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DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

SOIL SURVEY OF THE LOWER FRASER VALLEY

By

C. C. KELLEY

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R. H. SPILSBURY

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BRITISH COLUMBIA DEPARTMENT OF AGRICULTURE
CO-OPERATING WITH EXPERIMENTAL FARMS
SERVICE, DOMINION DEPARTMENT
OF AGRICULTURE

Published by authority of the Hon. JAMES G. GARDINER, Minister of Agriculture,
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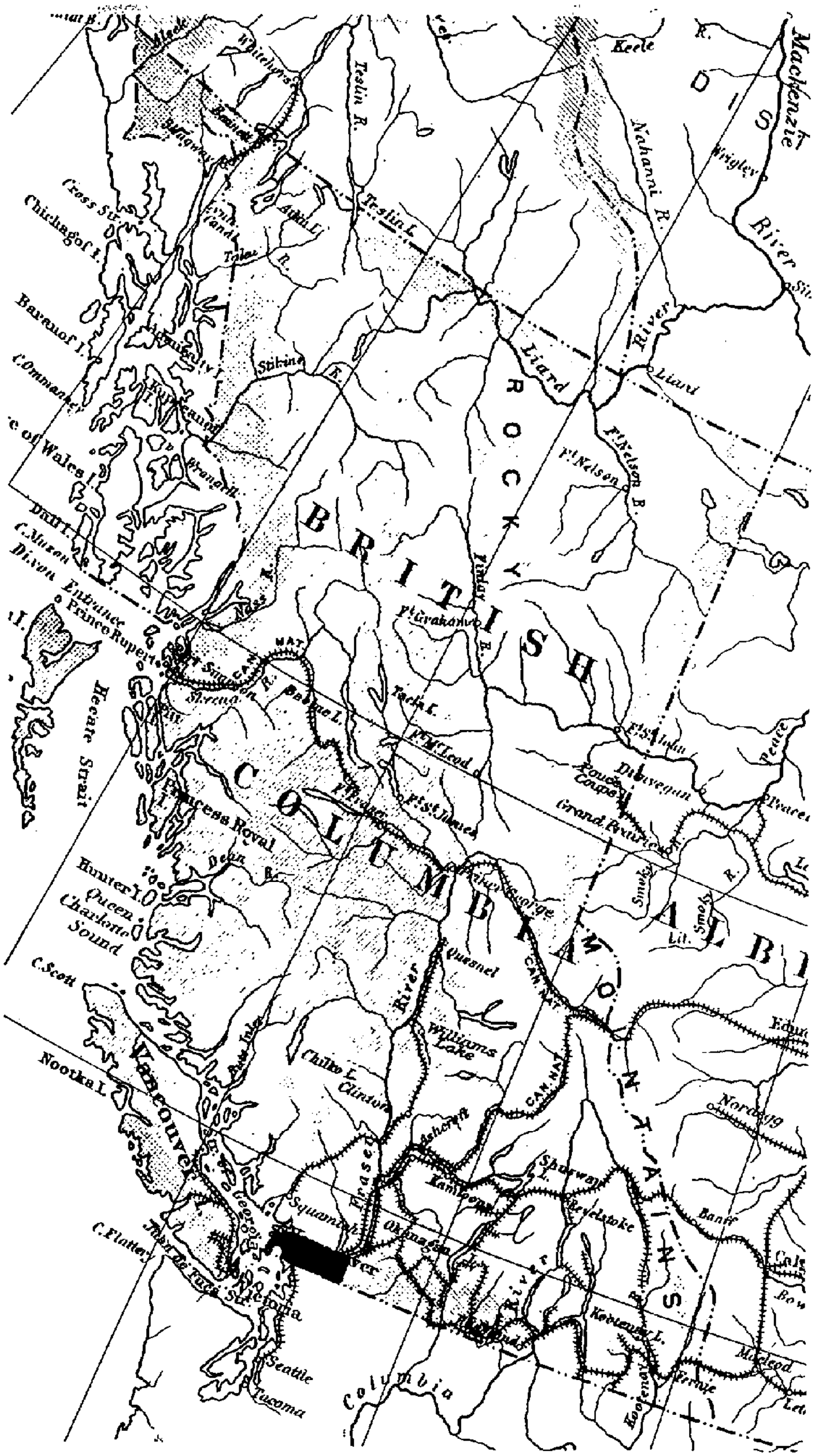

Map of British Columbia showing the location of the surveyed area.

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INTRODUCTION

The British Columbia Soil Survey is conducted by the Department of Agriculture, Victoria, B.C., with the co-operation of the Experimental Farms Service, Dominion Department of Agriculture, Ottawa. Soil survey work in British Columbia had its beginning in 1931, following recommendations made by the Royal Commission investigating the fruit industry, 1930.

This report, the first to be published, is intended to be a brief description of the area surveyed. Climatic, economic and other data bearing on the nature and capabilities of the soils were assembled and used to assist with the interpretation of the soils occurring in the area.

Every soil type is briefly described. The first part of each description is designed to show the characteristics of a given soil and how it differs from every other kind of soil in the region. The second part describes the relationship of the soil to the growth of crops. Primarily this description serves as a basis for classifying local experience and experiments regarding the uses of the different soils, in order that this information may be applied to the individual farm. In a general way the whole description directs land utilization by grouping the soils according to texture, topography, effect of climate and natural drainage conditions. The modification of these findings into practical use, particularly with respect to lands subject to the midsummer drought, is left to the several governing bodies involved.

The soil map is published in two sheets covering the eastern and western sections of the lower Fraser valley. These maps show the location and extent of the different soil types, their average surface textures and the elevations at which they are found. The soils located on the maps are differentiated by symbols and colours which are explained in the legend.

The soil map should not be used in the purchase or evaluation of farm land without personal inspection. While the survey indicates the extent and general character of each soil type, it is not sufficiently detailed to show variations on individual farms. The description of soil series, however, should be used for comparative purposes when appraising separate parcels of agricultural land.

To those who contemplate the purchase of farm land the warning is issued that certain types of soil are suitable only for specialized use. The qualities of each type should be carefully studied when land is being located, especially by land seekers who are not familiar with the region.

The soil survey shows that the Fraser delta region may be divided into three main sections based on soils, elevation and present agricultural development.

The first of these sections is the Recent Delta in which the Monroe and Ladner series and large areas of peat bog are located. The elevation of this division ranges up to 25 feet above sea level. It is dyked against the river and the sea and is the most highly developed and productive section.

The second division is the Raised Delta, which ranges from 25 to 150 feet above sea level. The Raised Delta has the same origin and approximately the same composition as the Recent Delta but is of greater age, having been deposited when the land was 50 to 150 feet lower than it is at present. This area has been separated into the Langley, Milner, Haney and Custer series and is second in agricultural development to the Recent Delta soils.

The third section is the Upland, which is referable to the last glaciation. The topography and the general composition of the soils are essentially different from the groups described above. The topography ranges in elevation up to about 900 feet. For the most part the forest cover is heavy and settlement is scattered. Only a small part of the land is cultivated.

The agriculture of the surveyed area is intimately related to the nature of the soils. This report together with the accompanying soil maps may be considered as a handbook of the agricultural geography of the area.

GENERAL DESCRIPTION OF THE AREA

Location and Extent

The area included in this soil survey comprises the delta of the Fraser river in Canada. The delta begins a few miles east of Agassiz and extends westward for about 75 miles to the strait of Georgia. It is bounded on the north by the Coast range and on the east by the Cascades. The southern limit of the delta is in the state of Washington but the map-sheet extends only to the 49th parallel, where it connects with the soil surveys of northern Washington. The area, which is divided throughout its length by the Fraser river, is one of the largest blocks of arable land in British Columbia, covering approximately 545,000 acres.

Topography

The topography of the delta is low, with elevations ranging from sea level to about 400 feet. In the eastern part, near Chilliwack and Agassiz, there are a few rocky hills, partly covered by soil material, varying in height up to 1,000 feet or more above the sea.

The uplands on the south side of the Fraser are composed of glacial deposits, dissected by subsequent river channels. They have rolling to fairly level upper surfaces lying up to 400 feet or more above sea level. On the north side of the Fraser there are several upland areas composed in part of glacial deposits and also partly formed by bedrock outcroppings or ridges covered with a thin coating of glacial materials.

The lowland or Recent Delta region represented by the Chilliwack, Sumas, Matsqui Prairie, Pitt Meadows and Lulu Island areas, is low and flat. The lowland is dyked against the river and the sea and the elevation is not more than about 25 feet above sea level.

The Fraser River

The Fraser is the largest river in British Columbia, whose basin is entirely within the province. It has a length, from its source in the Yellowhead pass, of 790 miles, and drains an area of 91,700 square miles.[7]

The mean monthly discharge of the river at Hope (about 100 miles from the mouth) for June, the highest month, 1911-30, was 248,000 cubic feet per second, and for March, the lowest month, 24,200 c.f.s. When unusual weather conditions prevail the maximum discharge may be much higher, with consequent danger of flood in the dyked areas of the valley. Below Hope, a number of tributaries contribute a maximum of about 56,000 c.f.s. and a minimum of about 8,500 c.f.s. to the river flow.[21]

THE DANGER OF FLOODS

The months of maximum flow or freshet are May, June and July. The freshet begins in May with a mean monthly discharge of about 162,000 c.f.s. at Hope. This rises in June to about 248,000 c.f.s. and falls in July to about 209,000 c.f.s. The greatest discharge on record was in June, 1921, when it amounted to 392,000 c.f.s., but there was a still greater freshet in 1894, which stands as the record for high water in the lowland district.

The 1894 high water reached a stage of 25 feet 9 inches on the bridge pier at Mission, with an estimate at Hope of nearly 500,000 c.f.s. Very little dyking had been done, and the lowland area was flooded. Now, however, the river is confined to its main channel and there is no relief between Hope and the sea to take care of excessive discharge.

The record of highest water at Mission Bridge is as follows:—

1876	June	29—22	feet	9	inches.
1882	"	14—23	"	10	"
1894	"	5—25	"	9	"
1903	"	18—22	"	6	"
1936	"	5—22	"	7⅓	"

The 1936 discharge amounted to 376,000 c.f.s. on June 5 at Hope, and the water rose to 22 feet 7⅓ inches at Mission. Some areas were flooded and others were threatened. The 1936 high water serves a warning that the dyking systems are not adequate to cope with a freshet comparable to that of 1894.

Variations in the height of the freshet from year to year are dependent on climatic conditions in the interior of the province, where the flood waters come from melting snow. The great freshets occur in those years in which hot weather comes early in a season preceded by heavy snowfall.[12] It is also probable that there is sufficient snowfall in the Fraser river drainage basin each winter to provide enough water for flood stages in the lower Fraser valley, if climatic conditions during the spring run-off are favourable.[24]

Removal of the danger lies in building up the dykes in the lowlands to take care of the greatest freshet the river can be expected to discharge, and the continous removal of alluvial silts at the mouth of the river by dredging.

Drainage of the Map-Area

The map-area, in the northern and eastern sections, is drained by rivers and creeks tributary to the Fraser. West of Langley Prairie the uplands which lie between the International Boundary, on the south, and the Fraser at New Westminster, on the north, are drained by the Nicomekl and Serpentine rivers, which empty into Mud bay.

Local drainage conditions vary greatly throughout the area. Some of the upland soil types have open, porous substrata, and these are excessively drained. Others are underlaid by impervious material which makes underdrainage necessary under some of the topographic conditions.

Previous to the time of dyking, poor drainage in the lowland region had a pronounced effect on the type of native vegetation. In contrast to the luxuriant growth of coniferous forest which at one time covered the uplands, the lowland vegetation consisted of cottonwoods, "prairies" covered with grass vegetation (from which several farming districts get their names) and extensive bogs of sphagnum peat. Since the establishment of dyking works, the lowland requires a system of canals and pumping units of sufficient capacity to cope with precipitation and high water. Inadequate drainage, by reason of inefficient canals, pumping units or incapacity to pay for power, is an important problem in some of the dyked areas.

The Climate of the Lower Fraser Valley

The climate of the lower Fraser valley is dependent on several factors, most important of which are the mountains on the north and east, and the modifying influence of the Pacific ocean. There are, in addition, climatic variations occurring within the area which are also of sufficient importance to be mentioned.

On the mountain side the temperature is decreased with altitude at an average rate of 1° F., for each 330 feet, except where special conditions vary this relationship. The moisture-holding capacity of the atmosphere is greatly reduced with decrease in temperature. Thus at 80° F., the saturation point is reached when the atmosphere contains 10·93 grains of water vapor per cubic foot. At 40° F., it falls to 2·85 grains and at zero to 0·48 grains per cubic foot.[2] The greatest amount of water is contained in the warmer air at sea level.

In winter the moisture-laden winds from off shore, turned upward by the Cascades and Coast mountains, are cooled by increase in elevation and they discharge a considerable part of their water as higher levels are reached. The offshore source of winter cloudbanks is from the north, but in summer the prevailing drift of wind at cloud levels is from the southwest Pacific ocean and these winds are moderately dry and cool.

While the direction of the wind at the cloud level varies from north to southwest in winter and summer, the prevailing drift of surface wind throughout the year is from the east. This is probably due to a downward movement of air through the canyon of the Fraser river, which brings variations in ground temperatures that are not always related to the conditions at cloud levels, particularly in the eastern part of the valley.

In the lower Fraser valley the pattern of precipitation follows closely the arrangement of the mountain systems. Great contrasts in relief produce great contrasts in the amounts of precipitation within short distances. Stave Falls, at the foot of the Coast range, has an annual precipitation of 79·42 inches, whereas Steveston on low-lying Lulu island, about 15 miles south of the Coast mountains, has an annual precipitation of 36·55 inches, or less than half as much. Similar contrasts are to be found in other parts of the valley region.

TEMPERATURE

In the lower Fraser valley comparatively uniform temperatures, characteristic of a marine climate, are maintained throughout the year. The mean annual temperature at different stations shows a variation of only two degrees in different parts of the valley. The difference between the average temperature of the coldest month and the warmest month is small, with a variation of about 27° F., as shown in figure 1. The average for the coldest month, January, is 36° F., and for the warmest month, July, 63° F.

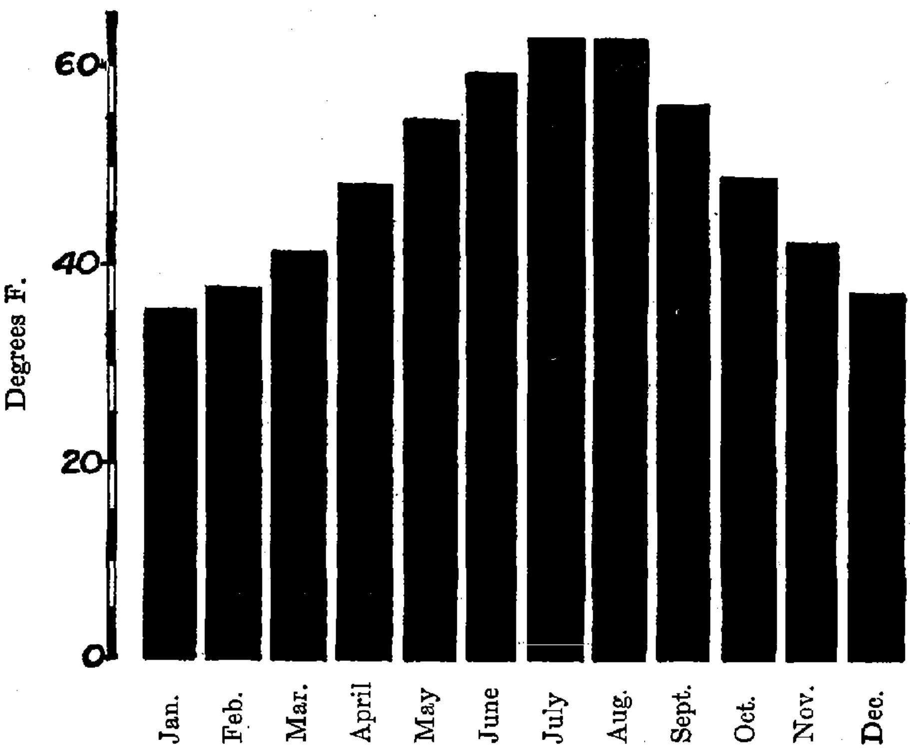

Fig. 1.—Mean Monthly Temperature. Average of lower Fraser valley stations.

The lowest and highest temperatures recorded since 1916 indicate that the greatest extremes are in the eastern part of the valley. A minimum of 3° below zero was recorded at Agassiz in 1924. The maximum temperature for Chilliwack and Agassiz is 97° F., recorded in 1925 and 1927. At Steveston, on the west shore of Lulu island, a minimum temperature of 1·5° F., was recorded in 1916, and a maximum of 86° F., was recorded in 1925. Such extreme temperatures are not common.

SUNSHINE

The amount of sunshine received in winter is considerably less than in summer. At Vancouver during January sunshine averages 49 hours for the month, or a little more than 1½ hours a day. In July, however, the average is 291 hours of sunshine or 9·3 hours per day. The total for the year at this location is 1,847 hours of sunshine, as compared with 1,424 hours at Agassiz, in the shade of the Coast mountains in the eastern part of the valley. Figure 2 shows the distribution of sunshine throughout the year.

With sunshine amounting to 9·3 and 8·6 hours daily in July and August, it is apparent that these two months are comparatively warm and dry. This factor is important in the management of soils with low drought resistance. Early-maturing crops are grown on such lands for harvest during the dry period.

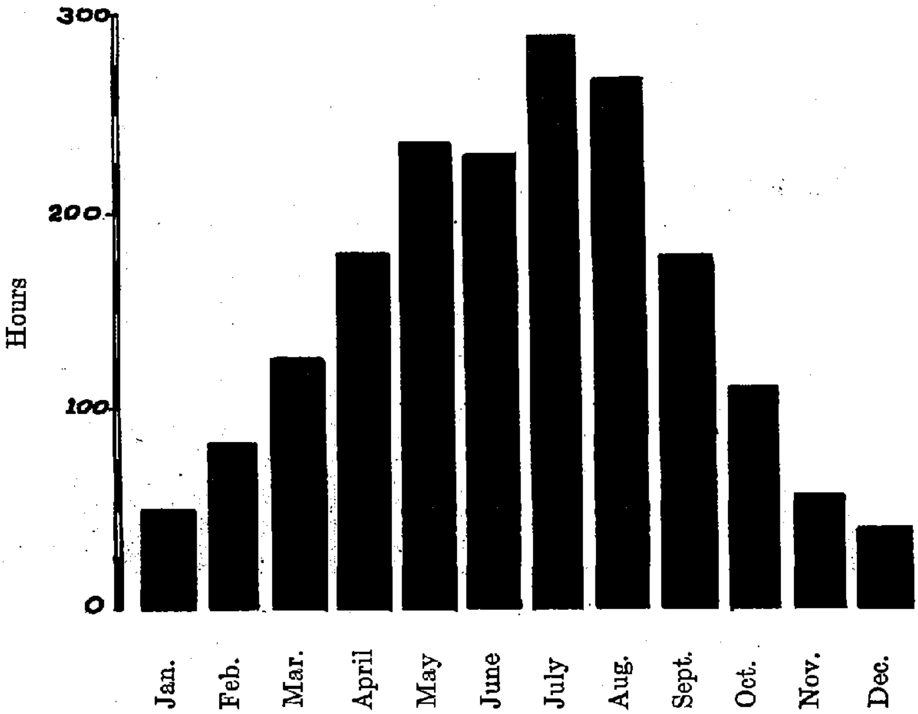

FIG. 2.—Hours of Bright Sunshine, Vancouver.

PRECIPITATION

The characteristic feature of the Pacific coast precipitation is the heavy winter rainfall succeeded by summer dryness. This is shown graphically in figure 3. The rainy season begins in October with about six inches. In November the average rises to eight inches, with slightly more than eight inches in December. In January the rainfall is reduced to about seven inches, followed by five inches in February and five inches in March. About two thirds of the annual precipitation occurs during the six colder months.

The farmer is mostly concerned with rainfall between April and September, the crop growing season. In April and May precipitation amounts to between three and four inches for each month. In June it falls to between two and three inches, while July and August, the dry months, average less than two inches. September is the beginning of the rainy season again with about four inches precipitation.

