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SOIL SURVEY

OF THE

OKANAGAN and SIMILKAMEEN VALLEYS

BRITISH COLUMBIA

BY

C. C. KELLEY
PROVINCIAL DEPARTMENT OF AGRICULTURE

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REPORT No. 3
OF BRITISH COLUMBIA SURVEY

The British Columbia Department of Agriculture in Co-operation with Experimental Farms Service, Dominion Department of Agriculture

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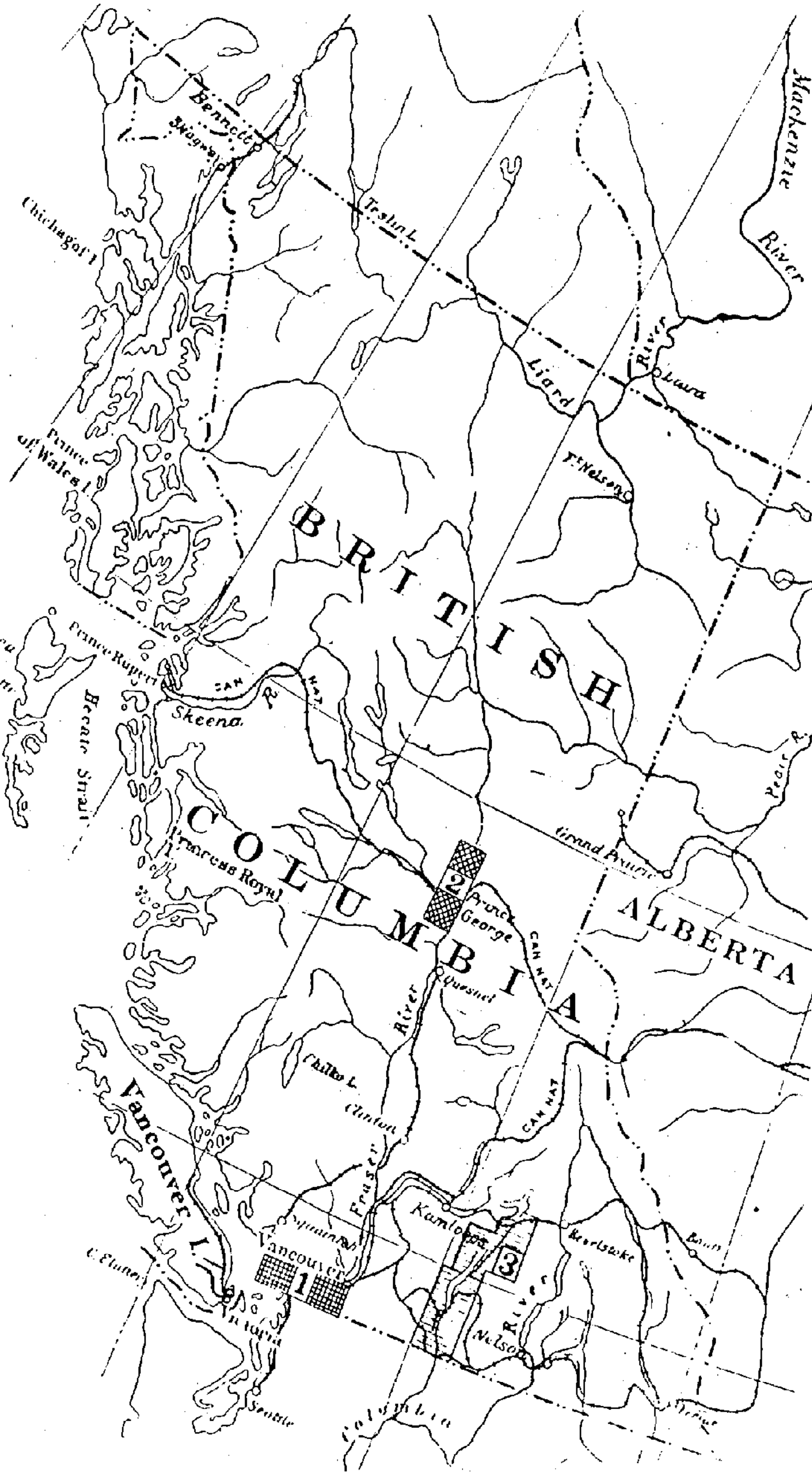


Map of British Columbia showing locations of surveyed areas for which reports and maps have been published: 1. Lower Fraser Valley. 2. Prince George Area. 3. Okanagan and Similkameen Valleys.

CONTENTS

INTRODUCTION

This publication is the third of a series reporting the results of a soil survey which, when completed, will cover the agricultural sections of British Columbia. Each report, complete in itself, is intended to be a brief description of the surveyed area. A description of the soils is the primary purpose, but the report includes other data bearing on their nature and utilization.

Taken as a whole, the Okanagan district is noteworthy for the diversity of its natural resources. The northern section produces grain, dairy products, pork, poultry, and vegetables, together with some fruit. In the south, a great variety of fruits and vegetables are grown in addition to dairy products for local use, and the variation of climate promotes a north and south movement of food supplies for local consumption at different seasons of the year.

In the surrounding mountain region are grazing areas for cattle and sheep, with the valley as the base for winter feeding. This resource partly supplies the Okanagan district with beef and mutton. The mountain district is also the catchment basin from which the irrigation and domestic water is obtained. At elevations up to 6,000 feet, the water from melting snow is stored in dammed lakes and meadows for use during the growing season.

Additional storage space at the higher elevations is still available, but thousands of acres of good soil cannot be reached by gravity water and remain idle for want of irrigation. These lands lie near valley lakes and rivers and they await the day of large-scale pumping. The sources of hydro-electric power for general needs are the British Columbia Power Commission, the supplier of the North Okanagan, and the West Kootenay Power & Light Co., whose distribution system covers the area to the south of Woods Lake. These utilities are interconnected for continuous service and their systems are capable of all demands.

Most of the mountain area is covered with timber, now being exploited for wood products and fuel. With conservation, this resource is extensive enough to ensure a continuous supply.

The soils of the region are the most important asset, and in the intensively cultivated district, even minor variations affect their conduct under irrigation. In this report they are classified into a simple system of great soil groups, soil series, and types. The approximate areas of the different soil types are shown in appended table 6.

The soil map is published in 4 sheets covering the Okanagan Valley, together with a few side valleys and the southern part of the Similkameen Valley. The maps show the location and extent of the different soil types and their average surface textures. The soils located on the maps are differentiated by symbols and colours which are explained in the legend.

GENERAL DESCRIPTION OF THE AREA

LOCATION AND EXTENT

The Okanagan district is a broad, irregular depression near the east side of the region of interior plateaux. In a northerly direction, it extends from north latitude 49° to north latitude 50° 45′, the average longitude being 119° 30′ west.

The mapped area is confined to bottoms and adjacent slopes of the main valley and side valleys, over a total length of about 120 miles. The southern half of the Okanagan Valley is only 3 to 6 miles wide, but it spreads out in the northern part, the total width at Armstrong being about 12 miles.

The classified area in the Okanagan Valley and lower part of the Similkameen Valley covers approximately 345,000 acres. This does not include the lakes and rough mountainous land shown on the soil map.

TOPOGRAPHY

The surface features of the main depression resemble those of an ancient peneplane shattered by violent earth movements, in which a drainage system subsequently became established. This old drainage probably took southward moving waters of Shuswap Lake and Shuswap River, which in Tertiary time flowed into the Columbia River. The North Okanagan, from Kelowna to Sicamous and Salmon Arm, is characterized by valleys that branch to east and west, and also by more or less parallel valleys in the main depression. To the south of Kelowna, the valley becomes a single trough, with smaller and less important tributaries.

A stage of glaciation left the valley bottoms U-shaped, with parts terraced and filled by colluvial fans and other parts occupied by lakes. The lake elevations, from north to south, indicate within a few feet the height of the lowest land areas. Low water in Shuswap Lake is 1130 feet above sea level, with Okanagan Lake 1121.7 feet. Skaha Lake is 1107 feet and Osoyoos Lake 903 feet elevation. At drainage level the south end of the valley is only 227 feet lower than the north end.

Above moderate valley slopes, the upland consists mainly of rounded and wooded hills with rolling upper surfaces which rise to elevations of from 4,000 to 6,000 feet. Some of these hills contain lakes and bogs of limited size, which have been dammed and used as a source of water supply by the irrigation districts.

DRAINAGE

In the northern part, the Okanagan district is drained by the Salmon and Shuswap Rivers, which rise in the hills and flow into Shuswap Lake. This irregular body of water, covering about 123 square miles, is tributary to the Fraser River. The Salmon River enters the Okanagan Valley at Glenemma and flows northward, following part of an old channel that at one time may have drained to the south. The Shuswap River rises in the Monashee Mountains near Revelstoke and after passing through Sugar and Mabel Lakes it enters that part of the Okanagan known as the Spallumcheen Valley at Enderby. It then flows north in the Spallumcheen Valley to Mara Arm of Shuswap Lake.

A striking feature of the Okanagan drainage is a low divide about a mile east of Armstrong in the Spallumcheen Valley. South of this point the waters are tributary to the Columbia River.

The Central and South Okanagan drainage system is famous for the size and beauty of its lakes, which occupy about 157 square miles in the valley depression. Otter Lake (0.34 sq. mi.) is a small body of water in Spallumcheen Valley, and Swan Lake (1.72 sq. mi.) is in Pleasant Valley. South from Vernon is Mission Valley, which contains Kalamalka or Long Lake (9.3 sq. mi.), Woods Lake (3.43 sq. mi.) and smaller Duck Lake (0.82 sq. mi.). In the main valley trough is Okanagan Lake, with an area of about 127.32 square miles. It is 69 miles long, about 2 miles wide, and has an extreme depth of about 760 feet.[4] South from Okanagan Lake are Skaha Lake (7.52 sq. mi.), Vasseaux Lake (1.13 sq. mi.), Tugulnuit Lake (0.2 sq. mi.), and Osoyoos Lake, which extends south of the International Boundary, has 5.59 square miles in Canada. Okanagan River drains from the south end of Okanagan Lake and passes through Skaha, Vasseaux, and Osoyoos Lakes.

The higher valley lands consist of naturally well-drained terraces, but slopes flatten lower down near the level of present run-off, and sections of the valley bottom have restricted drainage.

THE SIMILKAMEEN VALLEY

From Keremeos to the International Boundary, the Similkameen River Valley lies parallel to the lower part of the Okanagan, the two valleys being separated by a ridge of mountainous land used mainly for grazing. The Similkameen differs from the Okanagan by its smaller size and steep slopes, which rise more or less abruptly to about 3,500 feet elevation, with ultimate elevations 6,000 feet or more above the sea. Tributary streams cascade down the mountain sides and some of these are used as a source of irrigation water.

From Hedley to Keremeos, the valley bottom seldom exceeds 4,000 feet in width, the chief exception being at the junction of the Ashnola River. From Keremeos to the International Boundary, it broadens out to a width varying from 1½ to 2½ miles. Between Hedley and the 49th parallel, the mapped area in the valley bottom amounts to about 22,100 acres.

The elevation of the valley bottom is about 1,600 feet at Hedley and 1,400 feet at the International Boundary, a distance of about 35 miles. In the lower part, between Cawston and the Boundary, the grade is slight and the meandering stream has built comparatively wide second bottoms.

The valley has 2 small irrigation districts with a total of 1,254 acres under crop, the annual water tax being $12.50 per acre. An additional 176 acres under irrigation represents the small individual systems which obtain water independently of the organized irrigation districts. The total irrigated land in the mapped part of the valley amounts to about 1,420 acres.

The population of the irrigated section, and the small village of Keremeos, is about 1,165. At Hedley, there is an additional population of about 928, but this is a mining camp situated in a non-agricultural area.

SURFACE GEOLOGY

In the early part of the Tertiary, the southern interior plateau region was base levelled, and in the low valleys extensive swamp and lake deposits were formed. The coal measures around Princeton and the diatomaceous earths of Quesnel are said to date from the Eocene.

The Middle Tertiary, or Miocene, was noteworthy for uplift and volcanic activity with which extensive lava flows were associated. In many places the Eocene drainage system was obliterated. During this active period, a line of weakness appeared along the present course of the Okanagan Valley. There was extensive faulting and folding, the effects of which are still evident. From Kelowna north, the main depression is a compound valley with a great ridge in the centre, whereas to the south of Kelowna, the valley is more like a single trench.

The great depression thus formed, readily became the chief outlet of a new drainage system, the region now occupied by the Shuswap Lakes being part of the watershed. By the end of the Tertiary, the Okanagan had become a long established river valley. Even today, if it could be cleared of debris, it would take the drainage of Shuswap Lakes and Shuswap River.

During the Pleistocene, the Cordilleran ice sheet overrode the country up to 7,000 feet elevation. Ice action rounded off the surrounding hills by weight and abrasion. Pre-existing soils and other loose material were moved and mixed in the ice. Many kinds of rock formations were abraded into all textural sizes and mixed with the other foreign material in the ice.

Growth of glaciation was eventually followed by decline to a system of mountain glaciers, with valleys partly blocked by remnants of the ice sheet. Accumulation of debris to form till was succeeded by its redistribution in melt-water as valley-filling material.

While the present lake depressions remained blocked with ice, ponding took place to the north of Westbank. To the south of Westbank, drainage took the form of slow-moving rivers at the valley sides, between the mountains and the ice-filled lake depression.

The temporary lakes in the North Okanagan were bedded with heavy clay, laid down in the form of annual layers or varves. The varved clay lines parts of the present valley bottom between Westbank and Salmon Arm in the map-area, and westward to Sorrento.

The glacial rivers along the valley sides to the south of Westbank were slow moving and they built up their beds with silt and fine sands from the mountain glaciers. When the ice in Okanagan Lake depression melted, silt banks were left standing with one face exposed. These banks are prominent features near Summerland and Naramata. Stratified silts of the same type are partly exposed, and in part, buried under subsequent sands and gravels in the vicinity of Oliver and Osoyoos.

Tributary streams were the chief contributors of sorted till products and the main valley is most extensively filled at their points of entry. In such areas, gravelly and sandy terraces replace and overlie the lateral moraines.. The lateral moraines, and some of the older terraces, were in part composed of ice. When this ice melted the surface collapsed forming knob and kettle topography.

The post-glacial erosion cycle began when drainage approached present run-off levels. The streams carved channels through the glacial lake and river terraces and spread their fans in the valley bottom. With lower surface elevation, Okanagan Lake included Skaha Lake. Skaha and Okanagan Lakes are now separated by a post-glacial dam built by Ellis and Shingle Creeks, which enter at opposite sides of the valley near Penticton. Similarly, Woods Lake formerly included Duck Lake, but the two have become separated by the post-glacial fan of Vernon Creek.

Extensive post-glacial fans occur throughout the Okanagan. In the more humid northern section, the fans have no new additions. Recent additions have occurred in the south, where grasslands reach high elevations and cloudbursts cause violent erosion. The fans in the north were probably formed in early post-glacial time, before the higher elevations were forest covered.

In summary, it is evident that all mineral soils of the Okanagan district are derived from material transported by ice and water. The ancestral parent material is glacial till derived from many sources. The till covers high elevations, and with the drift, occurs in the form of lateral moraines. During the decline of the glaciers, the till was eroded to form gravelly terraces, sandy terraces, stratified river fine sands and silts, and glacio-lacustrine clays. The material deposited by the post-glacial erosion cycle on fans and flood-plains consists of freshly worked till and reworked terraces and other deposits of the earlier cycle. Soils derived from these materials have the same mixed heritage. Differences of chemical composition are those of degree and are generally the result of water sorting.

THE CLIMATE

The Okanagan climate is one of the mildest in Canada. Summers are warm with cool nights and winters are mild with occasional low temperatures lasting from a few days to a week. Generally there are one or two cold periods each winter, when the temperature may reach zero or go below zero. During such periods the smaller lakes are covered with ice, but Okanagan Lake is generally ice-free, excepting once or twice in a decade when a late cold spell will cause it to freeze over.

In the southern part of the valley, only about half of the winters have short periods of zero temperature, while in the north zero temperatures are somewhat more frequent. Important features of the valley climate are a rise in mean temperature, a gradual drying off, and an extension of the frost-free period from north to south.

Temperature

Since temperatures constantly change, the use of mean annual temperature has greatest value for comparative purposes. Different stations show that the northern part of the valley is from 4° to 6° colder than the south end.(5) The mean annual temperature at Salmon Arm in the north is 46° F., but it drops to 44° at Armstrong. Southward the mean annual temperature increases to 50° at Oliver.

Winter temperatures for December, January, and February are 26 for Salmon Arm and 29° at Oliver. These are among the highest winter temperatures in Canada. The lake influence is very marked, as indicated by the lower temperatures at Armstrong shown in table 1. Spring temperatures are the average of the monthly means for March, April, and May, and are useful in showing the relative earliness of the season. These are 47° at Salmon Arm and 51° at Oliver.

