tracts of RD5X and RD5+R. Deeper colluvial blankets occur as accessory features in all RD Ecosites. The deepest deposits are colluvial aprons, which occur sporadically as small, localized landforms at slope breaks below couloirs.

RD slopes are usually long, straight, and 55 to >100%, and occasionally as low as 45%. RD4 and RD6 are consistently the steepest (rarely <60%), particularly on rocky tracts which often have cliffs and sloping benches cut into resistant bedrock. RD3 and RD5 are characterized by the smoother, more subdued topography associated with recessive bedrock. A few RD tracts with complex slopes straddle ridge and mountain tops.

RD commonly occurs in avalanche starting zones but the effects of snow avalanching on soils and vegetation is generally negligible. However, the effects of fluvial and mudflow processes, causing erosion in couloirs and deposition below them, vary across the landscape. Rockfall and soil creep also are locally active. Solifluction, which produces disrupted and mixed upper soil horizons in turbic phases, is common, particularly in medium textured, slaty to schistose materials. Turbic soils occur in all RD Ecosites but are most extensive in RD3 and RD5. Due to variation in colluvial activity, RD tracts can be <50% unvegetated. A few tracts are complexes of an RD Ecosite plus **CR** (Colluvial Rubble), **T** (Talus), or **R** (Rockland) (*e.g.* RD4+CR) where they are 50 to 80% unvegetated.

SOILS

Well drained Dystric Brunisols and Humo-Ferric Podzols characterize the soils of RD, although Regosolics are also abundant in RD5. The soils, even though classed as different taxa (Table 81), are similar and have characteristics grouped around taxonomic boundaries. B horizon development is moderate to strong, except in RD5, and ranges from Bm and Bf (Brunisolic soils) to podzolic Bf (Podzolic soils). Three sampled pedons, illustrate the range of soils in RD. An Orthic Dystric Brunisol (Table D31, Plate 50), from RD3 in the Prairie Hills, has thick, moderately developed Bm horizons overlain by thin Bhf horizons developed in Eolian material B veneer. This pedon is virtually undisturbed compared to the turbic pedons surrounding the sample site. A lithic and turbic phase Orthic Humo-Ferric Podzol (Table D32, Plate 51), from RD4 on Cheops Mountain, illustrates strongly developed soils with a thick Bf horizon. Solifluction and soil creep have affected the upper horizons. The third pedon, a lithic Orthic Dystric Brunisol (Table D33, Plate 52) from west of Flat Creek Pass, illustrates weakly developed RD5 soils. Its faint horizons, with dark colors inhereted from Lardeau-derived parent material, were tenuously classified on subtle color differences and chemical data. Horizonation is even less perceptible in the closely related Orthic Regosols, which are codominant in RD5. Cumulic, Cumulic Humic, and Orthic Humic Regosols also occur sporadically. Regosolics occur on recently active sites in which B horizon development has been inhibited. They also occur in minor amounts in RD Ecosites other than RD5 and are most abundant in tracts of RD plus CR or T (*e.g.* RD3+CR, RD4+T).

RD soils often have thin Ah or Ahe horizons (Tables D31 and D33) developed under tundra vegetation. But A horizons may be absent (Table D31) or mixed with underlying B material (AB horizon). Occasionally, Ah horizons >10 cm thick occur, giving Orthic Sombric Brunisols, Sombric Humo-Ferric Podzols, and Orthic and Cumulic Humic Regosols. Orthic Sombric Brunisols are most abundant and are accessory soils of each RD Ecosite. Thick Ah horizons appear to be related to physical thickening by pedoturbation at the surface.

Orthic Humo-Ferric Podzols are subdominant or codominant with Orthic Dystric Brunisols in all RD Ecosites except RD5 (Table 81) where they are accessory soils. Closely related, Orthic Ferro-Humic Podzols occur as accessory soils and without laboratory data are often difficult to distinguish from the more common Humo-Ferric Podzols. Orthic Ferro-Humic Podzols have podzolic Bhf horizons likely developed by mechanical thickening of upper solum B horizons or in unusually thick veneers of Eolian material B.

Lithic soils are common accessory features in any RD Ecosite, but are characteristic of RD5X and about half of RD4 and RD6 tracts. Nonsoil areas occupy ≤80% of the very steep, rugged RD4 and RD6 landscapes, occurring as exposed bedrock or where there is <10 cm of overburden. Lithic phases are interspersed with nonsoil and the proportion varies among tracts. Deeper soils, with >1 m of overburden, occur in minor amounts on craggy terrain. Turbic phases, with disrupted horizons produced by solifluction, are accessory features in all RD Ecosites but are most extensive in RD3 and RD5.

VEGETATION

RD Ecosites are characterized by a mosaic of tundra v.t.s, mainly heather-everlasting (L5) and everlasting-white mountain heather-red heather (H18). L5 (Plates 53 and 54) is more extensive than H18, particularly in RD5 and RD6. The black alpine sedge-everlasting (H2) v.t. is also extensive on RD5 and gives a distinctive, brilliant green appearance when viewed from a distance during summer (Plate 55). RD5 soils under H2 are drier than normally associated with this v.t.

Fleabane-valerian (H16) is present in minor amounts at low Alpine elevations in RD6. Mountain avens-snow willow-moss campion (H1) may occur in minor amounts on any RD Ecosite and is restricted to high elevation, exposed, ridge crests with calcareous soils. Intergrades between H2 and the sedge (H21) v.t. occur sporadically in RD5 and RD6. Any RD Ecosite can occasionally have <5% cover of krummholz and dwarf trees, usually subalpine fir (*Abies lasiocarpa*) or Engelmann spruce (*Picea engelmannii*), on steep, southerly aspects. RD tracts can be ≤50% unvegetated in association with intense geomorphic activity and exposed bedrock. Complexes of RD plus CR, T or R are 50 to 80% unvegetated although saxicolous lichen (H12) is often present.

WILDLIFE

SMA 13 is assumed to be present in RD but direct evidence is only available for the presence of the yellow-pine chipmunk, not the other mouse or vole components of SMA13.

RD3 Wildlife Features

Ungulates: RD3 is of high summer and medium winter importance to goats and of medium importance to elk in summer.
Carnivores: No carnivore use was recorded.
Small Mammals: Association 13.
RD3 is highly important to Columbian ground squirrels and of low importance to pikas.
Breeding Birds: Community 17
A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Rosy Finch and Horned Lark. Columbian ground squirrel colonies provide an important prey source for Golden Eagles and Red-tailed Hawks.

RD4 Wildlife Features

Ungulates: RD4 is of high summer and medium winter importance to goats.
Carnivores: No carnivore use was recorded.
Small Mammals: Association 13.
RD4 is highly important to hoary marmots and of low importance to pikas and Columbian ground squirrels.
Breeding Birds: Community 17
A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to White-tailed Ptarmigan. Hoary marmot colonies are important prey sources for Golden Eagles.

RD5 Wildlife Features

Ungulates: RD5 is of high summer and medium winter importance to goats.
Carnivores: No carnivore use was recorded.
Small Mammals: Association 13.
RD5 is of low importance.
Breeding Birds:
RD5 was not sampled for breeding birds. Use by birds is probably very similar to that of RD3 and RD4.

RD6 Wildlife Features

Ungulates: RD6 is of high summer and medium winter importance to goats.
Carnivores: No carnivore use was recorded.
Small Mammals: Association 13.
RD6 is of low importance.
Breeding Birds:
RD6 was not sampled for breeding birds. Use by birds is probably very similar to that of RD3 and RD4.

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The RD Ecosection concept was developed in the BNP and JNP inventory (Walker *et al.* 1982d). It was extended to KNP (Walker *et al.* 1984b) and MRNP and GNP to accommodate similar landscape (2.3% of MRNP and GNP). Four new Ecosites, RD3 (0.6%), RD4 (1.3%), RD5 (0.3%), and RD6 (0.2%), were established for the Columbia Mountains. These differ from RD1 and RD2 in the Rocky Mountains by having more Podzolic and, except for RD5, fewer Regosolic soils, as well as only minor amounts of avens tundra (H1).

Table 82. Wildlife features of RD Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
RD3	high	goat (s)			low	Columbian gr. squirrel	medium
RD4	high	goat (s)			low	marmot	low
RD5	high	goat (s)			low		low
RD6	high	goat (s)			low		low

RD is the Alpine counterpart of the Upper Subalpine Asulkan (AK), Lower Subalpine Hermit (HR), and Interior Cedar-Hemlock Nordic (NC) Ecosections. No other Alpine landscapes resemble RD.

Steepness and colluviation are major limitations. Removal of vegetation may increase erosion and revegetation will be slow. Locally, outcrops, solifluction, avalanching, coarse textures, stony surfaces, and shallow soils limit use.

SN - STONEY ECOSECTION

The Stoney (SN) Ecosection concept includes Interior Cedar-Hemlock vegetation; fan and level landforms of non- to weakly calcareous fluvial and glaciofluvial materials, and well to moderately well drained Regosolic soils. Only one Ecosite (SN1, Table 83) was recognized and only two tracts mapped, both in GNP. One occurs on the north half of the Stoney Creek fan, the other (SN1A), is on the Incomappleux River floodplain south of Jeopardy Slide. Fig. 11 shows the topographic position of SN1.

Table 83. Definitive features of the Stoney (SN) Ecosection.

Ecosite	Bedrock	Landform	Soils	Vegetation
SN1	Various	Fluvial material A & Glaciofluvial material A; fan & level	Orthic Regosol	mixed open forest (O23), herb mat (H8)

GEOMORPHOLOGY

Fluvial material A (non- to weakly, calcareous stratified) and Glaciofluvial material A (noncalcareous, coarse textured) are the main constituents of SN1 fan and level landforms. SN1 is a rapidly aggrading landscape originating from glacial meltwater streams with heavy sediment loads. The streams are braided (Plate 56), with numerous, shifting, shallow channels on fans and floodplains. Daytime warming produces diurnal fluctuations of meltwater volume. These sites have little or no soil development, stratified fluvial and glaciofluvial materials, and fluctuating water tables. SN1 surface expression ranges from fan to level plain. Slopes are simple and 0 to 5%. Slope continuity on both tracts is often subtly broken by stream channels (Eroded modifier, C.S.S.C. 1978a), including narrow, slightly elevated ridges along the banks. Channels are better developed and more abundant on level landforms than on fans.

SOILS

SN1 is characterized by well to moderately well drained Regosolic soils with depositional layers rather than pedogenic horizons. These indicate recurrent fluvial deposition which precludes pedogenic development. Cumulic Regosols, accessory in SN1, show both pedogenic and physical incorporation of organic material either as buried Ah horizons or as organic matter that varies irregularly with depth.

Such soils indicate episodic deposition with surficial organic layers being formed during inactive periods. Orthic Regosols, dominant in SN1, are more uniform in color and organic matter content (Table D34, Plate 57), indicating more frequent and continuous geomorphic activity. Gleyed Cumulic Regosols and Rego Gleysols occur locally on imperfectly drained sites.

VEGETATION

SN1 is characterized by the Engelmann spruce-black cottonwood/yellow dryad (O23) and yellow dryad-willow herb (H8) v.t.s. The SN1 tract on Stoney Creek fan is dominated by O23 (Plate 58). H8 and accessory unvegetated localities occupy the remainder of the area adjacent to the active stream channels. SN1A on the Incomappleux River floodplain is dominated by unvegetated localities and a yellow dryad-poor variant of H8. Intergrades of the green alder/fern (S13) and alder/skunk cabbage (S17) v.t.s occur on snow avalanche runout zones on the tract margins.

WILDLIFE

SN1 Wildlife Features

Ungulates: SN1 is of high importance overall being used by all species occurring in GNP except mountain goat and mountain caribou. It is of medium importance to moose and elk in winter. Browsing on black cottonwood (*Populus trichocarpa*) and willows (*Salix* spp.) was recorded on forage use plots.

Carnivores: SN1 is of medium importance both overall and to lynx.

Small Mammals: Association 12.

SN1 is of low importance overall but of high importance to yellow-pine chipmunks.

Breeding Birds: Communities 22 and 11

A high density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to Cedar Waxwing, Song Sparrow, White-crowned Sparrow, Yellow Warbler and Yellow-rumped Warbler. Highest bird densities are on poorly-drained sites where O23 forest borders wetland vegetation communities. SN1 is also important to Barred Owl, Red-tailed Hawk and American Kestrel. The uncommon Tennessee Warbler and Blackpoll Warbler have been recorded here during the breeding season in the Beaver Valley.

Table 84. Wildlife features of SN Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
SN1	high		medium		low	chipmunk	high

DISCUSSION AND MANAGEMENT CONSIDERATIONS

SN occupies 0.1% of MRNP and GNP. Use is limited by aggrading landforms, gravelly coarse textures, and high water tables. Parts are flooded annually.

SN is of very limited area in GNP, occurring at only two sites. Because of its situation in valley bottoms, early successional vegetation and importance to birds and ungulates, its wildlife potential would be reduced by facility developments that remove habitat or increase disturbance by humans.

WR - WITCH TOWER ECOSECTION

The Witch Tower (WR) Ecosection concept incorporates: Upper Subalpine vegetation of the Engelmann Spruce-Subalpine Fir Ecoregion; morainal blankets and veneers of noncalcareous medium textured till (Till B) overlying inclined and ridged bedrock; and imperfectly to poorly drained Orthic Gleysols, Gleyed Dystric Brunisols, and Gleyed Ferro-Humic Podzols. Only the WR1 Ecosite is recognized (Table 85). The salient feature of WR1 is wetness due to high water tables and associated seepage. WR occurs on valley walls, benchlands and shoulders within valleys, broad ridges, passes, and cirque floors. WR1 is more common in areas underlain by recessive bedrock (Horsethief Creek and Lardeau Groups). Fig. 13 shows the topographic position of WR1.

Table 85. Definitive features of the Witch Tower (WR) Ecosection.

Ecosite	**Bedrock**	**Landform**	**Soils**	**Vegetation**
WR1	Various	Till B; blanket & veneer over inclined & ridged bedrock	Orthic Gleysol, Gleyed Dystric Brunisol, Gleyed Ferro-Humic Podzol	Engelmann spruce-subalpine fir open forest (O9), herb meadow (H16)

GEOMORPHOLOGY

WR1 is characterized by morainal blankets and veneers of Till B (noncalcareous, medium textured) overlying inclined and ridged bedrock. Thin, discontinuous veneers of Fluvial material A (non- to weakly calcareous, stratified) often overlie the till, and are from slope wash from higher adjacent slopes. Intact veneers of Eolian material B (altered, medium textured) occur on portions of the landscape, although it has often been redistributed by slope wash and likely has become a significant constituent of the fluvial veneers. Thin organic layers occasionally mantle the mineral soils as in the sampled pedon (Table D35).

Topographically, WR1 displays linear, inclined slopes on valley shoulders and upper valley walls, and irregular, ridged slopes on cirque and pass floors. Slopes are 5 to 45%. Inclined slopes usually reflect the bedrock. Ridged surfaces reflect either underlying bedrock, glacial deposition or, in a few cases, post-depositional failure. Failed till slopes on WR1 are usually seepage induced, rotational slumps. Solifluction and cryoturbation are subtly expressed on some WR1 tracts.

SOILS

WR1 soils reflect various degrees of gleying and saturation. Orthic Gleysols, Gleyed Dystric Brunisols, and Gleyed Ferro-Humic Podzols have imperfect to poor drainage and are characteristic WR1 soils. Gleying is variable but the B horizons indicate that upper sola are periodically oxidized. B horizons include Bg, Bm, Bf, Bhf, and Bh (Gleysolic and Brunisolic) as well as podzolic Bf, Bhf, and Bh (Podzolic soils). The iron, aluminum and humus enriched B horizons usually develop in the silty veneer overlying glacial materials. Gleyed Ferro-Humic Podzols are typical of Podzolic great groups and include Humo-Ferric and Humic Podzols as accessory soils. An Orthic Gleysol (Table D35, Plate 59) was sampled on WR1 in the Prairie Hills (GNP). The pedon has a surface organic layer (Ofh) different from fen peat. Ah horizons are common, especially under herb meadow. Turbic phase soils are associated with minor occurrences of solifluction and cryoturbation which have disrupted and mixed upper horizons.

VEGETATION

Vegetation of WR1 reflects the degree of seepage. The fleabane-valerian (H16) v.t. is predominant on most tracts (Plate 60), but a few are mainly Engelmann spruce-subalpine fir/valerian-fleabane (O9). Black alpine sedge-everlasting (H2) is an accessory v.t. that occurs in slight depressions and reflects late snow lie. Other v.t.s in drier localities include heather-everlasting (L5) and everlasting-white mountain heather-red heather (H18).

WILDLIFE

WR1 Wildlife Features

Ungulates: The extensive herb meadows of WR1 are highly important summer elk range in eastern GNP. WR1 is potentially important to the now rare mountain caribou, but caribou are now too rare to assess their use of any habitats in GNP without detailed study.

Carnivores: WR1 is of low importance overall because of high snow accumulation and gentle topography with the resultant lack of breaks in snow cover. It is of medium importance only to weasels.

Small Mammals: Association 16.

Tracts with well drained meadows are of high importance to Columbian ground squirrels. Richardson's water voles and jumping mice occur along streambanks but no other small mammals regularly occur here.

Breeding Birds: Communities 7 and 17

A low density of birds was recorded. Based on density indices derived from circular census plots, this Ecosite is highly important to the Water Pipit. WR1 is important to raptors such as Golden Eagles and Red-tailed Hawks due to its abundant prey base. White-tailed Ptarmigans occur here year round.

Table 86. Wildlife features of WR Ecosites. (w)=winter, (s)=summer

	UNGULATES		CARNIVORES		SMALL MAMMALS		BIRDS
Ecosite	Overall rank	Important species	Overall rank	Important species	Overall rank	Important species	Overall rank
WR1	medium	elk (s)	medium		low	water vole	medium

DISCUSSION AND MANAGEMENT CONSIDERATIONS

The WR1 Ecosite accounts for 0.3% of MRNP and GNP and is the counterpart of the Lower Subalpine Lookout (LK) Ecosection.

Imperfect to poor drainage due to ground water discharge and seasonal seepage severely limit most uses. Locally, WR may play a role in regulating streamflow and potential slope failure should be considered. Major construction (*e.g.* roads) may change hydrologic patterns.

ECOSITE MODIFIERS

A - AVALANCHED

The Ecosite Modifier **Avalanched** (A) is added to a map symbol when 20 to 50% of the tract is modified by frequent snow avalanches and the modification is not an integral part of the Ecosite concept. This modifier is used on many tracts in the Interior Cedar-Hemlock and Engelmann Spruce-Subalpine Fir Ecoregions. A discussion of avalanche processes and terminology is provided by Perla and Martinelli (1975). Avalanching affects mainly vegetation and to a lesser extent soils. Common v.t.s on avalanche paths include subalpine fir-willow (S2), green alder/fern (S13), willow-mountain hemlock-subalpine fir/tall bilberry (S14), willow (S15), fleabane-valerian (H16), and sedge (H21). Schaerer (1972) discusses specific terrain and vegetation relationships with avalanching at Rogers Pass.

Management Considerations

Ecosites affected by avalanching require modified management considerations, particularly for winter uses.

B - BURNED

The Ecosite Modifier **Burned** (B) is used when >50% of the vegetation of a tract is modified by fire and is not a recognized v.t. (Plate 61). Ecosites modified by B occur in the Interior Cedar-Hemlock and Engelmann Spruce-Subalpine Fir Ecoregions of MRNP and GNP.

Management Considerations

Burned areas may be conducive to accelerated rates of erosion, especially in the few years immediately following fire. They are often favorable for wildlife since fire usually results in forest being replaced by herbaceous or shrubby vegetation. Also, burned areas may serve as a research sites to determine the pathways and rates of vegetational succession.

F - FAILED

The Ecosite Modifier **Failed** (F) identifies three types of landscape. The first and most common type is bedrock failure resulting in irregular, hummocky to ridged, bench-like topography often superimposed on an inclined slope. Tension cracks are often present. The second is severe solifluction that has created prominent solifluction benches on a slope. The third type encompasses extinct rock glaciers that originated as talus and protalus ramparts below rock walls. This type is most common in areas of Horsethief Creek Group bedrock.

Management Considerations

Failed tracts with old rock glacier landforms should not receive changed management consideration because the rock glaciers are not expected to reactivate. Failed terrain that includes mass movement and severe solifluction will influence management considerations for park uses. Such tracts should be evaluated individually to determine the potential for further slope failure.

X - LITHIC

The Ecosite Modifier **Lithic** (X) is added to a map symbol when >50% of a tract has shallow, unconsolidated material overlying a lithic layer and lithic phase soils are not part of the Ecosite concept. A lithic layer is a consolidated bedrock layer within the control section below a depth of 10 cm (C.S.S.C. 1978a). The control section of most mineral soils in MRNP and GNP is 1 m. Even though lithic phase soils dominate X-modified tracts, bedrock outcrops may not be abundant. Lithic modified tracts occur in all Ecoregions.

Management Considerations

Shallow soils and bedrock will change management considerations for Lithic Ecosites. Uses that require deep unconsolidated material (*e.g.* sewage disposal) will be precluded.

MISCELLANEOUS LANDSCAPES

CR - COLLUVIAL RUBBLE

The Miscellaneous Landscape **Colluvial Rubble** (CR) consists of Colluvium A and B. Physical weathering (joint block separation) of highly jointed bedrock, followed by slow, gravity-induced movement, produces colluvial rubble. This process is less prominent in resistant, massive quartzites, gneisses and granites. Slow displacement of material downslope is caused by surface creep, solifluction, and sheet erosion.

Colluvial Rubble (CR) occurs in the Alpine Ecoregion and the Upper Subalpine portion of the Engelmann Spruce-Subalpine Fir Ecoregion in GNP. CR is not mapped in MRNP. Nonsoil and Regosolic soils dominate CR. Regosolics occur in association with fine earths formed *in situ* by weathering or transported by surface creep, wind, or water erosion. CR may be unvegetated or sparsely vegetated. V.t.s such as saxicolous lichen (H12) and mountain avens-snow willow-moss campion (H1) occur only in patches and occupy <20% of a tract.

CR tracts are 0.1% of MRNP and GNP. A greater proportion of landscape (1.3%) is mapped as R+CR, meaning Rockland (R) and CR are inseparable within these tracts. Ecosites with colluvial landforms may also be complexed with CR (*e.g.* RD4+CR).

Management Considerations

Land stability, as well as lack of soil and vegetation, are major factors limiting most recreational park uses. The colluviation process is slower than for landslides and thus, may permit some uses, (*e.g.* trails) but at significant development and maintenance costs.

GL - GLACIER

The Miscellaneous Landscape **Glacier** (GL) includes glacier (Plate 62), firn, icefield, and glacierette. GL tracts occur in the Alpine Ecoregion and the Upper Subalpine portion of the Engelmann Spruce--Subalpine Fir Ecoregion in MRNP and GNP. GL is unvegetated and nonsoil.

GL tracts are 9.1% of MRNP and GNP and are most abundant in areas of Hamill Group and Shuswap Metamorphic Complex bedrock. Compound mapping units involving GL are M+GL (1.4% of MRNP and GNP), R+GL (4.8%), and T+GL (0.1%). Tracts with these compound symbols contain inseparable areas of GL plus Recent Moraine (M), Rockland (R) or Talus (T).

Management Considerations

GL areas have scientific, ecological, and tourist interest. The implications for use are complex and require site specific studies by qualified personnel. The ecological concerns involve long term climatic and hydrologic influences of the environment.

M - RECENT MORAINE

The Miscellaneous Landscape **Recent Moraine** (M) is comprised of either Till A (noncalcareous, coarse textured), Till B (noncalcareous, medium textured), Till C (calcareous, medium textured), or a till mixture. Non- to weakly calcareous mixtures of Till B and C are common in areas of the Lardeau and Horsethief Creek Groups (Fig. 2). In areas underlain by the Hamill Group and Shuswap Metamorphic Complex, mixtures of Till A and B are more common. M occurs throughout the Alpine and Engelmann Spruce-Subalpine Fir Ecoregions.

M occurs in close proximity to glaciers (Plate 63). Ice retreat is so recent that Regosols and nonsoil are characteristic. Unvegetated portions are usually $\geq$80% and have virtually no soil development. Patchy vegetation on these landscapes includes heather-everlasting (L5), mountain avens-snow willow-moss campion (H1), and yellow dryad-willow herb (H8). Regosolic soils occur under these vegetated patches.

M tracts account for 1.4% of MRNP and GNP. Compound mapping units involving M are M+GL (1.4% of MRNP and GNP), M+R (2.5%), and T+M (0.9%). Tracts with these compound symbols contain inseparable areas of M plus Glacier (GL), Rockland (R), and Talus (T).

Management Considerations

Areas of Recent Moraine have scientific, ecological, and tourist interest, particularly for geomorphological and pedological studies, as well as paleoecological studies of vegetational succession. The lack of soil and vegetation preclude many recreational park uses.

R - ROCKLAND

The Miscellaneous Landscape **Rockland** (R) is composed of consolidated bedrock of all lithologies and occurs in the Engelmann Spruce-Subalpine Fir and Alpine Ecoregions. Rockland is most abundant on resistant bedrock of the Hamill Group and Shuswap Metamorphic Complex and is dominantly nonsoil and unvegetated. Some tracts are sparsely vegetated with v.t.s such as saxicolous lichen (H12) and mountain avens-snow willow-moss campion (H1). Portions have stunted trees growing in cracks and shallow pockets of soil.

R tracts account for 0.1% of MRNP and GNP. Compound mapping units involving R are M+R (2.5% of MRNP and GNP), R+CR (1.3%), R+GL (4.8%) (Plate 64) and R+T (1.4%). Tracts with these compound symbols contain inseparable areas of R plus Recent Moraine (M), Colluvial Rubble (CR), Glacier (GL) or Talus (T).

Management Considerations

Lack of soil and vegetation preclude many recreational park uses. Steepness and safety problems are other limitations to their use. Aesthetic values are high, as is their use for geological studies.

RG - ROCK GLACIER

The Miscellaneous Landscape **Rock Glacier** (RG) is a mass of poorly sorted, angular coarse fragments and fine earth material cemented by interstitial ice >1 m below the surface. RG is a product of colluvial and glacial processes. Material is fed from talus (protalus ramparts) along cirque and valley walls. The surface of RG is marked by a series of transverse, arcuate, and rounded ridges suggestive of slow flow. These forms probably result from a combination of flow and melting of interstitial or underlying ice. RG is dominantly nonsoil and unvegetated.

RG is inseparable from Talus (T) because of mapping scale and occurs in tracts mapped as T+RG (0.2% of MRNP and GNP). These occur only in GNP in Alpine and Upper Subalpine areas associated with Horsethief Creek Group bedrock.

Management Considerations

RG areas are of scientific, ecological, and tourist interest. Steepness and lack of soil and vegetation are severely limiting factors for most recreational park uses.

T - TALUS

The Miscellaneous Landscape **Talus** (T) consists of loose deposits of Colluvium A or B that include abundant, angular, coarse fragments. Talus is formed chiefly by gravitational falling, rolling, or sliding of fragments dislodged by physical weathering from very steep, resistant rock walls. In some cases, mudflows and avalanches also deposit material (Gray 1972, Luckman 1972). Talus occurs as steep, usually concave slopes in the form of cones, aprons, and fans. Material thickness diminishes from the bottom to the top of a slope with smaller fragments more abundant near the top. The upper slope is usually steeper than the lower. Talus has dominantly nonsoil or Regosolics and is unvegetated. A few tracts have sparse vegetation. T tracts occur in the Engelmann Spruce-Subalpine Fir and Alpine Ecoregions. T tracts account for 0.2% of MRNP and GNP. Compound mapping units involving T are R+T (1.4% of MRNP and GNP), T+GL (0.1%), T+M (0.9%), and T+RG (0.2%). Tracts with these compound symbols contain inseparable areas of T plus Rockland (R), Glacier (GL), Recent Moraine (M), or Rock Glacier (RG). Ecosites characterized by colluvial landforms also may be complexed with T (*e.g.* AK5+T).

Management Considerations

Steepness, instability, and lack of soil and vegetation result in severe limitations for most recreational park uses.

WATER BODIES

The Miscellaneous Landscape **Water Bodies** (blue on the map) includes lakes, ponds, and streams occurring in all Ecoregions. Water Bodies are delineated at the high water level where seasonal fluctuations are evident. Mappable Water Bodies are about 0.1% of MRNP and GNP.

Management Considerations

Water bodies are described by Donald and Alger (1984, Alger and Donald 1984).

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APPENDIX A - PLANTS OF MOUNT REVELSTOKE AND GLACIER NATIONAL PARKS

This list is based on collections made during the ecological land classification, collections in the MRNP and GNP herbarium, and checklists for MRNP (Soper n.d.) and GNP (Haber and Soper (1980). Nomenclature for vascular plants follows primarily Packer (1983) and Hitchcock and Cronquist (1973), for liverworts Stotler and Crandall-Stotler (1977), for mosses Crum *et al.* (1973), and for lichens Hale and Culberson (1970) and Hawksworth *et al.* (1980). The two parks together have a total of 546 vascular taxa (MRNP - 359, GNP - 533), 36 liverwort taxa (MRNP - 18, GNP - 36), 130 moss taxa (MRNP - 65, GNP - 130) and 129 lichen taxa (MRNP - 70, GNP - 129). Species with a † are considered *calciphiles* (see Chap. III). A G following the taxon name indicates occurrence only in GNP and an **R** only in MRNP. Taxa with neither occur in both parks.