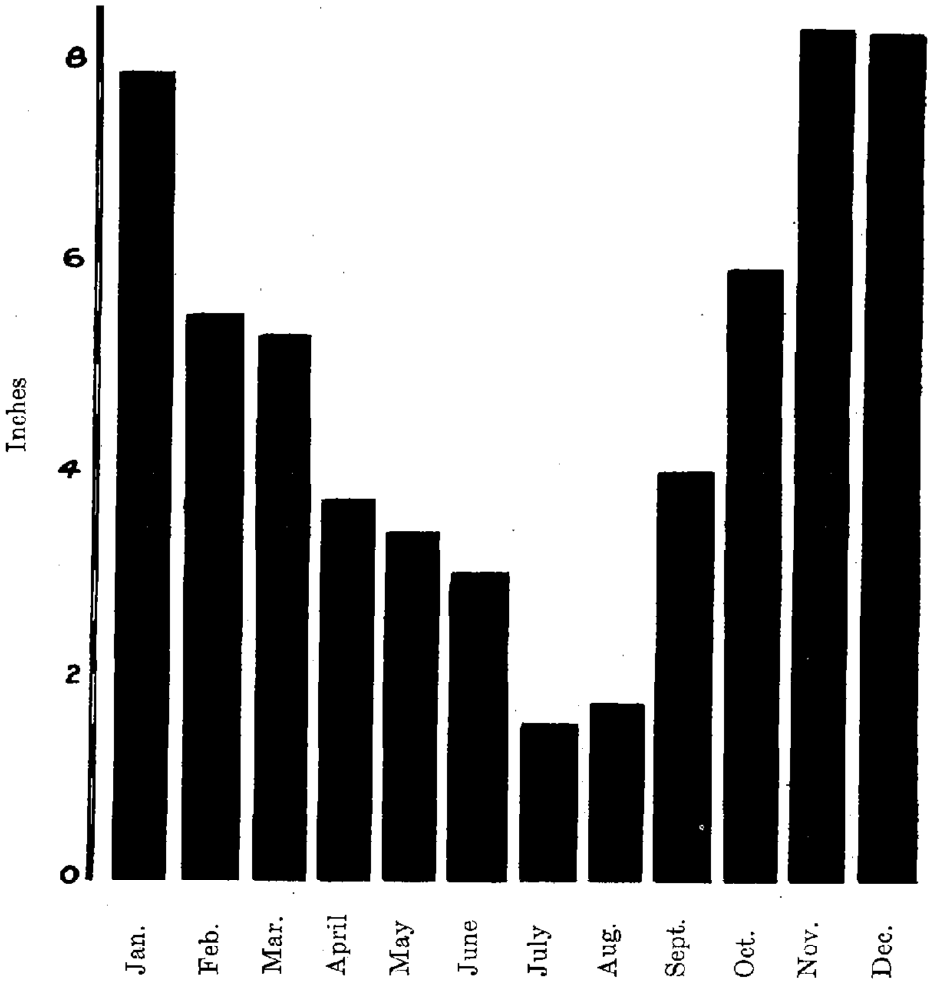

FIG. 3.—Mean Monthly Precipitation. Average of lower Fraser valley stations.

The distribution of rainfall over the lower Fraser valley is not so uniform as this summary would suggest. At Ladner, Steveston and White Rock on the west shore of the delta, annual precipitation ranges between 36 and 40 inches, indicating that precipitation on the south side of the Fraser, away from the mountains, is about one third less than on the north side of the Fraser and at the east end of the valley near the Cascades. Along the Coast range, from Vancouver to Chilliwack, precipitation amounts to from 50 to 70 inches.

Only a small amount of the annual precipitation is in the form of snow. Snowfall is light in the western part of the valley. At Vancouver (Brockton Point Station) the annual average is 10·7 inches; at Steveston 15·0 inches, and at Ladner 16·2 inches. Farther back from the coast the amount increases gradually. At Agassiz the average is 41·8 inches and at Chilliwack 38·4 inches. Snow remains on the ground for only a short time and has little effect on vegetation or climate.

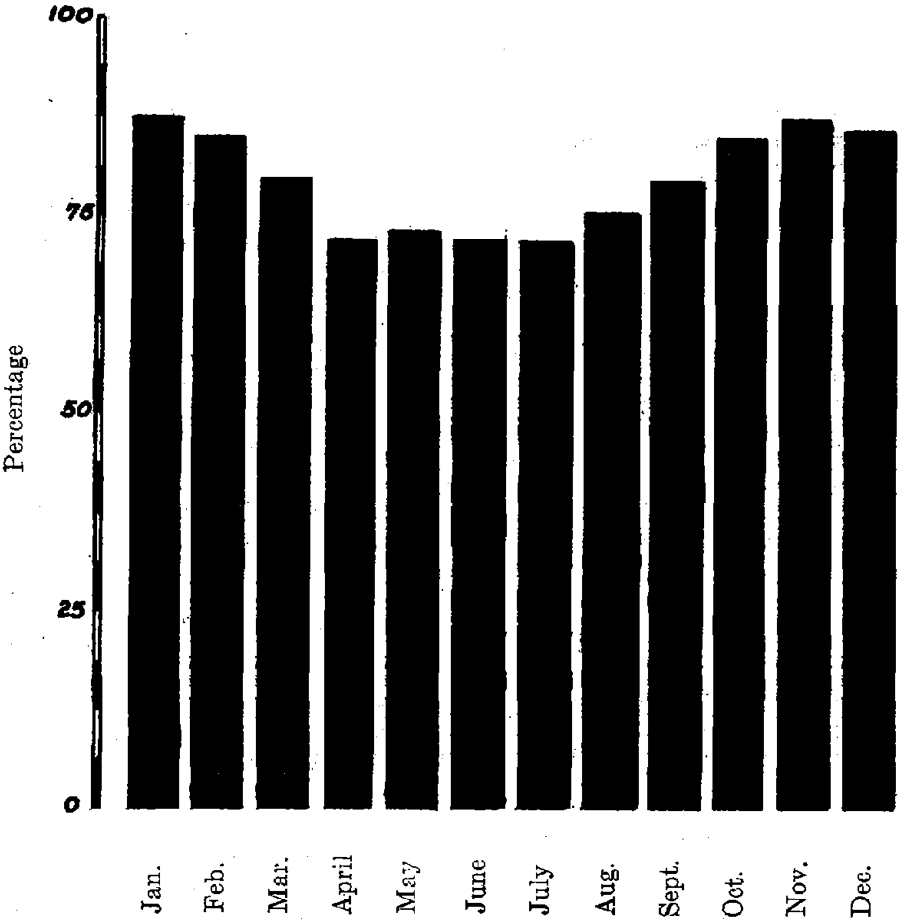

Fig. 4.—Relative Humidity, Vancouver.

RELATIVE HUMIDITY

The lower Fraser valley is noted for dense fogs which occur at intervals between September and March. There are from 20 to 30 days of fog each year. In the evenings or at night when humidity is high and temperature is decreased to the dewpoint, saturation occurs and condensation of the water vapour takes place.

While relative humidity in winter is greater than in summer, it remains high throughout the year with only a small variation, as illustrated in figure 4.

Agricultural History and Development

Fort Langley and Langley Prairie have the distinction of being the site of the first successful farming operation in the lower Fraser valley. While the immediate purpose of the establishment of Fort Langley in 1827 by the Hudson's Bay Company was to carry on the fur trade with the Indians, the possibilities of the black "prairies" or open meadows near the Fort for farming received attention. The report of Work[22] in 1824 states: "The soil here appears to be rich; is a black mould; the remains of a luxurious crop of fern and grass lie on the ground." This soil, defined as the Langley series in this report still retains its black colour.

Production was stimulated by local demand and by difficulties on the Stikine river in 1834 between the Russian authorities and the Hudson's Bay Company. The leasing of the Alaska Panhandle for ten years to the Hudson's Bay Company in 1839, further stimulated production as part of the rental called for quantities of agricultural produce, making the farm an important part of the establishment. This lease was renewed from time to time until 1867, when Alaska was acquired by the United States.

In 1860 a Pre-emption Proclamation was issued by Governor Douglas, which provided for the granting of rights for unsurveyed Crown Lands in parcels not exceeding 160 acres at a purchase price not exceeding 10 shillings per acre.[14] In the same year the first settlement in the Maple Ridge district took place between Pitt and Stave rivers on the north side of the Fraser. The British Columbia Directory of 1882-83 reports a number of settlers making good homes. At that time grains and root crops were produced but the general trend was towards dairying. There were thriving orchards throughout the settlement.

Samuel Brighouse, who purchased land on Lulu island in 1864, made the first systematic attempt at dyking the lowland soils. After this settler showed the possibilities of the lowland soils, settlement proceeded rapidly until by 1882 the population numbered nearly 200 and continuous chains of cultivated farms existed on both banks of the river for some distance above Sea island. At that time the best land with river frontage was valued at about $25 per acre, but the land some distance from the river could be bought at a lower figure.

Settlement of the Chilliwack district began in October, 1862, and by spring the following year about 60 persons had pre-empted land in the Chilliwack and Harrison valleys.[14] The land was described as prairie soil of the best quality, of which there existed not less than 40,000 acres, affording excellent opportunities for farming and grazing.[11] It is apparent that open meadow lands were common in that area.

The great drawback to early settlement in the Chilliwack and Sumas districts was the liability of the land to flooding during the annual freshets of the Fraser. In 1876 the greater part of the Chilliwack district and all of Sumas were submerged. As settlement increased, various dyking schemes were attempted but proved to be more or less unsuccessful. However, the great flood of 1894 finally provided the necessary stimulus and permanent dyking works were undertaken. These were completed in 1903, after which development was rapid.

AGRICULTURE

The type of agriculture followed in the lower Fraser valley to-day is governed largely by the climate, qualities of the different soils, density of vegetative cover, drainage and the requirements of the Vancouver market.

The low flood plains of the Fraser, less than 25 feet above sea level, and described in this report as the Monroe and Ladner series, were first settled because the soils were fine textured and fertile, and the vegetative cover was comparatively light. The cost of dyking these low plains against the Fraser was apparently less than that of clearing the heavy forest cover from the best of the upland soils. To-day these lowlands have the largest farms in the map-area, the largest of which have 400 acres or more under cultivation. When not covered by peat the land is well developed for dairying, mixed farming, grain growing and the intensive production of vegetables for the Vancouver market and for canning.

The extensive peat bogs are slowly coming into use, both for the manufacture of peat products and for the production of vegetables.

The difficulty of clearing the best of the upland soils of old logs and stumps and the heavy second growth has greatly retarded development in these sections of the map-area. The land is held in small parcels ranging from about 10 to 40 acres and only a small percentage is under cultivation. Farming is confined to small clearings and intensive cultivation. The growing of orchard fruits, small fruits and vegetables is now the principal activity in the upland district. The acreage of these crops is slowly increasing. However, under present conditions the high cost of development tends to limit the rate at which new settlement may take place, although there is room for a considerably enlarged population on arable soil types in the upland district.

The reserve productive power of the map-area as a whole is still enormous, when uncleared but potentially arable sections of the uplands are added to the reserves of the lowlands. This factor is of particular importance to the rapidly growing city of Vancouver.

Transportation and Marketing Facilities

Where perishable crops are grown, accessibility to market is most important. Practically the whole map-area is served by a system of municipal and provincial roads and highways. Main lines of the Canadian National Railway, the Canadian Pacific Railway and the British Columbia Electric Railway also serve the area. All parts of the map-area are within a few hours of the Vancouver market.

The larger meat packers maintain abattoirs in Vancouver and New Westminster for the handling of live stock. In addition to the Vancouver market there are adequate facilities for the processing of specialized and surplus crops. Within the valley there are factories for the production of condensed milk, butter and cheese. Fruit and vegetable crops are taken care of by canneries and jam factories. There is also a winery for handling surplus loganberries.

SOILS*

Soil Formation

Soils are the products of the environmental conditions under which they have developed or are developing. These conditions are the mineral parent materials plus topographic, climatic and biological factors. The climatic and biological factors are the normal forces acting in soil development, but under abnormal conditions other factors have a dominant influence. Soils with well developed or normal characteristics that reflect the active forces of soil genesis, climate and vegetation, are classified as *zonal* soils while those with more or less well developed characteristics that reflect the dominating influence of some local factor of relief, drainage or parent material over the normal effect of climate and vegetation are classified as *intrazonal* soils. Soils without any well developed profile characteristics owing to their youth, conditions of parent material, or relief are classified as *azonal* soils. All three of these groups of soils are represented in the lower Fraser valley.

The parent materials of lower Fraser valley soils are essentially of glacial and post-glacial flood-plain origin. Elevation and subsequent erosion developed a variety of drainage conditions and upon these primary characters was imposed the effect of a humid and temperate climate.

On the upland the large but unevenly distributed rainfall, together with moderately high temperatures and long growing season, combine to produce a luxuriant forest vegetation. Originally the upland supported a heavy forest of Douglas fir *(Pseudotsuga taxifolia)* and Western hemlock *(Tsuga heterophylla)*. In swampy places and where seepage occurred the Western red cedar *(Thuya plicata)* was abundant. Now, however, the upland is covered by a luxuriant second growth of shrubs, bracken, alder and vine maple.

In contrast to the luxuriant forest growth of the upland, the Recent Delta lowland, which was subjected to poor drainage and seasonal flooding, developed groves of black cottonwood *(Populus trichocarpa)*, open meadows and peat bogs. These two contrasting conditions are representative of a climatic zone and its associates.

ZONAL SOILS

The zonal soils have developed under the influence of a coniferous forest. The effect of a coniferous forest on the soil is normally toward the development of the podsol, but high prevailing temperatures (together with high rainfall) have developed a slight but observable tendency towards laterization. The resulting soil development is a compromise which does not yield a clear definition of either type, but it does distinguish the west coast region as an independent soil zone[20]

The tendency towards laterization in this latitude is probably helped by the midsummer drought in July and August, which brings about dehydration and chemical precipitation processes, an upward movement of water and a slight decrease in the acidity of the soil. Precipitation centres in the formation of numerous iron concretions, which have the appearance of small rusty gravel, in the first foot or more of the solum. According to Wheeting[25] these concretions are the only evidence of a B horizon in the upland soils. The pellets of iron oxide thus formed apparently absorb and hold substantial amounts of other minerals.

The presence of comparatively large amounts of essential minerals in these soils shows that solubility of salts and bases must be slow. The upward move-

*Data in regard to the chemical composition of the soils surveyed will be found in table 2 of the appendix. In this table it should be noted that the depth measurements of the various horizons do not correspond in every case with those given in the text. The latter are averages while the figures given in the table represent exact measurements at specific points.

ment of water during the dry period may also be the reason for the lack of any marked downward movement of minerals and their accumulation in the lower part of the solum. The change in the reaction of the surface soil under well drained conditions from slightly below pH 6·0 in wet seasons to slightly above pH 6·0 in dry seasons may be due to the upward movement of minerals in the dry season.

Although a large amount of organic material is shed by the trees the accumulation on the ground is seldom more than one or two inches thick. Decomposition is very rapid, but only a very small amount of organic matter becomes intermixed with the mineral soil below. In excessively drained soils an ashy grey podsolized layer only a fraction of an inch thick is generally found immediately below the layer of organic litter.

The colours of the zonal soils beneath the layer of forest litter range from reddish brown to yellowish brown. The reddish brown colour, probably due to unhydrated iron oxide (hematite) is most distinct in the A_3 horizon of the Whatcom series, exposed when cultivated. In the more sandy soils, oxidized hydrated iron (limonite) gives a brownish yellow colour to the exposed surface, which becomes yellowish brown in the lower part of the solum. The entire weathered layer or solum of the zonal soils seldom extends beyond a depth of two or two and a half feet. Below this layer the parent materials are generally grey, mottled with grey or rusty brown, or bluish grey depending on whether the drainage is good, restricted or poor.

INTRAZONAL SOILS

In parts of the Raised Delta and Lowland areas the drainage is restricted or poor and this factor has produced a group of soils with distinctions based mainly on the height of the groundwater level. In the Raised Delta district, ortstein and glei podsols were formed in sandy and clay profiles respectively, where the groundwater level fluctuated at a depth of about 10 to 12 inches below the surface. Where the groundwater level more closely approached the surface the half-bog soils were formed. These are found around the edges of the peat areas and may be regarded as shallow bog soils. When cultivated the layer of organic matter becomes mixed with the mineral soil beneath. The even more poorly drained phase developed the true bog soils which have been mapped as peat. In the peat areas the organic matter accumulated under excessive moisture conditions to a thickness in some places of about 25 feet.

AZONAL SOILS

The recent alluvial soils are azonal. Profile development is feeble or absent. Until reclaimed by dyking they received annual additions of fine sediments during the freshet stages of the Fraser river. The movement of fine materials from the interior of the province still continues, but to a less extent than formerly. At the present time the delta of the Fraser is being built out into the strait of Georgia at the rate of about 10 feet a year.[12]

A cross-section of the map-area showing the general features of the zone and its associates is illustrated in figure 5.

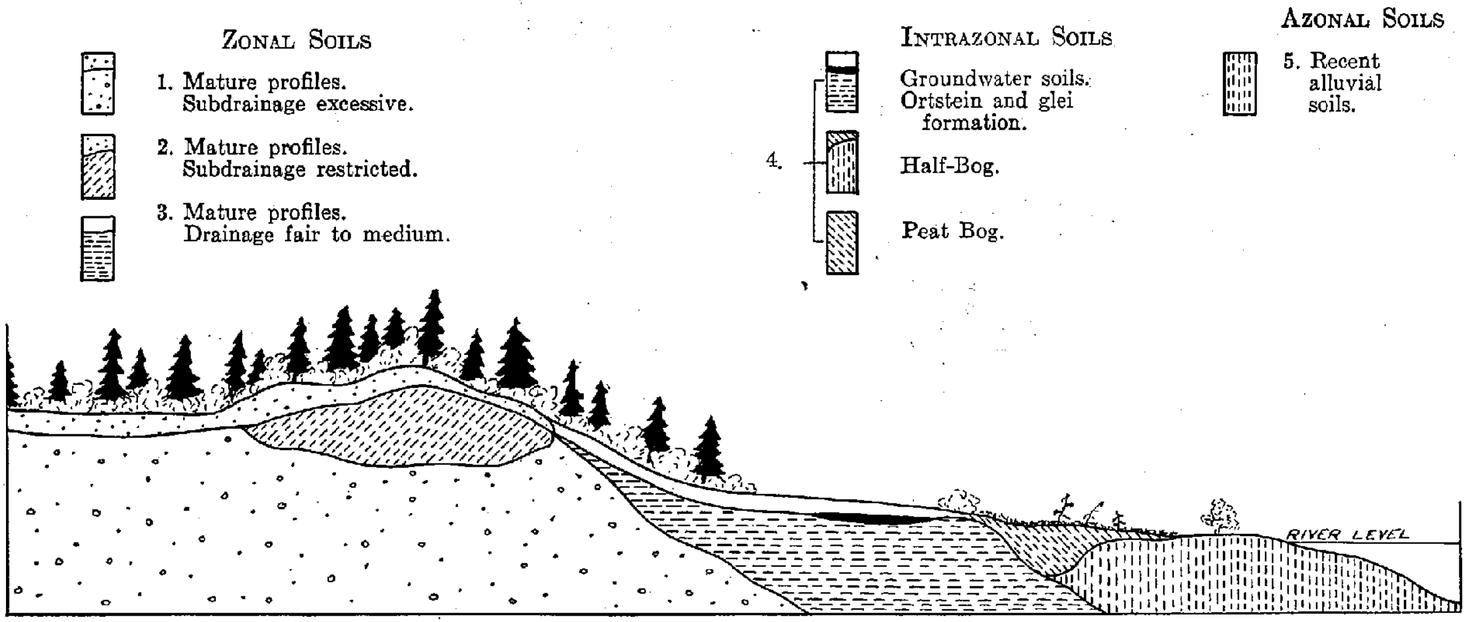

FIG. 5.—Illustration showing the general features of the soil zone and its associates. The five soil groups are described elsewhere in detail.

Soil Classification

FIELD METHODS

The kind of survey used may be defined as a detailed reconnaissance. The method of field work was to cruise all roads and trails by car, and on foot when necessary. Frequent examinations of soil profiles were made along the route, so that all soil boundaries intersected were accurately mapped. Boundaries between intersection points were joined by sketching. The topography, vegetation and short reconnaissance trips were the means whereby these sketched boundaries were plotted. Generally it was possible to examine the perimeter of every quarter section in detail so that the sketched boundaries were frequently checked. By these means all of the larger soil masses were examined and mapped. Areas smaller than ten acres were generally not shown on the map.

Soil textures were determined by feel. The surveyor's judgment was verified by numerous samples collected for mechanical analysis. These samples were analysed by the hydrometer method of Bouyoucos.[4] The textural classification was based on the standards of the United States Department of Agriculture.[10] The classification of soil profiles follows the method originally outlined by Marbut[10] and improved by the United States Bureau of Chemistry and Soils. Soil reaction was determined for each sample taken by colorimetric methods.

THE SOIL PROFILE

The classification of soils is based upon the colour, texture and other characteristics of the soil profile. Under general conditions the soil profile consists of a natural succession of layers or horizons extending downward into the weathered or unweathered parent material. These are called the A, B and C horizons, beginning from the surface. Taken together, the A and B horizons form the solum, which represents the true soil formed by soil-building agencies. The C horizon is the weathered or unweathered parent material which lies in contact with the soil above.

Originally the A horizon was considered to include the upper part of the solum, in which accumulation of organic matter takes place by direct influence of plants, and the B horizon included the lower part of the solum, which absorbed and held leached material from the A horizon.

While the principle remains the same this simple explanation is subject to modification to suit the conditions found in different regions, where the horizons of the solum may not have this regular and easily identified relationship. In some cases it may be necessary to separate a horizon into a number of sub-horizons. In others a part or a whole horizon may be missing. Figure 6 shows the principal soil horizons in their genetic positions in respect to one another, as found in the lower Fraser valley.

Each soil horizon has a distinctive colour, texture and structure. Soil colours may range from white, through many shades of brown to black as organic-matter content increases. In the lower Fraser valley organic staining is important only in the intrazonal soils. Colouring in the other soil types is due mainly to oxidation of the parent materials under different drainage conditions.