TABLE 1: AVERAGE SEASONAL TEMPERATURES. (Deg. F) (5)

Station	Elevation. Feet	Winter	Spring	Summer	Autumn	Year
Salmon Arm	1159	26	47	65	46	46
Armstrong	1187	24	45	64	44	44
Vernon	1287	26	47	66	46	47
Kelowna	1130	28	46	65	47	47
Summerland	1300	29	48	68	48	49
Penticton	1121	30	48	66	48	48
Oliver	995	29	51	71	49	50
Keremeos	1165	28	50	68	49	49

The summer temperature is the average of the monthly means for June, July, and August. These are 65° at Salmon Arm and 71° at Oliver, a difference of 6°. Autumn temperatures for September, October, and November are important for many late crops. The range of autumn temperature from north to south in the valley bottom is from 46° at Salmon Arm to 49° at Oliver. For some purposes, it may be desirable to supplement the seasonal temperatures with monthly means. The monthly means for selected stations are given in appended table 1.

In table 2 are shown the highest and lowest temperatures on record. At the north end of the valley, a high of 106° F. occurred at Salmon Arm in 1941, while at Oliver, 111° was recorded in the same year. The lowest known temperature in the north is –39° F., experienced at Armstrong in 1943. At Oliver a minimum of –21° was placed on record in 1943.

TABLE 2: EXTREME TEMPERATURES AND AVERAGE SNOWFALL 1916 TO 1946, (5)

Station	Temperature (Deg. F)			Year	Snowfall (Inches)
	High	Year	Low		
Salmon Arm	106	1941	–31	1916&17	66.7
Armstrong	105	1941	–39	1943	46.4
Vernon	104	1941	–26	1917	43.6
Kelowna	102	1941	–17	1935	31.9
Summerland	104	1941	–17	1916	29.9
Penticton	105	1941	–12	1935&36	31.2
Oliver	111	1941	–21	1943	21.5
Keremeos	106	1926	–20	1923	23.5

Among the chief factors affecting the micro-climate of the valley depression is altitude, which has an important influence on temperature and precipitation. The temperature drops as elevation is increased and the air loses its ability to hold moisture. Native vegetation and agriculture are affected by the greater relative humidity and shorter growing season at the higher elevations.

In the growing season, the deeper parts of the valley attain moderately high temperatures during the day, but collect cool air which drains from the slopes at night. Frost danger at night is offset by the valley lakes, which stabilize the climate of nearby areas.

The Growing Season

Each plant has its own growing season. Some plants are more resistant than others to cold and their periods of growth vary accordingly. A measure of this period is essential, however, in a description of climate, and this is defined as the date on which the mean of 43° F. occurs in spring and fall. On this basis, growth at Salmon Arm begins around April 6, and extends to October 22, a period of about 199 days. At Oliver, growth begins about March 16, and ends 226 days later on October 28, a difference of about 27 days in favour of the south end of the valley. The growth period at other stations is shown in appended table 2.

The occurrence of the last frost in spring and the first frost in fall is of significance mainly to the group of crops with the least frost resistance. It is with these crops that large commercial losses are likely to occur, and for them the last date in spring on which the temperature 32° F. is recorded, or the first similar condition in fall, is regarded as the date of the first and last killing frost.

The conditions surrounding the occurrence of frost are complex; altitude and air drainage being of primary importance in the interior valleys. The distribution of frost and its relative severity often varies with slight differences of elevation, owing to the tendency of cold air to collect in local depressions. Bodies of water also have a moderating influence and the frost-free period near valley lakes is generally greater than a mile or two away.

Because the period available for plant growth is largely confined to the time between the last killing frost in spring and the first in fall, the dates of these frosts and the periods between them are the most important statements of frost occurrence that can be recorded. These dates in any locality are subjected to wide variations from year to year, and the most significant fact regarding them is their irregularity. With spring planting, the possibility of frost damage lies between the narrowest and the widest limits, hence the question the farmer must decide is the degree of risk he is able to incur in order to make use of the period between the earliest final spring frost and the latest spring frost in the local record. In appended table 2 is shown the frost datum at selected stations in the Okanagan and Similkameen valleys.

Precipitation

The shape of the precipitation pattern in the valley region is dominated by the general climatic factors which affect the southern interior. These are the influence of the Pacific Ocean and the arrangement of the Coast Mountain systems.

In winter, the moisture-saturated winds from offshore, turned upward by the Cascades and the Coast Range, are cooled with increased elevation and they discharge the bulk of their water on the higher western slopes. When these winds arrive on the east side of the mountains they are at high elevation and much of their moisture has been lost; thus limiting the interior to a smaller total precipitation than the coast.

There is a secondary maximum of precipitation on the western slopes of the Selkirk Range, not far from the north end of the Okanagan Valley. Southward, the Okanagan veers away from the Selkirks, hence the north end is the most humid part, with a gradual drying off towards the International Boundary.

Summer is dominated by comparatively cloud-free westerly winds which bring dryness to the coast and to the interior. High winter precipitation succeeded by summer dryness, the chief characters of the coast climatic regime, yields a modified precipitation pattern in the Okanagan district as illustrated in Fig. 1.

In the interior, the lighter winter precipitation falls mainly in the form of snow; with an uneven distribution caused by difference of elevation. The high mountains receive the greatest snowfall and low elevations farthest away from high elevations receive the lightest fall of snow. Decreased rainfall in summer follows the trend of lighter snowfall and the whole precipitation pattern shrinks as distance from the high mountains to the low elevations is increased. A departure from the coast precipitation pattern is the secondary peak of rainfall in June. This feature is of great importance to agriculture, particularly in the North Okanagan.

Salmon Arm, at the north end of the Okanagan district, has an annual precipitation of 19.23 inches. Southward, the decrease in precipitation is progressive until at Oliver there is an annual average of only 9.42 inches. The gradual reduction of precipitation from north to south is the factor which creates successively more arid soil and the vegetative distinctions in the valley bottom. Appendix table 3 shows the amounts of precipitation under which these climatic types developed. Salmon Arm exemplifies the minimum needs of the Inter-

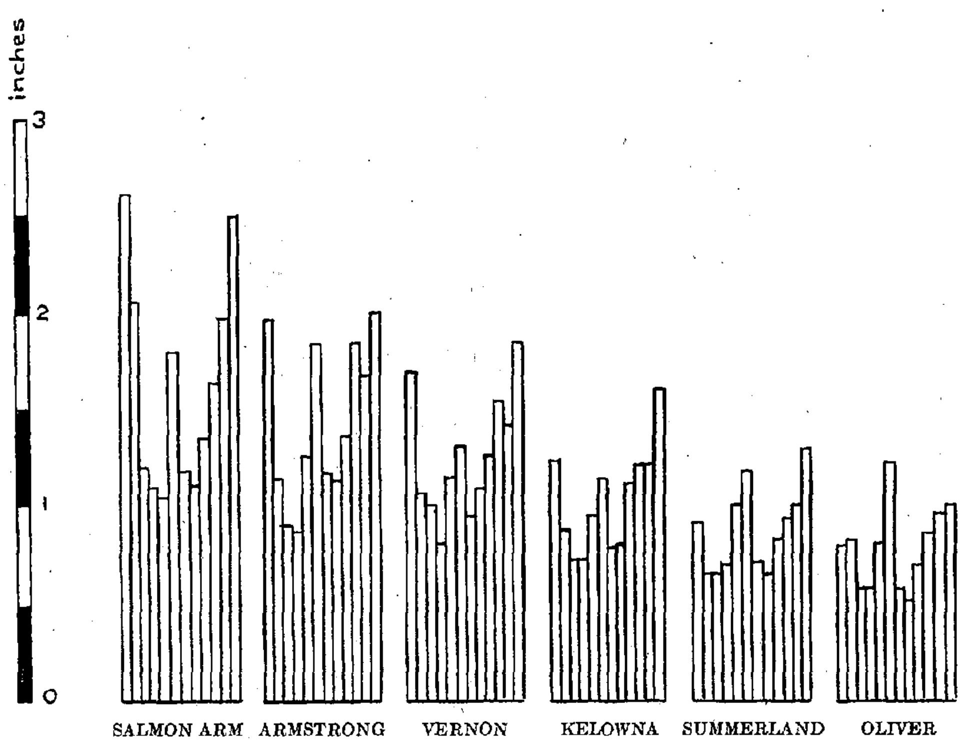


Fig. 1: Precipitation pattern in the Okanagan Valley, January to December, illustrating the drying off from north to south and important June rainfall. Average for 23 years or more.

mountain Podsol. Armstrong and Vernon, with high June rainfall, indicate the north and south limits of the Black Earth in the valley bottom. The Kelowna station shows the precipitation associated with the Dark Brown Soils, while Summerland and Oliver indicate the northern and southern precipitation of the Brown Soils.

Relative Humidity

Relative humidity, calculated from wet and dry bulb readings, is highest in winter and lowest in summer, as shown in Fig. 2. The average relative humidity at Vernon is shown in appended table 4.

In the absence of rain, the comparative constancy of water vapour in the atmosphere brings a drop in relative humidity as the temperature rises with the sun. Under these conditions, a relative humidity of 80 per cent at dawn may drop to 20 per cent in the hottest part of the day. While Vernon has the only humidity station in the Okanagan from which continuous data are available, there are many indications that relative humidity in the northern and southern parts of the district have some variation. Higher summer humidity in the north permits the growth of certain crops that cannot be produced successfully in the south.

Low relative humidity in summer also has a direct influence on the growth of parasitic fungi. Apple scab and similar parasites, which have gained a foothold in the north, cannot maintain their existance in the southern Okanagan because of the prevailing low humidities. An expression of comparatively low humidity throughout the map area in the growing season is the freedom of crop foliage from fungus spots of all kinds. However, the virile codling moth thrives under these conditions much better than in more humid districts.

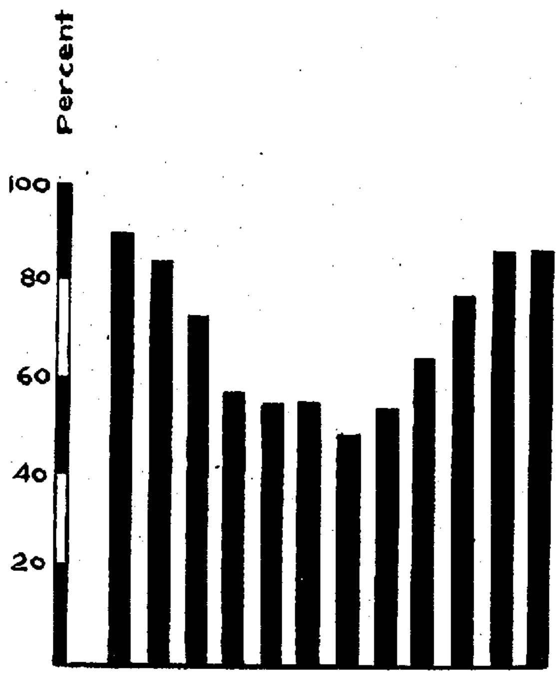


Fig. 2: Relative humidity at Vernon, January to December, average for 17 years.

Cloudiness and Bright Sunshine

In November, December, and January extreme cloudiness prevails in the southern part of British Columbia and bright sunshine is restricted to a remarkable degree. In the Okanagan Valley, this general cloudiness is increased by a low ceiling which forms at the height of the valley rim, and in mild winters when north winds rarely occur, the cloudiness can be greater than in any part of the Province where records are kept. In cold winters, which have more north wind, the hours of bright sunshine are considerably increased. While lack of sunshine in winter is not always appreciated, it has fundamental value to the valley agriculture. The cloud ceiling levels winter temperatures and the winter-killing of fruit trees by freak weather is of rare occurrence.

In summer, bright sunshine reaches a peak in July with 324 hours at Summerland. In the whole Province, this average is exceeded only by Victoria with 334 hours of sunshine. The distribution of sunshine throughout the year is shown in Fig. 3, and hours of bright sunshine at 4 valley stations are appended in table 4.

Prevailing Wind

For all months of the year, except July, the prevailing surface wind is up-valley from the southwest, with average velocity of 6.17 miles per hour. In July the wind prevails from the northeast, with average velocity of 6.94

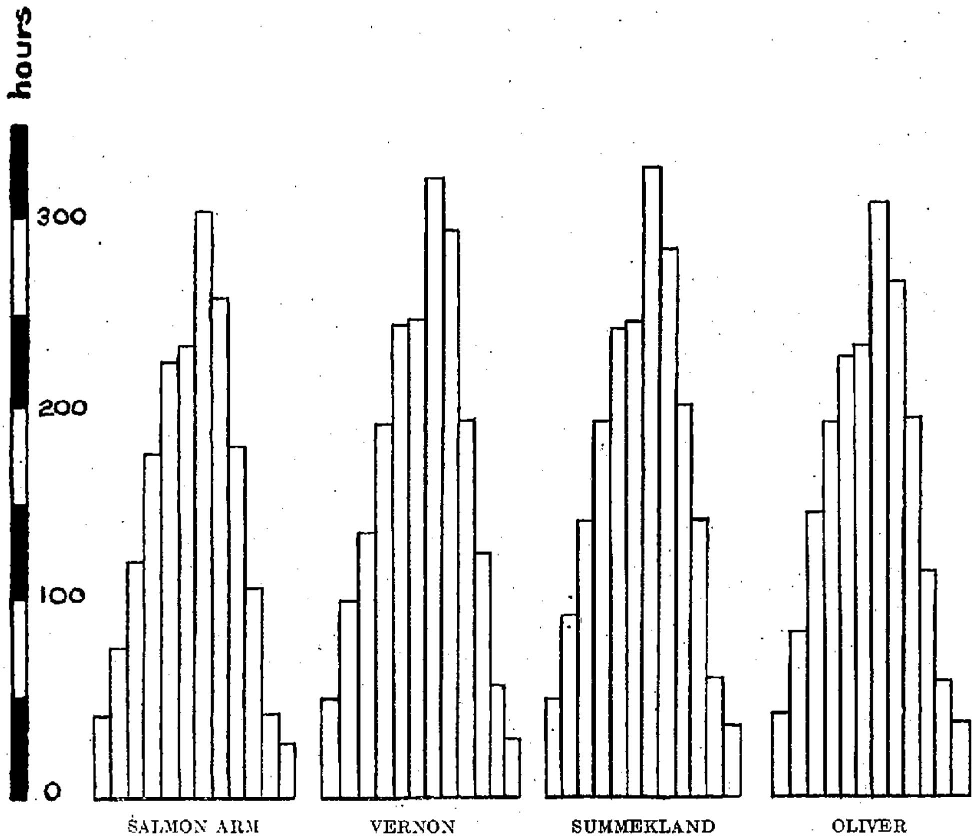


Fig. 3: Sunshine pattern, January to December, at four Okanagan Valley stations. Average for 23 years or more.

miles per hour. These winds are warm and light, but occasionally strong in spring and fall. They are varied with local down-draft from tributary stream coulees on the west and more rarely on the east, with occasional north winds. At the Summerland Experimental Station, the maximum velocity recorded in 10 years is 46 miles per hour, the average maximum velocity being about 24 miles per hour, and the yearly total about 54,000 miles.

The prevailing drift of air from the southwest in winter is slight, and this permits the accumulation of a low cloud ceiling over the valley depression. When the wind shifts to the north, the cloud ceiling is dispersed, but it returns when the drift of air is again from the southwest.

HISTORY AND DEVELOPMENT

The first white men to view the Okanagan were fur traders who made their way into the region from the south in 1811. Thereafter, a trading post was established at Kamloops and until 1848, when the International Boundary dispute was settled, the bulk of the fur trade passed north and south, using the valley route. Settlement of the boundary question diverted the trade elsewhere, and for the next 10 years the trail was little used until the gold rush in 1858.

Early land settlement in the Okanagan Valley was a result of the search for gold, and due partly to the failure to find easy wealth in the gold diggings. It began at L'Anse au Sable (now Kelowna) in 1859 by Oblate priests, who registered land claims in 1860. Several other recordings for farming purposes were taken up in 1860 and 1861 and by 1863 there was a school at the Mission with 5 or 6 pupils who were instructed in the French language.

In the northern part of the district the first locations were made by overlanders from the East who came to the Spallumcheen Valley in 1862, after which settlement was more or less continuous. In the south at Penticton, the first land claim was recorded in 1867 and at Oliver in 1869. [10].

Land settlements and villages were gradually built up in the northern part of the valley and small flour mills and saw mills, to supply local needs, were the first industries. Crops, dairy products, and beef were produced to supply the mines and for local consumption. By 1892 there were about 400 settlers in the valley and nearly 20,000 cattle between Osoyoos and Enderby.[13]

The heavy Black Soils between Vernon and Enderby placed early emphasis on grain growing, and about 6,800 acres are still used for this purpose. But in these soils alfalfa and timothy hays, ensilage corn, field peas, potatoes, field roots, small fruits, and vegetables were of subsequent importance. To the south of Vernon, the bottom lands with favourable summer moisture conditions, here described as Nisconlith series, were gradually cleared of brush and used for mixed farming. At the same time the bench lands, too dry for farming, were suitable for range.