LYCOPODIOPHYTA

LYCOPODIACEAE

Lycopodium alpinum L.
Lycopodium annotinum L.
Lycopodium complanatum L.
Lycopodium obscurum L. R
Lycopodium selago L.
Lycopodium sitchense Rupr.

SELAGINELLACEAE

Selaginella densa Rydb.
Selaginella selaginoides (L.) Link

EQUISETOPHYTA

EQUISETACEAE

Equisetum arvense L.
Equisetum fluviatile L.
Equisetum palustre L. G
Equisetum pratense Ehrh. G
Equisetum sylvaticum L. G
Equisetum variegatum Schleich. G †

POLYPODIOPHYTA

OPHIOGLOSSACEAE

Botrychium lunaria (L.) Sw.
Botrychium multifidum (Gmel.) Rupr. G
Botrychium simplex Hitchc. G
Botrychium virginianum (L.) Sw. G

POLYPODIACEAE

Adiantum pedatum L. var. *aleuticum* Rupr. †
Aspidotis densa (Brackenr.) Lell. = *Cheilanthes siliquosa* Maxon R
Asplenium trichomanes L. †
Asplenium viride Huds. G †
Athyrium distentifolium Taush *ex* Opiz = *A. alpestre* (Hoppe) Rylands
Athyrium filix-femina (L.) Roth
Blechnum spicant (L.) Roth R
Cryptogramma crispa (L.) R.Br. var. *acrostichoides* (R.Br.) Clarke
Cryptogramma stelleri (Gmel.) Prantl G †
Cystopteris fragilis (L.) Bernh. †
Dryopteris assimilis S. Walker
Dryopteris filix-mas (L.) Schott. †
Gymnocarpium dryopteris (L.) Newm.
Polypodium hesperium Max. = *P. vulgare* L. R
Polystichum lonchitis (L.) Roth G
Pteridium aquilinum (L.) Kuhn var. *pubescens* Underw.
Thelypteris phegopteris (L.) Slosson = *Dryopteris phegopteris* (L.) C. Chr. R
Woodsia scopulina Eat.

PINOPHYTA

CUPRESSACEAE

Juniperus communis L. var. *montana* Ait.
Juniperus horizontalis Moench R
Thuja plicata Don

PINACEAE

Abies lasiocarpa (Hook.) Nutt.
Picea engelmannii Parry
Pinus albicaulis Engelm.
Pinus contorta Dougl. *ex* Loud. var. *latifolia* Engelm.
Pinus monticola Dougl. *ex* D. Don
Pseudotsuga menziesii (Mirb.) Franco var. *glauca* (Beissn.) Franco
Tsuga heterophylla (Raf.) Sarg.
Tsuga mertensiana (Bong.) Carr.

TAXACEAE

Taxus brevifolia Nutt.

MAGNOLIOPHYTA

MAGNOLIATAE

ACERACEAE

Acer glabrum Torr. var. *douglasii* (Hook.) Dipp.

APOCYNACEAE

Apocynum androsaemifolium L.

ARALIACEAE

Aralia nudicaulis L.
Oplopanax horridum (Sm.) Miq.

ARISTOLOCHIACEAE

Asarum caudatum Lindl.

BALSAMINACEAE

Impatiens noli-tangere L. R

BERBERIDACEAE

Berberis repens Lindl. R

BETULACEAE

Alnus crispa (Ait.) Pursh = *A. viridis* (Chaix) DC.
Alnus tenuifolia Nutt. = *A. incana* (L.) Moench
Betula papyrifera Marsh.

Corylus cornuta Marsh. R

BORAGINACEAE

Myosotis arvensis L. G
Myosotis alpestris Schmidt G

CAMPANULACEAE

Campanula lasiocarpa Cham. G
Campanula rotundifolia L.

CAPRIFOLIACEAE

Linnaea borealis L.
Lonicera involucrata (Rich.) Banks
Lonicera utahensis Wats.
Sambucus coerulea Raf. R

Sambucus racemosa L. var. *melanocarpa* (Gray) McMinn
Symphoricarpos albus (L.) Blake
Symphoricarpos occidentalis Hook. R
Viburnum edule (Michx.) Raf.

CARYOPHYLLACEAE

Arenaria capillaris Poir.
Arenaria lateriflora L. = *Moehringia lateriflora* (L.) Fenzl. G
Cerastium beeringianum Cham. & Schl.
Cerastium vulgatum L. G
Dianthus armeria L.
Dianthus deltoides L. R
Minuartia biflora (L.) Schinz and Thell. = *Arenaria sajanensis* Willd.
Minuartia obtusiloba (Rydb.) House = *Arenaria obtusiloba* (Rydb.) Fern. G
Minuartia rubella (Wahl.) Graebn. = *Arenaria rubella* (Wahl.) Smith G
Sagina saginoides (L.) Karsten G
Silene acaulis L. †
Silene alba (Miller) Krause = *Lychnis alba* Miller G
Silene cserei Baumg. G
Silene drummondii Hook. G
Silene scouleri Hook. G
Silene uralensis (Rupr.) Bocq. = *Lychnis apetala* L. G
Spergularia rubra (L.) J. & C. Presl. G
Stellaria calycantha (Ledeb.) Bong.
Stellaria crispa Cham. & Schl. G
Stellaria longipes Goldie G
Vaccaria pyramidata Medic. = *V. segetalis* (Neck.) Garcke *ex* Asch. G

CELASTRACEAE

Pachystima myrsinites (Pursh) Raf.

CHENOPODIACEAE

Chenopodium album L. G

COMPOSITAE

Achillea millefolium L.
Adenocaulon bicolor Hook.
Agoseris aurantiaca (Hook.) Greene
Anaphalis margaritacea (L.) Benth. & Hook.
Antennaria alpina (L.) Gaertn.
Antennaria corymbosa E. Nels.
Antennaria lanata (Hook.) Greene G
Antennaria racemosa Greene
Antennaria rosea Greene G
Antennaria umbrinella Rydb. R
Arnica alpina (L.) Olin
Arnica amplexicaulis Nutt.
Arnica cordifolia Hook. G
Arnica diversifolia Greene
Arnica latifolia Bong.
Arnica longifolia D.C. Eaton G

Arnica louiseana Farr G
Arnica mollis Hook.
Arnica rydbergii Greene G
Artemisia campestris L. G
Artemisia michauxiana Bess.
Aster adscendens Lindl. G
Aster borealis (Torr. & Gray) Prov. G
Aster ciliolatus Lindl. R
Aster conspicuus Lindl. R
Aster engelmannii (D.C. Eat.) Gray
Aster foliaceus Lindl.
Aster hesperius Gray G
Aster modestus Lindl.
Aster sibiricus L. G
Centaurea maculosa Lam. R
Chamomilla suaveolens (Pursh) Rydb. = *Matricaria matricarioides* (Less.) Porter
Chrysanthemum leucanthemum L.
Cichorium intybus L.
Cirsium arvense (L.) Scop.
Cirsium brevistylum Cronq. G
Cirsium hookerianum Nutt. G
Cirsium vulgare (Savi) Tenore
Conyza canadensis (L.) Cronq. = *Erigeron canadensis* L.
Crepis nana Rich. G
Crepis tectorum L. G
Erigeron acris L. var. *asteroides* (Andrz. *ex* Bess.) DC.
Erigeron acris L. var. *elatus* (Hook.) Cronq.
Erigeron acris L. var. *debilis* Gray
Erigeron aureus Greene
Erigeron compositus Pursh
Erigeron humilus Grah.
Erigeron peregrinus (Pursh) Greene var. *callianthemus* (Greene) Cronq.
Erigeron philadelphicus L. G
Gnaphalium microcephalum Nutt. R
Haplopappus lyallii Gray
Hieracium albiflorum Hook.
Hieracium canadense Michx. R
Hieracium cynoglossoides Arv.-Touv.
Hieracium triste Willd. ssp. *gracile* (Hook.) Calder = *H. gracile* Hook.
Lactuca biennis (Moench) Fern.
Lactuca canadensis L. R
Lactuca muralis (L.) Fresen. G
Petasites sagittatus (Banks) Gray G
Petasites vitifolius Greene G
Rudbeckia hirta L.
Saussurea densa (Hook.) Rydb. = *S. nuda* Ledeb. G
Senecio fremontii Torr. & Gray G
Senecio integerrimus Nutt.
Senecio pauperculus Michx. G
Senecio pseudaureus Rydb. R
Senecio streptanthifolius Greene G
Senecio triangularis Hook.
Solidago canadensis L. var. *subserrata* (DC.) Cronq.
Solidago multiradiata Ait. var. *scopulorum* Gray
Sonchus arvensis L. Bieb. G
Sonchus asper (L.) Hill G
Taraxacum eriophorum Rydb. G
Taraxacum laevigatum (Willd.) DC. G
Taraxacum lyratum (Ledeb.) DC.
Tragopogon pratensis L. R

CORNACEAE

Cornus canadensis L.
Cornus stolonifera Michx.

CRASSULACEAE

Sedum lanceolatum Torr.

CRUCIFERAE

Arabis divaricarpa Neb. G
Arabis drummondii Gray G †
Arabis hirsuta (L.) Scop. G
Arabis holboellii Hornem. var. *retrofracta* (R.C. Grah.) Rydb. G
Arabis lemmonii Wats. G
Arabis lyallii Wats.
Arabis lyrata L.
Braya humilis (C.A. Meyer) Robins. G
Capsella bursa-pastoris (L.) Medic. G
Cardamine bellidifolia L. G
Cardamine occidentalis (Wats.) Howell G
Cardamine oligosperma Nutt.
Cardamine pensylvanica Muhl. *ex* Willd. G
Draba aurea Vahl G
Draba crassifolia R.C. Grah. G
Draba incerta Payson G
Draba lonchocarpa Rydb. var. *lonchocarpa* G
Draba praealta Greene
Draba stenoloba Ledeb. G

DROSERACEAE

Drosera anglica Huds. G †

ELAEAGNACEAE

Shepherdia canadensis (L.) Nutt. †

EMPETRACEAE

Empetrum nigrum L.

ERICACEAE

Cassiope mertensiana (Bong.) Don
Cassiope tetragona (L.) Don var. *saximontana* (Small) Hitchc. G
Gaultheria humifusa (Graham) Rydb.
Gaultheria ovatifolia Gray

Kalmia polifolia Wang. var. *microphylla* (Hook.) Heller
Ledum groenlandicum Oeder
Menziesia glabella Gray = *M. ferruginea* Smith var. *glabella* (Gray) Peck
Oxycoccus microcarpus Turcz. G
Phyllodoce empetriformis (Sw.) D. Don
Phyllodoce glanduliflora (Hook.) Colville
Phyllodoce x intermedia (Hook.) Camp G
Rhododendron albiflorum Hook.
Vaccinium caespitosum Michx. G
Vaccinium membranaceum Dougl. *ex* Hook.
Vaccinium myrtilloides Michx. R
Vaccinium myrtillus L. G
Vaccinium ovalifolium Sm.
Vaccinium scoparium Leiberg
Vaccinium uliginosum L. G

FUMARIACEAE

Corydalis aurea Willd. R

GENTIANACEAE

Gentiana glauca Pallas G
Gentianella propinqua (Richards.) Gillet G

MENYANTHACEAE

Menyanthes trifoliata L. G †

HIPPURIDACEAE

Hippuris vulgaris L. G

HYDROPHYLLACEAE

Phacelia hastata Dougl. *ex* Lehm. G
Phacelia sericea (Graham) Gray G
Romanzoffia sitchensis Bong. G

HYPERICACEAE

Hypericum formosum H.B.K. var. *scouleri* (Hook.) Coult. G
Hypericum perforatum L. R

LABIATAE

Galeopsis tetrahit L.
Lycopus uniflorus Michx. G
Mentha arvensis L. R
Prunella vulgaris L.

LEGUMINOSAE

Hedysarum boreale Nutt. R
Lathyrus ochroleucus Hook. G
Lupinus polyphyllus Lindl. var. *burkei* (Wats.) Hitchc. G
Lupinus latifolius Agardh R
Lupinus polyphyllus Lindl. R
Medicago lupulina L. G
Medicago sativa L.
Melilotus alba Desr. G
Melilotus officinalis (L.) Lam. G
Trifolium agrarium L. R
Trifolium aureum Poll. G
Trifolium hybridum L. G
Trifolium pratense L.
Trifolium repens L. G
Vicia cracca L.

LENTIBULARIACEAE

Pinguicula vulgaris L. G †
Utricularia intermedia Hayne G
Utricularia minor L. G
Utricularia vulgaris L. G

LOBELIACEAE

Lobelia kalmii L. G †

MONOTROPACEAE

Monotropa hypopitys L.
Monotropa uniflora L. R

ONAGRACEAE

Circaea alpina L.
Epilobium alpinum L. var. *alpinum* = *E. anagallidifolium* Lam.
Epilobium alpinum L. var. *clavatum* (Trel.) Hitchc. = *E. clavatum* Trel. G
Epilobium alpinum L. var. *lactiflorum* (Haussk.) Hitchc. = *E. lactiflorum* Haussk.
Epilobium alpinum L. var. *nutans* (Hornem.) Hitchc. = *E. hornemannii* Reichenb.
Epilobium angustifolium L.
Epilobium glandulosum Lehm. = *E. ciliatum* Raf.
Epilobium latifolium L.
Epilobium luteum Pursh G

Epilobium palustre L. G
Epilobium watsonii Barbey var. *occidentale* (Trel.) Hitchc. G

PLANTAGINACEAE

Plantago lanceolata L.
Plantago major L.

POLYGONACEAE

Fagopyrum sagittatum Gilib. G
Oxyria digyna (L.) Hill
Polygonum amphibium L. G
Polygonum austiniae Greene
Polygonum douglasii Greene var. *douglasii*
Polygonum douglasii Greene var. *latifolium* (Engelm.) Greene G
Polygonum engelmannii Greene
Polygonum minimum Wats. R
Polygonum persicaria L. R
Polygonum viviparum L. G
Rumex acetosella L.
Rumex obtusifolius L. G

PORTULACACEAE

Claytonia lanceolata Pursh G
Montia parviflora (Moc.) Greene

PRIMULACEAE

Androsace septentrionalis L. G
Lysimachia thyrsiflora L. R
Primula mistassinica Michx. G †
Trientalis europaea L. ssp. *arctica* (Fisch.) Hult. G

PYROLACEAE

Chimaphila umbellata (L.) Barton
Moneses uniflora (L.) Gray
Pyrola asarifolia Michx.
Pyrola chlorantha Sw. = *P. virens* Schweig. G
Pyrola minor L.
Pyrola picta Sm.
Pyrola secunda L. = *Orthilia secunda* (L.) House

RANUNCULACEAE

Actaea rubra (Ait.) Willd.
Anemone drummondii Wats. G
Anemone multifida Poir. †
Anemone occidentalis Wats.

Anemone parviflora Michx. G †
Aquilegia flavescens Wats.
Aquilegia formosa Fisch. G
Caltha leptosepala DC. G
Delphinium nuttallianum Pritz. G
Ranunculus acris L.
Ranunculus aquatilis L. R
Ranunculus eschscholtzii Schlecht.
Ranunculus gmelinii DC. var. *hookeri* (Don) Benson
Ranunculus pensylvanicus L.f. R
Ranunculus uncinatus D. Don
Ranunculus verecundus B.L. Robins.
Trollius albiflorus (Gray) Rydb.

RHAMNACEAE

Ceanothus sanguineus Pursh
Ceanothus velutinus Dougl. *ex* Hook.
Rhamnus purshianus DC. R

ROSACEAE

Amelanchier alnifolia Nutt.
Aruncus sylvester Kostel
Dryas drummondii Richards. G†
Dryas octopetala L. var. *hookeriana* (Juz.) Breit. †
Fragaria virginiana Duchesne G
Fragaria vesca L. R
Geum macrophyllum Willd. var. *perincisum* (Rydb.) Raup
Holodiscus discolor (Pursh) Maxim. R
Luetkea pectinata (Pursh) Kuntze
Potentilla argentea L. R
Potentilla diversifolia Lehm.
Potentilla drummondii Lehm.
Potentilla fruticosa L. G †
Potentilla hyparctica Malte G
Potentilla norvegica L. G
Potentilla palustris (L.) Scop. G
Potentilla uniflora Ledeb. G
Potentilla villosa Pall.
Prunus emarginata (Dougl.) Walpers
Prunus pensylvanica L.f. R
Prunus virginiana L. R
Rosa gymnocarpa Nutt. G
Rubus acaulis Michx. G
Rubus idaeus L. = *R. strigosus* Michx.
Rubus parviflorus Nutt.
Rubus pedatus Smith
Rubus procerus Muell. = *R. discolor* Weihe & Nees R
Rubus pubescens Raf. G
Sibbaldia procumbens L.
Sorbus scopulina Greene
Sorbus sitchensis Roemer
Spiraea densiflora Nutt. G
Spiraea douglasii Hook. R
Spiraea lucida Dougl. = *Spiraea betulifolia* Pallas var. *lucida* (Dougl.) Hitchc.

RUBIACEAE

Galium trifidum L. G
Galium triflorum Michx.

SALICACEAE

Populus balsamifera L. ssp. *trichocarpa* (Torr. & Gray) Brayshaw
Populus tremuloides Michx.
Salix arctica Pallas G
Salix arctophila Cock. G
Salix barclayi Anders.
Salix barrattiana Hook. R
Salix brachycarpa Nutt. ssp. *brachycarpa* G
Salix candida Fluegge *ex* Willd. G †
Salix commutata Bebb. G
Salix drummondiana Barr. G
Salix glauca L. var. *villosa* (Hook.) Anders.
Salix lasiandra Benth. G
Salix melanopsis Nutt. G
Salix nivalis Hook. = *S. reticulata* L. var. *nivalis* (Hook.) Anders. G
Salix prolixa Anders. G
Salix pseudomonticola Ball = *S. monticola* Bebb
Salix scouleriana Barr.
Salix sitchensis Sans. G
Salix vestita Pursh G

SANTALACEAE

Geocaulon lividum (Richards.) Fern. G

SAXIFRAGACEAE

Heuchera cylindrica Dougl.
Heuchera glabra Willd.
Heuchera richardsonii R. Br. R
Leptarrhena pyrolifolia (D. Don) R. Br.
Mitella breweri Gray
Mitella pentandra Hook. G
Mitella trifida Grah. G
Parnassia fimbriata Konig
Parnassia parviflora DC. G †
Ribes lacustre (Pers.) Poir.
Ribes laxiflorum Pursh
Saxifraga adscendens L. G
Saxifraga aizoides L. G †
Saxifraga bronchialis L.
Saxifraga caespitosa L. G †
Saxifraga cernua L. G
Saxifraga debilis Engelm. = *S. rivularis* L. G
Saxifraga ferruginea Grah.
Saxifraga lyallii Engelm.
Saxifraga mertensiana Bong.
Saxifraga occidentalis Wats.
Saxifraga oppositifolia L. †
Saxifraga rhomboidea Greene G

Tellima grandiflora (Pursh) Dougl. G
Tiarella unifoliata Hook.

SCROPHULARIACEAE

Castilleja hispida Benth.
Castilleja miniata Dougl.
Castilleja occidentalis Torr.
Castilleja rhexifolia Rydb.
Collinsia parviflora Dougl. *ex* Lindl. G
Digitalis purpurea L.
Euphrasia canadensis Townsend G
Melampyrum lineare Desr. G
Mimulus guttatus DC.
Mimulus lewisii Pursh
Mimulus moschatus Dougl.
Mimulus tilingii Regel.
Pedicularis bracteosa Benth.
Pedicularis racemosa Dougl.
Penstemon ellipticus Coult. & Fisch.
Penstemon fruticosus (Pursh) Greene
Penstemon serrulatus Menzies R
Verbascum thapsus L.
Veronica alpina L. var. *unalaschensis* Cham. & Schl.
Veronica americana (Raf.) Schw.
Veronica officinalis L. R
Veronica serpyllifolia L. G
Veronica serpyllifolia L.

UMBELLIFERAE

Angelica genuflexa Nutt. R
Cicuta douglasii (DC.) Coult. & Rose
Heracleum lanatum Michx.
Ligusticum canbyi Coult. & Rose
Osmorhiza chilensis Hook. & Arn.
Osmorhiza purpurea (Coult. & Rose) Suksd.
Osmorhiza depauperata Phil. G

URTICACEAE

Urtica dioica L. ssp. *gracilis* (Ait.) Selander

VALERIANACEAE

Valeriana sitchensis Bong.

VIOLACEAE

Viola adunca J.E. Smith
Viola glabella Nutt. G
Viola orbiculata Geyer
Viola palustris L. G

Viola renifolia Gray
Viola rugulosa Greene = *V. canadensis* L. var. *rugulosa* (Greene) Hitchc.

LILIATAE

ARACEAE

Lysichiton americanum Hulten & St. John

CYPERACEAE

Carex aenea Fern. G
Carex albo-nigra Mack. G
Carex angustior Wahl. G
Carex aperta Boott. R
Carex aquatilis Wahl. G
Carex aurea Nutt. G †
Carex brunnescens (Pers.) Poir. G
Carex canescens L. G
Carex capillaris L. G
Carex deweyana Schw. G
Carex disperma Dewey G
Carex eleusinoides Turcz. *ex* C.A. Meyer G
Carex flava L. G
Carex gynocrates Wormskj.
Carex illota Bailey G
Carex interior Bailey G †
Carex kelloggii Boott. G
Carex lasiocarpa Ehrh. G
Carex lenticularis Michx.
Carex leptalea Wahlenb. G
Carex limosa L. G
Carex macrochaeta C.A. Mey
Carex mertensii Presc.
Carex microglochin Wahl. G
Carex microptera Mack.
Carex nardina Fries G
Carex nigricans Meyer
Carex norvegica Retz. G
Carex pachystachya Cham.
Carex phaeocephala Piper
Carex praticola Rydb. G
Carex pyrenaica Wahl.
Carex rossii Boott. G
Carex rostrata Stokes G
Carex scirpoidea Michx.
Carex spectabilis Dewey
Carex tenera Muhl. G
Carex trisperma Dewey
Eleocharis nitida Fern. G
Eleocharis rostellata Torr. G
Eleocharis tenuis (Wild.) Schultes var. *borealis* (Svens.) Gleason G
Eriophorum angustifolium Honck.
Eriophorum chamissonis Meyer
Eriophorum gracile Koch R
Eriophorum viridi-carinatum (Engelm.) Fern. G
Scirpus acutus Muhl. *ex* Bigel. G
Scirpus caespitosus L. G
Scirpus microcarpus Presl.

GRAMINEAE

x *Agroelymus mossii* Lepage G
Agropyron pectiniforme Roem. & Schul.
Agropyron repens (L.) Beauv. G
Agropyron trachycaulum (Link) Malte var. *trachycaulum* G
Agropyron violaceum (Hornem.) Lange
Agrostis alba L. G
Agrostis borealis Hartm. R
Agrostis scabra Willd.
Agrostis stolonifera L.
Agrostis tenuis Sibth. G
Agrostis thurberiana Hitchc.
Agrostis variabilis Rydb.
Aira praecox L. G
Bromus carinatus Hook. & Arn. = *B. marginatus* Ness G
Bromus ciliatus L.
Bromus inermis Leysser G
Bromus sitchensis Trin. R
Bromus vulgaris (Hook.) Shear
Calamagrostis canadensis (Michx.) Beauv.
Calamagrostis inexpansa Gray G
Calamagrostis purpurascens R. Br. R
Calamagrostis rubescens Buckl. R
Cinna latifolia (Trev.) Griseb.
Dactylis glomerata L. G
Danthonia spicata (L.) Beauv.
Deschampsia atropurpurea (Wahl.) Scheele = *Vahlodea purpurea* (Wahl.) Fries
Elymus glaucus Buckl. var. *jepsonii* Davy
Elymus innovatus Beal R
Festuca occidentalis Hook. R
Festuca ovina L. var. *brachyphylla* (Schultes) Piper
Festuca rubra L.
Festuca subulata Trin. G
Glyceria elata (Nash) Hitchc.
Glyceria grandis Wats.
Glyceria pulchella (Nash) Schum. G
Glyceria striata (Lam.) Hitchc. R
Hierochloe odorata (L.) Beauv. G
Hordeum jubatum L. G
Lolium perenne L.
Melica smithii (Porter) Vasey G
Melica subulata Scribn. G
Muhlenbergia glomerata (Willd.) Trin. G
Phleum alpinum L. = *P. commutatum* Gaudin G
Phleum pratense L. G
Poa alpina L. G
Poa annua L.
Poa arctica R. Br.
Poa cusickii Vasey var. *purpurascens* (Beal) Hitchc.
Poa epilis Scribn.
Poa fendleriana (Steud.) Vasey G
Poa gracillima Vasey R
Poa grayana Vasey R
Poa leptocoma Trin. G
Poa nervosa (Hook.) Vasey R
Poa palustris L.
Poa pattersonii Vasey G
Poa pratensis L. G

Poa reflexa Vasey & Scribn. G
Poa rupicola Nash = *P. glauca* Vahl G
Poa stenantha Trin. G
Stipa columbiana Macoun G
Trisetum cernuum Trin.
Trisetum spicatum (L.) Richter

JUNCACEAE

Juncus acuminatus Michx.
Juncus alpinus Vill. = *J. alpinoarticulatus* Chaix
Juncus balticus Willd. G
Juncus bolanderi Engelm. G
Juncus dudleyi Wieg. = *J. tenuis* Willd. var. *dudleyi* (Wieg.) Herm. R
Juncus drummondii Meyer
Juncus ensifolius Wickstr.
Juncus mertensianus Bong.
Juncus parryi Engelm.
Juncus regelii Buch. G
Juncus saximontanus Nels.
Luzula arcuata (Wahl.) Wahl.
Luzula hitchcockii L. Hamet-Ahti = *L. glabrata* (Hoppe) Desv.
Luzula parviflora (Ehrh.) Desv.
Luzula piperi (Cov.) Jones = *L. wahlenbergii* Rupr. G
Luzula spicata (L.) DC.

JUNCAGINACEAE

Triglochin maritima L. G
Triglochin palustris L. G †

LILIACEAE

Camassia quamash (Pursh) Greene G
Clintonia uniflora (Schult.) Kunth
Disporum hookeri (Torr.) Britt. var. *oreganum* (Wats.) Jones
Disporum trachycarpum (Wats.) Benth. & Hook. G
Erythronium grandiflorum Pursh
Lilium columbianum Hanson R
Lilium philadelphicum L. var. *andinum* (Nutt.) Ker. R
Smilacina racemosa (L.) Desf. var. *amplexicaulis* (Nutt.) Wats.
Smilacina stellata (L.) Desf. G
Streptopus amplexifolius (L.) DC. var. *amplexifolius*
Streptopus amplexifolius (L.) Desf. var. *chalazatus* Fassett R
Streptopus roseus Michx. var. *curvipes* (Vail) Fasset
Streptopus roseus Michx. var. *perspectus* Fassett
Streptopus streptopoides (Ledeb.) Frye & Rigg G
Tofieldia glutinosa (Michx.) Pers. G †
Tofieldia pusilla (Michx.) Pers. G
Veratrum eschscholtzii Gray = *V. viride* Ait.
Zygadenus elegans Pursh G †
Zygadenus gramineus Rydb. = *Z. venenosus* Wats. var. *gramineus* (Rydb.) Walsh

ORCHIDACEAE

Corallorhiza maculata Raf. R
Corallorhiza mertensiana Bong. G
Corallorhiza striata Lindl.
Corallorhiza trifida Chat.
Goodyera oblongifolia Raf.
Habenaria dilatata (Pursh) Hook. var. *albiflora* (Cham.) Correll G
Habenaria dilatata (Pursh) Hook. var. *dilitata*
Habenaria hyperborea (L.) R. Br.
Habenaria orbiculata (Pursh) Torr. R
Habenaria saccata Greene
Habenaria unalascensis (Spreng.) Wats. var. *elata* (Jeps.) Correll G
Habenaria unalascensis (Spreng.) Wats. var. *unalascensis*
Habenaria viridis (L.) R.Br. var. *bracteata* (Muhl.) Gray R
Listera caurina (L.) G
Listera cordata (L.) R. Br.
Spiranthes romanzoffiana Cham.

POTAMOGETONACEAE

Potamogeton alpinus L. G
Potamogeton gramineus L. G
Potamogeton natans L. G

SPARGANIACEAE

Sparganium angustifolium Michx.
Sparganium minimum (Hartm.) Fries G

TYPHACEAE

Typha latifolia L.

LIVERWORTS

Anastrophyllum minutum (Schreb.) Schust. G
Asterella ludwigii (Schwaegr.) Underw. G
Asterella saccata (Wahlenb.) Evans G
Barbilophozia barbata (Schmid. *ex* Schreb.) Loeske R
Barbilophozia hatcheri (Evans) Loeske
Barbilophozia lycopodioides (Wallr.) Loeske
Barbilophozia radicosa G
Blepharostoma tricophyllum (L.) Dum. G
Calypogeja muelleriana (Schiffn.) K. Mull. G
Chiloscyphus polyanthos (L.) Corda var. *polyanthos* G
Conocephalum conicum (L.) Lindb. G
Diplophyllum albicans (L.) Dum.
Diplophyllum taxifolium (Wahlenb.) Dum. G
Geocalyx graveolens (Schrad.) Ness. G
Gymnocolea inflata (Huds.) Dum. G
Gymnomitrion concinnatum (Lightf.) Corda G
Jamesoniella autumnalis (DC.) Steph.
Lepidozia reptans (L.) Dum.