Soil texture refers to the size of the individual grains or particles, a property partly inherited from the parent material and partly a result of soil-forming processes. These particles have three main recognized groups—sand, silt and clay. A soil is usually composed of a mixture of all three. The distinction known as soil class is arrived at by the relative proportions of these three separates which a soil may have. The common classes of soil according to texture are sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam and clay. These textures go from coarse to fine in the order of their content of fine separates.

Soil structure refers to the manner in which the individual grains are arranged. The mechanical separates may be grouped into a considerable variety of forms. These forms depend on the texture, chemical nature of the clay fraction, aeration, plant cover, climate, etc. The structural units can be crumbs, plates, granules and others.

In the lower Fraser valley the upland soils are the most fully developed for the region. In the upland soils a fine granular structure permits a more or less free downward movement of the heavy rainfall. This comparatively porous structure appears to stand cultivation well; a factor which tends to limit erosion, but to favour leaching.

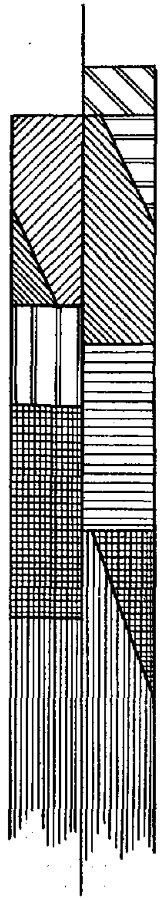

Fig. 6.—Hypothetical zonal and intrazonal profiles showing the positions of horizons as used in the description of soil series.

SOIL SERIES

The soils included in a series have approximately the same colour, depth and structure of profile horizons, similar drainage and topography, and the same conditions of parent material. The texture of the surface soil (the A horizon) may vary. The average profile is taken as the basis of the series separation. Abnormal conditions of the profile, which can occur within small areas, are due to localized conditions. In a more detailed survey these local variations could be shown on a map and classified separately.

Within the soil series are soil classes based on the texture of the surface soil or A horizon. The class name of the soil texture, such as clay loam or clay, is added to the series name to give the complete name of the soil type. Thus Monroe Loam, Monroe Clay Loam and Monroe Clay are different surface textures or types to be found in the Monroe series. With the exception of the variation in surface texture, the Monroe profile has the same characters throughout.

A phase of a soil type was used for the separation of soils within a type which differ in some minor character. Generally this minor character has some practical significance. Differences in relief and stoniness are frequently shown as phases. Neither of these distinctions may influence the soil character to any marked degree, but very often they are of marked significance in land use. On the soil map the Lynden and Everett series have been separated into gravelly and non-gravelly phases.

The soil series are given geographic names taken from the location in which they are first found. In subsequent work, wherever the same profile appears it is placed in the original series. This is done to avoid a confusion of names for the same profile. Most of the series mapped in the lower Fraser valley were previously identified and given place names just across the border in the state of Washington. Such types as the Langley, Milner, Haney and Ladner series were not previously mapped in Washington, and are given local names.

While in each soil zone the series are distinguished by differences both of profile character and parent materials, soils of similar geological origin may have several zonal or intrazonal distinctions which warrant their definition into different series. This principle was used for the separation of intrazonal soils in the lower Fraser valley.

SOILS NOT INCLUDED IN THE SERIES CLASSIFICATION

A number of small areas of soil occur that could not be mapped as soil series. These soils are called Mixed Areas. They include areas, generally small in size, that have been formed at various times by the water sorting which occurs in stream channels and on the littoral. They are shown on the map by means of numbered symbols.

SOIL SERIES

I—ZONAL SOILS, SUB-DRAINAGE EXCESSIVE

(Upland soils developed on modified glacial drift, including stratified sands and gravels. Porous and loose sub-stratum.)

Everett Series

The soils of the Everett series are derived from glacial materials which have been modified by the action of water; boulder clay being absent or fragmentary. The topsoil, which is light in texture, lies in direct contact with loose, open stratified sandy and gravelly material that may contain stones. The A horizon varies from a few inches to 30 inches in depth with little structural development and there is no recognizable B horizon. The organic-matter layer is seldom more than 1 to 2 inches thick although the contribution of leaves and twigs from the trees is large. Beneath this thin layer of organic matter the upper quarter inch of mineral soil is ashy grey, below which the soil is medium brown with some areas of light rich brown, fading to grey with depth. The topsoil is characterized, with other upland soils, by the occurrence of small round iron concretions which are smaller in average size and fewer in number than in the upland soil types with restricted drainage. Free lime is absent from the topsoil or sub-stratum.

This series is confined to the western part of the map-area where it occupies approximately 31,454 acres.

EVERETT GRAVELLY SANDY LOAM

The largest area of Everett Gravelly Sandy Loam occupies 12,060 acres in the vicinity of White Rock. The next largest area, 4,550 acres, lies on the fringe of the Surrey Upland, where it borders Mud bay. Smaller areas of this type are scattered on both sides of the Fraser river, making up a total of 19,620 acres.

The topography is rolling with occasional steep slopes and small flat areas. The highest elevation is about 300 feet above sea level.

The profile indicates a distant relationship to the Alderwood Sandy Loam, by the inclusion of fragmentary areas of boulder clay. During a period of emergence these areas were probably seashore exposed to wave action, which shattered the continuous or discontinuous boulder clay layer and mixed the underlying and overlying materials. The soil thus produced is coarse-textured and leached. Natural drainage is excessive.

A profile description of the Gravelly Sandy Loam, the most extensive type of the series, is given below.

Horizon	*Depth*	*Description*
A_0	0 –2″	Dark brown organic forest litter.
A_2	2 –2¼″	Ash-grey, podsolized.
A_3	2¼–12″	Pale medium-brown to brown sandy loam, some iron concretions, varying amounts of gravel and stone.
A_4	12–20″	Brown loamy sand, shading to grey in the deeper part. Concentration of gravel and stone.
C		Grey stratified sands and gravels, small areas of boulder clay.

Agriculture

The lack of moisture-holding capacity in this soil is detrimental to crops that do not mature before the dry season begins. This lack of drought resistance is the factor which grades the type as submarginal for general farming under present conditions. There are, of course, a few favoured locations which may support a small farm, and there are special types of farming that may be practised, such as poultry and fur production. These activities take advantage of the tendency of the land to dry quickly, and cultivation is a secondary factor.

An adequate supply of water for farm purposes is likely to be difficult to obtain owing to the usual great thickness of glacial sands and gravels. The best possibilities of a water supply exist where either a boulder clay layer or bedrock is encountered at a reasonable depth.

EVERETT SANDY LOAM

Everett Sandy Loam occurs in three small areas, covering a total of 4,734 acres. The largest area is located about four miles east of Langley Prairie, with elevation about 275 feet. It covers 4,470 acres with flat, terrace-like topography, apparently formed as a shore terrace.

This soil type is closely related to the Everett Loamy Sand, but has a slightly heavier texture and somewhat greater thickness of solum. Beneath about two inches of organic forest litter and a podsolized layer only a fraction of an inch thick, the soil is medium-brown sandy loam to a depth of about 8 to 10 inches, with occasional gravel, iron-coated gravel and small iron concretions. Beneath this horizon the soil shades to light-brown loamy sand for an additional 8 to 10 inches, becoming greyish-brown at the bottom. At a depth of 20 to 24 inches the sand is grey and stratified with coarse texture.

Profile samples for chemical analysis were taken from the area east of Langley Prairie. The analyses show that nitrogen and organic matter are low and deficient but the total phosphorus content is extremely high, particularly in the upper horizons. There is a fairly high content of the essential bases for plant growth although all the horizons of the profile have an acidic reaction. Except for phosphorus very little movement of the minerals has taken place. The slight movement that has taken place shows that silica tends to move downward while iron and aluminium tend to accumulate in the upper horizons. The parent material, or C horizon, is very similar in composition, except for phosphorus, to the soil which has been developed from it.

Agriculture

The soil profile indicates an open, porous sandy soil capable of drying out quickly after rains. The lack of moisture-holding capacity grades the type as marginal or submarginal for cultivation.

Soils of this kind are affected by the limitations imposed by the midsummer dry period. However, if this dry period can be utilized for specialized purposes, or if certain crops can be grown which are like the present native vegetation of fir, alder, willow, and maple, then a commercial use for the land may be found. The production of Christmas and cascara trees may come within this category.

EVERETT LOAMY SAND

The Everett Loamy Sand is confined to one area covering 7,100 acres, which lies to the south of Langley Prairie. The topography is flat terrace, with elevation about 150 feet above sea level.

The light-textured, single-grained topsoil varies to some extent in different parts of the area. In places it varies from light sandy loam to almost pure sand. The topsoil is weathered directly from the loose, open stratified sands which lie beneath. Irregular bands or pockets of gravel often occur in the underlying sands.

In topography and profile the Everett Sandy Loam and Loamy Sand are quite similar, indicating the same mode of origin, but at different elevations. The profile of the Loamy Sand, however, tends to be of coarser texture, with thinner solum and even lower drought resistance. A profile description of the Everett Loamy Sand is as follows:—

Horizon	*Depth*	*Description*
A_0	0 -2 "	Dark brown forest litter and roots.
A_2	2 -2¼"	Ash-grey, podsolized layer.
A_3	2¼-6 "	Brown loamy sand, single-grained, scattered gravel.
A_4	6 -12"	Light-brown loamy sand fading to grey in the deeper part; scattered gravel.
C		Coarse grey sand, scattered gravel, gravel in bands and pockets.

The chemical composition of this soil type is very similar to that of the Everett Sandy Loam, the chief points of difference being that calcium has leached to some extent in the loamy sand and phosphorus has accumulated to a more marked degree in the upper horizons. The phosphorus content of this soil is very high and is greater than in any other Fraser valley soil.

Except for the phosphorus concentration near the surface, the results show uniformity of composition for all horizons of the profile, including the stratified parent material.

Agriculture

The native vegetation of fir, willow, alder and birch is more sparse than in the other upland soil types. Lodgepole pine (*Pinus contorta*) was observed in this area indicating the dryness of the soil.

The sparse, more or less open native vegetation, the free drainage afforded by the coarse topsoil and subsoil, and the general appearance all suggest that this area would make an excellent recreational park, located as it is, within a short distance from Vancouver.

It is the driest soil type on the map-area and as such it is submarginal for cultivation. While there is some settlement, it is of the pioneer type and may survive only if forms of production can be developed which eliminate the need for cultivation of the land.

Lynden Series

The Lynden series occupies upland terraces formed by the river during glacial or post-glacial time. On the north side of the Fraser the type exists on several benches from Agassiz to Haney.

At the time when these benches were formed, at least part of the river flow swung south in a wide curve opposite Mission, building a terrace west of Abbotsford, which extends south and west to form a flood-plain across the border in the state of Washington. Concurrently a similar south-flowing outwash occurred at several hundred feet elevation above the present surface of Cultus lake, which suggests that glaciers and ice dams still existed in the delta region when the parent material now forming the solum of this series was deposited. Accordingly the type belongs with the older upland soils.

The topography is gently rolling or flat. The native vegetation consists mainly of a somewhat luxuriant second growth of fir, alder, cedar, maple and poplar.

The surface soils are reddish-brown, with a thin dark-coloured covering layer of organic matter accumulation in areas of second growth. Cultivated surfaces are distinctly reddish-brown, with iron concretions. Below the dark-coloured surface layer there is little structure, no compaction and no evidence of accumulated clay. The colour fades with depth from reddish-brown to brown. The solum is about 18 inches thick.

The sub-strata are of two kinds. One kind is stratified sand and the other is open stratified gravel. The topsoil was originally formed by the deposition of a comparatively thin layer of silty alluvium over the two kinds of sub-stratum.

Three types were mapped in the Lynden series, covering a total of about 35,549 acres. These are Gravelly Silt Loam, 15,639 acres, Gravelly Loam, 8,643 acres and Silt Loam, 11,267 acres.

LYNDEN GRAVELLY SILT LOAM

As a river bench and channel type the Gravelly Silt Loam exists in several isolated sections. The main area of the type, covering 9,685 acres lies on a broad terrace about two miles west of Abbotsford. The next largest area, covering 3,780 acres, lies between Cultus lake and the International Boundary. A third area of importance covers about 1,600 acres in the vicinity of Deroche on the north side of the Fraser.

The profile description of this type is as follows:—

Horizon	*Depth*	*Description*
A_0	0–2″	Dark-coloured organic forest litter and roots.
A_2	2–2¼″	Ash-grey, podsolized.
A_3	2¼–7″	Rich reddish-brown silt loam, finely granular, numerous iron concretions, scattered gravel and stones.
A_4	7–18″	Colour fades to light brown, silt loam, no compaction, increased amount of gravel and stones.
D		Grey sand, gravel and stones.

In places there is a more or less sharp division between the silty solum and the underlying gravels, but in other places the two are more intimately mixed. The gravel content of the surface soil varies greatly within short distances, Originally the silty layer on top contained no gravel but now the gravel is mixed through the solum, probably by the roots of falling trees.

Samples for chemical analysis were taken in the main area west of Abbotsford. Since there is no unaltered parent material or C horizon in the profile and the D horizon is quite different from the original parent material of the soil, only the A horizons were sampled. The nitrogen and organic matter in this soil are low as in the Everett soils. The phosphorus content of the various horizons is reasonably high and is fairly evenly distributed throughout the solum. Except for magnesium there is no marked movement of the other elements reported on. The magnesium content of the layer below the 5-inch depth is however more than double that of the layer above the 5-inch depth. The acidity of all horizons is fairly high, being greater in the surface soil than at the lower depths.

Agriculture

Taken as a whole the type is subject to excessive drainage through the open, porous sub-stratum and for this reason it is largely at the mercy of the mid-summer dry season. This would indicate a type approaching closely the marginal or submarginal for cultivated crops.

A few favoured locations exist in the vicinity of Deroche and elsewhere in the type where this generalization need not apply. However, great care should be used when selecting land for cultivation within the boundaries of the Lynden Gravelly Silt Loam.

Second growth is thin and clearing easy in comparison with the Alderwood and Whatcom series. Ease of clearing and cheapness of the land are the main inducements for the settler, but this has not promoted any extensive areas of farm land, about 90 per cent of the total area remaining undeveloped.

In the area west of Abbotsford settlement is extensive compared with the amount of land actually under cultivation. Development is in the pioneer stage, with small buildings and small clearings.

Crops that mature before the dry period, such as strawberries, potatoes, carrots and early garden truck have been produced. There has been a start in tree fruits, grapes and seed growing. This is mainly small-scale production. The area has proved to be suitable for intensive poultry raising, as it provides good drainage and feed growing is a secondary factor.

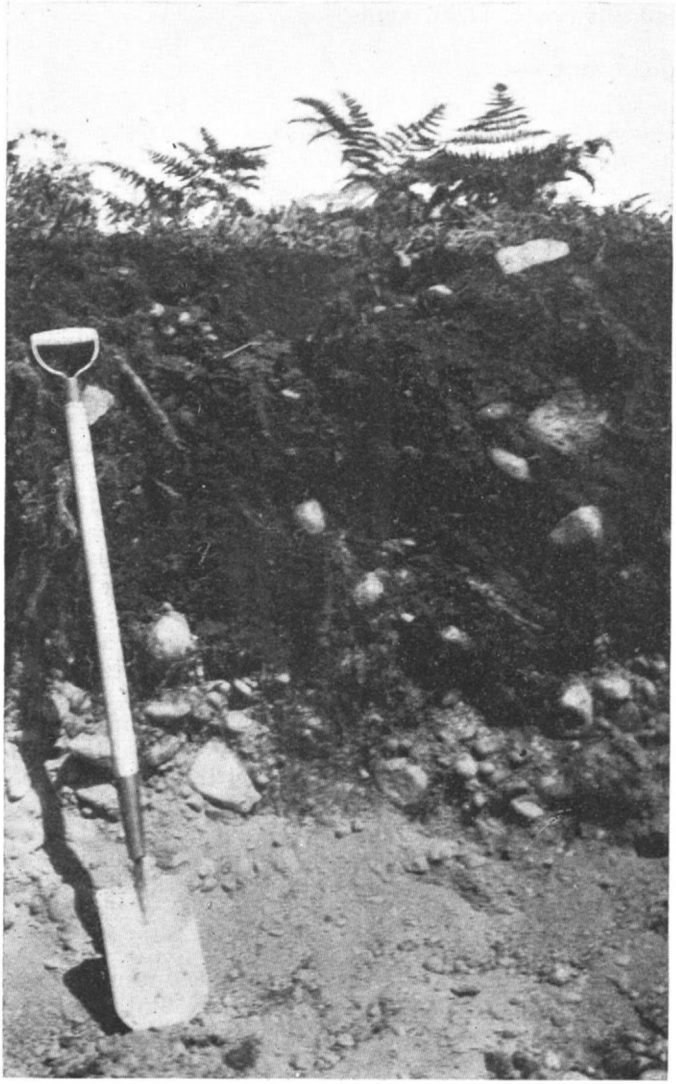

FIG. 7.—Lynden Gravelly Silt Loam profile illustrating excessive sub-drainage. The dark-coloured solum is silt loam containing stones and gravel. The light-coloured sub-stratum is composed of coarse sand and gravel.

Throughout the total area farm water supply is an uncertain factor. In the Cultus lake district the neighbouring hills provide occasional streams or springs. The bench at Deroche is also against a mountain and may have a fairly continuous boulder clay layer at some depth beneath the surface. In the locality west of Abbotsford, scattered areas of boulder clay have been observed underlying the Lynden Silt Loam to the east of the gravelly area. A boulder clay water table may exist at reasonable depth under at least part of the gravelly area itself.

LYNDEN GRAVELLY LOAM

The main area of Lynden Gravelly Loam extends westward from the main area of Gravelly Silt Loam almost to Blaine, covering a total of 6,742 acres. Elevation is from 200 to 400 feet with terrace topography.

The next area in size occupies a flat bench of 1,490 acres, with elevation about 300 feet, to the north and west of Aldergrove.

There is a smaller parcel covering 411 acres to the north of Haney, with elevation about 100 feet. This area enjoys greater precipitation near the Coast mountains, and for that reason is slightly more favourable for cropping than the same type on the south side of the Fraser river.

A profile description of the Gravelly Loam is as follows:—

Horizon	*Depth*	*Description*
A_0	0–2″	Dark-brown organic forest litter and roots.
A_2	2–2½″	Ash-grey, podsolized.
A_3	2½–14″	Reddish-brown loam with varying amounts of gravel and stone. Porous, some iron concretions.
A_4	14–20″	Brownish-yellow sandy loam, concentration of gravel and stones, porous, shades to grey in the deeper part.
D		Grey sand, gravel and stones. Similar to sands and gravels underlying Lynden gravelly silt loam, and the stratified materials underlying Alderwood boulder clay.

The gravel content of the surface soil often varies considerably within short distances. In places the surface is covered with gravel and rounded stones, while in adjacent areas the gravel occurs in compact stratified beds just below the loamy surface covering.

Agriculture

The profile is similar to the profile of the Lynden Gravelly Silt Loam, except for lower silt and clay content and evidence of more excessive drainage. In addition to this, the amount of surface stone is greater than in the Gravelly Silt Loam.

The drought status and marginality for cultivation of the Gravelly Silt Loam and Gravelly Loam compares with the status of the Everett Gravelly Sandy Loam and Everett Sandy Loam. The moisture-holding power of this group of soils is less than that of the Alderwood Sandy Loam, which is a fairly good example of a soil that approaches the margin in drought resistance for cultivation.

LYNDEN SILT LOAM

The Lynden Silt Loam lies in two separated areas, one covering about 4,720 acres in the vicinity of Mission, and the other, covering 6,547 acres, lying west of Abbotsford. The topography of the area near Mission takes the form of several terraces rising one above the other, with elevations betwen 200 and 500 feet above sea level. These terraces are trenched by coulees tributary to the Fraser.

The topography of the area in the vicinity of Abbotsford is terrace-like with gently rolling surface. The average elevation of the main part of this area is about 175 feet, but here and there are low hills or ridges with various elevations up to 300 feet above sea level. Broken sections of boulder clay have been seen outcropping on the knolls at some depth from the surface.

The profile of the Silt Loam differs from the other Lynden soils in the map-area mainly by having an underlying layer of grey stratified sand instead of gravel. The solum is about 20 inches thick, of silt loam texture with greyish sand beneath. In colour the type is distinct from the other Lynden soils as a dark brown phase, fading to light brown with depth.

Following is a profile description of the Lynden Silt Loam:—

Horizon	*Depth*	*Description*
A_0	0–2″	Dark brown organic forest litter.
A_2	2–2¼″	Ash-grey, podsolized.
A_3	2¼–8″	Dark brown silt loam, numerous iron concretions.
A_4	8–20″	Light brown silt loam, granular and friable.
D		Stratified sands, grey-brown at the top, fading to grey in the deeper part.

Analyses of samples taken near Abbotsford show that the nitrogen and organic-matter contents are higher than in the other excessively drained soils. In general there is a higher percentage of bases than in the gravelly phase of the same soil type and the acidity is not so great. These data indicate the gravelly phase to be a less fertile soil from the viewpoint of total plant food. Little movement of the mineral constituents has taken place, except phosphorus which has accumulated to a considerable extent in the surface horizons.

Agriculture

Agriculture in this type dates back to about 1885 when a nursery was started near Hatzic, and by 1900 small-fruit growing was established. Stimulus was given to small-fruit growing about 1920, when a large number of soldier settlers took holdings. After 1924, however, difficulties with raspberry production were encountered which remain unsolved.