The first fruit trees were planted by the priests at the site of the old Mission near Kelowna in 1859 and 1860. Owing to the more favourable moisture conditions, most of the early plantings were on the Nisconlith series, which is also the soil type upon which the Mission was located. At Kelowna and Vernon, some of the first commercial plantings of fruit trees were undertaken by Lord Aberdeen on the Guisachan and Coldstream ranches in 1892.

The quality and yield of fruit from the early orchards eventually led to the installation of irrigation systems. Large holdings were broken up into subdivisions between 1890 and 1900, and irrigation projects were organized with the idea of selling land at high prices. A fruit land boom, which increased values from $1 per acre in 1898 to $1,000 per acre in 1908, began in 1900 and lasted until 1910. [13] Extensive fruit tree plantings on the valley benches commenced around 1900 and were continued on a comparatively large scale until 1914. After 1914 the plantings were on a smaller scale and more nearly related to market requirements.

Irrigation and Domestic Water

The map-area contains 23 irrigation districts with about 35,613 acres under irrigation. Every organized district has a storage and supply system serving a group of farms, and the cost is met by an annual tax on each irrigated acre. The lowest water charge for any district is $2.75, and the highest $28, per acre per annum. The water cost in most districts is between these two extremes, the average being around $13 per acre per annum.

There are, in addition to the incorporated irrigation districts, a number of Water Users Communities, irrigated Indian lands, and privately-owned systems serving one or more farms. Some of these rights date from the earliest records, and they are mostly represented by short ditches that take off conveniently from creeks. Farms are located wherever sufficient water and a small area of suitable land is available, and while the individual acreage is often small, the total of these areas is about 9,285 acres.

In the Okanagan Valley there are about 43,478 acres under irrigation, and the mapped part of the Similkameen Valley contains an additional 1,420 acres. In the whole map-area the total of irrigated land amounts to about 44,898 acres.

Farm water supplies in well-developed irrigation districts are mainly secured from domestic pipelines, some of which provide water under pressure for lawns and gardens. Other sources of domestic water are creeks, wells dug into springs and seepages, and irrigation water. Users of irrigation water require concrete cisterns for storage in winter and in summer periods when the supply ditches are dry.

Population, Towns and Industries

From about 400 in 1892, the population of the Okanagan district has increased to about 62,508 in 1947, of which more than half is urban. There was a steady influx from the Prairie Provinces during the drought and depression years of the 1930's, when the increasing volume of Okanagan production enabled many people to find employment. A second and greater gain of population occurred during and after World War II, and this is still in progress. It is estimated that 21,123 newcomers have found homes and some kind of employment between 1940 and the beginning of 1948. Most of these people are from the Prairie Provinces.

The small towns and rural settlements are strung along the valley bottom from Salmon Arm to Osoyoos. Vernon, Kelowna, and Penticton, each with a population around 10,000, are the most important. Salmon Arm, Enderby, Armstrong, Lumby, Westbank, Peachland, Summerland, Oliver, Osoyoos, and Keremeos are smaller places with populations from a few thousand to a few hundred. In these centres, and particularly in the larger ones, there are a considerable number of industries complementary to the local agriculture. Packaging the crops for market requires a large saw-milling and box-making industry, and numerous packing plants and cold storages are necessary marketing equipment. Canneries, creameries, fruit and vegetable evaporators, fruit juice plants, a winery, flour mill, and cheese factory process large quantities of agricultural products and provide employment for a considerable part of the population.

Industries, towns, and farm homes in the map-area are supplied with electricity by two hydro-electric power systems. The Peachland-Westbank area and the region from Winfield north to Salmon Arm, obtain electrical energy from the British Columbia Power Commission, whose plant is at Shuswap Falls. An additional plant is under construction near Needles on Upper Arrow Lake. The remainder of the Okanagan Valley, to the south of Winfield, is supplied by the West Kootenay Power and Light Company, from installations on the Kootenay River near Nelson. This company also serves the Similkameen Valley. The towns are served by telegraph and both town and country areas have telephones with long distance connections. There are also radio stations at Kelowna and Vernon which transmit the programs of the Canadian Broadcasting Corporation, and a booster station at Penticton.

Transportation

The Okanagan and Shuswap Railway, operated by the Canadian Pacific Railway, was constructed between Sicamous and Okanagan Landing in 1892. From the Landing, steamers served all points on Okanagan Lake. In 1915 the Kettle Valley Railway, also operated by the C.P.R., was built into Penticton, and in 1925 the Canadian National Railway constructed a line between Vernon and Kelowna, which is used by both railways. Other railway construction connects Lumby with Vernon, and Osoyoos with Penticton, and points along Okanagan Lake are served by car barges.

Development of the main road, now paved, between the International Boundary and Salmon Arm, and an improved bus service, has finally put the lake steamers out of business. Gravelled lateral roads provide an elaborate network reaching almost every corner of the valley region.

Schools and Farm Homes

While the more distant localities are still served by local schools, consolidated schools are located at central points and most of the pupils are transported to and from school each day by bus. The health of school-age and pre-school children is cared for by public health nurses who cover the whole district. Inoculations for smallpox and diphtheria are regularly practised, and inoculations for scarlet fever are employed when the disease appears. Most school boards provide iodine tablets for goitre prevention and two courses of treatment are given each year. Dental clinics are used, and the whole valley has become a single unit under a qualified director of public health.

Farmsteads on most farms are well kept, houses stuccoed or painted, buildings attractive with electricity and sanitary conveniences.

AGRICULTURE

The first carload of fruit was shipped from the valley in 1903 and from that time the shipments continued to increase until by 1911 the annual production was nearly 1,000,000 boxes.(11) With new orchards coming into bearing the apple production in 1922 amounted to 2,719,475 boxes. By 1939 production of apples was 5,571,138 boxes and the 1946 crop amounted to 8,779,592 boxes.

Other important tree fruits show a corresponding increase of production, as shown in table 3. The number of trees, together with irrigated and non-irrigated tree fruit acreage as in 1945, is given in appended table 5.

TABLE 3: TREE FRUIT PRODUCTION (1)
Salmon Arm to Osoyoos including Similkameen Valley

Kind	Box or Crate	1922	1939	1946
Apples	42 lb.	2,719,475	5,571,358	8,779,592
Crabapples	36 "	183,708	121,074	213,760
Pears	42 "	88,005	307,231	674,741
Plums	15 "	———	62,774	128,634
Prunes	15 "	———	322,005	897,903
Cherries	20 "	103,595	178,779	283,084
Apricots	20 "	71,819	176,464	366,987
Peaches	20 "	209,186	526,190	1,660,547

NOTE: 1922 combined production of plums and prunes was 262,578 crates.

The production of small fruits is shown in table 4. Grapes became important about 20 years ago and from a production of 164 tons in 1931 the annual yield has shown a steady increase.

TABLE 4: SMALL FRUIT PRODUCTION

Salmon Arm to Osoyoos, including Similkameen Valley

Kind	Unit	1927	1939	1946
Strawberries	18 lb.	5,758	3,237	7,637
Raspberries	18 "	14,489	18,148	8,804
Blackberries	18 "	886	10	——
Loganberries	18 "	1,553	251	——
Red Currants	16 "	713	117	38
Black Currants	18 "	4,287	4,204	1,863
Gooseberries	18 "	3,712	704	28
Grapes	Tons	——	729	965

Production of different vegetables rises and falls with the demand, some varieties remaining more or less stationary from year to year. The more important ones are tomatoes, cucumbers, cantaloupes, onions, and celery, as shown in table 5. With climate, soil, and other conditions favourable, the production of vegetable seeds of late years has become a promising industry.

TABLE 5: VEGETABLE PRODUCTION

Salmon Arm to Osoyoos, including Similkameen Valley

Kind	Unit	1927	1939	1946
Onions	Tons	7,875	6,811	10,985
Potatoes	"	3,826	935	4,262
Celery	"	1,238	605	1,016
Silverskins	"	36	53	249
Beets	"	145	73	757
Carrots	"	292	363	2,373
Cabbages	"	684	475	1,708
Parsnips	"	42	5	296
Turnips	"	81	26	236
Asparagus	"	——	135	611
Peas	"	3	1,127	1,212
Beans	"	159	151	837
Tomatoes	"	——	4,183	4,422
Spinach	"	——	28	93
Corn	"	——	11	11
Cauliflower	"	——	6	20
Watermelon	"	——	——	12
Squash, Pumpkin	"	419	12	695
Zucca melons	"	——	——	255
Tomatoes	Crates	182,834	279,278	427,092
Lettuce	"	253	19,216	34,898
Cucumbers	"	65,334	72,093	190,990
Peppers	"	12,649	7,828	110,600
Eggplant	"	1,474	181	810
Cantaloupes	"	18,241	27,885	42,508

Dairying, which began around 1890, has become one of the most important mixed farming activities and dairy products are a major source of agricultural income. In the earlier years, the dairy cattle were low grade, but such herds are being replaced by high-producing animals of recognized breeds. Hogs and poultry are natural side lines of the dairy industry, with a large number of small producers and an impressive quality of breeding stock. Sheep and cattle are also produced and the larger flocks and herds spend their summers on the mountain range pastures. Importance is also attached in the valley to beekeeping, and production of honey has increased from 80,000 lb. in 1922 to 368,000 lb. in 1938 and 720,000 lb. in 1947.

The pioneers were concerned with problems of production for local needs, but as an increasing surplus of perishable fruits and vegetables were grown the problem of securing profitable outside markets became a factor of major importance. Co-operative marketing began in 1908 and by 1923 the Okanagan Valley supplied 82 per cent of the apples consumed on the prairie market through this agency. Since 1923 the co-operative selling organization has lived through difficult times, but with slowly mounting success. At the present time, all tree fruit in the valley is marketed by British Columbia Tree Fruits Ltd., an agency controlled by the British Columbia Fruit Growers' Association.

SOILS

SOIL FORMATION

Soils are the products of the environmental conditions under which they have developed. 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 certain conditions other factors have a dominant influence. Soils with well-developed or normal characteristics that reflect the native forces of soil genesis, climate and vegetation, are classified as *zonal* soils. In this report, the soils with more or less well-developed characteristics that reflect the dominating influence of ground water are grouped as *groundwater* soils, and their relationship to the several zonal regions in which they occur is explained.

Parent Materials

The material from which the Okanagan soils were derived is mostly glacial till composed of the Tertiary soil covering and a vast amount of debris abraded from a complex assembly of rock formations. The latter includes mica schists, gneisses, orthoclase felspars, argillites, quartzites, granites, basalts, limestones, and others. Much of this material was carried down to the lower elevations and sorted by the action of running water.

During the decay stage of glaciation, the valley was filled partly by glacial lakes and in part by glaciers which occupied the present lake depressions. The valley filling material discharged into the glacial lakes has the appearance of terraced fans whose lower parts coalesced and spread from the tributary stream valleys. Gravelly and stony terraces and moraines, sandy terraces, and deposits of silts and clays, were the products of the glacio-lacustrine stage of deposition.

When the valley ice melted and the lakes occupied their present depressions, the levels of surface waters were lowered in some cases by hundreds of feet. In finding their way to the new lake levels, the tributary streams cut ravines through the gravelly and sandy terraces to the glacial lake bottoms, where they spread their fan aprons, sometimes on top of the clay deposits. Since the post-glacial topographic regime is in an early stage of development, the lower and finer-textured fringes of these secondary fans generally have poor drainage.

Zonal Soils

Vertical as well as horizontal soil zonation occurs in the mapped area and 4 soil climatic types have been differentiated. These are not true soil zones as they are more representative of boundary conditions that occur on the margins of the major soil zones. The zonal distinctions are believed to be due mainly to

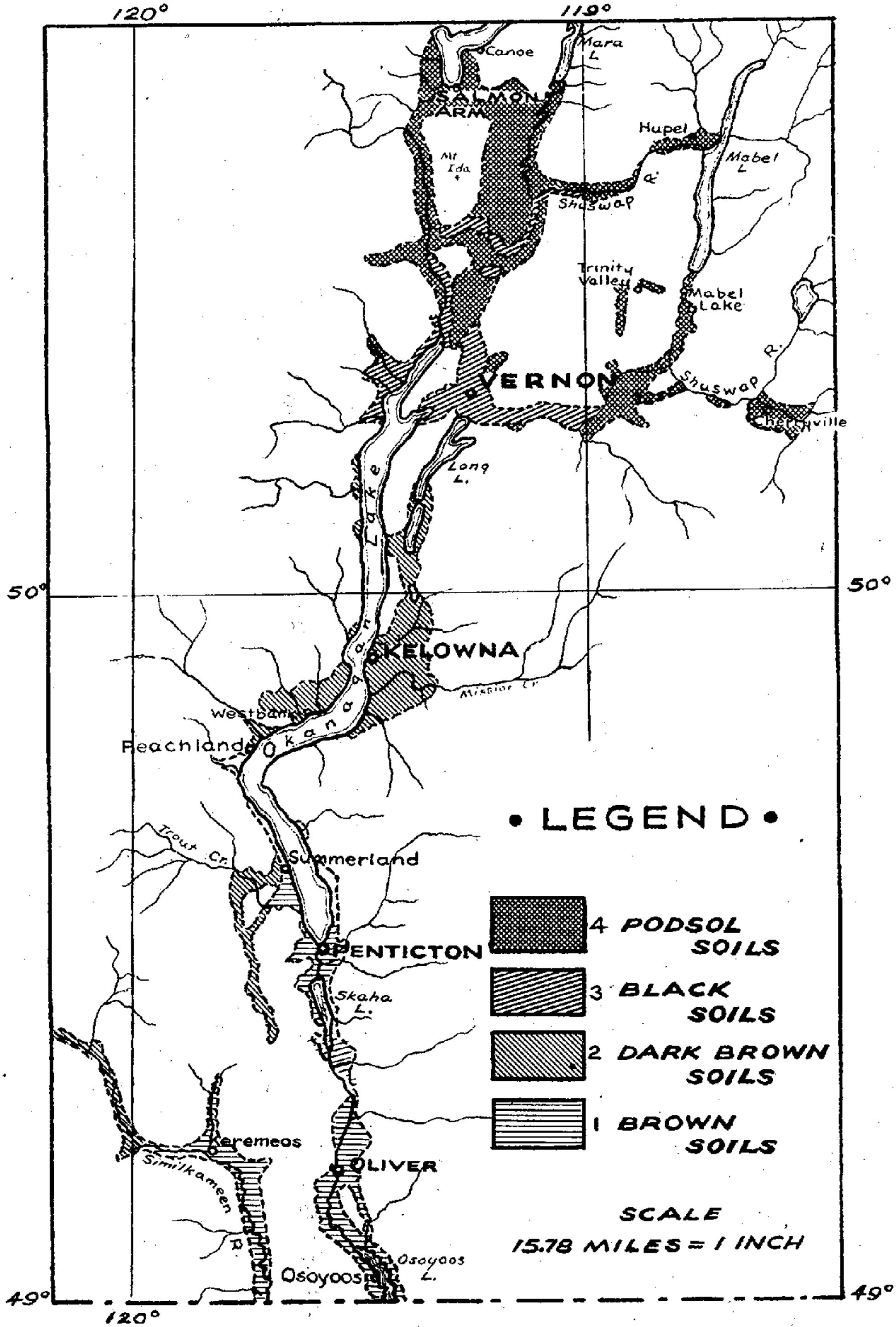


Fig. 4: Distribution of the several zonal soil groups in the classified area.

variable moisture and temperature relationships common to a mountainous country. The most arid part of the valley depression is occupied by the Brown Soils, adjoined by the Dark Brown Soils as elevation and precipitation are increased. In turn, the Dark Brown Soils are succeeded by the Black Soils, which merge into a wooded transition named Intermountain Podsol. The diagram in Fig. 4 illustrates their approximate locations and relative importance in the classified district.

The succession of zonal types is remarkable for the comparatively large area covered by each one. In part this is made possible by more humid conditions as the Okanagan Valley bends towards the Selkirk Mountains to the north of Peachland. The additional contributing factor is the very gradual increase of elevation, which amounts to about 227 feet at drainage level, between Osoyoos and Salmon Arm, with corresponding increases in the height of valley terraces.

A cross-section of the Okanagan Valley in its southern part permits examination of vertical zonation on a compressed scale. Under these conditions, there is a gradually decreasing temperature gradient with increasing elevation. Roughly, this amounts to about 1° F. in 330 feet, and its effects are related to increasing moisture economy by plants and a shorter growing season. These factors combine to bring about remarkable changes in soil profiles and native plant species within comparatively short distances.