Lophocolea heterophylla (Schrad.) Dum.
Lophocolea minor Nees R
Lophozia excisa (Dicks.) Dum.
Lophozia floerkei (Web. & Mohr) Schiffn. = *Barbilophozia floerkii* (Web. & Mohr) Loeske
Lophozia kunzeana (Hub.) Buch = *Barbilophozia kunzeana* (Hub.) Gams
Lophozia longidens (Lindb.) Macoun
Lophosia obtusata (Lindb.) Evans G
Lophozia porphyrolueca (Nees) Schiffn. = *L. guttulata* (Lindb. & H. Arnell) Evans G
Lophozia ventricosa (Dicks.) Dum.
Lophozia wenzelii (Nees) Steph. var. *wenzelii*
Marchantia polymorpha L. G
Mylia anomala (Hook.) S. Gray G
Pellia endiviifolia (Dicks.) Dum.
Plagiochila asplenioides (L.) Dum. G
Pleuroclada albescens (Hook.) Spruce G
Porella codaeana (Hub.) Moore R
Preissia quadrata (Scop.) Nees G
Ptilidium californicum (Aust.) Underw.
Ptilidium pulcherrimum (G. Web.) Hampe
Scapania subalpina (Nees) Dum. G
Solenostoma cordifolium (Dum.) Steph. G

MOSSES

Amblystegium serpens (Hedw.) B.S.G. R
Andreaea nivalis Hook. G
Andreaea rupestris Hedw. R
Aulacomnium palustre (Hedw.) Schwaegr.
Barbula icmadophila Schimp. *ex* C. Muell. G
Brachythecium albicans (Hedw.) B.S.G.
Brachythecium collinum (Schleich. *ex* C. Muell.) B.S.G. G
Calliergon cordifolium B.S.G. G
Brachythecium groenlandicum (C. Jens.) Schljak.
Brachythecium hylotapetum B. Hig. & N. Hig.
Brachythecium leibergii Grout
Brachythecium nelsonii Grout G
Brachythecium plumosum (Hedw.) B.S.G. G
Brachythecium populeum (Hedw.) B.S.G. G
Brachythecium reflexum (Starke *ex* Web. & Mohr) B.S.G. G
Brachythecium rivulare B.S.G. G
Brachythecium salebrosum (Web. & Mohr) B.S.G.
Brachythecium starkei
Brachythecium turgidum (C.J. Hartm.) Kindb. G
Bryoerythrophyllum recurvirostrum (Hedw.) Chen G
Bryum caespiticium Hedw. G
Bryum cuspidatum S.L. G
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Schreb.
Bryum weigelii Spreng. G
Calliergon cordifolium (Hedw.) Kindb. R
Calliergon giganteum (Schimp.) Kindb. G
Calliergon stramineum (Brid.) Kindb. G
Campylium chrysophyllum (Brid.) J. Lange G
Campylium hispidulum (Brid.) Mitt. R
Campylium polygamum (B.S.C.) C. Jens G
Campylium stellatum (Hedw.) C. Jens. G
Ceratodon purpureus (Hedw.) Brid.
Cladopodium bolanderi Best R
Cratoneuron commutatum (Hedw.) Roth G
Desmatodon latifolius (Hedw.) Brid.
Dichodontium pellucidum Schimp.
Dicranella crispa (Hedw.) Schimp. G

Dicranella heteromalla (Hedw.) Schimp. G
Dicranoweisia crispula (Hedw.) Lindb. *ex* Milde
Dicranum acutifolium (Lindb. & Arnell) C. Jens. *ex* Weinm. G
Dicranum brevifolium Kindb. G
Dicranum bistratosum Kindb. var. *bistratosum* Peters. G
Dicranum elongatum Schleib. & Schwaegr. G
Dicranum fragilifolium Lindb. G
Dicranum fuscescens Turn.
Dicranum groenlandicum Brid. G
Dicranum muehlenbeckii B.S.G.
Dicranum pallidisetum (Bail. *ex* Holz.) Irel.
Dicranum polysetum Sw. G
Dicranum scoparium Hedw.
Dicranum tauricum Sapeh.
Distichium capillaceum (Hedw.) B.S.G. G
Ditrichum flexicaule (Schwaegr.) Hampe G
Drepanocladus exannulatus (B.S.G.) Warnst. G
Drepanocladus revolvens (Sw.) Warnst. G
Drepanocladus uncinatus (Hedw.) Warnst.
Drepanocladus vernicosus (Lindl. *ex* C. Hartn.) Warnst. G
Dryptodon patens (Hedw.) Brid.
Encalypta rhaptocarpa Schwaegr. G
Eurhynchium pulchellum (Hedw.) Jenn.
Fissidens adiantoides Hedw. G
Grimmia affinis Hoppe & Hornsch. *ex* Hornsch. G
Grimmia apocarpa Hedw.
Heterocladium procurrens (Mitt.) Rau & Herv.
Hylocomium pyrenaicum (Spruce) Lindb.
Hylocomium splendens (Hedw.) B.S.G.
Hypnum callichroum Funck *ex* Brid. G
Hypnum circinale Hook.
Hypnum cupressiforme Hedw. G
Hypnum dieckii Ren. & Card. *ex* Roell R
Hypnum lindbergii Mitt.
Hypnum revolutum (Mitt.) Lindb. G
Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb. R
Kiaeria blyttii (Schimp.) Broth.
Kiaeria falcata (Hedw.) Hag. G
Leptobryum pyriforme (Hedw.) Wils. G
Lescuraea incurvata Hedw. = *Pseudoleskea incurvata* (Hedw.) Loeske
Lescuraea radicosa Mitt. = *Pseudoleskea radicosa* (Mitt.) Macoun & Kindb.
Lescuraea stenophylla (Ren. & Card.) Kindb. = *Pseudoleskea stenophylla* Ren. & Card. *ex* Roell G
Mnium blyttii B.S.G. G
Mnium lycopodioides Schwaegr.
Mnium spinulosum B.S.G.
Mnium thompsonii Schimp. G
Oligotrichum hercynicum (Hedw.) DC. G
Orthotrichum anomalum Hedw. G
Orthotrichum obtusifolium Brid. R
Orthotrichum rupestre Schleich. *ex* Schwaegr. R
Paraleucobryum enerve (Thed. *ex* C.J. Hartm.) Loeske G
Philonotis fontana (Hedw.) Brid. G
Plagiomnium ciliare C. Muell. = *Mnium ciliare* (C. Muell.) Schimp. G
Plagiomnium rugicum (Laur.) Koponen = *Mnium rugicum* Laur. G
Plagiomnium insigne (Mitt.) Koponen = *Mnium insigne* Mitt. R
Plagiomnium medium (B.S.G.) Koponen = *Mnium medium* B.S.G. G
Plagiothecium denticulatum (Hedw.) B.S.G. G
Plagiothecium laetum B.S.G.
Pleurozium schreberi (Brid.) Mitt.
Pogonatum alpinum (Hedw.) Roehl.
Pogonatum urnigerum (Hedw.) P.-Beauv. G
Pohlia cruda (Hedw.) Lindb.

Pohlia drummondii (C. Muell.) Andr. G
Pohlia elongata Hedw. G
Pohlia nutans (Hedw.) Lindb.
Pohlia wahlenbergii (Web. & Mohr) Andr. G
Polytrichadelphus lyallii Mitt. = *Polytrichum lyallii* (Mitt.) Kindb. G
Polytrichum commune Hedw. G
Polytrichum formosum Hedw. G
Polytrichum juniperinum Hedw.
Polytrichum piliferum Hedw.
Polytrichum sexangulare Brid.
Polytrichum strictum Brid. G
Pterigynandrum filiforme Hedw.
Ptilium crista-castrensis (Hedw.) DeNot.
Rhacomitrium canescens (Hedw.) Brid.
Rhacomitrium fasciculare (Hedw.) Brid. R
Rhacomitrium heterostichum (Hedw.) Brid.
Rhacomitrium lanuginosum (Hedw.) Brid. G
Rhacomitrium lawtonae Irel.
Rhacomitrium sudeticum Funck = *R. heterostichum* (Hedw.) Brid. var. *sudeticum* (Funck) Dix. *ex* Bauer G
Rhizomnium magnifolium (Horik.) Koponen G
Rhizomnium nudum (Williams) Koponen = *Mnium nudum* Williams *ex* Britt. & Williams
Rhizomnium pseudopunctatum (Bruch & Schimp.) Koponen = *Mnium pseudopunctatum* Bruch & Schimp.
Rhytidiadelphus squarrosus (Hedw.) Warnst. G
Rhytidiadelphus triquetrus (Hedw.) Warnst.
Rhytidiopsis robusta (Hedw.) Broth.
Roellia roellii (Broth. *ex* Roell) Andr. *ex* Crum.
Scorpidium scorpioides (Hedw.) Limpr. G
Sphagnum girgensohnii Russ. G
Sphagnum nemoreum Scop. G
Sphagnum russowii Warnst. G
Sphagnum squarrosum Crome
Sphagnum teres (Schimp.) Angstr. *ex* C. Hartm. G
Sphagnum warnstorfii Russ. G
Tetraphis pellucida Hedw. G
Thuidium abietinum (Hedw.) B.S.G. G
Tomenthypnum nitens (Hedw.) Loeske G
Tortella fragilis (Drumm.) Limpr. G
Tortella inclinata (Hedw.) Limpr. G
Tortella tortuosa (Hedw.) Limpr.
Tortula norvegica (Web.) Wahlenb. *ex* Lindb.
Tortula ruralis (Hedw.) Gaertn., Meyer & Schreb.
Trichostomum crispulum

LICHENS

Acarospora chlorophana (Wahlenb. *ex* Ach.) Mass. G
Acarospora fuscata (Schrad.) Arn. G
Alectoria sarmentosa (Ach.) Ach.
Arthroraphis citrinella (Ach.) Poelt G
Bacidia obscurata (Somm.) Zahlbr. G
Bacidia vermifera (Nyl.) Th. Fr. G
Baeomyces rufus (Huds.) Rebent. G
Bryoria abbreviata (Muell. Arg.) Brodo & D. Hawksw.
Bryoria capillaris (Ach.) Brodo & D. Hawksw.
Bryoria fremontii (Tuck.) Brodo & D. Hawksw.
Bryoria fuscescens (Gyeln.) Brodo & D. Hawksw.
Bryoria glabra (Mot.) Brodo & D. Hawksw.
Bryoria lanestris (Ach.) Brodo & D. Hawksw.
Bryoria oregana (Tuck.) Brodo & D. Hawksw. G

Bryoria pseudofuscescens (Gyeln.) Brodo & D. Hawksw.
Buellia papillata (Somm.) Tuck. G
Buellia punctata (Hoffm.) Mass. G
Buellia triphragmioides Anzi G
Calicium salicinum Pers. G
Caloplaca sinapisperma (Lam.) Mah. & Gill. G
Candelariella aurella (Hoffm.) Zahlbr. G
Cetraria chlorophylla (Willd.) Vain.
Cetraria cucullata (Bell.) Ach.
Cetraria ericetorum Opiz
Cetraria islandica (L.) Ach.
Cetraria nivalis (L.) Ach.
Cetraria pinastri (Scop.) S. Gray
Cetraria platyphylla Tuck. G
Cetraria subalpina Imsh.
Cetraria tilesii Ach. G
Chrysothrix chlorina (Ach.) Laundon G
Cladonia arbuscula (Wallr.) G
Cladonia bacillaris (Ach.) Nyl.
Cladonia bacilliformis (Nyl.) Dalla Torre & Sarnth.
Cladonia bellidiflora (Ach.) Schaer. G
Cladonia cariosa (Ach.) Spreng.
Cladonia carneola (Fr.) Fr.
Cladonia cenotea (Ach.) Schaer.
Cladonia cervicornis (Ach.) Flot. ssp. *verticillata* (Hoffm.) Ahti G
Cladonia chlorophaea (Floerke *ex* Somm.) Spreng.
Cladonia coccifera (L.) Willd.
Cladonia coniocraea (Floerke) Spreng.
Cladonia cristatella Tuck. G
Cladonia deformis (L.) Hoffm.
Cladonia ecmocyna (Ach.) Nyl.
Cladonia fimbriata (L.) Fr. G
Cladonia gracilis (L.) Willd.
Cladonia mitis (Sandst.) Hale & W. Culb.
Cladonia multiformis Merr.
Cladonia phyllophora Ehrh. *ex* Hoffm.
Cladonia pleurota (Floerke) Schaer. G
Cladonia pyxidata (L.) Hoffm.
Cladonia rangiferina (L.) Wigg. R
Cladonia scabriuscula (Del.) Leigh. R
Cladonia sulphurina (Michx.) Fr.
Cladonia uncialis (L.) Wigg. G
Coelocaulon aculeatum (Schreb.) Link G
Coniocybe furfuracea (L.) Ach. G
Cyphelium karelicum (Vain.) Raes.
Dactylina arctica (Hook.) Nyl. G
Dactylina ramulosa (Hook.) Tuck. G
Dermatocarpon weberi (Ach.) Mann. G
Haematomma lapponicum Raes. G
Huilia crustulata (Ach.) Hert. G
Huilia macrocarpa (DC.) Hert.
Hypogymnia austerodes (Nyl.) Raes. G
Hypogymnia enteromorpha (Ach.) Nyl.
Hypogymnia imshaugii Krog G
Hypogymnia physodes (L.) Nyl.
Hypogymnia subobscura (Vain.) Poelt G
Hypogymnia tubulosa (Schaer.) Hav. R
Icmadophila ericetorum (L.) Zahlbr. G
Lecanora epibyron (Ach.) Ach. G
Lecanora thamnoplaca Tuck. G
Lecidea berengeriana (Mass.) Nyl. G
Lecidea cinnabarina Somm. G
Lecidea fuscescens Somm.

Lecidea granulosa (Hoffm.) Ach.
Lecidea pantherina (Hoffm.) Th. Fr. R
Lecidea plana (Lahm in Koerb.) Nyl. G
Lecidella glomerulosa (DC.) Choisy G
Lepidoma demissum (Rutstr.) Choisy G
Lepraria incana (L.) Ach. R
Lepraria membranacea (Dicks.) Vain.
Lepraria neglecta (Nyl.) Lett. G
Letharia columbiana (Nutt.) Thoms. G
Letharia vulpina (L.) Hue G
Lobaria linita (Ach.) Rabenh. G
Lobaria pulmonaria (L.) Hoffm. G
Mycoblastus affinis (Schaer.) Schauer G
Nephroma arcticum (L.) Torss. G
Nephroma bellum (Spreng.) Tuck. G
Nephroma parile (Ach.) Ach. R
Ochrolechia androgyna (Hoffm.) Arn.
Ochrolechia arborea (Ljubitz.) Almb. G
Ochrolechia pseudopallescens Brodo G
Pachyospora verrucosa (Ach.) Mass.
Pannaria pezizoides (G. Web.) Trev. G
Parmelia omphalodes (L.) Ach. G
Parmelia sphaerosporella Muell. Arg. G
Parmelia subaurifera Nyl. R
Parmelia sulcata Tayl.
Parmeliopsis aleurites (Ach.) Nyl. G
Parmeliopsis ambigua (Wulf.) Nyl.
Parmeliopsis hyperopta (Ach.) Arn.
Peltigera aphthosa (L.) Willd.
Peltigera canina (L.) Willd.
Peltigera leucophlebia (Nyl.) Gyeln. G
Peltigera malacea (Ach.) Funck.
Peltigera polydactyla (Neck.) Hoffm. G
Peltigera rufescens (Weis.) Humb.
Peltigera venosa (L.) Hoffm. R
Physcia aipolia (Ehrh. *ex* Humb.) Fuernrohr R
Physcia millegrana Degel. G
Platismatia glauca (L.) W. Culb. & C. Culb.
Pseudephebe miniscula (Nyl. *ex* Arn.) Brodo & D. Hawksw. G
Pseudephebe pubescens (L.) Choisy G
Psora decipiens (Hedw.) Hoffm. G †
Psora rubiformis (Ach.) Hook. G
Psoroma hypnorum (Vahl) S. Gray
Ramalina fastigiata (Pers.) Ach. R = *R. americana* Hale
Ramalina sinensis Jatta
Rhizocarpon eupetraeum (Nyl.) Arn. G
Rhizocarpon geographicum (L.) DC.
Solorina crocea (L.) Ach. G
Sphaerophorus globosus (Huds.) Vain. G
Stereocaulon alpinum Laur.
Stereocaulon condensatum Hoffm. G
Stereocaulon grande (Magn.) Magn. G
Stereocaulon tomentosum Fr.
Thamnolia subuliformis (Ehrh.) W. Culb. G
Tremolecia jurana (Schaer.) Hert. G
Umbilicaria angulata Tuck. G
Umbilicaria cylindrica (L.) Del. *ex* Duby G
Umbilicaria deusta (L.) Baumg. G
Umbilicaria hyperborea (Ach.) Hoffm.
Umbilicaria krascheninnikovii (Sav.) Schol. G
Umbilicaria vellea (L.) Ach.
Umbilicaria virginis Schaer. R
Usnea glabrescens (Nyl. *ex* Vain.) Vain. R

Usnea scabrata Nyl. R
Xanthoria elegans (Link) Th. Fr. G

APPENDIX B - ANIMALS OF MOUNT REVELSTOKE AND GLACIER NATIONAL PARKS

INTRODUCTION

Nomenclature for this checklist is based on Stebbins (1966), American Ornithologists' Union (1982), and Banfield (1974). Records are based on observations by the wildlife inventory team during the ecological land classification, and information in the Warden Service and Interpretive Service files at Revelstoke. Further details are in Van Tighem and Gyug [1984]. Names in brackets are hypothetical species for which there is no verified record for either park. MRNP and GNP have a total of four amphibian species, three reptile species, 176 bird species (plus eight hypothetical), and 44 mammal species.

AMPHIBIANS

Long-toed salamander *Ambystoma macrodactylum*
Western toad *Bufo boreas*
Wood frog *Rana sylvatica*
Spotted frog *Rana pretiosa*

REPTILES

Northern alligator lizard *Gerrhonotus coeruleus*
Common (red-sided) garter snake *Thamnophis sirtalis parietalis*
Western terrestrial (wandering) garter snake *Thamnophis elegans vagrans*

BIRDS

Common Loon *Gavia immer* (Brünnich)
Horned Grebe *Podiceps auritus* (Linnaeus)
Great Blue Heron *Ardea herodias* (Linnaeus)
Cattle Egret *Bubulcus ibis* (Linnaeus)
Swan (unidentified) *Cygnus* spp.
White-fronted Goose *Anser albifrons* (Scopoli)
Snow Goose *Chen caerulescens* (Linnaeus)
Canada Goose *Branta canadensis* (Linnaeus)
Wood Duck *Aix sponsa* (Linnaeus)
Green-winged Teal *Anas crecca* (Linnaeus)
Mallard *Anas platyrhynchos* (Linnaeus)
Northern Pintail *Anas acuta* (Linnaeus)
Blue-winged Teal *Anas discors* (Linnaeus)
Cinnamon Teal *Anas cyanoptera* (Vieillot)
Northern Shoveler *Anas clypeata* (Linnaeus)
American Wigeon *Anas americana* (Gmelin)
Redhead *Aythya americana* (Eyton)
Ring-necked Duck *Aythya collaris* (Donovan)
Lesser Scaup *Aythya affinis* (Eyton)
Harlequin Duck *Histrionicus histrionicus* (Linnaeus)
White-winged Scoter *Melanitta fusca* (Linnaeus)
Common Goldeneye *Bucephala clangula* (Linnaeus)
Barrow's Goldeneye *Bucephala islandica* (Gmelin)
Bufflehead *Bucephala albeola* (Linnaeus)
Hooded Merganser *Lophodytes cucullatus* (Linnaeus)
Common Merganser *Mergus merganser* (Linnaeus)

Turkey Vulture *Cathartes aura* (Linnaeus)
Osprey *Pandion haliaetus* (Linnaeus)
Bald Eagle *Haliaeetus leucocephalus* (Linnaeus)
Northern Harrier *Circus cyaneus* (Linnaeus)
Sharp-shinned Hawk *Accipiter striatus* (Vieillot)
Cooper's Hawk *Accipiter cooperii* (Bonaparte)
Northern Goshawk *Accipiter gentilis* (Linnaeus)
Swainson's Hawk *Buteo swainsoni* (Bonaparte)
Red-tailed Hawk *Buteo jamaicensis* (Gmelin)
Rough-legged Hawk *Buteo lagopus* (Pontoppidan)
Golden Eagle *Aquila chrysaetos* (Linnaeus)
American Kestrel *Falco sparverius* (Linnaeus)
Merlin *Falco columbarius* (Linnaeus)
[Peregrine Falcon *Falco peregrinus* (Tunstall)]
Prairie Falcon *Falco mexicanus* (Schlegel)
Spruce Grouse *Dendragapus canadensis* (Linnaeus)
Blue Grouse *Dendragapus obscurus* (Say)
White-tailed Ptarmigan *Lagopus leucurus* (Richardson)
Ruffed Grouse *Bonasa umbellus* (Linnaeus)
Sora *Porzana carolina* (Linnaeus)
American Coot *Fulica americana* (Gmelin)
[Sandhill Crane *Grus canadensis* (Linnaeus)]
Killdeer *Charadrius vociferus* (Linnaeus)
Greater Yellowlegs *Tringa melanoleuca* (Gmelin))
Solitary Sandpiper *Tringa solitaria* (Wilson)
Spotted Sandpiper *Actitis macularia* (Linnaeus)
Upland Sandpiper *Bartramia longicauda* (Bechstein)
Western Sandpiper *Calidris mauri* (Cabanis)
Baird's Sandpiper *Calidris bairdii* (Coues)
Common Snipe *Gallinago gallinago* (Linnaeus)
Wilson's Phalarope *Phalaropus tricolor* (Vieillot)
Red-necked Phalarope *Phalaropus lobatus* (Linnaeus)
Bonaparte's Gull *Larus philadelphia* (Ord)
Ring-billed Gull *Larus delawarensis* (Ord)
Black Tern *Chlidonas niger* (Linnaeus)
Rock Dove *Columba livia* (Gmelin)
Band-tailed Pigeon *Columba fasciata* (Gmelin)
Mourning Dove *Zenaida macroura* (Linnaeus)
[Flammulated Owl *Otus flammeolus* (Kaup)]
Great Horned Owl *Bubo virginianus* (Gmelin)
Northern Hawk-Owl *Surnia ulula* (Linnaeus)
Northern Pygmy-Owl *Glaucidium gnoma* (Wagler)
Barred Owl *Strix varia* (Barton)
Long-eared Owl *Asio otus* (Linnaeus)
Boreal Owl *Aegolius funereus* (Linnaeus)
Northern Saw-whet Owl *Aegolius acadicus* (Gmelin)
Common Nighthawk *Chordeiles minor* (Forster)
Black Swift *Cypseloides niger* (Gmelin)
Vaux's Swift *Chaetura vauxi* (Townsend)
Calliope Hummingbird *Stellula calliope* (Gould)
Rufous Hummingbird *Selasphorus rufus* (Gmelin)
Belted Kingfisher *Ceryle alcyon* (Linnaeus)
Lewis' Woodpecker *Melanerpes lewis* (Gray)
Yellow-bellied Sapsucker *Sphyrapicus varius* (Linnaeus)
Downy Woodpecker *Picoides pubescens* (Linnaeus)
Hairy Woodpecker *Picoides villosus* (Linnaeus)
Three-toed Woodpecker *Picoides tridactylus* (Linnaeus)
Northern Flicker *Colaptes auratus* (Linnaeus)
Pileated Woodpecker *Dryocopus pileatus* (Linnaeus)
Olive-sided Flycatcher *Contopus borealis* (Swainson)
Western Wood Pewee *Contopus sordidulus* (Sclater)
Alder Flycatcher *Empidonax alnorum* (Brewster)
Willow Flycatcher *Emipdonax traillii* (Audubon)

Least Flycatcher *Empidonax minimus* (Baird & Baird)
Hammond's Flycatcher *Empidonax hammondii* (Xantus de Vesey)
Dusky Flycatcher *Empidonax oberholseri* (Phillips)
Western Kingbird *Tyrannus verticalis* (Say)
Eastern Kingbird *Tyrannus tyrannus* (Linnaeus)
Horned Lark *Eremophila alpestris* (Linnaeus)
Tree Swallow *Tachycineta bicolor* (Vieillot)
Violet-green Swallow *Tachycineta thalassina* (Swainson)
Northern Rough-winged Swallow *Stelgidopteryx serripennis* (Audubon)
Bank Swallow *Riparia reparia* (Linnaeus)
Cliff Swallow *Hirundo pyrrhonota* (Vieillot)
Barn Swallow *Hirundo rustica* (Linnaeus)
Gray Jay *Perisoreus canadensis* (Linnaeus)
Steller's Jay *Cyanocitta stelleri* (Gmelin)
Clark's Nutcracker *Nucifraga columbiana* (Wilson)
Black-billed Magpie *Pica pica* (Linnaeus)
American Crow *Corvus brachyrhynchos* (Brehm)
Common Raven *Corvus corax* (Linnaeus)
Black-capped Chickadee *Parus atricapillus* (Linnaeus)
Mountain Chickadee *Parus gambeli* (Ridgway)
Boreal Chickadee *Parus hudsonicus* (Forster)
Chestnut-backed Chickadee *Parus rufescens* (Townsend)
Red-breasted Nuthatch *Sitta canadensis* (Linnaeus)
White-breasted Nuthatch *Sitta carolinensis* (Latham)
Brown Creeper *Certhia americana* (Bonaparte)
Rock Wren *Salpinctes obsoletus* (Say)
House Wren *Troglodytes aedon* (Vieillot)
Winter Wren *Troglodytes troglodytes* (Linnaeus)
American Dipper *Cinclus mexicanus* (Swainson)
Golden-crowned Kinglet *Regulus satrapa* (Lichtenstein)
Ruby-crowned Kinglet *Regulus calendula* (Linnaeus)
Mountain Bluebird *Sialia currucoides* (Bechstein)
Townsend's Solitaire *Myadestes townsendi* (Audubon)
Veery *Catharus fuscesens* (Stephens)
Gray-cheeked Thrush *Catharus minimus* (Lafresnaye)
Swainson's Thrush *Catharus ustulatus* (Nuttall)
Hermit Thrush *Catharus guttatus* (Pallas)
American Robin *Turdus migratorius* (Linnaeus)
Varied Thrush *Ixoreus naevius* (Gmelin)
Sage Thrasher *Oreoscoptes montanus*
Water Pipit *Anthus spinoletta* (Linnaeus)
Bohemian Waxwing *Bombycilla garrulus* (Linnaeus)
Cedar Waxwing *Bombycilla cedrorum* (Vieillot)
Northern Shrike *Lanius excubitor* (Linnaeus)
European Starling *Sturnus vulgaris* (Linnaeus)
Solitary Vireo *Vireo solitarius* (Wilson)
Warbling Vireo *Vireo gilvus* (Vieillot)
Red-eyed Vireo *Vireo olivaceus* (Linnaeus)
Tennessee Warbler *Vermivora peregrina* (Wilson)
Orange-crowned Warbler *Vermivora celata* (Say)
Nashville Warbler *Vermivora ruficapillus* (Wilson)
Yellow Warbler *Dendroica petechia* (Linnaeus)
Magnolia Warbler *Dendrioca magnolia* (Wilson)
Yellow-rumped Warbler *Dendroica coronata* (Linnaeus)
Townsend's Warbler *Dendroica townsendi* (Townsend)
Blackpoll Warbler *Dendroica striata* (Forster)
American Redstart *Setophaga ruticilla* (Linnaeus)
Northern Waterthrush *Seiurus noveboracensis* (Gmelin)
MacGillivray's Warbler *Oporornis tolmiei* (Townsend)
Common Yellowthroat *Geothlypis trichas* (Linnaeus)
Wilson's Warbler *Wilsonia pusilla* (Wilson)
Western Tanager *Piranga ludoviciana* (Wilson)
Black-headed Grosbeak *Pheucticus melanocephalus* (Swainson)

Lazuli Bunting *Passerina amoena* (Say)
American Tree Sparrow *Spizella arborea* (Wilson)
Chipping Sparrow *Spizella passerina* (Bechstein)
Vesper Sparrow *Pooecetes gramineus* (Gmelin)
Savannah Sparrow *Passerculus sandwichensis* (Gmelin)
Fox Sparrow *Passerella iliaca* (Merrem)
Song Sparrow *Melospiza melodia* (Wilson)
Lincoln's Sparrow *Melospiza lincolnii* (Audubon)
Golden-crowned Sparrow *Zonotrichia atricapilla* (Gmelin)
White-crowned Sparrow *Zonotrichia albicollis* (Forster)
Dark-eyed Junco *Junco hyemalis* (Linnaeus)
Lapland Longspur *Calcarius lapponicus*
Snow Bunting *Plectrophenax nivalis* (Linnaeus)
Red-winged Blackbird *Agelaius phoeniceus* (Linnaeus)
Western Meadowlark *Sturnella neglecta* (Audubon)
Yellow-headed Blackbird *Xanthocephalus xanthocephalus* (Bonaparte)
Rusty Blackbird *Euphagus carolinus* (Muller)
Brewer's Blackbird *Euphagus cyanocephalus* (Wagler)
Common Grackle *Quiscalus quiscula*
Brown-headed Cowbird *Molothrus ater* (Boddaert)
Rosy Finch *Leucosticte arctoa* (Pallas)
Pine Grosbeak *Pinicola enucleator* (Linnaeus)
Purple Finch *Carpodacus purpureus* (Gmelin)
Cassin's Finch *Carpodacus casinii* (Baird)
Red Crossbill *Loxia curvirostra* (Linnaeus)
White-winged Crossbill *Loxia leucoptera* (Gmelin)
Common Redpoll *Carduelis flammea* (Wilson)
Hoary Redpoll *Carduelis hornemani* (Holboll)
Pine Siskin *Carduelis pinus* (Wilson)
American Goldfinch *Carduelis tristis* (Linnaeus)
Evening Grosbeak *Coccothraustes vespertinus* (Cooper)

MAMMALS

Masked shrew *Sorex cinereus* (Kerr)
Dusky shrew *Sorex monticolus* (Merriam)
Wandering shrew *Sorex vagrans* (Baird)
Water shrew *Sorex palustris* (Richardson)
Little brown bat *Myotis lucifugus* (Le Conte)
Northern long-eared bat *Myotis septentrionalis* (Merriam)
Long-eared bat *Myotis evotis* (H. Allen)
Long-legged bat *Myotis volans* (H. Allen)
California bat *Myotis californicus* (Audubon & Bachman)
Silver-haired bat *Lasionycteris noctivagans* (Le Conte)
Hoary bat *Lasiurus cinereus* (Palisot de Beauvois)
American pika *Ochotona princeps* (Richardson)
Snowshoe hare *Lepus americanus* (Erxleben)
Yellow-pine chipmunk *Eutamias amoenus* (J.A. Allen)
Woodchuck *Marmota monax* (Linnaeus)
Hoary marmot *Marmota caligata* (Eschscholtz)
Columbian ground squirrel *Spermophilus columbianus* (Ord)
Golden-mantled ground squirrel *Spermophilus lateralis* (Say)
Red squirrel *Tamiasciurus hudsonicus* (Erxleben)
Northern flying squirrel *Glaucomys sabrinus* (Shaw)
Beaver *Castor canadensis* (Kuhl)
Deer mouse *Peromyscus maniculatus* (Wagner)
Bushy-tailed wood rat *Neotoma cinerea* (Ord)
Gapper's red-backed vole *Clethrionomys gapperi* (Vigors)
Northern bog lemming *Synaptomys borealis* (Richardson)
Heather vole *Phenacomys intermidius* (Merriam)

Muskrat *Ondatra zibethicus* (Linnaeus)
Richardson's water vole *Arvicola richardsoni* (DeKay)
Meadow vole *Microtus pennsylvanicus* (Ord)
Long-tailed vole *Microtus longicaudus* (Merriam)
Western jumping mouse *Zapus princeps* (J.A. Allen)
Porcupine *Erethizon dorsatum* (Linnaeus)
Coyote *Canis latrans* (Say)
Wolf *Canis lupus* (Linnaeus)
Red fox *Vulpes vulpes* (Linnaeus)
Black bear *Ursus americanus* (Pallas)
Grizzly bear *Ursus arctos* (Linnaeus)
Marten *Martes americana* (Turton)
Fisher *Martes pennanti* (Erxleben)
Short-tailed weasel *Mustela erminea* (Linnaeus)
Long-tailed weasel *Mustela frenata* (Lichtenstein)
Mink *Mustela vison* (Schreber)
Wolverine *Gulo gulo* (Linnaeus)
Striped skunk *Mephitis mephitis* (Schreber)
River otter *Lontra canadensis* (Schreber)
Cougar *Felis concolor* (Linnaeus)
Canada lynx *Lynx lynx* (Linnaeus)
Bobcat *Lynx rufus* (Schreber)
Mountain caribou *Rangifer tarandus* (Linnaeus)
Mule deer *Odocoileus hemionus* (Rafinesque)
White-tailed deer *Odocoileus virginianus* (Zimmermann)
Moose *Alces alces* (Linnaeus)
Elk *Cervus elaphus* (Linnaeus)
Mountain goat *Oreamnos americanus* (de Blainville)
Bighorn sheep *Ovis canadensis* (Shaw)

APPENDIX C - CORRELATION OF MAP UNITS

Two nearby land inventories were compared with the MRNP and GNP Ecological Land Classification to correlate map unit concepts. The inventories are: *Soil resources of the Lardeau Map Area* (Wittneben 1980) and *Soil and terrain of the Seymour Arm Area* (Kowall 1980). Listed below are map units or groups of map units that correspond most closely to MRNP and GNP Ecosites. The following landscape components were evaluated.