Small-fruit and vegetable production would appear to be the best use yet found for this type, and a fairly large development has taken place in the vicinity of Mission.

The area west of Abbotsford has undergone more recent development, mainly along the lines of small-fruit production, but much of the land in both districts yet remains to be cleared of a luxuriant second growth of poplar, maple, alder, cedar and fir.

The Lynden Silt Loam is superior in drought resistance to the other Lynden soils. It is also superior to the Everett series. The moisture relationship is intermediate between the Alderwood Silt Loam and the Alderwood Sandy Loam. Where typically developed it is above the marginal category so far as drought resistance is concerned.

Drought resistance is the main limiting factor in the upland soils. For this reason a solum of more than average depth for the type should be most valued for crop production. Because of the free drainage afforded by the open, sandy sub-stratum, a thin solum, or one of less than average depth for the type, will greatly increase the effect of drought. It has been noted that crops produce larger yields during wet seasons than during seasons of average rainfall. This is due to the fact that a large part of the moisture is carried off through the open sub-stratum, a tendency that could be reduced to an appreciable extent by a cultural practice with provision for an increase in the organic-matter content of the soil.

II—ZONAL SOILS, SUB-DRAINAGE RESTRICTED

(Upland soils developed on glacial material.)

Alderwood Series

The Alderwood series occupies about 116,000 acres in parts of the upland region from the eastern to the western limits of the map-area. It has a more rugged relief than any other soil type on the map-sheet.

Representing a portion of the older deposits of the lower Fraser valley, the Alderwood series is characterized by a 2 to 6 foot layer of hard, sandy boulder clay containing stones and gravel, superimposed on a great thickness of stratified sands and gravels and buried under from 2 to 4 feet of alluvium. The deposition of the surface covering was probably made possible by submergence of the whole delta region.

The native vegetation consists mainly of a luxuriant second growth of fir, cedar, hemlock, alder, maple and birch, with scattered dogwood. There are many varieties of shrubs and a dense growth of bracken.

In virgin areas the surface soil is covered with a layer of organic-matter accumulation about two inches or less in thickness, beneath which the soil is reddish-brown to pale reddish-brown, fading to brown and brownish-yellow with depth. A B horizon of clay accumulation is absent, but numerous iron concretions are present. The soil profile is superior in moisture-holding capacity to upland soil types of light texture that are not underlaid by an impervious layer.

Two types, the silt loam and the sandy loam were found in the lower Fraser valley.

ALDERWOOD SILT LOAM

The Alderwood Silt Loam occupies approximately 56,000 acres in the district to the east of a north and south line from the International Boundary, which would touch Whonnock on the north side of the Fraser.

The topography is hilly to mountainous with inclusions of gentle slopes and small flat areas. At the higher elevations rock outcroppings are frequent. Elevation ranges from about 50 to 900 feet or more above sea level. Possibilities for agricultural development are limited to about 20 per cent of the total area by the mountainous nature of the land.

A profile description of the Silt Loam is given below:—

Horizon	*Depth*	*Description*
A_0	0–2″	Dark brown forest litter.
A_3	2–8″	Reddish-brown silt loam, fine granular structure, deficient in humus; numerous iron concretions, occasional gravel and stones.
A_4	8–20″	Brown to brownish-yellow loam to sandy loam, with stones, gravel and iron concretions.
D_1	20–32″	Brownish-grey to grey gravelly sandy loam. Weathered boulder clay, weakly cemented.
D_2		Hard, cemented, impervious sandy boulder clay, grey, 2–6 feet thick, overlying stratified sands and gravels.

Two profiles, one from east of Abbotsford and one from north of Mission were sampled for chemical analyses. The results given in table 2 of the appendix, show the variation that may exist between soils of the same type from different locations. The soil from east of Abbotsford is higher in the minerals essential for plant growth but contains only about one-half of the nitrogen and organic matter found in the soil from north of Mission. Since the latter soil is not deficient in minerals it would appear that it is probably the more productive soil owing to its greater depth and higher nitrogen and organic-matter contents.

The boulder clay layer is impervious to roots and water, thus forming an effective water table. The stratified sands and gravels beneath the boulder clay are grey in colour, loose, porous and non-calcareous. The uneven surface of the boulder clay layer serves to indicate that the underlying sands and gravels, which are believed to be of interglacial origin, were at one time subject to erosion. The boulder clay now caps and preserves an interglacial topography, which forms the present surface, except where cut by rock out-croppings and recent gullies.

Agriculture

Taken as a whole the topography is too rough for agriculture, with the exception of a number of small scattered localities. The most important of these small localities lies to the north of Mission City, but settlement is scattered and there is still room for further land clearing and general development.

Originally small-fruit growing was a profitable occupation, but in recent years this has gone backward owing to the failure of raspberry plantations, some of which have been abandoned. Local experience suggests, however, that the deeper phases of the type, where topography is suitable, are capable of giving comparatively large yields of small fruits and vegetables when well managed.

To the south of Mission City is Sumas mountain, a heavily wooded hill rising from the flat lying delta country to an altitude of about 2,900 feet above sea level. It covers about 20,000 acres, and is too rough for farming with the exception of included small areas, where there is a certain amount of pioneer development. Hay, corn, potatoes, vegetables, tree fruits and berries are grown in small clearings.

In the area surveyed, Vedder mountain and Chilliwack promontory cover about 19,000 acres to the south of Sumas and Chilliwack. Small bench-like areas on the north slope of Vedder mountain are cultivated.

The Chilliwack promontory rises several hundred feet above the flats, and is rolling and densely wooded on top. Where the slopes are gentle the bedrock is covered with Alderwood Silt Loam. Traces of boulder clay were found only in a few places. The topsoil is a deep reddish-brown with remarkably few iron concretions.

On the promontory near Ryder lake there is a comparatively flat area with a settlement supporting two schools, a community hall and a post office. The farming compares with that on Sumas mountain. At the west end of the promontory, above Vedder Crossing, there is another small farming area but with greater development. The farms are larger and more tree fruit is grown.

The main reason why this type of soil is not more extensively cultivated lies in the fact that clearing is both difficult and expensive. Agriculture is confined to small clearings and intensive cultivation is necessary.

When at the right depth, the underlying boulder clay is an advantage, tending to increase the drought resistance of the soil. Under some profile conditions there is no doubt that the boulder clay is also a disadvantage, promoting poor drainage and high acidity. Under-drainage would, in many cases, overcome this difficulty.

Advantage should be taken of small areas with restricted drainage to provide a farm water supply. Where wells have been dug, sufficient attention has not always been given to the boulder clay layer. Except under special conditions there can be little object in seeking water below the boulder clay layer, because the sands and gravels are porous, open and generally deep. If the boulder clay layer is penetrated the drainage from its surface will seep through the bottom of the well.

The surface topography will generally follow the boulder clay topography, and a depression in the form of a small drainage channel often means a similar depression in the boulder clay. Under some conditions it may be possible for drainage to accumulate from a number of acres at one point. The form of the well may be a rectangular roofed tank established in the boulder clay, with provision for free entry of the water from the surface of the impervious layer.

ALDERWOOD SANDY LOAM

The Alderwood Sandy Loam occupies about 60,000 acres in the western and northern parts of the map-area. In addition, observations indicate that areas of this type occur on the uplands on which Vancouver and New Westminster are situated. This upland was not surveyed.

The topography is rolling to mountainous on the north side of the Fraser, with included areas having more gentle slopes. On the south side of the river the slopes tend to flatten on the upland west of Langley Prairie and on the

Surrey upland. Taken as a whole the topography is more modified than in the silt loam of the same series. A larger part of the total area is flat enough for farming.

Profile and moisture relationships of the Alderwood Sandy Loam are intermediate between Alderwood Silt Loam and the Everett soils. The type probably correlates with the Bainbridge series[15] in Washington. It is included as Alderwood Sandy Loam in this report because of the profile relationship and lack of actual comparison with Bainbridge series in the field.

A profile description of the Alderwood Sandy Loam is as follows:—

Horizon	*Depth*	*Description*
A_0	0–2″	Dark brown organic forest litter.
A_2	2–2¼″	Ash-grey, feebly podsolized.
A_3	2¼–8″	Pale reddish-brown to rich brown; loose, open, single grained, sandy loam with iron concretions. Deficient in humus. Scattered gravel and surface stones.
A_4	8–20″	Sandy loam, concentration of gravel and stone. Colour shades from brown to yellowish-brown. Horizon ends in mat of roots which lies directly on hard boulder clay.
D		Grey boulder clay 20–24 inches thick, composed of a hard cement-like sandy mixture containing stones. Overlies stratified sands and gravels. Identical to D_2 horizon in Alderwood Silt Loam profile.

Agriculture

The profile description shows the average depth of the underlying boulder clay to be within 20 inches of the surface. There are deeper and shallower phases. When found at a depth of three feet or more in favoured locations there are possibilities for farming, but where the depth of the impervious layer is 20 inches or less, the land enters the marginal class for cultivation.

The moisture relationships of this type are on the borderline between a soil that is definitely arable and one that is definitely non-arable. It is, therefore, a marginal soil. Marginal soils are not recommended for general farming, although in a few favoured places farms may become established.

There is some justification, however, for the settlement of these marginal lands where commercial farming is a secondary factor and where a municipal water supply may be developed. A good example of this type of settlement is to be found on the Surrey upland, across the Fraser river to the south of New Westminster.

Part-time workers, regular employees and retired people can acquire acreage on the Surrey upland at moderate cost. When carefully fertilized and cultivated in small blocks the land will produce vegetables, berries and other garden crops. As a general rule, moisture is plentiful until the midsummer drought in July and August. Garden crops that can be harvested before the onset of the dry period will give satisfactory yields. In addition to this there are possibilities for poultry and fur farming. The more distant and more mountainous parts of the series should be used for forestry purposes.

The drainage and water supply are subject to the same conditions that prevail in the Alderwood Silt Loam. The most reliable source of well water is seepage from places where water accumulates in depressions underlaid by boulder clay.

Whatcom Series

The whole of the Whatcom series was mapped as Whatcom Silt Loam. This type covers a large section of the upland district, with a total area of about 67,700 acres. The principal area covers about 54,000 acres in the vicinity of Aldergrove. Smaller areas occur on the Surrey upland and on the north side of the Fraser between Haney and Ruskin. The age and formation of the Whatcom series compares with that of the Alderwood series, but it is found at lower elevations seldom exceeding 400 feet above sea level.

The topography consists of hills low and rounded and slopes never steep nor eroded. The area is full of small hills, and depressions that have no general direction; the depressions being poorly drained. There are many of these poorly drained depressions within small areas, which adversely affect the growth of crops.

The Alderwood and Whatcom series are the two upland soils with restricted sub-drainage. In the Alderwood series the restriction of drainage is due to an indurated sandy boulder clay. In the Whatcom series the material impervious to the downward movement of precipitation water has the general appearance of an ancient post-glacial delta deposit which has become weakly cemented. The Whatcom parent material consists of about one-third each of very fine sand, silt and clay, with scattered grit and occasional embedded stones.

For the purpose of identification the most important feature is the structure, which is jointed and fragmentary. The same structure without any cementation was noted in the C horizon of the Milner and Haney series, which are obviously post-glacial river deposits. It is concluded that the Whatcom series is probably the oldest post-glacial delta deposit to be formed under approximately the same delta building process that is now going on at the mouth of the Fraser river.

The average depth of the Whatcom parent material is unknown. During the survey only one cut was found which exposed the interglacial gravels that lie beneath. In this case the thickness of material was about four feet, but the location was too close to the boundary of another soil type to have any significance.

In the Whatcom series the problem of farm water supply is similar to that in the Alderwood series. Surface water from the top of the impervious parent material is the most probable source. The weakly cemented parent material is the cause of the high watertable and should be studied carefully before land drainage is undertaken.

The surface topography of the Whatcom series follows more or less faithfully the topography of the impervious sub-stratum. When a well is to be dug, a certain amount of prospecting should be done to ascertain the correctness of this theory in the given area, so that the well may be located where there will be an adequate supply of water free from barnyard contamination.

A profile description of Whatcom Silt Loam is as follows:—

Horizon	*Depth*	*Description*
A_0	0–1″	Dark brown organic forest litter.
A_3	1–12″	Reddish-brown silt loam, finely granular, loose, open, with many iron concretions. Occasional small stone or gravel.
A_4	12–20″	Pale reddish-brown, yellowish-brown to grey-brown loam or clay loam, massive and dense, iron staining but no iron concretions.
C_1	20–24″	Loam or clay loam, grey and iron stained. Transition to the C_2 horizon.
C_2		Parent material weakly cemented, impervious to water, drab grey, iron stained at the top. Angular fragmentary structure, dense and hard, somewhat tough when wet. Scattered fine grit and embedded stones. Clay loam to clay texture.

The chemical analysis shows that the nitrogen and organic-matter content compares favourably with that in the better types of upland soils. The total phosphorus content, while not deficient, is lower than in any other soil in the Fraser valley. The movement of minerals in this soil indicates that the process of podsolization has been dominant over that of laterization, iron, aluminium, calcium and magnesium having being leached to some extent while silica has tended to accumulate in the surface soil.

Horizon C_1 is the zone of maximum wetness in this soil type. Water moves over the more impervious C_2 horizon and for this reason drainage tile should be installed on top of this horizon.

Agriculture

The land is covered with a heavy second growth of alder, maple, fir, cedar and birch. The stumps of the original climax forest of Douglas fir, hemlock and giant cedar are large and frequent. Costs of clearing and drainage are the primary factors which have delayed development.

While only a small part of the available area has been cleared and cultivated, the fine-textured profile together with the gently rolling topography indicates that a permanent agriculture may eventually be developed. The

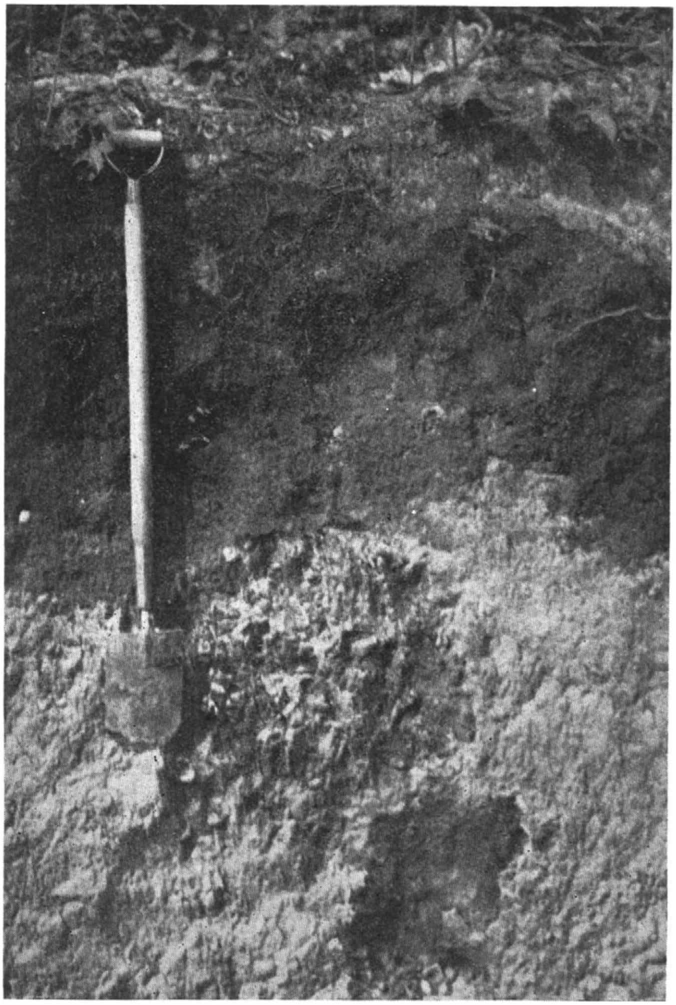

FIG. 8.—A Whatcom Silt Loam profile showing restricted sub-drainage. The upper layer is the reddish-brown solum. The lower layer is the weakly cemented sub-stratum which arrests the downward movement of rain water.

Whatcom Silt Loam should be adaptable to fruit, vegetable growing and mixed farming, yet all that is seen is a comparatively backward agriculture with few signs of prosperity or progressive development. Settlement is mainly of the pioneer type, with few farms of any size and few good buildings.

The reason for this slow development is believed to be mainly economic. The cost of clearing and drainage is high and economic conditions have not been favourable even for established farms for some years past. The development of such land from the raw state requires more capital than the average settler is able to provide. Thus, in the Whatcom Silt Loam the economic situation appears to be the governing factor retarding development rather than any permanent defect in the quality of the soil itself. Investment in land, clearing, drainage and proper fertilization are heavy primary costs.

Comparing the Whatcom type with other upland soils in the map-area, it appears that in potential productive power it rates higher than the Everett and Lynden series. It is also superior to the Alderwood sandy loam and is comparable with the best phases of the Alderwood Silt Loam.

When first cleared and cultivated the drought resistance during the midsummer dry period may be fairly low for the soil is deficient in humus. It should improve in moisture-holding capacity as the organic-matter content is increased. Therefore the importance of increasing the organic-matter content by green manuring practice and correcting the comparatively high acidity by the use of lime is emphasized. Alfalfa has been introduced with good results but always after lime application. Clovers do well, except in poorly drained depressions, for several years after clearing. Then they begin to fail unless lime, phosphate and potash are added.

On the border of the series the sub-stratum is often overlaid by sandy material, giving the surface soil a loamy texture. Here drainage is better than in the central part of the area and this land is more fertile under present conditions. This fact lays emphasis on the need for under-drainage in all parts of the area, if the land is to be brought to a productive stage.

Under its native cover the Whatcom series is deficient in the requirements for farm crops, but this condition can be changed and eventually this soil type will take its proper place as the most important of the upland soils.

III—ZONAL SOILS, DRAINAGE FAIR TO MEDIUM

(Soils composed of fine-textured post-glacial delta deposits with profile development.)

Milner Series

Only the clay loam type occurs in the mapped area. It occupies the better-drained parts of the valleys of the Serpentine and Nickomekl rivers at elevations between 25 and 150 feet, with a total area of about 10,500 acres.

In post-glacial time, with elevation lower than at present, the Fraser deposited fine delta materials of the same kind that are now discharged at the river mouth. These sediments filled an area which extends southward from the vicinity of Haney to include Nickomekl and Serpentine river valleys. After subsequent uplift of the land to the present elevation, several different moisture relationships were set up in the one type of parent material, which led to the development of Milner, Langley and Haney series.

The topography of the Milner Clay Loam is gently rolling, and the native vegetation consists mainly of second-growth poplar, maple and alder with scattered fir. There is a luxuriant profusion of shrubs and bracken.

In age, elevation and profile development the Milner series occupies an intermediate position between the older upland types, such as the Whatcom series, and the younger Monroe and Ladner series of the Lowlands or Recent Delta.

The surface soil, beneath a thin covering of forest litter, is bright reddish-brown, with many soft iron concretions. The surface colour, in relation to the parent material from which it developed, is the main distinguishing character of the type. The parent material is grey clay to silty clay, often iron-stained at the top, with jointed angular structure. The jointing is the same as that found in the Whatcom series but there is no sign of cementation. Stones and gravel are absent.

Following is a more detailed description of the Milner Clay Loam profile:—

Horizon	*Depth*	*Description*
A_0	0– 1″	Dark brown organic forest litter.
A_3	1– 6″	Reddish clay loam, fine granular structure, numerous soft iron concretions.
A_4	6–16″	Yellowish or yellowish-brown clay, scattered iron concretions, granular structure.
C		Grey clay or silty clay, iron stained at the top, dense, angular fragmentary structure.

Nitrogen and organic matter in the surface soil while not abundant are higher than in any other zonal soil. The amounts of phosphorus and the essential bases are intermediate between the low and high values obtained for these elements in the other zonal soils which have been analysed. Calcium and magnesium have tended to accumulate in the surface horizon while iron and aluminium have tended to move downwards, although there is no marked movement of any of the minerals except phosphorus which has accumulated near the surface. A noticeable feature shown by the analysis is that this soil has a higher percentage of alumina and a lower percentage of silica than the soil types previously discussed.

Agriculture

From the early history of the district the Milner Clay Loam received attention from settlers as soon as the more open Langley and Custer soils were taken up. Clearing was probably assisted by forest fires, and the land, once cleared, produced good returns.

To-day about 50 per cent or more of this type has been cleared of bush and cultivated. Agricultural development is along the same lines as in the Langley and Custer series. Mixed farming and dairying are the best uses of the type and prosperous-looking farms are numerous. No doubt, when future conditions warrant more development, the remaining uncleared acreage will be brought under cultivation.

In producing power the Milner Clay Loam does not rate so high as the black meadow type which has been mapped as Langley series, but when well managed, the margin of production between these two soils should not be large. Being a forest soil the upkeep of organic matter should receive serious consideration. Barnyard manure and soiling crops would improve tilth and drought resistance. The use of lime is necessary for clovers and other crops, and fertilizer should also be included in the soil management program.

The moisture relationship or drought resistance of the Milner type lies between the Whatcom series and the Haney series. The Haney series, on the same parent material as the Milner type, is in the more favourable position in respect to soil moisture because it lies in a belt of higher precipitation near the Coast mountains.

The farm water supply is secured in most parts of the Milner type from wells, some of which flow under light pressure.