In order to give meaning to the complex arrangement of zonal distinctions as they actually occur, it is essential to mention the ideal succession with rapidly increasing elevation of Zones 1 to 4, as illustrated in Fig. 5. Under such conditions, the Brown Soils occupy the lowest, well-drained areas in the southern part of the valley depression. This is the most arid soil region in the Province. As elevation is increased, the Dark Brown and Black Soils occur in order, and these in turn are supplanted at higher elevations by a series of successively more humid divisions of the Podsol soil zone.

Under natural conditions, however, the slope exposures are too variable to permit the ideal succession to occur without interruption. The slopes are frequently cut by ravines with north and south exposures, and at higher elevations the severely glaciated terrain is full of rounded hills whose slopes run in all directions.

On the valley sides, the kind of zonal soil varies with the slope exposures. At the lowest elevations, in the region of the Brown Soils, the south, east, and west slopes are grass-covered, while the north slope has forest cover. This would indicate that the south slope is most truly representative of the Brown Soils, while small soil areas on the east and west slopes grade towards the Dark Brown type. Higher up in the Dark Brown Soil zone, the east and west slopes shade towards the Black Earth and the north slopes are podsolic. This intermingling of zonal distinctions, often in remarkably small areas, is most striking in the podsols below the alpine region, where the Black Soils extend to about 4,500 feet elevation on south slopes of coulees and hills, all other slopes being forest covered. In mountainous country where ravines are frequent, the forested area between 3,500 and 4,500 feet may have grass-covered south slopes amounting to 20 or 30 per cent of the total area. These high, scattered, Black Soil areas provide summer range for stock.

Each soil zone has its own soil series, even though one kind of soil parent material may pass through several climatic types. It is therefore essential to discuss each zone as to soil and plant relationships. In this report, the soil type descriptions are grouped under a description of the zones in which they occur.

In addition to the zonal soils a group of Groundwater Soil soccur where natural drainage is restricted or poor. The characteristics of these soils are also discussed in this report.

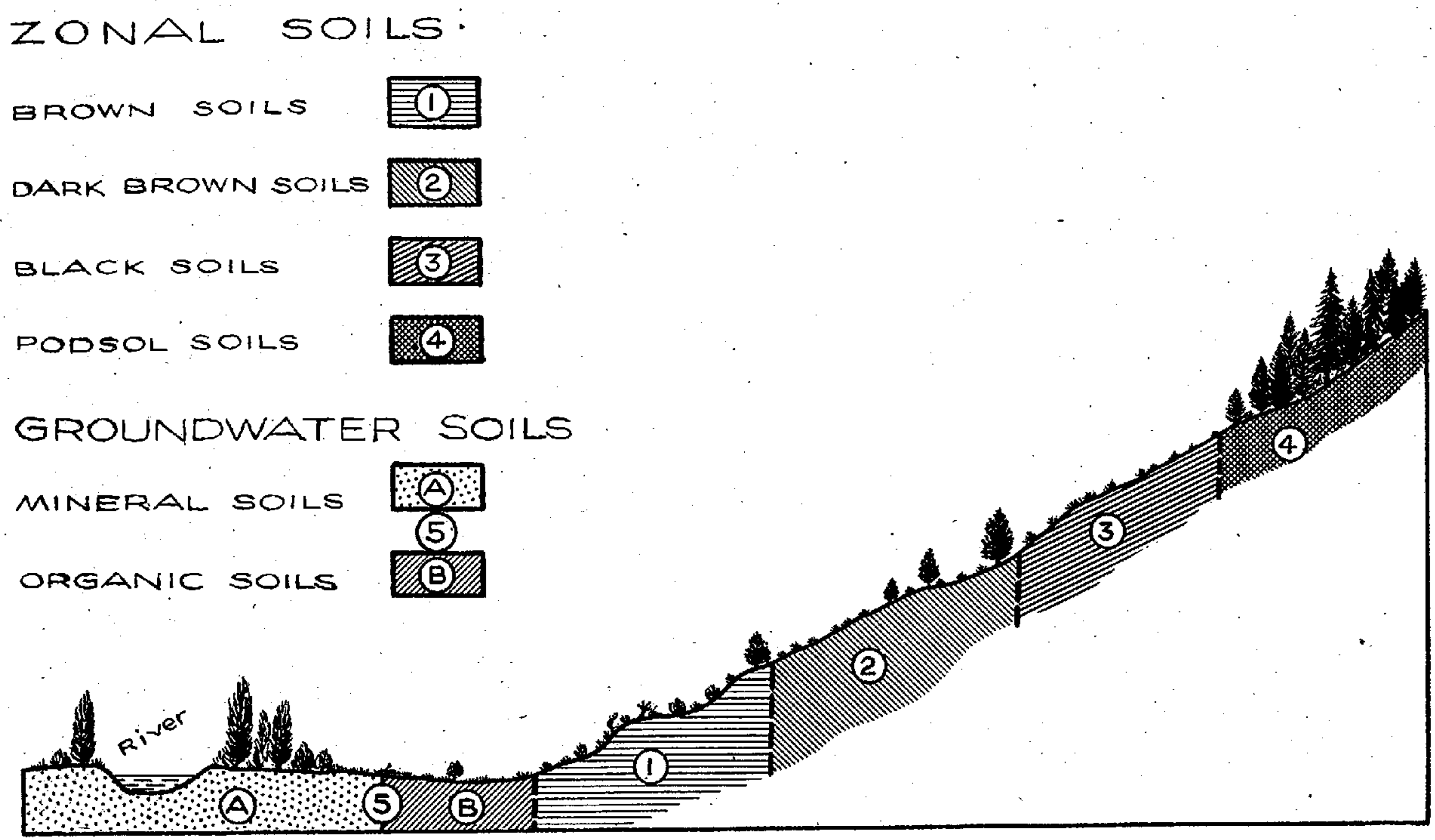


Fig. 5: Illustration showing the vertical positions of the 5 soil groups in the Okanagan Valley.

The Soil Profile

The soil profile, upon which soil classification is based, is the cross-section of that part of the soil mass that is actively used by roots. It consists of a natural succession of layers or horizons extending downward into the weathered or unweathered parent material, the average thickness being 2 to 3 feet. Its main divisions 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

BLACK, DARK BROWN and BROWN SOILS

A_1 Black, dark brown, or brown horizon with relatively high content of organic matter mixed with mineral soil.

A_2 Light coloured leached soil.

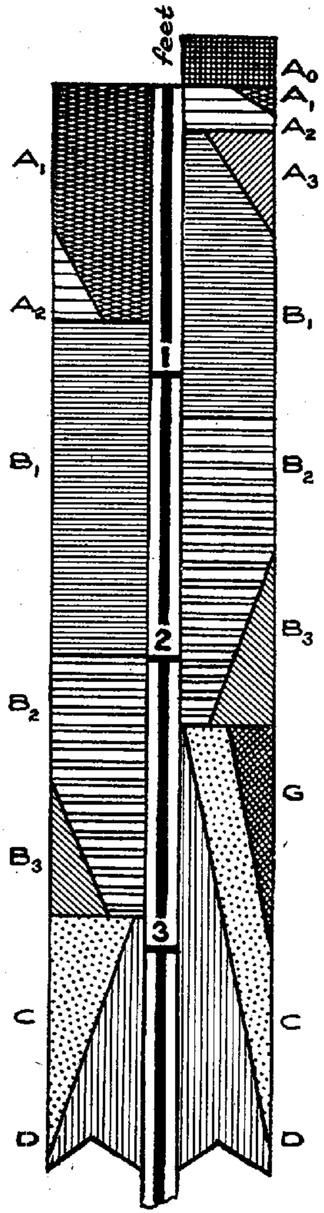
B_1 Dark brown or brown compact horizon.

B_2 Light brown to greyish brown. Horizon of lime accumulation. Transitional to C.

B_3 Transitional to C, usually absent.

C The parent material from which the solum developed. Absent in some soil types.

D Underlying statum. Present or absent.



FOREST SOILS

A_0 Forest litter largely undecomposed.

A_2 Light coloured leached soil.

A_3 Transitional to B.

B_1 Brown compact horizon.

B_2 Light brown to greyish brown. Horizon of lime accumulation. Generally transitional to C.

B_3 Transitional to C; usually absent.

G Horizon of groundwater fluctuation in poorly drained soils. Iron-stained. Absent in well drained soils.

C Parent material from which horizons A and B developed. Largely unchanged by soil forming process. Sometimes absent.

D Any stratum underlying but unrelated to horizon C which has significance to the overlying soil. Usually absent.

Fig. 6: Profiles showing the positions of soil horizons.

formed by soil building agencies. The C horizon is the weathered or unweathered parent material which lies in contact with the soil above. If the profile is underlain by geological material unrelated to the parent material of the solum, but of significance to the soil, it is designated horizon D.

The several divisions of the profile vary in response to the time period of weathering, and to other differences such as climate, vegetation, drainage, chemical composition, and texture. These variations are accounted for by subdividing the main horizons into A_1, A_2, A_3, B_1, B_2, etc., for more detailed description.

The mat of organic matter added to the surface by trees, shrubs, and grasses is designated horizon A_0. "Podsol" refers to forest soils with a leached A_2, horizon beneath an organic mat. In poorly drained soils the horizon developed under the influence of groundwater is called horizon G. Fig. 6 shows the soil horizons in relation to one another as found in the Okanagan Valley. Under field conditions the depth of horizons varies in different soil types and in some instances one or more sub-horizons are absent.

Each soil horizon has a distinctive colour, texture, and structure. Soil colours range from white, through many shades of brown to black as organic matter content increases. Organic staining is important in the Brown, Dark Brown, and Black soils. In the podsol zone and in the groundwater soils, the organic colours are mixed with colours formed by the oxidation of parent materials.

Soil texture refers to the size of the individual grains or particles, a property partly inherited from the parent material and in part as a result of soil-forming processes. These particles have 3 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 3 separates which a soil may have.

Soil structure refers to the manner in which the individual grains are arranged. The mechanical separates may be grouped into a variety of forms, such as crumbs, plates, granules, and others.

SOIL CLASSIFICATION

The natural effects of climate on parent materials under different conditions of topography, texture, and drainage is the basis used for grouping soils into series units. In the Okanagan Valley there are 4 climatic regimes in which parent material, topography, texture, and drainage, all have an important part in soil development.

Glacial till is regarded as the ancestral parent material from which the bulk of every Okanagan soil has been derived. Some soils at the higher elevations are weathered directly from the till, and some are derived from products eroded from it during the decay stage of glaciation. Still others developed from till material resorted from glacial lake terraces together with original till, which was transported by streams and deposited during the post-glacial erosion cycle.

The rough terrain has influenced soil genesis to a remarkable degree. Steep slopes are synonymous with fast flowing tributary streams, which removed large supplies of till from the high elevations and sorted their loads into valley filling masses of gravels, sands, silts, and clays. These textural groups of uniform materials formed similar profiles under the several climatic conditions.

Soils may be excessively drained, well-drained, or poorly drained, depending on topographical position and the texture of the whole soil profile. Those derived from gravelly and sandy terraces have excessive drainage. Their profiles show different development from soils in the same topographic position with finer textured profiles. Fine textured soils on slopes or terraces that are free from the influence of groundwater are well-drained soils. They have distinctive profiles and better productivity than excessively drained soils.

TABLE 6: CLASSIFICATION OF SOILS IN THE OKANAGAN AND SIMILKAMEEN VALLEYS

Glacial Materials	Brown Soils	Dark Brown Soils	Black Soils	Inter-Mountain Podsol	Groundwater Soils
	Series	Series	Series	Series	Series
Glacial till	—	Kelowna	Armstrong	Sicamous	—
Gravelly Terraces and Lateral Moraines	Skaha	Rutland	Nahun	Glenemma	—
Sandy Terraces and Lateral Moraines	Osoyoos	Oyama	Grandview	Shuswap	—
Silts and Clays	Penticton	Glenmore	Spallumcheen	Broadview	—
Post-glacial Materials					
Colluvial Fans	Similkameen	—	Kalamalka	—	Nisconlith
Second Bottoms	—	—	—	—	Nisconlith Mara
Organic Remains	—	—	—	—	Okanagan Muck

Poorly drained soils are those affected by groundwater. Their profile characters are usually fixed by the fluctuation of groundwater in the soil or above it for short or long periods each year.

The term "series" is used to designate a group of soils on uniform parent material, with the same colour, depth, and structure of horizons and similar conditions of drainage and topography. The different soils grouped into series, and their relationship to parent material, climate, and drainage is shown in table 6.

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, Kalamalka Sandy Loam and Kalamalka Loam are different surface textures or types to be found in the Kalamalka series. With the exception of the variation in surface texture, the Kalamalka soils have the same characters throughout.

Variations within the soil types that are of importance to agriculture are known as phases. Phases are based on such characters as gravel, stoniness, topography, and others.

The soil series are given convenient geographic names taken from the localities in which they are found. These include the names of towns, valleys, and districts.

Soils Not Included in the Series Classification

Two land classes were not included in the series classification. The first consists of the stony parts of colluvial fans, which have little or no value for cultivation. Such areas occur throughout the valley and they are shown on the soil map by means of a separate colour. The second unclassified type is Rough Mountainous Land, which surrounds the arable region.

Field Methods

Soil survey work in the Okanagan Valley was commenced in 1931 in aid of a research designed to find the cause of corky core, bitter pit, and other disorders of apples. It was thought that the texture of the soil profile, methods of irrigation, seepage water, and similar factors were contributing to tree injury. A very detailed survey was called for and eventually the irrigation districts to the north of Kelowna and two proposed irrigation projects were mapped on a scale of 400 feet to an inch. This was done by chaining the land at 1,000-foot intervals. In addition to this survey a number of problem orchards were mapped on a scale of 150 to 200 feet to an inch.

As a direct means of finding the cause of physiological disorders of fruit trees, the results from the large scale mapping were negative, but general knowledge of the soils was increased, methods were developed for draining seepage areas, and finally, research workers achieved success from experiments with boron.

Soil survey work in the Okanagan Valley was abandoned in 1936 in favour of field operations in the Lower Fraser Valley,(7) but in 1937 it was continued. All of the large scale work was reduced to smaller maps and a detailed reconnaissance survey of the remaining part of the valley was completed on a scale of 2 inches to a mile. The material was ready for printing in 1939, but the war brought delay in publication.

The reconnaissance work was done by cruising the roads and trails by car and on foot when necessary, with frequent profile examinations. Soil boundaries were placed and sketched between intersections that did not exceed half a mile. An aneroid barometer, contours, and aerial photographs were useful when establishing the boundaries of terrace formations. By such means the larger soil masses were examined and mapped, but soil distinctions covering less than 5 acres are not shown.

Soil textures were determined by feel. The surveyor's judgement was verified by numerous samples collected for mechanical analysis. These samples were analysed by the hydrometer method of Bouyoucos. (3) The textural classification was based on the standards of the United States Department of Agriculture.(6) Soil reaction was determined for each sample by colorimetric methods. Representative virgin profiles are the basis of soil type descriptions and from them samples were secured for chemical analyses.

DESCRIPTION OF SOILS

1. —*THE BROWN SOILS*

An intermountain desert region extends from Mexico to British Columbia between the Sierra Nevada and Cascade Mountains on the west and the Rocky Mountains on the east. From Wenatchee northward, the climate is more humid and the Brown Soils replace the Northern Grey Desert Soils at the lower elevations. (2) From the International Boundary, the Brown Soil zone extends north to the vicinity of Summerland, where it merges in the valley bottom with the transitional Dark Brown Soils.

The highest elevation at which the Brown Soils are known to occur in the Okanagan Valley is about 2,000 feet, and the lowest elevation, at Osoyoos Lake level, is about 903 feet. Above the 2,000-foot elevation, the Dark Brown and then the Black Soils appear on south exposures. On more shaded slopes there is a succession of mountain podsols with increased elevation beginning with the Intermountain Podsol.

Rainfall in the Brown Soil zone is too limited for soils of any texture to be dry farmed, but with irrigation the finer textured profiles are very productive. The soil is characterized by the brown colour of the slightly saline surface soil. The average reaction with good drainage is around pH 7.5 at the surface, and pH 8.4 in the subsoil region of lime accumulation. The average profile characters are as follow:

Horizon	*Depth*	*Description*
A_1	0–10″	Brown to light brown surface soil with fine granular structure.
B_1	10–26″	Light brown, compact and structureless.
B_2	26–32″	Greyish brown to grey. A compact, structureless horizon with lime accumulation in the lower part.

