SOIL SURVEY

of the

QUESNEL, NECHAKO, FRANCOIS LAKE AND BULKLEY-TERRACE AREAS

in the

CENTRAL INTERIOR OF BRITISH COLUMBIA

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Report No. 4 of the British Columbia Soil Survey

Experimental Farms Service, Canada Department of Agriculture in Co-operation with the University of British Columbia and the British Columbia Department of Agriculture.

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INTRODUCTION

The British Columbia Soil Survey is a co-operative project involving the Experimental Farms Service, Canada Department of Agriculture, the Provincial Department of Agriculture, and the Agronomy Department, University of British Columbia. This report, with four soil maps, is the second in a series covering the soil resources of the central interior and the fourth dealing with the soils of British Columbia. The previous publication on the soils of the central interior, Report No. 2, was published in 1946 and involved a rectangular block, of which the city of Prince George is the approximate geographical centre, lying immediately to the east of the presently described map area. The location map gives the relative position of these areas.

In order that the report may be of maximum value, supplementary and relative data are provided in addition to a description and tabulation of the soils—their nature, extent, location and use. Thus the first part of the report concerns itself with a general description of the area and is followed by sections dealing with physiography, drainage, climate, native vegetation and agricultural history. The main body of the report is devoted to a description of the various soils and a discussion of their relative suitability for agricultural and other purposes.

An attempt is made to rate the soils according to their ability to produce crops. This is based on physical data and other studies. These ratings should be regarded as tentative.

The field work has been done on such a scale as to prohibit the mapping of small soil units; hence the soil maps printed on a scale of 2 miles per inch do not show all the soil variations that may occur on any individual farm or quarter section. The designated soil areas are separated by either solid or broken lines and are identified by the use of colors, symbols and letter combinations. One should consult both soil map and the report before drawing conclusions as to agricultural rating or character of a soil.

Problems peculiar to many of the mapped soils are set forth. These were disclosed upon laboratory study of carefully selected samples. Some of these problems are strikingly apparent in the virgin soils, and evidently are the result of inherent weaknesses. Others are the result of past soil management practices.

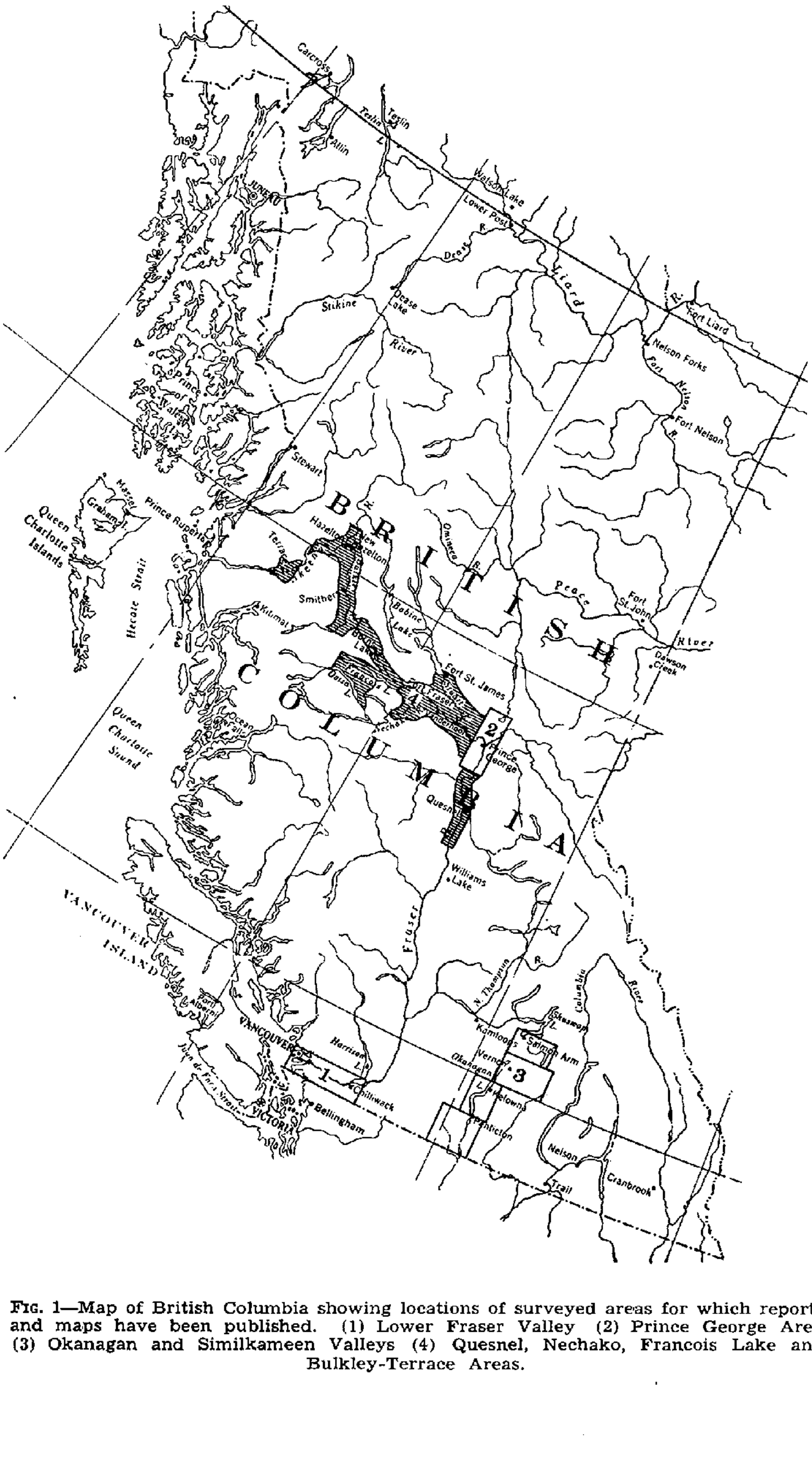


FIG. 1—Map of British Columbia showing locations of surveyed areas for which reports and maps have been published. (1) Lower Fraser Valley (2) Prince George Area (3) Okanagan and Similkameen Valleys (4) Quesnel, Nechako, Francois Lake and Bulkley-Terrace Areas.

DESCRIPTION OF THE AREA

Location and Extent

The area reviewed represents a relatively narrow strip of land extending in an easterly and westerly direction across the geographical centre of the province. Specifically it extends west from the Chilako river along an almost continuous series of valleys involving the Nechako, Endako, Bulkley and Skeena rivers. Also included is the Quesnel area south of Prince George and the "Lakes District" south of the village of Burns Lake.

The northern line of the Canadian National Transcontinental Railway roughly bisects the area which covers some 3,115,300 acres.

For general location see index map, Fig. 1.

Topography

The surveyed area lies partly within the Coast Range mountain system and partly in the interior plateau region and hence may be divided into two broad physiographic divisions: the Coast Range mountains and the Nechako plateau (Fig. 2). Thus, as might be expected, a wide range in elevation occurs throughout the area.

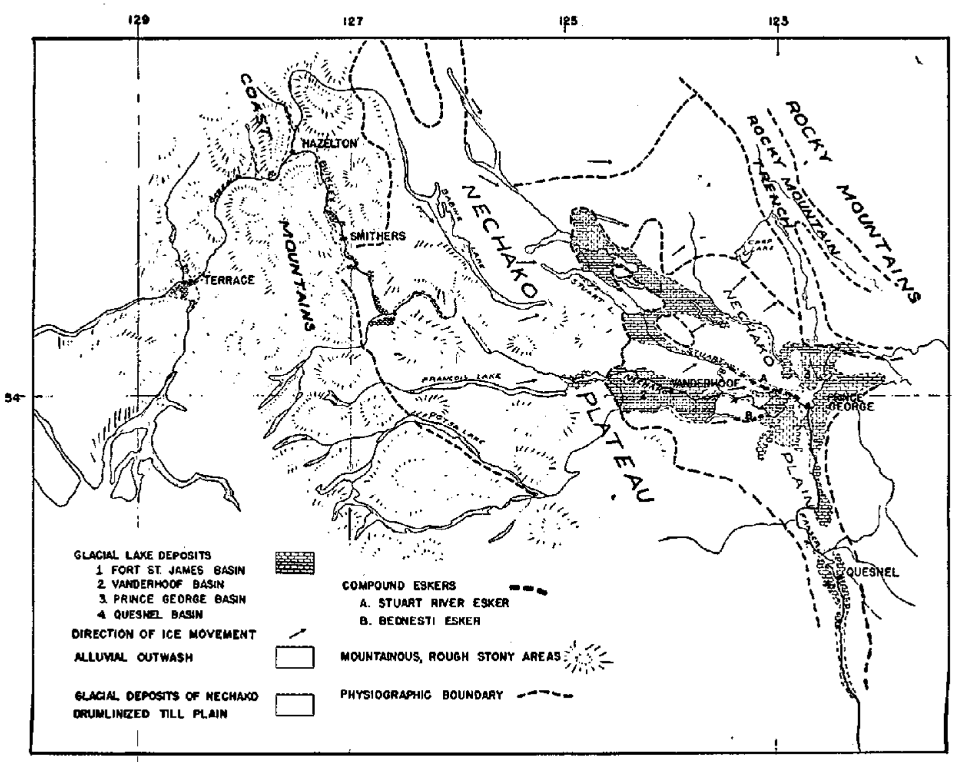


FIG. 2—Physiographic divisions and glacial geology of the central interior area, British Columbia. (Adapted from Armstrong and Tipper.)

The Coast Mountain region occupies a broad belt extending eastward from the Pacific Ocean for a distance of approximately 100 miles, and includes portions of the Skeena, Hazelton, and Coast ranges. These ranges are characterized, on the one hand by rugged mountains 6,000 to 10,000 feet high with deeply entrenched valleys, and on the other hand by low, rounded mountains (4,000 to 6,000 feet) adjacent to broad, U-shaped valleys. Areas topographically suitable for agricultural development are very limited and are confined to a few river terraces and valley bottoms. The most important of these are the broad drift-filled valleys of the Bulkley, Kispiox, Kitwanga, Kitsumgallum and Lakelse rivers. The largest, the Kitsumgallum and Lakelse valley, intersects the Skeena river at Terrace. It varies from 1 to 10 miles in width and extends northward from Kitimat Arm fiord to the Nass river.

The Nechako plateau, extending across the central portion of the province, is roughly bisected by the Canadian National Railway. It consists essentially of large rolling upland areas separated from one another by broad deep valleys. According to Armstrong and Tipper (2):

> The Nechako plateau may be subdivided into the plateau proper and the Nechako plain. In the plateau proper, the valleys are broad and the divides consist of rounded hills that rise 1,500 to 2,500 feet above the valley floors, with occasional peaks or small ranges of mountains rising as much as 4,000 feet. The Nechako plain occupies an area of several thousand square miles, has a maximum relief of only a few hundred feet and consists of a rolling plain with scattered shallow glacial lake basins. The main rivers have cut post-glacial channels into this plain to a depth of 400 feet at some points, and in some places bedrock is exposed. Generally, however, the plain is devoid of rock outcrop except for widely scattered rock knolls rising above the drift.

A cross section of British Columbia at latitude 54° 30′, as presented in Fig. 3, shows the approximate topography and general nature of the rock formations.

Geology

During the Pleistocene or glacial era the portion of the province under review was, except for a few scattered rock outcrops, entirely covered by an ice sheet. Deposition resulting therefrom consisted of a complex mixture of rock material which doubtless originated mainly in the west and southwest. Many types of landforms have resulted and these surface features, as they appear today, are largely the result of glacial deposition and subsequent erosion.

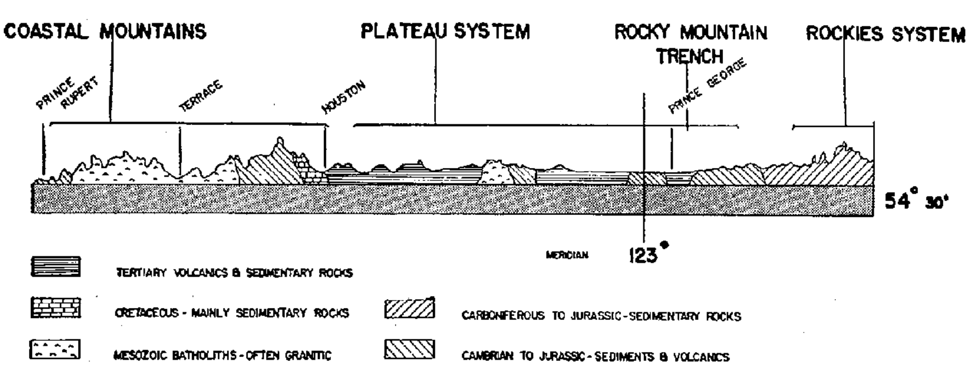


FIG. 3—Cross section of north central British Columbia showing approximate topography and general nature of the rock formations. (Adapted from Brink and Farstad).

The extent and distribution of these Pleistocene deposits have been studied by Armstrong and Tipper (2). The following excerpts are from their report:

> Assuming that conditions of precipitation in the Pleistocene period were similar to those existing today, it is apparent that in central British Columbia much the greatest accumulation of ice was on the Coast Mountains. Ice also accumulated, although to a much lesser extent, on the Rocky Mountains, Omineca Mountains and other ranges of the north central interior of British Columbia. Relatively little, if any, glacier ice forming occurred in the Nechako plain and plateau. As the mountain ice fields grew, the ice flowed out from them in all directions, at first largely confined to valleys. In the Coast and Rocky Mountains this movement was mainly easterly and westerly, and in the Omineca and other interior ranges, mainly northerly and southerly. These large valley glaciers coalesced in the low-lying Nechako plateau and plain. As glaciation continued, ice piled up until most of central British Columbia was covered with a great sheet of ice of varying thickness. A few of the higher peaks and ridges either projected through the ice or were not far below the surface, and apparently at no one time was the ice thick enough to flow indiscriminately over mountain and valley. In the mountainous areas the movement of the ice was confined largely to the valleys, although some evidence of former movement across the summits of the ranges forming the Omineca Mountains was observed. This movement was in general from west to east. However, during the maximum development of the Cordilleran glacier the ice moved across the low-lying Nechako plateau and plain in a general easterly and northeasterly direction. Apparently, as would be expected, the ice flowing easterly from the Coast Mountains, much the greatest source of ice, controlled the movement of the ice from the Coast Mountains to the Rocky Mountains. At the stages of maximum glaciation, the amount of ice supplied by the Rocky Mountains and Interior ranges was relatively small and did not affect the movement of the ice sheet.
>
> At least two major advances of the Cordilleran ice sheet have been recognised in the Nechako plateau and plain. The recession of the ice between these two major advances may have been limited to these low-lying areas. During the first advance of the ice, most of the rock debris was eroded from the weathered outcrop and deposited in the low-lying areas, the greatest accumulation of till being in the Nechako plain. Most of the till consists of material derived from the west; however, near the western base of the Rocky Mountains, some till composed of material from these mountains was observed. The first major advance of the ice was probably in the main from west to east, although most of the evidence for such a conclusion was obliterated by a later advance.
>
> Following the first major advance of the Cordilleran ice sheet, with its resultant scouring of bedrock, a recession of the ice sheet occurred in the Nechako plateau and plain. This recession was followed by a re-advance of the ice across the Nechako plateau and plain. It is this later advance of the ice that may be traced by the trend of the drumlins and striae, and at the close of which the compound eskers and glacial lakes were formed. In comparison to the earlier ice advance this later ice advance apparently carried a relatively much lighter load of till, and instead of dropping a heavy mantle of till as the first advance did, it mainly rearranged the earlier till into drumlins. As is evidenced by the elongation of the drumlins and the parallel groovings, the ice in general moved from the Coast Mountains east to the Rocky Mountains. In detail, the movement, particularly at the base of the ice, was much more variable, the underlying topography being the governing feature. In the area under discussion, the ice flowed southeasterly down such valleys as Babine and Takla. Wherever possible, the ice flowed easterly through gaps in the eastern walls of these valleys, apparently as a result of ice pressure from the west. The easterly flowing ice moved down the valleys of the Mesilinka, Osilinka, Omineca, and Nation rivers into the valley of the Parsnip river. At the southern end of Babine and Takla valleys the southeasterly moving ice met a great stream of easterly and northeasterly ice moving along the Nechako valley and across the Nechako plateau. The two streams of ice formed a great

> confluent piedmont glacier that moved easterly and northeasterly across the Nechako plain to the Rocky Mountain trench where this ice sheet met the westerly moving glaciers. Those from the west, being much the larger, overrode the smaller Rocky Mountain glaciers and moved upwards over the low western spurs of the Rockies. The Rocky Mountains acted as a barrier and turned the ice sheet northwesterly down the valley of the Parsnip river. The authors do not believe the ice moved across the Rocky Mountains, although no ground observations were made in these mountains.
>
> This last advance of the ice was apparently followed by stagnation and decay of the ice sheet in the Nechako plain and plateau. During this decay, the compound eskers and glacial lakes in the low-lying areas were probably formed.

The glacial till deposits vary in composition, texture, depth and compactness. The relief varies from gently rolling and sloping to hilly and mountainous. The surface land form, previously described by Kelley and Farstad (13) and Armstrong and Tipper (2), consists of nearly parallel drumlin-like ridges and intervening depressions and has been designated a drumlinized till plain. The till of this drumlinized plain is composed mainly of a loam, sandy loam or gravelly sandy loam surface that grades abruptly into a compacted and impervious greyish-brown boulder clay. The Chilako, Barrett and Driftwood series have developed from this type of parent material and are widespread throughout the Nechako plateau. In the Coast Mountain valleys the till deposits are very limited in extent, having been reworked by stream action or buried at considerable depths.

During late Pleistocene a great glacial lake or string of lakes extended along the Fraser, Nechako and Stuart rivers. Their presence is today recorded in the great thickness of stratified sand, silts and clays in the basins occupied by these rivers. The larger basins are Fort St. James, 850 square miles, Vanderhoof 600, Prince George 850 and Quesnel 350 square miles. Others of lesser extent occur in the Bulkley and Terrace valleys. Soils developed on these deposits include the Fort St. James, Pinchi, Vanderhoof, Nulki, Pineview, Narcosli, Telkwa, Doughty, Bednesti, Prairiedale, Lakelse, and Thornhill series.

Glacial outwash of sands and gravel occurs in the form of eskers, fans, delta plains and outwash. For the most part, they are composed of stratified sands and gravel. Two prominent glacial river channels or "compound eskers" have been described by Armstrong and Tipper (2). They are the Stuart and Bednesti river compound eskers. The soils associated with these outwash deposits include the Mapes, Eena, Gunniza, Kitsumgallum and Layton series; the last two occur in the Terrace valley.

Alluvial terraces, flood plains and alluvial fans frequently occur in the river valleys and former drainage channels. In age these deposits vary from late glacial to recent. Saxton, Braeside, Skeena, Kersley, Moricetown and Kispiox represent the sandy and gravelly soils on these deposits, while Fraser, Nechako, McCully, Australian and Remo characterize the lighter loamy soils.

In addition, organic deposits occur and are confined mainly to depressions in which drainage is restricted. This accumulation of organic matter has resulted in the formation of peat and muck soils.

Drainage

The two major drainage systems in the area are the Fraser and the Skeena. These with their tributaries and lakes, large and small, provide a network of waterways which in the early days of settlement afforded the only means of transportation in and through the area. The Fraser, rising near the British Columbia-Alberta boundary, flows northwest through the Rocky Mountain trench, then broadens into the wide Prince George basin where it is joined by the Willow, Salmon, and Nechako rivers. Farther south, in the Quesnel area, the important tributary streams include the Naver, Westroad, Cottonwood and Quesnel rivers. The Skeena, which drains the northwest plateau region, flows through the Coast Mountains by way of deep valleys and canyons, and enters the Pacific at Prince Rupert. The main tributaries are the Morice, Bulkley, Telkwa, Kispiox, Kitwanga, Zymoetz, Kitsumgallum and Lakelse rivers. Their present courses are in part entrenched in coarse gravel outwash evidently derived from mountain glaciers. Numerous tributary glacier-fed streams drain into these large rivers.

Lakes occur in abundance, each fed and drained by one or more streams. Pre-glacial and glacial erosion, and an irregular mountain upthrust have been the major factors in the production of numerous lake basins which vary considerably in depth, size and elevation. The largest lakes in the province are to be found in the northwestern part of the map area, particularly in the "Lakes District". Babine, the largest, is 110 miles long and drains into the Pacific by way of the Skeena. Francois, Ootsa, Stuart, Pinchi, Burns, Decker, Tachick, Nulki and Cluculz lakes are large and deep and drain in an easterly direction into the Fraser. Other lakes, such, for instance, as Bouchie, Dragon and Ten-mile near Quesnel, occupy depressions in glacial lake basins, or Lakelse and Kitsumgallum in the drift filled Terrace valley, which owe their existence to damming of pre-glacial channels.

Climate

British Columbia is mountainous in character, with three quarters of the land surface lying at an elevation of over 3,000 feet. Altitude and relief thus play a major role in the determination of the climate. In his "Climate of British Columbia for Agrologists", Brink (4) shows the importance of the orographic factor and suggests that certain characteristics of mountain climate should be noted in order to guard against unwise use of graphs and tables. The following excerpts from his paper bear repetition:

> That temperature decreases with increasing elevation is a well known fact. Quite generally it is stated that temperature varies with altitude about 1,000 times as rapidly as with latitude, or, in other terms, that the average lapse rate of temperature on a mountain in the temperate zone is 3·3° F. per 1,000 feet rise. In the mountain valleys of British Columbia and elsewhere temperature gradients frequently depart from this average and temperature inversions are commonplace. Sometimes the inversions are very local and occur only on a few summer nights, but in other cases they are frequent and involve considerable areas. Often "frost pockets" result from such temperature anomalies.
>
> Although rainfall increases with elevation in mountainous areas, the rate of increase varies with every location, with aspect, with latitude, with distance from the ocean, and with massiveness of the mountains.
>
> When a mountain lies across the storm track, air masses forced upwards, cool, and rain is more likely to fall. The increase in rainfall on the windward side of mountains is usually first evidenced several miles from the mountain base. Thus rainfall increases somewhat before the altitude begins to increase noticeably (approach effects).
>
> On their lee side, mountains have a rain shadow or zone where precipitation is much reduced as the rain-bearing winds are "milked dry" in their passage over mountains. Rain shadows and Chinook effects are often marked by strikingly low rainfall in certain localities.

Influences of topography, elevation and location on climate are very significant in the area under review.

A continental type of climate with warm summers and long cold winters prevails throughout the Nechako plateau region. Precipitation is, generally speaking, medium to light and well distributed throughout the year. In contrast to the foregoing, the Coast Mountain region has a climate typical of the Pacific Coast area; thus the Lakelse-Kitsumgallum intermountain valley enjoys cool, relatively dry summers and mild, wet winters.

Prince Rupert, on the windward side of the Coast Range, has an average annual precipitation of 96 inches. Terrace, 80 miles east and occupying a fiord-like valley, reflects the influence of the surrounding mountain masses and receives 46 inches annually. On the east (lee) side of the Coast Range, precipitation is much reduced. Hazelton, protected by Bulkley and Babine Mountains, has an average annual precipitation of 19 inches; and Telkwa, still farther east, receives 15 inches. Vanderhoof receives approximately 13 inches, and Prince George, lying at the eastern end of the plateau, has a precipitation of 23 inches. This increase is possibly due to the uptake of moisture by the prevailing winds in their passage across the wide Nechako plateau. Weather recording stations throughout the area illustrate clearly the precipitation pattern. (Table 2)

Recently Thornthwaite (17) devised a method for evaluating the adequacy of precipitation for plant growth in a given locality by comparing it with water need or potential evapotranspiration. This is defined as "the amount of water that would be transferred from the soil to the atmosphere by evaporation and transpiration if it were constantly available in optimum quantity." It is thus an expression of thermal efficiency in that the values are derived from mean monthly temperatures and take into account the variation in length of daylight during the growing season. Theoretical values for water surplus and water deficiency may, therefore, be computed and quantitatively expressed.

Factors of temperature (heat index), precipitation, evaporation and transpiration from a land surface fully covered by vegetation are used in calculating the data as presented in the charts. Suitable adjustments for latitude and possible duration of sunlight are made. Treating precipitation as income and water need (P.E.T.) as outgo, an approximation of the monthly consumptive use of water may be computed. Further interpretation provides information relative to total water need, daily water requirement, and approximate date at which soil moisture will be drawn upon. Because data regarding the moisture relationships of the soils within the area are distinctly limited, it was thought preferable to apply Thornthwaite's calculated value of 4 inches as the amount of soil moisture available for use of plants. Thus moisture in excess of 4 inches is considered surplus and when the reserve is exhausted drought is assumed to exist. Admittedly only the heavy-textured soils (Pineview, Nulki, Vanderhoof, etc.) approach this value, but until more data concerning consumptive use of plant species and available moisture capacity for the various soil horizons are obtained, the present classification will serve as a valuable guide.

Water surplus is the result of precipitation in excess of that required to maintain soil storage capacity. This surplus, depending upon degree and duration, determines soil profile development and characterization. It is conducive to podzolization, to glei formation, and may even on occasion result in peat formation. It may, too, depending on excess, impair yields. Moisture deficiencies, on the other hand, register the extent to which lack of moisture limits vegetative growth, and may contribute to the development of solonetzic or similar structured soils. Moisture deficiencies curtail plant growth and the time, intensity and duration have a considerable bearing on risk involved in the production of certain crops.

A graphical representation showing the relationships between water need and precipitation for a number of weather stations, is shown in Fig. 4. The moisture relationships for the Degraded Black soil areas are demonstrated in the graphs for Telkwa, Wistaria and Vanderhoof. A study of the graph discloses that the precipitation varies uniformly from 1 to 2 inches per month throughout the year and that a water need of more than 19 inches may be calculated. Further reference to the charts reveals that between mid-June and the first week in July the stored soil moisture is exhausted and from then until September the crops must rely entirely on current precipitation. Normally this is not sufficient and deficiencies of 6 to 7 inches result. By comparison, Vernon, representing a Black soil area in the Okanagan Valley, has an average water deficiency of 12·4 inches. Here irrigation waters are normally applied before moisture reserves reach low levels.

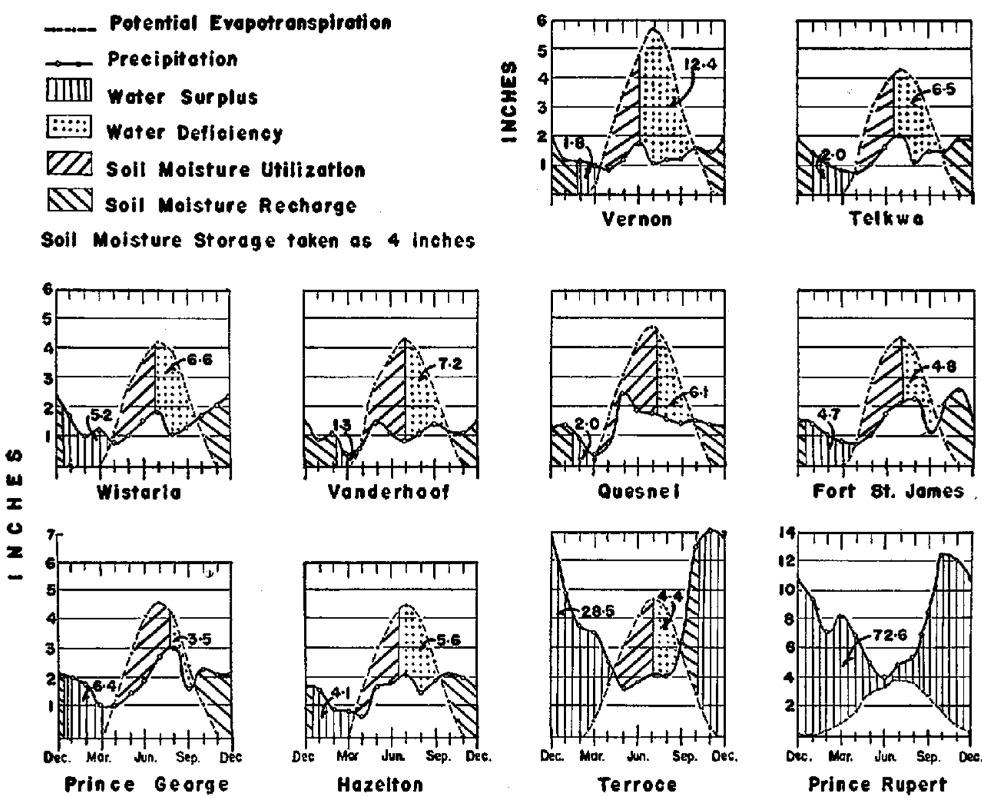


Fig. 4—Comparative moisture data at selected weather stations in the central interior of British Columbia.

The climatic data characteristic of the Grey Wooded soils is shown in the graphs for Quesnel, Fort St. James, Prince George and Hazelton. A study of these charts reveals an average annual precipitation of 18·6 inches, of which approximately 50 per cent falls during the growing season. It will also be noted that at Quesnel the water need rises above the precipitation in early May and by mid-July the soils moisture storage reserves have been exhausted. On the other hand, the charts show clearly that Prince George has a precipitation pattern during the growing season which more closely follows the need curve. Even so, during the latter part of July a need for additional moisture is apparent. The average moisture deficiency for Quesnel is 6·1 inches, and for Prince George 3·5 inches.

The graphs for Hazelton and Fort St. James are very similar and have deficiencies of 4·8 and 5·6 inches respectively. Like other stations throughout the plateau, the rainfall is lowest during the periods of greatest need, as is apparent from an examination of the graphs.

Terrace, representing a Brown Podzolic-Podzol soil area, has an average annual precipitation of 46·49 inches; this, however, does not exclude the possibility of drought. During the winter months the precipitation approximates 5 inches per month, resulting in an average water surplus of 28·5 inches. On the other hand, during the growing season the rate of water need is highest when precipitation is the least. This unfavorable distribution of moisture, apparent in the Terrace graph, results in an average moisture deficiency of 4·4 inches. Such deficiencies are of sufficient magnitude to reduce yields, in addition to creating conditions favorable to forest fires. In fact, such a study, treated in detail, will provide basic information relative to an appreciation of fire hazards, seasonal variation in runoff, and changes in groundwater levels.

Prince Rupert, lying to the west of the surveyed area, has an average annual water surplus of 72·6 inches. High surpluses are characteristic of the western slopes of the Coast Range and hence provide conditions favoring podzolization and peat formation.

Temperature data for the various weather stations throughout the surveyed area are presented in Table 1. Prince Rupert, under the influence of an oceanic climate, is characterized by moderate winter and summer temperatures.

Table 1. Monthly, Seasonal and Annual Temperatures at Selected Weather Stations, in Degrees F.