Haney Series

This series is heavy textured and was mapped as Haney Clay. The main area of the series lies in the vicinity of Port Haney, where it covers about 4,530 acres at elevations between 25 and 150 feet above sea level. There is also a small area covering 134 acres just north of Seabird island, near the eastern end of the soil map, giving a total of 4,664 acres.

The area near Port Haney forms part of a post-glacial deposit of fine delta materials which extends southward into the valleys of the Nickomekl and Serpentine rivers. Since elevation of the land the Fraser has trenched out its present channel, separating the part of the deposit which lies around Haney from the rest of the area to the south.

The topography is gently rolling and native vegetation consists of second-growth maple, alder and scattered fir. General relief and drainage conditions are the same as in the area covered by Milner Clay Loam, but the surface colour of this type is drab-brown, indicating that the environment in which it developed is somewhat different. This difference is thought to be due to the heavier texture of the Haney type, together with heavier original forest cover and higher precipitation on the north side of the Fraser.

Following is a description of the Haney Clay profile:—

Horizon	*Depth*	*Description*
A_0	0– 1″	Dark brown organic forest litter.
A_3	1–10″	Drab-brown clay, fine granular structure, soft drab-brown coloured iron concretions.
A_4	10–20″	Drab to yellow-brown clay, fine granular structure; mottled with iron staining.
C		Grey clay, soft angular fragmentary structure.

In general, the chemical composition of the Haney Clay is similar to that of the Milner Clay Loam. The nitrogen and organic matter are somewhat lower, however, and calcium has a more marked tendency to accumulate in the surface horizon. Another noticeable difference is that in the Haney profile the acidity increases with depth while in the associated Milner profile acidity tends to decrease with depth. Increase of acidity with depth indicates that availability of the basic minerals in the fine-textured Haney series must be very slow with a marked deficiency of available lime.

Agriculture

Early settlement of the Haney area was influenced by the nature of the soil and the building of the Canadian Pacific Railway. Settlers naturally desired productive land as close as possible to improved transportation facilities. The business created by railway building was itself an important factor. Under these conditions settlement got started and the district was incorporated in 1874 as Maple Ridge municipality.

Subsequent development was helped by local industries which date from about 1880, with brick-making. The first sawmill was established around 1904. Both of these industries are still operating. The brick and tile plant is now the largest of its kind in the province.

The Haney Clay area is well settled. The agriculture consists of mixed farming, poultry and fruit growing. In quality the Haney Clay will rate with Milner Clay Loam, the type with which it is most nearly comparable. The texture is heavier and the rainfall higher, but with due allowance for these factors the drainage is similar and agricultural practice follows a similar trend.

While the topography of this type would suggest good drainage, the heavy texture of the soil is against the free movement of groundwater, and this. together with the heavy precipitation, makes under-drainage desirable in the more flat-lying areas. Where the soil is well drained, growth is faster and earlier in the spring.

The need of maintaining organic matter in the soil is emphasized. Green manuring will not only improve the physical condition of the heavy soils, but will also increase the moisture-holding capacity. The Haney Clay is acid in reaction. For ordinary cropping and especially for the production of legumes, the use of lime and general fertilization is recommended.

IV—INTRAZONAL SOILS

(Groundwater soils with ortstein, glei and peat formation.)

Custer Series

The whole of this series was mapped as Custer Loam. It occupies three small areas in the valleys of the Nickomekl and Campbell rivers, with a total of about 3,800 acres. Each area has a slightly different profile which has not been differentiated on account of the small acreage. Correlation is with Custer and Edmonds series in the state of Washington.

The Custer series developed on low terraces and in shallow depressions. Parent materials are greyish and mottled with iron stains. Pockets of iron concretions and lenses or layers of ortstein are found at the level where the watertable fluctuates.

At Langley Prairie an area covering 1,040 acres occupies a shallow basin which was originally a depression in the clay material forming the sub-stratum of the Langley series. The type was formed by the gradual filling of the depression with loamy sand, upon which was deposited a layer of finer material, consisting mainly of very fine sand, silt and clay. This area passed through the stages of a poorly drained marsh, and the large amount of organic matter which now gives the surface its black to dark brown colour is derived from the slow decay of swamp vegetation.

The topography of this area is almost level and the natural drainage is poor. The underlying clay prevents the downward percolation of water, which tends to rise and maintain a level at the top of the sandy layer where it makes contact with the surface horizon of loam.

An iron or ortstein layer of hydrated ferric oxide has formed at the level of the watertable. Hence the subsoil contains a high percentage of iron, which often cements the sand into a compact mass. There are a large number of iron concretions at the top of the sandy layer, forming in places a more or less brittle horizon of bog iron about two inches or more thick. Beneath this the loamy sand is greyish-brown and iron stained. At about two feet the clay is encountered beneath the sandy layer.

An area to the south of Langley Prairie covering about 1,710 acres and an area in the vicinity of Hall's Prairie of 1,060 acres are low terraces fringing the Everett Loamy Sand. It is evident that the Everett Loamy Sand provides seepage water which has developed the ortstein in both of these areas. This feature is significant in view of the fact that the district in the vicinity of the Custer Loam is provided with a water supply from flowing wells. The Everett Loamy Sand, which lies in the background at higher elevation, apparently acts as a storage for precipitation water. At low elevation it is walled on the west and north by more recent clay deposits. Wells drilled in the clay yield water under light pressure.

In both of these areas of Custer Loam the surface is medium to dark brown, in contrast to the black surface and higher organic-matter content in the area at Langley Prairie. The subsoil is finer in texture and more dense and cemented. The concretions appear as lumps of iron-cemented sand distributed in the subsoil, whereas at Langley Prairie there is a more or less brittle layer at the top of the subsoil. At a depth of about four feet or more the same type of underlying clay is encountered.

A detailed description of this profile is as follows:—

Horizon	*Depth*	*Description*
A_1	0–5″	Black to brown loam, friable, no stones or gravel, high in organic matter.
A_3	5–12″	Brown to light brown loam, friable, no stones or gravel, iron-stained at the bottom.
G	12–16″	Layer of ferric oxide accumulation in the form of pockets of iron concretions, lumps of iron-cemented sand or layers and lenses of ortstein.
C	16–40″	Greyish sand, mottled with iron stains, coarse to fine texture in different areas. No stones or gravel.
D		Grey clay, dense, angular fragmentary structure.

Agriculture

The land is about 75 per cent cleared and cultivated. Where uncleared, mainly along the fringe of the Everett series, there is a second growth of fir, hemlock, cedar, poplar and willow.

The soil is well adapted to general farming and the range of possible crops does not appear to be limited. The usual varieties of grain, roots, small fruits, seed crops, forage crops and pasture are grown successfully. The organic-matter content of the soil is high and provision should be made in the system of farming to maintain the level of this all-important constituent.

Formerly the growth of clover was luxuriant, but of late years it has fallen off in yield. This is probably due to a reduction in the lime content of the soil, because increased production has been obtained after applications of 1 to 2 tons of ground limestone or 1 to 1½ tons of hydrated lime per acre.

The fine texture of the surface soil, together with the high content of organic matter and restricted drainage are factors increasing the drought resistance of the type. The position of organic matter as a drought-resisting factor is emphasized. Where drainage is restricted the excess water should be taken off by under-draining.

For the general run of crops, results have been secured from applications of potash and phosphate fertilizers. The proper use of these amendments, together with the application of lime, upkeep of organic matter and drainage are considerations that should be included in the program of soil management.

Langley Series

Langley series was mapped as Langley Clay Loam. Three small areas of this type, covering about 3,932 acres, are located in the bottom of an old channel of the Fraser in the vicinity of Langley Prairie. The old channel was abandoned by the river when the elevation of the land was about 50 feet lower than at present. A fourth area covering approximately 2,300 acres is located at Hall's Prairie. The total area of Langley series is about 6,232 acres.

The topography is almost level, with the general appearance of being saucer-like. The difference in elevation between the centre and surrounding edges is small. Run-off is from the centre of each area.

A report dating from 1824 states that these areas were fern- and grass-covered meadows, with black soil.[22] This type of meadow is not a zonal soil. It is to be found in small, naturally poorly-drained areas within other soil regions. The Langley series is the only example of this kind of meadow soil in the lower Fraser valley. It is recognized as Wiesenboden, a dark-coloured meadow soil which is developed with a vegetation of grasses or grass-like plants. Under the conditions of poor drainage glei is formed in the subsoil. The large amount of organic matter in the surface layers is well decomposed and is incorporated with the mineral soil, rather than resting upon the mineral material in the form of a peaty layer, as is the case with the peat and muck soils. When drained, this type of meadow is one of the best and most fertile soils for crops.

Under natural conditions, the high winter rainfall followed by the mid-summer dry period, caused a rise and fall of the groundwater level. This, in the presence of organic matter, increased and decreased the solubility of such minerals as iron, manganese, calcium and magnesium, which were not lost from the soil by leaching. The alternation of oxidizing and reducing conditions, promoted by the fluctuating watertable, led to the formation of the light-coloured or yellowish glei horizon which lies beneath the dark-coloured surface soil.

A detailed description of the Langley Clay Loam profile is as follows:—

Horizon	*Depth*	*Description*
A_1	0–9″	Black clay loam, high in organic matter, granular structure.
G	9–12″	Yellowish clay, dense, structureless, glei.
C_1	12–24″	Grey-brown clay, mottled and streaked with iron stains, fragmental structure.
C_2		Grey clay, dense, angular fragmental structure.

The surface or A_1 horizon is rich in nitrogen, organic matter and phosphorus, but there is a marked change with depth, the G horizon being deficient in these elements. The iron content of the surface horizon is much lower than that of the glei horizon or of the parent material. Except for iron and phosphorus little or no movement of the mineral constituents can be observed from the chemical data. While the surface horizon is markedly acid the underlying horizons are neutral or basic. This is the only instance of a neutral or basic soil horizon in the lower Fraser valley.

Agriculture

The Langley Clay Loam was the first soil to be farmed successfully in the lower Fraser valley. The old Hudson's Bay Farm is referred to in an early British Columbia Directory:[6] "At a distance of two and a half miles south from Fort Langley there commences what is known as the Hudson's Bay Company Farm. It contains a large area of prairie land of rare excellence, black loam with clay subsoil." The boundaries of the Langley Clay Loam in the Langley Prairie and Hall's Prairie districts are the limits of the old "prairies" from which these two communities get their names. Cultivation of the Langley Clay Loam was undertaken soon after the establishment of Fort Langley in 1827.

This type of soil is naturally best suited for mixed farming and dairying, the purpose for which it has been developed, and a great variety of field crops can be grown.

Under natural conditions the watertable was high, giving rise to the black surface and the yellowish glei horizon about 9 inches deep. This glei horizon was the level of the fluctuating watertable. From this it may be inferred that drainage is of first importance in the preparation of the land for greatest production.

As a meadow type the soil was capable of accumulating and retaining a greater store of organic matter, lime and fertility elements than the average soil of the region. Hence it would withstand more than average abuse after draining and cultivation. Against this natural advantage is the fact that the land has been cultivated from the time of the earliest settlement. It follows that there are advantages to be gained by a management program which includes liming, manuring and fertilization.

The whole of this series is cultivated or in pasture. The farms are of medium size, well stocked and have an appearance of prosperity above the average. The farm buildings are good.

The source of water supply is mainly from artesian wells. In the north end of the valley, toward Fort Langley, the depth at which water is secured is about 80 feet, while in the area around Langley Prairie the water is often at lower levels, nearer 400 feet. In the deeper wells the water is often brackish.

Peat Bog

The cool moist climate, together with poor drainage conditions to be found in parts of the lower Fraser valley, are ideal for peat formation. Wherever swampy conditions prevail, peat bogs have a tendency to grow. They are scattered throughout the map-sheet in uplands and lowlands, the main area being near sea level on the Recent flood-plains of the Fraser. The total area mapped as peat amounts to approximately 51,000 acres.

The surface peat in this region is mainly of sphagnum-moss origin, with different stages of decomposition, especially around the edges of the various peat areas, where the bogs are shallow. All lands having an organic covering greater than plough depth were classified as peat.

There are a number of small bogs in the upland area, where the topography is more or less rolling. These are scattered in coulees and pond-like depressions of limited extent and may be termed pothole bogs. There are about 12 of these pothole bogs ranging in size from 10 to 128 acres, with a total of about 500 acres.

The most important upland bog is located on the Pacific highway, about 3½ miles southeast of New Westminster. The total area is approximately 35 acres. There is a raw peat moss cover which varies in depth between 2 and 8 feet, with an average of 6 feet. This material is light brown, coarsely fibrous, and the plant remains are very well preserved. The total depth of the bog varies between 2 and 22 feet. Below the 6-foot moss layer the peat is fairly well humified.[1] The Highway Bog has been drained and a supply of commercial peat moss is harvested from it each year.

In the Monroe series, drainage, topography and soil are more favourable for the development of large areas of peat than the rolling upland area. In this type there are only two bogs, one covering 830 and the other 4,800 acres.

In the larger bog which lies southeast of Chilliwack, the original sphagnum moss covering has been reduced and in places destroyed by fire. The peat material remaining is considerably humified. It occurs chiefly in depressions afforded by the micro-relief. Over the higher parts of the area it has been burned to a thickness less than plough depth, and for agricultural purposes may be regarded as half-bog.

The most favourable conditions for peat formation on a large scale are found in the Ladner series, where a number of scattered areas total about 44,800 acres. In the Ladner series the high watertable permits the formation of ponds which give rise to peat-forming vegetation. Once started, further development is easily continued, especially if sphagnum mosses have gained a footing. The rise of peat in the bog so formed will lift the watertable also, and the peat will gradually spread from the depression if the water supply remains adequate.

Where the surface has little relief and many small depressions exist, the widening sphagnum spots coalesce and large peat bogs result.[3] In localities with meandering streams, low levees are formed along the stream banks, behind which the land is subject to flooding followed by peat formation. Such areas are to be found in the valleys of the Nickomekl and Serpentine rivers and in the Pitt Meadows district.

The largest bog in the lower Fraser valley begins about 3½ miles east of Ladner and continues eastward into the valleys of the Nickomekl and Serpentine rivers. The total area covered by this single mass of peat is about 22,700 acres. About 50 per cent of the bog has been reclaimed for pasture and crop growing.

At the west end of this bog the central part is still in its natural state. About 4,700 acres have a moss covering which varies in depth between 2 and 10 feet and averages 8 feet. The total depth of this part of the bog varies between 2 and 25 feet. The peat below the 8-foot moss layer is considerably humified.[1]

The Burnt Road bog lies just southwest of New Westminster on the same side of the river. It covers about 2,460 acres, about 700 of which have a moss covering which varies in depth between 4 and 8 feet and averages 6·5 feet. The total depth of the bog varies between 2 and 15 feet, and the peat below the raw moss layer is humified.[1]

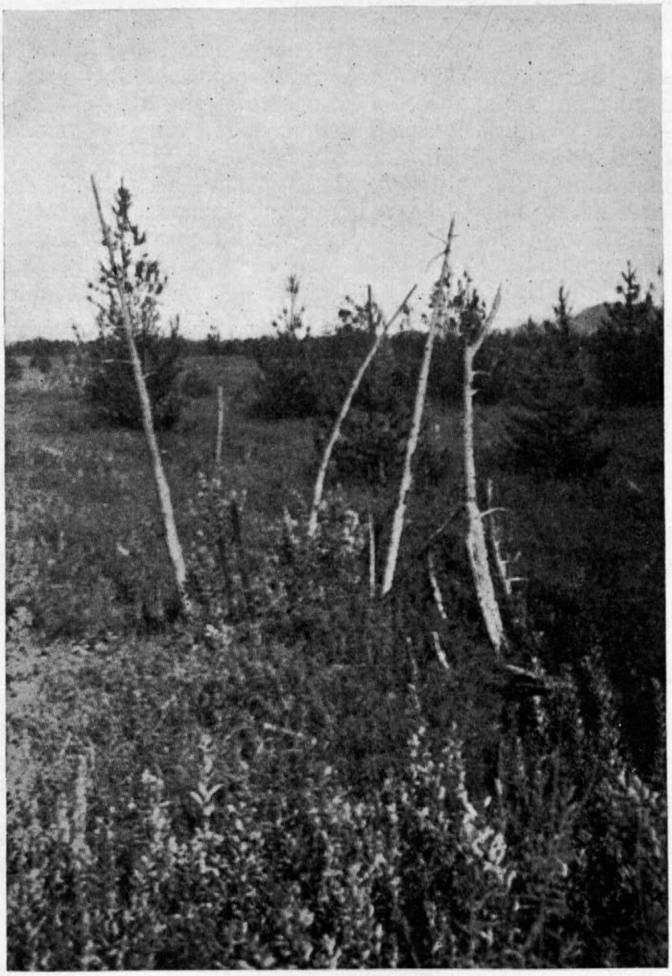

FIG. 9.—Typical vegetation on a growing sphagnum bog.

Across the north arm of the Fraser river from the Burnt Road bog is the smaller Lulu Island bog, which covers about 3,700 acres. Much of the surface moss cover has been burned off before being brought under cultivation. About 1,700 acres on the inner part of the bog has a moss covering which varies between 2 and 7 feet and averages 5 feet deep. The total depth of the bog varies between 2 and 20 feet, and the peat below the 5-foot raw moss covering is humidified.[1] A factory is established on this bog for the manufacture of peat products. A bog near the centre of Lulu island covers 5,300 acres. In the lowland area between New Westminster and Matsqui Prairie there are 10 or 12 more peat bogs ranging in size from 250 to about 2,000 acres.

It would appear that climatic and drainage conditions in the recent past have favoured the development of a comparatively thick sphagnum moss layer on top of older and more humified peat material. The raw moss layer is yellowish-brown to light brown in colour, spongy, coarsely fibrous and very well preserved. Fragments of associated plants are present in varying quantities. The moss is suitable for the manufacture of peat litter and many other peat products. About 5,000,000 tons containing 20 per cent moisture are favourably situated for this purpose.[1]

Conditions are most favourable for moss development in the centre and deeper parts of the bogs. As the outer edges are approached the peat is shallower, the growth has been slower and the material is in different stages of decomposition. Farming is first undertaken on the outer fringe, from which there is a gradual invasion towards the centre of the bog. Cultivated surfaces are reddish-brown to dark brown in colour depending on humification. The surface material is generally fibrous.

Occasional thin bands of clay may be found here and there in the peat profile in some areas, indicating a break in the sphagnum moss growth that occurred during exceptional floods which spread fine sediments over the bog. This condition is found in the most southerly part of the Delta bog, near Ladner. Here the surface 6 to 14 inches may be clay underlaid by undecomposed peat moss. In the low part of the Nickomekl and Serpentine river valley, bands of clay in the peat may be brought to the surface during cultivation.

The native vegetation on the peat bogs is a dense mat of living sphagnum moss supporting a fairly heavy cover of Labrador tea, with scattered scrub jack pine.

Agriculture

The survey was not detailed enough to separate the peat resources of the lower Fraser valley into classes based on botanical origin and stage of decomposition. The term "peat" is applied to a complex of unclassified peat. Remarks concerning agriculture in the peat areas are necessarily intended to be of a general nature.

The term "Hochmoor" or "raised bog" is applied in Europe to the class of peat land which rises from the edges toward the middle, showing a convex upper surface. This type develops in regions of high humidity or rainfall, partly on account of the habit of growth of the sphagnum mosses, which form the main surface cover. The raised type of development is a characteristic of the main peat deposits in the lower Fraser valley.

Care should be exercised when drainage systems are established to take into account the settling which occurs in the highest part of the bog. This may be done by a careful preliminary survey, to plan the whole system in advance. Open ditches should then be placed at regular intervals, the distance between the ditches depending on the amount of drainage necessary. The area should not be too deeply drained at the start as it may dry out and injure the crop growth. As the bog settles the ditches may require deepening from time to time to keep the watertable at its proper level. The development of an effective drainage system should be a gradual process, and eventually the open ditches should be replaced by tile drains.[2,3]

When attempts are made to reclaim raw sphagnum moss, it should be remembered that until a humified surface has been developed there will be no suitable medium for the roots of crop plants. It is simply a sponge for holding a solution of plant food. As humification occurs the mass of raw organic matter takes on more of the characteristics of a soil and becomes less like a sponge, until, in time, a peat soil is developed.

After an area of raw peat has been drained and is dry enough to support an animal's weight, the tramping action of cattle is recommended. If a herd can be grazed, the tramping effect, together with droppings, will do much to start humification of the surface layer and make it easier to cultivate and get a crop started. When possible a sod should be developed, which may be grazed for two or three years before ploughing and cultivation. Another plan followed is that of manuring, liming, ploughing and sowing with rye or oats to cut for hay, then seeding down for a sod the second or third year.

A method of reclamation suitable for small areas is followed by Oriental market gardeners. Their plan is usually to drain and plough; then plant such intertilled crops as potatoes, cabbage, celery, etc., and by heavy manuring and fertilization they reclaim the land within a few years. This method is possible only when cheap hand labour is available.

The application of fertilizer should be heavy. After humification has reached a satisfactory stage, the amount of crop is in fairly direct proportion to the amount of fertilizer applied. For intensive cropping some of the Orientals apply from 500 to 1,500 pounds of fertilizer per acre in addition to manure. Mixtures used at first should carry a small amount of available nitrogen, with large amounts of phosphate and potash, such as 3-10-8 or 4-10-10. The available nitrogen is necessary at the start but after humification is well advanced a mixture like 0-12-10 or 0-10-16 is satisfactory along with applications of manure.