Vegetation of the Brown Soil Zone

The vegetation of areas that have not been disturbed consists mainly of perennial bunch grasses. Bluebunch wheatgrass (*Agropyron spicatum* variety *inerme*) is the main species, while speargrass (*Stipa comata*) is of next importance, and dwarf bluegrass (*Poa secunda*), dropseed grass (*Sporobolus cryptandrus*), and three-awn grass (*Aristida longiseta*) are common. Grey sage (*Artemisia rigida*) and cactus (*Opuntia fragilis*) are also common. There are a number of plants of the "desert shrub" type, including sagebrush (*A. tridentata* and *A. trifida*), rabbit bush (*Bigelowia dracunculoides*), and antelope bush (*Purshia tridentata*) often miscalled "greasewood". Trees are confined largely to scattered yellow pine on the deeper soils.

A striking feature of the vegetation of this region is the common occurence of a number of plant species which are rare or absent in other parts of the Province. These are forms usually associated with conditions existing farther south, and their presence in the Okanagan seems to indicate that the dry phase of the Brown Soil zone reaches its northern limit in this locality. Some of these "southern" species are confined to the area south of Kaleden, but others extend as far as the northern boundary of the zone near Summerland. Dwarf sagebrush (*A. trifida*) and phlox (*Phlox longifolia*) are common examples of this group. The agricultural significance of the presence of these species in the Okanagan Valley lies in the fact that they are associated with warm climatic conditions which favour the production of fruits, such as peaches and apricots.

Changes due to Grazing

Due to less favourable conditions for plant growth, the effects of overgrazing have been more drastic than in the Dark Brown and Black Soils. With moderate overgrazing, bluebunch wheatgrass has been replaced by speargrass, dropseed grass, and other secondary grasses. Severe abuse has resulted in the elimination of even these grasses of moderate grazing value and desert shrubs and annual weeds have come to be dominant. At present the area occupied by the original type of bunchgrass cover is relatively small.

Soil Series and Types

The Brown Soils have been grouped into 4 soil series and 6 soil types. These are Skaha Gravelly Sandy Loam, Osoyoos Sandy Loam, Osoyoos Loamy Sand, Penticton Silt Loam, Similkameen Gravelly Sandy Loam, and Similkameen Silt Loam. Skaha and Osoyoos series have 2 topographic phases and Penticton and Similkameen series have one phase of topography.

*SKAHA GRAVELLY SANDY LOAM**

Description

This series occurs on gravelly terraces to the south of Summerland in the Okanagan and Similkameen Valleys at from 903 to 1800 feet elevation. It covers a total of about 12,563 acres in many scattered areas ranging in size from a few acres to a thousand acres or more.

The topography is of two kinds. Gently undulating and sloping terraces cover about 6,012 acres. The balance of 6,551 acres, shown as a kettle phase on the soil map, contains shallow and deep kettle holes, some of which are dry and some contain ponds.

The solum consists of brown, shading to light brown sandy loam, about 18 inches thick, with varying amounts of gravel and stones on different terraces. The lower part of the solum is characterized by a matrix of stones.

The substratum, with and without observable stratification, is a mixture of coarse sand, gravel varying from fine to coarse and stones ranging up to 8 inches or more in diameter. The size of the gravel and stones and the amount of sand in the mixture varies with each terrace. The kettle terraces may at one time have formed parts of lateral moraines and in these, the mass of stones, sand, and gravel is more varied than in terraces built up entirely by stream action. In some terraces, layers of cemented till are buried at various depths in the substratum. Where buried till occurs in the kettle phase, small lakes or ponds may form in the kettle holes.

Further detail in the following profile description indicates the shallow nature of the type and its low moisture-holding capacity:

Horizon	*Depth*	*Description*
A_1	0–6″	Brown sandy loam with fine granular structure. pH 7.5.
B-D	6–18″	Light brown structureless sandy loam with matrix of stones and gravel in the lower part. pH 7.8.
D		Greyish brown to grey coarse sand, gravel, and stones, with and without observable stratification. Lime plated stones and gravel in the upper part. Layers of cemented till present or absent at various depths in the gravelly material. pH 8.4.

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* Where only one type occurs within a series, the soil is described under the type name. Where a series comprises two or more types, a generalized description is given in addition to the descriptions of the types.

Agriculture

The Skaha Gravelly Sandy Loam is the most porous type of the Brown Soils. At present its main use is for range, but selected areas on different terraces have been irrigated for orchard fruits, cantaloupes, cucumbers, and tomatoes. Some comparatively large areas have been brought under cultivation in the vicinity of Summerland, Penticton, Oliver, Osoyoos, and Keremeos.

A large part of the kettle phase is full of steep slopes and kettle holes which make irrigation impracticable. Where water has been applied on slopes too steep for irrigation, there is a tendency for the soil covering on knolls to erode into the hollows. The knolls became barren as the underlying gravel is exposed. Cover crops help to keep this erosion in check, but where it has occurred, little can be done in the way of soil improvement.

A smaller erosion factor in the undulating phase makes it more desirable for irrigation than the kettle topography, but the practice is to use large quantities of irrigation water. The gravel substratum beneath the comparatively thin soil covering affords excessive drainage and co-operates with the crop in accelerating dehydration of the soil. Excessive irrigations tend to promote leaching, the breakdown of soil structure, and seepage at lower elevations.

Structural breakdown takes the form of increased compaction in horizon B-D, and where this occurs it can be ameliorated by greater provision of organic matter and more limited use of water. Due to leaching, there is more need of mineral fertilizers in the Skaha series than in finer textured profiles.

The indicated trend towards soil deterioration is neutralized in many orchards by favourable slopes and good management, but evidence of ruined acreage due to unfavourable location and poor practice is not lacking. Within the series there are also some good locations with deep solums and greater protection against deterioration, to which the less favourable features of the type do not apply. Such areas should be selected in future with more care than in the past when new development for irrigation is contemplated.

OSOYOOS SERIES

The Osoyoos series occupies sandy terraces in the Brown Soil zone between Summerland and the International Boundary. It lies at elevations between 903 and 2,000 feet on terraces of different lengths and widths, covering a total area of about 18,983 acres. There are two types of topography. Kettle areas cover 7,112 acres and gently undulating to flat terraces cover about 11,871 acres. Some of the smaller terraces are too narrow or too severely eroded for agricultural use.

The surface soils are brown, shading to a pale brown subsoil. There is a progressive reduction of the silt and clay content from the surface to the bottom of the solum, with a corresponding increase in the proportion of stone-free sand. Lime accumulates in the lower part of the B horizon.

The substratum consists of clean, grey, stratified sands of medium to coarse texture, which often contain lenses or layers of fine gravel. These materials were originally discharged into glacial lakes and deposited at the mouths of tributary streams. They occur throughout the Okanagan district in all soil regions and the soils derived from them have been named Osoyoos, Oyama, Grandview, and Shuswap series.

Two types were mapped in 2 phases as follows: Sandy Loam, kettle phase, 3,232 acres; undulating, sloping or flat, 88 acres. Loamy Sand, kettle phase, 3,880 acres; undulating, sloping or flat, 11,783 acres.

OSOYOOS SANDY LOAM

Description

As a stream bench type the Sandy Loam exists in several isolated sections. The largest areas occur as terraces near the mouth of Shingle Creek to the southwest of Penticton, and smaller sandy loam benches are near Summerland and Okanagan Falls.

Some of the narrow terraces have been rendered non-arable by natural erosion. Even in such areas, however, there is often room for one or more fruit farms of small extent, if a water supply is available. The kettle phase, defined by the presence of cone-like depressions or pot-holes with no drainage outlet, that often cover an acre or more, contain much land that is too rough for irrigation.

Cemented till is frequently found buried in the substratum, and this may cause impeded drainage where the sandy layer is thin. In some areas a variable thickness of sandy substratum overlies stratified gravels, and in others the sandy bench materials have been laid upon older silt deposits.

A profile description of the Sandy Loam is as follows:

Horizon	*Depth*	*Description*
A_1	0–10″	Brown sandy loam with a large proportion of very fine and medium sands. Finely granular to single-grained structure. pH 7.5.
B_1	10–22″	Greyish brown sandy loam to loamy sand of very fine to medium texture. Single-grained, slightly compact. Scattered fine gravel, small stones and finely divided mica. pH 7.8.
B_2	22–28″	Clean grey loamy sand, single-grained, compact, with finely divided mica and recognizable lime accumulation. pH 8.6.
C		Clean unweathered greyish brown to grey stratified sand containing finely divided mica. Porous and loose, with occasional thin layers of gravel or small stones. Stratification seldom noticed except where the finer grades of sand occur. pH 8.4.

Agriculture

Most of the mapped area is range. This is due in part to location, unavailability of low cost water, and to unsuitable topography. The main cultivated area consists of about 88 acres in the vicinity of Summerland, which is used for fruit growing.

The Sandy Loam is suitable for irrigated agriculture on gentle slopes where erosion can be held in check. Power to hold moisture between irrigations, in the absence of a higher silt and clay fraction in horizon B, is dependent on the preservation of the original surface soil and the maintenance of organic matter.

Owing to the porous nature of the underlying sand, excessive applications of irrigation water will leach away the soluble salts from the solum and develop seepage at the lower elevations. Frequent light irrigations with a minimum loss of water into the substratum are preferable where water supplies can be secured as required.

Where the sandy substratum overlies indurated till or stratified silt at no great depth, seepage may occur in orchards. As a general rule, this kind of seepage can be removed by a cross drain properly located and laid on the impervious material.

OSOYOOS LOAMY SAND

Description

The Osoyoos Loamy Sand is an important soil type in the southern part of the Okanagan Valley between Summerland and the Internation Boundary.

While the kettle phase contains much waste land, it has been most extensively developed owing to the availability of water supplies. One developed area near Osoyoos is pocked with a dozen or more kettle holes containing ponds. These holes were evidently caused by collapse of the surface following the melting of buried ice, and the water remains in them because of an underlay of cemented till or stratified silt.

The light textured, single-grained top-soil varies to some extent on different terraces. Some small areas of light sandy loam and very fine sandy loam are included, owing to their small size and very sandy subsoils.

A profile description of this type is as follows:

Horizon	*Depth*	*Description*
A_1	0–8″	Brown coarse to medium loamy sand, loose and single-grained. pH 7.2.
B_1	8–24″	Pale brown coarse to medium loamy sand, compact, single-grained, with occasional stones or gravel. pH 7.5.
B_2	24–30″	Greyish-brown coarse to medium loamy sand. Single-grained, with occasional small stones or gravel. Lime is indicated by a slight compaction or cementation of the sand. pH 8.6.
C		Deep clean, grey, unweathered, coarse to medium sand. sand. Loose, porous and stratified. Occasional layers of fine or coarse gravel. pH. 8.4.

Agriculture

While a large part of the total area is still used for range, an important acreage has been irrigated in the vicinity of Summerland, Kaleden, and Osoyoos.

The use of rough topography brings to attention certain limitations of this type for irrigated agriculture. It is apparent that furrow irrigation should be confined to gentle slopes and almost flat surfaces, where cutting and washing can be avoided. Where grades are not gentle the irrigation furrows cut miniature gullies into the subsoil, and the topsoil is transported to the toe of the slope. Washing on slopes can remove the entire solum and leave exposed the more or less impoverished parent material. The problem of stopping erosion is largely solved by the use of sprinkler irrigation.

The status of organic matter in the soil determines the fertility of the type. A high organic-matter content forms the basis of moisture-holding power and good crop yields, whereas its deterioration results in less drought resistance and low yields. Since warmth and added moisture promote bacterial activity and the oxidation of organic matter, the upkeep of this important substance is a problem assumed by every farmer who cultivates the Loamy Sand.

There is also a tendency to use irrigation water to excess, owing to the porous nature of the profile and the underlying sand. Excess irrigation water leaches soluble substances from the soil, leading to impoverishment. In areas underlaid at depth by cemented till or stratified silt, the excess irrigation water moves on top of these semi-impervious materials toward a natural outlet. In one seepage thus formed the sandy terrace bank has collapsed and gullies have cut inward along the line of seepage flow.

Advantages of the type lie in warmth, ease of cultivation, and earliness. With good management apples, peaches, apricots, plums, cherries, cantaloupes, cucumbers, tomatoes, and other crops can be made to give good yields.

For proper land-use the irrigation system should provide an adequate water supply as needed, so that frequent, light irrigations with a minimum loss of water into the substratum may replace infrequent and heavy applications of irrigation water.

Light textured profiles which lend themselves easily to erosion and leaching, particularly under rough topographic conditions, require conservation practices from the beginning of use. These practices should emphasize the upkeep of organic matter, together with prevention of erosion and leaching.

PENTICTON SILT LOAM

Description

This type covers about 7,265 acres in the southern part of the Okanagan Valley at elevations between 1,200 and 1,500 feet. It occurs in a remarkable terrace formation probably laid down in temporary rivers during deglaciation, when the present lake depressions were filled with ice. On melting of the valley ice the silt deposits were left with one side standing as an exposed bluff which faces the valley centre.

The most prominent deposits stand off from the shore on both sides of Okanagan Lake near Penticton. South from Penticton, the ragged fringes of silt deposits face the east shore of Skaha Lake, and other remnants lie partly exposed and in part buried beneath sandy terraces and colluvial fans between Oliver and Osoyoos.

A large part of the original gently undulating and sloping topography has been severly cut and in places reduced to hummocky forms and gullies by freshet run-off. Destructive erosion long before the advent of irrigation has greatly reduced the amount of land available for agriculture.

The solum, to a depth of about 40 inches, is brown, shading to greyish-brown silt loam, with lime accumulation in the lower part. The substratum is composed of deep beds of stratified silt, clay, and very fine sand in varying degrees of admixture. Here and there throughout the silt formation are stringers of gravel probably laid down by freshet run-off from the hillsides. These gravel lenses are of present significance as seepage outlets for excess irrigation water, and they sometimes aid the formation of gullies and the collapse of the unprotected banks.

The profile description is as follows:

Horizon	*Depth*	*Description*
A_1	0–10″	Brown to pale brown silt loam; soft and friable, with fine granular structure. pH 7.6.
B_1	10–20″	Pale brown silt loam, massive and compact. pH 8.0.
B_2	20–42″	Greyish-brown silt loam; compact with specks of lime. Breaks into angular fragments suggesting broken lamination. pH 8.6.
C		Stratified silt, silty clay, clay and very fine sands bedded and laminated in thin layers. Occasional lenses of gravel only a few inches thick. The upper part of this horizon is rich in lime. pH. 8.6.

The variable nature of the stratified parent material, which contains beds of silt, silty clay, clay, and very fine sand, permits similar variation in the solum, and a more detailed survey would differentiate several classes. The present survey names the type according to the dominant surface texture.

Agriculture

The Penticton Silt Loam is one of the most fertile and productive soil types in the Okanagan Valley. Yields of apples range as high as 1100 packed boxes per acre in mature orchards under the best conditions, and correspondingly high yields of other fruits are obtained.

Before irrigation systems were installed, the silt terraces were deeply cut and partly washed away by natural erosion, and in future, this destruction will be accelerated. The main loss of ground at present is caused by discharge of tailing water into unprotected coulees, and seepage due to general over-irrigation. Each year small sections of exposed bank fronts and gully sides collapse with total loss of ground. This destruction is often caused by saturation of beds of very fine sand in the lower parts of the banks, where seepage water forms a slum which flows in the spring. While the annual loss is scattered and does not appear large on superficial observation, the loss of rich land per decade is a more significant figure, which implies the need of conservation.

Since the excessive use of irrigation water is detrimental, provision should be made for frequent and light irrigations, with a minimum loss of water into the substratum. Tailing waters should be flumed where they cause saturation, washing, or collapse of gully walls. Active seepage near the surface in orchards, due to layers of gravel, clay or bedrock, should be removed by underdrainage.

SIMILKAMEEN SERIES

In the Brown Soil zone there are post-glacial colluvial fan areas of sufficient agricultural importance for classification as a separate soil series. These fan aprons were accumulated at the base of comparatively steep slopes by tumultuous outwash of temporary streams. Each fan has an area of angular rock at the coulee mouth, from which it grades into soil material lower down on the slope.

The topography is that of a fan cone, with a steep to gentle main slope towards the valley centre and secondary slopes to right and left of the main slope.

The series occurs at from 925 to 1800 feet elevation in the south Okanagan and Similkameen Valleys. Its classes are Gravelly Sandy Loam, 989 acres, and Silt Loam, 3,058 acres.

The surface soils are brown, shading to greyish brown variable and limey subsoils. In some cases the parent fan material has spread over the remnants of former silt, sandy, and gravelly terraces. On the lower fringes of the fans, where the land is cultivated, the buried terraces add to the complexity of the substrata.

SIMILKAMEEN GRAVELLY SANDY LOAM

Description

The Gravelly Sandy Loam occurs in one area of coalescing fan aprons to the southwest of Oliver. These fans differ from most others because the soil and stone were deposited with very little sorting. In one case, a cloudburst occurred about 30 years ago and the whole fan was deposited at once. The presence of several kinds of terraces at both ends and beneath the fan materials along the bank of the Okanagan River indicates variable conditions of subdrainage.