Average of 21 Years

Month	Prince Rupert	Terrace	Hazelton	Telkwa	Babine	Vanderhoof	Fort St. James	Prince George	Quesnel
December	37	28	19	18	14	20	15	18	21
January	35	25	16	16	7	9	9	14	15
February	37	29	23	21	16	16	14	19	20
Winter	36	27	19	18	12	15	13	17	15
March	39	36	32	30	26	24	23	30	32
April	43	44	41	38	36	36	36	41	43
May	49	51	49	47	44	47	46	49	52
Spring	44	44	44	38	35	36	35	40	42
June	53	58	55	53	52	53	53	56	58
July	56	61	59	56	56	57	57	60	62
August	57	62	58	56	55	56	56	59	61
Summer	55	60	57	55	54	55	55	58	60
September	54	55	51	49	47	49	47	50	53
October	47	45	41	39	37	39	38	41	43
November	41	35	30	28	26	26	25	29	29
Fall	47	45	41	39	37	38	37	40	42
Year	46	44	40	38	35	36	35	39	41

Terrace, lying within the Coast Mountains has lower winter and higher summer temperatures than Prince Rupert. The other stations as listed in Table 1 are located throughout the Nechako plateau where winter temperatures may at times drop below −40°F., and where sub-zero temperatures may be relatively frequent during the winter months. Summer temperatures of 85° to 90° F. may be recorded for several days at a time.

Further analyses of climate may be effected, in part, through a determination of length of vegetative period. This is frequently calculated as the period during which the mean temperature remains at or above 43° F. A review of such calculations for the various weather stations, as presented in Table 2, indicates an appreciable range in length of growing season. Fort St. James, for instance, has a vegetative period of 145 days starting on May 8, while Prince Rupert has 214 days starting on April 9. The information as set forth in Table 2 is, however, rather incomplete as no reference is made to temperature conditions within the dates indicated. To meet this weakness, the time between the last killing frost in the spring and the first killing frost in the autumn is sometimes referred to as the frost-free period. The temperature at which killing frost occurs is commonly considered to be 26° F. Calculations on this basis as well as determination of the period between the last spring frost at 32° F. and the first autumn frost are presented in Table 2.

A study of the data as presented in Table 2 discloses some interesting comparisons and leads one to conclude that too much emphasis should not be placed on the length of growing season, since frosts may occur throughout the Nechako plateau any month during this time. Vanderhoof experiences frost every month and the growing season is very short. It is not, however, much shorter than that of many other stations located on the Nechako plain. The data suggest that frost-resistant crops only should be grown at Vanderhoof and Fort St. James. It is possible that temperature inversions are frequent at these recording stations and therefore the data are not truly representative of the area.

Native Vegetation[1]

Diversity characterizes the vegetation of the surveyed area. To the complex interactions of topography, latitude, proximity to mountain mass and ocean, soil parent material, drainage, exposure, fire, grazing, logging and agriculture, the vegetation has responded sensitively. Many plant communities, genetically very different, may be observed from Lakelse on the west, set in magnificent coastal forest, to Castle Rock on the east, surrounded by "dry" grassland.

Reports on the botanical features of the area are few and limited in scope. Among the more useful are those of Macoun (14), Tisdale (18), Garman (9), Whitford and Craig (22) and Halliday (10).

Small acreages of native grassland are found near Hazelton and irregularly eastward and southward over the map area. They are for the most part scattered "islands" of a few hundreds or thousands of acres in a "sea" of forest. They may be classified roughly into (*a*) low elevation climax or permanent grassland; (*b*) low elevation temporary grassland; (*c*) meadow; and (*d*) alpine "tundra".

Low elevation climax or permanent grassland exists in the area and is fairly typical of the *Agropyron* bunch grass (19) more extensively developed in the southern interior of British Columbia. A few decades ago much of this grassland could be easily characterized by the abundance of bluebunch wheat grass (*Agropyron spicatum* var. *inerme*). Today, however, nearly all sections are fully utilized as range, pasture or plowland, and the wheat grass is not

[1] Contributed by Dr. V. C. Brink.

Table 2—Some Climatic Factors Affecting Plant Growth in the Central Interior

—	Prince Rupert	Terrace	Hazelton	Wistaria	Telkwa	Babine	Vanderhoof	Fort St. James	Prince George
North latitude	54° 20′	54° 33′	55° 15′	53° 49′	54° 47′	54° 45′	54° 02′	54° 15′	53° 56′
West longitude	130° 18′	128° 33′	127° 35′	126° 17′	127° 11′	126° 00′	124° 01′	124° 26′	122° 43′
Altitude above mean sea level (feet)	170	200	1,150	2,900	2,000	2,300	2,226	2,280	1,862
Mean annual temperature (°F)	46	44	40	38	38	35	36	35	39
Beginning of vegetative period (1)	Apr. 9	Apr. 11	Apr. 19	May 2	May 2	May 8	Apr. 30	May 8	Apr. 25
End of vegetative period	Nov. 9	Oct. 21	Oct. 11	Oct. 3	Oct. 3	Sept. 30	Oct. 6	Sept. 30	Oct. 8
Duration of vegetative period (days)	214	193	175	154	154	145	160	145	166
Mean date of last frost in spring (32°)	Apr. 18	May 20	June 18	June 25	June 18	June 19	June 30	July 1	June 17
Mean date of first frost in fall (32°)	Nov. 2	Sept. 28	Sept. 1	Aug. 23	Aug. 20	Aug. 20	Aug. 9	Aug. 3	Aug. 24
Duration of frost-free period (32°) (days)	198	132	74	59	64	62	40	32	68
Mean date of last killing frost in spring (26°)	....	Apr. 12	May 12	May 24	May 17	....	May 15	....	May 11
Mean date of first killing frost in fall (26°)	....	Nov. 3	Sept. 20	Sept. 17	Sept. 19	....	Sept. 12	....	Sept. 18
Duration of frost-free period (26°)	....	215	133	116	125	....	85	....	144
Yearly precipitation (inches)	96·01	46·49	18·55	18·02	15·80	20·04	13·30	15·83	23·17
Precipitation during vegetative period (inches)	49·25	17·37	10·21	6·88	7·27	7·75	7·14	8·05	11·66
Water need (inches)	23·38	23·13	20·67	19·36	19·56	18·64	19·16	18·87	20·59
Water deficiency (inches)	0	4·39	5·59	6·57	6·47	4·78	7·19	4·82	3·52
Days from beginning of vegetative period to drought point	....	86	71	57	53	62	61	56	70
Mean date of drought point	....	July 6	June 29	June 28	June 24	July 9	July 1	July 3	July 4
One inch of rain changes drought point by (days)	0	12	15	14	14	11	8	13	16
Hours of bright sunlight	1,006	....	....	....	1,558(2)	....	....	....	1,784

1. Vegetative period is considered as the period during which the mean temperature is at or above 43°F.
2. Smithers.

much in evidence except on steep south-facing "goat-prairies"; needle grasses, rather (*Stipa comata, S. Columbiana,* and *S. Richardsonii*), are the prominent species. Also prominent in the community are June grass (*Koeleria cristata*), oat grass (*Danthonia intermedia*), Kentucky blue grass (*Poa pratensis*), silver sagebrush (*Artemisia frigida*), pussytoes (*Antennaria parvifolia*), yarrow (*Achillea millefolium*) and many other species listed by Tisdale (19) for the grasslands farther south. Associated with the "typical" climatic bunch grass community just described, however, are several "spectra" of edaphic grasslands—from almost pure *Danthonia* grassland on the light-textured soils near Vanderhoof to the *Calamagrostis* meadows on the Nulki clays and to the *Poa Distichis* prairies on the Cuisson saline-alkali soils at Castle Rock.

Early stages in the plant succession following the burning of forest in the valleys of the Skeena, Bulkley, Nechako and Fraser rivers in north central British Columbia often take the form of a "soft" (i.e. poorly curing) grassland or open chaparral. The species composition of the seral communities varies greatly with the age and intensity of the burn, but in general is representative of the permanent grassland and of the undercover of the montane forest. Common grasses are blue wild rye (*Elymus glaucus*), pine grass (*Calamagrostis rubescens*), Canada reed grass (*Calamagrostis canadensis*), northern wheat grass (*Agropyron trachycaulon*) and the needle grasses. Also common are the alien grasses Kentucky blue grass (*Poa pratensis*) and timothy (*Phleum pratense*). Forbs are many and are often dominant; abundant, conspicuous and colorful are northern bedstraw (*Galium boreale*), peavine (*Lathyrus ochroleucus* and *L. palustris*), vetch (*Vicia americana*), fireweed (*Epilobium angustifolium*), cow parsnip (*Heracleum lanatum*), larkspur (*Delphinium Brownii*), paintbrush (*Castilleja miniata*), meadow rue (*Thalictrum occidentale*), lupines (*Lupinus* spp.) and many others. Shrubs are common and often dominant, e.g. Hazel (*Corylus rostrata*), rose (*Rosa acicularis* and *R. Woodsii*), serviceberry (*Amelanchier alnifolia*), twinflowering honeysuckle (*Lonicera involucratum*), red osier dogwood (*Cornus stolonifera*), birch (*Betula glandulosa*), aspen (*Populus tremuloides*), willow (*Salix* spp.), alder (*Alnus sinuata*) and rocky mountain maple (*Acer glabrum*).

Impaired drainage, attributable in large measure to the recent glaciation, has resulted in numerous lakes, peat meadows and muskegs over many sections of the map area. Most of the meadows provide forage for wildlife and wild hay for livestock. Level of the water table and quality of the water are the principal determinants of their botanical composition. Some meadows consist of almost pure stands of a few *Carex* and *Scirpus* species; in other meadows one or more of the following grasses may be dominant: reed canary grass (*Phalaris arundinacea*), reed grass (*Calamagrostis canadensis*), (*Glyceria major* and *G. minor*), bent grass (*Agrostis stolonifera*) or squirreltail (*Hordeum jubatum*)

At least two of the principal Canadian forest regions as designated by Halliday (10) are presented in the surveyed area.

Coast forest occurs in occasional moist valleys along the Bulkley river as far east as Smithers and continuously along the Skeena river below Pacific. Great trees of western red cedar (*Thuja plicata*) and western hemlock (*Tsuga heterophylla*) denote the coastal relationships. Locally abundant, in the Lakelse and Kitsumgallum valleys especially, are the tall trees of Sitka spruce (*Picea sitchensis*), amabilis fir (*Abies amabilis*) and yellow cedar (*Chamaecyparis nootkatensis*). In the undercover are many mosses and lichens, two shrubby *Vaccinium* spp., queen cup (*Clintonia uniflora*), bunchberry (*Cornus canadensis*), twinflower (*Linnaea borealis*), creeping raspberry (*Rubus pedatus*), rattlesnake orchid (*Goodyera Menziesii*), devil's club (*Fatsia horrida*) and salmonberry (*Rubus spectabilis*). Logged or burned areas about Terrace revegetate commonly to aspen, rocky mountain maple, birch, willow, bracken

(*Pteris aquilina*), pearly everlasting (*Anaphalis margaritacea*), fireweed and hawkweed (*Hieracium umbellatum* and *H. albiflorum*). Sandy and rocky areas near Terrace are commonly populated with lodgepole pine (*Pinus contorta*).

Halliday (10) has classified most of the climax forest from Hazelton to Quesnel at the lower elevations as transitional montane. However, of the two tree species which characterize the great montane community in its range from Mexico to central British Columbia, Douglas fir (*Pseudotsuga taxifolia*) alone is represented in the map area and then only in small, often relict stands. Similar relationships in respect to the subalpine and boreal forest regions of Halliday hold throughout the area. Fire has ravaged the forest with such frequency that little remains of anything approaching climax stands. When fully developed the community might be best characterized by spruce (*Picea Engelmanii* and *P. glauca* and intergrades between the two). The commonest tree over the area is lodgepole pine; sometimes it occurs in pure stands but more often with spruce, aspen (*Populus tremuloides*) or less commonly, cottonwood (*Populus trichocarpa*). Subalpine fir (*Abies lasiocarpa*) grades into the forest from the higher and moister elevations and is common in the forest about Prince George. Willow, alder and birch and other arborescent shrubs are frequent components of seral forest. The undercover in dense spruce-pine stands, and in open pine on sandy locations is sparse; but under the open pine-aspen stands it is usually luxuriant. Only a few species, such as twinflower, bunchberry, wintergreen, cranberry, rice grass (*Oryzopsis asperifolia*) accompany sparse moss and lichen on the floor of the dense forest. The undercover of the open aspen-pine, however, is frequently luxuriant and varied: pine grass, several asters, paintbrush, lupines, strawberry, vetch, pea-vine, bedstraw, meadow rue, fireweed, yellow rattle (*Rhinanthus crusgalli*), false dandelion (*Agoseris* sp) and hawkweeds are all common; and shrubs like soopalallie, rose, twinflowering honeysuckle, buckbrush (*Symphoricarpos racemosa*), and spiraea are much in evidence.

On the plateau surface at 3,500 to 5,500 feet, adjacent to the montane transition forest of the Nechako and Bulkley valleys in the mapped area, is the northern aspen forest of Halliday (10). Over the triangular area described by the towns of Smithers, Prince George and Quesnel the trembling aspen is the most characteristic tree. Lodgepole pine and Engelmann spruce, in some parts, are mixed with the aspen. On the whole the type is open and supports a rich undercover which has strong affinities with the montane forest undercover.

In the mountains near Smithers and westward, and, to a limited extent, in the hills east of Prince George, subalpine forest adjoins the montane transition and coastal forests. Engelmann spruce is the most characteristic tree but as the alplands are approached alpine fir may become very common. Bryophytes and lichens predominate in the undercover.

Also in the mountain sections, above 4,000 feet on the seaward side and above 5,000 feet on the leeward side, are numerous high tundras. In summer this alpland displays a varied flora which must be one of the world's most colorful. Two principal alpine associations may be recognized: where the rain and snowfall are heavy, as in the mountains facing the coast, a heath flora (*Phyllodoce* and *Cassiope* spp.) predominates; but in the Interior mountains of rolling concordant summits, where rain and snow are limited, a grass-sedge-willow flora (*Poa-Festuca-Carex-Salix*) predominates.

Natural Resources

For a review of the extent and value of the natural resources of the area, the reader is referred to the Transactions of the B.C. Natural Resources Conference (20). While agriculture is of major importance throughout the area, it is well to mention briefly other resources that are directly or indirectly related to soils.

The immediate value of the accessible forests is very great since they provide the major industrial payroll in the area under review. Virgin forests are capable of furnishing approximately 12,557,300 thousand board-feet (15) of which an estimated 4,462,000 M.B.M. are accessible. The annual depletion by logging and fires amounts to approximately 233‡ million feet, which is 245 million feet less than the district's mean annual growth. Principal species in the Coastal region include western hemlock, spruce, cedar, silver balsam and black cottonwood. In the Interior districts spruce and lodgepole pine are the two principal species cut.

The mining industry, involving gold, silver, lead, mercury, zinc, copper and coal, has contributed much to agricultural development throughout the area. At the same time, however, instability associated with mining has had its repercussions, to the detriment of agriculture.

The topography and climate of the area is a great physical asset for potential hydro-elecric power development. Important undeveloped power sites include Soda Creek: 310,000 h.p., Quesnel River: 180,000 h.p. (with three sites), Nechako River: 157,000 h.p. at two sites, Bulkley River: 186,000 h.p. with three sites, and 29,500 h.p. on the Skeena River and Kitsilas Canyon. Current developments by the Aluminum Company of Canada include a hydro plant and processing plant at Kitimat. It is expected that the initial stages of development will produce some 300,000 h.p. giving a production of 80,000 metric tons of aluminum. An ultimate development of 1,600,000 horsepower and 500,000 metric tons of primary aluminum is contemplated.

Trapping provides winter employment and serves as an important source of revenue. The main fur-bearing animals include beaver, muskrat, red, silver and brown fox, mink, fisher, marten, weasel, wolverine, otter, lynx, wolf and coyote. Moose, deer and black bear generally occur throughout the area. Mountain goat, caribou and grizzly bear have been observed in the mountainous areas. Franklin grouse is the most abundant game bird but other species are also present. Geese and ducks are very common in the early autumn. Fish are numerous in most lakes and streams and salmon ascend the upper reaches of the Skeena and Fraser rivers to spawn.

The value realised by citizens through park development cannot be estimated in terms of money alone. Parks with potential use for fishing, scenery, camping, riding, hiking and mountaineering are attracting thousands of tourists. Provincial parks include Kitsumgallum, Burns Lake (Deadman's Island) and Tweedsmuir. The last named involves approximately 3,400,000 acres and is at present undeveloped. In addition to the above-mentioned there are a number of recreational reserves at such places as Kleanza Creek Canyon, Findlay Lake, and Lakelse Lake.

Transportation and Marketing Facilities

The region is well provided with transportation facilities. The main line of the Canadian National Railway from Edmonton to Prince Rupert traverses the length of the area. Few points are more than 25 miles from the railroad. The Pacific Great Eastern, formerly terminating at Quesnel, now has rail con-

‡ Refers to the Prince Rupert and Prince George Forest Districts.

nections with the transcontinental railway at Prince George. Highways and secondary roads traverse the area in all directions. Roads radiate from such centres as Quesnel, Vanderhoof, Burns Lake, Hazelton and Terrace. From the last-named, one can proceed by road to the seaport of Prince Rupert. A good road leads north from Fort St. James for approximately 125 miles to the mining area surrounding Germansen Landing. The Hart Highway, recently completed, now links Prince George with the Peace River District. The Department of Transport maintains airports at Prince George, Quesnel, Vanderhoof, Smithers and Terrace, and the Canadian Pacific Airways operate a regular service to these points.

The area is well provided with schools, churches and medical facilities. Many small, isolated and sparsely populated districts are, however, without social services of any kind.

The proportion of non-farming population in the area is high and as a consequence there are local markets for a considerable amount of farm produce. Further expansion of established industries will provide permanent markets for many of the products of the farm. At present, shipments of agricultural products from the area favor the more concentrated animal products. Creameries are operating at Quesnel, Prince George, Telkwa and Prince Rupert. Considerable numbers of livestock are shipped out annually to the Edmonton and Vancouver markets. Timothy, brome, fescue and Alsike seed are produced in abundance and compete successfully on outside markets. Vegetable seed production, a relatively recent venture, seems to have considerable promise, although the markets for these seeds is by no means assured.

History and Development

The opening up of the central interior of British Columbia was incidental to the fur trade of the Canadian West. It resulted from the competition between the two great fur trading companies, the Northwest of Montreal, and the Hudson's Bay of London. Each sought to outdo the other by exploring new regions and setting up trading posts. These were the motives that led Alexander MacKenzie to explore the northern and central interior regions. In 1792-93 he followed up the Peace and Parsnip rivers, down the Fraser to Quesnel, and then overland to Bentinck Arm on the Pacific Coast. The first trading post west of the Rocky Mountains was established in 1805 by Simon Fraser and James McDougal, at McLeod Lake. The following year, (1806), Fraser journeyed from Lake Athabaska west up the Peace and Parsnip rivers, across to the McGregor river and down the Fraser to Nechako. Following the Nechako to Stuart lake, he established Fort St. James. Later the same year, he proceeded up the Nechako to Fraser lake where he founded Fort Fraser. Fort George, at the confluence of the Nechako and Fraser rivers, was founded in 1806, and Fort Alexandria, south of Quesnel, a few years later.

The newly opened region soon became a valuable asset to fur trading companies through the abundance of fur-bearing animals. In 1811 David Harmon, at Fort St. James, cleared land for the first garden site on the Canadian mainland west of the Rockies. Potatoes, carrots, beets, parsnips, onions and barley were grown successfully. Later, factors at Fort George, Fort Alexandria, and other posts followed his example. Fort Alexandria became a storage depot and granary, following the development of a farm to supply wheat and flour for the Company's operations.

Placer gold was discovered in the Cariboo in 1859. The Cariboo Trail, constituting the first highway into the region, was constructed in 1863 and served as a means of access to the area prior to the building of the Grand Trunk Pacific and Pacific Great Eastern in the early years of the 20th century. In 1885 the Western Union Telegraph Company commenced building a line to the Bering Straits. These ventures were immediately followed by an influx of gold seekers, traders and merchants. With the decline of the mining industry, many turned to agriculture. The open grassy plains and alluvial flats in the Nechako and Bulkley valleys were among the first to be settled.

Agriculture remained a minor industry for there was little incentive to develop it beyond local needs. In the late 1880's, established Anglican and Roman Catholic missions encouraged farming, and towards the close of the century, the number engaged in farming was appreciable. In 1890 the Provincial Government organized the Department of Agriculture to foster interest in livestock, dairying and horticulture. Thus agriculture received its first great impetus.

The major portion of settlement in the area under review has taken place since the building of the Grand Trunk Pacific and the Pacific Great Eastern Railways. Steel was laid to Prince Rupert in 1905, and to Quesnel in 1915. Since then there has been a progressive, though spasmodic, increase in settlement.

It is difficult to trace the development of agriculture in the area previous to 1931 due to changes made in the Census divisions. Data from the 1931 and 1941 Census indicate that agriculture in the area did expand considerably. (Table 3.)

Table 3. Number of Farms Occupied and Acres of Improved Land in the Mapped Area (6)

(includes Census Subdivisions C, D, E, F & G in Division 8, B.C.)

Year	Number of farms	Acres occupied	Acres improved	Per cent land improved
1931	1,318	418,020	75,541	18·1
1941	1,244	459,473	95,363	20·8

There were 1,318 farms in 1931 and these decreased to 1,244 in 1941. While the number of farms decreased slightly the acreage occupied increased, as did the percentage of improved land. This would indicate some consolidation of farms into larger holdings.

The population of the map area is predominantly Anglo-Saxon, with Scandinavians, Germans and French in about equal proportions. Chinese are present in smaller numbers. Indians constitute about one quarter of the population.

Table 4 gives data on population by census subdivisions for the years 1921-1941. The figures are drawn from those for unorganized areas, villages and Indian Reserves.

Table 4. Population by Census Subdivisions for 1921-41 (6)

Subdivision	1921	1931	1941
Chilcotin North	903	1,052	1,560
Cariboo	3,201	2,991	5,907
Skeena-Bulkley (plus Terrace Village)	3,982	5,433	5,217
Upper Nechako	3,379	3,083	3,546
Babine-Stuart-Takla Lakes	997	1,744	1,453
Total	12,462	14,303	17,683

The data as presented in Table 4 indicate a general trend toward increase in population. This is particularly true of the Cariboo and the Skeena and Bulkley valleys.

Agriculture centres, for the most part, around mixed-farming and ranching (1). The former is common practice in most districts throughout the surveyed area. The latter, while practised quite widely, is more or less concentrated in districts such as Francois Lake, Grassy Plains, etc. As might therefore be expected an appreciable proportion, one third to three quarters, of the cultivated land is occupied by grass and grass-legume mixtures. Oats is the important grain crop. Wheat and barley are not grown extensively. Specialized lines such as dairying, poultry raising and seed production including forage and vegetable seeds are a major source of revenue in some districts. Dairying is important in the Terrace, Bulkley valley, Prince George and Quesnel areas. Forage seed production, particularly that of timothy, alsike and red clover, is important—the first-named notably in the Smithers area and the clovers in the Prince George and Quesnel districts. Spinach and turnip seed production is an important enterprise in the vicinity of Houston as indicated by the fact that in 1949 a total of 9,000 pounds of spinach seed and 7,200 pounds of turnip seed were produced.

Potatoes and vegetables are important farm crops in the Terrace and Soda Creek districts. Small fruits and hardy tree fruits are of some importance in the lower Skeena valley.

SOILS

Soil Classification and Mapping

In making the soil survey of the central interior, the soils were examined, classified and mapped in the field, and their characteristics recorded. Traverses were made by car whenever possible, but owing to lack of roads in the sparsely settled areas, traverses on foot or by pack horse were frequently necessary.

Soils and the underlying formations were examined systematically in numerous locations. Test pits were dug; highway, road and railway cuts or other exposures were studied. Characteristics considered in examining the soil profile included the number and arrangement of the soil horizons, the permeability, color, texture, structure, chemical composition, thickness and geology of the soil material. The effective depth of the root feeding zone, available moisture capacity, general nutrient supply, soil reaction, salinity, relief, drainage, erosion, stoniness and any other factors exercising an influence on soil character or land use, were also evaluated in delineating the mapping units.

From the above information, soil boundaries were determined and plotted on maps. The field work was carried out without the aid of topographic maps or aerial photographs. Following the establishment of soil boundaries, representative samples were carefully collected and taken to the laboratory for further study.

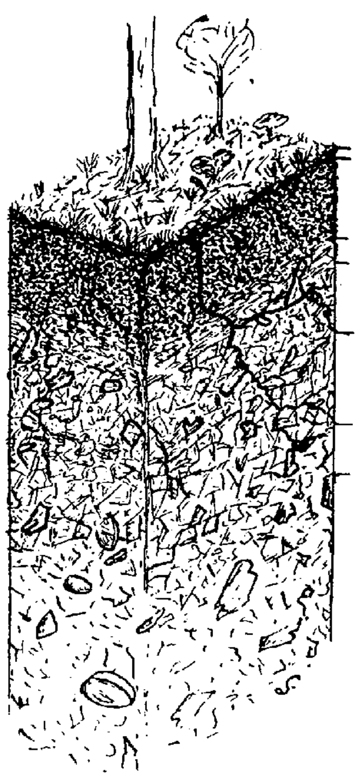
In the more remote areas, soil boundaries were sketched arbitrarily, according to the lay of the land. These conjectured boundaries are shown on the soil maps by broken lines and should not be confused with those that are established more accurately.

Major Soil Groups

The more important soils of the central interior fall into five zonal groups: the Degraded Black, Grey Wooded, Brown Podzolic, Podzol, and Podzolized Grey Wooded. The major portion of the area lies in the Grey Wooded zone. The Degraded Black soils occurring as scattered "islands" represent the most northerly extension of the interior grasslands. These soils are, for the most part, confined to medium- and heavy-textured deposits. Physiography plays an important part in their distribution as they are invariably confined to valleys and occupy well-drained slopes with southern exposures. These soils seldom occur above an elevation of 2,800 feet, and are associated with slightly to moderately calcareous parent materials.

The general sequence of horizons of the average Degraded Black soil is presented diagrammatically in Fig. 5. All the horizons and sub-horizons as shown are not necessarily present in every instance. The striking features of this zonal soil are the thin A_0, the well-developed dark grey to black mineralized layer (A_1) varying from 3 to 12 inches in thickness, the thin or weakly developed bleached layer (A_2) and the occurrence of a lime carbonate horizon at varying depths.

The Grey Wooded soils form one of the dominant upland groups of soils of the Interior Plateau (16). Lakes, streams, muskegs and heavy forest cover are characteristic of these grey soil areas. As a group these soils generally



A_0 accumulated layer of leaves, grasses, roots, etc., rarely over 1 inch deep.

A_1 Dark grey to black well-decomposed organic matter well mixed with mineral soil 3 to 12 inches thick.

A_2 Grey bleached horizon, may be very thin or attain a thickness of 8 inches in strongly degraded profile.

B_{21} Grey brown compact, coarse blocky structured horizon averaging about 4 inches thick.

B_{22} Grey brown colored, coarse blocky to massive structured horizon. 4 to 5 inches thick.

B_3 Grey brown, massive structured slightly weathered parent material, moderate to low content of lime.

C Soil parent material, largely unweathered by soil-forming processes. This horizon is limy; glacial stones are present here as well as throughout the profile.

Fig. 5—Diagram representing an average Degraded Black profile. These soils appear to represent degradation of former grassland (Black) soils. Driftwood loam.

have inferior physical properties and are often low in natural fertility. However, the better types may be built up to a high state of productivity by the use of legumes, grasses, manure and fertilizers where needed.

The modal types of Grey Wooded soil may vary in profile characteristics depending on the parent material. All, however, have a distinct organic mat consisting of decomposed and partially decomposed plant remains. The upper mineral soil layer is grey to light grey in color (A_2), seldom exceeding 6 inches in thickness. Below this is a distinct greyish-brown to brownish-grey horizon (B) having a heavier texture than any other horizon in the profile. Free lime is usually found in the subsoil at a depth of 36 to 48 inches.

The diagrammatic sketch (Fig. 6) represents a typical well-developed Grey Wooded soil of this area.

A_0 Partially decomposed remains of needles, twigs, mosses, etc., 2 to 4 inches thick.

A_1 Thin, often absent, layer consisting of mineral and organic matter intimately mixed.

A_2 Light grey, platy structured layer varying from 2 to 6 inches in thickness, generally strongly acid in reaction.

A_3 Light grey platy to nuciform structure.

B_{21} Grey brown moderately hard and compact normally nuciform to blocky structure slightly acid in reaction, and varying from 5 to 7 inches in thickness.

B_{22} Grey brown compact and coarse to very coarse blocky structure, slightly acid in reaction, varying from 5 to 7 inches in thickness.

C_1 Grey compact and impervious slightly weathered parent material.

C_2 Grey compact till neutral to slightly alkaline in reaction. Moderate content of lime carbonate; stones and boulders may occur throughout the profile.

FIG. 6—Diagram representing a typical Grey Wooded profile on glacial till in the north central interior. Chilako sandy loam.

The Brown Podzolic soils occur mainly in the Terrace area where the climate is characterized by cool summers, mild winters, and the commonly wet and dry seasons of the Pacific Coast. The zonal soil tentatively classed as Brown Podzolic differs in some respects from similarly named soils in Eastern Canada. The most striking difference is the occurrence of numerous shot-like aggregates, concentrated in or near the surface. These hard and persistent structural aggregates are similar to those found in such other areas as the Fraser Valley, southeast Vancouver Island and northwestern Washington. These aggregates are believed by some authorities (21) to represent diffused B horizons that develop around local nuclei coincident with drying out conditions prevalent during the summer months.

Well-drained Brown Podzolic soils in the Terrace area have an organic mat (A_0) lying on the surface, varying from 1 to 3 inches in thickness. Beneath this horizon is a grey leached layer varying in thickness from a mere film to a maximum of one inch. The B horizon is often 8 to 10 inches thick, containing numerous spheroidal persistent shotty aggregates embedded in a driable yellowish-brown matrix. The color of the solum becomes lighter with depth, finally grading to greyish parent materials. While these soils have developed under very heavy stands of coniferous forests and a total rainfall often exceeding 50 inches, they are still incompletely podzolized. This is probably due, in part, to the fact that the soil materials do not remain in place permanently. The large coast trees frequently uproot and invert large masses of soil to a depth of several feet leaving a forest floor of very rough microtopography. Normally, there is great variation in the depth of surface litter. The criss-cross of fallen tree trunks, ferns, bracken, etc., provides very uneven distribution of decaying vegetation. The result is a very patchy soil; in fact, few profiles show a definite orderly arrangement of horizons.