The acidity of the peat ranges from pH 4·8 to pH 5·4. A dressing of lime is necessary to reduce acidity and permit decomposition. The bacterial decomposition of peat requires well drained, neutral conditions, with an available supply of nitrogen. Manure will inoculate the peat with decomposing bacteria and the addition of lime will encourage humification by reducing acidity.

Determination of the amount of lime to apply is still in the experimental stage. However, ground limestone is recommended and applications should be more or less continuous. As a general rule two tons per acre of ground limestone have been recommended at the start. This should be followed with subsequent applications as needed.

In the past a great deal of harm and very little good has come from the burning of peat lands. The use of fire as a reclamation agent is not recommended. Where peat is deep and dry enough to burn, the control of fire is difficult in the absence of rainfall. Serious pitting often occurs and the field takes the general appearance of one from which large stumps have been removed.

Thorough cultivation is of primary importance. This should be deep in the fall and relatively shallow in the spring. When ploughing, the furrow slice should be turned over flat, particularly if the peat is coarse, and should be pressed down firmly into the underlying material. Repeated cultivation with a heavy disk, and rolling should follow in order.

The peat should be maintained in compact condition. This practice is necessary to ensure a moisture supply for the seed and close contact between the seed, or roots, and the soil. Improved returns have been ascribed to the increased compaction of peat through the use of heavy machinery.

The crops usually grown on the peat soil, apart from Oriental enterprise, are timothy, red top, orchard grass, sweet clover, alsike, white or Dutch clover, vetch, rye, oats, buckwheat and potatoes. Yield and quality depend on how well the peat has been built up for the crops. When mineral supplies are lacking, grain crops have a tendency to produce heavy straw and light grain, potatoes are low in dry matter and hay crops are light in clover.

The Orientals cultivate intensively and produce a variety of truck crops, such as lettuce, cabbage, carrots, celery, spinach and onions. Small fruits, such as blackberry, gooseberry, raspberry, strawberry and blueberry are also produced in varying amounts.

The Half-Bog Phase

In the Ladner series there are three drainage phases based on the height of the watertable. In the order from the poorest to best drainage for the series these are Bog, Half-Bog and exposed mineral soil. In pond-like depressions under the most waterlogged conditions, peat bogs ranging up to 25 feet in thickness have formed. As the peat deposit spreads out from these depressions to higher ground the peat layer thins out. That part of the bog where the peat has a greater thickness than plough depth was mapped as peat. Where the thickness of peat is less than plough depth the material is defined as Half-Bog. The Half-Bog phase was not differentiated on the soil map, but nevertheless it warrants some description.

The Half-Bog is transitional between the true bog and the exposed mineral soil. Essentially it is shallow bog. When cultivated the surface layer of organic matter is mixed with the mineral soil beneath. The Half-Bog phase exists on the outer edges of the peat areas, and in low-lying parts of the Ladner series such as the Pitt Meadows district.

With drainage and cultivation the Half-Bog areas will gradually disappear, leaving the exposed Ladner Clay. There is, however, an important distinction between the two. This distinction is due to the effect of the high watertable and the raw or humified layer of organic matter on the underlying mineral soil. This may tend to make the Half-Bog phase less productive than the naturally exposed Ladner Clay for some time after reclamation.

In places the acidity of the Half-Bog is high, and this should be equalized with the best drainage phase of the type by liming, together with manuring and other fertilization.

V—AZONAL SOILS

(Recent alluvial soils with restricted sub-drainage; profile development feeble or absent. Dyked against annual flooding.)

Monroe Series

The Monroe series occupies about 89,000 acres in the lowland to the east of Matsqui Prairie. It covers the Sumas and Chilliwack areas together with part of the Agassiz district and a number of islands in the Fraser river.

The topography is flat. The elevation ranges from 2·87 feet below sea level in the lower part of Sumas to about 30 feet above the sea in the vicinity of Chilliwack. Average elevation is about 25 feet above sea level. Before dyking, the land was subject to overflow during the freshet stages of the Fraser river. Ponds were formed for a period each year at the lower elevations, which developed as open meadows with grass-like vegetation. The higher ground was submerged for short periods during the greater floods, permitting the growth of a tall stand of cottonwood with scattered fir and cedar.

The district between Chilliwack and Huntington was a post-glacial channel of the Fraser. At least part of its waters flowed southward into the state of Washington. This outlet was in use when the river occupied Langley valley. Being close to the mouth of Fraser canyon, the currents were rapid, especially in freshet season, and this wide, shallow channel was eventually floored with sand. When Langley valley was abandoned by the river, this area was abandoned also, except as a relief for freshet overflow. During the subsequent freshet stages of the Fraser, silty alluvium was deposited on top of the sand stratum, thus forming a young profile with two layers having a marked difference in texture. The upper layer ranges from loam to clay, whereas the bottom layer ranges from sandy loam to sand of medium texture. In the Agassiz district and on Nicomen island the outwash from the Fraser left the same type of profile, which extends as far west as Dewdney.

The Monroe series is differentiated from the associated Ladner type by feeble profile development and coarser texture. The Ladner series is fine textured and has no profile development. The surface 6 inches of the Monroe soils is dull brown to dark brown. This is the depth of weathering and may be rightly called the solum, although plants have no difficulty in rooting in the parent material beneath. In the bottom inch of this solum there is a tendency towards platiness. Iron concretions are absent. The weathered 6 inches is underlain by a comparatively unweathered layer of silty alluvium, grey or brownish-grey in colour and 10-20 inches thick. It is compact parent material, mottled with iron stains but without ortstein development. At a depth of from 16 to 20 inches there is a sharp change in texture into stratified grey-brown to grey medium sand, which often has a sandy loam or loamy sand texture. This feature of the Monroe profile is of great importance. While the sub-drainage is restricted under natural conditions, the sandy sub-stratum assists land drainage after reclamation.

The Monroe series was divided into the following types based on the texture of the surface soil: Loam, Clay Loam, Clay and Loamy Sand, which are described separately.

FIG. 10.—Monroe series in the Sumas valley. Mount Baker in the background.

MONROE LOAM

The Monroe Loam covers about 15,500 acres in a number of scattered areas. The most important area, in the vicinity of Sardis, covers approximately 6,900 acres. The whole area is cultivated, drainage systems are well developed, and the soil is productive. The remaining 8,600 acres is made up from a number of islands in midstream, most important of which is Seabird island, which covers about 4,200 acres.

Seabird island is located just east of Agassiz. It is mainly undeveloped and the soil is of poorer quality than the area of loam near Sardis. This is because the layer of fine alluvium on top of the sand is generally thin. Grey sand is encountered at a depth of a few inches, hence there is a greater content of sand in the surface soil, and on more detailed survey much of this area could be divided off into soils of lighter texture, such as sandy loam and loamy sand. This gives the island the general appearance of having a lighter and drier soil, a factor which would govern the kinds of crops to be grown, since the midsummer drought must be considered. While it is well drained for most of the year, it is not dyked, is subject to flooding, and the land should be carefully selected in order to avoid outcroppings of subsoil sand. Possibilities for the development of Seabird island would increase if at any time it became profitable to dyke and irrigate by pumping from the river. The use of irrigation water would carry the crops through the dry season.

The Loam has the most variable profile in the series because of the tendency of the topsoil to thin out and merge with the sandy sub-stratum. A description of the Loam profile is as follows:—

Horizon	*Depth*	*Description*
A_1	0–6″	Horizon shades from dark brown to light brown with depth. Finely granular with tendency towards thin platey structure in the lower part. No stones or gravel.
C	6–16″	Brown to grey-brown loam, coloured or mottled with iron stains, compact but without ortstein development.
D		Clean brown to grey stratified sand or loamy sand, medium grained, porous.

Agriculture

In the Sardis loam area the land has the general appearance of fertility for cropping, subject to a satisfactory drainage system. The mottled and iron stained C horizon marks the height of groundwater under natural conditions, and this is obviously too close to the surface for satisfactory cropping in many parts of the area. The groundwater level should be adjusted to suit the needs of the crops to be grown.

The soil is slightly less acid than other soils of the region, with the possible exception of the Langley series, but applications of lime are beneficial except where acid-loving crops are grown. As in other soils of the region the organic-matter content is of first importance. Soil improvement by the use of barnyard manure is made easy in the Sardis district by the large numbers of live stock.

The agriculture in the Sardis area has developed to a point of stability, and the land has proved its high value for mixed farming and dairying. Specialized farming includes hop growing on a commercial scale in the better-drained part of the district. Tree fruits, berries and nursery stock are side lines.

The smaller islands in midstream are of no value for agriculture and the larger ones are unsafe without dyking. The top layer of fine alluvium is often thin and there are out-croppings of sand on the surface. Such conditions have retarded or have made development impossible, and with the exception of a few small farms, this part of the loam area is still in its native state.

MONROE CLAY LOAM

This is the most important type in the series. There is a large area, covering about 34,000 acres surrounding the city of Chilliwack. A small block, only 1,544 acres, lies in the old bottom of Sumas lake. There are two areas in the Agassiz district covering about 2,800 acres, and an area in the vicinity of Nicomen island and Hatzic lake of an additional 13,700 acres. The total area of Monroe Clay Loam is approximately 55,500 acres.

The layer of clay loam on top of the underlying sand was deposited in recent time during the annual freshet stages of the Fraser river. This type of deposit extends west of Hatzic lake on the Fraser, and southwest to the centre of the reclaimed Sumas lake basin.

The area to the north and east of Chilliwack is trenched by old flood channels of the Fraser, which separate the land into "islands." These islands are large areas of land separated by slough-like ditches, about 100 feet or more in width. Characteristically, there is a slightly higher elevation and a fringe of lighter soil along the channel banks, which have the appearance of low levees.

In the clay loam the layer of fine alluvium covering the underlying sand shows some variation in thickness and texture in different parts of the area. A detailed description of this profile is as follows:—

Horizon	*Depth*	*Description*
A_0	0–2″	Dark brown organic litter from deciduous trees, mixed with soil.
A_1	2–14″	Brown, shading to greyish-brown clay loam with depth. Fine granular structure with tendency towards thin platey structure at the bottom of the horizon. No stones or gravel.
C	14–20″	Compact clay loam, greyish and mottled with iron stains.
D		Porous grey-brown to grey sand, medium texture, stratified.

Except in the shallow surface layer of partly decomposed deciduous remains, the organic-matter and nitrogen content compares with the upland soils. Phosphorus and calcium are also highest in the A_0 horizon but the other mineral elements are fairly evenly distributed throughout the profile. The reaction is acidic and is uniform from topsoil to the D horizon. The analysis confirms the field observations in that the D horizon is not composed of the same material as the parent material of the overlying soil.

Agriculture

Settlement of the clay loam began in 1862, in the Chilliwack area. To-day the city of Chilliwack gets its main support from the fertile Monroe soils. Native growth was mainly cottonwood with some cedar and fir. The fir was largely confined to the highest ground. The greater part of the area is now cleared and cultivated. The soil is fertile and the main activity is dairying. Hay and corn for ensilage are important crops. The good farm buildings seen everywhere reflect the soil fertility and the stability of the market for dairy products. The Monroe Clay Loam has the general appearance of being one of the best farming soils in the lower Fraser valley.

East of Chilliwack the soil becomes somewhat heavier at the surface and the land has a micro-topography consisting of flat surface divided by low ridges which stand about one foot or more above the surrounding flat areas. The flat areas are covered by a layer of humified peat only an inch or more thick, while the low ridges are free from this organic covering.

Cultivation has worked the partly-decomposed organic material into the soil, and the result is beneficial for general cropping. In the lowest parts the organic matter has greater thickness and more closely resembles true peat.

Essentially this is an area of half-bog which has been successfully reclaimed. With good drainage and treatment similar areas of half-bog in other parts of the valley and especially at Pitt Meadows, can be made productive.

In the vicinity of Agassiz the clay loam is more variable than on the south side of the Fraser and there are showings of sandy soil. Native vegetation is the same as in the Chilliwack area, and the land is well developed for commercial hop-growing and general farming.

Nicomen and Skumlasph islands cover about 8,000 acres, and the average surface texture is clay loam. Small sandy patches were noted at the eastern end of this area. The underlying sand is closer to the surface on the east than on the west end. Native vegetation is the same as in the Chilliwack district. Nicomen island is about 80 per cent cultivated. The land is used for mixed farming and dairying and the farms compare favourably with those near Chilliwack. In the Hatzic lake area development is along the same lines, but drainage is a greater problem.

The profile, when properly drained, is well aerated and the soil reaction is slightly higher than average. The lime is probably more available because the

Fraser river water is slightly alkaline. The use of lime, however, is indicated for lime-loving crops, and the program of soil management should have provision for the maintenance of organic matter.

The crops produced include orchard fruits, grain, corn, hay, pasture, roots, tobacco, hops, legumes and potatoes. The hop yards on the clay loam are the most important in British Columbia.

MONROE CLAY

The Monroe Clay covers about 12,000 acres in one area which lies between Huntington and Kilgard. Originally the area formed part of a large settling basin which received the finer materials from the freshet overflow of the Fraser.

About five series of low, narrow mounds which have the appearance of shorelines of Sumas lake rise about 10 feet above the level of the flat Monroe clay. Well scattered throughout the clay area, their general direction is broadside to the southwesterly trend of the Sumas valley. They are composed of the sand which underlies the Monroe series. The deposition of fine sediments was subsequent to the shoreline formations, hence the mound-like knolls are mainly small and isolated from one another.

A description of the Monroe Clay profile is as follows:—

Horizon	*Depth*	*Description*
A_1	0–6″	Grey-brown clay, with dense, granular structure.
C_1	6–24″	Grey clay, compact, dense, structureless, well mottled with iron stains.
C_2	24–30″	Silt loam or loam, grey, iron stained.
D		Grey medium-textured sand, often reddish with iron stains at the top.

Agriculture

Settlement in the Monroe Clay dates from the earliest settlement in the Chilliwack district. At that time much of the low-lying meadow land was subject to flooding, but the sandy knolls which cross the area, originally tree covered, afforded high and dry ground for buildings.

To-day about 90 per cent of the area is cultivated for the production of grain, forage crops and pasture. The general trend of agricultural practice in the Monroe Clay is similar to the development in the Ladner series. This is accounted for by more restricted drainage conditions and by the heavier texture of the soil.

Drainage is the main problem. Under natural conditions the groundwater was within six inches of the surface, which is too high for any but the most shallow rooted crops. In the lower lying lands under-draining and lowering of the groundwater to a deeper level is essential for the best results. The management program should include provision for the upkeep of organic matter, and the use of lime for lime-loving crops.

MONROE LOAMY SAND

The boundaries of this type, which occupies about 6,300 acres, are within the shoreline of Sumas lake which was drained and reclaimed in 1924. Originally there was a shallow, basin-like depression with bottom elevation below sea level, lying betwen the areas mapped as Monroe Clay Loam and Monroe Clay. This depression received the freshet discharge of the Vedder river.

The outwash material consists mainly of sand, with occasional lenses of gravel. At the same time the Sumas lake basin was subject to freshet overflows from the Fraser, which contributed small but variable amounts of silt and clay to the sandy output of the Vedder.

The reclamation of the Sumas lake area involved the diversion of the Vedder river from a point near Yarrow, northwards to the Fraser. Reclamation was completed by the establishment of a system of drainage ditches and an electric pumping station located on the Sumas river, about a mile southwest from the mouth of the diversion canal.

The land is almost flat and subject to surface floods during exceptionally heavy rains. The water drains away quickly through the porous soil and into the ditch system.[18] The elevation ranges from 2·87 feet below to about 10 feet above sea level. This is below the average level of the Fraser, hence a continuous pumping service is a necessary part of the drainage works.

The surface two inches is grey-brown loamy sand, typically young and comparatively unweathered. In some places the surface is loamy fine sand or loamy very fine sand. The next 48 inches is grey to brown stratified sand with some iron staining. The texture varies from coarse to fine, with occasional lenses of gravel. At a depth of about 48 inches the sand often turns bluish in colour, indicating poor aeration. From the surface downward the recently reclaimed Loamy Sand is parent material.

Agriculture

The area is flat and open, except where willow growth has invaded the ditch system. Placed at higher elevation, with free drainage, this type would compare with the Everett Loamy Sand, which is submarginal for dry farming.

The drought resistance of the soil can be improved by building up the organic matter and by adjustment of the groundwater level. In some parts of the area adjustment of the water level may not be necessary, while in others the depth of drainage ditches may lower the water below the reach of shallow rooted crops. Without the aid of the groundwater the soil is too porous to carry a crop through the dry season.

At the present time the area is in an experimental stage of development, with no definitely established result. However, this is an unusual soil with good possibilities for specialized cropping. What crops may be grown most successfully may best be determined by means of experimental plots.

The main specialized crop grown in any quantity is tobacco. Other crops are grain, hay, clover and pasture. Grapes and nut trees have been planted. Volunteer alfalfa was noted along the ditches, and this legume may be worthy of attention.

Ladner Series

The Ladner series was mapped as Ladner Clay. It covers the lowland from Matsqui Prairie to the sea, with a total area of about 95,000 acres.

The topography is typically flat. Elevation is below freshet level in the east and below freshet and high tide level in the west.

The Ladner Clay has several drainage phases which have promoted the growth of different types of native vegetation. The most important of these has been mapped separately as Peat Bog. In addition to the Peat Bog there is a shallower half-bog phase which was not differentiated. The half-bog supports a swamp forest of willow and poplar, with scattered cedar and fir, which formed the main tree growth on the Ladner series. The better drained, exposed mineral soil was mainly open meadow covered with grass vegetation.

Practically the whole Ladner Clay area is dyked against overflow and is provided with open ditch drainage systems to keep the water level low enough for cropping. Where necessary a continuous electric pumping service is provided.

The soil is recently deposited sediment. Profile development is absent. Where the land has been in permanent pasture a dark-coloured surface layer of organic matter accumulation from 4 to 6 inches thick has developed.

This is grey-brown to black clay, granular and heavy. The next 50 inches is grey clay well mottled with iron stains. The structure is massive and tough when wet. When the land is ploughed the grey, mottled parent material is turned to the surface. At about 50 inches a stratum of bluish and micaceous sandy clay is encountered. This material is probably related to horizon D of the Monroe series.

Since the Ladner Clay is comparatively uniform in texture, with smooth topography, the profile varies but little from place to place. In general characteristics and agricultural adaptations its nearest relative in the lower Fraser valley is the Monroe Clay.

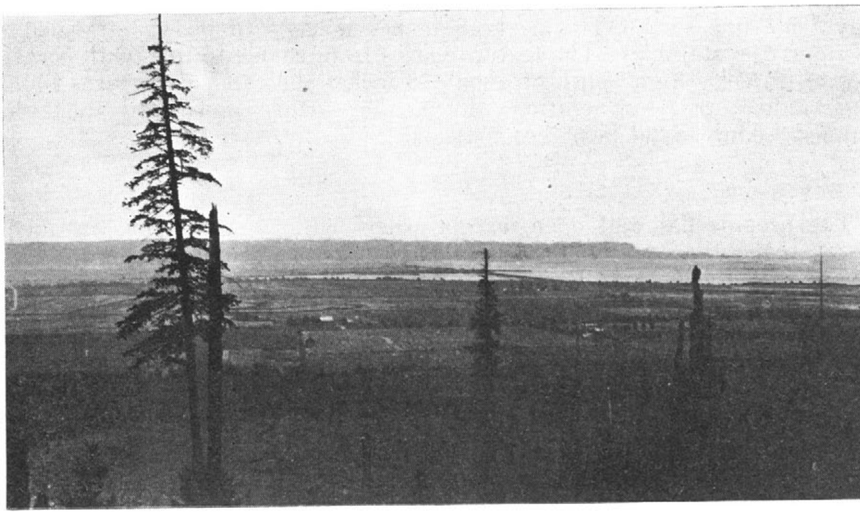

FIG. 11.—Ladner series at Mud bay, showing flat topography nearly at sea level. A sphagnum peat bog is shown in the left foreground.

Agriculture

The low, fertile and open flood-plains of the Fraser received early attention from land-hungry people. In the days when the uplands were heavily timbered and the roads were few and unsatisfactory, the Recent Delta soils were easily accessible by water, and clearing did not present any great difficulty.

Settlement dates from 1864 when the first land was cultivated and the first attempt at dyking was made on Lulu island. The results were promising and since that time it has been more profitable to dyke and drain the alluvial soils than to undertake extensive clearing operations on the more arable of the upland soils.

To-day the Ladner Clay is well developed where the drainage systems are adequate. It is only where failure has dogged attempts to dyke and drain that the natural productivity of the soil may be questioned.

In productivity the Ladner Clay compares with the most productive soils in the lower Fraser valley. The farms are mainly large, and on the larger farms the production of grains, chiefly oats, is an important enterprise. Dairying, however, is the main source of income. A smaller part of the total acreage is used for purposes other than grain growing and dairying. Vegetable and potato growing are important industries, and near Vancouver some of the larger farms have been subdivided into small parcels and sold to commuters, who produce truck for their own use and for sale.

The Ladner type takes the general form of a number of scattered flats and islands with different elevations above sea level. The most easterly section is Matsqui Prairie, situated between Mission City and Abbotsford. The area of clay on Matsqui Prairie is approximately 9,200 acres and elevation is about 16 feet. The soil is comparable to Sea and Lulu islands in texture, but the topography is slightly rolling and the elevation is higher. Drainage conditions are good except in small areas near Sumas mountain. Dairying is the most important practice. The land is mainly in hay, oats and pasture. Canning peas are grown on this area and there are small acreages of corn, tree fruits, berries and vegetables. The land is dyked along the Fraser and drained by a system of open ditches.