1. **Physiographic Regions:** Correlation is restricted to map units of the Interior Wet Belt, Southern Plateau and Mountain Area (Wittneben 1980) and of the Selkirk Mountains Physiographic Region (Kowall 1980). Not all extrapolations may be valid because MRNP and GNP may contain different bedrock types or Physiographic Regions (*e.g.* Purcell Mountains) than occur in the soil inventory areas.
2. **Ecoregion and Ecoregion subdivision** *vs.* forest zone or subzone are correlated as follows:
   a) Interior Cedar-Hemlock (MRNP and GNP) is equated with the Interior Western Hemlock-Western Red Cedar Zone (Kowall 1980, Wittneben 1980).
   b) Lower Subalpine (MRNP and GNP) is equated with the Lodgepole pine-whitebark pine Subzone of the Subalpine Engelmann Spruce-Alpine Fir Zone plus the Subalpine Mountain Hemlock Zone (Kowall 1980) and to the Forested Subzone of the Subalpine Engelmann Spruce-Alpine Fir Zone (Wittneben 1980).
   c) Upper Subalpine (MRNP and GNP) is equated with the Krummholz subzone of the Engelmann Spruce-Alpine Fir Zone (Kowall 1980, Wittneben 1980).
   d) Alpine (MRNP and GNP) is equated with the Alpine tundra zone.
3. **Landform and parent materials:** Each inventory uses a similar rationale to divide the landscape according to geomorphic features, but the classes and the levels at which they are important in the legends differ.
4. **Soil classification:** Most Ecosites are characterized by a group of different soils among which predominance was not established. However, soil associations have a single, dominant Subgroup, and predominance is always implicit in soil association components. This different philosophical approach is reflected by the single asterisk below. Seepage phases in the soil association components are not important to the correlation. Some differences in soil taxonomy are due to differing interpretations of field characteristics and, more importantly, to use of older versions of the Canadian soil taxonomy.

The following symbols and conventions are used in the list below:

Virgule (/): one of three things in descending order of use:

1. Soil associations differentiated by bedrock lithology or texture are regrouped, but separated by a virgule, opposite one MRNP and GNP Ecosite.
2. Two soil associations, each from a different forest zone or subzone, correspond to one MRNP and GNP Ecosite of the Lower Subalpine and are separated by a virgule in the list (see 2b above).
3. Occasionally, soil associations differentiated by fan *vs.* plain fluvial landforms are regrouped, but separated by a virgule, opposite one MRNP and GNP Ecosite.

Plus (+) and greater than (>): a combination of soil associations or soil association components best correspond to a MRNP and GNP Ecosite (*e.g.*, a soil association of till + one of glaciofluvial equates to an Ecosite of ice contact stratified drift).

Asterisk (*): indicates that the dominant Subgroup of a soil association is the same as one of the soils characterizing an Ecosite and the other characteristic soils have no soil association equivalent.

Bullet (•): indicates that the dominant soil of a soil association differs at the Subgroup level from one of the soils characterizing the Ecosite.

Double Asterisk (**): indicates that the landscapes appear similar but soil classification is different at the Great Group or Order levels.

Dagger (†): indicates that the elevational range of a soil association extends well below the lower limit (in one case, above the upper limit) of the corresponding Ecosite, the latter being defined by the

Ecoregion (or subdivision) in which it occurs. Thus, there are probably significant vegetation differences between an Ecosite and its corresponding soil association. For example, RL occurs in the Alpine tundra zone but was assigned an elevational range >1980 m (Wittneben 1980) which, in MRNP and GNP, extends below the Alpine to include much of the Upper Subalpine. The correlation of the AB1 Ecosite with the SO and TY soil associations is the only exception to the Ecoregion-forest zone correlation outlined above. SO and TY occur in the Alpine tundra zone but were assigned elevations as low as 1675 m (Kowall 1980) which in MRNP and GNP extends well into the Lower Subalpine where AB1 occurs.

MR & GNP	Lardeau	Seymour Arm
AB1	—	SO*†/TY*†
AK1	CH*†	SD1**†
AK2	CF2*†/CH*†	SD1**†
AK4	CF2†/CH†	FB1**†/SD1**†
AK5	CS2*†/CT2*†	GN●†/HH●†
AK6	BC4*†/BO4*†/BU3*†	SD6**†/FB6**†
BU1	SD*	RR1*,5*/DE1*,5*
BU2	SH3●/ST1●,2●/SD●	RR1●,5●/DE1●,5●
BU3	SD*	RR1*,5*/DE1*,5*
BU4	SH3*/ST1*,2*/SD*	WS5*/RR1*,5*/DE1*,5*
CE1	—	—
CM1	—	—
CM2	—	—
CT1	SL2*,4*	MH1**,5**
CT2	SN● + SR1*,2*/SL2●,4● + SB2*	MH1●,5●
CT3	SL2●,4● + SB2*	MH1●,5●
CT4	SN● + SR*,2*/SL2●,4● + SB2*	SB1*,5*/MH1●,5●
CT5	(SN● + SR1*,2*/SL2●,4● + SB2*) + (KX1* + KO1●)	MH1●,5●/SB1●,5● + AE1*/KX1*
CT6	(SN● + SR1*,2*/SL2●,4● + SB2*) + (KX1* + KO1●) > seepy phases + O*	MH1●,5● + AE1* > w & y phases + BE1●
GF1	AS5**,6** + O*	BE● + y phases of: MM1**/AS1**
GF2	AS5**,6**	y phases of MM1**
GH1	—	—
HE3	—	—
HR1	CY3*	BM1*,5*/RK1*,5*
HR2	CC1*/CY3*	BM1*,5*/RK1*,5*
HR3	CY3*	BM1*,5*/RK1*,5*
HR4	CC1*/CY3*	BA1*†,5*†/BM1*,5*/RK1*,5*
HR5	CS2●†/CT2●†	GN●†/HH●†
HR6	BA5*/BE5*/BT5*	BM6*/BA6*/BO6*/RK6*
JD1	SA*†	—
JD2	—	—
JD3	SA*†	—
JD4	—	—

MR & GNP	Lardeau	Seymour Arm
JN2	——	——
KX1	KX1*+KO1•	AE1*/KX1*
LK1	——	w & y phases of: RR1**,5**/DE1**,5**
LR1	FT2•	KV*/AU*
LR2	——	——
NC1	CL1*	GM1**,5**
NC2	CP1•+CX1*†/CL1•+CE1*	GM1*,5*
NC3	CL1•+CE1*	GM1*,5*
NC4	CP1•+CX1*†/CL1•+CE1*	BY1*,5*/GM1*,5*
NC5	CS2•†/CT2•†	GH•/CS•
NC6	CP1*+CX1*†/CL1*+CE1*	BY1*,5*/GM1*,5*
RD3	RL1•†,2•†	AD•†,5•†
RD4	RL•†	AD•†
RD5	RL1**†,2**†	AD1**†,5*†
RD6	RL•†	SS•†/AD•†
SN1	AS1	MM1
WR1	——	——

APPENDIX D - PEDON DESCRIPTIONS AND ANALYTICAL DATA

Appendix D contains descriptions and analytical data of 35 pedons chosen to represent soils of selected Ecosites and Ecosections. The tables are arranged alphanumerically by Ecosite symbol. The table title includes the Provincial Identification Number (*e.g.* Alberta 1982 No. 970) by which the pedon information can by accessed in the Canada Soil Information System (CanSIS), Agriculture Canada, Ottawa.

Table D1. Pedon (Alberta 1983 No. 36) describing an Orthic Dystric Brunisol of the AB1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: AB1.

LOCATION: MILITARY GRID REF. 11 UMG 6720 7760; NTS MAP AREA 82N 6*.

CLIMATE: 1580 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 10 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=MF3004*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND SANDY, EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, MIXED; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), MORAINAL (TILL), MIXED; LANDFORM CLASSIFICATION: MORAINAL, AVALANCHED AND GULLIED, INCLINED; SLOPE: 85% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING NORTH, SITE AT MIDDLE POSITION, 100 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, VERY RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT3004*APN=391-102*DATE=27/07/83*PH=6.4 AT 25CM*NO SAMPLE OF LF* LFM=CV/MI-A,-V*

LF: 1 TO 0 CM, RANGE 0 TO 1 CM; HORIZON MOIST; 20% GRAVELLY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BM: 0 TO 7 CM, RANGE 5 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; LOAMY SAND; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, FINE AND MEDIUM AND MICRO AND VERY FINE, RANDOM ROOTS; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2AB: 7 TO 12 CM, RANGE 4 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; GRAVELLY SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, FINE AND MICRO AND VERY FINE, RANDOM ROOTS; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BM: 12 TO 55 CM, RANGE 35 TO 50 CM; HORIZON MOIST; 10YR 6/5; GRAVELLY SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE, RANDOM ROOTS; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY; SLIGHTLY ACID 6.1-6.5 FIELD PH.

2BC: 50 TO 88 CM; HORIZON MOIST; 10YR 6/4; GRAVELLY SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE, RANDOM ROOTS; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

				C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	BUFF.	PERM. CHARG	CA	MG	NA	K
LF									
BM	4.3	0.6		2.0		0.5	-.1	-.1	0.1
2AB	4.9	0.1		0.7		0.2	-.1	-.1	-.1
2BM	5.3	0.0	0.1	0.8		0.2	-.1	-.1	-.1
2BC	5.5		0.2	0.5		0.3	-.1	-.1	-.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
BM	-.1		-.1		-.1
2AB	-.1		0.0		0.0
2BM	-.1		0.0		0.0
2BC					

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS														
	% PASSING									% OF SAMPLE					
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
BM					8	14	16	22	13	73		27	0		
2AB					8	13	13	18	13	65		34	1		
2BM					10	13	12	17	12	64		34	2		
2BC	99	75	57	46	9	12	12	18	12	63		36	1		1.8

ENGINEERING

	MOISTURE STATUS (%)												
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
BM													
2AB													
2BM													
2BC		7.8	1.3			0	0						03

Table D2. Pedon (Alberta 1983 No. 50) describing an Orthic Humo-Ferric Podzol of the AK1 Eco-site.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: AK1.

LOCATION: MILITARY GRID REF. 11 UMG 7290 9310; NTS MAP AREA 82N 6*.

CLIMATE: 2090 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 3 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=HD3007*VTN=022*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, SCHIST AND PHYLLITE; DEPTH TO BEDROCK IS 0.9 M; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED, VENEER; SLOPE: 65% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING WEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,500 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3007*DATE=83/07/29*APN=BC5391-139*LFM=CV/RI-MINOR AVALANCHING*LITHIC PHASE*BLOTCHY BF, STRONG ON LEFT SIDE OF PIT*TOP OF R FRACTURED,SLIGHTLY SOFT*AHE REPLACES AE AT SOME NEARBY SITES*

LF: 1 TO 0 CM, RANGE 0 TO 2 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 6 CM, RANGE 4 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; GRAVELLY SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 30% SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BF: 6 TO 50 CM, RANGE 39 TO 61 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6, MATRIX MOIST 10YR 5/4; GRAVELLY SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC1: 50 TO 64 CM, RANGE 7 TO 18 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO ROOTS; 50% SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC2: 64 TO 92 CM, RANGE 24 TO 35 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3; GRAVELLY COARSE SANDY LOAM; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO ROOTS; 70% SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

R: 92 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.5	36.2						
AE	3.5	5.9	24.0		0.3	0.1	-.1	0.1
BF	4.3	1.5	10.8		-.1	-.1	-.1	-.1
BC1	4.6		6.4		-.1	-.1	0.1	-.1
BC2	4.8		3.0		0.1	-.1	-.1	-.1
R								

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AE					
BF	0.5		0.2		0.0
BC1					
BC2					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AE					4	7	6	8	7	32		60	8		
BF					2	8	8	10	8	36		58	6		
BC1					5	13	11	12	8	49		45	6		
BC2	99	79	60	41	9	20	13	12	7	61		33	8		1.9
R															

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BF													
BC1													
BC2		18.4	3.0			22	26						07
R													

Table D3. Pedon (Alberta 1983 No. 38) describing an Orthic Humo-Ferric Podzol of the AK5 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: AK5.

LOCATION: MILITARY GRID REF. 11 UMG 6130 8080; NTS MAP AREA 82N 5*.

CLIMATE: 2180 METERS ABOVE MEAN SEA LEVEL. STATION AT MT FIDELITY HAS MODERATE RELEVANCE TO THE SOIL SITE.

VEGETATION: VPN=MF3006*VTN=H16*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, MIXED; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED, BLANKET; SLOPE: 55% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, 500 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT3006*APN=391-101*LFM=CB/RI-A*DATE=28/7/83*

AH: 0 TO 3 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 20% CHANNERY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AHE: 3 TO 8 CM, RANGE 3 TO 6 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 40% CHANNERY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; SMOOTH, CLEAR HORIZON BOUNDARY.

AE: 8 TO 21 CM, RANGE 16 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; GRAVELLY FINE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 50% CHANNERY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF1: 21 TO 43 CM, RANGE 19 TO 25 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/6; GRAVELLY FINE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 50% CHANNERY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF2: 43 TO 63 CM, RANGE 17 TO 22 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/4; GRAVELLY FINE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 60% CHANNERY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BHF: 63 TO 68 CM, RANGE 0 TO 7 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE, RANDOM ROOTS; 10% CHANNERY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BC: 68 TO 98 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY FINE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; 60% CHANNERY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
AH	4.9	13.3						
AHE	4.4	4.8	17.9		2.2	0.6	-.1	0.6
AE	4.0	2.6	12.9		0.3	-.1	-.1	0.2
BF1	4.1	2.8	20.2		0.2	0.1	-.1	0.1
BF2	4.4	2.1	16.4		0.1	-.1	0.2	0.1
BHF	4.6	7.6	57.3		0.1	0.1	-.1	0.1
BC	4.6		10.8		0.1	-.1	-.1	-.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
AH					
AHE					
AE					
BF1	0.5		0.2		-.1
BF2	0.4		0.3		-.1
BHF	0.6		1.3		-.1
BC					

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING										% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
AH														
AHE					14	14	10	10	8	56		40	4	
AE					5	11	9	12	11	48		48	4	
BF1					5	10	8	12	12	47		48	5	
BF2					4	11	9	13	14	51		46	3	
BHF					2	6	5	8	12	33		55	2	
BC	99	70	42	33	5	12	10	12	12	51		45	6	

	MOISTURE STATUS (%)							ENGINEERING					
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
AH													
AHE													
AE													
BF1													
BF2													
BHF													
BC		19.4	4.7			0	0						03

Table D4. Pedon (Alberta 1983 No. 49) describing an Orthic Humo-Ferric Podzol of the BU1 Eco-site.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: BU1.

LOCATION: MILITARY GRID REF. 11 UMG 7230 9340; NTS MAP AREA 82N 6*.

CLIMATE: 1860 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=HD3006*VTN=021*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), SCHIST AND PHYLLITE; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 47% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING NORTH, SITE AT MIDDLE POSITION, LEVEL MICROTOFOGRAFHY,1000 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3006*DATE=83/07/29*APN=BC5391-139*LFM=MB/RI*MIX OF BHF+BF MATERIALS IN BHF HORIZON;INCLUDES HIGH PROPORTION OF EOLIAN*

L: 4 TO 0 CM, RANGE 3 TO 5 CM; MATRIX MOIST 10YR 2.5/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 6 CM, RANGE 2 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/2; GRAVELLY SILT LOAM; WEAK, COARSE, PLATY STRUCTURE; WEAK, MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 30% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHF: 6 TO 10 CM, RANGE 0 TO 8 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/2.5, MATRIX MOIST 5YR 4/6; SILT LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 20% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BF: 10 TO 21 CM, RANGE 8 TO 20 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/4, MATRIX MOIST 5YR 4/4; GRAVELLY SILT LOAM; WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; 40% SLATY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC1: 21 TO 50 CM, RANGE 25 TO 35 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; GRAVELLY COARSE SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE ROOTS; 50% SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

BC2: 50 TO 80 CM, RANGE 23 TO 42 CM; HORIZON MOIST; MATRIX MOIST 10YR 3.5/2; GRAVELLY COARSE SANDY LOAM; VERY WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 60% SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

C: 80 TO 100 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3; GRAVELLY SILT LOAM; WEAK TO MODERATE, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO ROOTS; 50% SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; MEDIUM ACID 5.6-6.0 FIELD PH.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
L	3.2	38.0						
AE	3.4	1.5	18.8		0.1	-.1	-.1	0.1
BHF	4.0	13.2	109.6		-.1	-.1	-.1	0.1
BF	4.2	2.1	26.1		0.1	-.1	-.1	-.1
BC1	4.4		12.9		-.1	-.1	-.1	-.1
BC2	4.6		7.1		-.1	-.1	-.1	-.1
C	4.7		8.2		0.1	-.1	-.1	-.1

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
L					
AE					
BHF	2.3		2.1		0.0
BF	1.0		0.4		0.0
BC1					
BC2					
C					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
L															
AE					0	2	2	6	10	20		73	7		
BHF					3	7	4	4	7	25		64	11		
BF					6	13	8	8	7	42		52	6		
BC1					6	19	14	13	7	61		33	6		
BC2					11	24	16	10	5	66		32	2		
C	99	88	65	48	6	12	6	9	10	43		51	6		1.6

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L													
AE													
BHF													
BF													
BC1													
BC2													
C		30.4	4.9			33	37						07

Table D5: Pedon (Alberta 1981 No. 33) describing an Ortstein Humo-Ferric Podzol of the BU2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTSTEIN HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: BU2.

LOCATION: MILITARY GRID REF. 11 UMG 6340 8290; NTS MAP AREA 82N 5*.

CLIMATE: 1480 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 7 DEG(C) AT 50 CM IN SEPTEMBER.

VEGETATION: VPN=PA1066*VTN=C49*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), MIXED AND METAMORPHIC; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 42% SIMPLE SLOPE OF CLASS 7 (31-45%), FACING EAST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY, 500 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT1127*APN=BC5391-101*DATE=81/09/15*LFM=MB/RI

LF: 8 TO 0 CM, RANGE 7 TO 10 CM; HORIZON MOIST; MATRIX MOIST 5YR 2.5/2; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE1: 0 TO 14 CM, RANGE 10 TO 16 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 6/2; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, FINE AND MEDIUM ROOTS; FEW, VERY FINE PORES; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AE2: 14 TO 20 CM, RANGE 5 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3, MATRIX MOIST 10YR 3/3; FINE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, FINE AND MEDIUM ROOTS; FEW, VERY FINE PORES; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BF: 20 TO 25 CM, RANGE 3 TO 8 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 3/2; FINE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM ROOTS; VERY FEW, VERY FINE PORES; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BFC1: 25 TO 38 CM, RANGE 8 TO 16 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/4; FINE SANDY LOAM; MODERATE, MEDIUM, ANGULAR BLOCKY STRUCTURE; FIRM CONSISTENCE; STRONGLY CEMENTEDBY HUMUS-ALUMINUM AND IRON, CONTINUOUS; FEW, FINE AND MEDIUM ROOTS; FEW, VERY FINE PORES; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BFC2: 38 TO 55 CM, RANGE 10 TO 20 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/7; FINE SANDY LOAM; WEAK TO MODERATE, MEDIUM, ANGULAR BLOCKY STRUCTURE; FIRM CONSISTENCE; WEAKLY CEMENTEDBY HUMUS-ALUMINUM AND IRON, CONTINUOUS; FEW, FINE AND MEDIUM ROOTS; FEW, VERY FINE PORES; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BCCJ: 55 TO 78 CM, RANGE 20 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3, MATRIX MOIST 10YR 5/6; SILT LOAM; WEAK TO MODERATE, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; FIRM CONSISTENCE; VERY FEW, FINE ROOTS; COMMON, VERY FINE PORES; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; VERY STRONGLY ACID 4.6-5.0 FIELD PH.

BC: 78 TO 100 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; SILT LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, FINE ROOTS; VERY FEW, VERY FINE PORES; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	2.7	52.8						
AE1	3.1	0.6	6.8		0.1	-.1	0.1	-.1
AE2	3.4	0.5	4.9		0.1	-.1	-.1	-.1
BF	3.4	4.7	25.0		-.1	-.1	-.1	0.1
BFC1	4.0	3.3	21.5		-.1	-.1	-.1	-.1
BFC2	4.2	1.9	12.1		-.1	-.1	-.1	-.1
BCCJ	4.4	0.6	4.4		0.1	-.1	-.1	-.1
BC	4.3		4.3		0.1	-.1	-.1	-.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)	
HORIZON	1	2	1	2
LF				
AE1				
AE2				
BF	1.3		0.3	
BFC1	1.0		0.7	
BFC2	0.5		0.6	
BCCJ	0.2		0.2	
BC				

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING										% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AE1					1	4	6	13	13	37		51	12		
AE2					2	7	10	18	17	54		44	2		
BF					5	11	12	17	12	57		38	5		
BFC1					3	8	10	19	19	59		40	1		1.6
BFC2					4	7	9	19	20	59		39	2		
BCCJ					1	5	8	16	14	44		54	2		1.7
BC	99	88	77	65	2	4	7	15	14	42		56	2		

ENGINEERING

	MOISTURE STATUS (%)												
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE1													
AE2													
BF													
BFC1													
BFC2													
BCCJ													
BC		15.4	3.5			0	0						07

Table D6. Pedon (Alberta 1983 No. 54) describing an Orthic Humo-Ferric Podzol of the BU4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: BU4.

LOCATION: MILITARY GRID REF. 11 UMG 1940 5340; NTS MAP AREA 82M 1*.

CLIMATE: 1620 METERS ABOVE MEAN SEA LEVEL. STATION AT REVELSTOKE HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=HD3010*VTN=021*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), METAMORPHIC; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 23% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING SOUTH, SITE AT MIDDLE POSITION, STRONGLY MOUNDED MICROTOPOGRAPHY, 200 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE PRESENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3011*DATE=83/08/01*APN=BC5378-083*LFM=MB/RH*UPPER 3 MIN-HOR'S STREAKED,BLOTCHY,CONTAIN FEW CHARCOAL FRAGMENTS; PERHAPS CHURNED BY TREE THROW + SLOPE WASH*COLOR 2 FOR BCC IS MINOR,MAINLY AROUND COARSE FRAGMENTS*AIR DRY BCC CLOD SLAKED IN WATER*

LF: 4 TO 0 CM, RANGE 3 TO 6 CM; HORIZON MOIST; MATRIX MOIST 5YR 2.5/2, MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AHE: 0 TO 8 CM, RANGE 4 TO 10 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/2, MATRIX MOIST 7.5YR 5/2; GRAVELLY FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BFU: 8 TO 33 CM, RANGE 18 TO 28 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/4, MATRIX MOIST 7.5YR 3/3; GRAVELLY COARSE SANDY LOAM; MODERATE TO STRONG, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; COMMON, MICRO AND VERY FINE PORES; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BFUCJ: 33 TO 45 CM, RANGE 10 TO 14 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/3, MATRIX MOIST 5YR 3/2; GRAVELLY COARSE SANDY LOAM; MODERATE TO STRONG, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; WEAKLY CEMENTED; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; COMMON, MICRO AND VERY FINE PORES; 50% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BFCJ1: 45 TO 75 CM, RANGE 25 TO 35 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/3; GRAVELLY COARSE SANDY LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FIRM CONSISTENCE; WEAKLY CEMENTED; FEW, MICRO AND VERY FINE AND FINE ROOTS; COMMON, MICRO AND VERY FINE PORES; 50% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BFCJ2: 75 TO 81 CM, RANGE 0 TO 10 CM; HORIZON WET; MATRIX MOIST 7.5YR 4.5/4, MATRIX MOIST 5YR 4/4; GRAVELLY SANDY LOAM; MODERATE, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FIRM CONSISTENCE; WEAKLY CEMENTED; VERY FEW, MICRO AND VERY FINE ROOTS; COMMON, MICRO AND VERY FINE PORES; 50% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BCC: 81 TO 105 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 5YR 4/4; GRAVELLY SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; MODERATE TO STRONG, VERY COARSE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FIRM CONSISTENCE; WEAKLY CEMENTED AND STRONGLY CEMENTED; MANY, MICRO AND VERY FINE PORES; 50% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.4	52.6						
AHE	3.5	2.7	16.4		0.3	0.1	-.1	0.1
BFU	4.2	2.1	19.4		0.1	-.1	-.1	-.1
BFUCJ	4.1	3.3	19.4		0.1	-.1	-.1	0.1
BFCJ1	4.2	2.1	15.3		0.1	-.1	-.1	-.1
BFCJ2	4.2	2.0	14.4		0.1	-.1	-.1	-.1
BCC	4.5		8.2		0.1	-.1	-.1	-.1

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AHE	0.1		0.1		0.0
BFU	0.8		0.4		0.0
BFUCJ	0.5		0.4		0.0
BFCJ1	0.5		0.3		0.0
BFCJ2	0.3		0.3		0.0
BCC	0.1		0.2		0.0

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AHE					4	12	11	12	11	50		45	5		
BFU					9	17	18	16	8	68		27	5		
BFUCJ					10	16	16	14	8	64		30	6		
BFCJ1					7	18	18	15	9	67		27	6		
BFCJ2					5	14	16	18	11	64		31	5		
BCC	99	69	57	47	5	11	15	13	14	58		37	5		2.0

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AHE													
BFU													
BFUCJ													
BFCJ1													
BFCJ2													
BCC		13.8	3.7			18	19						03

Tabie D7. Pedon (Alberta 1983 No. 59) describing an Rego Gleysol of the CE1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: REGO GLEYSOL. SOIL MAP UNIT: NOTATION: CE1.

LOCATION: MILITARY GRID REF. 11 UMG 7200 6950; NTS MAP AREA 82N 3*.