The profile of this colluvium is as follows;

Horizon	Depth	Description
A_1	0–6″	Brown sandy loam. Fine granular structure on older fan materials, but structureless in more youthful debris. Upper parts of fans stony and gravelly, with more sandy soil along the lower fringe. pH 7.8.
B	6–10″	Light brown structureless sandy loam, with a mass of stones in the upper parts of fans and fewer stones along the lower fringe. pH. 8.6
C		Light brown to grey sandy loam mixed with a mass of angular stones. This material covers sandy, gravelly and silt terraces, which influence sub-drainage in the lower parts of the fans. pH 8.8.

Agriculture

The upper limit of cultivation on the gentle fan slope depends on the rock content of the soil, which varies from place to place. Since there is a considerable amount of soil between the stones, fruit trees can be planted where the ground may be too stony for cultivation.

The least amount of stone and the greatest thickness of soil is on the lower part of the fans, and this permits cultivation and the planting of orchards. Selected locations with a deeper than average layer of comparatively stone-free soil make good orchard sites, the topography being ideal for irrigation.

Disadvantages of the type refer mainly to excessive amounts of rock too close to the surface, and certain adverse drainage conditions. Where the fan has spread over a silt terrace, the colluvium is generally thin at its lower edge and the silt is close to the surface. Under these conditions the silt substratum serves as a semi-impervious layer upon which excess irrigation water can move and saturate the lower fringe of the fan. This difficulty can be overcome by means of cut-off drains.

SIMILKAMEEN SILT LOAM

Description

The Silt Loam occurs in the Okanagan and Similkameen Valleys. In the Okanagan Valley there is one area near Fairview amounting to 336 acres, and the balance of about 2,722 acres is situated in the Similkameen Valley.

The area near Fairview consists of fine textured fan material overlying an older silt deposit, with admixture of the two types and fan slope topography. In the Similkameen Valley the type occurs on remarkable cone-like fan deposits which slope at a comparatively steep angle from the valley sides. The outer fringes of the large fan aprons have been pared off by the Similkameen River so as to present abrupt, terrace-like banks which face the second bottoms.

The fan materials are a mixture of silt and angular rock fragments derived from decomposition of silty till deposits high up on the valley sides. Some of these deposits have eroded to small areas of "hoodoos". The rubble at the top of the fans consists of large angular boulders, sharp stones, and gravels embedded in silts and fine sands.

Lower down is the arable area, which progressively loses stones and boulders down-slope, until it becomes a deep structureless silt, small areas being stone-free.

A profile from a stone-free area is described as follows:

Horizon	Depth	Description
A_1	0–10″	Brown silt loam, finely granular to structureless. pH 8.0.
B_1	10–19″	Light brown silt loam, structureless, compact, with free carbonates. pH 8.4.
B_2	19–25″	Whitish grey silt loam, structureless, compact, with variable amounts of accumulated lime. pH 8.6.
C		Massive whitish grey calcareous silt in stone free areas. In other parts there are variable mixtures of silt and angular stones. pH 8.6

Agriculture

The area near Fairview is irrigated and successfully used for the production of orchard fruits. The seepage developing along the lower fringe of this fan could probably be ameliorated by the proper use of drains.

In the Similkameen Valley, areas of the type between Hedley and Keremeos have little or no agricultural importance. To the south of Keremeos are larger areas partly included in Indian reserves, their present use being a limited value for range. One of these is an area covering about 1,256 acres to the east of Cawston, which may be regarded as a promising site for a new irrigation project.

This area has a gentle slope towards the valley centre and the greater part of the soil is sufficiently stone-free for cultural practice. The river has cut into its lower edge, forming a terrace-like bank which assures good drainage and the absence of any seepage.

2. —THE DARK BROWN SOILS

The Dark Brown Soils occupy an important region in eastern Washington, but their northward extension into British Columbia is limited by increasing humidity and a decreasing temperature gradient. In the southern interior the Dark Brown Soils occupy semi-arid parts of valley depressions in areas of no great extent.

In the Okanagan district the Dark Brown Soils occur on the lower slopes and in well-drained parts of the valley bottom between Oyama and Summerland. The upper boundary of the zone is in contact with the Black Earth, except on northern slopes, where the Intermountain Podsol often forms contact without an intervening Black Soil area.

Southward from Summerland the Dark Brown Soils occupy an area between the Brown Soils in the well-drained part of the valley bottom and the Black Soils at higher elevations. The lowest elevation at which the Dark Brown Soil occurs is about 1,130 feet and the highest elevation reached on favourable exposures in the southern part of the valley is about 3,500 feet.

The Dark Brown Soils are transitional between the Brown and Black Soils. Their main characters are the dark brown colour of the surface soil, the thick bunchgrass cover in areas not overgrazed, and scattered trees of Western Yellow Pine (*Pinus ponderosa*). Beneath each tree, where the needles and twigs fall to the ground, is an area of degraded and podsolized soil about 20 feet or more in diameter.

The moisture relations of the Dark Brown Soils in the Okanagan Valley rate with the Brown Soil zone on the prairies. The season is short for peaches and apricots, except on favoured locations, but apples, pears, cherries, plums, prunes, and grapes give excellent yields under good conditions of soil and drainage. The heavy clay has been dry farmed, but lighter textures are marginal without irrigation. The average surface reaction under well drained conditions is around pH 7.2, and pH 8.4 in the subsoil horizon of lime accumulation.

Profile characters are as follows:

Horizon	*Depth*	*Description*
A_1	0–8″	Dark brown with fine granular structure in light soils and fine crumb structure in clay loam and clay.
A_2	8–10″	Degraded horizon in vicinity of trees. Light brown, platey to structureless, absent in areas of permanent grass.
B_2	10–22″	Brown to yellowish brown or brownish grey, depending on texture and drainage. Structureless in light soils and columnar in clay.
B_2	22–30″	Pale brown to yellowish brown in light soils, brownish grey in clay. Structureless, with accumulated lime in the lower part.

Vegetation of the Dark Brown Soil Zone

Areas that have not been affected too severely by overgrazing, or other disturbing factors, are occupied mainly by perennial bunchgrasses. The principal species is blue bunch wheatgrass (*Agropyron spicatum* variety *inerme*), while rough fescue (*Festuca scabella*) and June grass (*Koeleria cristata*) are of secondary importance. Common herbs include yarrow (*Achillea millefolium*), everlasting (*Antennaria parvifolia*), balsam-root (*Balsamorhiza sagittata*) and fleabanes (*Erigeron sp.*). Shrubs are not abundant, the common forms being rabbit bush (*Bigelowia dracunculoides,*) rose (*Rosa sp.*), and coralberry (*Symphoricarpos racemosa*). Saskatoon (*Amelanchier alnifolia*) is common in the region, although the plants are often dwarfed. Yellow pine occurs over much of the region in thin stands, forming a "savannah" type of vegetation. This savannah becomes denser and shades off to forest on favoured locations, while in the drier parts of the zone trees are few or absent.

Changes Due to Grazing

The vegetation over a large part of the zone has been altered considerably. On moderately overgrazed areas the bunchgrasses have been replaced to a large extent by the less palatable herbs and shrubs mentioned above. With more serious depletion, even these plants have decreased, the short-lived perennials and annuals becoming dominant. Downy brome grass and Russian thistle are prominent among the annuals.

On many areas where the yellow pine savannah has been cut over, a rather dense growth of young trees has sprung up, giving the impression of a trend towards forest conditions. However, there is no evidence that the mature stand of pines will be any thicker than that of their predecessors.

Soil Series and Types

The Dark Brown Soils have been grouped into 4 series and 6 types as follows: Kelowna Gravelly Sandy Loam, Rutland Gravelly Sandy Loam, Oyama Sandy Loam, Oyama Loamy Sand, Glenmore Clay, and Glenmore Clay Loam. The topography is separated into a kettle phase and a mixed phase in which the land is sloping, undulating, or almost flat.

KELOWNA GRAVELLY SANDY LOAM

Description

Glacial till, the direct deposit of the ice sheet, blankets the hills and valley slopes above the elevation of stratified materials. The soil type developed by surface weathering of the till itself has been designated the Kelowna series.

The topography consists of the sloping valley sides and the rolling surfaces of low hills, which contain scattered pot-hole sloughs. Classified areas of the type amount to only 1,342 acres between 1,500 and 2,000 feet elevation, but very extensive areas occur between Okanagan Landing and the International Boundary on the higher valley slopes below the region of the Black Soils. Such areas are classed with the Rough Mountainous Land.

The surface soil is dark brown, shading to brown and yellowish brown with depth and good drainage. The soil material is sandy loam with a variable inclusion of rounded stones and gravel. The substratum consists of till which may or may not be indurated. On steep slopes, it is evident that much of the solum material attained its present position by sloughing from higher up instead of by direct weathering of the till lying beneath.

The profile is decribed as follows:

Horizon	Depth	Description
A_1	0-8″	Dark brown sandy loam with fine granular structure. Scattered gravel and stones. pH 7.0
B_1	8-20″	Brown to yellowish brown sandy loam, slightly compact, structureless. Scattered stones and gravel. pH 8.2
B_2	20–28″	Transition to glacial till. Greyish brown sandy loam with specks and veins of lime. Dense, structureless, with fragments of cemented till. pH 8.6
C		Indurated grey till of sandy loam texture, containing stones and gravel. Occasionally this mixture is not cemented, or the cemented material lies at greater depth. pH 8.4

Agriculture

A few small parcels have been cultivated to a limited extent where water supplies are available, but the best use of the Kelowna series is for range. In Alberta, the Dark Brown Soils from sandy loam to clay are farmed for grain. In the Okanagan district, however, these soils would appear to be somewhat more arid, and the clay is the only texture that has been used for farming without irrigation.

The Kelowna and Armstrong series combine to enlarge the area of rangeland surrounding the Okanagan Valley bottom. The extension of the Dark Brown and Black soils up the valley sides and on southern slopes to comparatively high elevations is an asset which adds beef and mutton to the great variety of other production in the district.

RUTLAND GRAVELLY SANDY LOAM

Description

This series is derived from gravelly and stony terraces in the Dark Brown Soil zone, which occur at elevations between 1,200 and 2,700 feet. In the Okanagan Valley, areas are scattered southward from Oyama, which attain the highest elevations in side valleys to the south of Summerland. In the Similkameen Valley, the type occurs between Hedley and the Ashnola River.

Two kinds of topography have been differentiated. Kettle terraces cover about 13,054 acres, and terraces that are sloping, undulating, or almost flat occupy approximately 13,352 acres. In many large, small, and broken areas the series covers about 26,406.

The surface soil is dark brown shading to brown in the lower part, with varying amounts of stones and gravel. The average solum is about 24 inches thick, but in parts of terraces or on whole terraces it may range from 12 inches to more than 24 inches in thickness.

The substratum compares with that of the Skaha, Nahun, and Glenemma series, the same kind of terrace formation occurring in the several soil zones. Beneath the comparatively fine textured solum, the underlying material consists of coarse stratified sands and gravels having considerable thickness. Sometimes there is a discontinuous layer of indurated till buried at different depths from the surface. The profile, which has excessive subdrainage, is described as follows:

Horizon	Depth	Description
A_1	0–12″	Dark Brown sandy loam, fine granular structure. Gravelly with numerous small stones. pH 7.0
B-D	12–24″	Brown coarse structureless sandy loam, very gravelly and stony in the lower part, some of the stones at the bottom of the horizon being lime plated. Open and porous. pH 7.8
D		Brown to grey stratified sands, gravels and stones. Sometimes a discontinuous layer of cemented till at different depths. pH 8.0

Agriculture

The type has been extensively developed for irrigation in the vicinity of Kelowna, Westbank, Trepannier, Peachland, and Summerland.

While many of the terraces have a comparatively thin solum, others have a fairly deep thickness of soil on top of the underlying gravel, and these have been irrigated most successfully. Some of the best orchards on the Rutland series are in East Kelowna, where the topography is almost flat, and where cemented till occurs within reach of the tree roots. This impervious material, sometimes 4 to 6 feet from the surface, checks the downward movement of water. The tree roots secure moisture from the top of the hard layer and the orchards give good yields. In other places, there is no underlay of cemented till to check the downward movement of water, and irrigation practice is more difficult. Where cemented till exists in the substrata, seepage conditions often develop in depressions and on the lower parts of slopes. This kind of seepage can generally be cleared up by means of a cross drain laid on the impervious layer.

The Rutland series is subject to conditions of erosion and leaching described elsewhere.* In irrigated areas, the amount of surface stone is often excessive and large quantities, from 2 to 6 inches in diameter, have been removed and piled along the fence lines.

Owing to cultural difficulties the type is more suitable for orchards than for tilled crops, and in areas where the solum is 2 feet or more in thickness, fair yields of apples, prunes, and pears are obtained. Peaches and apricots are produced only in the most favoured locations because of limitations imposed by the growing season.

OYAMA SERIES

The Oyama series is derived from sandy terraces in the Dark Brown Soil zone. The type occurs on scattered terraces from Oyama southward to the Summerland district. It lies at elevations between 1,150 and 2,500 feet, covering a total of about 13,451 acres.

Two types of topography were mapped. Kettle areas cover 1,534 acres, and gently undulating to sloping terraces cover about 11,917 acres. Drainage is good to excessive.

The surface soils are dark brown to brown, shading to a light brown subsoil, losing silt and clay content from the surface downward. The structure is finely granular to single-grained, becoming structureless with depth. Lime accumulates to a small extent in the lower part of the B horizon.

The parent materials are similar to those of the Osoyoos, Grandview, and Shuswap series. They consist of pale brown shading to grey stratified sands of medium to coarse texture with layers of fine gravel. In some areas, there is a rather thin overlay of sandy terrace on top of lateral moraines. Where this occurs within 4 feet of the surface, the coarse morainal debris is recognized as a D horizon.

Two types were mapped in 2 phases as follows: Sandy Loam, kettle phase, 637 acres; undulating or sloping, 5,419 acres. Loamy Sand, kettle phase, 897 acres; undulating or sloping, 6,498 acres.

OYAMA SANDY LOAM

Description

The Sandy Loam occurs on scattered terraces between Oyama and the Summerland district, the largest and best developed areas being in the vicinity of Kelowna.

*See Skaha series.

Stones and gravel occur to a greater extent in the substratum than in sandy loams derived from similar terraces in the other soil regions. This is believed to be due to a comparatively shallow terrace formation which overlies a mixture of glacial sands and gravels.

The profile description is as follows:

Horizon	*Depth*	*Description*
A_1	0–7″	Dark brown sandy loam with fine granular structure; mainly composed of very fine and medium sands. Scattered fine gravel. pH 7.2
A_2	7–9″	Degraded light brown, structureless or weakly plated horizon, sometimes absent. pH 7.0
B_1	9–22″	Dark brown shading to brown light sandy loam, losing silt and clay with depth. Fine granular structure, becoming structureless at bottom of horizon. Scattered fine gravel. pH 7.6
B_2	22–38″	Pale brown loamy sand, structureless, porous, with slight lime accumulation in the lower part. Scattered fine gravel pH 8.4
C		Stratified medium and very fine sands containing thin layers of fine gravel. This horizon present or absent. Pale brown to grey. pH 8.4
D		A mixture of grey glacial sands and gravels, probably lateral moraines. Porous and not related to the solum. Sometimes this horizon occurs directly under horizon B_2. pH 8.4

Agriculture

The type is well drained and suitable for irrigation where water supplies are available, but where irrigation is not feasible its best use is for range. The main cultivated areas lie on benches to the east and south of Kelowna, and these are utilized for the production of apples, prunes, grapes, asparagus, cucumbers, onions, etc. High yields are obtainable with good management.

The Sandy Loam is subject to erosion on the steeper slopes when intertilled crops are grown, but under orchard, the dense leguminous cover crop largely prevents active soil movement. The organic matter of the soil is more easily maintained than in similar soils in the Brown Soil region, and drought resistance is greater between irrigations.*

Excessive amounts of irrigation water promote leaching, owing to the porous nature of the substratum. Where water can be obtained as needed, it is preferable to irrigate lightly and frequently, with a minimum loss of water into the substratum.

Glacial till, which was deposited in parts of the valley bottom previous to the time of terrace formation, occurs in places as cemented material at various depths below the surface. This is often a cause of seepage, which can be relieved by a cross drain installed on the impervious material.

OYAMA LOAMY SAND

Description

In the main Okanagan Valley, the Oyama Loamy Sand occurs in scattered areas between Woods Lake and Trepannier. At higher elevations, it occurs also in side valleys to the south of Summerland. The main cultivated areas are on the east side of Woods Lake and between Winfield and Okanagan Centre.

There is some variation of the light-textured topsoil on different terraces. In places it is light sandy loam and in others a coarse loamy sand, but it is always characterized by lower silt and clay content with depth. Fine gravel or grit is

*See Osoyoos Sandy Loam.

scattered throughout the solum and it occurs also as thin, irregular bands in the parent material.