Between Mission City and Pitt Meadows are a series of narrow flats, dyked and cultivated mainly along the same lines as on Matsqui Prairie. The islands in the same area show different stages of development.

At Pitt Meadows the Ladner series extends from the mouth of Pitt river to Pitt lake, with a total area of about 22,000 acres. The elevation is about 6 to 10 feet above sea level. The clay profile shows some variation, with layers of sand and silt in the subsoil. The surface is overlaid by a thin layer of decomposed peat, or half-bog, from one to three inches thick. In some places a glei horizon is recognizable in the subsoil. Where cultivated the humified peat is well mixed with the soil.

Pitt Meadows is dyked against overflow, but the area is low-lying, and provision should be made for adequate drainage. A controlled water level is necessary for crop production. A swamp forest covers the uncleared part. The cleared land is used for dairying.

Certain nutritional troubles have been noted in this area, mainly in young stock and in breeding stock, which point to a lack of lime and other minerals. The problem has been at least partially solved by feeding a mineral supplement.

The effect on production of poor drainage and the thin peat covering would appear to be the outstanding factors which require investigation. It has been noted that at Chilliwack there is a comparable area of half-bog which has yielded to good drainage and soil treatment. Undoubtedly the Pitt Meadows area is more strongly acid than the normal drainage phase of Ladner Clay, on which the mineral soil is exposed. The application of two tons of ground limestone is recommended at the start, followed at intervals by subsequent applications of one ton to the acre. Such treatment will tend to neutralize soil acidity, which, in turn, will induce humification. The rate of humification may be increased by the addition of organic manures.

Lack of nutritional value in forage crops and pasture is an indication of low availability of the plantfood elements, such as phosphates and potash. While the availability of these elements may increase as the soil becomes less acid, it is necessary, for maximum results, to apply them to the land in the form of commercial fertilizers. With proper drainage and soil treatment the Pitt Meadows area is capable of growing into a productive farming district.

Lulu island is a well developed area lying between the north and south arms of the Fraser at the river mouth. The topography is flat. Elevation ranges between 3 and 10 feet above sea level. The total area of the island amounts to about 27,000 acres, of which 9,000 acres is peat bog and 18,000 acres is Ladner Clay. The Ladner Clay is all under cultivation. Dairying is the main practice on the larger farms. On smaller holdings quantities of vegetables, corn, potatoes, berries, etc., are produced. The island is dyked against the river and the sea. Land drainage consists of a system of open ditches, together with an electric pumping service for the regulation of the water level.

The available data indicate improvement resulting from the liberal use of manures and an increase in the humus content of the soil. Excellent catches of clover have followed applications of lime, either hydrated or as ground rock. For maximum results the use of commercial fertilizer is also indicated, especially in the form of phosphate.

Other developed islands at the mouth of the Fraser are Sea island, covering about 3,600 acres, and Westham island with an area of about 2,000 acres. These islands are dyked and well drained. The soil and farming practice are comparable to Lulu island.

The Ladner district is a large dyked area lying between the south arm of the Fraser and Mud bay. The Ladner Clay in this area amounts to approximately 26,000 acres. Settlement, which dates from 1868, has now reclaimed the whole area and subdivision of some of the larger farms has already begun. Grain growing is more important in this district than on Lulu island, followed by dairying. On smaller holdings potatoes, vegetables, small fruits, etc., are produced.

In the Glen Valley, Matsqui and Ladner areas, all of which are part of the Ladner series, the milk from dairy farms exhibits a lower average calcium content than that produced in other areas in the lower Fraser valley. This in turn affects the $\frac{CaO}{P_2O_5}$ ratio of the milk, and it has been observed in practice that milk from the Ladner area is particularly sensitive to the effect of heat. This instability to heat is of critical importance to the evaporated milk industry.[5] Average values throughout the map-area indicate a tendency towards low phosphorus content and this is intensified in districts where the calcium content of the milk falls to the lowest level.

While this research was made before the soils were mapped, and perhaps does not separate the herds pastured entirely on Ladner Clay from those pastured on adjacent peat areas, the noted trend towards deficiency is significant. The application of lime and phosphates to the soil is indicated, not only in the most deficient areas, but throughout the Ladner series.

MIXED AREAS

This group consists of soil areas that cannot be mapped satisfactorily as soil series. It includes areas composed of sandy and gravelly fans of streams tributary to the Fraser and areas where the parent materials of two soil series have been mixed to an extent where neither type is predominant. These areas are shown on the soil map by means of a symbol and a number. Some are arable while others are submarginal for agriculture. They are described separately or in groups in this section.

MIXED AREA NO. 1

This area covers about 7,800 acres on the Surrey upland south of the New Westminster bridge. The topography is rolling and elevation varies from 75 to 300 feet above sea level. It is composed of a mixture of Whatcom Silt Loam and Alderwood Sandy Loam parent materials, neither of which predominates.

The surface texture varies from sandy loam to clay loam, with depth of solum varying between 16 and 30 inches. Beneath the solum the underlying impervious material is the Whatcom or Alderwood type. It varies from place to place. In some places there are different degrees of mixture of the two materials. Originally the land was covered by a stand of fir, which has been logged off. The second growth is largely composed of young fir, alder, cedar, vine maple and bracken.

The land is arable but the area is mainly undeveloped. The present holdings are small and the clearings are used for the production of berries and garden truck.

The area is accessible to New Westminster by bus line and electric railway, and may eventually be settled by commuters and people who are able to secure part-time employment in New Westminster.

MIXED AREA NO. 2

The area covers about 520 acres facing Semiamu bay, near Blaine at the International Boundary. The topography is rolling to hummocky and elevation is 25 to 50 feet above sea level. The surface is covered by fir, alder, cedar, vine maple and bracken.

The topsoil is sandy loam, which is underlaid by clay similar in appearance to the parent material which underlies the Milner Clay. The land is mainly undeveloped except for a golf course near the Canadian Customs Station. It is of small importance for agricultural purposes.

MIXED AREA NO. 3

Area No. 3 covers approximately 2,300 acres in the vicinity of Port Kells. The topography is a gentle slope from 25 to 100 feet elevation. The vegetation is less dense but similar to that in other areas.

The surface soil is a light sandy loam, light brown in colour, from 12 to 18 inches deep. In places the substratum is deep sand. In others it is a variable mix of coarse sand, gravel and small stones.

With moisture relationships comparable to the Everett Sandy Loam and Loamy Sand, it is submarginal for general farming, but may be used successfully for poultry and fur raising.

MIXED AREAS NOS. 4 AND 5

Mixed Area No. 4 is a gravel deposit covering approximately 32 acres. It borders the Fraser about a mile downstream from the west end of Brae island, near Fort Langley. This area has no value for agriculture and is used mainly as a source of gravel.

Mixed Area No. 5 covers about 410 acres. It has the general appearance of a low rounded hill rising to an elevation of about 50 feet, around which the Fraser at one time trenched its course, leaving a settled and weathered mass of sands and gravels of interglacial origin, on which the town of Fort Langley is now situated. The surface texture is sandy loam, underlaid with stratified sand and gravel. Moisture relationships are comparable with the Everett Sandy Loam.

MIXED AREA NO. 6

This area covers 216 acres about a mile from Langley Prairie on the Murrayville road. The topography is gently rolling and elevation is between 25 and 50 feet above sea level. The surface soil consists of loam to a depth of about 30 inches, underlaid by sand. The land is arable and fully developed for general farming. It is composed of a mixture of outwash fan materials derived from the Everett, Whatcom and Custer soils which lie in that locality at higher elevation.

MIXED AREAS NOS. 7 AND 8

Mixed Area No. 7 covers 192 acres at the west end of Glen valley. Topography is a gentle slope with elevation between 20 and 75 feet above sea level. It is composd of fan material derived from the Whatcom series to the south. The surface soil is composed of silt and clay loam, with sand on the surface bordering the creek which runs through the area. The soil is variable, greyish in colour and immature. It is used for general farming.

Area No. 8 covers about 432 acres and lies adjacent to Area No. 7. Topography is terracelike. Elevation is 15 to 75 feet above sea level. The surface soil is sandy loam to a depth of from 12 to 18 inches, underlaid by stratified sands and gravels. It is composed of variable sandy materials and is comparable to Area No. 3 at Port Kells. Some development has taken place, but moisture relationships are the same as in the Everett Loamy Sand.

MIXED AREA NO. 9

This area covers about 1,410 acres in the vicinity of Aldergrove. The topography is rolling with the general appearance of being hummocky. Elevation is between 300 and 400 feet above sea level. Native vegetation consists mainly of dense second growth fir, cedar, alder, vine maple, shrubs and bracken.

Beneath a thin layer of dark brown organic forest litter, the surface soil, to a depth of about 12 inches, is a medium brown loam, slightly acid, granular structure, with scattered gravel and iron concretions. The next 10 to 12 inches is light brown sandy loam, with scattered gravel, and slightly compact at the bottom. In both of these horizons the sand is fine textured. The underlying material is medium, greyish-brown stratified sand, with scattered fine and occasionally coarse gravel, becoming grey with depth.

The land is arable and about 20 per cent of the area is under cultivation in small clearings. Agriculture is comparable to that in the Alderwood Silt Loam. There is small-scale production of tree fruits, small fruits and vegetables. Where sufficient land has been cleared, small parcels have been seeded down to pasture.

MIXED AREA NO. 10

This is a long narrow strip of land covering about 1,064 acres. It lies between Vedder Crossing and Yarrow on the south side of the Vedder river. The topography is flat. Elevation is about 25 feet above sea level. The native vegetation is mainly cottonwood, with an undergrowth of shrubs and bracken.

The soil is composed of talus from Vedder mountain mixed with sandy outwash from the Vedder river and fine Monroe sediments from the Fraser. The hillside materials are mostly along the southern boundary. At the west end, near Yarrow, there is an overlap of Monroe Clay Loam and some small areas of peat. The area as a whole is very mixed in surface texture, drainage conditions and in quality. Some of the land is arable and is used for dairying.

MIXED AREA NO. 11

This area, which covers about 1,256 acres, lies opposite Area No. 10 on the north side of the Vedder river. The topography is flat. Elevation is about 50 feet above sea level. It is composed of sandy and gravelly outwash from the Vedder river. The topsoil consists of a thin layer with texture ranging from light sandy loam to coarse loamy sand, underlaid by sand and gravel.

The land is submarginal for cultivation. It could be used for pasture or as a settlement for people who find employment in Chilliwack or in the surrounding district. It could be used also as a recreation ground and as a source of sand and gravel.

MIXED AREA NO. 12

The above area covers approximately 3,360 acres between Rosedale and Cheam View on the south side of the Fraser river. The surface is hummocky and the native vegetation is second-growth cedar, alder, maple and cottonwood.

The topsoil is a thin gravelly loam, underlaid by talus from the bordering mountain and river gravels mixed together by the action of water and ice. In some of the depressions there are small peat bogs.

A large part of the area is covered by Indian Reserve, which has undergone little or no development. Most of the land is marginal for cultivation, but here and there in bottoms and on the slopes of the hummocky hills, small parcels of arable land may be found. Clearings are scattered and small, and the farms still retain their pioneer aspect.

The Cariboo highway runs through this area, and the main prospect for development lies in the tourist trade as a location for tourist and recreational camps. Much of the land might also be used as a permanent source of wood for fuel.

MIXED AREA NO. 13

This area covers about 3,880 acres in a narrow valley between Agassiz and Harrison Hot Springs on Harrison lake. With elevation near Agassiz about 56 feet, the land slopes with almost flat topography to the north and west.

Originally the Harrison river flowed from Harrison lake to the Fraser at Agassiz, flooring the valley with sands and gravels. This coarse material was eventually overlaid in places by fine sediments from the Fraser and from the glaciers on the mountains bordering Harrison lake. A patchy surface of fine alluvium was thus supplied, leading to the formation of small areas of clay, clay loam, loam and sandy loam in different places.

The south and southwestern parts of the area are in contact with Monroe Clay Loam at slightly lower elevation. On Monroe series the freshet overflows of the Fraser were of sufficient importance to govern the type of native vegetation, of which cottonwood is the most important, and periodical additions of alluvium retarded the weathering process.

On Area No. 13, however, a part of the native growth developed on slightly higher ground, which has not been subject to regular flooding for a considerable time. Hence, on the higher parts of the area the vegetation of cedar, fir, dogwood, maple and birch, and the soil development more closely approximate the zonal soils with restricted sub-drainage than the comparatively unaltered Monroe type with which it is associated.

A description of the profile on the better drained part of the area is as follows:—

Horizon	*Depth*	*Description*
A_0	0–1″	Dark brown organic forest litter.
A_3	1–6″	Dark brown horizon. Texture varies from sandy loam to clay loam. No iron concretions, fine granular structure.
A_4	6–16″	Light brown to yellowish brown, texture variable, granular structure. Some iron staining at the bottom.
C–D		Light greyish brown sand, with lenses of gravel.

In the well-drained phase nitrogen and organic matter are high in the A_0 horizon. The percentage of phosphorus compares with that of the Whatcom and Alderwood series. Horizon A_3 is deficient in calcium. There is a downward movement of magnesium but no corresponding movement of the other mineral elements. Reaction of the parent material is slightly less acid than the surface soil. The well-drained phase of Mixed Area No. 13 is a zonal soil.

In the above profile the C horizon is related to the A in the sandy loam and loam. Where alluvium was laid over the sand as in the heavier soils, the sandy C horizon is not the true parent material.

The better-drained phase grades into the poorly-drained parts of the area as elevation decreases and the groundwater level more closely approaches the surface. The forest cover becomes more dense and the profile development more closely resembles the development in the intrazonal soils. A description of the poorly-drained profile is as follows:—

Horizon	*Depth*	*Description*
A_1	0–4″	Dark brown horizon, texture varies from loam to clay. High in organic matter, fine granular structure.
G	4–16″	Grey with iron stains, compact, structureless. Silt loam to clay.
C	16–24″	Grey, well mottled with iron stains, compact, structureless, streaked with blue near the bottom. Silt loam to clay.
D		Grey to blue sand.

The poorly-drained phase has weak intrazonal development with an accumulation of organic muck on top. The nitrogen and organic-matter content of this layer is high, but falls to low levels in succeeding horizons. Phosphorus is also high in the surface soil but the soil below the four-inch level is deficient in this element. Calcium, on the other hand, is low in the muck layer, and increases noticeably with depth. Only small movements of the other mineral constituents have taken place. Some significance may be attached to the fact that aluminum tends to accumulate in the upper horizons. This tendency may be associated with the extreme acidity of the surface horizon, which is much greater than that of any other soil analysed.

In the better-drained profile A_0 and A_3 horizons show a reaction of pH 5·08 and pH 5·62. In the poorly-drained profile horizons A_1 and G react pH 4·05 and pH 5·25. In contrast to this, the more productive Monroe Clay Loam shows a reaction of pH 5·93 and pH 5·87 in the A_0 and A_3 horizons.

Part of the land is drained by a ditch which starts from the northeast corner of the Dominion Experimental Farm, and runs through the main part of the district into Miama creek, which flows into Harrison lake. The remainder of the district is drained by the McCallum ditch, which flows westward from Agassiz and finally into the Fraser.

The layer of fine materials which covers the underlying sand varies in thickness from place to place. In the heavier-textured soils it is often four or more feet thick, sometimes grading to the blue colour of reduced iron with depth under the poorest drainage conditions. In the shallower parts of the area the dark and light brown to yellowish-brown horizons are only a foot or more thick, and sometimes the underlying sand is turned up by the plough. Where lenses of gravel occur in the underlying sand strata they sometimes appear on the surface in the form of low ridges, otherwise the land is free from gravel.

Much of the area is undeveloped and poorly drained. Mixed farming is practised in the better drained parts of the district. The Dominion Experimental Farm has the largest acreage under cultivation.

MIXED AREA NO. 14

Area No. 14 covers about 1,030 acres on the west side of the Harrison river. It extends north from the highway bridge for about two miles to Chehalis river. It is a low flood-plain near river level, with more or less flat topography.

On the best parts of this area two or three farms are located, but the land is not dyked. The surface 6 to 12 inches varies in texture from sandy loam to silt loam, underlaid by sand and gravel. The covering of fine materials over the underlying sand and gravel is too thin for cultural purposes. Dyking and development of the area should not be undertaken. Taken as a whole the land is of submarginal quality for cultivation.

MIXED AREA NO. 15

Area No. 15 covers approximately 420 acres. It is located about three miles east of Dewdney on the railway. This area is composed of the delta deposits of Norrish creek, which falls quickly from a high altitude. The topography is flat, elevation is about 25 feet above sea level. Native vegetation consists of a fairly dense growth of cottonwood and willow, with some fir and cedar. The soil is a thin layer of greyish sandy loam underlaid with sands, gravels and stones. Near the mountain the land is very stony. While small parcels may be of value as rough pasture, most of the area is gravelly, sandy and generally unsuitable for cultivation.

MIXED AREA NO. 16

This area, which covers about 1,240 acres, is located one-half mile west of Webster's Corners. The topography is rolling, with elevation between 200 and 325 feet above sea level. The native cover consists of second-growth fir, cedar, alder, vine maple, shrubs and bracken. The surface soil is mainly sandy loam, reddish-brown in colour, to a depth of about 20 inches, with scattered gravel and stones. Beneath this solum there is a hardpan representing a mixture of the impervious materials that underlie the Alderwood and Whatcom series. In this respect it is similar to Area No. 1, except that sandy loam is the predominating surface texture.

The land is arable, with about 30 to 40 per cent cleared and cultivated. Fruit, berry, vegetable and poultry farming are the main activities, mostly in small holdings.

MIXED AREA NO. 17

Area No. 17 covers about 775 acres. It is located two and one-half miles north of Port Haney. The topography is almost flat, with elevation about 25 feet above sea level. Native cover consists of fir, alder, cedar, maple and hemlock, with a dense undergrowth of shrubs and bracken. The area is composed of recent overflow deposits of the Alouette river, consisting of silts, sands and gravels. The surface texture is variable due to the shifting bed of the stream. Coarse sands and gravels predominate, but here and there are small patches where the soil is more silty, and these have been cleared and used for pasture. Taken as a whole the area is submarginal for cultivation.

MIXED AREAS NOS. 18 AND 19

Area No. 18 covers approximately 1,900 acres between Port Haney and Port Hammond. The topography is smooth, with elevation ranging from 50 to 100 feet above sea level.

The surface soil is loam and sandy loam to a depth of about 6 inches, medium to dark brown in colour, fine granular structure, free from stones and with insufficient gravel to interfere with cultivation. Beneath this dark-coloured surface horizon the colour fades from light brown to greyish brown for an additional 12 to 14 inches, and the texture varies from light sandy loam to loamy sand. Below this 18- to 20-inch solum the area is underlaid by grey stratified sand. The sand is variable with bands of silt, clay and sandy silt, having the effect of a hardpan in some parts of the area. Where bands of fine stratified materials occur the land should be under-drained.

Area No. 19 covers approximately 800 acres in the vicinity of Pitt Meadows. The topography is smooth, with elevation from 25 to 50 feet above sea level. The soil is sandy loam of the same kind as Area No. 18. Originally these two areas were connected, and their origin is probably associated with that of Area No. 3, which lies in the vicinity of Port Kells. However, the surface soils and substrata of Areas Nos. 18 and 19 were enriched to some extent by closer association with fine sediments.

Most of the land is cleared and used for the production of tree fruits, strawberries and vegetables. Tree fruits and strawberries are the most important crops. The moisture relationships place this soil in the arable category, but at the same time the lighter-textured parts of the area do not have the drought resistance to withstand prolonged dry periods, hence the annual crops are ripened before the midsummer dry period begins. The resistance to drought could be increased to an appreciable extent and the soil generally improved, however, by the use of organic manures.

MIXED AREA NO. 20

This area covers approximately 3,700 acres in the vicinity of Port Coquitlam. Elevation ranges between 25 and 75 feet. The topography is gently sloping. It is composed of outwash materials eroded from the Alderwood series by the Coquitlam river. In the upper part and along the banks of the river the soil is gravelly loamy sand, thickly studded with boulders. Away from the more recent stream deposits the soil changes to loamy sand and sandy loam, about 4 to 6 inches deep. Beneath this layer is a light brown horizon of loamy sand or sandy loam about 12 to 14 inches thick, which fades into greyish sands and gravels.

The land is mainly undeveloped for agriculture. Settlement is scattered and confined to small selected holdings. Taken as a whole this area should be classed as submarginal for cultivation.

THE GENERAL TREND OF LAND DEVELOPMENT

In a new area the trend of land settlement is to occupy the most fertile and most readily available soils at the start, and from these the settlement spreads by stages to lands that must be reclaimed and brought under cultivation with ever-increasing degrees of difficulty and cost. This is the general trend of development in the lower Fraser valley.

The first attempt at farming was made in 1827 in open meadows here described as Langley series. With food supplies at a premium, settlement soon spread over the meadows in the Langley district and a search began for easily developed meadow soils in other parts of the valley.