The Podzol soils occur in the more humid sections. They are developed mainly on sandy and gravelly low-lime parent materials, under a spruce-fir-lodgepole pine type of vegetation.

The Thin Podzol occurring in the vicinity of Hazelton, Prince George or Terrace has a surface organic mat 1 to 4 inches in thickness. Below this dark brown strongly acid layer is a light grey to white layer, the A_2 horizon, varying from $\frac{1}{2}$ to 2 inches in thickness. This is followed by a yellowish-brown to reddish-brown layer, the B horizon, which may vary in thickness from 6 to 18 or more inches and from single grain to weakly cemented structure. The highly colored B horizon dulls gradually with depth and small concretionary aggregates may occur throughout the B but are not prominent. The general sequence of horizons is illustrated in Fig. 7.

A_0 Accumulation of needles, leaf litter, etc., semi-decomposed, strongly acid in reaction.

A_2 Light grey sandy loam, weak platy structure and strongly acid in reaction.

B_{21} Light brown to yellowish-brown sandy loam containing a few dark colored "shot-like" aggregates. Strongly acid in reaction.

B_{22} Brown to yellowish-brown sandy loam, loose and friable.

C Greyish sands or gravelly material, unweathered. Neutral to acid in reaction.

FIG. 7—Diagram representing a Thin Podzol soil profile occurring in the vicinity of Terrace. Skeena sandy loam.

The Podzolized Grey Wooded soil appears to occupy a tension zone between the Grey Wooded and Podzol soils. Under these circumstances, the profiles are characterized by what appears to be a Thin Podzol profile above the clay accumulation characteristic of the Grey Wooded B horizon. This thin secondary profile is readily recognizable by its light grey A_2 horizon overlying a yellowish-brown to brown slightly compacted B horizon, which is underlain by a grey to pale brown horizon representing remnants of a former Grey Wooded A_2. (See Plate IV E.)

Other soil groups, limited in their distribution, occur in the surveyed areas. They include Bog, Half Bog, Dark Grey Gleisolic, Groundwater Podzol, and Alluvial Soils.

The Bog soils have developed in poorly drained depressions and consist of accumulations of plant material which usually exceed 12 inches in thickness.

The Half Bog soils are usually shallow mucky deposits over mottled mineral subsoils. Normally, these deposits vary in depth from a few to 12 inches.

The Dark Grey Gleisolic soils, occurring mainly in the Prince George and Terrace districts, have developed on heavy materials and occupy poorly drained positions. Thornhill, the hydromorphic member of the Lakelse catena, is the only series mapped and described. The profile somewhat resembles grassland meadow profiles of other areas and has a thick dark brown to black surface organic mat overlying a 4- to 6-inch layer of highly organic clay, the A_1. The subsoil is a compact greyish glei horizon consisting of two distinct layers; the upper, frequently mottled, is grey to light grey in color, very sticky and plastic when wet and of massive structure. The lower represents a highly mottled plastic horizon that remains wet the major portion of the year.

The Groundwater Podzol soils in the area have developed from poorly drained sandy deposits. They may be recognized by a thin organic layer beneath which lies a light grey, highly leached sandy layer. This layer, in turn, rests upon a mottled reddish-brown to dark brown compacted and frequently cemented subsoil.

The soils classified as Alluvial are found adjacent to streams and are characterized by lack of definite profile development. Distinguishing characteristics within the group are mainly due to differences in parent material, drainage and texture. Bottom lands such as Fraser, Remo, etc., are examples.

Soil Series and Types

Subdivisions of the major groups of soils mentioned above were made on the basis of difference in mineral parent material and topographic position, which affects drainage. Thus on any particular parent material may be found well-drained, imperfectly drained, poorly drained, shallow or truncated soils, and in some areas, saline soils. Such an association or grouping of soils developed on similar parent materials is called a "soil catena", whereas the individual members of profile types which make up the catena are referred to as "soil series". The series is the most important unit in mapping and is made up of soils similar in regard to the nature of their profiles, relief, and other external characteristics. The series are given convenient place names taken from the general locality in which they were first mapped. Vanderhoof, Telkwa and Lakelse are names of important soils. As a further separation, the series may be divided into "classes" according to the texture of the surface soil. The class names, such as loam or clay, are added to the series name, thus completing the name of the soil type, e.g. Pineview clay.

The soil type is often modified by external characteristics that have a marked influence on the utilization and management of the soil. These features, such as stones, gravel, topography, etc., are indicated on the maps by appropriate symbols.

In the surveyed area, four topographic classes representing variations in surface configuration were mapped. These are:—

1. Level to undulating (0 to 3 per cent slopes)
2. Gently rolling to moderately sloping (3 to 7 per cent slopes)
3. Rolling to steeply sloping (7 to 25 per cent slopes)
4. Hilly, eroded and mountainous (over 25 per cent slopes).

The level to undulating topographic class, while including an appreciable acreage of depressional topography, consists of simple smooth slopes rarely exceeding 3 per cent. Much of this land is associated with the lacustrine basins. The gently rolling to moderately sloping topographic class is more irregular and is characterized by a succession of low smooth ridges and intervening depressions. The rolling and steeply sloping land is for the most part associated with the drumlinized till plain. Here the slopes are steeper than those associated with the gently rolling class and in some instances very steeply sloping soils (16 to 30 per cent) are farmed with considerable success, provided the upper slopes are adequately protected by native vegetation to regulate runoff. On irregular steeply sloping lands, having complex slopes or broken land surfaces, 15 per cent is considered to be the extreme upper limit upon which tillage can be satisfactorily practised. In general, the rolling and steeply sloping lands are inferior agriculturally and with few exceptions are heavily timbered. The hilly, eroded and mountainous lands are too rough, steep or broken to permit cultivation and these areas are considered to be non-agricultural. While these areas are of little immediate importance to agriculture, they have a high forestry, mining, wildlife, watershed and recreational value and have therefore been included.

The soils of the area are classified according to the scheme outlined in Table 5. It should be pointed out at this time that rarely do the mapped soils represent a uniform type. There may be gradual changes from the soils of one group to the soils of another group, or inclusion of one group may occur within the boundaries of another. For convenience, in reconnaissance mapping, many soils have been classed with the group they most resemble. In some instances, only the dominant soil series are indicated, while in others intimate mixtures of different soils are mapped as complexes. The Driftwood-Barrett complex is an example of such a mapping unit.

Table 5. Classification of the Central Interior Soils

A. Soils of the Nechako Plain Developed from Water-Deposited Materials.

1. Clay to clay loam lacustrine deposits.

b. Well drained

Nulki clay	Degraded Black
Telkwa clay	Degraded Black
Cuisson clay loam	Degraded Black

c. Imperfectly drained

Pineview clay	Poorly Drained Grey Wooded
Vanderhoof silty clay loam	Grey Wooded
Fort St. James clay	Grey Wooded
Narcosli clay	Grey Wooded
Doughty clay	Grey Wooded
Pinchi clay	Degraded Black

2. Silt loam to silty clay loam lacustrine deposits.

b. Well drained

Bednesti silt loam	Podzolized Grey Wooded
Prairiedale silt loam and silty clay loam	Degraded Black

Table 5. Classification of the Central Interior Soils—*Concluded*

3. Loamy sand to sandy loam Alluvio-Lacustrine deposits.
   a. Drainage excessive
      Mapes sandy loam and loamy sand .... Grey Wooded
      Eena sandy loam and loamy sand .... Thin Podzol

4. Sandy loam, loamy sand and gravel on river terraces.
   a. Drainage excessive
      Saxton sandy loam and loamy sand .... Grey Wooded
      Giscome gravelly loamy sand .... Grey Wooded
      Braeside sandy loam and loamy sand .... Grey Wooded
      Kersley sandy loam .... Grey Wooded

5. Clay loam to silt loam on river terraces.
   b Well drained
      Fraser silt loam .... Alluvial
      Nechako silt loam .... Weakly Developed Grey Wooded
      Australian fine sandy loam, silt loam and clay loam....... Grey Wooded

B. Soils of Nechako Plateau (uplands) Developed on Glacial Till.
1. Sandy loam till.
   b. Well drained
      Chilako sandy loam .... Grey Wooded
      Barrett sandy loam .... Grey Wooded
      Driftwood sandy loam .... Degraded Black

2. Sandy loam and gravelly sandy loam deposits in the form of beaches.
   a. Drainage excessive
      Gunniza gravelly sandy loam .. .. Podzol

C. Soils of the Coast Range Intermountain Valleys Developed on Water-Deposited Materials.
1. Sandy loam and gravelly sandy loam outwash.
   a. Drainage excessive
      Kitsumgallum gravelly sandy loam .... Podzol
      Layton gravel .... Brown Podzolic

2. Sandy loam alluvial material on terraces.
   a. Drainage excessive
      Skeena sandy loam .... Podzol
      Moricetown sandy loam .... Podzol
   c. Poorly drained
      Kispiox sandy loam .... Groundwater Podzol

3. Lacustrine clay deposits.
   b. Well drained
      Lakelse clay .... Brown Podzolic—Podzol
   c. Poorly drained
      Thornhill clay .. .. Dark Grey Gleisolic

4. Recent alluvial deposits.
   a. Drainage variable
      McCully loam .... Alluvial
      Remo loam and clay loam .... Alluvial

D. Miscellaneous Land Types.
1. Alluvial lands .... Alluvial
2 Eroded lands .... Land Type
3. Rough and mountainous land .... Land Type

E. Organic Soils.
1. Peat Meadows, Muck, etc. .... Bog
2. Peat Bogs ....:......................... Bog

SOIL DESCRIPTIONS

A. Soils of the Nechako Plain Developed from Water-Deposited Material

The Nechako plain has been formed largely from glacial lake deposits. These have been sorted to a point where a large percentage of the mapped soils are classified as sands, silts and clays. The depth of this material varies considerably, being approximately 100 feet in the vicinity of Fort St. James, 260 in the Vanderhoof area, 220 at Prince George and 75 to 100 at Quesnel. In the Bulkley valley, on the other hand, the lake-laid deposits are shallow with the depth of clay over till or stratified sands and gravels varying from 1 to 10 feet or more (average depth 3 to 4 feet). The surface of the lake basin merges with till uplands, but boundaries clearly marked by old gravelly beaches, strand lines etc., are still apparent.

The approximate elevations of the major lake basins are as follows: Fort St. James, 2,200 to 2,600 feet; Vanderhoof, 2,200 to 2,500 feet; Prince George, 2,000 to 2,500 feet; and Quesnel, 2,000 to 2,500 feet.

Further detail with respect to the soils of the Nechako plain are presented herewith.

1b. Nulki (Degraded Black Clay)

Nulki soils, comprising some 6,100 acres, occur as small irregular areas adjacent to Nulki and Tachick lakes which lie to the south and east of Vanderhoof. These soils have developed from fine textured lacustrine deposits and range from Thin Black to strongly Degraded Black. They may be recognized by a deep dark grey to black A_1 horizon, underlain by partially leached A_2 and A_3 horizons. The parent material consists of varved clay and silty clay similar in many respects to that of Vanderhoof. (Plate IV, C).

Clay is the dominant textural class. Several areas are somewhat silty but, as a rule, they do not contain sufficient silt to be included in the silty clay category. The soil is generally free from stones.

The vegetative cover is a parkland type consisting of small grassland areas interspersed with light stands of deciduous trees. The topography varies from slightly undulating to gently rolling and the entire area is suitable for cultivation. Surface drainage is accelerated by the existing topography. The heavy-textured subsoils might be expected to impede drainage, but such is not the case due to the numerous shrinkage cracks, joints and root channels.

The following profile description is representative of a large portion of the area:

Horizon	*Depth in inches*	*Description*
A_0	1- 0	Dark brown decomposed and semi-decomposed remains of leaves, grasses, herbs, etc. pH 5·6
A_{11}	0- 3	Dark grey to very dark grey clay. Well-developed granular structure, friable consistency and high in organic matter. pH 5·6
A_{12}	3- 6	Dark grey clay with weakly developed platy-granular structure. Friable consistency. The whole horizon interwoven with a mass of grass roots forming a firm sod. pH 5·6
A_2	6- 9	Grey to light grey clay arranged in a well-developed medium nuciform structure. Weakly developed platy structure occurs in the upper 2 inches. It is friable when moist, plastic when wet, and hard when dry and is somewhat lighter in texture than the underlying B. pH 6·2

Horizon	Depth in inches	Description
B_{21}	9-14	Brownish-grey clay. Strongly developed coarse nuciform structure becoming blocky with depth. It is very plastic when wet and hard to very hard when dry. pH 6·7
B_{22}	14-20	Grey to brown grey clay strongly developed medium to coarse blocky structure, similar to B above. pH 8·3
B_{31}	20-28	Grey to light grey alternating bands of clay and silty clay. Varves divided by vertical cracks giving a coarse blocky structure—few roots—no effervescence. Plant roots penetrate above horizons. pH 8·5
B_{32}	28-35	Light grey varved clay, slightly calcareous, lime segregated in soft concretionary forms. pH 8·8
B_{ca}	35-36	Similar to above horizon but contains much lime accumulation. pH 8·8
C	36-	Grey compact and impervious varved clay containing lime carbonate.

In some cases, strongly Degraded Black profiles are associated with the modal described above. They differ in that the A_1 is grey in color, is thin and overlies a highly leached platy structured A_2 varying from 4 to 6 inches in thickness. In shallow depressions soils exhibiting poorly drained conditions and mottled subsoils occur.

Agriculture

The Nulki soils are, in general, highly fertile and productive. The loose well-aggregated surface soil has a high porosity and is fairly high in organic matter and nitrogen. The data as presented in Table 11 suggest a fairly high base status, while the data on minor elements (Tables 12, 13, and 14) indicate neither excesses nor deficiencies.

The Nulki soils are used mainly for grain production, oats and barley being the most important crops. Alfalfa, clovers, and grasses are grown successfully and it would appear that the ability of these soils to grow coarse grains and forage crops makes them desirable for livestock production.

The strongly degraded soils associated with Nulki are somewhat inferior agriculturally and the small peaty areas in the depressions often lack adequate drainage.

TELKWA (Degraded Black Clay)

The Telkwa soils, involving 14,100 acres, belong to the Degraded Black soil group and have a dark colored surface soil to a depth of 6 to 9 inches. Below this, the color becomes lighter and the soil material progressively firmer and more compact. At a depth of 20 to 30 inches the material changes abruptly to a boulder clay, glacial gravels or bedrock.

The dominant textural class is clay. Clay loam and loam classes occur and are associated with the morainic deposits frequently outcropping. Glacial boulders, stones and gravel occur in the shallow soils representing the Telkwa-Driftwood complex.

Telkwa soils, like Nulki, have developed under a parkland type of vegetation. Thick stands of bunch grasses, groves of aspen, black poplar and willow characterize the virgin areas.

These soils occupy flat to gently rolling terrace plains paralleling the Bulkley river in the vicinity of Smithers and Telkwa. Undulating topography, interspersed with numerous flat and depressional areas representing approximately 25 per cent of the total acreage, is typical. (Plate III D).

Telkwa soils are well drained except for the depressional areas where the soils closely resemble Doughty.

The following is a description of a profile typical of the Telkwa series:

Horizon	*Depth in inches*	*Description*
A_0	1- 0	Black fibrous partially decomposed plant remains. pH 7·1
A_1	0- 3	Dark grey to very dark grey clay, strongly developed small nuciform structure aggregates. Platiness common. pH 6·1
A_2	3- 5	Light brownish grey clay, moderately well developed, small nuciform structure aggregates. Platiness common. pH 6·1
B_{21}	5-11	Grey to grey brown coarse nuciform structured clay of hard consistence when dry and moderately plastic when wet. Few stones and gravel. pH 5·7
B_{22}	11-17	Grey brown clay to heavy clay coarse nutty and blocky aggregates arranged in a weakly developed prismatic manner. Hard when dry and extremely plastic when wet. This horizon is penetrated by roots. pH 5·2
B_{31}	17-22	Grey to light grey partially weathered stratified clay. pH 5·7
C	22-	Grey to light grey varved clay. pH 5·7

Telkwa soils occur in a complex with Driftwood, the latter representing medium-textured soils on glacial till deposits. Small areas having a peaty surface layer and a mottled subsoil are also common.

Agriculture

The Telkwa are among the very good agricultural soils occurring in the central interior of British Columbia. Lying as they do 50 to 100 feet above the river, air drainage is normally good. They have high drought resistance, high organic-matter and nitrogen content. Chemical data indicate neutral reaction and moderately high base status. Exchangeable calcium is moderately high and magnesium and potassium contents are satisfactory. The structure, initially strong, shows a tendency to break down after a number of years of cultivation.

The Telkwa soils respond very well to application of nitrogen and phosphorus fertilizers. Experimental work conducted at the Dominion Experimental Substation at Smithers indicates that the turning under of green manure crops such as legumes contributes to higher yields and better tilth. It is interesting to observe that this Substation is located on both Telkwa clay and Driftwood loam and thus the results of experiments conducted are applicable to the two most important soils in the Bulkley valley.

CUISSON CLAY LOAM (Degraded Black loam to clay loam)

Cuisson clay consists of Degraded Black solodized solonetz soils developed on somewhat saline parent materials in the vicinity of Alexandria. Some 3,500 acres of this type were mapped and it is possible several hundred additional acres occur in association with the Chilako soils in the same area.

Cuisson soils have a dark greyish brown surface soil to a depth of 4 inches overlying a light brownish grey platy structured A_2. The columnar structured B horizon is very compact and the aggregates are frequently stained with a dark glossy coating. The lower horizons are varved and contain varying amounts of lime and salts.

Clay loam is the dominant textural class. Finer textures, such as clay and heavy clay, frequently occur. The cultivated surface soil is grey brown is color and is almost entirely free from stones or gravel.

The native vegetation is typically parkland consisting of small stunted poplar bluffs interspersed with open grassy plains. Nearly all the area has been mapped as undulating. Depressional areas are fairly common and are characterized by accumulations of soluble salts. Frequently these depressions give way to sloughs, ponds or meadows. Surface drainage, therefore, varies greatly. On the gently sloping lands surface runoff is frequently excessive. The dominant upland soils have reasonably satisfactory internal drainage, but the heavy impervious B horizon tends to restrict free movement.

The Cuisson soils have a solodized solonetz type profile. A generalized description is as follows:

Horizon	*Depth in inches*	*Description*
A_1	0- 3	Dark greyish brown clay loam, granular to weak platy structure, friable. pH 6·8
A_2	3- 5	Light brownish grey loam, thin platy structure, very friable. pH 6·0
B_{21}	5-10	Grey to dark grey clay, strongly developed columnar structured aggregates having rounded tops. There is a very sharp horizonal boundary between A and B. Removal of the A exposes the rounded tops of the columns. The aggregates are normally hard when dry, become very sticky and plastic when wet. pH 6·3
B_{22}	10-14	Brown to grey brown clay, with well-developed medium blocky structure which breaks down readily to smaller aggregates. Moderate accumulation of organic matter occurring mainly as a dark brown glossy coating on the aggregates. Hard when dry and very plastic when wet. pH 7·1
B_{31}	14-20	Greyish-brown clay. Weak platy structure; accumulations of soluble salts apparent. pH 7·8
C	20-	Greyish-brown laminated clay, contains moderate amounts of gypsum, salts and lime. pH 8·2

Associated with the Cuisson soils and on the same parent material is a poorly drained soil which occupies flat or depressional topographic positions and which has a shallow profile usually containing varying amounts of soluble salts.

Agriculture

The Cuisson soils have high fertility and are moderately drought resistant. However, the occurrence of saline spots, small ponds, sloughs and meadows seriously reduces their agricultural value. Grain crops are grown to the practical exclusion of all others and moderately good yields are reported.

1c. PINEVIEW CLAY (Poorly Drained Grey Wooded Clay)

Pineview soils, located in the Prince George and Quesnel districts, have developed from fine-textured, slowly pervious, lacustrine parent materials that are virtually free of stones and gravel. Some 383,700 acres have been surveyed, of which 129,000 occur in the area under review.

The virgin soil has a thin layer lying beneath the forest leaf mat. This is underlain by a leached A_2 horizon, which is light grey in color and has a well-developed granular structure. The sub-surface horizons are very compact and grade into the greyish-brown varved parent material. (Plate II A).

The tree cover typical of Pineview soils consists of heavy coniferous forests dominated by lodgepole pine. Spruce, fir and poplar also occur and are co-dominant in many areas. The topography is essentially level to undulating and surface drainage is reasonably satisfactory except where seepage from adjacent slopes does not find an adequate outlet. Internal drainage is very slow; in fact, in many instances little, if any, free water passes through the soil profile.

The profile of Pineview clay has the following characteristics:

Horizon	*Depth in inches*	*Description*
A_0	2- 0	A forest floor, dark brown color averaging 2 inches in thickness and consisting chiefly of undecomposed plant remains. pH 4·5
A_1	0- 1	Dark grey clay having a coarse granular structure but may also demonstrate granular-platiness. Friable in consistence. pH 4·6
A_2	1- 5	Light grey clay having coarse granular structure. Granules moderately vesicular. Readily permeable. Hard when dry and very plastic when wet. pH 5·1
A_3 or B_1	5- 7	Light grey clay. Coarse nuciform structure. Very hard when dry, sticky and plastic when wet. pH 5·1
B_{22}	7-14	Grey brown heavy clay somewhat mottled with reddish and light grey streaks and splotches. Structural aggregates have a coarse blocky shape and are very plastic when wet, hard when dry and contain very few non-capillary pores or root channels. pH 6·2
B_{23}	14-20	Light grey clay; less compact and impervious than foregoing horizon. Coarse blocky structure very similar to above. pH 6·5
C	20-	Grey to light grey clay and heavy clay. Hard when dry and very plastic when wet. Consists essentially of alternating layers of light grey and dark grey varves. No reaction to dilute HCl. pH 7·2

On level and poorly drained areas or on slopes where there is seepage, higher moisture conditions prevail. The lack of aeration and the lowering soil temperatures result in hydromorphic conditions which have induced the development of soils having high surface organic-matter content and a very impervious and mottled subsoil. The name Dark Grey Gleisolic has been applied to this group of soils. (Plate IIB). They have not been mapped separately but occur extensively throughout the areas mapped as Pineview.

The Pineview soils have also been mapped as a complex with the Chilako soils, which represent those soils developed on undifferentiated till deposits.

Agriculture

The natural fertility of Pineview is relatively high compared with other Grey Wooded soils of the central interior. This is apparent from the satisfactory crops of grains, grasses and legumes harvested annually. However, Pineview has several serious defects. Because of soil moisture relationships, fine texture, compactness and low organic-matter content, effective cultivation can only be undertaken within a relatively narrow moisture range (see plasticity data, page 71). Porosity determinations reveal that the soils on the better drained positions have an average air capacity or non-capillary porosity of 24·0 and 3·9 per cent at depths of 0 to 6, and 6 to 16 inches respectively, whereas for adequate sub-surface drainage, a desirable non-capillary porosity should be about 10 per cent.

The data on acidity indicate that Pineview soils are slightly acid with a range of 5·1 to 6·0 in the surface cultivated layer. The base exchange capacity and percentage saturation of the cations indicate a moderately favorable condition. (See Table 11).

Oats, while not grown extensively, are the major grain crop on these soils. Alsike and red clover, for seed and forage, provide a major source of income. Alfalfa has not been too successful because of low soil temperatures, poorly drained conditions, low noncapillary porosity of subsoil and frequent winterkilling. Timothy, and to some extent, reed canary grass alone or in mixtures with clover are grown successfully.

VANDERHOOF SERIES (Grey Wooded silty clay loam)

Vanderhoof soils, comprising approximately 277,400 acres, are lacustrine in origin, developed on silty clay to clay parent materials. Silty clay loam is the dominant textural class. Areas of clay and clay loam occur but their boundaries have not been delineated. A few stones occur where the clay is shallow and lying on till. The soils are located largely in the Nechako valley centering on the village of Vanderhoof. Small scattered areas also occur in the vicinity of Fort Fraser and Burns Lake.

The cultivated surface of Vanderhoof is a light grey color when dry but turns a pale brown upon moistening. This light-colored surface layer is underlain at 12 to 15 inches by a light brown, compact, almost impervious horizon of clay. At 35 to 50 inches, free carbonates of lime occur and are disseminated throughout a varved clay material. (Plate 1A).

The forest cover consists essentially of two types—deciduous and evergreen trees. The deciduous cover, consisting largely of aspen poplar and willows interspersed with less abundant alder, lodgepole pine or spruce, provides a dense vegetative growth that involves relatively heavy and expensive clearing. The coniferous forests of lodgepole pine, spruce and fir are of considerable commercial value.

The topography of Vanderhoof soils varies from nearly level to strongly sloping and hilly. The hilly topography is relatively limited and occupies approximately 3,500 acres. The gently undulating to relatively flat topography is conducive to ineffective drainage and this is so marked that frequently spring cultivation is seriously delayed. These slowly drained areas may represent relatively large acreages or may exist as isolated depressional spots on individual farms.

A representative profile of Vanderhoof silty clay as found on a well-drained site under mature forest is as follows:

Horizon	*Depth in inches*	*Description*
A_0	4- 0	Dark brown decomposed and semi-decomposed organic debris. Very fibrous and contains numerous roots. pH 4·7
A_1	0- 2	Grey brown silty clay arranged in a weakly developed thin platy structure, very loose and friable. pH 5·2
A_2	2- 8	Light grey silty clay. Massive to very coarse irregularly shaped aggregate. pH 6·4
A_3 or AB	8- 9	Light grey coarse nuciform sity clay. pH 6·4
B_{21}	9-15	Grey brown to brown coarse nuciform heavy clay. Hard when dry and very plastic when wet. Contains a number of small concretionary forms. pH 6·4
B_{22}	15-24	Grey brown coarse blocky clay to silty clay. Moderately impervious. Few roots. pH 7·2
B_{31}	24-29	Similar to B_{22} above yet showing evidence of pronounced varving. pH 8·0
C	29-	Grey to grey brown varved clay. Varves to 1 and 1½ inches thick, intermixed with hard concretions of $CaCO_3$. pH 8·3

In the depressional areas the A_1 is somewhat deeper and the A_2 is slightly less developed. The B has a darker color and is generally highly mottled.

Agriculture

In general the agricultural adaptations of Vanderhoof soils are similar to those of Pineview at Prince George and Quesnel. With the melting of the snow and the withdrawal of the frost, the silty A_2 and A_3 horizons assume a very plastic condition and thus become subject to puddling. Upon evaporation of the excess water, the soil dries into a firm compact mass which when tilled shows little or no evidence of granulation but appears rather as a hard dense crust which hinders the emergence of seeds and interferes with the normal functions of plant growth. (See plasticity data, page 71.)

Pore size distribution data (page 69), as for Pineview, is very unfavorable. This is particularly apparent in all horizons other than the shallow A_1. Evidence of the fact is clearly revealed in a study of Figure 7, and the condition exercises a profound influence on infiltration, percolation and aeration.

Particle size distribution analyses of Vanderhoof soils are revealing. The A_2 horizon, constituting the major portion of the cultivated layer, shows a silt content of 74·4 per cent and a clay content of 12·6 per cent. Such a particle size distribution, when viewed together with the extremely low organic-matter content, results in "close packing" of the soil particles and the development of unfavorable physical properties.

In order to avoid unfavorable structures developing and thereby to maintain production, the cropping system and soil management practices must provide for frequent incorporation of organic matter. This may be accomplished on the general farm through the establishment of soil improvement practices involving the use of legumes, crop residues, barnyard manures, organic wastes and commercial fertilizers.

The virgin soil, when brought under cultivation, responds to good management practices and gives excellent returns when devoted to pasture and cereal crops. Timothy and such legumes as alfalfa and alsike clover do very well and their further use is highly recommended.

FORT ST. JAMES SERIES (Grey Wooded clay)

The Fort St. James soils occur in the north central part of the surveyed area principally in the Necosli Creek, Fort St. James and Pinchi districts. Approximately 106,700 acres have been mapped, but there are probably thousands of acres still to be surveyed and reported upon. The Fort St. James soils have been mapped as clay and the areas are usually stone-free, except where contact is made with the till soils. Rock outcroppings, in the vicinity of Stuart and Pinchi lakes, are common.

The Fort St. James profile has little or no A_1 horizon, while the granular to fine nuciform A_2 is clearly apparent. The B, massive and compact may be separated, upon drying, into prismatic aggregates. The C, a varved lacustrine deposit, contains moderate amounts of lime and salts.

The forest cover consists dominantly of dense stands of mature lodgepole pine with varying proportions of poplar, spruce, birch and willow. Black spruce predominates in the depressional and poorly drained areas. The topography varies from flat to gently undulating and rolling. Surface drainage is satisfactory except on areas having little or no relief. Internal or profile drainage, as in the Pineview, is greatly restricted.

A profile description, as found under moderately well-drained virgin conditions, is presented herewith:

Horizon	Depth in inches	Description
A_0	1- 0	Surface deposit of needles, mosses, twigs, etc.
A_1	0- 1	Dark grey fine granular clay. pH 5·6
A_2	1- 4	Grey clay to heavy clay; strongly developed coarse granular to fine nuciform structure. Hard when dry and very plastic when wet. pH 5·2
B_{21}	4-10	Dark greyish-brown to dark brown coarse prismatic heavy clay. Very hard when dry and very plastic and sticky when wet. Few roots. pH 5·9
B_{22}	10-18	Brown and dark brown massive heavy clay. pH 5·9
B_{31}	18-28	Similar to B_{22}. Laminated structure apparent. pH 5·9
C	28-	Varved material occurring in alternating bands of grey and dark grey clay and heavy clay. Lime carbonates and salt accumulations frequently occur. pH 7·9 to 8·0

Agriculture

The agricultural possibilities of Fort St. James clay are similar in many respects to Pineview clay, and the problems already enumerated and discussed relative to Pineview soils apply equally well to these soils. The frost data suggest that at Fort St. James frost-resistant crops only should be grown.

NARCOSLI SERIES (Grey Wooded clay)

The Narcosli series consists of heavy-textured soils developed on varved clay and occupies some 8,700 acres in the vicinity of Quesnel. While similar to Pineview in some respects, they differ in having a somewhat lighter texture, a deeper A_1 dark grey in color, a platy structured A_2 and a well-aggregated nutty B.

Narcosli soils are mapped as clay. Gravel patches may occur while stones are rarely encountered except along the boundaries of the till soils.

The native vegetation consists of moderately open stands of mixed coniferous and deciduous trees. Black spruce is the dominant species in many of the low-lying areas.

The topography is characterized by a number of undulating and moderately sloping areas separated from one another by streams or gullies. Surface runoff from the level and undulating areas is of relatively minor importance while on the steeply sloping and hilly areas it is often excessive. Internal drainage is inclined to be slow but more satisfactory than that of Pineview.