CLIMATE: 1820 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 9 DEG(C) AT 30 CM IN JULY.

VEGETATION: VPN=SD3003*VTN=S15*..

SOIL SITE: PARENT MATERIAL 1: UNSPECIFIED WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND STRATIFIED (MINERAL AND ORGANIC), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), FLUVIAL, MIXED AND QUARTZITE; LANDFORM CLASSIFICATION: FLUVIAL, ERODED(CHANNELLED), FAN; SLOPE: 2% SIMPLE SLOPE OF CLASS 3 (2-5%), FACING SOUTH, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: POORLY DRAINED, SLOWLY PERVIOUS, SLOW SURFACE RUNOFF, SEEPAGE PRESENT, 0.4 M TO WATERTABLE; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=0A3003*DATE=83/07/28*APN=391-085*OM HORIZON NOT SAMPLED*

OF: 5 TO 0 CM, RANGE 4 TO 6 CM; HORIZON MOIST; MATRIX MOIST 5YR 2.5/1; ORGANIC; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CG1: 0 TO 12 CM, RANGE 10 TO 14 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/2, MATRIX MOIST 5Y 7/2; SILT LOAM; COMMON, FINE, PROMINENT, 7.5YR 5/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 10% GRAVELLY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

OM: 12 TO 14 CM, RANGE 1 TO 3 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2; ORGANIC; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CG2: 14 TO 19 CM, RANGE 4 TO 8 CM; HORIZON MOIST; MATRIX MOIST 5Y 7/1; SILT LOAM; FEW, FINE, PROMINENT, 7.5YR 5/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; 10% GRAVELLY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CG3: 19 TO 63 CM, RANGE 41 TO 46 CM; HORIZON MOIST; VERY GRAVELLY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; 80% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

CG4: 63 TO 66 CM; HORIZON MOIST; MATRIX MOIST 5Y 7/1; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; WEAK TO MODERATE, FINE TO MEDIUM, PLATY SECONDARY STRUCTURE PSEUDO; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND FINE ROOTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
OF	4.0	30.7						
CG1	4.3	0.7	2.4		0.2	-.1	-.1	-.1
OM								
CG2	4.2	1.4	4.4		0.3	-.1	-.1	-.1
CG3	4.4	0.3	1.4		0.1	-.1	-.1	-.1
CG4	4.3	1.5	3.3		0.3	-.1	-.1	-.1

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
OF														
CG1					0	0	1	9	20	30		69	1	
OM														
CG2					1	2	2	6	14	25		74	1	
CG3					27	33	16	7	3	86		13	1	
CG4	99	99	99	96	0	1	1	5	9	18		81	1	

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
OF													
CG1													
OM													
CG2													
CG3													
CG4		23.8	3.3			26	27						09

Table 8. Pedon (Alberta 1983 No. 58) illustrating Podzolic soils of the CM2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1970, SUBGROUP: ORTHIC FERRO-HUMIC PODZOL. SOIL MAP UNIT: NOTATION: CM2.

LOCATION: MILITARY GRID REF. 11 UNG 6260 8320; NTS MAP AREA 82N 5*.

CLIMATE: 1630 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 9 DEG(C) AT 50 CM IN JULY.

VEGETATION: VFN=SD3002*VTN=S13*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), FLUVIAL, MIXED; LANDFORM CLASSIFICATION: FLUVIAL, AVALANCHED AND ERODED(CHANNELLED), FAN; SLOPE: 28% SIMPLE SLOPE OF CLASS 6 (16-30%), FACING SOUTHEAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA3002*DATE=83/07/27*AH1 NOT SAMPLED*AFN=391-101*

LF: 2 TO 0 CM, RANGE 1 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AH1: 0 TO 1 CM, RANGE 0 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; 20% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BM1: 1 TO 10 CM, RANGE 2 TO 18 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3; SANDY LOAM; WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; 30% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

AH2: 10 TO 15 CM, RANGE 0 TO 9 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 2.5/2; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; 20% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BM2: 15 TO 19 CM, RANGE 0 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/6; SILT LOAM; WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, RANDOM ROOTS; 50% GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BHF1: 19 TO 44 CM, RANGE 14 TO 30 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 3/2; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; 70% GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BHF2: 44 TO 94 CM, RANGE 43 TO 62 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; 80% GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BHF3: 94 TO 104 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/6; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; 70% GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

RANDOM ROOTS; 70% COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	4.2	38.5						
AH1								
BM1	3.4	2.9	10.8		0.2	0.1	-.1	0.1
AH2	3.2	13.2	41.1		0.5	0.3	-.1	0.2
BM2	3.4	3.3	12.9		0.2	0.1	-.1	0.1
BHF1	3.4	8.3	35.5		0.1	0.1	-.1	0.1
BHF2	3.6	5.9	26.7		0.1	-.1	-.1	-.1
BHF3	3.6	5.0	20.8		0.1	-.1	-.1	-.1

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AH1					
BM1	0.3		0.1		-.1
AH2	0.6		0.2		0.0
BM2	0.4		0.1		0.0
BHF1	1.1		0.1		0.0
BHF2	1.4		0.1		0.0
BHF3	1.3		0.1		0.0

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AH1														
BM1										50		47	3	
AH2										46		50	4	
BM2										45		52	3	
BHF1										45		51	4	
BHF2										45		51	4	
BHF3	99	68	56	44						43		52	5	

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	ENGINEERING MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AH1													
BM1													
AH2													
BM2													
BHF1													
BHF2													
BHF3		32.1	11.1			43	49						17

Table D9. Pedon (Alberta 1983 No. 63) describing an Eluviated Dystric Brunisol of the CT1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: CT1.

LOCATION: MILITARY GRID REF. 11 UMG 7020 8720; NTS MAP AREA 82N 6*.

CLIMATE: 1260 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 7 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=SD3007*VTN=C52*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), MIXED; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 38% SIMPLE SLOPE OF CLASS 7 (31-45%), FACING NORTH, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; NONSTONY; NONROCKY.

SPECIAL NOTES: SSN=DA3007*DATE=83/07/30*APN=391-140*

LF: 4 TO 0 CM, RANGE 3 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 5 CM, RANGE 1 TO 12 CM; HORIZON MOIST; MATRIX MOIST 10YR 6.5/1; SILT LOAM; WEAK, FINE TO MEDIUM, PLATY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 10% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BF: 5 TO 10 CM, RANGE 0 TO 15 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/8, MATRIX MOIST 5YR 5/8; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; WEAK, FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 10% GRAVELLY AND COBBLY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BM1: 10 TO 18 CM, RANGE 4 TO 14 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/6; SILT LOAM; WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 10% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM2: 18 TO 24 CM, RANGE 4 TO 12 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6; SILT LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 20% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC1: 24 TO 78 CM, RANGE 50 TO 60 CM; HORIZON MOIST; MATRIX MOIST 10YR 5.5/4; GRAVELLY SILT LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; 30% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC2: 78 TO 98 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY SILT LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; FRIABLE CONSISTENCE; 40% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	3.1	58.9						
AE	3.1	1.4	14.1		0.4	0.1	0.1	0.1
BF	4.5	4.9	44.8		1.0	0.2	0.1	0.2
BM1	4.9	0.8	10.6		0.2	0.1	0.1	0.2
BM2	5.3	0.9	15.8		0.6	0.1	-.1	0.2
BC1	5.0		5.6		0.2	0.1	-.1	0.2
BC2	4.6		4.6		0.3	0.2	-.1	0.2

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
AE					
BF	0.7		0.8		-.1
BM1	0.2		0.2		0.0
BM2	0.3		0.2		-.1
BC1					
BC2					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING										% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AE										26		66	8		
BF										20		66	14		
BM1										24		61	15		
BM2										22		59	19		
BC1										25		58	17		
BC2	99	95	82	69						23		61	16		1.9

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BF													
BM1													
BM2													
BC1													
BC2		22.0	5.1			19	23						10

Table D10. Pedon (Alberta 1982 No. 950) describing an Orthic Humo-Ferric Podzol of the CT3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: CT3.

LOCATION: MILITARY GRID REF. 11 UMG 5330 7380; NTS MAP AREA 82N 4*.

CLIMATE: 1130 METERS ABOVE MEAN SEA LEVEL. STATION AT GLACIER HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 7 DEG(C) AT 50 CM IN SEPTEMBER, NO. 2 WAS 5 DEG(C) AT 2 CM IN SEPTEMBER.

VEGETATION: VPN=HD2129*VTN=C50*.

SOIL SITE: PARENT MATERIAL 1: CHEMICAL AND PHYSICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), SCHIST AND PHYLLITE; LANDFORM CLASSIFICATION: MORAINAL, LOAMY, BLANKET; SLOPE: 45% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING NORTHEAST, SITE AT MIDDLE POSITION, EXTREMELY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY STONY; NONROCKY; PRESENT LAND USE: PRODUCTIVE WOODLAND; HUMUS-FORM: MOR.

SPECIAL NOTES: SSN=GC2005*APN=BC5391-089*LFM=MB/RI*DATE=82/09/13*DARK COLORS IN SOLUM INHERITED FROM PARENT MATERIAL*

H: 1 TO 0 CM; MATRIX MOIST 5YR 2.5/1; ABUNDANT, VERY FINE AND COARSE, OBLIQUE ROOTS; HIGHLY POROUS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 5 CM, RANGE 2 TO 8 CM; MATRIX MOIST N 4/0, MATRIX MOIST N 3/0; SILT LOAM; MODERATE, MEDIUM, PLATY STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND COARSE, OBLIQUE ROOTS; HIGHLY POROUS, FEW, VERY FINE PORES; 40% GRAVELLY AND SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BF1: 5 TO 13 CM, RANGE 5 TO 12 CM; MATRIX MOIST 7.5YR 3/2; LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, COARSE, OBLIQUE ROOTS; HIGHLY POROUS, FEW, VERY FINE PORES; 40% GRAVELLY AND SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF2: 13 TO 35 CM, RANGE 18 TO 25 CM; MATRIX MOIST 10YR 3/3, MATRIX MOIST 7.5YR 4/4; LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, FINE AND COARSE, OBLIQUE ROOTS; HIGHLY POROUS, MANY, VERY FINE PORES; 40% GRAVELLY AND SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

BF3: 35 TO 55 CM, RANGE 17 TO 26 CM; MATRIX MOIST 10YR 3/3; LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MEDIUM ROOTS; MODERATELY POROUS, COMMON, VERY FINE PORES; 40% GRAVELLY AND SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

BC: 55 TO 96 CM, RANGE 37 TO 46 CM; MATRIX MOIST 10YR 4/1, MATRIX MOIST 10YR 4/2; LOAM; VERY WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MEDIUM ROOTS; MODERATELY POROUS, COMMON, MICRO PORES; 40% GRAVELLY AND SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

C: 96 TO 150 CM; MATRIX MOIST 10YR 4.5/1, MATRIX MOIST 5YR 4/4; LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; MODERATELY POROUS; 40% GRAVELLY AND SLATY AND COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
H	3.4	40.9						
AE	3.4	1.9	14.4		0.5	0.2	-.1	0.1
BF1	3.9	3.0	27.3		0.1	0.1	0.2	0.1
BF2	4.5	1.6	17.3		0.6	0.1	-.1	-.1
BF3	4.5	1.1	13.2		0.2	0.0	-.1	-.1
BC	5.5	0.5						
C	5.0	0.5						

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
H					
AE					
BF1	1.5		0.3		-.1
BF2	0.8		0.3		-.1
BF3	0.5		0.3		-.1
BC					
C					

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS														
	% PASSING									% OF SAMPLE					
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
H															
AE										35		58	7		
BF1										47		44	9		1.2
BF2										45		46	9		
BF3										43		49	8		
BC										42		50	8		1.6
C	99	88	68	49						43		49	8		1.8

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
H													
AE													
BF1													
BF2													
BF3													
BC													
C		28.6	3.1			28	30						07

Table 11. Pedon (Alberta 1983 No. 68) illustrating Podzolic soils of the CT4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC FERRO-HUMIC PODZOL. SOIL MAP UNIT: NOTATION: CT4.

LOCATION: MILITARY GRID REF. 11 UMG 1770 5210; NTS MAP AREA 82M 1*.

CLIMATE: 1200 METERS ABOVE MEAN SEA LEVEL. STATION AT REVELSTOKE HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 10 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=MF3016*VTN=C51*.*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), MIXED; LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 35% SIMPLE SLOPE OF CLASS 7 (31-45%), FACING SOUTHWEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA3012*DATE=83/08/16*APN=378-083*CHARCOAL UNDER LF*

LF: 4 TO 0 CM, RANGE 3 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1, 10YR 3/1; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND COARSE AND MICRO ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 4 CM, RANGE 2 TO 7 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5.5/2; SANDY LOAM; VERY WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND COARSE AND MICRO ROOTS; 10% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHF: 4 TO 14 CM, RANGE 8 TO 17 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 4/6, MATRIX MOIST 5YR 5/8; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND FINE AND MEDIUM AND MICRO ROOTS; 10% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM: 14 TO 32 CM, RANGE 10 TO 21 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/8, MATRIX MOIST 7.5YR 5/6; GRAVELLY FINE SANDY LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, VERY FINE AND FINE AND MEDIUM AND MICRO ROOTS; 30% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC: 32 TO 71 CM, RANGE 24 TO 42 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6.5/4; GRAVELLY SANDY LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, VERY FINE AND FINE AND MEDIUM AND MICRO ROOTS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BCCJ: 71 TO 110 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6.5/4; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; FIRM CONSISTENCE; WEAKLY CEMENTED, CONTINUOUS; 70% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.7	55.6						
AE	3.6	1.6	10.0		1.6	0.2	-.1	0.1
BHF	4.6	5.3	44.8		1.4	0.1	-.1	0.1
BM	4.8	0.9	10.6		0.3	-.1	-.1	-.1
BC	4.8		7.9		0.2	-.1	-.1	-.1
BCCJ	4.8		4.6		0.1	-.1	-.1	-.1

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AE					
BHF	0.3		0.8		0.0
BM	0.1		0.2		0.0
BC	0.1		0.2		0.0
BCCJ	-.1		0.1		0.0

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AE					0	5	8	15	15	48		49	3		
BHF					3	5	8	14	12	42		50	8		
BM					6	10	12	17	17	62		36	2		
BC					5	10	25	1	18	59		39	2		
BCCJ	99	80	61	46	8	9	16	15	9	67		31	2		2.0

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BHF													
BM													
BC													
BCCJ		8.0	2.8			0	0						07

Table D12. Pedon (Alberta 1983 No. 42) describing an Eluviated Dystric Brunisol of the CT5 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: CT5.

LOCATION: MILITARY GRID REF. 11 UMG 1560 5170; NTS MAP AREA 82M 1*.

CLIMATE: 550 METERS ABOVE MEAN SEA LEVEL. STATION AT REVELSTOKE HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 11 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=MF3014*VTN=C52 VARIANT*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), EOLIAN; PARENT MATERIAL 2: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND STRATIFIED (MINERAL), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), GLACIOFLUVIAL, METAMORPHIC; PARENT MATERIAL 3: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), MORAINAL (TILL), METAMORPHIC; LANDFORM CLASSIFICATION: GLACIO FLUVIAL AND MORAINAL, BLANKET; SLOPE: 7% COMPLEX SLOPE OF CLASS 5 (10-15%), FACING SOUTHWEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; SLIGHTLY ROCKY.

SPECIAL NOTES: SSN=WT3014*DATE=01/08/83*LFM=EV/MFGB/RR*APN=378-084*PH=4.8 AT 30CM*CEMENTING DISCONTINUOUS IN HZNS 5 AND 6, CONTINUOUS IN 7*

LF: 4 TO 0 CM, RANGE 2 TO 6 CM; HORIZON MOIST; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 3 CM, RANGE 1 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/2; SILT LOAM; WEAK TO MODERATE, MEDIUM, ANGULAR BLOCKY STRUCTURE; VERY WEAK, FINE, PLATY SECONDARY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 10% GRAVELLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM: 3 TO 9 CM, RANGE 5 TO 19 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/6, MATRIX MOIST 7.5YR 5/6; SANDY LOAM; MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 10% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BM: 9 TO 21 CM, RANGE 6 TO 14 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/5; COARSE SANDY LOAM; MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 40% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BMC1: 21 TO 36 CM, RANGE 5 TO 25 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/6, MATRIX MOIST 10YR 7/6; GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, MASSIVE STRUCTURE; MODERATE TO STRONG, FINE TO MEDIUM, ANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; VERY FRIABLE CONSISTENCE; WEAKLY CEMENTEDBY HUMUS-ALUMINUM AND IRON, DISCONTINUOUS; FEW, MICRO AND VERY FINE AND FINE ROOTS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; IRREGULAR, CLEAR HORIZON BOUNDARY; VERY STRONGLY ACID 4.6-5.0 FIELD PH.

2BMC2: 36 TO 64 CM, RANGE 10 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/5; GRAVELLY COARSE SAND; STRUCTURELESS, MASSIVE STRUCTURE; MODERATE TO STRONG, FINE TO MEDIUM, ANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; LOOSE CONSISTENCE; WEAKLY CEMENTED BY HUMUS-ALUMINUM AND IRON, DISCONTINUOUS; VERY FEW, MICRO AND VERY FINE ROOTS; 60% GRAVELLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

2BCC: 64 TO 92 CM, RANGE 25 TO 35 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; LOAMY COARSE SAND; STRUCTURELESS, MASSIVE STRUCTURE; MODERATE TO STRONG, COARSE, ANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; VERY FRIABLE CONSISTENCE; WEAKLY CEMENTEDBY HUMUS-ALUMINUM AND IRON, CONTINUOUS; 50% GRAVELLY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

3C: 92 TO 105 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/4; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; 40% GRAVELLY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	4.8	48.2						
AE	4.3	1.0	12.9		1.1	0.2	-.1	0.1
BM	5.5	2.2	32.0		0.8	0.1	-.1	0.2
2BM	5.4	0.9	15.8		0.3	-.1	-.1	0.1
2BMC1	4.9	0.4	7.8		0.2	-.1	0.1	0.1
2BMC2	5.1	0.1	4.1		0.2	-.1	-.1	0.1
2BCC	5.0		4.1		0.1	-.1	-.1	0.1
3C	4.4		7.5		0.2	-.1	-.1	0.1

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AE					
BM	0.1		0.3		0.0
2BM	-.1		0.2		0.0
2BMC1	-.1		0.1		0.0
2BMC2	-.1		0.1		0.0
2BCC	-.1		-.1		0.0
3C					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AE					2	9	9	11	12	45		51	4		
BM					7	16	11	9	10	53		41	6		
2BM					11	22	13	10	9	65		31	4		
2BMC1					10	22	19	15	8	74		21	4		
2BMC2					16	36	26	11	3	92		6	2		
2BCC	99	94	83	69	13	20	15	20	11	79		19	2		
3C	99	96	91	84	4	9	11	12	8	44		52	4		1.6

PHYSICAL DATA

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BM													
2BM													
2BMC1													
2BMC2													
2BCC		5.0	2.4			0	0						07
3C		18.4	3.9			18	20						19

Table D13. Pedon (Alberta 1983 No. 44) describing an Terric Fibrisol of the GF1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: TEPRIC FIBRISOL. SOIL MAP UNIT: NOTATION: GF1.

LOCATION: MILITARY GRID REF. 11 UMG 6770 9430; NTS MAP AREA 82N 6*.

CLIMATE: 850 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 14 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=HD3011*.

SOIL SITE: PARENT MATERIAL 1: STRATIFIED (MINERAL AND ORGANIC), ORGANIC, PEAT; LANDFORM CLASSIFICATION: FEN, HORIZONTAL; SLOPE: 0% SIMPLE SLOPE OF CLASS 1 (0-0.5%), FACING LEVEL, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: VERY POORLY DRAINED, PONDED SURFACE RUNOFF, 0 M TO APPARENT WATERTABLE; NONSTONY; NONROCKY; PRESENT LAND USE: FEN.

SPECIAL NOTES: SSN=WT3016*APN=391-140*DATE=16/08/83*LFM=NH*HZN 4,6,8 NOT SAMPLED*O+C REFLECTS A RECENT INCREASE IN MINERAL DEPOSITION* FRAGMENT FREE*

O+C: 0 TO 15 CM; HORIZON WET; NATURAL WET/REDUCED 10YR 3/3; ABUNDANT, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, CLEAR HORIZON BOUNDARY.

OM: 15 TO 26 CM; HORIZON WET; NATURAL WET/REDUCED 7.5YR 3/2; MATERIAL COMPOSITION 95% SEDGE AND REED, SLIGHT DECOMPOSITION; VON POST SCALE 05; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, CLEAR HORIZON BOUNDARY.

OF1: 26 TO 62 CM; HORIZON WET; NATURAL WET/REDUCED 7.5YR 3/3, NATURAL WET/OXIDIZED 5YR 4/5; MATERIAL COMPOSITION SLIGHT DECOMPOSITION; VON POST SCALE 03; FEW, MICRO AND VERY FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

CG1: 62 TO 63 CM; HORIZON WET; NATURAL WET/REDUCED N 6; SILTY CLAY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; SLIGHTLY STICKY CONSISTENCE; SMOOTH, ABRUPT HORIZON BOUNDARY.

OF2: 63 TO 70 CM; HORIZON WET; NATURAL WET/REDUCED 7.5YR 3/3, NATURAL WET/OXIDIZED 5YR 4/5; MATERIAL COMPOSITION SLIGHT DECOMPOSITION; VON POST SCALE 03; SMOOTH, ABRUPT HORIZON BOUNDARY.

CG2: 70 TO 71 CM; HORIZON WET; NATURAL WET/REDUCED N 6; SILTY CLAY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; SLIGHTLY STICKY CONSISTENCE; SMOOTH, ABRUPT HORIZON BOUNDARY.

OF3: 71 TO 84 CM; HORIZON WET; NATURAL WET/REDUCED 7.5YR 3/3, NATURAL WET/OXIDIZED 5YR 4/5; MATERIAL COMPOSITION 95% SEDGE AND REED, SLIGHT DECOMPOSITION; VON POST SCALE 03; SMOOTH, ABRUPT HORIZON BOUNDARY.

CG3: 84 TO 85 CM; HORIZON WET; NATURAL WET/REDUCED N 6; SILTY CLAY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; SLIGHTLY STICKY CONSISTENCE; SMOOTH, ABRUPT HORIZON BOUNDARY.

OF4: 85 TO 110 CM; HORIZON WET; NATURAL WET/REDUCED 7.5YR 3/3, NATURAL WET/OXIDIZED 5YR 4/5; MATERIAL COMPOSITION 95% SEDGE AND REED, SLIGHT DECOMPOSITION; VON POST SCALE 03.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
O+C	6.5	23.2	75.8		39.8	6.8	0.2	0.6
OM	5.7	45.2						
OF1	5.7	55.5						
CG1								
OF2	5.9	55.7						
CG2								
OF3	5.6	54.7						
CG3								
OF4	5.7	57.9						

PHYSICAL DATA

ENGINEERING

HORIZON	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
O+C								
OM								
OF1								
CG1								
OF2								
CG2								
OF3								
CG3								
OF4								

Table D14. Pedon (Alberta 1983 No. 41) describing an Orthic Gleysol of the GF2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC GLEYSOL. SOIL MAP UNIT: NOTATION: GF2.

LOCATION: MILITARY GRID REF. 11 UMG 6940 9100; NTS MAP AREA 82N 6*.

CLIMATE: 850 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 8 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=MF3009*VTN=C51*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, STRATIFIED (MINERAL), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), FLUVIAL; LANDFORM CLASSIFICATION: FLUVIAL, ERODED(CHANNELLED), LEVEL; SLOPE: 2% SIMPLE SLOPE OF CLASS 2 (0.5-2%), FACING NORTH, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: POORLY DRAINED, MODERATELY PERVIOUS, SLOW SURFACE RUNOFF, SEEPAGE ABSENT, 0.9 M TO APPARENT WATERTABLE; NONSTONY; NONROCKY.

SPECIAL NOTES: SSN=WT3009*DATE=30/07/83*APN=391-140*THIN ORGANIC STAINING ABOVE HZNS 5 AND 10*BCG2 IS STRATIFIED*SEVERAL COARSE ROOT CHANNELS IN BCG2 INFLUENCE AERATION AND MOTTLING*LFM=FT-E*PEDON IS FRAGMENT FREE*

LF: 4 TO 0 CM, RANGE 3 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/1; PLATY STRUCTURE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM, HORIZONTAL AND RANDOM ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 3 CM, RANGE 1 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 7/1; SILT LOAM; VERY WEAK, VERY FINE, PLATY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM, HORIZONTAL AND RANDOM ROOTS; SLIGHTLY POROUS, FEW, FINE, HORIZONTAL PORES; WAVY, CLEAR HORIZON BOUNDARY.

BMGJ: 3 TO 10 CM, RANGE 5 TO 9 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/4; SILT LOAM; COMMON, MEDIUM AND COARSE, DISTINCT MOTTLES; 7.5YR 5/6 MOTTLES; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, HORIZONTAL AND RANDOM ROOTS; SLIGHTLY POROUS, FEW, FINE, RANDOM PORES; WAVY, CLEAR HORIZON BOUNDARY.

BCG1: 10 TO 19 CM, RANGE 7 TO 13 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; SILT; COMMON, MEDIUM AND COARSE, PROMINENT MOTTLES; 7.5YR 5/6 MOTTLES; WEAK TO MODERATE, MEDIUM, SUBANGULAR BLOCKY STRUCTURE PSEUDO; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, HORIZONTAL AND RANDOM ROOTS; MODERATELY POROUS, COMMON, FINE AND MEDIUM AND COARSE, RANDOM PORES; SMOOTH, ABRUPT HORIZON BOUNDARY.

AEGB: 19 TO 22 CM, RANGE 2 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 7/1; VERY FINE SANDY LOAM; FEW, COARSE, PROMINENT MOTTLES; 7.5YR 5/6 MOTTLES; VERY WEAK, FINE, PLATY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE, HORIZONTAL AND RANDOM ROOTS; SLIGHTLY POROUS, FEW, FINE, HORIZONTAL PORES; WAVY, CLEAR HORIZON BOUNDARY.

BGB: 22 TO 36 CM, RANGE 11 TO 16 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/5, MATRIX MOIST 2.5Y 6/1; SILT LOAM; MANY, COARSE, PROMINENT, 7.5YR 4/6 MOTTLES; 7.5YR 5/6 MOTTLES; VERY WEAK, COARSE, ANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE, HORIZONTAL AND RANDOM ROOTS; SLIGHTLY POROUS, VERY FEW, FINE, RANDOM PORES; WAVY, CLEAR HORIZON BOUNDARY.

BCG2: 36 TO 63 CM, RANGE 25 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 10YR 5/3; VERY FINE SANDY LOAM; MANY, COARSE, PROMINENT MOTTLES; 7.5YR 5/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE, HORIZONTAL AND RANDOM ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

CG1: 63 TO 90 CM, RANGE 25 TO 35 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3, MATRIX MOIST 10YR 6/4; SILT LOAM; MANY, COARSE, PROMINENT, 5Y 6/1 MOTTLES; 7.5YR 5/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

CG2: 90 TO 96 CM, RANGE 4 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3; LOAMY SAND; MANY, COARSE, PROMINENT MOTTLES; 7.5YR 5/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; WAVY, ABRUPT HORIZON BOUNDARY.

CG3: 96 TO 109 CM; HORIZON MOIST; MATRIX MOIST 5Y 6/1; SILT LOAM; MANY, COARSE, PROMINENT, 7.5YR 4/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; WAVY, CLEAR HORIZON BOUNDARY.

CG4: 109 TO 120 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/1; FINE SANDY LOAM; MANY, COARSE, PROMINENT MOTTLES; 7.5YR 5/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; WAVY, CLEAR HORIZON BOUNDARY.

CG5: 120 TO 130 CM; HORIZON MOIST; MATRIX MOIST 5Y 6/1; SILT LOAM; MANY, COARSE, PROMINENT, 7.5YR 4/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE;

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													ENGINEERING			
	% PASSING										% OF SAMPLE						
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	BULK DENS G/CC	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	UNIFIED CLASS
LF																	
AE					0	0	0	11	30	41		57	2				
BMGJ					0	0	0	7	32	39		59	2				
BCG1					0	0	0	1	6	7		85	8				
AEGB					0	0	1	20	27	48		49	3				
BGB					0	0	0	7	20	28		69	3				
BCG2					0	0	4	27	28	59		39	2				
CG1					0	0	1	11	22	34		63	3				
CG2					4	12	31	25	8	80		19	1				
CG3					0	0	1	2	10	13		78	9				
CG4	99	99	99	99	0	1	9	29	20	59		38	3		0	0	09
CG5	99	99	99	99	0	0	4	13	16	33		62	6	1.5	0	0	09

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	4.9	46.5						
AE	4.3	0.9	4.8		1.3	0.1	-.1	-.1
BMGJ	3.9	1.0	8.2		0.6	0.1	-.1	-.1
BCG1	4.0	1.5	11.4		0.3	0.1	-.1	-.1
AEGB	4.3	0.6	4.8		0.1	0.1	-.1	-.1
BGB	4.3	0.6	6.5		0.2	0.1	-.1	-.1
BCG2	4.6		2.9		0.3	-.1	-.1	-.1
CG1	4.8		4.2		1.1	0.1	0.1	-.1
CG2	5.0		2.1		0.5	-.1	-.1	-.1
CG3	5.0		7.5		3.0	0.3	-.1	0.1
CG4	5.1		3.4		1.1	0.1	-.1	-.1
CG5	5.1		4.5		1.6	0.2	-.1	-.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)			MOISTURE STATUS (%)	
HORIZON	1	2	1	2	EXTR MN (%)	0.33 ATM	15 ATM
LF							
AE							
BMGJ	0.3		-.1		-.1		
BCG1							
AEGB							
BGB	0.4		0.1		-.1		
BCG2							
CG1							
CG2							
CG3							
CG4						12.1	2.9
CG5						18.8	3.3

Table D15. Pedon (Alberta 1983 No. 34) describing an undefined soil of the GH1 Ecosite.