The profile of the Loamy Sand is as follows:

Horizon	*Depth*	*Description*
A_1	0–8″	Dark brown to brown loamy sand with scattered fine gravel and occasional small stones. Coarse, porous and single-grained. pH 7.0
B	8–20″	Dark brown or brown shading to light brown with depth. Single-grained loamy sand with scattered fine gravel and occasional small stones. Slight compaction and lime accumulation in the lower part. pH 8.2
C		Light brown to grey stratified coarse to medium sand, with occasional layers of fine gravel and small stones. pH 8.0

Agriculture

Where not irrigated, the Oyama Loamy Sand is best suited for range. This type is subject to the same limitations as the Osoyoos Loamy Sand where irrigation is practised.* There is a tendency towards deterioration of the soil, due to erosion and leaching. Steep irrigated slopes are subject to washing and cutting. For this type of soil, the sprinkler system of irrigation would be the most satisfactory as a means of controlling erosion and leaching. After years of irrigation the soil is assuming an acid reaction.

The type produces apples of good colour and quality, and is suitable also for grapes and certain soft fruits. In frost-free locations, its warmth and earliness allows, to some extent, the production of crops that are normally confined to the Brown Soil zone.

In orchards, the soil management program should include the upkeep of organic matter by means of a luxuriant legume cover crop, which will also help to keep erosion in check where the soil is inclined to wash downhill. Where possible, frequent and light irrigations should replace heavy watering in order to control excessive leaching.

GLENMORE SERIES

This series is derived from lacustrine sediments deposited in temporary glacial lakes. In the main Okanagan Valley, the Glenmore series occurs in scattered areas from Whiteman's Landing to Trepannier. It also occupies small terraces in side valleys to the south of Summerland. The total area covered by the series amounts to about 15,854 acres. Clay and clay loam textures were mapped, the Clay covering about 12,645 acres, and the Clay Loam, 3,209 acres.

The main bodies of Clay lie near the valley bottom, at elevations between 1,150 and 1,500 feet. Its topography is undulating and gently sloping towards the valley centre. The gentle topography, heavy texture, and location near the valley bottom are causes of restricted drainage in areas where irrigation water is used to excess. The stratified parent material, which is often varved, is similar to that of the Spallumcheen and Broadview series.

The Clay Loam occupies smaller, terrace-like areas at elevations between 1,300 and 2,300 feet, which are sloping, sometimes eroded. It is better drained, with two kinds of substrata. In places, the material underlying the solum is stratified clay, while in others the normal parent material, consisting of finely banded stratified silt, has considerable thickness.

*See Osoyoos Loamy Sand.

GLENMORE CLAY

Description

The main area of Glenmore Clay lies in the Glenmore and Mission Valleys to the north of Kelowna. In the Mission Valley, a part of the original clay deposit has been buried under the post-glacial fan aprons of Mill and Scotty Creeks.

The surface soil is brownish grey, heavy clay with a brownish grey, very heavy columnar subsoil (solonetzic) in some places featured by round topped columns. The parent material is stratified heavy clay often found in annual layers or varves, with occasional bands of silt.

The clay profile is as follows:

Horizon	*Depth*	*Description*
A_1	0–8″	Heavy brownish grey clay with angular crumb structure. Hard and cracked when dry. Slight tendency towards lamination in the lower part. pH 7.5
B_1	8–24″	Heavy brownish grey clay. Columnar with small angular nutty micro structure. pH 8.4
B_2	24–37″	Dense brownish grey clay, broken laminations, with lime accumulation and pockets of gypsum crystals in the lower part. pH 8.7
C		Heavy stratified clay, plated and often varved, brittle when dry. High lime content and pockets of gypsum crystals in the upper part. pH 8.2

Agriculture

Glenmore Clay is the best zonal soil type for dry farming in the Dark Brown Soil zone. Certain areas not irrigated are still farmed for wheat.

In the Glenmore Valley, the higher and better drained parts of the type have been irrigated and planted to orchards, which give good yields. The larger part of the area, however, has gentle slopes and the general effect of irrigation has not been satisfactory. This is due to the many parts that are poorly drained. The downward movement of excess water on gentle slopes is the cause of subsoil saturation in the lower part of the valley. In some places the saturated area has moved up-grade, and some of the lower lying orchards have been destroyed. The trees have been pulled out and the land is now used more successfully for hay and pasture.

Drainage is the primary concern where this type is irrigated. The heavy solum and equally heavy substratum restrict the downward movement and removal of excess water. The excessive moisture moves to the surface and evaporates, leaving a deposit of sodium carbonate to combine with the surface soil and break down the structure. The result is a run-together condition of the soil particles which defies cultural practices. Amelioration of this condition implies the need of adequate drainage and soil treatment with large quantities of gypsum or sulphur, together with heavy applications of organic matter. Such measures could not be applied with profit to other than small areas of degraded clay. The present use and the only feasible practice is to farm areas with restricted drainage for legume hay, grain, and pasture.

In orchards, the main requirements of the type consist of economy in the use of irrigation water and heavy leguminous cover crops to build up the organic-matter content of the soil.

GLENMORE CLAY LOAM

Description

The Clay Loam is a friable, rich type occuring throughout the Dark Brown Soil zone in comparatively small, scattered, terrace-like areas. The topsoil is dark brown, with a large inclusion of silt and clay, changing to a greyish brown subsoil of the same composition.

In some areas, this mixture of sediments has been thinly spread over the stratified clay which forms the parent material of Glenmore Clay. Where this occurs, the solum and substratum are of widely different texture and porosity, and the sub-stratum is designated horizon D.

In other areas the coarser sediments which form the solum were deposited in greater thickness and stratified clay is absent. In this case the solum and substratum are composed of the same material and the substratum is called horizon C.

The Glenmore Clay Loam profile is as follows:

Horizon	*Depth*	*Description*
A_1	0–8″	Dark brown clay loam, rich and friable, with fine granular structure. Slight indication of platiness in the lower part. pH 7.4
B	8–20″	Light brown clay loam or silt loam, structureless but friable, with lime accumulation in the lower part. pH 8.6
C		Greyish brown to gray finely banded silt, compact but porous. pH 8.4
D		Where horizon C is absent, stratified clay similar to horizon C of Glenmore Clay forms the substratum. pH 8.4

Agriculture

In terrace-like areas where drainage is good, this type is one of the best orchard soils in the Okanagan Valley. The comparatively heavy surface soil is rich and moisture retentative, and the silt substratum affords good, but not excessive drainage.

Where a clay substratum is within 2 feet or more of the surface, seepage may develop as a result of over-irrigation on certain kinds of slopes. This can be ameliorated by means of intercepting drains which should be properly located and should lie on the semi-impervious clay.

3. —THE BLACK SOILS

The Dark Brown Soils extend northward from eastern Washington, and across the Boundary in British Columbia they merge at the higher elevations with the Black Soil zone. From south to north at the higher elevations adjacent to the valley depression, the Black Soils occupy south exposures of coulees and hills up to about 4,500 feet elevation.

From south to north in the main valley depression, precipitation is increased and the lower boundary of the Black Soil zone creeps downward until it occupies well-drained areas in the bottoms of the main valley and side valleys between Vernon and Enderby.

The Black Soils in the Okanagan Valley occupy comparatively small areas isolated from one another by more shaded slopes which are forest covered. The distance from the centre of each area to the boundary of an associated zone is seldom more than one-half mile, and these miniature soil and plant communities reflect the neighboring zone to some extent in the profile. The influence of the podsol zone on the chemical profile of the Black Soils make them members of a vertical series only approximately comparable with the large Black Soil areas in the Prairie Provinces.

The distinguishing features of these black soil areas are; the colour of the soil, the luxuriant bunchgrass cover in areas that have not been over-grazed, and the groves of aspen that grow in the damp depressions. The thickness of the black soil layer varies with the parent material from which it developed. On gravelly benches, the black soil is only about 5 inches thick, but under the most favourable conditions it attains a depth of 20 inches. The variable thickness of the black soil layer may be related to the variety of minor differences found everywhere in the region of vertical zones.

Moisture relations rate most nearly with the Dark Brown Soils on the prairies. Grain is grown with dry farming practice in textures ranging from sandy loam to clay, but with greatest success in the clay soils. The average surface reaction under well drained conditions is pH 6.8 to pH 7.0, which often rises to pH 8.4 in the subsoil horizon of lime accumulation.

Important features of the zonal profile are as follows:

Horizon	*Depth*	*Description*
A_1	0–10″	Black to very dark brown in different soil types. The structure is fine grained and dusty when dry in the sandy loam and loam. In the clay loam and clay it is granular and in small angular crumbs. Grass roots are abundant.
A_2	10–12″	Degraded black to dark brown layer with platy structure. Sometimes absent.
B_1	12–21″	Black shading to dark brown. Compact and weakly columnar in light soils; definitely columnar in heavy soils and structureless in colluvial fans.
B_2	21–33″	Yellowish brown to grey, depending on drainage. Dense, structureless, sometimes floury in the lower part with accumulated lime, beneeth which are pockets of gypsum crystals in clay soils.

Vegetation of the Black Soil Zone

This zone is dominated by grasses of medium height, and it yields the most productive natural grasslands. Conditions for growth are more favourable than in the Brown and Dark Brown Soil zones and the grass cover is denser and a little taller.

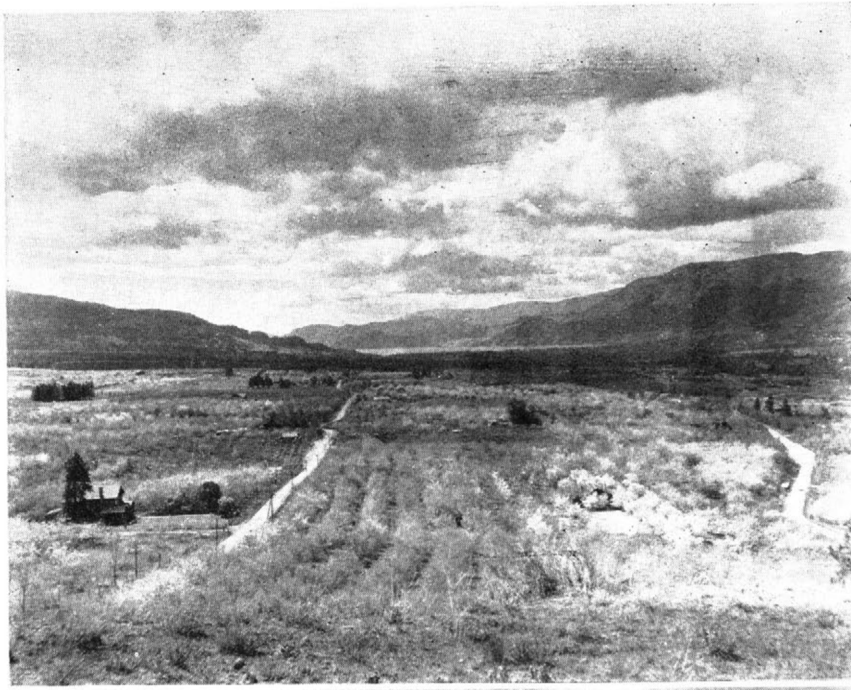
The principal grasses are bluebunch wheatgrass (*Agropyron spicatum*), Columbia speargrass (*Stipa columbiana*), and Kentucky bluegrass (*Poa pratensis*). The first two are bunchgrasses, while the third is a sod-forming species. All are highly nutritious and quite palatable to livestock. Other plants common in the original vegetation include Junegrass (*Koeleria cristata*), long awned speargrass (*Stipa comata*), Blue lupine (*Lupinus sp.*), puccoon (*Lithospermum pilosum*), balsam root (*Balsamorhiza sagittata*), wild rose (*Rosa nutkana*), and coral-berry (*Symphoricarpos racemosa*).

Changes Due to Grazing

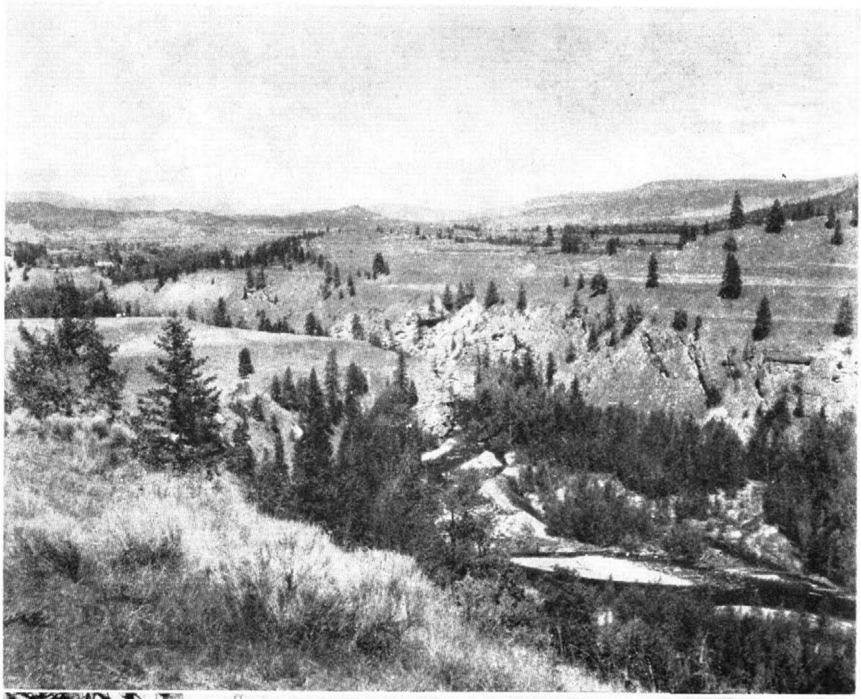
It would appear that originally the bunch grass existed in nearly pure stands over most of the Black Soils, and that the Columbia speargrass and Kentucky bluegrass have increased with grazing. Severe over-grazing has brought about more marked changes and has greatly reduced the grazing capacity. Many areas are now covered with plants such as downy brome (*Bromus tectorum*), wormwood (*Artemisia frigida*), yarrow (*Achillea millefolium*), everlasting (*Antennaria parvifolia*), oyster plant (*Tragopogon pratensis*) and mullein (*Verbascum Thapsus*), which have little or no grazing value. The vegetation of these soils is adapted particularly for grazing in the late spring and early summer and again in the fall. When grazed heavily from early spring to late fall, the grass has no chance to make normal growth or produce seed, and deterioration of the pasture follows.

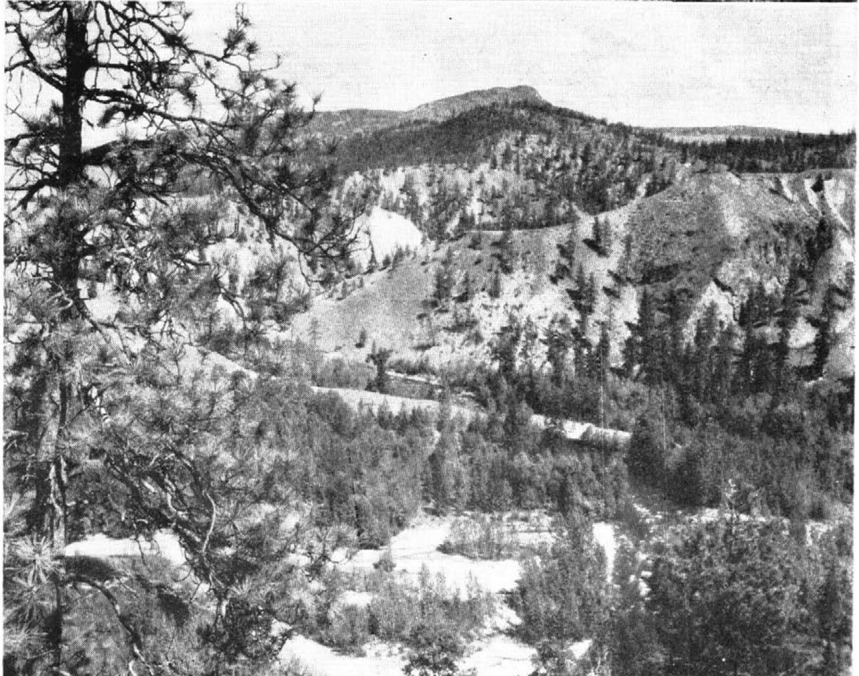
Soil Series and Types

The 5 series and 9 types classified as Black Soils are as follow: Armstrong Gravelly Sandy Loam, Nahun Gravelly Sandy Loam, Grandview Sandy Loam and Loamy Sand, Spallumcheen Clay and Clay Loam, and Kalamalka Sandy Loam, Loam and Clay Loam. The topography is separated into a kettle phase and a mixed phase in which the land is sloping, undulating, or almost flat.