The profile of Narcosli clay has the following characteristics:

Horizon	Depth in inches	Description
A_0	2- 0	Partially decomposed organic matter consisting mainly of needles, leaves, twigs and grasses.
A_1	0- 3	Dark grey clay to clay loam. Strongly developed fine granular structure. pH 6·0
A_2	3- 6	Grey to light grey clay. Strongly developed medium platy structure breaking readily to medium sized granules. Aggregates are quite vesicular. pH 6·2
A_3 or B_1	6- 7	Light grey to grey clay. Strongly developed coarse nuciform aggregates which blend gradually to the B horizon. pH 5·8
B_{21}	7-12	Grey brown clay. Coarse to very coarse nutty aggregates. Hard when dry and very plastic when wet. Moderately permeable and penetrated by numerous roots. pH 5·7
B_{22}	12-18	Grey brown clay; massive to weakly developed coarse blocky structure. A compact heavy clay that is slightly permeable. pH 5·8
B_{31}	18-24	Similar to B_{22} but some varving characteristic of C. pH 6·5
C	24-	Grey to dark grey varves of clay and heavy clay. pH 7·0 to 7·2

Agriculture

Narcosli soils are moderately well suited for the production of a variety of farm crops. A considerable acreage is devoted annually to the production of wheat. Oats and barley are grown in lesser amounts. Legumes, including alfalfa, are successfully grown and constitute an appreciable percentage of many hay and tame pasture mixes.

These soils are superior in productivity to Pineview or Fort St. James soils and appear to respond very well to applications of nitrogenous fertilizers. The fine-textured and compact B horizon is more open and permeable than Pineview, with the result that plant roots extend to greater depths and are better supplied with the plant food elements. Deep rooted legumes will help to open up these tight subsoils. Like Pineview, they tend to develop unfavorable physical properties when cultivated.

DOUGHTY SERIES (Grey Wooded clay)

The soils of this series comprise about 7,100 acres in the Smithers and Moricetown districts. They have developed on heavy-textured lacustrine deposits and are the Grey Wooded counterpart of the Telkwa series. Clay is the predominant texture and stones are rarely encountered except on a few localized areas where the underlying boulder clay is at or very near the surface. Occasional large erratics occur.

The forest cover typical of Doughty soils consists normally of dense stands of coniferous trees, mainly pine, spruce and fir. Much of this timber is suitable for lumber, ties, poles and other purposes. On burned areas light stands of poplar, lodgepole pine and willows occur separately or in mixtures.

Approximately 85 per cent of the Doughty soils are mapped as undulating but interspersed are a number of small depressional areas. The rolling and steeply sloping classes occur along the borders of the Barrett soils. Surface drainage or runoff is adequate on the undulating and gently rolling surfaces. Percolation is greatly reduced by the slowly permeable subsoil, thus inducing lateral movement of water on the slopes with the creation of seepage areas.

The type profile taken under mature forest conditions and occupying a moderately well-drained site, is described as follows:

Horizon	*Depth in inches*	*Description*
A_0	2- 1	Variable depth of accumulated remains of needles, grasses, etc., only partially decomposed. pH 4·1 to 4·5
A_1	0- 1	Grey to grey brown clay weakly developed medium granular structure. Platiness in the lower portion. pH 4·2 to 4·5
A_2	1- 4	Light grey to grey clay and heavy clay; thin platy structure. pH 4·9 to 5·1
AB	4- 6	Grey clay, coarse thick platy to weakly developed nutty structure. This horizon is finer in texture and more dense and compact than above horizon. pH 5·2
B_{21}	6-12	Grey heavy clay, having a well-developed coarse nuciform and blocky structure. This horizon is quite compact and impervious. Hard when dry and very plastic when wet. Frequently few rounded pebbles may occur. pH 5·0 to 5·2
B_{22}	12-18	Grey brown to brown heavy clay. Strongly developed coarse to blocky structure. Similar to above horizon. pH 5·0
B_{31}	18-22	Partially weathered varved clay. Grey color. pH 5·2
C	22-	Brown to grey brown varved clay. This horizon may be underlain by glacial till or stratified gravels. pH 5·5

Other profiles associated with the Doughty soils are the poorly drained members occurring in shallow depressions and around the margins of meadow and peat deposits. These poorly drained profiles are characterized by a deep A overlying a heavy plastic permanently wet subsoil often mottled with rusty, red, yellowish and grey spots and streaks. These variants occupy a relatively small acreage and have not been separately mapped.

Agriculture

The Doughty soils have problems in common with the Pineview and Fort St. James soils, and all are in the pioneer stage of agricultural development. The sparse information available indicates that these soils have a relatively high productivity and respond to applications of manure and nitrogenous fertilizers. Crops include wheat, oats, barley and legumes such as alfalfa, alsike and red clovers. Root crops, such as potatoes, turnips, etc., do moderately well.

PINCHI SERIES (Degraded Black clay)

The Pinchi series consist of very heavy-textured soils developed on lacustrine deposits occurring in the Fort St. James glacial lake basin. These soils are, in general, the Degraded Black counterpart of the Fort St. James clays and occur in the vicinity of Pinchi Lake north of the village of Fort St. James. Approximately 4,000 acres have been mapped. The soils of this series do not vary appreciably in texture, and hence only one soil type has been mapped—Pinchi clay. Glacial stones are relatively few in number but frequently the lower horizons of the profile contain a few small water-worn pebbles or an occasional stone or boulder.

On the better drained positions, Pinchi series consist chiefly of Degraded Black to Thin Black soil. They are characterized by black or nearly black thin surface horizons overlying a grey slightly leached A_2 or AB horizon. At a depth of 12 to 14 inches a very fine, extremely compact and impervious layer occurs which greatly impedes free movement of moisture. This layer is underlain by a varved clay which contains varying amounts of accumulated salts and carbonates of lime.

The vegetation consists of a luxuriant growth of grasses and broadleafed plants interspersed with many bluffs of aspen and willow. In the depressional areas, lodgepole pine, willows and occasionally black spruce predominate.

The topography is typically undulating with a few gently rolling phases interspersed. Surface drainage of the uplands is moderately rapid and as is to be expected meadows and peats are common in the depressional areas. The internal or soil profile drainage of the surface horizons is adequate but very slow in the subsoil. The heavy texture and impervious nature of the lower horizons are responsible for this condition.

The profile suggests a forest invasion of grassland and is described as follows:

Horizon	*Depth in inches*	*Description*
A_1	0- 6	Dark grey to black heavy clay with a strongly developed granular structure. pH 5·5
A_2	6- 8	Grey heavy clay, fine to medium nuciform structure. pH 5·5
B_{21}	8-16	Dark brown very heavy clay consisting of extremely compact and hard very coarse prismatic aggregates. These aggregates break down to dense hard cubical fragments. pH 6·5
B_{22}	16-22	Brown heavy clay. Massive to very coarse blocky structure. pH 6·5 to 7·0
B_{31}	22-24	Brown heavy clay resembling B_{22} but has definite laminated and varved structure. pH 7·5
C	24-	Grey brown heavy clay, varying in some localities, sufficient lime to produce slight effervescence to dilute HCl. Salts may occur. pH 8·0 to 8·4

A strongly degraded type occurring under the forest vegetation differs from the above in possessing a moderately well-developed platy structured A_2 horizon several inches thick. The underlying B is slightly darker in color and more massive in structure.

Local soils occurring with Pinchi include Fort St. James clay, muskeg and shallow meadow soils.

Agriculture

Approximately 350 acres of Pinchi soils have been cultivated; the remainder, which supports dense stands of grasses and scattered bluffs of trees, provides natural pastures.

While Pinchi soils have very good possibilities for agricultural development, there are a number of important problems to be considered. The physical condition of the surface soils permits adequate movement of moisture while the subsoils are of such a nature that percolation is extremely slow. This condition often tends to delay spring planting as well as the maturity of the crops. The frequent occurrence of summer frosts may also cause serious losses.

Grasses and legumes, in mixtures or as single crops, do very well and produce high yields of forages. The use of manures and nitrogen-carrying fertilizers together with the wide use of forage crops and early maturing grains is recommended. The soils should be devoted to mixed farming in which livestock represents a large part of the farm activity.

2b BEDNESTI SERIES (Podzolized Grey Wooded Silt Loam)

The Bednesti series consists of medium-textured soils developed from silty lacustrine and alluvial materials deposited in the Prince George glacial lake, and are located adjacent to the Bednesti and Stuart compound eskers. The mapped area amounts to approximately 41,200 acres, of which some 37,000 acres are topographically suitable for agricultural development.

The area has been mapped as belonging to the silt loam textural class but islands of silty clay loam and fine sandy loam occur. Stones are present where shallow silty deposits overlie the morainic till. Gravel and sandy deposits are frequently observed, particularly in the transitional types bordering the Eena series adjacent to Bednesti and Stuart compound eskers.

The surface soil of Bednesti consists of several distinct layers. The podzolic, A_{2p}, is continuous and uniformly light grey in color and overlies the B_p which is a brown to yellowish-brown in color. This layer is in turn underlain by a thick pale brown to grey horizon which rests on a somewhat finer textured and more compact horizon that breaks into angular blocky fragments varying in size. This layer grades into a greyish well-stratified silty parent material. While Bednesti soils have been classified as having a Podzolized Grey Wooded profile, it consists essentially of a double profile. The properties of the upper profile are interpreted as a Thin Podzol developed in the A_2 horizon of a former Grey Wooded profile. (Plate IV E).

The native vegetation consists mainly of heavy and very heavy stands of mixed spruce and lodgepole pine. On burned-over areas poplar and lodgepole pine quickly establish themselves.

An undulating and hilly topography characterizes the area. The former covers approximately 37,000 acres and the latter, having slopes exceeding 15 per cent, covers approximately 4,200 acres. Surface drainage varies from satisfactory to excessive depending upon topography and, as might be expected, some erosion is apparent on the steeper slopes.

The following profile is typical of the area:

Horizon	Depth in inches	Description
A_0	2- 0	Dark brown partially decomposed remains of mosses, needles, twigs, and other organic debris. pH 4·5
A_{2p}	0- 2	Light grey very fine sandy loam, friable and exhibiting a fine platy structure. pH 4·6
B_p	2- 8	Brown silt loam with moderately well-developed medium sized granular structure, coherent in place, very friable, and containing a few concretionary forms. pH 5·4 to 5·6
C_p	8-14	Brownish-grey silt loam, weakly developed nuciform structure. pH 5·6 to 6·0
B_{22}	14-22	Light brownish-grey to pale brown silty clay loam that is moderately compacted; coarse blocky structure. Aggregates are sharply angular. pH 6·5
B_{31}	22-28	Pale brown silt loam occurring in compacted stratified layers of varying thickness. pH 6·5
C	28-	Pale brown to very pale brown stratified silt loam. pH 7·0

Thin profiles frequently occur where the Bednesti profile overlies a gravel, till or clay D horizon. Occasionally poorly drained seepage areas, calcareous to the surface, are encountered. In some localities, Bednesti occurs in close association with Pineview and Eena soils. Peats, muskegs and meadow soils frequently occur in shallow depressional areas.

Agriculture

Bednesti silt loam is a moderately productive soil, friable and, unlike Pineview, may be cultivated under a wide range of moisture conditions. This soil warms up early in the spring and responds greatly to improved methods of tillage and fertilization.

Bednesti soils are slightly acid in reaction with an average pH value of 5·5 or higher. Exchangeable bases under virgin conditions are only moderate (Table 11). Thus, when brought under cultivation and subjected to careless cropping practices, fertility may rapidly decline. The moisture-holding capacity is low but the heavy-textured B horizon may prove beneficial in maintaining and regulating the supply of moisture during the growing season.

The major soil management problem involves the building up and maintaining of organic-matter levels. This may be most readily effected through the adoption of a mixed-farming enterprise based primarily on a livestock economy.

PRAIRIEDALE SERIES (Degraded Black silt loam)

The Prairiedale soils have been derived from deposits originally laid down in the Vanderhoof lake basin and varying from medium to medium heavy texture. These soils lie below the 2,200-foot contour and cover approximately 11,400 acres. Several distinctly separated areas occur, the largest and most important of which lies north of Vanderhoof in townships 11, 12 and 19.

The Prairiedale series contains two classes: the silt loam and the silty clay loam. Stones, boulders or gravelly areas seldom occur.

The Prairiedale soils are characterized by well-developed dark grey to blackish A_1 horizons which are high in organic matter and possess a well-developed granular structure. The leached A_2 layer, varying considerably in thickness, is very weakly developed under the grassland vegetation, while under the forest cover it is well-developed and lies close to the surface. The B horizon, showing some clay accumulation, is not so compact and impervious as similar horizons in the adjacent Vanderhoof soils. The subsoil consists of well-stratified, moderately compact silty material containing lime carbonate accumulations at 40 to 50 inches.

The native vegetation is characterized by light to medium stands of poplar interspersed with small groves of lodgepole pine and open grassy areas.

The topography is level or nearly so, with a small portion having a gently sloping surface. Surface drainage is moderately good, and internal or profile drainage adequate throughout.

The following profile description taken under a light stand of poplar is representative of the silt loam class:

Horizon	*Depth in inches*	*Description*
A_0	1- 0	Partially decomposed remains of leaves, needles, etc., dark brown color. pH 5·5
A_1	0- 5	Grey to very dark grey silt loam well-developed granular structure becoming platy with depth. pH 5·9
A_2	5- 8	Light grey silt loam, combined platy and granular structure. pH 6·3
B_{21}	8-16	Grey brown silty clay loam, medium sized nuciform aggregates which disintegrate with moderate pressure to fine powdery form. Slightly plastic when wet. pH 6·8
B_{22}	16-23	Grey brown silt loam and silty clay loam, coarse weakly developed nuciform structure, friable and slightly compact. pH 7·7
B_{31}	23-28	Grey to dark grey silt loam, weakly stratified and moderately compact. pH 7·7
C	28-	Grey to light greyish brown well-stratified silt loam. Lime carbonate accumulation 40 to 50 inches in depth. pH 8·3

The Prairiedale silt loam as mapped is a very uniform soil. The silty clay loam is more variable and possesses characteristics ranging from the silt loam described above to those of Vanderhoof silty clay.

Poorly drained associated soils are identified by a thick peaty surface horizon. The A_1 is dark grey to very dark grey in color, and overlies grey, mottled, compact and poorly aerated subsoils. Meadow and peat profiles are frequently associated with the soils of these depressional and poorly drained areas.

Agriculture

Prairiedale soils are among the most productive in the central interior. They are fertile, yet contain only moderate amounts of organic matter and nitrogen. These soils are largely used for grain production, principally wheat, oats and barley. Alfalfa and clovers are also grown. The abundance of coarse grains, grasses and legumes that are capable of being produced, and the availability of water supplies favor livestock enterprises.

The Dominion Illustration Station at Prairiedale is a source of information concerning management practices.

3a MAPES SERIES (Grey Wooded sandy loam and loamy sand)

The Mapes soils are fairly coarse in texture and have developed on relatively shallow coarse-textured alluvial-lacustrine deposits. These soils occur mainly to the south and east of Vanderhoof in the vicinity of Sinkut lake. In all, approximately 8,400 acres have been mapped.

Two soil classes, the sandy loam and loamy sand have been mapped. Gravelly and stony phases occur to a limited extent, but have not been mapped. Stones are few in number and occur only on localized areas or along the borders of the Chilako soils.

The area is sparsely settled and the acreage under cultivation limited. The A_1 horizon is shallow, loose and very porous; it is underlain by a thin leached single grain structured A_2 horizon. The B horizon, showing slight accumulation of finer materials, is grey brown in color and has a very weakly developed structure. The parent material consists of stratified sands and gravel.

The forest cover consists of a semi-open stand of poor quality lodgepole pine suitable only for fuel, fencing material, etc. The undergrowth is a sparse cover of kinnikinick, blueberry, and shepherdia.

The surface relief is mainly undulating and is pitted occasionally with large and small "kettle-like" depressions occupied by small ponds or organic accumulations. Surface and internal drainage are variable.

Mapes loamy sand, occupying about 95 per cent of the area, is described as follows:

Horizon	*Depth in inches*	*Description*
A_0	1- 0	Dark brown layer of needles, twigs, herbs, grasses, etc.
A_1	0- 1	Dark grey loamy sand, single grain structure, contains numerous roots. pH 5·2
A_2	1- 2	Loamy sand having somewhat lighter color than A_1 above. A weakly developed horizon. pH 5·0
B_{21}	2- 9	Loamy sand to sandy loam. Shows very slight accumulation of finer materials and is dominantly of single grain structure. Few weakly developed nuciform aggregates. pH 5·5
B_{22}	9-18	Loamy sand slightly lighter in color and more compact than above horizon. Weakly developed nuciform structural aggregates, breaking down readily to single grain structure. pH 5·5
B_{31}	18-22	Brown loamy sand showing evidence of stratification, iron staining along root channels. pH 6·5
C	22-	Brown and grey stratified loamy sand, frequently mottled. pH 6·5

The sandy loam class shows very similar profile development to the foregoing loamy sand, but has been placed in a separate class due to textural differences.

Agriculture

The Mapes soils are of limited agricultural value. Low-lying areas along streams or in depressions are slightly heavier in texture and catch seepage from the adjacent uplands and therefore possess an added agricultural value. It is on these, or the thin profiles adjacent to the Vanderhoof or Chilako soils, that any settlement has taken place. Farming on these soils is at best a doubtful venture, and they should be left under native vegetation and thereby serve as a source of fuel, fencing material, etc.

EENA SERIES (Grey Wooded and Podzol sandy loam and loamy sand)

The Eena soils are found primarily to the north and west of Prince George, and occupy the glacial outwash plains and the wide post-glacial channels connecting the Fort St. James and the Prince George lake basins. In all, some 33,500 acres have been mapped.

Eena soils have been mapped as sandy loam and loamy sand types. The former, due to its somewhat finer texture, has a higher moisture-holding capacity. Both types have been previously described in the soil survey report of the Prince George area. (13).

Prominent morphological features of Eena soils include an eluvial A horizon consisting of an A_0 and a light grey, frequently platy structured A_2. The illuvial horizon is compact and colored brown.

The forest cover consists dominantly of mature stands of spruce and lodgepole pine, interspersed with sparse stands of poplar, birch and alder. An occasional large cottonwood occurs on moist sites.

A description of a virgin sandy loam profile is given below:

Horizon	*Depth in inches*	*Description*
A_0	2- 0	Dark brown layer consisting of undecomposed and semi-decomposed remains of mosses, needles, wood, etc. pH 5·2
A_2	0- 4	Grey to light grey sandy loam. Single-grain structure, platiness occasionally present. This horizon frequently extends to a depth of 7 or 8 inches along root channels. pH 5·8
B_{22}	4-12	Brown to light brown sandy loam, single grain structure. pH 6·4
B_{23}	12-20	Brown firmly packed sandy loam, friable single grain structure. pH 6·5
B_{31}	20-30	Grey brown sandy loam very similar to above horizons. pH 6·4
C	30-	Grey irregularly stratified sand, occasional bands of gravel, cobbles or fine silty material. pH 6·5

The depths of the sola and degree of development vary with topography, texture and amount of gravel and cobbly material present. The very gravelly and cobbly profiles are frequently associated with hilly topography. Lenses of coarse sand, gravel or silty material frequently occur in the sandy loam and loamy sand classes. The position of these layers in relation to the surface horizon largely determines the agricultural value of these soils.

Agriculture

Eena soils, like Mapes, are among the poorest soils in the Grey Wooded areas. They have low moisture-holding capacity, low native fertility and are inclined to be droughty during the growing season. The cultivated surface is incoherent when dry and shows little cohesion when wet.

A few areas have been cleared and cultivated but development has seldom progressed beyond the initial stages. In some instances successful farms are observed on fine-textured inclusions, which, when conveniently located, find development in specialized enterprises.

Like Mapes, these soils are best suited for forestry purposes and when maintained under native vegetation the numerous small lakes, peat bogs, etc., add to the attractiveness of the landscape and increase the value of the area as a game preserve or for park purposes.

4a SAXTON SERIES (Grey Wooded sandy loam and loamy sand)

Saxton soils are found in close association with the Giscome and Fraser soils, and are mapped as narrow terraces, benches and low uplands along the valleys of the Fraser, Nechako and Chilako rivers. The soils have developed on sandy stratified deposits which normally contain layers of gravel or coarse sand in the lower horizon. Approximately 1,300 acres have been mapped.

Saxton soils are of two classes, the sandy loam and loamy sand. The latter usually has coarse-textured, often gravelly, B and C horizons.

The native vegetation consists of fir, spruce and lodgepole pine in comparatively heavy stands. The undercover is sparse and consists mainly of shepherdia and various other shrubs.

In the uncultivated state, Saxton has a surface layer of plant remains varying in thickness and in state of decomposition. Beneath this lies a 2- to 3-inch layer of whitish highly leached sandy material having single-grain or a thin platy structure. The B horizon is commonly light brown in color, contains scattered reddish rusty spots and is normally single grained. The subsoil, a greyish stratified sand containing varying amounts of gravel, is usually shallow to glacial till, lacustrine clay or bedrock.

A detailed description of a typical Saxton sandy loam profile follows:

Horizon	*Depth in inches*	*Description*
A_0	1- 0	Dark brown partially decomposed plant remains, variable in composition and depth.
A_2	0- 2	Light grey sandy loam, single-grain structure; may extend to a depth of several inches along root channels. pH 6·0
B_{12}	2- 7	Grey brown sandy loam, single-grain structure showing light compaction. Gravel and cobbles may be present. pH 6·4
B_{22}	7-14	Brown sandy loam and frequently gravelly sandy loam. Single grain structure. pH 6·5
C	14-	Grey brown and light greyish-brown stratified sandy loam. pH 6·7

Agriculture

The Saxton soils are chiefly under forest vegetation and in general may be classed as non-arable. As indicated on the map, these soils occupy narrow terraces paralleling the rivers, and in many cases the precipitous escarpments are also included. Areas once cleared for farming purposes have now been largely abandoned.

The Saxton soils should be retained in forest. Small areas adjacent to the better agricultural soils are of value as a source of fuel, logs, sand or berries, and have also a limited amount of grazing and browse value. In the vicinity of Prince George and Quesnel, many of these terraces have been placer mined and now represent virtually waste land.

GISCOME SERIES (Grey Wooded gravelly sandy loam)

The Giscome soils are coarse in texture and have developed on post-glacial river and stream deposits. They are closely associated with the Saxton soils, differing mainly in having developed on gravelly and cobbly materials. Approximately 4,600 acres of this type have been mapped, principally in the Woodpecker to Soda Creek area.

Giscome soils have a 1- to 2-inch grey highly leached A_2 horizon. This is in turn underlain by a brownish-grey slightly compacted B which grades into the coarse parent material. This layer is in turn underlain by lacustrine clay, glacial till, or bedrock at variable depth.

Giscome soils have an undulating to gently sloping topography, and, while excessively drained, they support a heavy stand of fir, spruce and lodgepole pine. Stones and boulders frequently occur.

Illustrations

Plate I—A. A profile of Vanderhoof silty clay loam. Note varved parent material. B. Alpine meadow or mountain meadow soil on gently sloping topography. Elevation 5,200 feet. Note low mounds in the foreground. C. Alpine meadow profile. D. Timothy hay on Driftwood sandy loam from which the stones have been removed. Hudson Bay Glacier in the background.

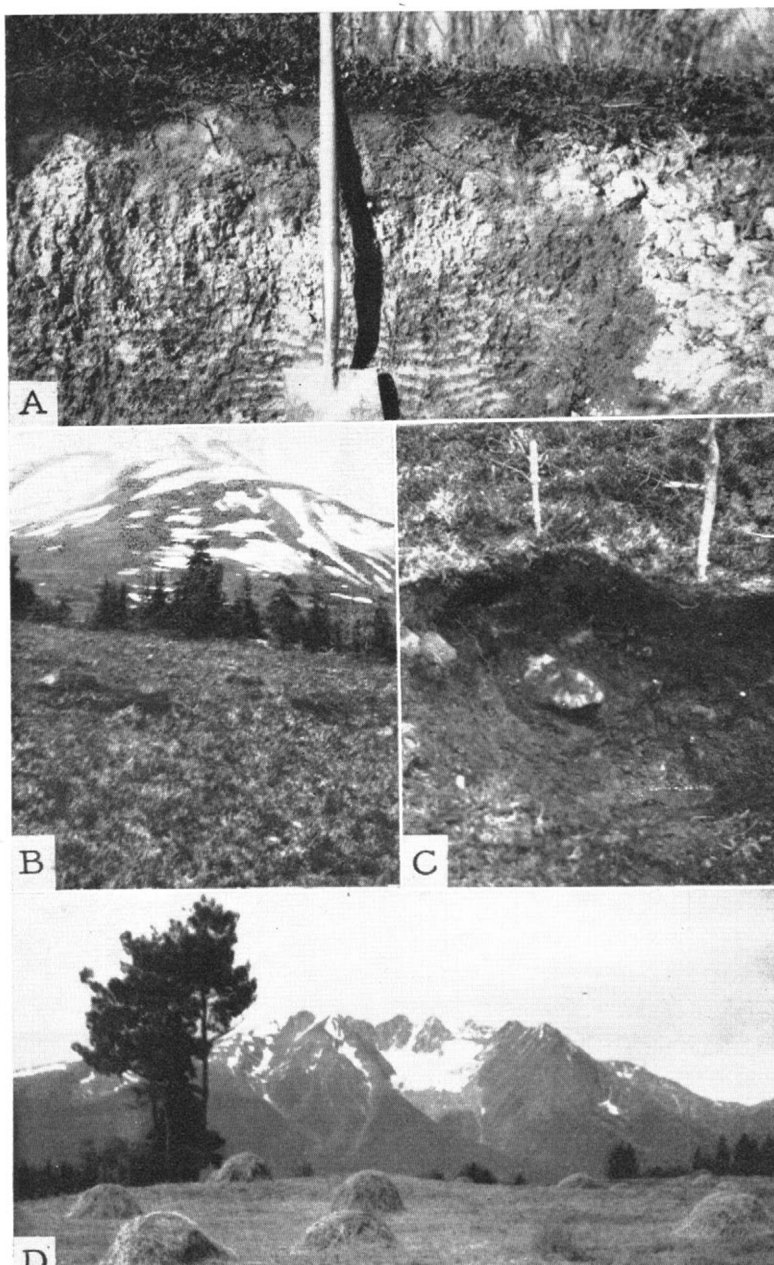


PLATE II—A. Pineview clay—a poorly drained Grey Wooded soil. B. Poorly drained member of Pineview clay—classified as Dark Grey Gleisolic. C. Landslides cause serious losses of cultivated land. Pineview clay at Quesnel. D. Spinach seed production on Alluvial clay loam, Houston.

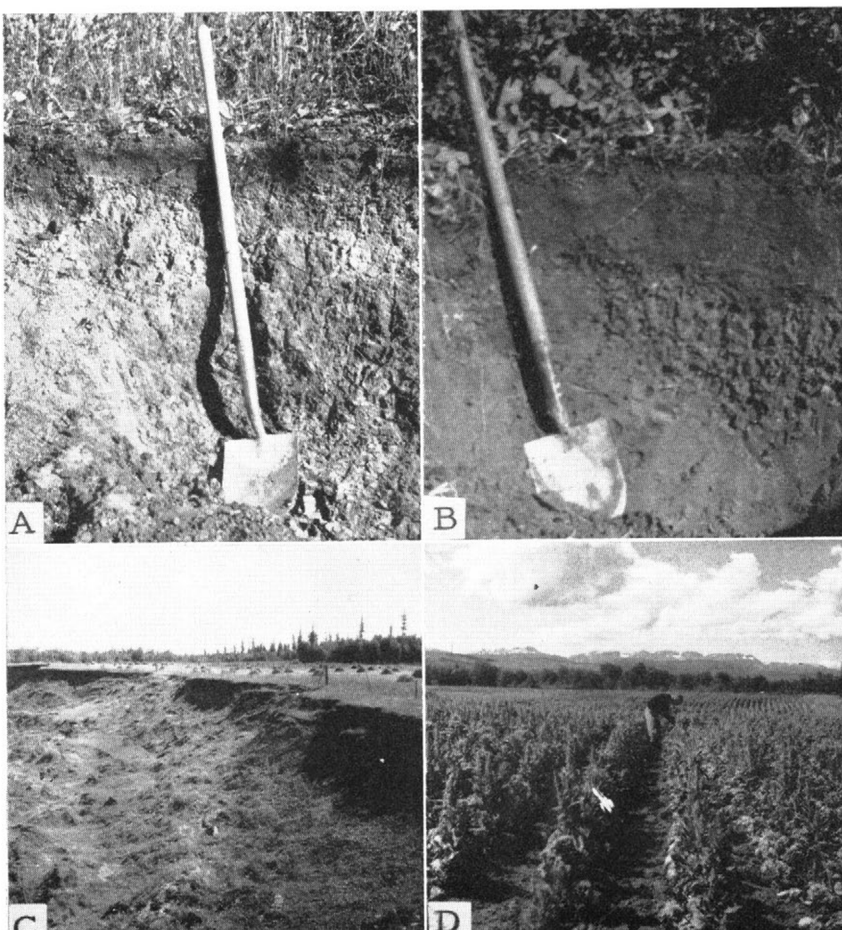
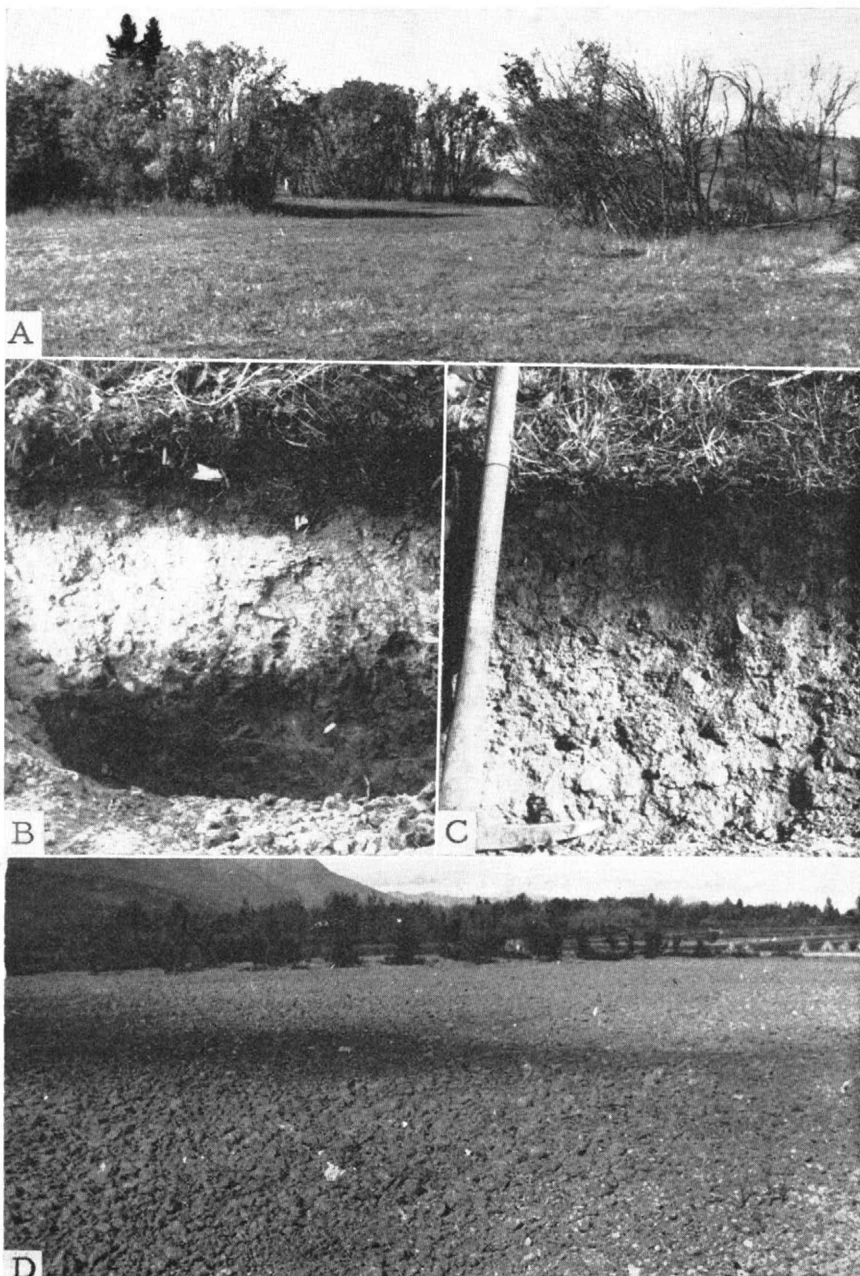


PLATE III—A. Aspen followed by lodgepole pine characterizes the advancing forest. B. Driftwood loam. This is Degraded Black profile. C. Thin Black member of Driftwood loam. D. General character of topography associated with Telkwa soils. Darker colored soils frequently occur in the flat and depressional areas.