SOIL MAP UNIT: NOTATION: GH1.

LOCATION: MILITARY GRID REF. 11 UMG 6640 7810; NTS MAP AREA 82N 6*.

CLIMATE: 1370 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 6 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=MF3003*VTN=C47,OPEN VARIANT*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, QUARTZITE; LANDFORM CLASSIFICATION: COLLUVIAL, HUMMOCKY; SLOPE: 35% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING NORTH, SITE AT UPPER SLOPE POSITION, 25 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT3003*APN=391-101*DATE=27/07/83*LFM=CAH*ILLUVIAL SILTY CAPPINGS ON TOPS ONLY OF FRAGMENTS IN AB AND LOWER HORIZONS*CLR OF CAPPINGS AS BRIGHT AS 10YR7/4M IN AB*PEDON CLASSIFICATION UNDEFINED*

LF: 23 TO 12 CM, RANGE 9 TO 13 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/1; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

F: 12 TO 0 CM, RANGE 15 TO 10 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, HORIZONTAL ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

AE1: 0 TO 9 CM, RANGE 7 TO 11 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/1.5; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, HORIZONTAL AND RANDOM ROOTS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AB: 9 TO 40 CM, RANGE 26 TO 36 CM; HORIZON MOIST; MATRIX MOIST 10YR 8/2; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

AE2: 40 TO 80 CM, RANGE 35 TO 45 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 8/2; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE, RANDOM ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

AE3: 80 TO 120 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 8/1; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE, RANDOM ROOTS; 70% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, DIFFUSE HORIZON BOUNDARY.

AE4: 120 TO 205 CM; MATRIX MOIST 2.5Y 8/1; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; 70% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	2.8	56.8						
F	2.6	58.7						
AE1	2.8	5.0	17.9		0.1	-.1	0.1	
AB	3.0	0.3	4.1		0.1	-.1	-.1	
AE2	3.3	0.1	1.9		-.1	-.1	-.1	
AE3	3.4	0.1	0.9		-.1	-.1	-.1	
AE4	3.9	0.1	0.5		-.1	-.1	-.1	

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
F					
AE1	-.1		-.1		0.0
AB	0.0		0.0		0.0
AE2	0.0		0.0		0.0
AE3	0.0		0.0		0.0
AE4	0.0		0.0		0.0

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS										% OF SAMPLE			
	% PASSING													
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
F														
AE1					3	4	5	10	13	35		63	3	
AB					11	19	15	11	9	65		34	1	
AE2					13	20	15	12	8	68		31	1	
AE3					15	19	15	12	7	68		32	0	
AE4	99	65	38	24	13	20	16	13	7	69		30	1	

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
F													
AE1													
AB													
AE2													
AE3													
AE4		5.9	0.6			0	0						01

Table D16. Pedon (Alberta 1983 No. 61) describing an Orthic Ferro-Humic Podzol of the HE3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC FERRO-HUMIC PODZOL. SOIL MAP UNIT: NOTATION: HE3.

LOCATION: MILITARY GRID REF. 11 UMG 8380 8150; NTS MAP AREA 82N 6*.

CLIMATE: 2410 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 20 CM IN JULY.

VEGETATION: VPN=SD3005*VTN=L5*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), EOLIAN, UNDIFFERENTIATED OR UNDETERMINED; PARENT MATERIAL 2: UNSPECIFIED WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), RESIDUAL, SCHIST AND PHYLLITE AND SLATE; DEPTH TO BEDROCK IS 0.2 M; LANDFORM CLASSIFICATION: BEDROCK, HUMMOCKY; SLOPE: 19% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING SOUTHWEST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; MODERATELY ROCKY.

SPECIAL NOTES: SSN=OA3005*DATE=83/07/29*APN=391-104*LITHIC PHASE*LF IS TURFY*LF NOT SAMPLED*

LF: 3 TO 0 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AH1: 0 TO 5 CM, RANGE 2 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 10% SLATY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

AH2: 5 TO 8 CM, RANGE 2 TO 6 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/4; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 10% SLATY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHF: 8 TO 20 CM, RANGE 0 TO 12 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 4/6, MATRIX MOIST 2.5YR 3/4; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 10% SLATY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

2BC: 20 TO 22 CM, RANGE 0 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/6, MATRIX MOIST 10YR 5/8; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; 50% SLATY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

R: 22 CM

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF								
AH1	4.0	12.7	38.5		0.5	0.3	0.1	0.4
AH2	4.3	10.3	38.5		0.2	0.1	-.1	0.1
BHF	4.6	8.1	59.5		0.2	0.1	0.1	0.1
2BC	4.5		10.8		0.2	0.1	0.1	0.1
R								

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
AH1					
AH2	1.0		1.0		-.1
BHF	0.5		1.0		-.1
2BC					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING				% OF SAMPLE									
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AH1										41		48	11	
AH2										32		59	9	
BHF										17		68	15	
2BC	99	84	53	36						47		47	6	
R														

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AH1													
AH2													
BHF													
2BC		24.2	5.2			19	35						04
R													

Table D17. Pedon (Alberta 1983 No. 67) describing an Orthic Humo-Ferric Podzol of the HR3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: HR3.

LOCATION: MILITARY GRID REF. 11 UMG 5170 7580; NTS MAP AREA 82N 4*.

CLIMATE: 1630 METERS ABOVE MEAN SEA LEVEL. STATION AT MOUNT FIDELITY HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 8 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=SD3011*VTN=C25*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL; DEPTH TO BEDROCK IS 1 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 60% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHEAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA3011*DATE=83/08/02*APN=391-089*

LFH: 7 TO 0 CM, RANGE 5 TO 15 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1, MATRIX MOIST 10YR 3/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AH: 0 TO 7 CM, RANGE 3 TO 9 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/2; LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; WEAK, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 40% GRAVELLY AND ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BF1: 7 TO 21 CM, RANGE 12 TO 19 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2, MATRIX MOIST 10YR 3/1; SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF2: 21 TO 31 CM, RANGE 8 TO 12 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; LOAM; WEAK, FINE AND MEDIUM, SUBANGULAR BLOCKY STRUCTURE; WEAK, FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF3: 31 TO 43 CM, RANGE 10 TO 17 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3, MATRIX MOIST 10YR 3/2; SANDY LOAM; WEAK, FINE, SUBANGULAR BLOCKY AND GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF4: 43 TO 100 CM; HORIZON MOIST; MATRIX MOIST 5Y 3/2; LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 60% ANGULAR GRAVELLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LFH	4.1	32.8						
AH	4.0	7.6	33.8		5.0	0.7	-.1	0.1
BF1	4.1	4.4	27.9		2.9	0.5	-.1	0.1
BF2	4.2	3.4	24.4		1.1	0.1	-.1	0.1
BF3	4.3	3.3	24.4		1.0	0.1	-.1	0.1
BF4	4.5	1.7	14.4		0.4	-.1	-.1	0.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LFH					
AH	0.7		0.2		-.1
BF1	0.9		0.3		-.1
BF2	1.1		0.6		-.1
BF3	1.1		0.6		-.1
BF4	0.3		0.4		-.1

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING										% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LFH															
AH					5	8	10	10	8	41		49	10		
BF1					0	1	2	6	8	31		60	9		
BF2					7	11	10	12	8	48		44	8		
BF3					6	15	14	13	8	56		38	6		
BF4	99	88	71	56	5	11	12	14	9	51		41	8		1.7

PHYSICAL DATA

ENGINEERING

	MOISTURE STATUS (%)												
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AH													
BF1													
BF2													
BF3													
BF4		21.5	8.8			26	32						18

Table D18. Pedon (Alberta 1983 No. 56) describing an Orthic Humo-Ferric Podzol of the HR4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: HR4.

LOCATION: MILITARY GRID REF. 11 UMG 2550 5940; NTS MAP AREA 82M 1*.

CLIMATE: 1770 METERS ABOVE MEAN SEA LEVEL. STATION AT REVELSTOKE HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=SD3015*VTN=C47*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, METAMORPHIC; PARENT MATERIAL 2: FRACTURED WEATHERING, FRAGMENTAL (STONES,COBBLES AND GRAVEL), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), RESIDUAL, METAMORPHIC; DEPTH TO BEDROCK IS 0.8 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 75% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING EAST, SITE AT UPPER SLOPE POSITION, LEVEL MICROTOPOGRAPHY,600 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3015*APN=BC5378-131*DATE=83/08/18*LFM=CV/RUV/RI*LITHIC+TURBIC PHASES*IRREGULAR BEDROCK SURFACE (40-80CM);BC REPLACES 2BC IN A R TROUGH+BORDERLINE TURBIC;CHARCOAL BITS IN B+AU,BHFCJU*PATCHY WEAK CEMENTING IN BHFCJU*2BC IS FRAGMENTAL*

LF: 3 TO 0 CM, RANGE 1 TO 6 CM; MATRIX MOIST 5YR 2.5/2; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 8 CM, RANGE 4 TO 15 CM; MATRIX MOIST 5YR 5.5/3, MATRIX MOIST 5YR 6/2; GRAVELLY SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; WEAK, VERY FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

B+AU: 8 TO 18 CM, RANGE 4 TO 25 CM; MATRIX MOIST 7.5YR 5/6, MATRIX MOIST 7.5YR 6/4; GRAVELLY SANDY LOAM; WEAK, VERY FINE TO FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHFCJU: 18 TO 27 CM, RANGE 0 TO 18 CM; MATRIX MOIST 2.5YR 3/3; GRAVELLY SANDY LOAM; MODERATE TO STRONG, FINE TO MEDIUM, PLATY AND SUBANGULAR BLOCKY STRUCTURE; VERY WEAK, VERY FINE TO FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FIRM CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; COMMON, MICRO PORES; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR AND ABRUPT HORIZON BOUNDARY.

BF: 27 TO 64 CM, RANGE 9 TO 40 CM; MATRIX MOIST 5YR 3.5/3; GRAVELLY COARSE SANDY LOAM; WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY WEAK, VERY FINE TO FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

BC: 71 TO 75 CM, RANGE 0 TO 7 CM; MATRIX MOIST 7.5YR 5/4, MATRIX MOIST 7.5YR 4/4; GRAVELLY SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; 60% GRAVELLY AND ANGULAR GRAVELLY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

2BC: 64 TO 77 CM, RANGE 0 TO 22 CM; ANGULAR GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

R: 77 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	2.0	55.2						
AE	3.2	1.7	13.5		0.2	-.1	-.1	0.1
B+AU	4.0	3.3	23.8		0.1	-.1	-.1	0.1
BHFCJU	4.1	6.7	46.3		0.1	-.1	-.1	0.1
BF	4.3	3.6	36.7		0.1	-.1	-.1	-.1
BC								
2BC								
R								

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AE	-.1		0.1		0.0
B+AU	0.5		0.4		0.0
BHFCJU	0.8		1.5		-.1
BF	0.6		1.3		0.0
BC					
2BC					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AE					3	12	15	17	12	59		35	6	
B+AU					6	15	16	17	11	65		29	6	
BHFCJU					6	17	18	17	10	68		27	5	
BF	99	76	53	37	6	15	17	17	10	65		28	7	
BC														
2BC														
R														

PHYSICAL DATA

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
B+AU													
BHFCJU													
BF		24.2	13.8			0	0						03
BC													
2BC													
R													

Table D19. Pedon (Alberta 1983 No. 47) describing an Orthic Humo-Ferric Podzol of the HR6 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: HR6.

LOCATION: MILITARY GRID REF. 11 UMG 5980 8080; NTS MAP AREA 82N 5*.

CLIMATE: 1930 METERS ABOVE MEAN SEA LEVEL. STATION AT MT FIDELITY HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 20 CM IN JULY, NO. 2 WAS 5 DEG(C) AT 40 CM IN JULY.

VEGETATION: VPN=HD3003*VTN=020*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, METAMORPHIC; DEPTH TO BEDROCK IS 0.4 M; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED, VENEER; SLOPE: 80% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING SOUTH, SITE AT UPPER SLOPE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,800 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, VERY RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; MODERATELY ROCKY.

SPECIAL NOTES: SSN=BW3003*DATE=83/07/28*APN=BC5391-100*LFM=CV/RI + R WITH MINOR AVALANCHING*LITHIC PHASE*HUMUS ACCUMULATION IN A ZONE ABOVE BEDROCK*SLOPES FROM 60% ON BENCHES TO 790% ON ROCKY RISERS

LF: 1 TO 0 CM, RANGE 0 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; FEW, MICRO ROOTS; 10% ANGULAR GRAVELLY AND SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 13 CM, RANGE 10 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 50% ANGULAR GRAVELLY AND SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AB: 13 TO 27 CM, RANGE 7 TO 18 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3, MATRIX MOIST 10YR 4/4; FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% ANGULAR GRAVELLY AND SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF: 27 TO 39 CM, RANGE 11 TO 15 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/3, MATRIX MOIST 7.5YR 3/2; FINE SANDY LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 50% ANGULAR GRAVELLY AND SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

R: 39 CM

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	3.7	29.9						
AE	3.4	2.7	14.1		0.2	0.1	-.1	0.1
AB	4.0	1.8	15.2		-.1	-.1	-.1	0.1
BF	4.1	4.9	33.8		0.1	-.1	-.1	0.2
R								

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
AE					
AB	0.4		0.2		-.1
BF	0.9		0.6		-.1
R					

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING										% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AE					4	6	8	23	15	56		39	5	
AB					6	7	8	23	15	59		37	4	
BF					2	4	7	22	22	57		37	6	
R														

Table D20. Pedon (Alberta 1983 No. 48) describing an Orthic Dystric Brunisol of the JD2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: JD2.

LOCATION: MILITARY GRID REF. 11 UMG 5950 8120; NTS MAP AREA 82N 5*.

CLIMATE: 2080 METERS ABOVE MEAN SEA LEVEL. STATION AT MT FIDELITY HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 20 CM IN JULY.

VEGETATION: VPN=HD3005*VTN=L5*.

SOIL SITE: PARENT MATERIAL 1: UNSPECIFIED WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, FLUVIAL, UNDIFFERENTIATED OR UNDETERMINED; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL); DEPTH TO BEDROCK IS 0.3 M; LANDFORM CLASSIFICATION: MORAINAL, VENEER; SLOPE: 21% COMPLEX SLOPE OF CLASS 7 (31-45%), FACING WEST, SITE AT UPPER SLOPE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,100 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE PRESENT, 0.3 M TO PERCHED WATERTABLE; MODERATELY STONY; MODERATELY ROCKY.

SPECIAL NOTES: SSN=BW3005*DATE=83/07/28*APN=BC5391-100*LFM=FV/MV/RH*LITHIC PHASE*IRREGULAR BEDROCK SURFACE;MINOR SEEPAGE AND MATERIAL SORTING ALONG TROUGHS*0-1CM FHB ON BEDROCK SURFACE;THICKEST IN TROUGHS*MINOR MOTTLES OR BLOTCHES IN 2BC*

H: 6 TO 0 CM, RANGE 5 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/1, MATRIX MOIST 10YR 2/1; SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BHF: 0 TO 2 CM, RANGE 1 TO 3 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/2; FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

2BM: 2 TO 12 CM, RANGE 8 TO 13 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/4, MATRIX MOIST 10YR 3/3; GRAVELLY SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 50% GRAVELLY AND ANGULAR GRAVELLY AND SLATY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2BC: 12 TO 24 CM, RANGE 4 TO 15 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/3; GRAVELLY FINE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO ROOTS; 50% GRAVELLY AND ANGULAR GRAVELLY AND SLATY AND COBBLY AND ANGULAR COBBLY COARSE FRAGMENTS; IRREGULAR, ABRUPT HORIZON BOUNDARY.

R: 24 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
H	3.7	20.3	67.3		0.7	0.3	0.2	0.5
BHF	4.0	7.9	57.3		0.1	-.1	-.1	0.1
2BM	4.2	1.4	11.4		-.1	-.1	-.1	-.1
2BC	4.2		2.6		-.1	-.1	-.1	-.1
R								

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
H					
BHF	0.9		1.1		0.0
2BM	0.3		0.2		0.0
2BC					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING										% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
H					1	2	4	11	6	24		64		12
BHF					1	5	4	9	9	28		64		8
2BM					8	9	10	27	20	74		21		5
2BC	99	88	68	54	4	6	8	28	23	69		29		2
R														

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
H													
BHF													
2BM													
2BC		5.9	1.7										18
R													

Table D21. Pedon (Alberta 1983 No. 53) describing an Orthic Humo-Ferric Podzol of the JD3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978. SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: JD3.

LOCATION: MILITARY GRID REF. 11 UMG 5350 6620; NTS MAP AREA 82N 4*.

CLIMATE: 2150 METERS ABOVE MEAN SEA LEVEL. STATION AT MT FIDELITY HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=HD3009*VTN=H16*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), SLATE; PARENT MATERIAL 2: FRACTURED WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), RESIDUAL, SLATE; DEPTH TO BEDROCK IS 0.7 M; LANDFORM CLASSIFICATION: MORAINAL, AVALANCHED AND SOLIFLUCTED AND GULLIED, VENEER; SLOPE: 32% COMPLEX SLOPE OF CLASS 7 (31-45%), FACING SOUTHWEST, SITE AT LOWER SLOPE POSITION, SEVERELY MOUNDED MICROTOPOGRAPHY,30 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE.ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3010*DATE=83/07/31*APN=BC5391-039*LFM=MV/RUV/RH-S,A,V*LITHIC PHASE*LOW COARSE FRAGMENTS NEAR SURFACE PROB DUE TO SOLIFLUCTION + EOLIAN ADDITIONS*DARK COLORS INHERITED*

AHE: 0 TO 5 CM, RANGE 3 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/1.5; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY WEAK, FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

BHF: 5 TO 13 CM, RANGE 4 TO 10 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/3, MATRIX MOIST 7.5YR 3/2; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; WEAK, FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, VERY FINE AND FINE AND MEDIUM ROOTS; 10% SLATY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BF: 13 TO 33 CM, RANGE 17 TO 27 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/1; SILT LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; MANY, MICRO PORES; 40% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY; STRONGLY ACID 5.1-5.5 FIELD PH.

2BC1: 33 TO 54 CM, RANGE 11 TO 27 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/2, MATRIX MOIST 10YR 3/3; GRAVELLY SILT LOAM; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 60% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2BC2: 54 TO 71 CM, RANGE 13 TO 24 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/0; VERY GRAVELLY SILT LOAM; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 80% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

R: 71 CM

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
AHE	4.2	10.2	33.8		2.3	0.9	-.1	0.8
BHF	4.3	5.9	30.8		0.2	0.1	-.1	0.1
BF	4.5	2.2	10.6		-.1	-.1	-.1	-.1
2BC1	4.7	1.2	5.4		-.1	-.1	-.1	-.1
2BC2	4.8	3.7	6.1		-.1	-.1	-.1	-.1
R								

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
AHE					
BHF	1.4		0.7		-.1
BF	0.5		0.3		-.1
2BC1	0.3		0.1		-.1
2BC2					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING				% OF SAMPLE											
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
AHE										26		64	10		
BHF										25		65	10		
BF	99	99	94	74						36		59	5		1.3
2BC1										41		55	4		
2BC2	99	99	79	52						41		54	5		
R															

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
AHE													
BHF													
BF						37	41						09
2BC1													
2BC2		24.5	4.4			38	44						17
R													

Table D22. Pedon (Alberta 1983 No. 55) describing an Orthic Humo-Ferric Podzol of the JD4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: JD4.

LOCATION: MILITARY GRID REF. 11 UMG 2050 5640; NTS MAP AREA 82M 1*.

CLIMATE: 1880 METERS ABOVE MEAN SEA LEVEL. STATION AT REVELSTOKE HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=SD3012*VTN=020*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), METAMORPHIC; LANDFORM CLASSIFICATION: MORAINAL, AVALANCHED AND SOLIFLUCTED AND GULLIED, BLANKET; SLOPE: 39% COMPLEX SLOPE OF CLASS 7 (31-45%), FACING NORTHWEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,50 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3012*APN=BC5378-130*DATE=83/08/16*LFM=MB/RR -MINOR SOLIFLUCTION,GULLYING,AVALANCHING*UPPER 2 MIN HOR'S WEAKLY DISRUPTED;MIX OF EOLIAN,FLUV,TILL MATERIALS* BF2 CLR 2 -MINOR STREAKS,BLOTCHES,AROUND FRAGMENTS*

L: 3 TO 0 CM, RANGE 2 TO 5 CM; MATRIX MOIST 5YR 2.5/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AHEU: 0 TO 8 CM, RANGE 6 TO 10 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/2; FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY WEAK, VERY FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 40% GRAVELLY AND CHANNERY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BFU: 8 TO 25 CM, RANGE 12 TO 20 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/3, MATRIX MOIST 5YR 3/4; FINE SANDY LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; WEAK, VERY FINE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 40% GRAVELLY AND CHANNERY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF1: 25 TO 39 CM, RANGE 10 TO 19 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/6; GRAVELLY FINE SANDY LOAM; MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 50% GRAVELLY AND CHANNERY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

BF2: 39 TO 57 CM, RANGE 12 TO 24 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/5, MATRIX MOIST 5YR 4/4; GRAVELLY SANDY LOAM; MODERATE TO STRONG, VERY COARSE, PLATY STRUCTURE; MODERATE TO STRONG, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO ROOTS; MANY, MICRO PORES; 50% GRAVELLY AND CHANNERY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; SMOOTH, GRADUAL HORIZON BOUNDARY.

BCCJ: 57 TO 94 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; MODERATE TO STRONG, COARSE, PLATY SECONDARY STRUCTURE; FIRM CONSISTENCE; MANY, MICRO AND VERY FINE PORES; 50% GRAVELLY AND CHANNERY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
L	3.0	62.0						
AHEU	3.5	6.2	27.9		0.1	0.1	-.1	0.2
BFU	4.1	3.5	31.4		-.1	-.1	-.1	0.1
BF1	4.3	2.3	29.1		0.1	-.1	-.1	0.1
BF2	4.4	1.1	17.6		0.1	-.1	-.1	0.1
BCCJ	4.6		13.5		0.1	-.1	-.1	0.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
L					
AHEU	0.2		0.2		0.0
BFU	1.2		0.6		0.0
BF1	1.1		0.6		0.0
BF2	0.3		0.4		0.0
BCCJ	0.1		0.2		0.0

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS															
	% PASSING										% OF SAMPLE					
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
L															
AHEU					2	9	12	11	11	45		49	6		
BFU					1	9	16	19	11	56		35	9		
BF1					2	10	17	19	10	58		31	11		
BF2					3	12	18	18	10	61		30	9		
BCCJ	99	74	64	52	3	11	16	18	10	58		32	10		2.0

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L													
AHEU													
BFU													
BF1													
BF2													
BCCJ		15.7	6.6			25	31						18

Table D23. Pedon (Alberta 1983 No. 62) describing an Orthic Ferro-Humic Podzol of the JN2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC FERRO-HUMIC PODZOL. SOIL MAP UNIT: NOTATION: JN2.

LOCATION: MILITARY GRID REF. 11 UMG 8330 8170; NTS MAP AREA 82N 6*.

CLIMATE: 2320 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 6 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=SD3006*VTN=H18*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL), MIXED AND SCHIST AND PHYLLITE; PARENT MATERIAL 2: SHATTERED WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), RESIDUAL, MIXED AND SCHIST AND PHYLLITE; LANDFORM CLASSIFICATION: MORAINAL, VENEER; SLOPE: 17% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING SOUTH, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA3006*DATE=83/07/29*APN=391-104*EOLIAN + TILL MIXTURE IN AH AND BHF HORIZONS*

LFH: 3 TO 0 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS.

AH: 0 TO 4 CM, RANGE 3 TO 6 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/2; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 10% ANGULAR GRAVELLY AND SLATY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BHF1: 4 TO 9 CM, RANGE 0 TO 8 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 2.5/2; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; 10% ANGULAR GRAVELLY AND SLATY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BHF2: 9 TO 16 CM, RANGE 3 TO 12 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/6; VERY GRAVELLY SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 10% ANGULAR GRAVELLY AND SLATY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BC: 16 TO 49 CM, RANGE 20 TO 41 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/6; VERY GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; 80% GRAVELLY AND ANGULAR GRAVELLY AND CHANNERY AND SLATY AND ANGULAR COBBLY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BC: 49 TO 70 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/4; COARSE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; 30% SLATY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH								
AH	3.9	10.8	38.5		0.9	0.5	0.1	0.5
BHF1	4.1	12.0	63.9		0.4	0.2	0.1	0.2
BHF2	4.4	5.5	41.1		0.2	0.1	0.1	0.1
BC	4.5		7.9		0.1	-.1	-.1	0.1
2BC	4.4		6.7		0.1	-.1	-.1	0.1

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LFH					
AH					
BHF1	1.5		1.5		-.1
BHF2	0.7		1.3		-.1
BC					
2BC					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH														
AH					4	6	7	7	7	31		58	11	
BHF1					4	9	7	7	7	34		54	12	
BHF2					6	12	7	7	7	39		53	8	
BC	99	83	50	31	9	18	15	9	4	55		38	7	
2BC	99	83	55	37	11	16	11	10	5	53		40	7	

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	ENGINEERING OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AH													
BHF1													
BHF2													
BC		22.6	4.7			28	33						17
2BC		24.9	4.3			28	31						03

Table D24. Pedon (Alberta 1983 No. 33) describing an Eluviated Dystric Brunisol of the KX1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: KX1.

LOCATION: MILITARY GRID REF. 11 UMG 7030 8940; NTS MAP AREA 82N 6*.

CLIMATE: 920 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS MODERATE RELEVANCE TO THE SOIL SITE.

VEGETATION: VPN=MF3001*VTN=C52*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, EOLIAN; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND SANDY, EXTREMELY TO STRONGLY ACIDIC (PH.5.5), GLACIOFLUVIAL, MIXED; LANDFORM CLASSIFICATION: GLACIO FLUVIAL, TERRACED; SLOPE: 0% SIMPLE SLOPE OF CLASS 1 (0-0.5%), FACING LEVEL, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, SLOW SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT3001*APN=391-140*LFM=EV/FGT*DATE=260783*PH=5.3 AT 30CM*HZN4 IS BRITTLE*

LF: 5 TO 0 CM, RANGE 4 TO 7 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, HORIZONTAL ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 4 CM, RANGE 2 TO 5 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 6/1; SILT LOAM; WEAK, FINE, PLATY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE, HORIZONTAL ROOTS; 10% GRAVELLY COARSE FRAGMENTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BM: 4 TO 12 CM, RANGE 5 TO 23 CM; HORIZON MOIST; MATRIX MOIST 5YR 5/6, MATRIX DRY 7.5YR 6/6; SILT LOAM; VERY WEAK, VERY FINE TO FINE, ANGULAR BLOCKY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; WAVY, CLEAR HORIZON BOUNDARY.

2BM: 12 TO 24 CM, RANGE 7 TO 16 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/5; SANDY LOAM; WEAK, FINE TO MEDIUM, ANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; WEAKLY CEMENTEDBY HUMUS-ALUMINUM AND IRON, DISCONTINUOUS; FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 30% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BC: 24 TO 70 CM, RANGE 25 TO 50 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/4; GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 50% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY; STRONGLY ACID 5.1-5.5 FIELD PH.

2C: 70 TO 105 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 70% GRAVELLY AND CHANNERY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.1	58.6						
AE	3.1	2.2	20.2		0.2	-.1	-.1	0.2
BM	5.2	3.0	34.9		0.2	-.1	-.1	0.2
2BM	5.1	0.5	8.8		0.2	-.1	-.1	0.1
2BC	5.0		2.4		0.1	-.1	-.1	-.1
2C	4.8		2.9		0.1	-.1	-.1	-.1

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AE					
BM	0.1		0.4		-.1
2BM	-.1		0.1		0.0
2BC	-.1		-.1		0.0
2C					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AE					1	5	5	9	11	31		66	3	
BM					6	9	6	6	13	40		54	6	
2BM					5	14	13	14	7	53		43	4	
2BC					12	26	22	12	5	77		22	1	
2C	99	70	45	28	9	22	24	15	6	76		22	2	

PHYSICAL DATA

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BM													
2BM													
2BC													
2C		10.6	2.5			0	0						01

Table 25. Pedon (Alberta 1983 No. 60) illustrating gleyed Podzolic soils of the LK1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: GLEYED HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: LK1.

LOCATION: MILITARY GRID REF. 11 UMG 7240 6910; NTS MAP AREA 82N 3*.

CLIMATE: 1820 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 5 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=SD3004*VTN=C21*.

SOIL SITE: PARENT MATERIAL 1: UNSPECIFIED WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), FLUVIAL; PARENT MATERIAL 2: UNSPECIFIED WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), MORAINAL (TILL); LANDFORM CLASSIFICATION: MORAINAL, BLANKET; SLOPE: 7% COMPLEX SLOPE OF CLASS 4 (6-9%), FACING NORTHEAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: IMPERFECTLY DRAINED, SLOWLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE PRESENT, 0.5 M TO WATERTABLE; NONSTONY; NONROCKY.