By 1862 land seekers had found the more easily available parts of the Monroe series, and in 1864 the Ladner series on Lulu island was receiving attention. As settlement increased, areas subject to floods during the freshet stages of the Fraser river were taken up and agitation began for extensive dyking systems. The great freshet of 1894 had the effect of consolidating public opinion, and from that time permanent drainage and dyking works were gradually established. These undertakings reclaimed the Monroe and Ladner series for settlement.

To-day the Langley, Custer, Ladner and Monroe series are largely taken up and cultivated. Future development in these soils will be in the direction of more specialized use, which may take the form of intensive cultivation and the sub-division of the larger farms into smaller holdings.

A considerable part of the peat land in the same area is already producing as rough pasture, and a much smaller acreage is used for intensive cultivation. Most of the peat area will become arable, but at a development cost which will approximate the cost of clearing, cultivating and fertilizing the upland soils.

The second stage of development came after the meadows were taken up in each district. This took the form of clearing off the lightest bush cover. During this period the Milner and Haney soils and the bush covered parts of the Monroe and Ladner series received attention.

The general trend of development has now reached a stage where the settler with small capital must begin to investigate the possibilities of the upland soils. The upland is composed of the true soils of the climatic zone which influences the area, and these have been divided into soils with restricted sub-drainage and soils with excessive sub-drainage.

The heavier soils with restricted sub-drainage obviously have the greatest resistance to the midsummer drought and the best assurance of farm water supplies. These factors commend themselves to the prospective settler. However, certain adverse factors should be considered and these require separate mention for each of the more important upland types.

The Alderwood Silt Loam is drought resistant, especially when the organic-matter content of the soil has been increased, but about 80 per cent of the area is non-arable by reason of the mountainous topography. The remaining 20 per cent, amounting to about 11,250 acres, is potentially arable and mainly undeveloped.

The Whatcom Silt Loam, covering approximately 67,747 acres, is another series with restricted sub-drainage. It has favourable topography, soil texture and moisture relationships. This area is about 90 per cent undeveloped for farming, and would appear to be the most favourable for new settlement on a comparatively large scale. Standing against the factors which favour the Whatcom series, however, is the cost of clearing.

Next in drought-resisting power to the Alderwood and Whatcom Silt Loams is the Lynden Silt Loam, which, with an area of about 11,267 acres, is an exception in the class of upland soils with porous sub-strata. This type has a fine surface texture capable of improvement by an increase in the organic-matter content, and a sandy sub-stratum of moderately fine texture which tends to reduce the downward movement of precipitation water. About 60 per cent of this area awaits development.

In the Alderwood Sandy Loam the mountainous topography eliminates the possibilities for agriculture in about half of the area. Where the topography is modified, the coarse texture of the soil and the close proximity of the boulder clay layer to the surface again emphasizes the drought factor. In the order of decreasing drought resistance this type may be placed below the Lynden Silt Loam, and approximately on the border line between more definitely arable and non-arable soils. At the present time the Alderwood Sandy Loam has been developed successfully as a homesite for commuters near New Westminster and for poultry and fur farming.

The upland soils with excessive sub-drainage are at once subject to the limitations imposed by the dry period which occurs in July and August, two of the most important crop growing months. The drought factor is sufficiently well emphasized to place them below the Alderwood Sandy Loam in the order of drought resistance and to indicate that development is unwarranted until the urban population has been vastly increased.

The order of land development should tend to follow the order of drought resistance and development cost. When the Alderwood Silt Loam, Lynden Silt Loam and Whatcom Silt Loam are under cultivation and the need for food supplies becomes great enough to create a large demand for early-maturing crops, the value of these lands for agriculture will tend to increase. In the meantime the soils with excessive sub-drainage, which includes the Everett and parts of the Lynden series, could best be used as a source of wood for fuel, timber, Christmas trees, for parks and like purposes. The exceptions to this rule are settlement by commuters, retired people, poultry and fur farming, and where early maturing crops can be grown with profit.

Using topographical, textural and moisture relationships as a basis for division, and excluding the undifferentiated peat, the possible total of land already developed and land recommended for development is about 317,926 acres or approximately 58·4 per cent of the map-area. Of the remainder, 32·1 per cent or 175,881 acres comprises lands with adverse topography, excessive sub-drainage or other unsuitable conditions, while 50,890 acres or 9·5 per cent is of undifferentiated peat. Table 1 of the appendix shows these figures.

The rate at which development may take place is related to an increased demand for local products afforded by a growing urban population. The 1931 Census gave British Columbia a population of 694,263, about 53 per cent or 366,757 of which live in the urban and rural parts of the lower Fraser valley. The urban population, centred mainly in Vancouver and New Westminster, amounted to 309,641 and the communities which may be classed as rural had a total of 57,116.

Between 1921 and 1931 the increase of population in Vancouver alone amounted to 83,373 or a little more than 8,000 a year. Since 1931, economic conditions have to some extent retarded normal expansion, but overcrowding of schools, hospitals and other public services suggests that the population has increased to a considerable extent since the last census.

A general increase of consuming power at the 1921-31 rate will encourage expansion of the rural area. Such problems as over-production are therefore problems of a temporary nature, which will take care of themselves as the city population is increased and economic conditions improve.

With an optimistic future afforded by a steadily expanding home market to encourage the rural community, the main problems of the area remain those of production.

APPENDIX

TABLE 1—AREAS OF DIFFERENT SOILS

Soil Series	Arable Areas		Lands with adverse topography, excessive sub-drainage, etc.	
	Acres	Per cent	Acres	Per cent
Langley Clay Loam	6,232	1·1	....	....
Custer Loam	3,800	0·7	....	....
Milner Clay Loam	10,508	1·9	....	....
Haney Clay	4,664	1·0	....	....
Ladner Clay	95,293	17·5	....	....
Monroe Clay	12,130	2·2	....	....
Monroe Clay Loam	55,406	10·2	....	....
Monroe Loamy Sand	6,300	1·1	....	....
Monroe Loam	11,102	2·0	4,400	0·8
Whatcom Silt Loam	67,747	12·4	....	....
Alderwood Silt Loam	11,250	2·1	45,004	8·2
Alderwood Sandy Loam	....	....	59,852	10·8
Lynden Silt Loam	11,267	2·1	....	....
Lynden Gravelly Silt Loam	....	....	15,639	2·9
Lynden Gravelly Loam	....	....	8,643	1·6
Everett Sandy Loam	....	....	4,734	0·9
Everett Gravelly Sandy Loam	....	....	19,620	3·6
Everett Loamy Sand	....	....	7,100	1·3
Miscellaneous Areas	22,227	4·1	10,889	2·0
Totals	317,926	58·4	175,881	32·1
Undifferentiated Peat	50,890	9·5	....	....
Total Area	....	....	544,697	100·0

TABLE 2—CHEMICAL ANALYSIS

Horizon	Depth	Nitrogen	Organic Carbon	Organic Matter	Loss on Ignition	SiO_2	Fe_2O_3	Al_2O_3	P_2O_5	CaO	MgO	K_2O	Na_2O	pH
Everett Sandy Loam														
	Inches													
A_0–A_3	0– 2	0·090	1·97	3·40	6·46	a 63·52	6·00	16·23	0·465	1·94	1·87	0·69	1·33	5·92
						b 68·00	6·42	17·40	0·498	2·08	2·00	0·74	1·42	
A_3	2–10	0·062	1·35	2·33	5·13	a 65·43	5·71	16·74	0·261	1·95	1·58	0·66	1·31	5·52
						b 69·00	6·00	17·65	0·275	2·06	1·67	0·69	1·38	
A_4	10–24	0·032	0·65	1·12	3·53	a 67·66	5·45	15·86	0·165	1·94	1·81	0·70	1·30	5·58
						b 70·00	5·65	16·45	0·171	2·01	1·87	0·73	1·35	
C	24–	0·026	0·29	0·49	2·18	a 70·53	4·70	14·82	0·090	2·08	1·91	0·76	1·79	5·63
						b 72·00	4·80	15·15	0·092	2·12	1·95	0·78	1·83	
Everett Loamy Sand														
A_0–A_3	0– 6	0·091	2·24	3·86	5·07	a 67·84	5·30	13·89	0·556	1·17	2·35	0·79	1·97	5·70
						b 71·40	5·59	14·62	0·586	1·23	2·48	0·83	2·08	
A_4	6–12	0·024	0·55	0·95	2·87	a 68·28	5·38	14·79	0·310	1·91	2·55	0·73	1·75	5·82
						b 70·40	5·55	15·30	0·320	1·97	2·63	0·75	1·81	
C	12–	0·012	0·16	0·27	1·52	a 70·76	5·11	14·06	0·064	2·04	2·93	0·81	1·92	5·48
						b 71·80	5·18	14·30	0·065	2·07	2·98	0·82	1·95	
Lynden Gravelly Silt Loam														
A_0–A_3	0– 5	0·086	1·98	3·41	7·05	a 61·75	6·91	15·77	0·242	1·61	0·98	0·80	1·37	5·27
						b 66·50	7·44	17·00	0·260	1·73	1·05	0·86	1·47	
A_4	5–21	0·053	1·01	1·76	5·06	a 64·28	6·86	16·76	0·218	1·87	2·10	0·90	1·52	5·75
						b 67·60	7·23	17·65	0·230	1·97	2·20	0·95	1·60	

a Whole soil, oven dried at 110° C. b Whole soil, calculated to mineral constituents only.

LYNDEN SILT LOAM

A_0–A_3	0– 5	0·206	3·54	6·10	9·04	a 61·45	6·90	15·62	0·282	2·08	1·63	1·07	1·48	5·93
						b 67·50	7·60	17·20	0·310	2·29	1·79	1·19	1·63	
A_4	5–20	0·101	1·19	2·05	4·77	a 62·58	7·23	16·64	0·157	1·72	2·14	1·04	1·38	5·87
						b 65·70	7·60	17·50	0·165	1·81	2·24	1·09	1·45	
D	20–	0·045	0·77	1·33	2·61	a 67·98	5·42	15·32	0·097	1·70	2·11	0·76	1·51	5·93
						b 69·80	5·59	15·80	0·099	1·75	2·17	0·78	1·55	

ALDERWOOD SILT LOAM (East of Abbotsford)

A_0–A_3	0– 4	0·111	1·80	3·10	5·04	a 66·08	6·52	14·08	0·214	1·42	1·83	1·01	1·00	5·30
						b 69·50	6·89	14·80	0·225	1·50	1·93	1·06	1·05	
A_4	4–18	0·084	1·62	2·79	5·19	a 64·27	6·58	15·20	0·197	1·82	1·84	0·94	1·26	5·80
						b 67·60	6·94	16·00	0·207	1·92	1·94	0·99	1·33	
D_1	18–30	0·037	0·58	1·00	2·50	a 68·68	5·34	14·87	0·097	2·73	1·97	0·75	1·58	5·68
						b 70·50	5·49	15·25	0·099	2·80	2·02	0·77	1·62	
D_2	30–	0·016	0·23	0·39	1·45	a 70·84	4·70	14·09	0·129	2·87	1·83	0·78	1·39	5·90
						b 71·90	4·77	14·30	0·131	2·94	1·86	0·79	1·41	

ALDERWOOD SILT LOAM (North of Mission)

A_0–A_3	0– 6	0·182	3·84	6·62	9·21	a 61·72	5·76	14·56	0·151	2·55	1·52	0·54	1·68	5·20
						b 68·00	6·35	16·00	0·166	2·82	1·66	0·59	1·85	
A_4	6–12	0·153	3·42	5·90	10·03	a 58·79	6·66	16·81	0·047	0·88	1·35	0·74	1·51	5·32
						b 65·40	7·40	18·70	0·052	0·98	1·50	0·82	1·68	
A_4	12–24	0·106	2·51	4·33	7·60	a 62·32	5·95	16·41	0·056	1·68	1·97	0·75	1·58	5·49
						b 67·40	6·44	17·80	0·061	1·82	2·13	0·81	1·71	
D	24–	0·030	0·73	1·26	2·73	a 68·48	5·04	14·75	0·032	2·41	1·98	0·79	1·72	5·47
						b 70·30	5·19	15·20	0·033	2·44	2·04	0·81	1·77	

WHATCOM SILT LOAM

A_0	0– 2	0·228	4·50	7·76	9·56	a 63·46	6·98	13·74	0·128	1·14	1·78	0·96	1·36	5·02
						b 70·20	7·74	15·20	0·141	1·26	1·97	1·06	1·50	
A_3	2– 6	0·117	2·62	4·52	7·05	a 61·75	7·76	16·00	0·152	1·17	1·71	0·96	1·21	5·36
						b 66·40	8·35	17·20	0·164	1·26	1·84	1·03	1·30	
A_4	6–12	0·049	0·70	1·20	4·52	a 62·46	7·42	17·68	0·058	1·67	2·66	1·02	1·44	5·21
						b 65·50	7·78	18·52	0·061	1·75	2·78	1·07	1·51	
C_1	12–20	0·027	0·29	0·50	3·89	a 61·94	7·70	17·69	0·046	1·55	2·64	1·11	1·83	5·12
						b 64·49	8·01	18·40	0·048	1·62	2·74	1·16	1·91	
C_2	20–	0·021	0·07	0·12	2·55	a 62·05	7·38	17·25	0·127	2·98	2·92	1·18	2·28	6·81
						b 63·70	7·56	17·70	0·131	3·06	3·00	1·21	2·34	

CHEMICAL ANALYSIS

Horizon	Depth	Nitrogen	Organic Carbon	Organic Matter	Loss on Ignition	SiO_2	Fe_2O_3	Al_2O_3	P_2O_5	CaO	MgO	K_2O	Na_2O	pH
Milner Clay Loam														
	Inches													
A_0	0– 4	2·244	5·89	10·15	13·71	a 54·43	7·55	16·95	0·272	1·55	1·92	1·00	1·31	5·32
						b 63·00	8·75	19·68	0·315	1·79	2·23	1·16	1·52	
A_3	4–13	0·109	1·93	3·33	7·77	a 56·97	8·16	20·69	0·157	1·39	1·88	0·96	1·03	5·58
						b 61·60	8·85	22·45	0·170	1·51	2·04	1·04	1·12	
A_4	13–26	0·052	0·68	1·17	5·99	a 58·52	8·65	19·07	0·052	1·39	1·99	1·18	1·11	5·45
						b 62·30	9·20	20·20	0·055	1·48	2·12	1·25	1·18	
C	26–	0·022	0·14	0·24	5·08	a 58·95	8·57	18·29	0·137	1·43	3·16	1·09	1·31	5·90
						b 62·00	9·03	19·25	0·144	1·51	3·33	1·15	1·38	
Haney Clay														
A_0-A_3	0–10	0·156	2·62	4·51	9·07	a 57·53	8·39	17·99	0·233	1·34	2·27	0·99	1·17	5·31
						b 63·40	9·22	19·72	0·256	1·47	2·50	1·09	1·29	
A_4	10–20	0·067	0·97	1·67	7·79	a 55·60	9·29	20·10	0·082	0·83	2·62	1·21	1·21	5·15
						b 60·30	10·00	21·80	0·089	0·90	2·84	1·31	1·31	
C	20–	0·033	0·25	0·43	5·59	a 57·38	8·94	18·73	0·124	0·84	2·92	1·19	1·44	5·17
						b 60·60	9·45	19·85	0·131	0·89	3·10	1·26	1·52	
Langley Clay Loam														
A_1	0– 6	0·535	6·31	10·88	14·75	a 59·82	4·21	14·47	0·331	1·55	1·10	0·81	1·46	5·23
						b 70·00	4·94	17·00	0·388	1·82	1·29	0·95	1·71	
G	6–16	0·036	0·38	0·66	3·39	a 63·54	7·21	17·63	0·058	1·76	1·46	0·74	1·58	6·63
						b 66·00	7·46	18·20	0·060	1·82	1·51	0·76	1·64	
C	16–	0·027	0·15	0·26	3·25	a 62·24	7·86	18·71	0·101	1·84	1·48	1·09	1·90	7·20
						b 64·40	8·13	19·30	0·105	1·90	1·53	1·13	1·97	

Monroe Clay Loam

A_0	0– 2	0·687	11·20	19·31	22·30	a 49·00	6·18	14·16	0·218	2·35	2·15	1·56	1·31	5·93
						b 63·00	7·95	18·20	0·282	3·02	2·77	2·01	1·69	
A_1	2–14	0·106	1·29	2·22	4·78	a 62·66	7·17	16·86	0·155	1·89	2·56	1·65	1·36	5·87
						b 65·70	7·53	17·70	0·163	1·99	2·69	1·73	1·43	
D	14–	0·029	0·26	0·45	1·92	a 70·72	5·84	13·16	0·129	1·30	2·30	0·89	1·04	5·93
						b 71·90	5·97	13·40	0·132	1·33	2·34	0·91	1·06	

Mixed Area No. 13, Well drained phase

A_0	0– 3	0·461	—	—	15·00	a 57·70	6·44	14·81	0·160	1·84	1·45	1·12	1·33	5·08
						b 68·00	7·58	17·45	0·188	2·16	1·71	1·32	1·57	
A_3	3–23	0·111	1·22	2·10	5·54	a 62·76	7·84	16·46	0·092	0·90	2·26	1·24	1·29	5·62
						b 66·50	8·30	17·40	0·097	0·95	2·39	1·31	1·36	
C–D	23–	0·054	0·83	1·43	3·90	a 63·31	7·78	16·76	0·072	1·39	2·40	1·25	1·35	5·35
						b 65·90	8·10	17·45	0·075	1·45	2·50	1·30	1·40	

Mixed Area No. 13, Poorly drained phase

A_1	0– 4	0·936	11·54	19·87	24·07	a 52·52	4·18	14·67	0·209	0·82	1·05	1·23	0·87	4·05
						b 69·50	5·51	19·35	0·276	1·08	1·38	1·62	1·14	
G	4–16	0·054	0·86	1·48	3·16	a 67·56	6·45	17·03	0·065	1·38	1·31	1·21	1·20	5·25
						b 70·00	6·68	17·65	0·067	1·43	1·35	1·25	1·24	
C	16–	0·027	0·38	0·66	1·89	a 68·44	6·84	15·35	0·098	2·19	1·58	0·88	0·98	5·82
						b 69·80	6·98	15·65	0·100	2·24	1·61	0·89	1·00	

TABLE 3.—MEAN MONTHLY TEMPERATURES (Degrees F.)[9]

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	No. of years
Vancouver	36	39	43	48	54	60	63	63	57	50	43	38	50	35
New Westminster	36	39	43	49	54	60	64	63	58	50	42	38	50	48
Stave Falls	34	38	42	49	55	60	65	65	58	50	42	36	50	27
Agassiz	34	38	43	49	55	60	64	63	59	50	42	37	50	45
Steveston	36	38	42	47	53	58	61	60	55	48	42	38	48	40

TABLE 4.—MEAN MONTHLY PRECIPITATION (Inches)[9]

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	Average annual snow fall. 10 years or more
Vancouver average 36 years.	8·76	5·70	5·24	3·22	2·76	2·32	1·29	1·64	3·80	5·80	8·45	8·56	57·54	29·0
New Westminster average 43 years.	8·36	5·71	5·06	3·34	2·75	2·57	1·32	1·54	3·79	5·48	8·29	7·96	56·17	29·0
Stave Falls average 27 years.	11·17	7·22	7·84	5·09	4·40	3·60	2·14	2·46	5·31	8·53	10·40	11·26	79·42	23·7
Agassiz average 47 years.	7·69	5·83	5·48	4·26	4·39	3·94	1·92	2·20	4·60	6·70	8·37	8·12	63·50	41·8
Steveston average 41 years.	5·33	3·61	2·92	2·00	1·87	1·66	0·93	1·14	2·38	3·66	5·53	5·52	36·55	15·6
Abbotsford* average 16 years.	6·30	5·01	5·43	4·75	4·24	3·93	1·57	1·47	4·19	5·08	9·10	8·46	56·53	....

*Report for 1935.

TABLE 5.—SUMMARY OF CLIMATE[9]

Hours of Bright Sunshine	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Vancouver average of 24 years	49	84	127	180	234	230	291	267	179	111	56	39	1847
Agassiz average of 29 years	46	77	103	132	164	162	213	198	136	96	53	44	1424
Relative Humidity:— Percentage Vancouver average of 32 years	88	86	80	72	73	72	72	76	81	86	88	87	80
Days of Rain:— Vancouver average, 1924 to 1935 inclusive.	20	16	17	12	11	9	7	6	10	16	19	23	166

TABLE 6.—CLIMATIC DATA (Record of 10 years or more)[8]

Station	Growing Season						Mean Annual Precipitation				
	First day	Last day	Total days	Total heat units	Mean temp. of the six hottest weeks.	Mean annual temp.	1st quarter, inches	2nd quarter	3rd quarter	4th quarter	Total inches
Vancouver	Mar. 16	Nov. 14	243	13,369·8	63·7°	49°	18·97	8·58	6·61	22·65	56·81
Steveston	Mar. 22	Nov. 9	232	12,441·3	60·7°	48°	11·43	5·65	4·27	14·52	35·87
Ladner	Mar. 16	Nov. 14	243	13,091·0	61·7°	49°	11·22	5·51	4·58	14·44	35·75
Chilliwack	Mar. 24	Nov. 7	228	12,696·4	63·7°	49°	10·29	5·51	4·62	15·42	35·84

NOTE:—*The dates of the growing season* are those at which the temperature 43° occurs in spring and fall.
The total heat units are the sum of the products of the monthly means by the number of days in that month.

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