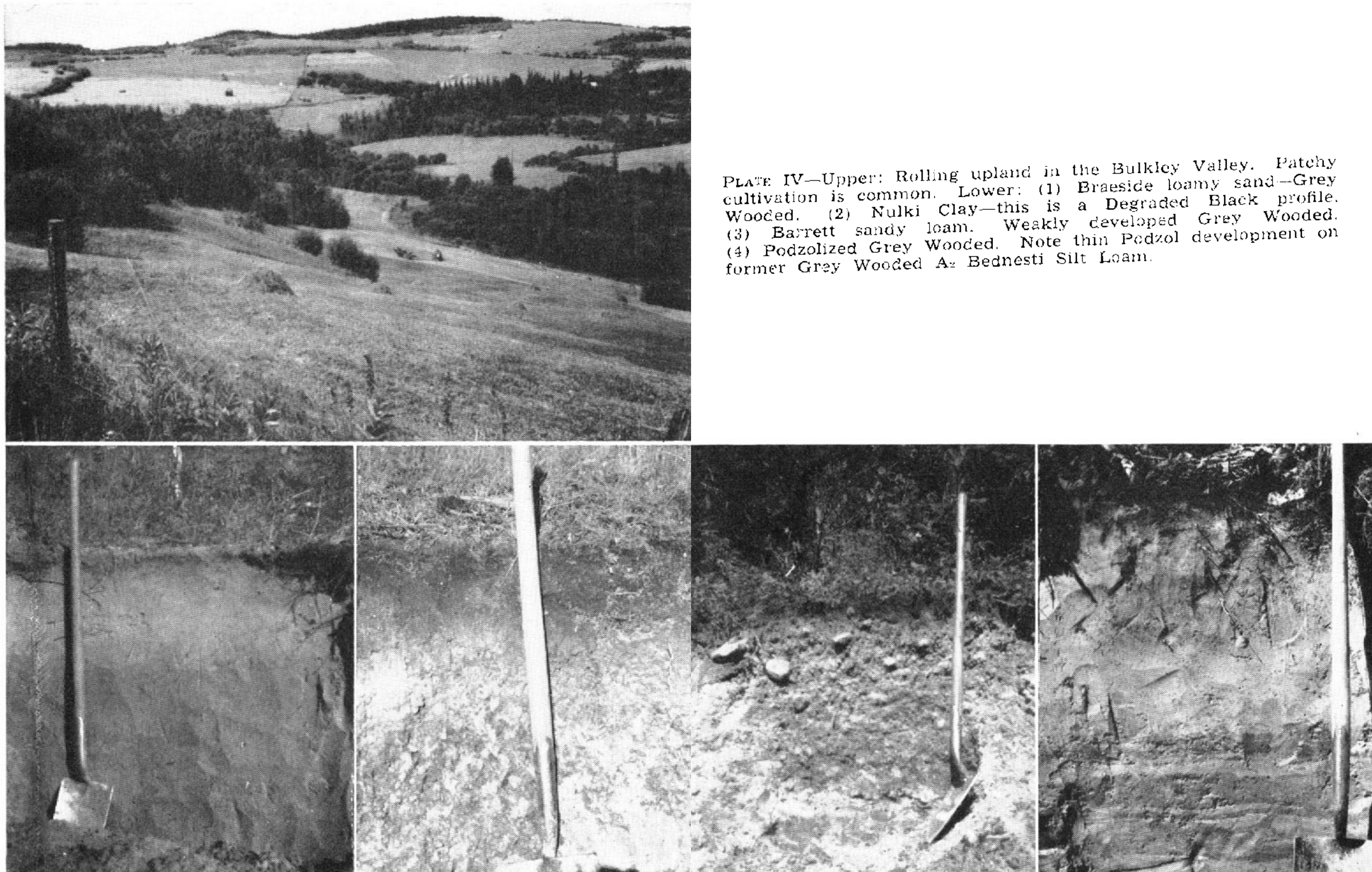


PLATE IV—Upper: Rolling upland in the Bulkley Valley. Patchy cultivation is common. Lower: (1) Braeside loamy sand—Grey Wooded. (2) Nulki Clay—this is a Degraded Black profile. (3) Barrett sandy loam. Weakly developed Grey Wooded. (4) Podzolized Grey Wooded. Note thin Podzol development on former Grey Wooded A_2 Bednesti Silt Loam.

Agriculture

Giscome soils have little value for agricultural production. They do provide, however, a source of gravel for road-making and building purposes. Much of this land has been placer mined and considerable quantities of gold have been recovered. A more complete description of these soils may be found in the Soil Survey report of the Prince George area (13).

BRAESIDE SERIES (Grey Wooded sandy loam and loamy sand)

The Braeside soils occur in the Nechako valley in the vicinity of Vanderhoof and Fort Fraser, and occupy approximately 48,900 acres. These soils occur on alluvial terrace and flood plain positions and resemble Saxton except for the distinctly darker surface horizons.

The surface texture ranges from loamy sand through sandy loam to fine sandy loam. The first named occupies the largest acreage, while the fine sandy loam is of limited occurrence. Stones are rarely encountered. Beneath the surface forest litter lies a light greyish-brown loamy sand horizon ranging in thickness from 2 to 4 inches, and lying on a B horizon which is a brownish slightly compacted sandy loam. This horizon grades into a well-stratified parent material. (Plate IVB).

The vegetative cover consists mainly of mature stands of lodgepole pine with a sparse ground cover of shrubs and grasses. The topography is characterized by level to undulating surfaces that occur in the form of relatively narrow benches bordering the Nechako river. The largest and most elevated area has a gently rolling dune topography. Surface runoff, due to the rapid loss of moisture by percolation, is insignificant. Restricted drainage occurs only in localized areas where the soil is shallow and underlain by an impervious substratum.

The following is a description of the profile occuring under natural forest cover.

Horizon	*Depth in inches*	*Description*
A_0	1- 0	Sparse cover of needles, grasses, etc.
A_2	0- 2	Grey brown to light brownish-grey loamy sand. Single-grain structure frequently containing bleached sand grains. Roots fairly numerous. pH 6·0
B_{21}	6-15	Greyish-brown loamy sand, slightly compacted, weakly developed nutty structure. pH 6·0
B_{22}	15-21	Greyish-brown loamy sand slightly less compact than above horizon. pH 6·2
C	21-	Greyish stratified loamy sand and sand. pH 7·0

Agriculture

Braeside soils are among the poorer agricultural soils occurring in the Nechako Valley. Low organic-matter content, poor drought-resistance, sandy texture and low nutrient content combine to make general farming a hazardous occupation. When cultivated these soils require the incorporation of large quantities of organic matter to increase their moisture-holding capacity and increase fertility levels.

KERSLEY SERIES (Grey Wooded sandy loam and loamy sand)

The Kersley series consists of light-textured soils developed on alluvial terrace and flood-plain deposits along the Fraser river in the vicinity of Kersley and Alexandria. The uppermost terraces approach 1,700 feet in elevation, below which successive terraces, bordered by steep escarpments, reach down to the present river level. Almost 19,800 acres have been mapped, of which approximately 14,600 acres represent sandy loam. The remainder, consisting of loamy sand, is less extensive. Stones are rarely encountered, but gravelly areas may frequently occur.

The Kersley soils have a thin dark colored surface to a depth of 2 inches. Below this, the color becomes lighter and the soil material progressively heavier. At a depth of 16 inches there is a fairly sharp break to the limy parent material.

The native vegetation varies from a heavy forest cover to one of open grassland. The forested areas occupy the higher elevations and consist mainly of Douglas fir and lodgepole pine. At lower elevations the bunch grasses predominate. This range in vegetation along with color suggests that Kersley soils are geographically associated with the Black and Dark Brown soils of the interior regions.

The prevailing undulating topography is occasionally broken by post-glacial meandering streams which provide a modest range of 4 feet in local relief. Surface drainage is adequate, except in occasional areas where seepage occurs adjacent to the steep escarpments. These seepage spots frequently contain high concentrations of soluble salts.

The following description is typical of the sandy loam class occurring under forest vegetation.

Horizon	*Depth in inches*	*Description*
A_0	1- 0	A thin layer of forest debris consisting mainly of needles, leaves and grasses.
A_1	0- 2	Dark grey to dark greyish-brown sandy loam, granular to platy structure. ph. 7·0 to 7·2
A_2	2- 3	Greyish-brown sandy loam, weakly developed platy structure, very friable. pH 6·4 to 6·7
B_{21}	3-10	Brown to grey brown heavy sandy loam, weakly developed nuciform structure, slight compaction. pH 6·6 to 7·0
B_{22}	10-16	Brown sandy loam, weakly developed nutty structural aggregates breaking readily to fine granular and single grain. pH 6·7 to 7·0
B_{ca}	16-18	Brown to light brown sandy loam containing much free calcium carbonate. pH 8·3 to 8·5
C	18-	Light brownish-grey well stratified calcareous sandy loam. pH 8·2 to 8·5

A more highly developed profile occurs in the vicinity of Kersley, where it is characterized by a thin A_1 horizon, a light grey weak platy structured A_2 and a brown to dark brown nutty structured B. In many places, the Kersley profiles rest upon a D horizon of gravel, coarse sand, glacial till or lacustrine deposits.

Agriculture

The Kersley soils range from non-arable to fairly good agricultural land. Those which are predominantly of loamy sand texture should not be dry farmed. The sandy loam type has sufficient fine material, particularly in the B horizon, to make it a more desirable agricultural soil but it will, however, require additions of organic matter to maintain productive capacity. Recent studies (12) indicate that an appreciable portion is irrigable, thus making it possible to bring additional acreages into high production.

5b FRASER SERIES (Alluvial Silt loam)

The Fraser soils, mapped as an alluvial complex, occur entirely in the Prince George and Quesnel areas. They have been developed on deep silty alluvial terraces and bottom lands adjacent to the Fraser river and tributary streams.

The Fraser soils are mapped as a silt loam, but more detailed study will reveal many inclusions of coarser-textured materials and indicate differences in origin of parent materials, drainage and age of the deposits.

The surface soil is grey brown in color and possesses a weakly developed granular structure. Below the surface horizon is a light brown subsoil, slightly compacted and often characterized by reddish and yellowish streaks along root channels and cleavage faces. The substratum is a greyish-brown silt loam stratified and very slightly compacted. A D horizon of stratified sand, gravel or glacial till occurs at varying depths.

Practically all the Fraser soils are still under heavy timber consisting of spruce, cottonwood, birch and aspen. Where burning has occurred the deciduous trees predominate.

Much of the land included in this category has an undulating topography which has been appreciably modified by abandoned arms and coulees of former streams. Many areas, too, are bordered by steep, broken or eroded untillable land. Drainage is extremely variable, particularly on the lower benches where frequent flooding occurs. The higher benches and terraces are in general well drained.

A profile description of Fraser silt loam, the dominant type, is as follows:

Horizon	*Depth in inches*	*Description*
A_0	4- 0	Dark brown partially decomposed litter of leaves, needles, moss, etc. pH 7·0
A_1	0- 1	Dark brown to brown silt loam, granular structure. pH 7·0
	1- 3	Light brownish-grey silt loam platy-granular structure weakly developed. pH 6·9
	3-12	Light brownish-grey silt loam, slightly compacted with weakly developed coarse nuciform structure. Contains much finely divided mica. pH 6·9
	12-	Greyish-brown stratified silt loam, may include lenses or bands of stratified sands and gravels. pH 7·2

Agriculture

Agricultural development has been slow mainly because of the high cost of clearing. Modern land-clearing equipment now being available at moderate cost will undoubtedly hasten development on many of the less heavily timbered areas.

Favorable moisture-holding capacity, organic-matter content and soil reaction allow these soils to be classed as highly productive. To maintain them as such, good management practices are essential. These include systematic manuring, fertilization and careful selection of crops involving legumes and grasses.

Due to physiographic position the soils are subject to frequent summer frosts.

NECHAKO SERIES (Alluvial and weakly developed Grey Wooded)

The Nechako soils prevail on the narrow bottoms and low terraces along the streams in the vicinity of Vanderhoof and Fort Fraser. These soils are similar in general characteristics to the Fraser soils, but differ mainly in having been derived from somewhat calcareous parent materials, and showing more advanced profile development. A total of 26,800 acres have been mapped.

There is considerable variation in the character of these alluvial deposits. Small patches of permeable sand and gravel are of frequent occurrence, particularly on the low ridges. In other places the underlying clay closely approaches the surface. These variations are reflected in the surface texture. Silt loam is the most extensive type, but sandy loam, loam, and silty clay loam textures are to be found.

Beneath a 2- to 3-inch mat of organic litter the upper 2 inches of the surface soil is friable and slightly granular in structure. Between depths of 2 and 4 inches the leached horizon is grey in color and merges gradually into a greyish-brown irregularly stratified and slightly compacted subsoil.

The original forest cover has been largely burned over. The present cover consists of poplars, willows and deciduous brush with a few lodgepole pine and spruce.

Nechako soils occupy level to undulating surfaces. Drainage is satisfactory except for a few low terraces adjacent to the existing streams. Some of the lower benches are subject to annual or periodic flooding and are therefore still in the process of formation and modification.

Nechako silt loam, the most extensive type, is described in more detail below.

Horizon	*Depth in inches*	*Description*
A_0	1- 0	Dark brown well-decomposed peaty layer composed of remains of leaves, needles, etc.
A_1	0- 2	Grey to dark grey granular silt loam. pH 6·0
A_2	2- 3	Grey silt loam; weakly platy to granular structure. pH 5·5
B_{21}	3-15	Greyish-brown clay loam with yellowish and rusty mottling along root channels and cleavage faces. Coarse granular to fine nuciform structure. pH 6·5
C	15-	Greyish-brown stratified silt loam and loam. pH 6·5

Variations in this group of relatively recent soils occur and are similar to those already noted in the Fraser soils. The poorly drained soils have a peaty surface, 4 to 6 inches thick, and where convenient have been classified and mapped separately.

Agriculture

Nechako soils are naturally fertile, but as a whole are not so desirable as the productive soils occurring on the uplands. They are easily cleared, generally hold abundant moisture, and when properly handled are very productive. However, frost is a hazard and is of fairly frequent occurrence. Grain growing, therefore, is hazardous. Timothy, brome and other grasses, as well as clover and alfalfa, do well. Hardy vegetables are quite successful.

Water supplies from springs, streams, or shallow wells occur in abundance. Mixed farming, involving the growing of grasses and legumes, together with livestock, is practised by the majority of settlers.

AUSTRALIAN SERIES (Alluvial and Grey Wooded fine sandy loam to clay loam)

The Australian soils have developed on silty outwash flood plains and terraces. Also included with the Australian soils are several alluvial fan deposits consisting essentially of silty materials derived from the adjacent lacustrine clay and glacial till. They are closely associated with the soils of the Kersley group but in most cases occupy separate terrace or bench positions interspersed throughout the Quesnel-Soda Creek area. A total of 19,800 acres has been mapped.

Australian soils consist of fine sandy loam, silt loam, loam, silty clay loam and clay loam textural classes. Stones and boulders are rarely encountered. However, in areas where the surface deposits are shallow, gravel outcrops occur, which may seriously interfere with crop production.

In representative areas, the surface organic mat is very thin and consists mainly of the current year's fall of leaves and needles. The underlying and slightly leached A_2 horizon varies considerably, but in general it is dark in color, friable and only in some areas becomes decidedly grey. The B is yellowish-brown in color and slightly heavier in texture than the surface. The lower subsoil is loose and porous, shows weak stratification and is frequently highly micaceous.

The native vegetation is composed of mixed forest, predominantly of coniferous trees such as Douglas fir and lodgepole pine, while poplar, cottonwood and birch are frequently encountered. Many of the areas represent open and grassy sites that are confined to the drier and more exposed positions.

The topography of Australian soils consists mainly of gently undulating surfaces that slope towards the river. Long narrow terraces, paralleling the river and bordered by abrupt escarpments, characterize the physiographic features. They have good surface drainage except in local areas adjacent to steep escarpments where seepage and often saline spots occur. The combined acreage of these areas is relatively small and of minor importance. Under the prevailing conditions of low precipitation internal drainage is satisfactory for the growth of most crops.

Australian silt loam, the most uniform type, is described below.

Horizon	*Depth in inches*	*Description*
A_0	1- 0	A thin layer of forest litter consisting mainly of needles, leaves and grasses.
A_2	0- 2	Grey brown silt loam having a weakly developed platy structure. pH 6·1
B_{22}	2- 8	Yellowish-brown silty clay loam. Coarse nuciform structure. pH 5·4
B_{23}	8-16	Yellowish-brown silt loam slightly compacted with weakly developed nuciform structure. pH 5·3
B_{31}	16-25	Light grey to light brownish-grey silt loam. pH 6·0
C	25-	Light grey silt loam stratified into layers of varying thickness. Strong effervescence to HCl. pH 8·5

While the foregoing profile dominates in the forested areas, a grassland type is common on the lower and more exposed terraces. The A_1 of the latter type, averaging 4 inches in thickness, is dark brown in color and has a well-developed granular structure. The B horizon is brown in color, slightly compacted and has a coarse granular structure. This horizon grades rather abruptly into the limy parent material or C horizon. A poorly drained profile also occurs and is recognized by a deep A_1 horizon and mottled subsoil. Salt accumulations are frequently associated with these poorly drained areas.

Agriculture

The Australian soils are very productive soils, well suited to grain crops and, in many instances, specialized production. The silty clay loam and clay loam types will rate with the best and most productive soils in the province. The Yorstan farm at Australian, while somewhat atypical, is irrigated and is indicative of the development and high production of which the fine-textured soils are capable. Unfortunately, the area of these finer-textured soils is limited. They are used mainly for the production of grain crops but potatoes are also grown.

The lighter-textured soils, including fine sandy loam and silt loam, are somewhat lower in moisture-holding capacity and crops frequently suffer from drought. Organic matter and general fertility are also lower. The mapped areas of these soils are often isolated by deeply eroded gullies which interfere with maximum development and use.

The Australian soils, like Kersley, are well adapted to a mixed-farming enterprise involving livestock as a major interest.

B. Soils of the Nechako Upland Developed on Glacial Till and Cravels

The till soils of the Nechako uplands are developed from sandy loam and clay loam unsorted parent materials. The soils included in this group are Chilako, Barrett, Driftwood and Gunniza, and total approximately 900,000 acres.

Chilako, Barrett and Gunniza soils are developed under heavy coniferous forest and exhibit a Grey Wooded type of profile development. Driftwood, on the other hand, with its parkland vegetation, represents the Degraded Black group; recent encroachment of forest vegetation, however, has tended towards the development, in the profile, of some Grey Wooded features.

1b CHILAKO SERIES (Grey Wooded sandy loam)

The Chilako series consists of light to medium-textured soils developed on undifferentiated glacial till. They occupy the upland positions of the Nechako plateau and are located principally around Vanderhoof, Prince George and Quesnel. Other areas include Fort St. James and possibly Carp lake.

Chilako soils are extremely variable and further study will undoubtedly disclose the presence of several parent materials and types of profiles. The dominant textures are sandy loam with stones and gravel occurring on the crests of knolls and drumlin-like ridges. Finer-textured soils are normally observed in the low-lying positions. Stones and boulders are often present on the surface and throughout the profile in excessive numbers. The typical natural profile consists of a light grey A_2, a hard, nuciform structured B, and a grey indurated subsoil. While Chilako has been classified as Grey Wooded, certain morphological features suggest that a double profile such as a Thin Podzol or Brown Podzolic superimposed on an older Grey Wooded soil is characteristic in several areas.

The virgin forest stand consists dominantly of lodgepole pine, spruce and other conifers, which are of merchantable quality. On burned over areas a maze of windfalls is usually found, but solid stands of pine, aspen, willow and alder, or mixtures of these, are gradually becoming established.

The topography consists of a series of nearly parallel low rounded hills separated by undrained depressions. Such areas have been previously referred to as a drumlinized till plain. (13). In a recent geological survey, Armstrong and Tipper (2) made the following observations:

> The drumlinized plain consists essentially of parallel ridges of till and of gravel derived from the till. The till consists of well-rounded pebbles and boulders embedded in a grey to reddish-brown clay, and sandy clay. Stratified

sands and gravels were observed in a few places in the till plain, occurring in beds and probably representing interglacial outwash. The drumlins are most pronounced and best preserved in a large part of the Nechako plain along some of the major streams. They vary considerably in outline and size, generally from ½ to 1½ miles long. Most are ¼ mile or less in width. They vary considerably in height, probably averaging 50 to 75 feet.

The drumlins seldom occur singly and are for the most part aligned in groups 5 to 6 miles long, separated laterally by parallel trough-like valleys.

The intervening troughs are 50 to 150 feet deep and in places up to one half mile wide.

Drainage for the most part is adequate. On the knolls and crests of drumlin ridges runoff is very rapid, while in the valleys and undrained depressions it is very slow. This condition has favored the development of numerous muskegs and meadows, some of which cover several hundreds of acres. Numerous lakes and sloughs also characterize much of the landscape.

Chilako sandy loam, being the most extensive type, is described in detail below.

Horizon	*Depth in inches*	*Description*
A_0	4- 0	Dark brown partially decomposed remains of needles, leaves and woody plants. pH 4·5 and 5·0
A_1	0- 1	Dark grey to grey brown sandy loam. pH 5·0 to 5·2
A_2	1- 5	Light grey platy structured sandy loam and gravelly sandy loam. Varies considerably in depth due to tonguing along root channels and cracks. Stones and gravel common. pH 5·0 to 5·2
B_{21}	5-10	Light greyish-brown to grey sandy loam. Moderately well developed coarse nuciform structure. Aggregates friable in upper part but become hard and dense with depth. Stones and pebbles common. pH 5·0 to 5·5
B_{22}	10-16	Grey brown sandy loam, moderately hard and compact. Aggregates of coarse irregular nuciform shapes with considerable iron staining on cleavage faces. Numerous pebbles, stones and cobbles, etc. pH 5·6 to 6·0
B_{23}	16-22	Grey very compact and dense sandy loam and loam. Massive to coarse and very coarse blocky structure. Stones, pebbles iron-stained. Impervious to water. pH 5·7 to 6·5
C_1	22-24	Grey very compact and indurated sandy loam. Massive structure, impervious to water. No effervescence. pH 6·5 to 7·0
C	24-	Greyish compacted till contains considerable amounts of stone, and gravel embedded in a compact sandy loam matrix. Very slowly permeable. Lime commonly absent. pH 7·0 to 7·2

Agriculture

The Chilako soils are largely unsuited for agricultural development, under present conditions. The heavy clearing, stoniness, coarse texture, low moisture-holding capacity and lack of adequate profile drainage are obstacles hindering development. The settlers who have located on these soils have largely abandoned their holdings. The remaining few are invariably located in depressional areas, along creeks and margins of lakes where soils are atypical and conditions more suitable for agricultural production.

The better classes of soil include the fine-textured and relatively stone-free areas. However, most of these are small, isolated and generally inaccessible. Chilako soils contain valuable stands of timber and their continued use for forestry purposes is recommended until the demand for agricultural land warrants their conversion.

BARRETT SERIES (Grey Wooded sandy loam to loam)

Barrett soils, like Chilako, have developed from unsorted glacial till deposits and occur throughout the west central portion of the Nechako plateau. Approximately 290,400 acres have been mapped. The Barrett soils vary from sandy loam to loam, with a gravelly texture characterizing the knolls. Stones are generally quite numerous and their presence greatly intensifies the clearing problem; in fact, many areas are so stony as to make the cost of clearing prohibitive. Rock outcrops, especially in the steeply sloping and semi-mountainous areas, are common.

Morphologically Barrett soils as compared with the Chilako have a thicker A_1 horizon, a darker colored A_2 and only slight clay accumulation in the B. The profile suggests a weakly developed Grey Wooded soil. (Plate IV D).

On the more typical Barrett soil the forest cover consists mainly of coniferous trees. Lodgepole pine and fir, varying in size up to two feet in diameter, occur in open and well-stocked stands. Much of this timber is of high merchantable quality.

The Barrett soils occur mostly on the steeply sloping and mountainous terrain of the Coast Range foothills, while a smaller percentage occupy drumlinized till plains. Undulating, gently rolling and steeply sloping topographic classes have been mapped. Surface runoff varies from slow to rapid, depending on the topography, while permeability throughout is extremely slow due to the compact subsoil horizons.

A profile description of Barrett sandy loam, the most extensive type, is given below:

Horizon	*Depth in inches*	*Description*
A_0	3- 0	Dark brown, accumulated remains of partially decomposed needles, leaves, grasses, etc. pH 4·9 to 5·0
A_1	0- 2	Grey brown to brown loam and sandy loam frequently abundant gravel and pebbles, friable. Weakly developed granular structure. Contains numerous roots. pH 5·0 to 5·2
A_2	2- 4	Grey loam to light loam, weakly developed platy structure. pH 4·8 to 5·0
B_{21}	4-10	Grey to grey brown loam. Coarse nuciform structure, very hard when dry and firm when moist. pH 4·6 to 4·8
B_{22}	10-16	Similar to B_1, but more compact, blocky structure. Iron staining on stones and pebbles. pH 4·8 to 5·0
B_{31}	16-20	Grey compact partially weathered till of sandy loam and loam texture. pH 5·0 to 5·2
C	20-	Grey to dark grey brown compacted loam till. Contains numerous pebbles and gravel embedded in soil matrix. pH 6·2 to 7·0

The Barrett soils, like the Chilako, show many variations. The most common is a poorly drained soil which is characterized by a surface peaty layer varying from 1 to 4 inches and an A_2 horizon light grey in color, frequently mottled and overlying a permanently wet highly mottled subsoil.

In the Bulkley valley and the "Lakes District" Barrett soils are mapped as complexes with the Doughty, Telkwa and Driftwood soils. Like Chilako, these soils also contain numerous peat bogs and meadows in the depressions. These areas have been delineated where of sufficient size.

Agriculture

The natural fertility of Barrett soils is fairly high, but due to unfavorable topography, stoniness and heavy tree cover only a relatively small acreage is under cultivation. They require frequent additions of organic matter, nitrogen and phosphorus in order to supplement the low supply in the soil.

Alfalfa and clovers are grown successfully and should be featured in the regular cropping practices whenever possible. These, combined with grasses such as timothy and brome which do particularly well, suggest a livestock economy which should facilitate the maintenance of fertility at a reasonably high level. Information relative to management problems on these and other soils in the Bulkley valley is to be had from the Dominion Experimental Sub-station and the Provincial Department of Agriculture offices at Smithers.

DRIFTWOOD SERIES (Degraded Black to Thin Black sandy loam and loam)

The Driftwood series consists of medium to light-textured soils developed on glacial till deposits and occupying much of the upland surface in the Bulkley valley and Ootsa lake regions. A total of 155,500 acres has been mapped.

The texture varies from gravelly sandy loam to loam and clay loam. Varying amounts of stone and boulders occur on the surface and throughout the profile.

The striking morphological features of Driftwood soils, sketched in Fig. 5 include a black surface horizon and the thin greyish subsurface (A_2) overlying a fairly hard and compact subsoil. (Plate III B, C).

Driftwood soils have developed under a wooded type of parkland vegetation.

> The grassland areas in question are scattered, are often limited by virtue of a fairly rough topography and only in a few instances involve large areas. Bunch grasses are dominant on the wooded areas. *Festuca scabrella* and sometimes *Calamagrostis* sp. may predominate though not infrequently *Stipa columbiana* and *S. Richardsonii* are the dominant grasses. The tree commonly characterizing the advancing forest is the aspen (*Populus tremuloides*) which is often succeeded by lodgepole pine (*Pinus contorta*) and other conifers (esp. *Picea* sp. *glauca*). Sometimes a shrubby vegetation (*Rosa, Symphoricarpos,* etc.) precedes the aspen, though at higher latitudes scrub birch (*Betula glandulosa*) and willow may herald the advance. (5) (Plate III A)

The topography ranges from undulating, gently rolling to steeply sloping and hilly. The gently rolling surfaces occur chiefly at lower elevations in close proximity to the drainage systems and occupy approximately 107,000 acres. The hilly and steeply sloping soils generally occur on well-drained slopes having a southern exposure. Surface drainage, as in Barrett soils, varies with topography while internal drainage, due to the dense compact nature of the subsoil, is very slow, with the result that surface erosion is often serious.

Driftwood loam is the most extensive type and is described in detail below.