SPECIAL NOTES: SSN=DA3004*DATE=83/07/28*LFM=FV/MB/RH*APN=391-085* AH NOT SAMPLED*

LF: 5 TO 0 CM, RANGE 3 TO 7 CM; HORIZON MOIST; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AC: 0 TO 8 CM, RANGE 6 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 3.5/3; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AH: 8 TO 9 CM, RANGE 0 TO 3 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; SILT LOAM; WEAK TO MODERATE, FINE, GRANULAR STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

ABG: 9 TO 21 CM, RANGE 10 TO 14 CM; HORIZON MOIST; MATRIX MOIST 10YR 3.5/2; SILT LOAM; FEW, MEDIUM, PROMINENT, 5YR 4/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY SECONDARY STRUCTURE PSEUDO; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

BFG: 21 TO 36 CM, RANGE 12 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 10YR 5/3; SILT LOAM; MANY, COARSE, PROMINENT, 2.5YR AND 5YR 4/8 MOTTLES; 5YR 5/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

ACGB: 36 TO 46 CM, RANGE 9 TO 11 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 5/2; SILT LOAM; COMMON, MEDIUM, PROMINENT, 2.5YR 4/8 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AHB: 46 TO 50 CM, RANGE 2 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; SILT LOAM; STRUCTURELESS, MASSIVE STRUCTURE; FRIABLE CONSISTENCE; SMOOTH, ABRUPT HORIZON BOUNDARY.

2BCG: 50 TO 65 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 6/4; SILT LOAM; MANY, MEDIUM, PROMINENT, 7.5YR 5/8 MOTTLES; 7.5YR 5/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; FIRM CONSISTENCE; 30% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.6	52.1						
AC	3.6	6.7	31.4		1.0	0.2	0.1	0.2
AH								
ABG	4.2	3.0	18.5		0.8	-.1	0.1	0.1
BFG	4.5	2.6	20.3		1.2	0.1	-.1	0.1
ACGB	4.6	4.3	25.5		1.6	0.1	-.1	0.1
AHB	4.5	10.4	59.5		5.3	0.3	-.1	0.1
2BCG	4.5	0.2	3.7		0.7	0.1	-.1	0.1

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
AC	0.4		0.3		0.0
AH					
ABG	0.3		0.5		0.0
BFG	0.5		0.5		0.0
ACGB	0.4		0.6		0.0
AHB					
2BCG					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	% OF SAMPLE TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
AC										16		74	10		
AH															
ABG										23		68	9		
BFG										25		67	8		
ACGB										22		68	10		
AHB										18		65	17		
2BCG	99	99	96	90						28		66	6		1.9

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AC													
AH													
ABG													
BFG													
ACGB													
AHB													
2BCG		23.0	2.7			20	22						19

Table D26. Pedon (Alberta 1983 No. 45) describing an Eluviated Dystric Brunisol of the LR1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: LR1.

LOCATION: MILITARY GRID REF. 11 UMH 6630 10; NTS MAP AREA 82N 6*.

CLIMATE: 830 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 7 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=HD3001*VTN=C44*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, STRATIFIED (MINERAL) AND SANDY, EXTREMELY TO STRONGLY ACIDIC (PH.5.5), FLUVIAL, MIXED AND METAMORPHIC; LANDFORM CLASSIFICATION: FLUVIAL, ERODED(CHANNELLED), FAN; SLOPE: 3% SIMPLE SLOPE OF CLASS 3 (2-5%), FACING SOUTHEAST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY; FRESENT LAND USE: OUTDOCR RECREATION.

SPECIAL NOTES: SSN=8W3001*DATE=83/07/26*APN=8C5391-217*POSSIBLY EOLIAN MATTER INCLUDED IN AE & BM1* THIN DISCONT 5YR4/6M BAND AT TOP BM1*WEAK PATCHY BRITTLENESS IN BC1*

LF: 5 TO 0 CM, RANGE 3 TO 9 CM; MATRIX MOIST 10YR 2/2; ABUNDANT, MICRO AND VERY FINE AND FINE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 4 CM, RANGE 1 TO 11 CM; HORIZON MOIST; MATRIX MOIST 5YR 5/1, MATRIX MOIST 10YR 4/2; GRAVELLY SILT LOAM; WEAK, VERY FINE TO FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM1: 4 TO 21 CM, RANGE 12 TO 20 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6, MATRIX MOIST 5YR 4/6; GRAVELLY SILT LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 50% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM2: 21 TO 41 CM, RANGE 16 TO 30 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/6; GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; 60% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC1: 41 TO 49 CM, RANGE 0 TO 15 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 70% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BC2: 49 TO 60 CM, RANGE 0 TO 22 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/4; VERY GRAVELLY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE ROOTS; 70% GRAVELLY AND COBBLY COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BC3: 60 TO 90 CM; HORIZON MOIST; MATRIX MOIST 10YR 5.5/4; GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE ROOTS; 70% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; STRONGLY ACID 5.1-5.5 FIELD PH.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	4.2	60.1						
AE	3.3	2.0	17.9		0.8	0.1	-.1	0.2
BM1	4.8	4.6	54.9		0.5	-.1	-.1	0.2
BM2	4.5	0.6	6.5		0.2	-.1	-.1	-.1
BC1	4.6		2.8		0.2	-.1	-.1	-.1
BC2	4.6		2.4		0.1	-.1	-.1	-.1
BC3	4.7		4.2		0.1	-.1	-.1	-.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
AE					
BM1	0.2		0.7		-.1
BM2	0.1		0.1		0.0
BC1					
BC2					
BC3					

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS													
	% PASSING										% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AE					1	4	4	12	15	36		61	3	
BM1					6	8	6	9	12	41		53	6	
BM2					18	23	16	14	9	80		17	3	
BC1					6	21	21	19	12	79		18	3	
BC2					30	32	14	7	4	87		11	2	
BC3	99	51	32	21	12	26	26	15	7	86		12	2	

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BM1													
BM2													
BC1													
BC2													
BC3		4.1	1.8			0	0						01

Table D27. Pedon (Alberta 1983 No. 66) describing an Orthic Dystric Brunisol of the NC1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: NC1.

LOCATION: MILITARY GRID REF. 11 UMG 6720 9700; NTS MAP AREA 82N 6*.

CLIMATE: 970 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 9 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=SD3010*VTN=C52*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, SCHIST AND PHYLLITE; DEPTH TO BEDROCK IS 0.7 M; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 76% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING WEST, SITE AT LOWER SLOPE POSITION; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA3010*DATE=83/08/01*APN=391-140*LITHIC PHASE*

LF: 3 TO 0 CM, RANGE 2 TO 5 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 1 CM, RANGE 0 TO 8 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/2; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 50% GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BM1: 1 TO 18 CM, RANGE 15 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/6, 7.5YR 5/4; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM2: 18 TO 40 CM, RANGE 19 TO 26 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/4; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BM3: 40 TO 46 CM, RANGE 2 TO 12 CM; MATRIX MOIST 7.5YR 5/8, 7.5YR 5/6; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 50% GRAVELLY AND ANGULAR COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC: 46 TO 74 CM; HORIZON MOIST; MATRIX MOIST 5Y 6/3.5; SILT LOAM; WEAK, FINE, GRANULAR STRUCTURE; STRUCTURELESS, SINGLE GRAIN SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 70% GRAVELLY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS.

R: 74 CM

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	4.4	50.9						
AE	4.5	1.4	7.6		1.8	0.3	-.1	0.1
BM1	4.6	1.3	9.7		1.1	0.1	-.1	0.2
BM2	5.0	1.1	8.9		1.4	0.2	-.1	0.2
BM3	5.4	1.4	14.1		1.6	0.2	-.1	0.2
BC	5.1		3.1		1.0	0.1	-.1	0.1
R								

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
AE					
BM1	0.2		0.2		-.1
BM2	0.1		0.2		0.0
BM3	0.1		0.2		0.0
BC					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING									% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AE										40		57	3	
BM1										40		57	3	
BM2										37		59	4	
BM3										38		60	2	
BC	99	92	66	47						44		53	3	
R														

PHYSICAL DATA

ENGINEERING

	MOISTURE STATUS (%)												
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AE													
BM1													
BM2													
BM3													
BC		13.7	2.7			23	23						07
R													

Table D28. Pedon (Alberta 1983 No. 46) describing an Eluviated Dystric Brunisol of the NC2 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ELUVIATED DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: NC2.

LOCATION: MILITARY GRID REF. 11 UMG 5750 7810; NTS MAP AREA 82N 5*.

CLIMATE: 1190 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 6 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=HD3002*VTN=C50*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, METAMORPHIC AND QUARTZITE; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED AND GULLIED, BLANKET; SLOPE: 75% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING SOUTH, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY,800 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, RAPIDLY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3002*DATE=83/07/27*APN=BC5391-100*LFM=CB/RI-MINOR GULLYING + AVALANCHING*BFB (OR AHB, BFB) PROB OF EOLIAN ORIGIN*MOST B + BC HORIZONS MACRO-BLOTCHY WITH 2 OR MORE COLORS*

LFH: 7 TO 0 CM, RANGE 4 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; WAVY, ABRUPT HORIZON BOUNDARY.

AE: 0 TO 11 CM, RANGE 6 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; GRAVELLY FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BMU: 11 TO 38 CM, RANGE 21 TO 37 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4.5/4, MATRIX MOIST 10YR 5/4; GRAVELLY FINE SANDY LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM: 38 TO 72 CM, RANGE 24 TO 40 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/6, MATRIX MOIST 10YR 5/6; GRAVELLY FINE SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

BC1: 72 TO 88 CM, RANGE 0 TO 25 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 5/4, MATRIX MOIST 5Y 4/3; GRAVELLY FINE SANDY LOAM; VERY WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BFB: 88 TO 95 CM, RANGE 0 TO 16 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; FINE SANDY LOAM; WEAK TO MODERATE, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; BROKEN, ABRUPT HORIZON BOUNDARY.

BCU: 95 TO 122 CM, RANGE 21 TO 50 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/6; GRAVELLY FINE SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC2: 122 TO 140 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 5/4; GRAVELLY FINE SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 60% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LFH	3.3	50.6						
AE	3.4	1.0	11.4		0.8	-.1	0.2	
BMU	3.7	1.0	9.9		0.2	-.1	-.1	
BM	4.1	1.1	9.3		0.4	0.3	0.1	
BC1	4.3		7.8		0.1	-.1	-.1	
BFB	4.5	3.4	44.9		0.3	-.1	-.1	
BCU	4.5	1.0	9.9		0.2	-.1	-.1	
BC2	4.5		5.7		0.1	-.1	-.1	

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LFH					
AE					
BMU	0.3		0.1		0.0
BM	0.3		0.1		0.0
BC1					
BFB	0.2		0.6		-.1
BCU	0.1		0.2		0.0
BC2					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LFH														
AE					7	8	6	13	17	51		43	6	
BMU					4	8	8	16	18	54		41	5	
BM					4	8	7	14	17	50		46	4	
BC1					8	8	6	12	15	49		48	3	
BFB					3	6	6	13	20	48		46	6	
BCU					6	9	8	17	18	58		39	3	
BC2	99	58	40	29	8	11	8	15	17	59		37	4	

PHYSICAL DATA

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LFH													
AE													
BMU													
BM													
BC1													
BFB													
BCU													
BC2		9.2	2.1			0	0						03

Table 29. Pedon (Alberta 1983 No. 51) illustrating Podzolic soils of the NC5 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: SOMBRIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: NC5.

LOCATION: MILITARY GRID REF. 11 UMG 6550 7980; NTS MAP AREA 82N 6*.

CLIMATE: 1310 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS GOOD RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 7 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=PA3004*VTN=S13*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, METAMORPHIC; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED, APRON; SLOPE: 52% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, SLIGHTLY MOUNDED MICROTOPOGRAPHY, 500 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; VERY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3008*DATE=83/07/30*APN=BC5391-101*LFM=CA-A*L MAINLY ALDER LEAVES*AH BLOTCHY*UPPER 65CM HAS DARK REDDISH TINGE, HUMUS RICH;A OR B HORIZONS?*BF + LOWER AB TILL-LIKE;PERHAPS MUD-OR DEBRIS FLOW MATERIAL*

L: 1 TO 0 CM, RANGE 0 TO 2 CM; MATRIX MOIST 2.5YR 3/4; BROKEN, ABRUPT HORIZON BOUNDARY.

AH: 0 TO 19 CM, RANGE 11 TO 25 CM; HORIZON MOIST; MATRIX MOIST 5YR 2.5/2; FINE SANDY LOAM; VERY WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY WEAK, VERY FINE, GRANULAR SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM AND COARSE ROOTS; 60% SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AB: 19 TO 65 CM, RANGE 40 TO 56 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2; SILT LOAM; WEAK TO MODERATE, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 60% SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BF: 65 TO 117 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4.5/4; SILT LOAM; MODERATE, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE ROOTS; 40% SLATY AND ANGULAR COBBLY AND FLAGGY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
L								
AH	4.2	7.6	24.4		8.3	1.1	-.1	0.2
AB	4.7	3.8	15.3		5.4	1.0	-.1	0.1
BF	5.0	1.0	7.3		2.2	0.5	-.1	-.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
L					
AH	0.4		-.1		-.1
AB	0.5		0.1		-.1
BF	0.5		0.1		-.1

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

	% PASSING										% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
L															
AH										46		49	5		
AB										40		55	5		
BF	99	82	73	64						33		61	6		1.4

PHYSICAL DATA

ENGINEERING

	MOISTURE STATUS (%)												
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
L													
AH													
AB													
BF		21.7	5.9			30	35						18

Table D30. Pedon (Alberta 1983 No. 43) describing an Orthic Dystric Brunisol of the NC6 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: NC6.

LOCATION: MILITARY GRID REF. 11 UMG 3400 5700; NTS MAP AREA 82N 4*.

CLIMATE: 1000 METERS ABOVE MEAN SEA LEVEL. STATION AT REVELSTOKE HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 13 DEG(C) AT 50 CM IN AUGUST.

VEGETATION: VPN=MF3015*VTN=015 CLOSED VARIANT*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, METAMORPHIC; LANDFORM CLASSIFICATION: COLLUVIAL, VENEER; SLOPE: 85% SIMPLE SLOFE OF CLASS 9 (71-100%), FACING SOUTHEAST, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: RAPIDLY DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY STONY; MODERATELY ROCKY.

SPECIAL NOTES: SSN=WT3015*DATE=02/08/83*LFM=CV/RI*BC FRAGMENTAL, NO SAMPLE*PH=5.3 AT 25 CM*APN=391-033*

LF: 6 TO 0 CM, RANGE 2 TO 8 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/1; PLENTIFUL, FINE AND MEDIUM AND MICRO AND VERY FINE, RANDOM ROOTS; 10% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

AB: 0 TO 11 CM, RANGE 8 TO 15 CM; HORIZON MOIST; MATRIX MOIST 5YR 4/5; LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; MODERATE, FINE, GRANULAR SECONDARY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM AND COARSE AND MICRO AND VERY FINE, RANDOM ROOTS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM1: 11 TO 63 CM, RANGE 45 TO 70 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/6, MATRIX MOIST 7.5YR 5/6; FINE SANDY LOAM; VERY WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; WEAK, FINE, GRANULAR SECONDARY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM AND COARSE AND MICRO AND VERY FINE, RANDOM ROOTS; 50% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; IRREGULAR, CLEAR HORIZON BOUNDARY; STRONGLY ACID 5.1-5.5 FIELD PH.

BM2: 63 TO 92 CM, RANGE 15 TO 35 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/5; FINE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, FINE AND MEDIUM AND COARSE AND MICRO AND VERY FINE, RANDOM ROOTS; 70% ANGULAR GRAVELLY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; IRREGULAR, CLEAR HORIZON BOUNDARY.

BC: 92 TO 105 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, FINE AND MEDIUM AND COARSE AND MICRO AND VERY FINE, RANDOM ROOTS; STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	5.2	52.8						
AB	5.4	5.7	37.9		6.5	0.7	-.1	0.4
BM1	5.1	2.8	32.0		1.9	0.2	-.1	0.2
BM2	4.8	0.7	14.1		0.9	-.1	-.1	-.1
BC								

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
LF					
AB	0.2		0.5		-.1
BM1	0.1		0.5		0.0
BM2					
BC					

PHYSICAL DATA (SURVEY)

	% PASSING				PARTICLE SIZE ANALYSIS						% OF SAMPLE			
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AB					2	8	12	15	13	50		43	7	
BM1					6	12	12	14	12	56		38	6	
BM2	99	64	52	48	1	6	17	28	15	67		30	3	
BC														

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AB													
BM1													
BM2		13.5	4.7			0	0						03
BC													

Table D31. Pedon (Alberta 1983 No. 39) describing an Orthic Dystric Brunisol of the RD3 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: RD3.

LOCATION: MILITARY GRID REF. 11 UMG 7450 9310; NTS MAP AREA 82N 6*.

CLIMATE: 2350 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=MF3007*VTN=LS*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, EOLIAN; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, SCHIST AND PHYLLITE; PARENT MATERIAL 3: CHEMICAL AND PHYSICAL WEATHERING, FRAGMENTAL (STONES,COBBLES AND GRAVEL), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), RESIDUAL, SCHIST AND PHYLLITE; DEPTH TO BEDROCK IS 0.9 M; LANDFORM CLASSIFICATION: COLLUVIAL, SOLIFLUCTED, VENEER; SLOPE: 40% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING WEST, SITE AT MIDDLE POSITION, 120 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; SLIGHTLY STONY; SLIGHTLY ROCKY.

SPECIAL NOTES: SSN=WT3007*DATE=29/07/83*LFM=EV/CV/RUV/RI-S*TURBIC PHASE IS COMMON IN VICINITY*PH AT 32 CM=5.2*HZN 8 IS FRAGMENTAL*APN=391-139*

LF: 10 TO 7 CM, RANGE 2 TO 4 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/2; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; SMOOTH, GRADUAL AND ABRUPT HORIZON BOUNDARY.

H: 7 TO 0 CM, RANGE 4 TO 10 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 3/1; SILT LOAM; WEAK TO MODERATE, VERY FINE, GRANULAR STRUCTURE; FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; 10% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BHF1: 0 TO 3 CM, RANGE 0 TO 5 CM; HORIZON MOIST; MATRIX MOIST 5YR 3/2; SILT LOAM; WEAK TO MODERATE, VERY FINE, GRANULAR STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 10% CHANNERY COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

BHF2: 3 TO 6 CM, RANGE 0 TO 6 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/6; SILT LOAM; WEAK, FINE, ANGULAR BLOCKY STRUCTURE; VERY WEAK, FINE, GRANULAR SECONDARY STRUCTURE; FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 10% CHANNERY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

2BM1: 6 TO 27 CM, RANGE 8 TO 22 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 2.5Y 5/3; GRAVELLY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 50% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; STRONGLY ACID 5.1-5.5 FIELD PH.

2BM2: 27 TO 57 CM, RANGE 24 TO 33 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; VERY FEW, MICRO AND VERY FINE, RANDOM ROOTS; 70% CHANNERY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BC: 57 TO 80 CM, RANGE 20 TO 30 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 5/4, MATRIX MOIST N 5; GRAVELLY FINE SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; 80% CHANNERY AND FLAGGY COARSE FRAGMENTS; WAVY, GRADUAL HORIZON BOUNDARY.

3BC: 80 TO 98 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 5/4, MATRIX MOIST N 5; SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; LOOSE CONSISTENCE; CHANNERY AND FLAGGY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
LF	4.1	54.8						
H	4.0	21.5	79.0		7.6	0.7	-.1	0.4
BHF1	4.3	12.9	89.6		2.8	0.2	0.1	0.1
BHF2	4.8	9.2	73.1		2.2	0.1	-.1	0.1
2BM1	4.6	1.7	16.4		0.6	-.1	-.1	-.1
2BM2	4.8	0.3	7.1		0.3	-.1	-.1	-.1
2BC	4.8		6.9		0.5	0.1	-.1	-.1
3BC	5.0							

HORIZON	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		EXTR MN (%)
	1	2	1	2	
LF					
H					
BHF1	1.3		1.7		0.0
BHF2	0.5		1.0		0.0
2BM1	0.3		0.3		-.1
2BM2	0.1		0.1		-.1
2BC					
3BC					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING										% OF SAMPLE			
	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
H					3	8	6	9	4	30		70	0	
BHF1					1	4	5	7	8	25		62	13	
BHF2					1	3	2	3	14	23		67	10	
2BM1					4	12	11	13	9	49		44	7	
2BM2					5	15	15	16	8	59		36	5	
2BC	99	57	35	24	3	12	13	16	10	54		41	6	
3BC	99	34	14	6	4	20	16	15	7	62		33	5	

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%)					ENGINEERING							
	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
H													
BHF1													
BHF2													
2BM1													
2BM2													
2BC		15.8	3.7			20	21						03
3BC		15.8	4.7			17	24						02

Table D32. Pedon (Alberta 1983 No. 37) describing an Orthic Humo-Ferric Podzol of the RD4 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC HUMO-FERRIC PODZOL. SOIL MAP UNIT: NOTATION: RD4.

LOCATION: MILITARY GRID REF. 11 UMG 6120 8130; NTS MAP AREA 82N 5*.

CLIMATE: 2500 METERS ABOVE MEAN SEA LEVEL. STATION AT MT FIDELITY HAS POOR RELEVANCE TO THE SOIL SITE.

VEGETATION: VPN=MF3005*VTN=L5*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, SCHIST AND PHYLLITE AND QUARTZITE; DEPTH TO BEDROCK IS 1 M; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED AND SOLIFLUCTED, VENEER; SLOPE: 70% SIMPLE SLOPE OF CLASS 9 (71-100%), FACING SOUTHWEST, SITE AT MIDDLE POSITION, 270 M LONG; SOIL MOISTURE AND DRAINAGE: WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; EXCEEDINGLY STONY; SLIGHTLY ROCKY.

SPECIAL NOTES: SSN=WT3005*DATE=280783*APN=391-101*LFM=CV/RI-S,A*PEDON TURBIC AND LITHIC PHASES*PH=4.8 AT 30 CM*

LF: 3 TO 0 CM, RANGE 5 TO 1 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 30% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

AHE: 0 TO 4 CM, RANGE 3 TO 6 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 5/2; SILT LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 50% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM: 4 TO 16 CM, RANGE 4 TO 16 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/4; SILT LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 60% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

AEB: 16 TO 20 CM, RANGE 0 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/2; SILT LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE AND MEDIUM ROOTS; 60% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

A+BU: 20 TO 55 CM, RANGE 20 TO 45 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4, MATRIX MOIST 10YR 5/2; SILT LOAM; WEAK, MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW ROOTS; 60% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; VERY STRONGLY ACID 4.6-5.0 FIELD PH.

BF: 55 TO 71 CM, RANGE 8 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/4; FINE SANDY LOAM; WEAK, FINE AND MEDIUM, SUBANGULAR BLOCKY STRUCTURE; STRUCTURELESS, MASSIVE SECONDARY STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW ROOTS; 60% ANGULAR COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BC: 71 TO 95 CM, RANGE 15 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 6/5; FINE SANDY LOAM; COMMON, MEDIUM, FAINT, 10YR 5/6 MOTTLES; STRUCTURELESS, MASSIVE STRUCTURE; VERY FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE ROOTS; 30% ANGULAR GRAVELLY AND CHANNERY AND ANGULAR COBBLY COARSE FRAGMENTS.

R: 95 CM

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	C.E.C. (ME/100G) BUFF.	C.E.C. (ME/100G) PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	3.7	18.4						
AHE	3.8	5.3	14.1		0.5	-.1	-.1	0.2
BM	4.4	2.3	13.5		0.1	-.1	0.1	-.1
AEB	4.3	3.6	14.1		0.2	-.1	-.1	0.1
A+BU	4.6	2.4	15.2		0.2	-.1	-.1	-.1
BF	4.7	1.8	15.2		0.2	-.1	-.1	-.1
BC	4.8		3.1		0.1	-.1	-.1	-.1
R								

HORIZON	EXTRACT IRON (%) 1	EXTRACT IRON (%) 2	EXTRACT ALUMINUM (%) 1	EXTRACT ALUMINUM (%) 2	EXTR MN (%)
LF					
AHE					
BM	0.3		0.3		0.0
AEB					
A+BU	0.3		0.4		0.0
BF	0.3		0.4		-.1
BC					
R					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	% OF SAMPLE V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY
LF														
AHE					2	9	3	11	13	38		61	1	
BM					4	8	8	12	12	44		55	1	
AEB					2	8	8	11	11	40		57	3	
A+BU					4	11	10	10	10	45		54	1	
BF					3	8	9	15	16	51		45	4	
BC	99	93	82	71	3	8	11	21	22	65		34	1	
R														

PHYSICAL DATA

ENGINEERING

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
AHE													
BM													
AEB													
A+BU													
BF													
BC		5.2	2.4			0	0						07
R													

Table D33. Pedon (Alberta 1983 No. 52) describing an Orthic Dystric Brunisol of the RD5 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC DYSTRIC BRUNISOL. SOIL MAP UNIT: NOTATION: RD5.

LOCATION: MILITARY GRID REF. 11 UMG 5370 6690; NTS MAP AREA 82N 4*.

CLIMATE: 2410 METERS ABOVE MEAN SEA LEVEL. STATION AT MT FIDELITY HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 2 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=HD3008*VTN=H2*..

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), COLLUVIAL, SLATE; PARENT MATERIAL 2: FRACTURED AND WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), EXTREMELY TO STRONGLY ACIDIC (PH.5.5), RESIDUAL, SLATE; DEPTH TO BEDROCK IS 0.8 M; LANDFORM CLASSIFICATION: COLLUVIAL, AVALANCHED AND SOLIFLUCTED, VENEER; SLOPE: 62% SIMPLE SLOPE OF CLASS 8 (46-70%), FACING SOUTH, SITE AT MIDDLE POSITION, SEVERELY MOUNDED MICROTOPOGRAPHY,300 M LONG; SOIL MOISTURE AND DRAINAGE: MODERATELY WELL DRAINED, MODERATELY PERVIOUS, RAPID SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=BW3009*DATE=83/07/31*APN=BC5391-089*LFM=CV/RUV/RI-S,A*LITHIC PHASE*POOR HORIZON DISTINCTNESS;DARK COLORS INHERITED FROM BEDROCK;HORIZON + PEDON CLASSIFICATION TENUOUS*

AHE: 0 TO 7 CM, RANGE 5 TO 10 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/0, MATRIX MOIST 10YR 2/1.5; SILT LOAM; VERY WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE ROOTS; 10% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

AB: 7 TO 20 CM, RANGE 10 TO 18 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/1; GRAVELLY SANDY LOAM; VERY WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; ABUNDANT, MICRO AND VERY FINE AND FINE ROOTS; 40% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM1: 20 TO 48 CM, RANGE 22 TO 30 CM; HORIZON MOIST; MATRIX MOIST 2.5Y 3/2; GRAVELLY SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE ROOTS; 40% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BM2: 48 TO 67 CM, RANGE 17 TO 24 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; GRAVELLY SILT LOAM; WEAK, FINE TO MEDIUM, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE ROOTS; 40% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2BC: 67 TO 83 CM, RANGE 14 TO 18 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/3; GRAVELLY SILT LOAM; VERY WEAK, MEDIUM TO COARSE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; 70% SLATY AND FLAGGY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY; MEDIUM ACID 5.6-6.0 FIELD PH.

R: 83 CM

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
AHE	4.0	5.0	14.1		1.0	0.4	-.1	0.4
AB	4.5	1.6	7.6		0.1	-.1	-.1	-.1
BM1	4.8	1.1	5.4		0.1	-.1	-.1	-.1
BM2	4.9	0.9	5.2		0.1	-.1	-.1	-.1
2BC	4.8	0.6	3.4		0.1	-.1	-.1	-.1
R								

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
AHE	0.4		0.1		0.0
AB	0.5		0.1		-.1
BM1	0.3		0.1		-.1
BM2	0.2		0.1		0.0
2BC	0.1		-.1		0.0
R					

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS														
	% PASSING				% OF SAMPLE										
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
AHE										33		60	7		
AB										43		49	8		
BM1										40		54	6		
BM2	99	92	80	65						44		50	6		1.5
2BC	99	74	55	44						34		59	7		
R															

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
AHE													
AB													
BM1													
BM2		34.3	4.8			38	40						07
2BC		37.2	3.7			29	36						17
R													

Table D34. Pedon (Alberta 1983 No. 57) describing an Orthic Regosol of the SN1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC REGOSOL. SOIL MAP UNIT: NOTATION: SN1.

LOCATION: MILITARY GRID REF. 11 UMG 6810 9260; NTS MAP AREA 82N 6*.

CLIMATE: 870 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS MODERATE RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 13 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=SD3001*VTN=023*.

SOIL SITE: PARENT MATERIAL 1: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND STRATIFIED (MINERAL), WEAKLY CALCAREOUS (1 TO 6% CACO3), FLUVIAL, MIXED; LANDFORM CLASSIFICATION: FLUVIAL, ERODED(CHANNELLED), FAN; SLOPE: 8% SIMPLE SLOPE OF CLASS 4 (6-9%), FACING NORTH, SITE AT MIDDLE POSITION; SOIL MOISTURE AND DRAINAGE: RAPIDLY DRAINED AND WELL DRAINED, RAPIDLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE ABSENT; MODERATELY STONY; NONROCKY.

SPECIAL NOTES: SSN=DA3001*DATE=83/07/26*APN=391-140*CK HORIZONS LIKE TILL, POSSIBLE MUDFLOW*

LF: 3 TO 0 CM, RANGE 1 TO 5 CM; HORIZON MOIST; MATRIX MOIST 2.5YR 2.5/2; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, HORIZONTAL ROOTS; SMOOTH, ABRUPT HORIZON BOUNDARY.