Horizon	*Depth in inches*	*Description*
A_0	½- 0	Partially decomposed remains of leaves, grasses, herbs, etc. pH 5·9 to 6·0
A_1	0- 4	Dark grey to black loam, well-developed, fine to medium granular structure, very friable, few stones. pH 5·8 to 6·0
A_2	4- 6	Grey brown loam, medium to coarse, platy-granular structure. pH 5·5 to 5·6
B_{21}	6-14	Grey to grey brown loam and heavy loam, medium to coarse blocky structure. Very compact and hard and frequently quite stony. pH 5·5
B_{22}	14-20	Grey loam very similar to B_{21}, very hard when dry and only slightly plastic when wet. pH 5·0
C	20-	Grey brown very compact loamy till. pH 6·5

A thin profile occurs on the steeply sloping and hilly areas, due to relatively high natural erosion. The A, is dark brown to black in color and overlies a compact B. These areas are frequently gravelly.

In the wooded areas the Driftwood loam has a more degraded profile than that described. (See Plate III B).

Driftwood soils occur as a complex with Telkwa and Barrett. In combinations with Telkwa the Driftwood soils occupy the somewhat higher and better-drained positions. In mixtures with Barrett, Driftwood occupies the more exposed slopes having a southern exposure.

Agriculture

Driftwood loam is highly satisfactory for agricultural purposes, provided it has an undulating or gently rolling topography. The rolling, steeply sloping, hilly and coarse-textured areas are less desirable.

The prevention of water runoff is an important factor in the utilization of these soils. The maintenance of native vegetation in certain locations is to be strongly recommended. For instance, the crests of knolls or hills, at higher elevations, if retained under forest vegetation, will not only check spring runoff and prevent undue erosion, but will also ensure subirrigation for at least an important part of the growing season. (Plate IV A).

Much of the topography is characterized by long steep slopes of 30 per cent or more. This fact combined with a shallow soil overlying a hardpan is conducive to serious sheet erosion. In the management of these sloping lands, hay mixtures of brome and alfalfa are very satisfactory. This mixture remains productive for seven or eight years and both plants are well adapted to these soils. Timothy, as a forage or seed crop, is still a very satisfactory crop and well adapted to the higher elevations.

Fertility experiments conducted on similar soils at the Smithers Experimental Substation indicate a favorable response to ammoniated phosphatic fertilizers.

2a GUNNIZA SERIES (Grey Wooded and Thin Podzol gravelly sandy loam)

The Gunniza series occurs mainly in association with the Chilako soils occupying beach and shoreline positions, but may also be found in association with the Eena series. They are derived mainly from sorted and partially sorted till. Approximately 1,500 acres have been mapped in the vicinity of Chief Lake and Prince George.

The surface textures are variable, consisting mainly of coarse sandy loams and gravelly sandy loam. Stones are frequently found in the profile and on the surface.

Gunniza soils are characterized by a brown to dark brown surface litter of organic debris which is underlain by a well-developed and highly leached A_2 horizon. The B horizon, brown to yellowish-brown in color, is gravelly and porous and shows little evidence of structural development or cementation. The parent material consists mainly of grey sand and gravels that show weak stratification. At varying depths the profile is underlain by lacustrine clay or glacial till.

The native vegetation, over most of the mapped area, is sparse and consists mainly of lodgepole pine interspersed with limited numbers of aspen, alder and associated shrubs.

While the topography of Gunniza soils is gently rolling, steeply sloping, or hilly, the surface runoff is slight and the movement of water through the profile is too rapid for the optimum growth of the native vegetation.

Agriculture

Agriculturally, Gunniza soils are among the poorest in the surveyed area. The free drainage, low organic-matter content, high porosity and low moisture-holding capacity of these gravelly soils combine to make general farming a very hazardous enterprise. Even under the best of farm management practices, Gunniza soils are unlikely to provide profitable returns.

A more detailed review of these soils may be found in the soil survey report of the Prince George area. (13)

C. Soils of the Coast Range Intermountain Valleys Developed from Water-Deposited Materials

The soils of the Coast Range intermountain valleys are developed from water-deposited materials of glacial origin. The climate and vegetation under which they have evolved differ materially from those of the central interior, and the zonal soils have been classified as belonging to the Brown Podzolic and Podzol Great Soil Groups.

1a KITSUMGALLUM SERIES (Podzol sandy loam and gravelly loam)

The Kitsumgallum soils, involving 11,100 acres, are characterized by Thin Podzol development on stratified sands and gravels laid down by streams entering the Terrace valley at the head of lake Kitsumgallum.

Kitsumgallum soils have been classified as loamy sand, but textures varying from fine sandy loam to gravel may occur. Stones are seldom encountered in the surface layers except where the depositions of glacial till or possibly talus materials occur.

The Kitsumgallum soils have a thin but well-developed A_2 horizon underlying the thick organic mat of forest debris. This light grey layer is in turn underlain by a yellowish-brown, weakly cemented layer that merges gradually with the greyish stratified sandy and gravelly subsoil.

Kitsumgallum soils have developed under dense stands of lodgepole pine, spruce and Douglas fir. The entire area has been logged and now supports a second growth consisting mainly of lodgepole pine.

The topography varies from undulating to rolling with numerous kettle holes associated with the latter in the vicinity of Kitsumgallum lake. Due to the prevailing character of the soil, surface runoff gives place to rapid percolation.

A detailed description of a Kitsumgallum profile as it occurs under virgin conditions is as follows:

Horizon	*Depth in inches*	*Description*
A_0	3- 0	Undecomposed layer of needles, moss, twigs, and residue of shrubby plants. pH 4·5
A_2	0- 2	Light grey to white sandy loam, single-grain to weakly developed platy structure. pH 4·6
B_{21}	2- 8	Yellow brown sandy loam (reddish-brown when moist), contains a few concretionary forms, gravel, pebbles and sand grains cemented together forming a weakly developed ortstein layer. pH 5·2
B_{22}	8-16	Greyish-brown coarse sandy loam, quite open and porous. Pebbles and gravel coated with iron staining. pH 5·2
B_{23}	16-20	Light greyish-brown sandy loam, some iron staining. pH 5·2
C	20-	Grey stratified sands. This horizon is frequently replaced by a D horizon of coarse gravel or stony material. pH 5·2

Variations within this type are mainly due to varying amounts of stone, gravel and other coarse fragments. Glacial till, talus, and colluvial inclusions appear, but are insufficient in extent to warrant separate mapping.

Agriculture

Agriculturally, Kitsumgallum soils are very poor and have been given a low rating. The extent to which they may be cultivated will depend upon the soil texture, depth, stoniness, and water supply. Their open porous and sandy texture make them very susceptible to drought. Carefully selected areas may be satisfactory for pasturage, orchards and small fruits, but unless limed, fertilized and irrigated they are unlikely to provide economic returns. In addition, the high cost of clearing is a serious handicap to profitable crop production.

LAYTON SERIES (Brown Podzolic stony loamy sand)

The Layton soils, involving 4,200 acres, occupy gravelly fans and coarse river-wash in the Lakelse-Kitsumgallum valley. They may be distinguished by the thin dark brown organic surface layer, 1 to 4 inches thick, overlying a light grey layer that attains a thickness of 1 inch. Beneath this strongly acid A_2 the yellowish-brown material consisting mainly of coarse angular fragments continues for an undetermined depth.

The forest cover consists mainly of mixed stands of Douglas fir, lodgepole pine and hemlock. On logged or burned areas, lodgepole pine predominates.

The topography of Layton soils ranges from nearly level to steeply sloping. The latter topographic class is mainly confined to the fan apex where the soil is in part colluvial. These soils are all excessively drained. Their high noncapillary porosity ensures little runoff.

Agriculture

Owing to their low natural fertility, poor drought resistance, coarse texture and stony nature, the Layton soils have little agricultural value.

2a SKEENA SERIES (Thin Podzol sandy loam)

The Skeena soils, covering 7,300 acres, occupy well-drained terraces along the Skeena river. The material in these terraces consists of medium- to coarse-textured deposits upon which a thin or feebly expressed Podzol has developed. The surface texture varies from fine sandy loam to sandy loam, with the latter being the dominant texture. Stones are rarely encountered.

Skeena soils may be distinguished by a 2- to 4-inch mat of forest litter, a thin ashy grey sandy loam A_2, and a brown to yellowish-brown upper subsoil which grades to the pale yellowish-brown and grey brown stratified sandy parent material.

The natural tree growth on this soil is much the same as on the Kitsumgallum soils. The topography is uniformly flat to undulating. The terraces, bordered by steeply sloping escarpments, are long and narrow and slope gently towards the river, thus providing for adequate removal of excess water. Internal drainage provides maximum aeration for the optimum growth of most farm crops.

Horizon	Depth in inches	Description
A_0	2- 0	Surface organic mat consisting dominantly of mosses, needles, etc. pH 4·5
A_2	0- 1	Light grey to white sandy loam, weakly developed thin platy structure. pH 4·5
B_{21}	1- 8	Yellowish-brown to reddish-brown sandy loam, weakly developed aggregates resembling coarse and nutty structure. pH 5·2
B_{22}	8-16	Yellowish-brown sandy loam, slightly more compact than above horizon. No well-defined structure. pH 5·2
C	16+	Greyish-brown stratified parent material. Includes small bodies of brown stained material. Frequently underlain by coarse sand, gravel and occasionally lake-laid clay. pH 5·5

Shallower soils than the above occur and are characterized by a gravelly substratum a few inches below the surface. In one instance the soil profile is underlain by stratified clays which serve as the parent material for the Lakelse soils; in this case the profile shows evidence of poor drainage.

Agriculture

Skeena soils have a high agricultural potential but at present are still largely under native vegetation. Although the soils are acid and relatively deficient in mineral plant-food elements, they can be made moderately productive through the adaption of approved soil management practices. Late seeded crops generally suffer from the lack of adequate precipitation during the months of July and August, and irrigation, where possible, may be a decided advantage.

Cultivated areas are devoted mainly to fodder crops. Potatoes are grown to a limited extent and a number of farmers are engaged in the production of such fruits as apples, pears, plums, cherries and berries.

Most of the Skeena soils are heavily timbered and until recently few attempts have been made to clear additional land.

MORICETOWN SERIES (Podzol sandy loam and gravelly sandy loam)

The Moricetown soils covering 28,500 acres consist of coarse-textured deposits occupying a succession of river terraces and benches in the general area of Moricetown and Cedarvale. Two soil classes, sandy loam and gravelly sandy loam, have been mapped. Areas of finer textures occur but are generally too small to be shown on the map. Small stones commonly occur throughout the profile.

The surface layer, consisting of a thin mat of needles, moss and plant remains, is underlain by a 1- to 2-inch light grey layer having little or no structure. Below this is a yellowish-brown to reddish-brown weakly cemented subsoil. At about 16 to 18 inches the subsoil grades into a grey gravelly parent material which is compacted but porous.

Moricetown soils occur on undulating to gently sloping terraces and are well drained. Their permeable profiles permit rapid infiltration with considerable lateral movement resulting in the development of a second drainage member, i.e. Kispiox, which has been mapped separately.

A detailed description of Moricetown sandy loam as observed under well-drained and heavily wooded conditions is as follows:

Horizon	Depth in inches	Description
A_0	2- 0	Dark brown layer of partially decomposed organic matter. pH 3·8
A_2	0- 1	Light grey platy structured sandy loam. pH 3·9
B_{21}	1- 8	Reddish-brown sandy loam, slightly compacted and showing slight indication of cementation. pH 5·2
B_{22}	8-16	Reddish-brown to yellowish-brown sandy loam, single-grain structure, some compaction. pH 5·6
C	16+	Grey to grey brown stratified sandy loam and gravelly sandy loam. pH 5·6

At some points, the Moricetown profile is very shallow and rests on a D horizon of glacial till or bedrock. These areas are generally small and are characterized by a rolling topography and are frequently associated with numerous stones or rock outcroppings. Peat, meadow and Kispiox soils occur in depressional areas.

Agriculture

Owing to the open porous nature of the soil, low organic-matter content and deficiency of plant food elements, Moricetown sandy loam can only be considered as a marginal soil. Its agricultural use will depend largely on cultural practices followed. Cultivated lands are devoted mainly to the production of forage crops, coarse grains and, to a limited extent, potatoes, strawberries and other small fruits.

The gravelly sandy loam should be considered as submarginal.

2c Kispiox Series (Groundwater Podzol sandy loam)

The Kispiox soils occur in the Hazelton district and occupy an area of 2,200 acres. They are found in close association with Moricetown soils and lie at the base of slopes, in depressions or other poorly drained sites. They have developed on stratified water-deposited materials, geologically similar to the Moricetown, but due to the moisture relationships have resulted in soils with entirely different characteristics.

Under natural forest conditions, the organic mat attains a thickness of 2 inches and overlies a grey leached A_2 horizon. The B horizon is a reddish-brown to brown color, much compacted and streaked with yellowish-brown and rusty mottlings. When dry this horizon is very hard and frequently cemented.

Pine, spruce and poplar are the dominant tree species, although cedar, hemlock and black spruce may occur in the moister positions.

A detailed description of a representative profile is as follows:

Horizon	Depth in inches	Description
A_0	2- 0	Partially decomposed remains of mosses, needles, leaves and woody plant remains. pH 5·5 to 6·0
A_2	0- 5	Grey to light grey sandy loam of weak platy to single-grain structure. pH 4·5 to 5·0
B_{21}	8-14	Reddish-brown sandy loam, weakly developed coarse nuciform structure that breaks to single-grain and finely granular condition; few rusty colored concretionary forms. pH 6·0 to 6·3
B_g	14-19	Grey sandy loam much compacted and highly mottled with reddish, yellowish and rusty-brown streaks; dries to a cemented mass. pH 5·5 to 6·5
C	19+	Grey mottled sandy loam. Generally permanently moist. This layer is frequently underlain at relatively shallow depths by an impervious substratum which restricts free water movement. pH 5·5 to 6·5

Agriculture

Kispiox soils are not well suited for agricultural development. A few tracts may be artificially drained but most areas are too small to justify such means of improvement.

3b LAKELSE SERIES (Brown Podzolic and Thin Podzol clay)

The Lakelse soils consist of heavy-textured, weakly stratified materials laid down in glacial lake beds. They are the most extensive agricultural soils in the Lakelse-Kitsumgallum valley and occur within easy access of Terrace. Approximately 13,000 acres have been mapped.

The dominant textural class is clay. Small isolated areas of lighter textures occur but their combined acreage is relatively small. The soil in general is stone free but scattered glacial stones and boulders may occur. Gravelly areas are more common and appear as narrow lenses in the parent material or in surface deposits adjacent to a soil boundary.

In the virgin state Lakelse soils have a thick dark brown organic mat overlying a thin light grey to grey podzolized horizon. This layer in turn overlies a reddish-brown, highly aggregated clay.

The forest cover throughout is a heavy stand of coniferous trees, principally Douglas fir, hemlock, spruce and white fir. Less common, and occupying the low-lying areas, are red cedar and cottonwood. The undergrowth is a dense tangle of many plant species, the most conspicuous being huckleberry bushes, oregon grape, salal, ferns, bracken and numerous seedling types.

The topography varies from undulating to moderately and strongly sloping with occasional flat and depressional areas. The rolling and sloping classes amount to approximately 7,000 acres and are frequently associated with shallow soils and rock outcroppings. This is particularly noticeable in the area surrounding Mount Herman. Mounds and pits made by uprooted trees leave a rather uneven micro-relief.

Surface drainage is generally adequate, tending to be rapid on the more sloping lands and restricted in the hollows and depressions. The porous nature of the upper aggregated layers allows adequate and fairly rapid movement of water. Subsoil drainage is slow and often impeded by the impervious character of the subsoil.

A detailed description of a representative profile is as follows:

Horizon	*Depth in inches*	*Description*
A_0	2- 0	Dark brown fibrous mat consisting of leaf mold, roots and woody fragments. pH 3·7
A_2	0- 1	Light grey to grey clay with weakly developed fine platy structure. pH 3·8
B_{21}	1- 8	Reddish-brown clay having a moderately well-developed granular structure. Generally loose and permeable. Friable when dry and firm when moist. Contains numerous spheroidal concretionary forms. pH 5·1
B_{22}	8-16	Reddish-brown clay, more compact than the foregoing horizon and has a well-developed nuciform structure; concretionary aggregates are numerous. pH 4·9
B_{31}	16-24	Greyish to yellowish-brown mottled clay, moderately dense and compact and consisting of coarse and very coarse blocky partially weathered aggregates. pH 5·0
C_1	24-32	Greyish-brown tight and compact clay. Somewhat mottled with reddish and grey streaks and splotches. pH 5·5
C_2	32+	Grey to grey brown clay, slightly mottled along lines of stratification. Extremely hard when dry and plastic when wet. pH 6·0

Closely associated with the above well-drained types is a poorly drained member occupying the flat and depressional areas. These poorly drained soils differ considerably from the typical Lakelse and have been mapped separately.

Agriculture

The Lakelse soil has a high potential agricultural value, but has not been utilized to the best advantage. Although Lakelse clay is moderately to strongly acid and relatively low in plant nutrients, it has considerable capacity for improvement and offers more promise for agricultural use than the other upland soils available for settlement in the Terrace area.

The fertility of Lakelse soils can be greatly improved by frequent additions of organic matter in the form of barnyard manure or green manure, and by use of commercial fertilizers and lime. The principal crops grown are coarse grains and grasses. Some vegetable crops, berried fruits and hardy tree fruits are also grown.

In the vicinity of Mount Herman the agricultural value of Lakelse soils is greatly reduced due to the rough topography and numerous rock outcrops. The economic value lies mainly in the forest cover, for which it is well suited.

3c THORNHILL SERIES (Dark Grey Gleisolic clay)

The Thornhill soils cover approximately 3,200 acres in the Terrace valley and occur in close association with the Lakelse soils. The parent materials of the two series are geologically similar, consisting of water-deposited heavy-textured sediments, but they differ in respect to drainage.

Only one type, Thornhill clay, has been mapped in the series. The subsoil on occasion is characterized by the presence of appreciable amounts of gravel, but such occurrences are of relatively minor importance. Stones are seldom encountered.

Thornhill soils have a dark brown to black surface A_0 of 4 to 12 inches thick consisting mainly of mosses, needles, woody material and grasses. Immediately below, a plastic grey to light grey layer varying from 2 to 7 inches occurs, characterized by reddish and yellowish-brown mottling and overlying a wet greyish highly mottled plastic clay. At a depth of approximately 20 inches it grades into a grey brown impervious substratum.

The vegetative cover consists mainly of cedar, hemlock, fir and spruce, with a dense undercover of shrubby vegetation.

Typical areas of Thornhill soils occupy level to depressional positions and are poorly to very poorly drained. The compact and impervious nature of the subsoil contributes to a high water table which prevails throughout the major portion of the year. This imperfectly to poorly drained series, as might be expected, includes many variations as well as small units of Lakelse soils. Half bogs and bogs also occur.

Agriculture

Improved drainage conditions are essential before satisfactory crop production may be secured. Lack of drainage, associated with high cost of clearing has hindered development. The few areas cleared and cultivated are used chiefly for pasture and hay.

4a McCULLY SERIES (Alluvial loam)

The McCully soils, occupying approximately 2,700 acres, are found along the banks of the Kispiox river and on several tributary streams in the vicinity of Hazelton. The soils are immature, and are developed on materials washed off the adjacent hills, appearing in the form of alluvial fans and flood plains.

The surface texture ranges from loam, through silt loam to clay loam. Stones and boulders do not normally occur on the surface but are frequently present in the subsoil.

The surface soil, in undisturbed areas, consists of a thin grey brown loam, low in organic matter and underlain by a brown friable loam with a weakly developed nutty structure. This horizon gives way to a stratified gravelly and stony substratum at depths varying from a few inches to several feet.

The natural vegetation on McCully soils is variable. Poplar is dominant, with pine and birch occurring as secondary types. Willow, cottonwood and black spruce are common on the poorly drained sites.

The general topography is gently sloping, becoming rolling and steeply sloping at the apex of the fan deposits. Surface drainage varies from slow on the level areas to rapid on the more sloping lands.

McCully loam is the only type mapped. A representative profile is described below:

Depth in inches	*Description*
2- 0	Partially decomposed layer of leaves, needles, grasses, etc. pH 5·0
0- 2	Grey brown loam to clay loam, weakly developed coarse platy-granular structure. Slightly plastic when wet and firm to hard when dry. pH 5·5
2-14	Brown to dark brown loam, moderately well developed coarse to very coarse nuciform structure. Plastic when moist and hard when dry. pH 6·0
14+	Grey to grey brown somewhat iron stained stratified sands, gravels or cobbly materials.

Agriculture

McCully soils are in general satisfactory for agricultural purposes, but the low organic-matter content, shallow profile and occurrence of sand and gravel spots present difficulties.

A relatively small acreage of this soil is under cultivation. Crops are fair in normal years and include mainly oats, clover and timothy.

Remo Series (Alluvial clay loam and clay)

The Remo soils consist of the comparatively recent alluvial deposits confined to valley bottoms in the Lakelse-Kitsumgallum valley. Abandoned stream channels along the Skeena river are included in this category. Approximately 3,200 acres have been mapped.

A range in texture from clay loam to clay is included in the mapping unit, as well as small islands of gravel and woody peat. Stones are absent.

Remo soils have a friable and slightly granular 6-inch surface soil layer ranging in color from brown to dark brown, underlying the thin A_0. From a depth of 6 to 20 inches or more the soil material is made up of grey and greyish-brown irregularly stratified sediments that are frequently mottled and that lie on a compact stratum of mottled rusty brown sand, gravel, or sandy clay. The majority of the land has smooth to nearly level topography, much of which is poorly drained. The virgin cover of cedar, hemlock, deciduous trees, etc., is usually very dense.

Agriculture

Remo soils are fertile, easy to work, free from stones and, where drainage conditions are satisfactory, are adapted to a wide variety of crops. Lack of drainage and danger of flooding during the freshet season are factors contributing to decreased agricultural value. Artificial drainage and, in some instances, dyking against overflow would greatly improve these lands.

The Remo soils lying above the high-water level are probably the most fertile in the area, but their extent is limited. Strawberries, cane fruits, potatoes and vegetables are among the crops that give good yields.

D. Miscellaneous Land Types

The miscellaneous land types do not fall into the general soil classification scheme. Their development and characterization are influenced largely by relief, parent materials and age of same, drainage and many other factors. Members of this group include the recent alluvial, eroded and mountainous lands.

1. Alluvial (Alluvial undifferentiated)

The alluvial soils, involving approximately 53,800 acres, include the majority of the recently deposited sediments in the valleys of the main rivers and their tributary streams. They occupy narrow benches and vary from a few yards to a mile or more in width.

Textures vary horizontally as well as vertically, so much so that separation into textural classes is possible only in a general way. The soil profiles are weakly developed. The native vegetation varies from open grassy plains to a heavy forest cover.

The topography for the most part is undulating, dissected and eroded somewhat by post glacial stream action. Drainage varies from excessive in respect to the lighter-textured soils on the more elevated terraces, to saturated conditions and occasional flooding at the lower levels.

Agriculture

A fairly large proportion of the heavier-textured and more accessible soils have been cleared and have proved to be highly productive and generally superior to the Fraser or Remo soils.

One area worthy of note is the heavy-textured alluvial soil in the immediate vicinity of Houston. These soils, while lacking well-defined genetic horizons, reflect certain characteristics common to the Thin Black profiles. Here the growing of specialized crops, such as vegetable seed, has been very successful. Due to their limited occurrence they have not been mapped as a separate series. (Plate II D.)

2. Eroded Lands

The eroded land type includes areas that are unfit for cultivation because of steeply sloping, rough and broken relief, and in some instances rock outcrops. Most of the slopes have a gradient of more than 30 per cent and have practically no agricultural value other than for timber and scant grazing. There are 102,000 acres mapped.

3. Mountainous Land

The classification "mountainous" is applied to the areas of undifferentiated soils, which on account of their steep, eroded, rocky or mountainous nature, are non-arable. Approximately 200,000 acres are included in the mapped area.

The greater portion of the mountainous land occurs in the western part of the mapped area, which includes portions of the Coast Range. With the exception of the few rock outcroppings and the high peaks above timberline the land type is heavily timbered. The covering of soil and soil material varies in depth and character and has limited agricultural value.

Above timberline, in areas of relatively low relief, the soils have a characteristic pattern of mounds, 8 to 24 inches high, and commonly 3 to 4 feet wide, and the plant cover is dominated by low-growing shrubs intermingled with sedges, alpine blue grass and fescue. A profile examined on a drier site on a slope of about 8 per cent exhibits the following characteristics:

Horizon	*Depth in inches*	*Description*
A_0	4- 0	Dark brown fibrous organic accumulations.
A_1	0-10	Black loam, weakly developed, granular structure, many roots.
A_2	10-11	Grey to light grey loam to sandy loam, granular to platy in structure, rarely exceeds 1 inch in thickness.
B_g	11-18	Reddish-brown loam streaked with black and yellowish markings, friable; few roots.
C	18+	Grey somewhat mottled gravelly and stony sandy loam, permanently wet.

Where accessible, some of these soils may be useful for summer grazing, but for the most part the tundra-like grasslands are used by big game. When considered in connection with its timber and mining resources as well as scenic, recreational and watershed values, this land has great value. (See Plate I, B and C.)

E. Organic Deposits

Organic deposits, varying in size, shape, stage of decomposition, drainage conditions, depth and character of the accumulated material, are a distinctive feature of the landscape. They occupy low-lying poorly drained depressions and are frequently associated with the shorelines of lakes and ponds. The total area of these deposits is roughly 55,300 acres. They may be divided into two sub-groups, depending on the stage of decomposition, depth of material and the source of the accumulated plant remains. The groups are discussed below.

1. Muck and Peaty Meadows

The meadow soils consist mainly of the moderately well-decomposed remains of sedges, meadow grasses, and other moisture-loving plants. Willows, found in abundance along the margins, have in many cases completely invaded many of the shallower and better drained places. These meadows are used to some extent for the production of wild hays or for pasture, but in many cases the quality is poor.

The top 8 to 10 inches forms a dense fibrous and dark brown to black sod bound together by numerous live roots and underground stems. The reaction varies somewhat but is generally slightly acid to alkaline (pH 6·0 to 7·5). A mixture of decomposed and partially decomposed plant remains lie below the raw plant material. Lime is often present in considerable quantities, principally in the form of small shells of aquatic life.

Timothy and alsike clover establish themselves readily and compete successfully with the native species. Oats make rank growth, are inclined to lodge, and do not fill properly. Late-spring and early fall frosts are generally more common than on the surrounding uplands.

2. Peat Bogs

Peat bogs, muskegs, etc., consist mainly of the accumulated remains of mosses, Labrador tea, and associated species in a relatively raw state. They vary from the floating type, through types supporting a sparse growth of black spruce and lodgepole pine to drier areas supporting dense stands of spruce, pine and willows.

The surface is covered with a thick mat of moss 2 to 4 inches thick. Below this for a depth of 6 to 12 inches is a brownish layer of undecomposed mossy peat, twigs, roots, etc. This layer is underlain by partially decomposed moss intermixed with tree-trunks, stumps and roots.

Apart from the small amount of grazing and browse value these soils are of little agricultural significance.

LAND-CAPABILITY CLASSES

The foregoing descriptions and discussions relative to the individually mapped soils suggest that their productivity and general capabilities vary greatly. A reconnaissance survey may not normally furnish sufficient detail to permit an accurate grouping on a fertility level, but the field observations supplemented by laboratory study and economic data justify the tentative grouping which is presented herewith. This grouping is subject to revision as more detailed pedologic, agronomic, and economic information becomes available. The introduction of new varieties of farm crops, advances in tillage methods, change in types of farming and management practices and other factors may require some readjustment in respect to classification of land-use groups.

The criteria for the capability groupings are based primarily on the relevant soil characteristcs which affect land quality and land use in the various zones. Specifically a number of basic soil characteristics have been evaluated and in order to be classed as arable a soil must measure up to a definite standard.

Major factors limiting complete utilization include moisture-holding capacity, physical condition, topography, elevation, and the presence of coarse fragments. Slopes of 15 per cent or over have been considered as grazing or forest land unless the area in question consists of relatively smooth simple slopes upon which contour tillage or other soil conservation measures such as complete grass coverage may be practised. Very steeply sloping classes (16 to 30 per cent) are occasionally farmed with some success provided the upper slopes and crests of ridges are adequately protected by native vegetation. Observations indicate that an elevation of 3,000 feet represents the upper limit beyond which it is inadvisable to attempt the production of cultivated crops. The presence of coarse fragments such as gravel, stones, etc., in amounts exceeding 25 per cent of the total soil volume are considered excessive. Such soils are perhaps better retained, for the present at least, as grazing or forest land.

The capability classes, as presented, group the soils of the area into 6 land-use divisions. Within the arable groups (groups 1 to 4), the soils have been rated as good, moderately good, fair and poor. Group 5 is essentially a forest land category within which numerous small acreages of arable land are commonly distributed; and Group 6 in non-arable forest land.

The soils of the Degraded Black zone are for the most part fertile and have favorable drainage conditions. Air-water capacities as expressed in moisture-holding capacity, wilting point, percolation rate, capillary and non-capillary porosity have, pending further investigation, been placed at the following levels:

Field moisture-holding capacity	15 to 20 per cent
Permanent wilting point	6 to 8 per cent
Percolating rate (minimum)	0·1 inches per hour
Capillary porosity (maximum	48 to 50 per cent
Noncapillary porosity (minimum)	2 to 3 per cent

The nature and concentration of salts exercise a dominant influence on soil structure and moisture movement and at times a concentration toxic to plant growth may be apparent. In general this point of interference is reached when the conductivity value of the saturated soil extract exceeds 500 x 10^{5} mhos.

In establishing minimum specifications for the Grey Wooded soils, emphasis has again been placed on the more stable physical characteristics, whose values have been tentatively established as follows:

Field moisture-holding capacity	12 to 16 per cent
Permanent wilting point	4·0 to 5·0 per cent
Percolation rate (minimum)	Tentatively same
Capillary porosity (maximum)	as Degraded
Noncapillary porosity (minimum)	Black soils.

Specific data relative to the Brown Podzolic and Podzol soils of the area are lacking. However, information from similar soils in the lower Fraser valley suggests that a soil, to be classed as arable, should have as minimum requirements the following moisture relationships:

Field moisture-holding capacity	10 to 14 per cent
Permanent wilting point	5 to 7 per cent
Total available moisture storage	1 to 1·5 inches

Many Brown Podzolic and Podzol soils having moisture relationships below the above stated levels are utilized to a limited extent for agricultural purposes. In such instances the uses are confined to specialized enterprises such as poultry, fruits for early market, etc., where the characteristics of the soil are of secondary consideration.

Soils of Land-capability Class I

The soils of Class I, in general, constitute good arable land suited to general farming and in many instances specialized production. These soils have a high moisture-holding capacity, are moderately well supplied with organic matter and are above average in fertility. Soil and topographic conditions are such as to ensure effective natural drainage and these, combined with slopes of 1 to 3 per cent, permit normal tillage without fear of erosion. Stones are of no serious moment.

The following mapped soils have been included in Class I:

Nulki silty clay	6,100
Australian clay loam	3,400
Australian silt loam	3,600
Prairiedale silt loam and silty clay loam	11,400
Telkwa clay	11,000
Alluvial clay loam	1,000
	36,500 acres

Soils of Land-capability Class II

The soils of this class are considered moderately good agricultural lands for general farming purposes. They have been rated lower than the soils of Class I due to inferiority in respect to one or more of the following characteristics: organic-matter content, natural fertility, physical condition, moisture-holding capacity, susceptibility to erosion, stoniness and shallowness of solum, etc.

The following mapped soils have been included in Class II:

Narcosli clay	6,700	
Cuisson clay loam	3,500	
Pinchi clay	4,000	
Lakelse clay	6,000	
Telkwa clay (rolling)	3,100	
Driftwood loam	106,800	
Bednesti silt loam	37,200	
Nechako silt loam	26,800	
Fraser silt loam	15,800	
Australian fine sandy loam	5,600	
Skeena sandy loam	7,300	
Alluvial silt loam and loam	1,800	
Telkwa-Driftwood complex	5,100	
	229,700	acres

The Narcosli and Pinchi soils require careful handling in order to maintain a desirable physical condition. Lakelse, Skeena and Bednesti soils, though low in natural fertility, are easy to work and responsive to good management practices such as applications of manure, lime and fertilizers. Driftwood and the rolling classes of Telkwa are very productive but due to their susceptibility to erosion, shallowness of soil and the occurrence of stones, have received a lower rating. Nechako, Fraser, Australian and the medium-textured alluvial soils are considered inferior to the soils of Class I due to lower moisture-holding capacity and nutrient level, unfavorable physiographic position or some other modifying factor.

Soils of Land-capability Class III

The soils of this class are rated as reasonably satisfactory agricultural land with a high natural fertility in most cases. They are rated below the soils of Class II principally on account of their adverse physical characteristics, steep slopes, low nutrient level in some instances, or susceptibility to erosion. The following mapped soils are placed in this capability class:

Pineview clay	91,000	
Vanderhoof silty clay loam	160,700	
Narcosli clay, gently rolling	2,000	
Doughty clay	6,900	
Fort St. James clay	106,700	
Thornhill clay loam	3,200	
Remo clay loam	3,200	
McCully loam	2,700	
Kersley sandy loam	14,600	
Alluvial sandy loam to loam	26,600	
Kersley-Australian complex	1,900	
Vanderhoof-Prairiedale complex	1,500	
Telkwa-Driftwood complex, steeply sloping	2,100	
	423,100	acres

Pineview, Vanderhoof, Doughty and Fort St. James, due to heavy texture, low noncapillary porosity, particularly in the B horizon, and level topography, are generally imperfectly to poorly drained and difficult to maintain in a state of good tilth. Thornhill and Remo soils, to be productive, require underdrainage to correct a high water table. Kersley and the Alluvial soils have low moisture-holding capacity, often shallow to gravel, and crops are frequently uneven and spotty.

Soils of Land-capability Class IV

The majority of the soils included in Class IV are considered fair to poor land for general farm purposes, though some soils may rate fair to good for certain crops. Their topographic features, moisture relationships and structural properties, at or slightly above the previously prescribed minimum standards for soils of this class, impose severe limitations to their complete utilization.

The following mapped soils have been included in Land-Capability Class IV.

Pineview clay, rolling	36,000
Vanderhoof silty clay loam, rolling	113,100
Doughty clay, rolling	200
Lakelse clay, rolling	7,000
Bednesti silt loam, rolling	4,000
Eena sandy loam	7,300
Braeside sandy loam	7,300
Mapes sandy loam	500
Moricetown sandy loam	24,600
Kersley loamy sand	5,200
Kitsumgallum gravelly sandy loam	8,500
Driftwood sandy loam and loam (steeply sloping and hilly)	48,700
Cuisson-Chilako complex	2,300
Barrett-Driftwood complex	20,600
Vanderhoof-Chilako complex	3,300
Doughty-Barrett complex	2,100
Pineview-Chilako complex	2,800
	293,500 acres

A considerable acreage of the Pineview, Vanderhoof, Narcosli, Doughty, Lakelse and Bednesti soils have steep slopes which in conjunction with their unfavorable physical properties provide additional handicaps to cultivation. Driftwood sandy loam has a steeply sloping topography and is often shallow and stony. Braeside, Eena, Kersley, Mapes, Moricetown and Kitsumgallum soils, compared with the soils of Class III, are low in moisture-holding capacity and in natural fertility. High production, therefore, cannot be expected without additions of irrigation water, fertilizers, organic matter, and through the adaption of other approved practices.

Soils of Land-capability Class V

The soils of Class V, for the most part, are not suited for general farming purposes, and have been rated as poor agricultural land.

In general, topographic conditions, moisture relationships, stoniness, depth of soil and soil material, elevation and other factors are such that few measure up to the previously stated minimum standards for an arable soil. However, should a critical need for land develop, many thousands of acres of these soils may be made productive through irrigation, drainage, clearing, etc.

The following soils, now supporting a valuable growth of forests, have been included in category V:

Pineview clay, steeply sloping and hilly	2,000
Vanderhoof silty clay loam, steeply sloping and hilly	3,600
Barrett stony sandy loam	290,400
Chilako stony sandy loam	791,000
Barrett-Driftwood complex, steeply sloping	5,600
Gunniza gravelly sandy loam	1,500
Saxton sandy loam	800
Saxton loamy sand	500
Mapes loamy sand	7,900
Eena sandy loam, rolling to hilly	7,000
Eena loamy sand	19,200
Moricetown gravelly sandy loam	3,900
Braeside loamy sand	41,600
Kitsumgallum gravelly sandy loam, steeply sloping and hilly	2,600
Kispiox sandy loam	2,200
Vanderhoof-Chilako complex, hilly	22,800
Muck and Peaty Meadow soils	25,300
	1,227,900 acres

Soils of Land-capability Class VI

The soils included in this land-use category are essentially non-arable forest land. They include a number of recurrent land types having a peculiar combination of physical features, which militate against use for agricultural purposes.

Included in this land class are the following:

Giscome gravelly loamy sand	4,600
Layton gravel	4,200
Alluvial sand, gravel, etc.	24,400
Peat	30,000
Eroded lands	102,000
Rough mountainous land	200,000
	365,200 acres

In the grassland regions these soils may be used, in part, for grazing purposes. On the other hand, in the forested regions these lands have value as a source of merchantable timber, tourist attraction, wildlife refuge, and for moisture storage.

AGRICULTURAL PROBLEMS

Soil represents a three-phase system: solid, liquid and gas, and as such is extremely complex. Bearing in mind the influence on this system of climate and biological features associated with different parent materials, one can appreciate the diversity of distinct soil types which are readily recognizable. Detailed studies will obviously disclose many more.

The soil survey indicated that certain problems or hazards are more pronounced in some soils and may be attributed to the effect of one or the combination of several factors such as particle size distribution, plasticity, erosion and runoff, inadequate drainage and lack of fertility. The extent and distribution of these problems are dealt with in the following paragraphs.

Particle Size Distribution

The important role in soil of particle size distribution is obvious, since texture determines many of its fundamental physical and chemical properties. Size of particle, for instance, not only determines the effective diameter of the pores, but also surface area per unit volume and, to a considerable degree, cohesion in the soil. Colloidal particles when present, owing to their small size and degree of hydration, strongly affect the water relations as well as mechanical behavior.

The results of the particle size distribution analyses are presented in Table 6. The data show that both Vanderhoof and Nulki soils are high in silt and clay and the various horizons in each case are silty clay loams. The Pineview profile, containing 52·50 per cent clay in the surface horizon, increasing to 63·15 and 74·70 per cent in the B_{21} and B_{22} sub-horizons, is obviously classed as clay.

TABLE 6. Particle Size Distribution of Pineview, Vanderhoof and Nulki Soils

Horizon	Sand 00·05 mm per cent	Coarse Silt 0·05—0·005 mm per cent	Fine Silt 0·005—0·002 mm per cent	Clay 0·002 mm per cent
	PINEVIEW CLAY			
A_1	11·90	13·80	21·80	52·50
A_2	11·45	14·15	21·50	52·90
B_1	5·70	10·00	21·15	63·15
B_2	1·90	6·90	16·50	74·70
C	0·70	10·80	29·70	58·80
	VANDERHOOF SILTY CLAY LOAM			
A_1	4·30	23·85	48·45	23·40
A_2	13·00	49·00	25·40	12·60
B_1	3·99	22·50	47·25	26·26
B_2	2·60	20·60	44·60	32·20
C	0·09	5·54	50·83	42·67
	NULKI SILTY CLAY LOAM			
A_1	5·10	10·45	54·20	30·25
A_2	7·00	11·10	57·45	27·45
B_1	1·10	8·40	55·50	35·00
B_2	2·02	10·38	53·25	34·35
C	1·50	7·30	56·15	45·05

It is important to note the high silt content of the Vanderhoof soil, particularly of the A_2 horizon which constitutes approximately three quarters of the soil volume to cultivated depth. This horizon with its low organic-matter content is characterized by unstable aggregates and a particle size distribution that tends to compaction and formation of tough surface crusts. These crusts, platy and massive in structure, attain a thickness of 2 to 3 inches, impair aeration, have low infiltration rates and, when associated with a level topography result in the accumulation of free water for an indefinite period of time.

Nulki and Pineview soils are similarly affected, but to a lesser degree. This is due primarily to the higher organic-matter content and the stability of the aggregates resulting in higher noncapillary porosity.

Pore Size Distribution

Porosity is a condition essential to the storage of water, the circulation of air, and to soil penetration by roots. The two factors greatly affecting size and distribution of the pores are structure and texture. In the case of fine-textured soils a crumb structure is highly desirable, in fact essential, in order to permit adequate aeration and optimum plant root development within the soil. Sands and mucks contain many large pores and therefore have a high noncapillary porosity, while clays, unless well aggregated, have relatively few large pores. Each soil horizon will, with its specific infiltration rate and porosity, exercise a specific influence on percolation rate.

The results of the pore size distribution determinations (Fig. 8) show extremely favorable aeration-porosity relationships in the surface horizons of Pineview clay. This is evidenced by the fact that 21 and 41·8 per cent* of the total porosity is occupied by pores having an effective diameter greater than 0·02 mm. In keeping with the high clay accumulation in the subsoil, the B_{21}

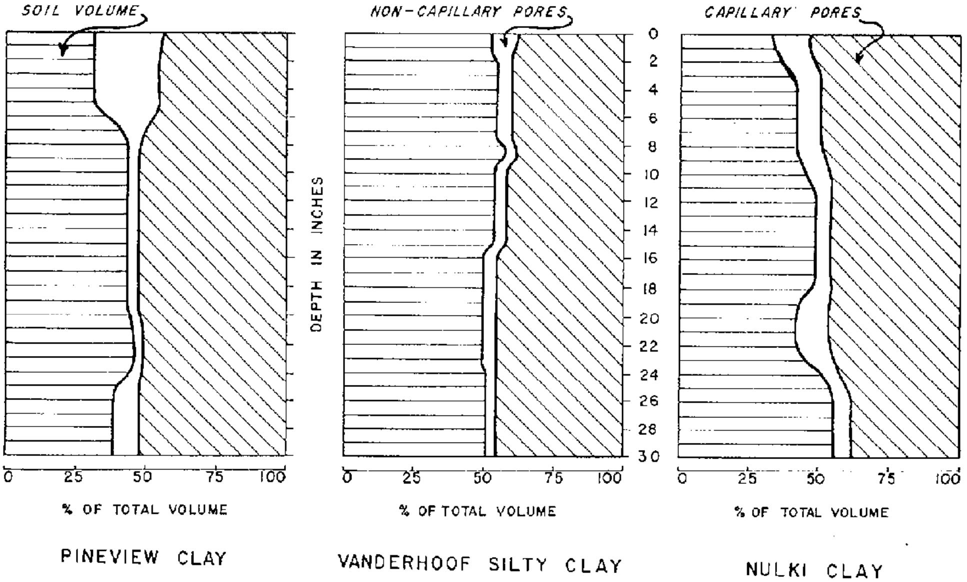


FIG. 8—Diagram showing pore space relationships in Pineview, Vanderhoof and Nulki soils.

and B_{22} horizons have noncapillary porosity values of 3·9 and 3·6 per cent respectively. This sharp decrease in noncapillary porosity, with a consequent decrease in infiltration and percolation rates results, as has been observed, in the production of a cold wet soil, and one subject to soil heaving and winter-killing.

Amelioration of this condition is one of the major problems facing agricultural development on Pineview soils. Surface drainage, the use of shallow-rooted crops and possibly deep tillage may prove beneficial. Should conditions improve one might eventually introduce, by degrees, deep-rooted crops.

Doughty, Fort St. James and Narcosli soils, like Pineview soils, have unfavorable porosity relationships.

Porosity features in the Vanderhoof soil profile are also presented in Fig. 8. Examination of the chart reveals that even where the aggregating effect of organic matter is greatest, the noncapillary porosity is nevertheless low, ranging as it does from 4·6 in the A_2 to 2·6 per cent in the C. There is, therefore, a gradual decrease with depth in the number of noncapillary pores. The difficulty as disclosed appears to be associated with particle size distribution

*Per cent of soil volume drained at 40 cm. tension.

and instability of soil aggregates. Porosity, permeability, infiltration and drainage may be improved by frequent use of deep-rooted legumes, such as alfalfa. Such a crop, in rotation with grasses, tends to open up new channels and stabilize the structure in the soil.

In Nulki soils, representing the Degraded Black counterpart of Vanderhoof soils, the combination of structure, degree of aggregation and organic-matter content results in favorable capillary and noncapillary relationships. The A_{11} containing 6 to 8 per cent organic matter and averaging 6 inches in depth, has a noncapillary pore space of 13 per cent. The B_{22} horizon, occurring at a depth of 15 to 20 inches, has a nutty to blocky structure, low organic-matter content and a noncapillary porosity of 11·5 per cent. These marked physical differences between horizons are clearly set forth in Fig. 8.

Capillary and noncapillary porosity and structural relationships as reported for Nulki are fairly representative of Telkwa, Pinchi and Cuisson soils.

Fertility

Soils of the map area have, for the most part, developed under a woodland vegetation and, as is to be expected, are normally low in humus and nitrogen. The incorporation of organic matter either in the form of stable manure or crop residues is essential as a regular farm practice if fertility is to be built up or even maintained. Frequent light applications usually give better results than heavy infrequent ones. Where livestock is not a feature of the farm operation it is essential that cropping practices provide for the frequent turning under of sod or green manure crops.

The Co-ordinating Committee on Agriculture recommends a rotation in which not more than two successive crops of grain or four of hay be removed. This recommendation, however, does not apply to the more steeply sloping and stony lands (Driftwood, Barrett, etc.) that do not permit frequent cultivation; nor does it apply to areas where alfalfa may be successfully grown as a forage crop. The incorporation of legumes in the regular rotation increases materially the productive powers of these soils.

Fertility experiments are being conducted on many of these soils but there is still much work to be done in this connection. However, the evidence to date appears to point, first and foremost, to the need for organic matter and nitrogen fertilization followed in order by phosphates.

A large percentage of the fine-textured soils have shallow, permeable surface horizons and dense, slowly permeable subsoils. The best use of these poorly drained claypan soils probably is for the production of shallow-rooted crops that can withstand wide ranges of moisture conditions. The use of sod crops together with such legumes as alsike and red clover appears to be the most effective way of opening up these subsoils. Organic matter, fertilizers and the use of other amendments, such as gypsum, as required, may be advantageously used to encourage vigorous root development.

In consideration of the foregoing it should be apparent that grasses and legumes must have a prominent place in the crop rotations. An awareness of these requirements might also stimulate greater interest in livestock production.

Plasticity

The lower plastic limit, liquid limit and plasticity indices have been determined and the results presented in Table 7. The lower plastic limit represents the moisture content of the soil at the point where it changes from a friable to a plastic consistency. In essence it represents the lowest moisture content at which the soil will puddle. The liquid limit or upper plastic limit is the moisture content at which the various surface phenomena associated with water films permit the soil mass to flow under an applied force; as such it is the point at which the majority of the soil pores are occupied by water. The plastic number, which is the conventional index of plasticity, is the difference between the upper and lower plastic limits, and represents the range over which plasticity is shown. Generally, very plastic clays have plasticity numbers greater than 20; moderately plastic soils from 10 to 20 and slightly plastic soils less than 10. Reference to Table 7 indicates that the cultivated layer (A_1 and A_2) of Pineview and Vanderhoof soils have lower plastic limits of 37·1 and 31·7 respectively. These soils should not be cultivated until the moisture content has fallen below these levels. The addition of organic matter, as evidenced by Nulki (lower plastic limit 40·7 per cent) will significantly improve the tillage properties of these soils.

TABLE 7. Lower Plastic Limit, Liquid Limit and Plasticity Index Value for Average Profile of Pineview, Vanderhoof and Nulki soil.

Horizon	Pineview	Vanderhoof	Nulki
LOWER PLASTIC LIMIT (Per cent)			
A_1	39·2	34·4	40·5
A_2	34·0	28·1	26·6
B_{21}	27·0	23·6	23·0
B_{22}	26·1	22·6	22·3
C	27·1	22·9	23·1
LIQUID LIMIT (UPPER PLASTIC LIMIT) (Per cent)			
A_1	60·6	39·2	61·7
A_2	47·9	31·7	34·6
B_{21}	53·4	33·6	46·1
B_{23}	72·7	37·8	49·0
C	49·5	43·6	51·2
PLASTICITY INDEX (Per cent)			
A_1	21·4	4·8	21·2
A_2	13·9	3·6	8·0
B_{21}	26·4	10·0	23·0
B_{22}	46·6	15·2	26·7
C	22·4	20·7	28·1

The effect of clay content on the upper plastic limit and the plastic number is apparent from further examination of the data. Vanderhoof soils, high in silt, are only slightly plastic, while Nulki and Pineview soils are moderately to very plastic clays.

Land Clearing and Breaking

Heavy forest cover is a major impediment to agricultural development throughout the surveyed area. Most of the clearing until recently has been at the expense of slow laborious hand methods.

In recent years, the use of heavy crawler-type tractors with suitable attachments has revolutionized land clearing. Government-owned equipment has operated in the area for the past several years and improvements are being effected to such a degree that there is an ever increasing demand for such equipment. There is, however, some danger that methods such as these may lead to indiscriminate removal of timber resulting in, for example, depletion of water resources and wastage of water supplies. Another danger associated with power clearing is the removal and destruction through burning of the surface organic horizons. This results in waste and exposure of the heavy inactive subsoil which must of necessity be built up before original productive level is reached. It should be remarked at this time that government agencies concerned with power clearing are cognizant of these dangers and have taken steps to eliminate them.

The costs of clearing and piling vary from $20 to $50 per acre, depending on the size and density of the tree cover. Additional costs for burning, breaking, root picking and other land preparations range from $10 to $30 per acre, again depending on the size, density and type of tree growth.

Erosion and Runoff

Soil erosion and water wastage are major agricultural problems in many areas in the central interior. These, more serious in the Bulkley valley and "Lakes District", are closely related to topography, soil structure and vegetative cover. A careful study of soil and topography features involving productive capacity, natural water reservoirs, etc., should be undertaken preparatory to the removal of forest growth as frequently some potentially arable land should be left forested in such a fashion as to protect against soil erosion and to ensure conservation of water supplies. Land submarginal for agriculture should be left forested. Determination of optimum land use in the central interior is more than simply evaluating crop yields.

DISCUSSION OF ANALYTICAL DATA

Chemical Analyses

Chemical analyses have been completed for a number of the more important soils of the mapped area and are presented in accompanying tables. These analyses disclose horizon differences, provide information respecting potential fertility, and serve in part as a guide to soil management practices.

Nitrogen

The nitrogen content of the soils analysed, reported in Table 8, varies greatly in the surface horizons throughout the area. There is also considerable variation between the soils of the different zonal groups as well as differences between the soils of the same Great Soil Group. The Degraded Black soils have a high nitrogen content in the A_1 horizons and a pronounced decrease in nitrogen with depth. The Grey Wooded, Podzolized Grey Wooded, and Podzol soils are all low in this nutrient and one must conclude that these soils, when cultivated, will require nitrogenous fertilizers if even the original fertility is to be maintained.

Phosphorus

The total phosphorus contents of the soils analysed are reported in Table 8. The Degraded Black soils appear moderately well supplied with total phosphorus (P_2O_5) having the highest content in the A_1 and the lowest in the B horizons. In the Grey Wooded soils the values for phosphorus vary in somewhat the same manner but not to so great a degree. The Podzolized Grey Wooded and Podzol soils, as indicated by Bednesti and Lakelse soils, are well supplied with total phosphorus in the upper part of the solum but are inclined to be low in the parent material. Unfortunately, analyses of available supplies are lacking but when considered collectively the general level of available phosphorus is low.

Reaction

The intensity of soil acidity or alkalinity is expressed in pH. A pH value of 7·0 is neutral; lower values indicate acidity and higher values, alkalinity. A desirable range for most crops grown in the area is from medium acid to mildly alkaline (pH 5·6–7·8). The Degraded Black and the majority of the Grey Wooded soils fall within this range. The most acid horizons of the profiles analysed are the A_0, A_1 and A_2 horizons of the Grey Wooded, Podzolized Grey Wooded and Podzol soils.

Applications of lime are not generally considered essential to successful crop production except on the Brown Podzolic and Podzol soils in the Hazelton and Terrace Areas. The low exchangeable bases (Table 11) and strongly acid reaction of many of the Grey Wooded and Podzolized Grey Wooded soils suggest that additions of lime might prove beneficial.

Table 8—Nitrogen, Phosphorus and pH Determinations of Representative Profiles

Depth in Inches	Horizon	(per cent)		
		N	P_2O_5	pH
	Nulki Clay—Degraded Black			
0–4	A_1	0·37	0·23	5·6
4–8	A_2	0·06	0·08	6·2
8–14	B_{21}	0·06	0·10	6·7
14–20	B_{22}	0·04	0·18	8·3
20–28	B_{31}	0·03	0·20	8·5
28–35	B_{32}	0·03	0·24	8·8
35–37	B_{ca}	0·03	0·21	8·8
37-	C	0·04	0·21	8·9
	Telkwa Clay—Degraded Black			
0–3	A_1	0·46	0·23	6·7
3–6	A_2	0·27	0·13	6·1
6–12	B_{21}	0·10	0·08	5·7
12–15	B_{22}	0·09	0·07	5·1
15-	D	0·05	0·14	5·7
	Prairiedale Silty Clay Loam—Degraded Black			
0–2	A_1	0·14	0·27	4·9
2–6	A_2	0·04	0·21	6·3
6–7	A_3	0·04	0·15	6·4
7–14	B_{21}	0·04	0·17	6·9
14–21	B_{22}	0·03	0·18	7·7
21–26	B_{23}	0·03	0·21	8·3
	Cuisson Loam—Degraded Black			
0–3	A_1	0·55	—	6·8
3–5	A_2	0·35	—	6·0
	Driftwood Loam—Degraded Black			
0–4	A_1	0·33	0·22	5·8
4–6	A_2	0·10	0·14	5·6
6–14	B_{21}	0·07	0·13	5·5
14–20	B_{22}	0·04	0·18	6·2
20-	C	0·04	0·20	7·6

Table 8—Nitrogen, Phosphorus and pH Determinations of Representative Profiles— *Concluded*

Depth in Inches	Horizon	(per cent) N	P_2O_5	pH
Vanderhoof Silty Clay Loam—Grey Wooded				
2–0	A_0	1·52	0·23	4·7
0–2	A_1	0·16	0·28	5·2
2–8	A_2	0·04	0·19	6·4
8–15	B_{21}	0·04	0·15	6·4
15–24	B_{22}	0·04	0·22	7·2
24–29	B_{31}	0·03	0·21	8·0
29–	C	0·02	0·25	8·3
Narcosli Clay—Grey Wooded				
0–3	A_1	0·10	0·12	6·0
3–6	A_2	0·05	0·17	6·2
7–12	B_{21}	0·01	0·17	5·7
12–18	B_{22}	—	0·19	5·8
Doughty Clay—Grey Wooded				
2–0	A_0	1·20	0·19	4·5
0–1	A_1	0·09	0·14	4·5
1–4	A_2	0·06	0·13	5·1
6–12	B_{21}	0·02	0·08	5·2
12–18	B_{22}	0·05	0·07	5·0
22–	C	0·04	0·14	5·5
Barrett Sandy Loam—Weakly Developed Grey Wooded				
3–0	A^0	1·19	0·26	4·9
0–2	A_{21}	0·14	0·19	5·1
2–4	A_{22}	0·05	0·13	5·0
4–10	B_{21}	0·04	0·12	4·8
10–16	B_{22}	0·03	0·12	5·0
20–	C	0·04	0·19	6·5
Chilako Sandy Loam—Grey Wooded				
1–5	A_2	0·09	—	4·5
5–10	B_{21}	0·06	—	4·9
Australian Fine Sandy Loam—Grey Wooded				
0–2	A_2	0·06	—	6·1
2–8	B_{21}	0·08	—	5·4
8–16	B_{22}	—	—	5·3
25–	C	—	—	8·5
Bednesti Silt Loam—Podzolized Grey Wooded				
0–3	A_2p	0·07	0·22	4·6
3–10	Bp	0·07	0·27	5·4
10–19	Cp	0·03	0·14	5·8
19–30	B_{22}	0·03	0·16	6·0
30–	C	0·02	0·20	6·6
Lakelse Clay—Thin Podzol				
0–1	A_2	0·06	0·12	3·7
1–8	B_{21}	0·07	0·39	3·8
8–16	B_{22}	0·02	0·47	5·1
16–24	B_{31}	0·02	0·08	4·9
24–	C	0·02	0·10	6·0

Calcium and Magnesium

Data presented in Table 9 indicate that these soils are well supplied with total calcium and magnesium. In the Degraded Black and Grey Wooded soils the subsoils are better supplied with these elements than the upper horizons. Generally the depth to lime accumulations varies from 2 to 4 feet and is an indication of the depth of moisture penetration. Information on exchangeable bases (Table 11) indicates that the Degraded Black and Grey Wooded soils are well supplied, and the Brown Podzolic soils, as indicated by Lakelse clay, are poorly supplied with available calcium and magnesium.

Potassium

The Degraded Black and Grey Wooded soils are moderately well supplied with total potash (K_2O) with a relatively uniform distribution throughout the profiles. On the other hand the Brown Podzolic soil, Lakelse clay, has a low content of total potash in the A and B horizon although the parent material is moderately high.