C1: 0 TO 6 CM, RANGE 2 TO 10 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/0; GRAVELLY LOAMY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, HORIZONTAL ROOTS; 40% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

C2: 6 TO 10 CM, RANGE 0 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; GRAVELLY COARSE SANDY LOAM; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE, HORIZONTAL ROOTS; 40% GRAVELLY COARSE FRAGMENTS; BROKEN, ABRUPT HORIZON BOUNDARY.

C3: 10 TO 16 CM, RANGE 3 TO 11 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/2; VERY GRAVELLY COARSE SAND; STRUCTURELESS, SINGLE GRAIN STRUCTURE; LOOSE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE, HORIZONTAL ROOTS; 60% GRAVELLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK1: 16 TO 31 CM, RANGE 12 TO 21 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; VERY GRAVELLY COARSE SANDY LOAM; WEAK, FINE, SUBANGULAR BLOCKY STRUCTURE; VERY FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE, HORIZONTAL ROOTS; VERY WEAK EFFERVESCENCE; 80% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

CK2: 31 TO 90 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; GRAVELLY SANDY LOAM; STRUCTURELESS, MASSIVE STRUCTURE; WEAK, COARSE, SUBANGULAR BLOCKY SECONDARY STRUCTURE; FRIABLE CONSISTENCE; VERY WEAK EFFERVESCENCE; 40% GRAVELLY AND COBBLY AND STONY (BOULDERY) COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

HORIZON	PH 1	ORG C (%)	CALC CARB EQU.%	C.E.C. (ME/100G) BUFF.	PERM. CHARG	EXCHANGEABLE CATIONS BUFFERED (ME/100G) CA	MG	NA	K
LF	5.4	50.1							
C1	5.5	0.7		3.3		2.4	0.2	-.1	0.1
C2	5.5	0.4		2.5		1.9	0.3	-.1	-.1
C3	5.8	0.5		2.4		2.6	0.1	-.1	-.1
CK1	6.2	0.5	0.4	3.7		3.8	0.4	-.1	0.1
CK2	6.7		1.7						

HORIZON	EXTRACT IRON (%) 1	2	EXTRACT ALUMINUM (%) 1	2	EXTR MN (%)
LF					
C1	-.1		-.1		-.1
C2	-.1		-.1		-.1
C3	-.1		-.1		-.1
CK1					
CK2					

PHYSICAL DATA (SURVEY)

PARTICLE SIZE ANALYSIS

HORIZON	% PASSING 3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	% OF SAMPLE 70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
LF															
C1					8	23	23	18	7	79		20	1		
C2					12	22	13	11	8	66		32	2		
C3	99	74	53	31	16	24	23	16	8	87		13	0		
CK1					15	20	11	8	7	61		35	4		
CK2	99	85	69	57	8	12	10	12	12	54		42	4		2.0

PHYSICAL DATA

HORIZON	MOISTURE STATUS (%) 0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ENGINEERING ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
LF													
C1													
C2													
C3		4.0	2.1			0	0						05
CK1													
CK2		14.6	1.6			19	20						07

Table D35. Pedon (Alberta 1983 No. 40) describing an Orthic Gleysol of the WR1 Ecosite.

CLASSIFICATION: TAXONOMIC SYSTEM OF THE YEAR 1978, SUBGROUP: ORTHIC GLEYSOL. SOIL MAP UNIT: NOTATION: WR1.

LOCATION: MILITARY GRID REF. 11 UMG 7410 9290; NTS MAP AREA 82N 6*.

CLIMATE: 2180 METERS ABOVE MEAN SEA LEVEL. STATION AT ROGERS PASS HAS POOR RELEVANCE TO THE SOIL SITE. SOIL TEMP READING NO. 1 WAS 4 DEG(C) AT 50 CM IN JULY.

VEGETATION: VPN=MF3008*VTN=H16*.

SOIL SITE: PARENT MATERIAL 1: MODERATE CHEMICAL WEATHERING, COARSE LOAMY AND COARSE SILTY (<18% CLAY), UNDIFFERENTIATED, FLUVIAL, MIXED; PARENT MATERIAL 2: WEAK CHEMICAL WEATHERING, SKELETAL (>35% OF PARTICLES 2-25 CM) AND COARSE LOAMY AND COARSE SILTY (<18% CLAY), MEDIUM ACID TO NEUTRAL (PH 5.6-7.3), MORAINAL (TILL), MIXED; LANDFORM CLASSIFICATION: MORAINAL, FAILING, BLANKET; SLOPE: 20% COMPLEX SLOPE OF CLASS 6 (16-30%), FACING WEST, SITE AT MIDDLE POSITION, 180 M LONG; SOIL MOISTURE AND DRAINAGE: POORLY DRAINED, SLOWLY PERVIOUS, MODERATE SURFACE RUNOFF, SEEPAGE PRESENT, 0.7 M TO APPARENT WATERTABLE; SLIGHTLY STONY; NONROCKY.

SPECIAL NOTES: SSN=WT3008*APN=391-139*DATE=29/07/83*LFM=FV/MB/RI-F*PH AT 31CM=6.2*

OFH: 7 TO 0 CM, RANGE 5 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 2/1; ABUNDANT, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; SMOOTH, CLEAR HORIZON BOUNDARY.

AH: 0 TO 6 CM, RANGE 5 TO 8 CM; HORIZON MOIST; MATRIX MOIST 10YR 3/1.5; SILT LOAM; VERY WEAK, FINE, GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; 10% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

BH: 6 TO 10 CM, RANGE 0 TO 5 CM; HORIZON MOIST; MATRIX MOIST 7.5YR 4/6; SILT LOAM; VERY WEAK, FINE, ANGULAR BLOCKY AND GRANULAR STRUCTURE; VERY FRIABLE CONSISTENCE; PLENTIFUL, MICRO AND VERY FINE AND FINE AND MEDIUM, RANDOM ROOTS; 10% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, ABRUPT HORIZON BOUNDARY.

2BM: 10 TO 14 CM, RANGE 0 TO 6 CM; HORIZON MOIST; MATRIX MOIST 10YR 4/3; SILT LOAM; WEAK, FINE TO MEDIUM, ANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 40% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; BROKEN, CLEAR HORIZON BOUNDARY.

2BMGJ: 14 TO 32 CM, RANGE 15 TO 20 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/4; SILT LOAM; MANY, FINE, FAINT, 10YR 5/5 MOTTLES; MODERATE, FINE TO MEDIUM, ANGULAR BLOCKY STRUCTURE; FRIABLE CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; SLIGHTLY POROUS, FEW, VERY FINE, RANDOM, DISCONTINUOUS PORES; 50% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY; SLIGHTLY ACID 6.1-6.5 FIELD PH.

2BCG: 32 TO 56 CM, RANGE 22 TO 30 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3.5; FINE SANDY LOAM; MANY, FINE, FAINT, 10YR 5/5 MOTTLES; FEW, MEDIUM, PROMINENT MOTTLES; MODERATE TO STRONG, MEDIUM TO COARSE, ANGULAR BLOCKY STRUCTURE PSEUDO; FIRM CONSISTENCE; VERY FEW, MICRO AND VERY FINE AND FINE, RANDOM ROOTS; 60% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS; WAVY, CLEAR HORIZON BOUNDARY.

2CG: 56 TO 90 CM; HORIZON MOIST; MATRIX MOIST 10YR 5/3; LOAM; MANY, FINE, FAINT, 10YR 5/5 MOTTLES; FEW, MEDIUM, PROMINENT, 5YR 4/6 MOTTLES; MODERATE TO STRONG, MEDIUM TO COARSE, ANGULAR BLOCKY STRUCTURE PSEUDO; FIRM CONSISTENCE; 60% GRAVELLY AND CHANNERY AND COBBLY COARSE FRAGMENTS.

CHEMICAL DATA (SURVEY)

			C.E.C. (ME/100G)		EXCHANGEABLE CATIONS BUFFERED (ME/100G)			
HORIZON	PH 1	ORG C (%)	BUFF.	PERM. CHARG	CA	MG	NA	K
OFH	6.1	31.3						
AH	5.9	9.6	62.0		19.0	4.7	-.1	0.1
BH	6.1	5.4	53.2		12.4	2.9	-.1	0.1
2BM	6.1	2.0	17.3		9.1	2.3	-.1	-.1
2BMGJ	6.1	0.8	9.9		5.5	1.6	-.1	-.1
2BCG	6.1		4.2		2.1	0.8	-.1	-.1
2CG	6.4		3.9		2.0	0.8	-.1	-.1

	EXTRACT IRON (%)		EXTRACT ALUMINUM (%)		
HORIZON	1	2	1	2	EXTR MN (%)
OFH					
AH					
BH	0.1		0.4		-.1
2BM	0.2		0.2		-.1
2BMGJ	0.1		0.1		-.1
2BCG					
2CG					

PHYSICAL DATA (SURVEY)

	PARTICLE SIZE ANALYSIS														
	% PASSING										% OF SAMPLE				
HORIZON	3" SIEVE	.75" SIEVE	NO.4 SIEVE	NO.10 SIEVE	V.C. SAND	C. SAND	MED. SAND	F. SAND	V.F. SAND	TOT. SAND	70-2U SILT	50-2U SILT	2U CLAY	0.2U CLAY	BULK DENS G/CC
OFH															
AH					4	7	6	8	10	35		56	9		
BH					2	5	4	5	13	29		62	9		
2BM					5	10	7	8	6	36		56	8		
2BMGJ					2	7	7	10	8	34		56	10		
2BCG					4	14	11	12	7	48		48	4		
2CG	99	86	62	39	8	18	11	8	5	50		43	7		2.1

PHYSICAL DATA

	MOISTURE STATUS (%)					ENGINEERING							
HORIZON	0.1 ATM	0.33 ATM	15 ATM	HYGR. MOIST	FIELD MOIST	ATTERBURG PLASTIC LIMIT (%)	ATTERBURG LIQUID LIMIT (%)	SHRINKAGE LIMIT (%)	OPT MOIST CONTENT (%)	MAX DRY DENSITY (G/CC)	COLE VALUE	AASHO CLASS	UNIFIED CLASS
OFH													
AH													
BH													
2BM													
2BMGJ													
2BCG													
2CG		23.3	4.4			22	25						07

APPENDIX E - VEGETATION TYPES OF MOUNT REVELSTOKE AND GLACIER NATIONAL PARKS

CLOSED FOREST VEGETATION TYPES

C14: *Picea engelmannii-Abies lasiocarpa/Menziesia glabella/Vaccinium scoparium*
(Engelmann spruce-subalpine fir/false azalea)

C21: *Picea engelmannii-Abies lasiocarpa/Vaccinium membranaceum/Barbilophozia lycopodioides*
(Engelmann spruce-subalpine fir/tall bilberry/liverwort)

C25: *Picea engelmannii-Abies lasiocarpa/Alnus crispa/Vaccinium membranaceum/Dryopteris assimilis*
(Engelmann spruce-subalpine fir/green alder)

C28: *Populus balsamifera/Equisetum pratense*
(balsam poplar/horsetail)

C44: *Picea* spp.*-Populus tremuloides-Pinus contorta-*(*Betula papyrifera*)*/Shepherdia canadensis/Calamagrostis rubescens*
(spruce-aspen-lodgepole pine-(paper birch)/buffaloberry/pine grass)

C47: *Tsuga mertensiana-Abies lasiocarpa/Rhododendron albiflorum-Vaccinium membranaceum/ Rubus pedatus*
(mountain hemlock-subalpine fir/rhododendron-tall bilberry)

C48: *Picea engelmannii-Tsuga mertensiana/Rhododendron albiflorum-Vaccinium membranaceum/Clintonia uniflora*
(Engelmann spruce-mountain hemlock/rhododendron-tall bilberry)

C49: *Tsuga mertensiana-Pseudotsuga menziesii-Abies lasiocarpa-Picea engelmannii/Rhododendron albiflorum-Vaccinium membranaceum*
(mountain hemlock-Douglas fir-subalpine fir-Engelmann spruce/rhododendron-tall bilberry)

C50: *Tsuga heterophylla-Thuja plicata/Taxus brevifolia/Gymnocarpium dryopteris*
(western hemlock-western red cedar/western yew/oak fern)

C51: *Thuja plicata-Tsuga heterophylla/Oplopanax horridum/Gymnocarpium dryopteris*
(western red cedar-western hemlock/devil's club/oak fern)

C52: *Tsuga heterophylla-Thuja plicata-*(*Pseudotsuga menziesii*)*/Pachystima myrsinites*
(western hemlock-western red cedar-(Douglas fir)/mountain lover)

C53: *Pseudotsuga menziesii-Thuja plicata/Pachystima myrsinites*
(Douglas fir-western red cedar/mountain lover)

OPEN FOREST VEGETATION TYPES

O9: *Picea engelmannii-Abies lasiocarpa/Valeriana sitchensis-Erigeron peregrinus*
(Engelmann spruce-subalpine fir/valerian-fleabane)

O10: *Picea engelmannii-Abies lasiocarpa/Phyllodoce glanduliflora-Cassiope mertensiana*
(Engelmann spruce-subalpine fir/heather)

O11: *Picea* spp./*Ledum groenlandicum/Tomenthypnum nitens*
(spruce/Labrador tea/brown moss)

O15: *Populus tremuloides-Pinus monticola/Pachystima myrsinites*
(aspen-western white pine/mountain lover)

O20: *Abies lasiocarpa-Tsuga mertensiana/Cassiope mertensiana-Phyllodoce empetriformis-Luetkea pectinata*
(subalpine fir-mountain hemlock/white mountain and red heather-luetkea)

O21: *Picea engelmannii-Abies lasiocarpa/Rhododendron albiflorum-Vaccinium membranaceum*
(Engelmann spruce-subalpine fir/rhododendron-tall bilberry)

O22: *Abies lasiocarpa-Pinus albicaulis-Picea engelmannii/Vaccinium membranaceum-Cassiope mertensiana*
(subalpine fir-whitebark pine-Engelmann spruce/tall bilberry-white mountain heather)

O23: *Picea engelmannii-Populus trichocarpa/Dryas drummondii*
(Engelmann spruce-black cottonwood/yellow dryad)

SHRUB VEGETATION TYPES

S2: *Abies lasiocarpa-Salix* spp./*Valeriana sitchensis*
(subalpine fir-willow)

S13: *Alnus crispa*/fern
(green alder/fern)

S14: *Salix* spp.-*Tsuga mertensiana-Abies lasiocarpa/Vaccinium membranaceum*
(willow-mountain hemlock-subalpine fir/tall bilberry)

S15: *Salix commutata-Salix brachycarpa*
(willow)

S17: *Alnus tenuifolia/Lysichiton americanum*
(alder/skunk cabbage)

LOW SHRUB-HERB VEGETATION TYPES

L5:	*Phyllodoce glanduliflora-Cassiope mertensiana-Antennaria lanata* (heather-everlasting)

HERB-DWARF SHRUB VEGETATION TYPES

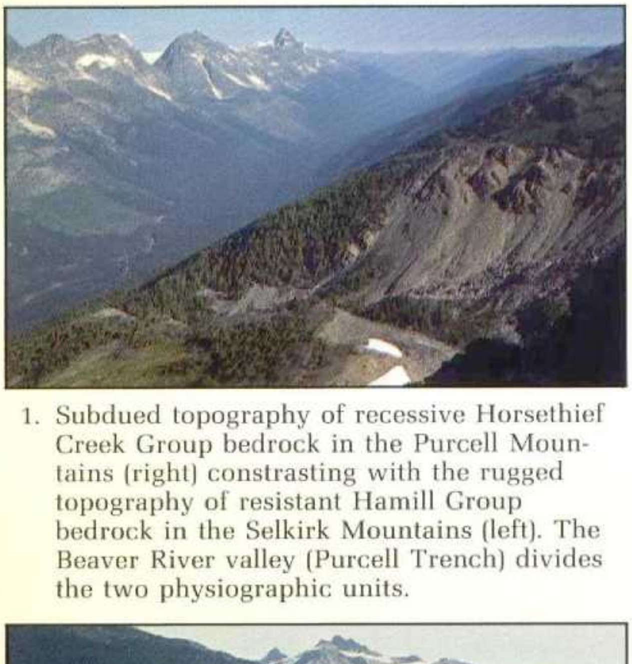
H1:	*Dryas octopetala-Salix nivalis-Silene acaulis* (mountain avens-snow willow-moss campion)
H2:	*Carex nigricans-Antennaria lanata* (black alpine sedge-everlasting)
H8:	*Dryas drummondii-Epilobium latifolium* (yellow dryad-willow herb)
H11:	*Carex aquatilis-Carex rostrata* (water sedge-beaked sedge)
H12:	Saxicolous lichen (saxicolous lichen)
H16:	*Erigeron peregrinus-Valeriana sitchensis* (fleabane-valerian)
H18:	*Antennaria lanata-Cassiope mertensiana-Phyllodoce empetriformis* (everlasting-white mountain heather-red heather)
H21:	*Carex* spp. (sedge)

COLOR PLATES
1-64

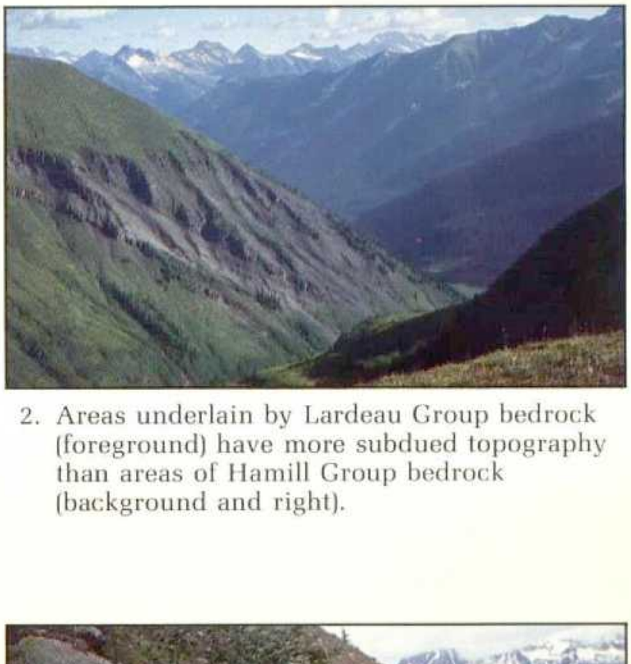
4. Sampled Orthic Dystric Brunisol of the AB1 Ecosite.

6. Sampled Orthic Humo-Ferric Podzol (lithic phase) of the AK1 Ecosite.

7. Sampled Orthic Humo-Ferric Podzol of the AK5 Ecosite.



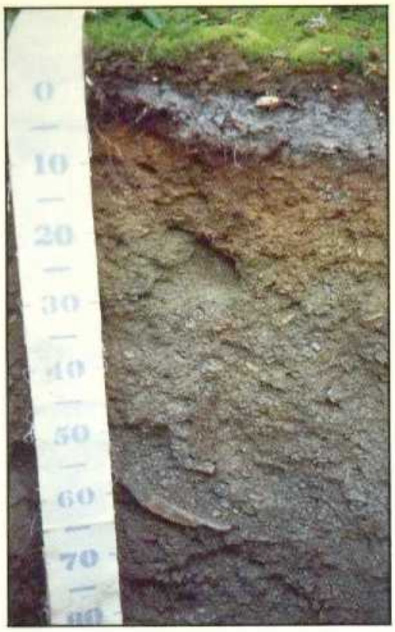
1. Subdued topography of recessive Horsethief Creek Group bedrock in the Purcell Mountains (right) constrasting with the rugged topography of resistant Hamill Group bedrock in the Selkirk Mountains (left). The Beaver River valley (Purcell Trench) divides the two physiographic units.



2. Areas underlain by Lardeau Group bedrock (foreground) have more subdued topography than areas of Hamill Group bedrock (background and right).

3. Moraines along the forest edge are the boundary of AB1 landscape below Beaver Glacier.

5. Steeply sloping AB1 sample site with sparse vegetation.



11. Sampled Orthic Humo-Ferric Podzol of the BU1 Ecosite.

12. Sampled Ortstein Humo-Ferric Podzol of the BU2 Ecosite.

14. Sampled Rego Gleysol of the CE1 Ecosite.

8. Subalpine fir-mountain hemlock/heather-luetkea (O20) is the dominant v.t. of AK1, AK2 and AK4.

9. Steep, rocky slopes with subalpine fir-whitebark pine-(Engelmann spruce)/tall bilberry-heather (O22) open forest typify AK6.

10. AK5 tract with fleabane-valerian (H16), one of several avalanche v.t.s in the Upper Subalpine.

13. Mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) forest dominates all BU Ecosites.

18. Sampled Eluviated Dystric Brunisol of the CT1 Ecosite.

19. Sampled Orthic Humo-Ferric Podzol of CT3 with dark colors derived from Lardeau Group bedrock.

17. CM2 along upper Connaught Creek on a fluvial fan with green alder/fern (S13) vegetation and small patches of the sedge (H21) v.t.

16. Sampled Orthic Ferro-Humic Podzol which is an accessory soil of CM2. Characteristic soils have similar humus-enriched profiles and include Orthic Dystric and Sombric Brunisols and Orthic Humo-Ferric Podzols.

15. Willow (S15) v.t. on CE1 in central MRNP.

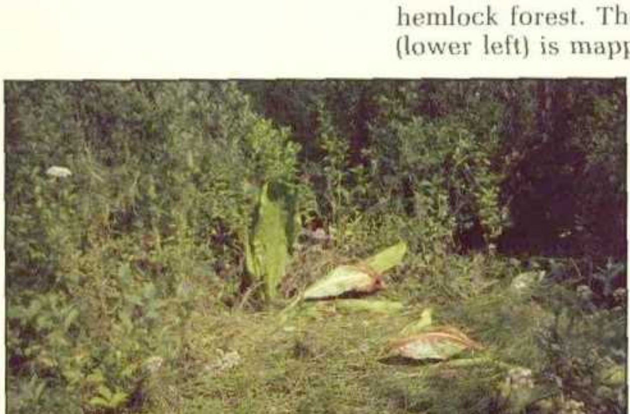
20. Sampled Eluviated Dystric Brunisol of the CT5 Ecosite.

21. Western hemlock-western red cedar/western yew/oak fern (C50) forest is one of two co-dominant v.t.s characterizing CT Ecosites.

23. Sampled Orthic Gleysol of the GF2 Ecosite.

24. Sampled Terric Fibrisol of the GF1 Ecosite.

22. Fluvial wetland along Mountain Creek with the vegetation pattern typical of GF1, *i.e.* wet shrub thicket and sedge fen > cedar-hemlock forest. The drier, forested fluvial fan (lower left) is mapped as LR1.



25. GF1 landscape with alder/skunk cabbage (S17) vegetation.

26. Western red cedar-western hemlock/devil's club/oak fern (C51) forest typical of GF2 and LR1.

27. Sampled undefined soil of the GH1 Ecosite.

29. Sampled Orthic Humo-Ferric Podzol (lithic phase) of the HE3 Ecosite.

31. Sampled Orthic Humo-Ferric Podzol (lithic phase) of the HR6 Ecosite.

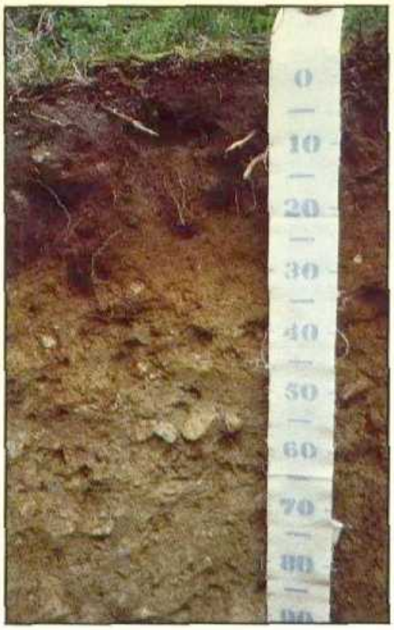
28. Landscape around the GH1 sample site with an open, western hemlock variant of the mountain hemlock-subalphine fir/rhododendron-tall bilberry (C47) v.t. behind and a sparsely vegetated site on blocky, fragmental material in the foreground.

32. Engelmann spruce-subalpine fir/tall bilberry/ Liverwort (C21) forest is codominant with mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) on HR1, HR2, HR3 and HR4.

30. HE3 sample site with heather-everlasting (L5) vegetation and rock outcrops.

33. Steep rocky slope with Engelmann spruce-subalpine fir/rhododendron-tall bilberry (O21) open forest typical of HR6.

34. HR5 (lower to mid slope) and AK5 (mid to upper slope) with a mosaic of avalanche types in Clachnacudainn Creek valley. HR6 and AK6 are on rocky terrain to the right of the avalanched area.

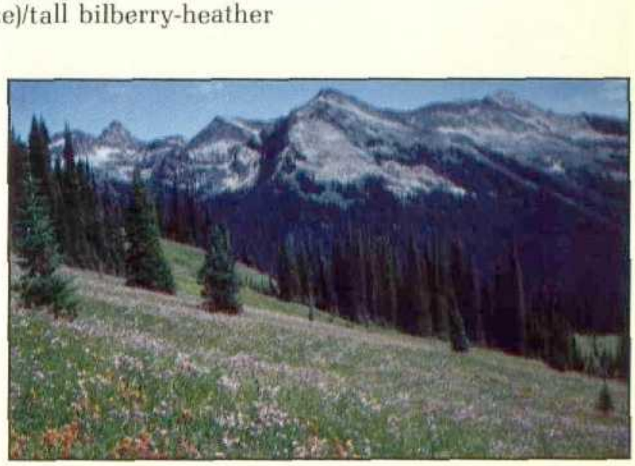


35. Sampled Orthic Humo-Ferric Podzol of the JD4 Ecosite.

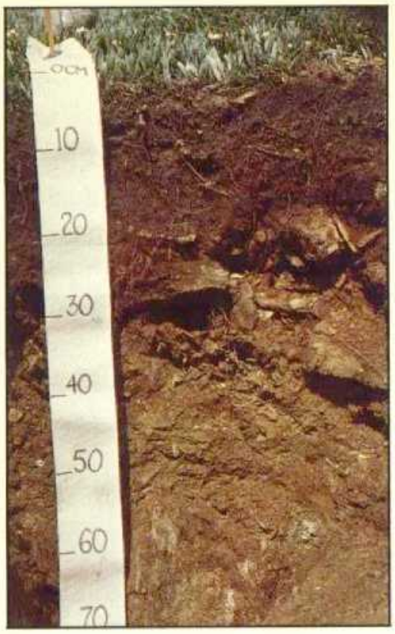
37. Sampled Orthic Humo-Ferric Podzol (lithic phase) of JD3 with dark colors derived from Lardeau Group bedrock.

38. JD2 landscape on a ridgetop in western GNP with a pattern of tundra (heather-everlasting (L5)) plus open forest (subalpine fir-whitebark pine-(Engelmann spruce)/tall bilberry-heather (O22)).

36. Sampled Orthic Dystric Brunisol (lithic phase) of the JD2 Ecosite.



39. JD4 landscape near Mount Revelstoke with a pattern of meadow (fleabane-valerian (H16)) plus open forest (subalpine fir-mountain



40. Sampled Orthic Humo-Ferric Podzol of the JN2 Ecosite.

41. Everlasting-white mountain heather-red heather (H18) v.t. typical of JN2.

42. Sampled Eluviated Dystric Brunisol of the KX1 Ecosite.

43. KX1 sample site with western hemlock-western red cedar-(Douglas fir)/mountain lover (C52) forest.

44. Sampled Gleyed Humo-Ferric Podzol of the LK1 Ecosite. Gleyed Ferro-Humic Podzols are more characteristic.

45. LK1 sample site with a wet, open variant of the Engelmann spruce-subalpine fir/tall bilberry/liverwort (C21) v.t.

47. Sampled Orthic Dystric Brunisol of the NC6 Ecosite.

49. NC5 sample site with the green alder/fern (S13) v.t.

50. Sampled Orthic Dystric Brunisol of the RD3 Ecosite.

51. Sampled Orthic Humo-Ferric Podzol (turbic and lithic phases) of the RD4 Ecosite.

46. Mountain hemlock-subalpine fir/rhododendron-tall bilberry (C47) forest on an LR1 tract.

48. Aspen-western white pine/mountain lover (O15) open forest on NC6.

52. Sampled Orthic Dystric Brunisol (lithic phase) of RD5 with dark colors derived from Lardeau Group bedrock.

57. Sampled Orthic Regosol of the SN1 Ecosite.

53. RD3 sample site with the heather-everlasting (L5) and everlasting-white mountain heather-red heather (H18) v.t.s.

54. RD4 sample site with a stony surface and heather-everlasting (L5) vegetation.

55. Bright green on an RD5 tract (midslope to crest) is the black alpine sedge-everlasting (H2) v.t. The AK5 tract below is dominated by fleabane-valerian (H16) vegetation.

56. Braided floodplain along the Incomappleux River consisting of recent glaciofluvial deposits.

59. Sampled Orthic Gleysol of the WR1 Ecosite.

61. Recent fire has modified (Modifier B) forest vegetation on morainal landscape near Copperstain Creek.

64. This matterhorn-like peak above the cirque glacier is mapped as R+GL.

58. SN1 sample site with an Engelmann spruce-black cottonwood/yellow dryad (O23) open forest.

60. WR1 sample site with fleabane-valerian (H16) vegetation.

62. Valley glaciers, such as Beaver Glacier, are included in the Miscellaneous Landscape GL.

63. Recent Moraine (M) below Woolsey Glacier.