Table 9—Calcium, Magnesium, Potassium and Sodium Analysis of Representative Profiles

Depth in Inches	Horizon	pH	CaO%	MgO%	K_2O%	Na_2O%
			Nulki Clay—Degraded Black			
0-4	A_1	5·6	1·78	1·41	2·09	2·76
4-8	A_2	6·2	1·67	1·41	2·05	3·12
8-14	B_{21}	6·7	1·68	1·93	1·87	2·89
14-20	B_{22}	8·3	2·07	2·12	1·99	2·88
20-28	B_{31}	8·5	1·69	2·74	2·03	2·26
28-35	B_{32}	8·8	3·05	2·05	1·94	2·60
35-37	B_{ca}	8·8	4·04	2·10	1·36	2·61
37-	C	8·9	2·41	2·63	1·87	2·61
			Telkwa Clay—Degraded Black			
0-3	A_1	6·7	2·27	1·49	1·18	—
3-6	A_2	6·1	—	—	—	—
6-12	B_{21}	5·7	—	—	—	—
12-15	B_{22}	5·1	1·40	1·73	1·64	
			Prairiedale Silty Clay Loam—Degraded Black			
0-2	A_1	4·9	1·93	0·96	1·57	2·98
2-6	A_2	6·3	1·97	1·10	1·88	3·37
6-7	A_3	6·4	1·92	1·23	1·79	3·16
7-14	B_{21}	6·9	2·12	1·43	1·68	2·68
14-21	B_{22}	7·7	2·58	1·43	1·75	2·87
21-26	B_{31}	8·3	2·64	1·57	1·53	2·97
			Cuisson Loam—Degraded Black			
0-3	A_1	6·7	2·44	1·16	1·05	—
3-5	A_2	6·0	2·09	1·50	1·29	—
5-10	B_{21}	6·3	1·90	2·53	1·41	—
10-14	B_{22}	7·1	1·90	3·37	1·47	—
20	C	8·2	4·70	3·75	0·97	—
			Pineview Clay—Poorly Drained Grey Wooded			
0-1	A_1	4·6	3·31	2·10	1·61	1·55
1-5	A_2	5·1	3·60	2·82	2·00	1·48
5-7	A_3	5·1	3·46	2·45	2·03	0·94
7-14	B_{21}	5·2	2·77	2·80	1·93	0·71
14-20	B_{22}	6·3	2·28	3·66	1·94	0·88
20-	C	7·6	2·07	3·73	2·11	0·82

Table 9—Calcium, Magnesium, Potassium and Sodium Analysis of Representative Profiles—*Concluded*

Depth in Inches	Horizon	pH	CaO%	MgO%	K_2O%	Na_2O%
		VANDERHOOF SILTY CLAY LOAM—GREY WOODED				
0–2	A_1	5·2	1·69	1·37	1·79	2·82
2–8	A_2	6·4	1·80	1·35	1·81	3·27
8–15	B_{21}	6·4	1·83	1·85	1·77	2·68
15–24	B_{22}	7·2	1·96	2·30	1·82	2·36
24–29	B_{31}	8·0	2·02	2·30	1·92	2·41
29–	C	8·3	3·14	2·11	1·44	2·66
		BARRETT SANDY LOAM—WEAKLY DEVELOPED GREY WOODED				
0–4	A_1	5·0	1·54	1·17	—	—
4–6	A_2	4·9	1·53	1·51	—	—
6–12	B_{21}	4·8	1·65	1·58	—	—
12–19	B_{22}	5·0	1·59	1·50	—	—
24–	C	6·3	1·87	1·57	—	—
		BEDNESTI SILT LOAM—PODZOLIZED GREY WOODED				
0–3	A_2	4·6	2·58	1·90	0·89	1·08
3–10	B_p	5·4	2·93	1·85	0·90	0·98
10–19	C_p	5·8	3·06	1·82	1·30	1·04
19–30	B_{22}	6·0	3·38	2·11	1·07	1·09
30–	C	6·6	3·13	2·00	1·59	1·03
		LAKELSE CLAY—THIN PODZOL				
0–1	A_2	3·7	2·23	—	0·36	—
1–8	B_{21}	3·8	1·60	0·36	0·23	—
8–16	B_{22}	5·1	1·31	0·73	0·17	—
16–24	B_{31}	4·9	1·71	1·94	0·37	—
24–	C	6·0	1·83	2·32	1·66	—

Table 10—Silica and Sesquioxide Analysis of Representative Profiles

Depth in Inches	Horizon	pH	SiO_2%	Fe_2O_3%	Al_2O_3%	R_2O_3%
		NULKI CLAY—DEGRADED BLACK				
0–4	A_1	5·6	61·89	4·48	15·38	19·86
4–8	A_2	6·2	67·64	4·23	16·04	20·27
8–14	B_{21}	6·7	63·22	5·64	18·02	23·66
14–20	B_{22}	8·3	63·46	5·84	17·74	23·58
20–28	B_{31}	8·5	60·57	6·90	18·30	25·20
28–35	B_{32}	8·8	63·51	5·56	16·19	21·75
35–37	B_{ca}	8·8	61·84	5·54	16·05	21·59
37–	C	8·9	59·37	6·64	18·03	24·57
		TELKWA CLAY—DEGRADED BLACK				
0–3	A_1	6·7	53·92	—	—	22·82
3–6	A_2	6·1	—	—	—	—
6–12	B_{21}	5·7	—	—	—	—
12–15	B_{22}	5·1	54·96	—	—	27·48

Table 10—Silica and Sesquioxide Analysis of Rrepresentative Profiles—*Concluded*

Depth in Inches	Horizon	pH	$SiO_2\%$	$Fe_2O_3\%$	$Al_2O_3\%$	$R_2O_3\%$
			Prairiedale Silty Clay Loam—Degraded Black			
0–2	A_1	4·9	67·13	4·63	14·43	19·06
2–6	A_2	6·3	70·06	4·76	15·08	19·84
6–7	A_3	6·4	68·06	5·14	15·55	20·69
7–14	B_{21}	6·9	65·72	6·24	16·39	22·63
14–21	B_{22}	7·7	66·62	5·76	15·89	21·65
21–26	B_{31}	8·3	66·67	5·50	16·06	21·56
			Cuisson Loam—Degraded Black			
0–3	A_1	6·8	60·54	1·83	17·58	19·41
3–5	A_2	6·0	67·32	2·58	19·12	21·70
5–10	B_{21}	6·3	56·08	2·18	24·82	27·00
10–14	B_{22}	7·1	52·55	2·49	28·60	31·09
20–	C	8·2	50·40	2·70	26·66	29·36
			Pineview Clay—Poorly Drained Grey Wooded			
0–1	A_1	4·6	36·05	8·47	16·70	25·17
1–5	A_2	5·1	50·00	11·71	21·15	32·86
5–7	A_3	5·1	53·39	11·86	20·88	32·74
7–14	B_{21}	5·2	55·15	10·54	22·31	32·85
14–20	B_{22}	6·3	58·89	9·52	21·98	27·90
20–	C	7·7	57·59	9·85	22·17	32·03
			Vanderhoof Silty Clay Loam—Grey Wooded			
0–2	A_1	5·2	65·09	3·96	15·70	19·66
2–8	A_2	6·4	68·87	4·42	15·59	20·01
8–15	B_{21}	6·4	64·43	5·64	17·38	23·02
15–24	B_{22}	7·2	62·84	5·83	17·95	23·78
24–29	B_{31}	8·0	63·43	6·15	17·52	23·67
29–	C	8·3	63·43	5·32	16·77	22·09
			Barrett Sandy Loam—Weakly Developed Grey Wooded			
0–4	A_{21}	5·0	62·72	—	—	20·14
4–6	A_{22}	4·9	67·20	—	—	20·42
6–12	B_{21}	4·8	67·12	—	—	21·36
12–19	B_{22}	5·0	66·44	—	—	21·28
24–	C	6·3	62·68	—	—	23·32
			Bednesti Silt Loam—Podzolized Grey Wooded			
0–3	A_{2p}	4·6	74·04	5·44	12·13	17·57
3–10	B_p	5·5	69·50	7·12	15·11	22·23
10–19	C_p	5·8	69·31	10·92	13·40	24·32
19–30	B_{22}G.W	6·0	67·22	8·57	16·21	24·78
30–	C	6·6	67·50	9·57	14·45	24·02
			Lakelse Clay—Thin Podzol			
0–1	A_2	3·7	63·10	—	—	16·73
1–8	B_{21}	3·8	54·13	—	—	22·64
8–16	B_{22}	5·1	51·96	—	—	25·59
16–24	B_{31}	4·9	49·44	—	—	22·80
24–	C	6·0	55·10	—	—	22·80

Silica and Sesquioxides

A limited number of silica, iron and aluminum analyses representative of three Great Soil Groups of the area are included in the Table. Indications of sesquioxide (R_2O_3) translocations from the A to B horizons in the Grey Wooded and Brown Podzolic soils are apparent. The effect of the leaching processes in the Degraded Black soils is largely confined to the movement of the alkaline earths.

Base Exchange Capacity and Exchangeable Bases

The base exchange capacity of a soil and the degree to which that capacity is saturated with exchangeable bases are closely related to such factors as the availability of plant food elements, plant growth, physical properties of a soil, soil development, soil reaction and lime requirements.

Since the base exchange capacity of a soil depends on its content of organic matter and clay there is a considerable variation in exchange capacity between the different soils in the area and between different horizons of the same soil. Considering their texture and organic-matter content one may conclude that these soils have a very satisfactory total base exchange capacity.

The Degraded Black soils generally are well saturated throughout their profiles. The surface horizons of the Grey Wooded soils are only moderately saturated while their subsoils are well saturated. On the other hand the Brown Podzolic soils, the Lakelse for instance, is quite unsaturated in the A and B horizons. The low level of exchangeable bases in this soil indicates the need for liming for crop production. A similar condition exists on the other Brown Podzolic and Podzol soils of the area; namely Skeena, Kitsumgallum and Moricetown.

Exchangeable potassium is at a satisfactory level for all soils in which this determination was made. The data, while incomplete, indicate that the Degraded Black and Grey Wooded soils are well supplied with available potassium. Unfortunately analyses for exchangeable potassium in the Brown Podzolic and Podzol soils of the area were not made, but information on similar soils elsewhere in the province would indicate that they are low in available potassium.

The strongly alkaline solonetzic member of the Cuisson soil contains exchangeable sodium as the dominant base. The effect of this condition is seen in the poor soil structure and poor vegetative growth. Fortunately, the extent of this soil type is very limited.

Table 11—Exchangeable Cations and Base Exchange Capacity of Representative Soils

Soil Series	Horizon	Depth in.	pH	Exchange Capacity	Base Saturation per cent	Exchangeable Cations (m.e./100 gr.)				
						H	Ca	Mg	K	Na
Lakelse clay (B.P.)	A_2	0 – 1	3·7	24·8	16	21·0	3·1	0·8	—	
	B_{21}	1 –18	3·8	19·9	11	16·4	1·6	0·5	—	
	B_{22}	8 –16	5·1	12·8	10	11·9	1·0	0·3	—	
	B_{31}	16–24	4·9	13·8	39	7·3	2·9	2·5	—	
	C_1	24–32	6·0	22·0	78	3·4	10·0	7·2	—	
Pineview clay (G.W.)	A_1	0 – 1	4·6	36·1	65	13·5	12·8	10·6	—	
	A_2	1 – 5	5·1	26·1	58	8·0	6·2	8·8	—	
	B_{21}	7 –14	5·5	28·1	75	9·1	7·5	13·5	—	
	B_{22}	14–20	6·2	32·9	85	8·2	10·6	17·4	—	
	C	20+	7·6	25·1	92	1·8	9·8	17·0	—	
Vanderhoof silty clay loam (G.W.)	A_1	0 – 2	5·2	21·3	52	10·0	6·4	4·0		
	A_2	2 – 8	6·4	8·6	75	1·8	3·1	3·3		
	B_{21}	9 –15	6·4	13·5	93	1·8	5·8	6·7		
	B_{22}	15–24	7·2	17·2	93	0·9	7·2	8·8		
	C	29+	8·3	16·4	100	0·0	10·2	9·4		

Table 11—Exchangeable Cations and Base Exchange Capacity of Representative Soils—*Concluded*

Soil Series	Horizon	Depth in.	pH	Exchange Capacity	Base Saturation per cent	Exchangeable Cations (m.e./100 gr.)				
						H	Ca	Mg	K	Na
Bednesti silt loam (P.G.W.)	A_2	0 – 3	4·6				2·50	0·50	0·23	—
	B_p	3 –10	5·4				3·94	0·65	0·38	—
	C_p	10–19	5·8				6·44	2·34	0·23	-
	B_{22} G.W.	19–30	6·0				9·23	3·03	0·45	—
	C	30+	6·6				8·95	3·38	0·32	—
Barrett loam (G.W.)	A_1	0 – 2	5·0	22·0	50	8·8	7·6	2·6	0·66	
	A_2	2 – 4	4·9	9·7	60	4·7	3·2	1·5	0·75	
	B_{21}	4 –10	4·8	8·5	60	4·7	3·1	1·8	0·19	
	B_{22}	10–16	5·0	9·8	51	4·7	3·2	1·8	—	
	C	20+	6·3	17·1	85	2·5	9·3	5·1	0·13	
Doughty clay (G.W.)	A_1	0 – 1	4·5	14·8	41	11·0	2·9	2·3	0·28	
	A_2	1 – 4	5·0	11·7	71	5·5	5·5	2·6	0·15	
	B_{21}	6 –12	5·1	16·3	72	4·0	8·5	3·2	0·19	
	B_{22}	12–18	5·0	24·2	82	5·0	15·8	3·7	0·27	
	C	22+	5·5	24·0	86	2·5	15·7	4·8	0·16	
Kersley sandy loam (G.W.)	A_2	0 – 2	7·0	9·9	89	1·2	6·7	1·6	0·50	
	B_{21}	3 –10	7·0	8·7	73	1·2	4·4	1·8	0·17	
	B_{22}	10–16	7·0	12·8	89	1·2	8·7	2·6	—	
	C	18+	8·6		100	0·0	—	4·3	0·08	
Telkwa clay (D.B.)	A_1	0 – 3	6·7	34·8	91	1·9	30·0	3·4	—	
	A_2	3 – 6	6·1	25·0	89	3·9	18·2	3·1	0·94	
	B_{21}	6 –12	5·7	27·2	79	3·9	17·3	3·9	0·31	
	B_{22}	12–15	5·1	38·2	67	4·7	20·4	4·8	0·42	
Nulki silty clay loam (D.B.)	A_{11}	0 – 3	5·6	40·2	85	4·9	22·5	11·6	—	—
	A_{12}	3 – 6	6·2	27·5	82	3·5	13·2	9·0	—	—
	A_2	6 – 9	6·2	17·0	94	1·4	7·1	8·8	—	—
	B_{21}	9 –14	6·7	25·0	100	0·0	8·5	15·9	—	—
	B_{22}	14–20	8·3	23·2	100	0·0	10·3	16·3	—	—
	C	36+	8·9	20·5	100	0·0	14·3	16·6	—	—
Cuisson clay loam solonetz (D.B.)	A_1	0 – 1	6·8	12·1	55	2·7	2·3	2·8	—	1·6
	A_2	1 – 6	6·0	...	100	0·0	2·8	4·1	—	10·9
	B_{21}	6 –12	6·3	27·0	100	0·0	7·4	9·6	—	12·9
	B_{22}	12–18	7·1	28·0	100	0·0	6·2	7·9	—	15·6
Cuisson clay loam (D.B.)	A_1	0 – 3	9·5	27·2	57	6·8	6·8	7·7	—	1·0
Australian loam (G.W.)	A_2	0 – 2	6·1	13·1	56	4·7	4·9	1·6	0·85	—
	B_{21}	2 – 8	5·4	25·8	70	3·2	12·1	5·2	0·51	—
	B_{22}	8 –16	5·3	34·1	75	4·7	17·0	8·1	0·48	—
	C	25+	8·5	27·1	75	3·2	13·5	6·7	0·18	—

Minor Elements

The occurrence and distribution of minor elements in the soils of British Columbia are being given increasing attention because of the frequency with which minor-element deficiencies are being reported. Consequently a large number of samples representing parent materials and surface soils of the Degraded Black, Grey Wooded and Brown Podzolic soils were selected and studied in the belief that the data might contribute much to the solution of some soil fertility problems.

Boron

The data covering total and available boron as presented in Table 12 indicate that the Degraded Black soils, with an average of 0·87 p.p.m. in the cultivated soils and approximately double that in the virgin ones, are reasonably well supplied with available boron. This conclusion is based on the assumption that where the available supply falls below 0·5 p.p.m., plant deficiency symptoms are likely to occur (8). This favorable situation, however, does not apply to the Grey Wooded and Brown Podzolic soils. The average in the cultivated Grey Wooded soils observed is only 0·42 and in some samples as low as 0·1 p.p.m., while that for the few samples belonging to the Brown Podzolic soils is significantly lower. The relatively high available boron content in the parent material of the Grey Wooded soils may in part compensate for the deficiency of available boron in the surface soils. Thus it would appear that soon, if not already, Brown Podzolic soils and some Grey Wooded soils will be requiring applications of boron.

Table 12—Boron Content in Degraded Black, Grey Wooded and Brown Podzolic Soils (8)

—	Parent Material		Virgin		Cultivated	
	Total p.p.m.	Avail. p.p.m.	Total p.p.m.	Avail. p.p.m.	Total p.p.m.	Avail. p.p.m.
Degraded Black	23·0	0·6	22·2	1·61	—	0·87
Grey Wooded	20·8	1·07	16·6	1·23	12·0	0·42
Brown Podzolic	32·7	0·18	—	—	19·8	0·33

The total boron content of a soil is of lesser agricultural significance than the available boron in view of the fact that a large proportion occurs in forms extremely resistant to weathering. However, the numerous determinations for total boron have proved to be extremely valuable in further characterizing soils and parent materials.

Copper

The amount of copper in soils depends to a large extent on parent material and on the soil-forming processes involved. In the United States (11), 20 to 40 p.p.m. seem to be the usual upper limits for soils. While data relative to minimum levels are lacking, it appears from a study of Table 13 that, at least for certain crops, these amounts are satisfactory.

Table 13—Copper Content of Some Soils in the Interior of British Columbia (7)

Soil Type	Horizon	Total Copper p.p.m.
Nulki silty clay loam	A	35
	C	47
Vanderhoof silty clay loam	A	27
	C	37
Mapes loamy sand	A	12
	C	14

Manganese

The soils formed on the Nechako plain are relatively high not only in total manganese but also in the available and easily reducible forms. It is generally believed that the available forms are immediately usable by plants and that the reducible forms may be taken directly by plants through the agency of plant root excretion. Assuming 5 p.p.m. available manganese as the minimum requirement, the levels as presented in Table 14 appear highly satisfactory and should provide for the optimum needs of the plant.

Table 14—Manganese Content of Uncultivated Soils (3)

Soil		Total p.p.m.	Available p.p.m.	Reducible p.p.m.	pH
GREY WOODED					
Vanderhoof silty clay loam	A	1584·0	26·6	156·6	6·7
	C	1380·0	21·6	128·0	7·6
Pineview clay	A	186·0	21·6	72·0	4·7
	C	2368·0	39·2	277·0	7·5
Bednesti silt loam	A	—	—	—	—
	C	1940·0	31·2	386·0	6·8
Fort St. James clay	A	4936·0	324·0	876·0	—
	C	1856·0	162·0	864·0	—
Mapes loamy sand	A	2334·0	236·6	788·0	5·2
	C	1550·0	55·0	357·2	6·5
DEGRADED BLACK					
Nulki silty clay loam	A	700·0	44·0	212·0	5·6
	C	1260·0	12·6	516·0	8·9
Driftwood loam	A	—	—	—	—
	C	1100·0	88·0	458·0	7·2

Unfortunately, analyses are lacking for the Brown Podzolic and Podzol soils of the intermountain valleys. However, significant increases have been reported with the Cuthbert raspberry upon adding manganese to a Brown Podzolic soil on the lower mainland, and records from Vancouver Island indicate that increases in milk production have likewise resulted from the incorporation of manganese in the animal ration. These isolated cases suggest that the manganese content of similar soils, such as those at Terrace, requires investigation.

COBALT

While no determinations of cobalt were made it is strongly suspected that cobalt may be deficient in a number of areas throughout the region under review. In the vicinity of Grassy Plains and Francois Lake sheep ailments have apparently been remedied by cobalt salt treatment and as a result of further investigations* the Livestock Branch at Victoria have zoned a number of so called cobalt-deficient areas.

* Gunn, W. R. Personal Communication.

APPENDIX

Approximate acreage of different soils

Soil Name	Topographical Class: 1: level to undulating	2 & 3: gently rolling and rolling	4: steeply sloping and hilly	Total Acreage
Nulki silty clay	6,100			6,100
Telkwa clay	11,000	3,100		14,100
Cuisson clay loam	3,500			3,500
Pineview clay	91,000	36,000	2,000	129,000
Vanderhoof silty clay loam	160,700	113,100	3,600	277,400
Fort St. James clay	106,700			106,700
Narcosli clay	6,700	2,000		8,700
Doughty clay	6,900	200		7,100
Pinchi clay	4,000			4,000
Bednesti silt loam	37,200	4,000		41,200
Prairiedale silt loam	5,500			5,500
Prairiedale silty clay loam	5,900			5,900
Mapes loamy sand		7,900		7,900
Mapes sandy loam		500		500
Eena loamy sand			19,200	19,200
Eena sandy loam	7,300	700	6,300	14,300
Saxton sandy loam	800			800
Saxton loamy sand	500			500
Giscome gravelly loamy sand	4,600			4,600
Braeside loamy sand	41,600			41,600
Braeside sandy loam	7,300			7,300
Kersley sandy loam	14,600			14,600
Kersley loamy sand	5,200			5,200
Fraser silt loam	15,800			15,800
Nechako silt loam	26,800			26,800
Australian fine sandy loam	5,600			5,600
Australian silt loam	3,600			3,600
Australian clay loam	3,400			3,400
Barrett sandy loam		134,300	156,100	290,400
Chilako sandy loam		791,000		791,000
Driftwood loam and sandy loam		106,800	48,700	155,500
Gunniza gravelly sandy loam			1,500	1,500
Kitsumgallum gravelly sandy loam	8,500		2,600	11,100
Layton gravel	4,200			4,200
Skeena sandy loam	7,300			7,300
Moricetown sandy loam	24,600			24,600
Moricetown gravelly sandy loam	3,900			3,900
Kispiox sandy loam	2,200			2,200
Lakelse clay	6,000	7,000		13,000
Thornhill clay loam	3,200			3,200
McCully loam	2,700			2,700
Remo clay loam	3,200			3,200
Alluvial clay loam	1,000			1,000
Alluvial silt loam and loam	1,800			1,800
Alluvial loam and sandy loam	26,600			26,600
Alluvial sand, gravel, etc	24,400			24,400
Peat and Meadow	55,300			55,300
Barrett-Driftwood		20,600	5,600	26,200
Vanderhoof-Prairiedale	1,500			1,500
Vanderhoof-Chilako		3,300	22,800	26,100
Doughty-Barrett		2,100		2,100
Pineview-Chilako		2,800		2,800
Kersley-Australian	1,900			1,900
Telkwa-Driftwood	1,200	3,900	2,100	7,200
Cuisson-Chilako Complex		2,300		2,300
Eroded Lands			102,000	102,000
Rough mountainous lands, rock outcrops, etc.			200,000	200,000
Water				539,400
Total	761,800	1,243,900	572,500	3,115,300

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GLOSSARY

Acid Soil—A soil, containing more hydrogen than hydroxyl ions. Precisely, a soil with a pH of less than 7·0, but for practical purposes a soil with a pH of less than 6·6 usually refers to the surface soil.

Aeration (soil)—The process by which air and other gases in the soil are renewed. The rate of soil aeration depends largely on the size and number of soil pores and on the amount of water held by the pores. A soil with many large pores permits rapid air-water exchange and is said to be well aerated. A poorly aerated soil generally has few large pores.

Aggregate (soil)—A single mass or cluster of soil consisting of many soil particles held together, such as a prism, granule, or crumb, etc.

Alkaline Soil—A non-acid soil or one containing more hydroxyl ions than hydrogen ions. Precisely, a soil having a pH above 7·0, but for practical purposes a soil with a pH greater than 7·3.

Alluvial Fan—A fan-shaped deposit of sand, gravel and fine material dropped by a stream where its gradient lessens abruptly.

Alluvium—Water-transported sediments, usually fine materials, on which the soil-forming processes have not acted long enough to produce distinct soil horizons.

Alpine Meadow or Mountain Meadow—Dark colored soils occurring above timber line and associated with an open or sparsely timbered vegetative cover. They occupy moist places usually free of permafrost. Common in the Coast Range and Rocky Mountains.

Available water-holding capacity—The available water-holding capacity in inches of water per depth of soil is equal to the difference between the percentage of water at field capacity and the percentage of water at wilting point, times the volume weight, divided by one hundred.

Available plant nutrients—Plant nutrients readily available to plant roots.

Base exchange capacity—A measure of the absorptive capacity of the soil for cations (hydrogen plus bases) or the amount of cations which can be absorbed by a given amount of soil, expressed in terms of millieouivalents per 100 grams of soil. Generally speaking, a soil with a fairly high cation exchange capacity is preferred to one with a low exchange capacity because it will retain more plant nutrients and be less subject to leaching or exhaustion.

Calcareous material—Material containing calcium carbonate. Will effervesce visibly when treated with hydrochloric acid.

Cleavage—The capacity of a soil on shrinkage to separate along certain planes more readily than others.

Colluvial material—Heterogeneous deposits of rock fragments and soil material accumulated at the base of comparatively steep slopes through the influence of gravity, including creep and local wash.

Concretions—Local concentrations of certain chemical compounds such as calcium carbonate or compounds of iron, that form hard grains or nodules of mixed composition and of various sizes, shapes and coloring.

Consistence (soil)—The relative mutual attraction of the particles in the whole soil mass, or their resistance to separation or deformation. Consistence is described by such general terms as loose or open; slightly, moderately or very compact; mellow; friable; crumbly; plastic; sticky; soft; firm; hard and cemented.

Degradation—Change from one soil type to a more leached one.

Drift—Material of any sort moved from one position and deposited elsewhere. The term is most commonly used when referring to glacial drift, or material deposited after having been moved by glacial action. *Glacial drift* includes unstratified glacial deposits, or till, and stratified glacial outwash materials.

Drumlin—An oval hill of glacial drift, normally compact and unstratified, usually with its longer axis parallel to the movement of the ice responsible for its deposition.

Dune—A mound or ridge of loose sand piled up by the wind.

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

(a) Sheet—removal of a more or less uniform layer of material from the land surface.

(b) Rill—a type of accelerated erosion that produces small channels which can be obliterated by tillage.

(c) Gully—erosion produced channels which are larger and deeper than rills and cannot be obliterated by tillage. Ordinarily, these channels carry water only during and immediately after rains, or following the melting of snow.

Esker—A long ridge deposited by a glacial stream in an ice tunnel and composed chiefly of stratified drift.

Evapotranspiration—Combined loss of water from soils by evaporation and plant transpiration.

Fertility (of soil)—The quality that enables a soil to provide nutrients for the growth of specified plants, when other factors, such as light, temperature, and the physical condition of the soil are favorable.

Field Capacity—The moisture content of a soil, expressed as the percentage oven-dry weight after the gravitational or free water has been allowed to drain, usually for two to three days. It is the field moisture content two or three days after a soaking rain.

Flood plain—The nearly flat surface subject to overflow along stream courses.

Friable—Easily crushed in the fingers; non-plastic.

Gley—A soil in which the material has been modified by saturation with water for long periods in the presence of organic matter.

Green manure crop—Any crop, grown and plowed under for the purpose of improving the soil, through incorporation of organic matter.

Horizon—A layer in the soil profile approximately parallel to the land surface with more or less well-defined characteristics that have been produced through the operation of soil-building processes.

Humus—The well-decomposed, more or less stable portion of the organic matter of the soil.

Impervious Materials—Materials resistant to penetration by water, air, and roots.

Infiltration—The downward entry of water into soil or other material, as contrasted with percolation.

Kettle—A closed depression created by the melting of buried or partly buried blocks of ice after sedimentation has ceased.

Lacustrine deposit—Materials deposited by or settled out of lake waters and exposed by lowering of the water levels or elevation of land.

Leaching—The removal of soluble constituents from the soil by percolating waters.

Lime—Strictly, calcium oxide (CaO), but as commonly used in agricultural terminology, calcium carbonate ($CaCO_3$) and calcium hydroxide ($Ca(OH)_2$) are included. Used as an amendment for acid soils.

Lithosol—A soil having no clearly expressed profile characteristics and consisting of an imperfectly weathered mass of rock fragments.

Mature soil—A soil with well developed characteristics produced by the processes of soil formation. and in equilibrium with its environment.

Mottled—Irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Muck—Fairly well decomposed organic soil material, relatively high in mineral content, dark in color, and accumulated under conditions of imperfect drainage.

Nutrients (Plant)—The elements taken in by the plant, essential to its growth, and used by it in the elaboration of its food and tissue. These include nitrogen, phosphorus, calcium, magnesium, potassium, iron, copper, manganese, boron, zinc and others obtained from the soil; and carbon, hydrogen, and oxygen, obtained largely from air and water.

Organic soil—A general term used in reference to any soil the solid part of which is predominantly organic matter.

Ortstein—Hard, irregularly cemented, dark yellow to nearly black sandy material formed by soil-forming processes in the lower part of the solum.

Parent material—The unconsolidated mass from which the soil profile develops.

Peat—Unconsolidated soil material consisting largely of undecomposed or slightly decomposed organic matter accumulated under conditions of excessive moisture.

Permeability—The quality or state of a soil or any horizon in the soil profile that enables it to transmit water or air to all parts of the mass.

Percolation—The downward movement of water through the soil, especially the downward flow of water in saturated or nearly saturated soil. Contrast with infiltration.

pH—A numerical measure of the acidity, or hydrogen ion activity of a soil or other materials. All pH values below 7·0 are acid and all above 7·0 are alkaline. A change in one unit in pH value represents a tenfold change in hydrogen ion concentration. (pH represents intensity of acidity, not total exchangeable hydrogen, or quantity of potential acidity).

Plastic—Capable of being molded or modeled without rupture; not friable.

Podzolization—A general term referring to that process by which soils are depleted of bases, become acid and develop leached A horizons and illuvial B horizons. Specifically it refers to the process by which a Podzol is developed and in which the iron and alumina are removed from the upper part of the profile more rapidly than is silica.

Porosity—The degree to which the soil mass is permeated with pores or cavities. It is expressed as the percentage of the whole volume of the soil which is occupied by solid particles. The total porosity includes both capillary and noncapillary porosity. The *capillary porosity* refers to the small pores that hold water by capillarity, while the *noncapillary porosity* refers to the larger pores that will not hold water by capillarity. A soil with low noncapillary porosity may be called a "non-porous" or "dense" soil, while a soil with high noncapillary porosity may be called "porous" or "open".

Profile—A vertical section of the soil through all its horizons and extending into the parent material.

Puddle (soil)—Handling a soil when it is in a wet, plastic condition, so that when dried, it assumes a hard, compact, massive structure.

Relief—The elevations or inequalities of a land surface when considered collectively.

Solonetzic soil—Soil developed on somewhat saline parent materials and characterized by a compact B horizon.

Solum—The upper part of the soil profile, above the parent material, in which the processes of soil formation are taking place. It includes the A and B horizons.

Stratified—Composed of, or arranged in, strata or layers, as stratified alluvium. Those layers in soils that are produced by the processes of soil formation are called horizons, while those inherited from the parent materials are called strata.

Structure—The morphological aggregates in which the individual soil particles are arranged. The following structures are recognized in this report:

Platy—Thin horizontal plates, as in the A_2 horizons of Podzol and Grey Wooded soils.

Prismatic—Large aggregates with a vertical axis longer than the horizontal and with fairly well defined edges and surfaces. Usually the tops of these aggregates are flat.

Columnar—Prismatic with rounded edges. Usually the tops of these aggregates are rounded.

Blocky—Block-like aggregates with vertical and horizontal axis of approximately the same length. Usually with sharp edges.

Nuciform or Nut-like—Block-like aggregates with mixed rounded and flattened faces, with many rounded vertices.

Granular—More or less rounded soil aggregates with an absence of smooth faces and edges. Very porous aggregates are frequently referred to as having a *crumb* structure.

Shot or shot-like—Angular, spheroidal, persistent aggregates or concretions that develop around local nuclei and appear to be mainly ordinary soil particles cemented together with iron and aluminum compounds. Common in the forested soils of the Pacific northwest.

Massive—Large cohesive masses, almost amorphous or structureless, with irregular cleavage faces.

Talus—Fragments of rock and soil material collected at the foot of cliffs of steep slopes, chiefly as a result of gravitational forces.

Terrace (geological)—A flat or undulating plain, commonly rather narrow and usually with a steep front, bordering a river, a lake, or the sea. Many streams in the area are bordered by a series of terraces at different levels indicating flood at successive periods.

Texture—The relative proportion of the various size groups of individual soil grains. Clays are said to be fine or heavy textured, loams are medium textured, and sandy or gravelly soils are coarse or light textured. In the laboratory, texture is determined by particle size distribution analysis; in the field, by the feel when a moist soil is rubbed between the thumb and fingers. Size groups larger than ·05 mm in diameter are called *sands*, those from ·05 to ·002 are called *silt*, and those less than ·002 mm in diameter are called *clay*. In the soil classes most commonly referred to in this report, the relative proportions of these soil separates are as follows:

sand: contains over 90 per cent sand-sized soil grains.

loamy sand: contains from 80 to 90 per cent sand-sized soil grains.

sandy loam: contains from 50 to 80 per cent sand and not more than 25 per cent clay-sized soil grains.

loam: contains not more than 50 per cent sand, not more than 50 per cent silt, and less than 25 per cent clay-sized soil grains.

silt loam: contains 50 per cent or more silt-sized soil grains.

clay loam: contains from 25 to 40 per cent clay-sized grains.

silty clay loam: contains 25 to 40 per cent clay and less than 20 per cent sand-sized soil grains.

clay: contains 40 per cent or more clay-sized grains.

Qualifying terms such as "gravelly" and "stony" are incorporated into the soil textural designations of horizons when the soil mass contains 15 to 20 per cent, by volume, of the coarse fragments.

Till—A heterogeneous mixture of stones, sand, silt and clay transported by glaciers and deposited during the melting of the ice.

Till plain—A level or undulating land surface covered by glacial till.

Water table—The upper limit of that part of the soil or underlying material wholly saturated with water.

Weathering—The physical and chemical disintegration and decomposition of rocks and minerals.

Zonal soil—Any one of the Great Soil Groups having well-developed soil characteristics that reflect the influence of climate and living organisms, chiefly vegetation. In the areas under review these groups include Thin Black, Degraded Black, Grey Wooded, Podzolized Grey Wooded, Brown Podzolic and Podzol soils.

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