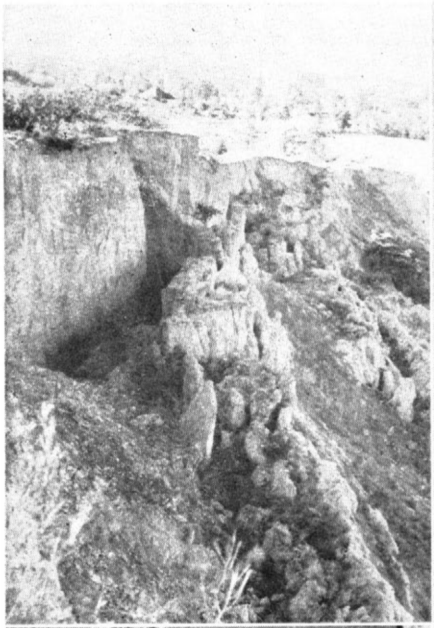
1. Orchard lands near Penticton, looking south over Skaha Lake.
2. South end of Okanagan Lake looking northwest towards Summerland. The soils on the silt benches adjacent to the lake belong to the Penticton Series.

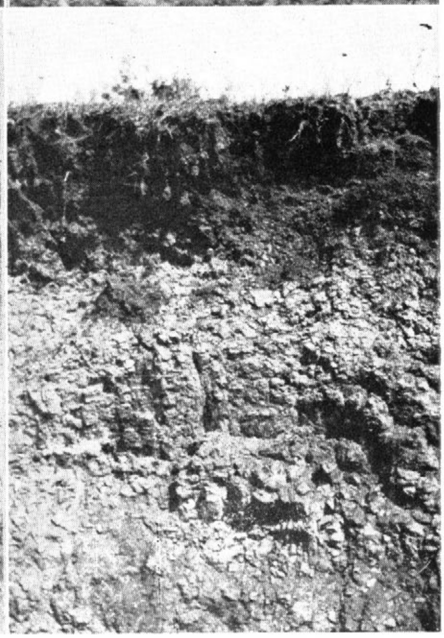




3. Oyama and Rutland Soils on terraces of Mission Creek.

4. Rough Mountainous Land adjacent to Mission Creek. Such lands are of value as sources of water and for grazing, forestry and recreational purposes.



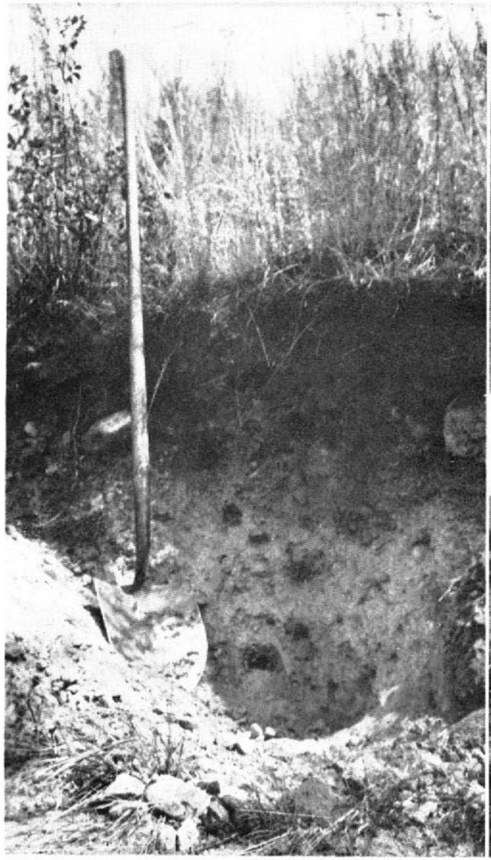


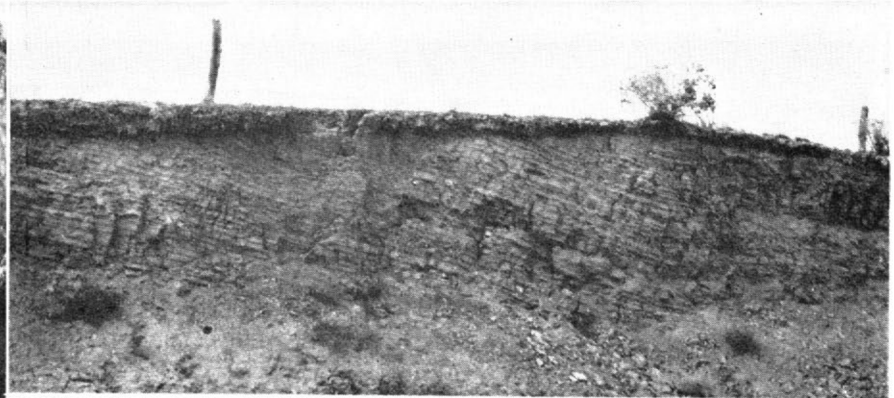
5. Collapse of silt bank, Penticton Silt Loam.

6. Profile of Oyama Loamy Sand. This is a dark brown soil developed on sandy terraces.

7. Profile of Osoyoos Sandy Loam. This is a brown soil developed on sandy terraces.

8. Profile of Spallumcheen Clay. This is a black soil developed on clay.





9. Profile of Armstrong Gravelly Sandy Loam. This is a black soil developed on glacial till.
10. Profile of Glenmore Clay. This is a dark brown soil developed on varved clay.
11. Gully erosion in Glenmore Clay.

ARMSTRONG GRAVELLY SANDY LOAM

Description

The Armstrong and Kelowna series are both derived from glacial till, the distinguishing feature being development in 2 different soil zones. The Armstrong series occurs above the elevation of stratified soil materials which line the valley bottom.

The topography consists of sloping south exposures on the valley sides and the rolling surfaces of low hills in the main valley depression, which contain a few small lakes and sloughs. At higher elevations, the type occupies the south slopes of hills and coulees up to about 4,500 feet elevation between Armstrong and the International Boundary. Classified areas cover about 5,658 acres along the lower mountain slopes, from 1,350 to 2,500 feet elevation, where the topography is sufficiently modified for cultivation. The non-arable areas are classed in with Rough Mountainous Land. They constitute an extensive acreage and the main asset of the valley district for grazing.

The surface is black to very dark brown, shading into a brown or yellowish brown subsoil. The soil material is sandy loam with varying amounts of stones and gravel scattered through the profile, stones in the lower part being lime plated. The parent material is glacial till which may or may not be cemented. Owing to steepness of slopes and consequent sliding of soil particles, the thickness of material above the glacial till can vary considerably from place to place.

Following is a more detailed description of the Armstrong soil profile:

Horizon	*Depth*	*Description*
A_1	0–12″	Black to very dark brown sandy loam; fine grained structure, dusty when dry, scattered stones and gravel. pH 7.0
B_1	12–20″	Brown sandy loam, slightly compact and structureless, scattered stones and gravel. pH 7.2
B_2	20–32″	Brown to yellowish brown sandy loam, compact, structureless, with increased amounts of stones and gravel. Scattered fragments of glacial till and lime accumulations in the lower part. pH 8.4
C		Cemented till of sandy loam texture, containing stones and gravel. Occasionally the till is not cemented or the cemented material lies at greater depth. pH 8.2

Agriculture

The mountainous Armstrong series is used mainly for grazing. As range land, the main difficulty lies in overgrazing. When this is done, weeds and less nutritious grasses supplant the original bunchgrass. Good range management is necessary if the original grasses are to be preserved.

Throughout the series are small areas with topography suitable for cultivation. As a general rule, the arable parcels are scarcely large enough to support farm units and they have been developed with most success for grain growing by conveniently situated farms on other soil types in the valley bottom. The grain, mostly wheat, is planted in the fall to take advantage of the June precipitation.

The largest cultivated area is on Mission Hill, to the southwest of Vernon. In this district, the topography is steeply rolling, with included areas of gently rolling and gently undulating land that may be cultivated. Rock outcrops feature the rangeland, with aspen-fringed ponds in depressions. A water supply for several farms is secured from springs. Cattle and fall wheat are produced.

NAHUN GRAVELLY SANDY LOAM

Description

This type occupies gravelly and stony terraces in a number of scattered areas that occur in the vicinity of Glenemma, Vernon, and the north end of

Okanagan Lake. These different terraces have elevations between 1,200 and 1,800 feet.

The topography has been differentiated into sloping and undulating terraces and terraces containing kettle holes. The total area of the series amounts to about 8,270 acres, of which there are approximately 3,322 acres of undulating and sloping terraces and 4,948 acres of kettle areas.

Under bunchgrass cover, the surface soil is black to dark brown with varying amounts of stones and gravel, shading to brown with depth. The average solum is about 18 inches thick, but in parts of terraces or on whole terraces it may be as much as 24 inches thick or less than 18 inches thick.

The underlying gravelly material compares with that of the Skaha, Rutland, and Glenemma series, the same terrace formation existing in the several soil zones. Beneath the finer textured solum, it consists of coarse stratified sands and gravels of considerable thickness. Occasional layers of cemented till, which originally sloughed down the valley slopes before the terraces were formed, is buried at different depths from the surface.

The profile is characterized by excessive subdrainage as indicated by the following description:

Horizon	*Depth*	*Description*
A_1	0–5″	Black sandy loam with fine grained structure. Loose and porous, with abundance of grass roots. Scattered gravel and stones. pH 7.2
B_1	5–11″	Dark brown shading to brown sandy loam, the silt and clay fraction being fine grained. Increasing amounts of gravel and stones. pH 7.3
B-D	11–18″	Brown to light brown sandy loam, with concentration of gravel and stones. Structureless and porous. Lime plated stones and gravel in the lower part. pH 8.3
D		Brown to grey stratified sands, gravels and stones of a kind used for gravelling roads and making concrete, underlaid here and there by cemented till. pH 8.2

Originally, the thin layer of alluvium on top and the mass of sand and gravel beneath, were two separate layers deposited as a result of water sorting. These two layers of widely different texture form the basis of an A-D profile. In the course of time, the upper layer has subsided into the lower one, causing admixture in the lower part of the solum, which is designated horizon B-D.

Agriculture

The Nahun series is used for range with the exception of one area that has been irrigated successfully for orchard fruits. The irrigated area lies on terraces of B.X. Creek, just north of Vernon. It has modified kettle topography and cemented till buried at different depths in the substratum. Where it occurs near the surface, the indurated till is the cause of imperfect subdrainage.

The thickness of the solum varies from place to place on the same terrace and also on different terraces. Land enters the irrigable class where the solum is 24 inches or more in thickness, and where slopes are sufficiently modified to hold erosion in check. In the Black Soil zone erosion of the gravelly terrace type in orchards is not so intense as in more arid regions, because the leguminous cover crop attains much stronger growth. Excessive use of irrigation water should be avoided owing to its leaching effect on the solum and promotion of seepage at the lower elevations.

GRANDVIEW SERIES

The Grandview series is derived from sandy terraces in the Black Soil zone. It occurs on scattered terraces to the west of Armstrong and in the vicinity of Vernon. The elevations above sea level at which these soils are found lie between 1,300 and 1,800 feet, and the total area of the series is about 10,050 acres. The topography consists of gently undulating terraces and terraces with gentle to steep slopes. Drainage is good, its direction being towards the valley centre.

The surface soils are black, with abundant grass roots. The structure is fine-grained to single-grained, becoming structureless with depth. Stones and gravel are of minor occurrence. The solum is rich in lime, which moves downward and accumulates in the lower part of the B horizon.

The Grandview soils developed from the same parent materials which underlie the Osoyoos, Oyama, and Shuswap series. The substratum consists of brown shading to grey stratified sands of medium to coarse texture, with layers of fine gravel and a few small stones.

Sandy Loam and Loamy Sand textures were differentiated, the Sandy Loam covering about 9,280 acres and the Loamy Sand 769 acres.

GRANDVIEW SANDY LOAM

Description

The largest areas of Grandview Sandy Loam occur in a valley to the northwest of Armstrong, on the Grandview bench and on Mission Hill. The type is well-drained, and where water supplies can be made available there are possibilities for development of irrigation projects.

The soil is rich and mellow. Stones and gravel occur to a minor extent along the boundaries of other soil types, but not to a degree that would interfere with cultural practice.

A profile, taken in a representative place, is described as follows:

Horizon	*Depth*	*Description*
A_1	0–7″	Black sandy loam, well matted with grass roots, fine grained structure, loose and friable. pH 7.2
B_1	7–17″	Black shading to dark brown sandy loam, compact and weakly columnar. Scattered fine gravel. pH 7.3
B_2	17–31″	Brown sandy loam, compact and structureless. pH 7.4
B_3	31–44″	Brown loamy sand, loose, porous and limey, sometimes slightly cemented with lime accumulation. pH 8.3
C		Greyish brown shading to grey stratified medium to coarse sand, slightly compact, with layers of grit or fine gravel. Limey in the upper part. pH 8.6

Agriculture

The Grandview Sandy Loam is excellent for range, but its main use is for the production of fall grain, peas, and alfalfa, with dry farming practice. On the Grandview Bench, an area covering about 2,973 acres to the northwest of Vernon, a non-irrigated block was at one time planted to orchard, and about 100 acres of trees are still producing. To the northwest of Armstrong, the type is more variable and is cultivated mainly for fall wheat. In the Coldstream Valley, about 352 acres have been irrigated successfully for the production of orchard fruits.

Mission Hill, to the west of Vernon, contains an area of Grandview Sandy Loam with a north slope, covering about 2,658 acres. At present, this is used partly for grain growing and in part as an army encampment, but at some time in the future it will make a successful irrigation district. With irrigation it would be particularly well favoured for orchards.

On the Grandview Bench and in the Coldstream Valley, farm water supply is piped in. Since wells are not a reliable source, this practice will have to be followed on Mission Hill when that area is developed for irrigation.

The type has proved to be sufficiently drought resistant to warrant dry farming operations, and the natural fertility of the soil is high. The yields from year to year are dependent on the minor fluctuations of the local rainfall. When June rains are abundant the crops yield well, but when these rains are short the harvest is reduced. With irrigation, the type is wonderfully productive for vegetables, legumes, and tree fruits.

GRANDVIEW LOAMY SAND

Description

The largest area of Grandview Loamy Sand is situated at the mouth of Deep Creek Valley, to the west of Enderby. In this area the topography is almost flat, with a gentle slope towards the valley centre. Near the east shore of Swan Lake on a B.X. Creek terrace, two small areas are irrigated for orchard fruits.

The texture of the light topsoil shows some variation. There is a progressive loss of silt and clay with depth, and fine gravel occurs in the solum and in the substratum. A profile description is as follows:

Horizon	*Depth*	*Description*
A_1	0–10″	Black single-grained loamy sand containing considerable fine gravel and occasional small stones. The small included amount of silt and clay is fine grained and dusty when dry. High in organic matter, with many grass roots, loose and porous. pH 6.8
B_1	10–24″	Dark brown loamy sand shading to brown in the lower part. Fairly compact, structureless. Fine gravel and occasional small stones. pH 7.0
B_2	24–32″	Brown loamy sand, slightly compact, structureless, with fine gravel and a few small stones. Slight accumulation of lime in the lower part. pH 7.6
C		Greyish brown shading to grey stratified coarse sand, with seams of fine gravel and scattered small stones. pH 8.2

Agriculture

In the northern part of the valley, the Loamy Sand is utilized for the production of fall grain. It is not so suitable for this purpose as the Grandview Sandy Loam, owing to a smaller margin of drought resistance.

The irrigated areas near Swan Lake are on a fairly steep slope, and the soil is subject to washing. Under these conditions, the Loamy Sand can lose the entire solum, leaving the trees to produce from the more or less sterile parent material. Whether this will lead to disuse or not is problematical. Where such soils are irrigated on slopes, the porous substratum carries away large quantities of excess irrigation water, causing seepage at the lower elevations.

SPALLUMCHEEN SERIES

The Spallumcheen series is derived from glacio-lacustrine clays which were formerly eroded from till at higher elevations and discharged into temporary lakes during the decay stage of glaciation. The series is confined to the main Okanagan Valley between Enderby and the north end of Okanagan Lake, and the total area is about 12,752 acres. Clay and clay loam textures were differentiated, the Clay covering about 12,091 acres and the Clay Loam 661 acres.

The main areas of Clay lie near the valley bottom, at elevations between 1,300 and 1,500 feet. The topography is almost flat, with a gentle slope towards the valley centre. The stratified parent material is the same as that which lies beneath the Glenmore and Broadview series. The texture of the Clay profile varies along with changes in the parent material. The textural range is from light to heavy clay, with included small areas high in silt, due to silt bands in the substratum.

The Clay Loam occupies smaller areas at about the same elevations and with the same gently sloping topography. It is more variable, with two kinds of substrata. Apparently the Clay Loam was formed by accumulation of silt around masses of clay in a glacial lake. In places, it thinly overlays stratified clay, while in others the silt deposit has more depth and the material beneath the solum consists of finely banded silt, with occasional layers of fine sands. Stones and gravel are absent in both Clay and Clay Loam profiles.

SPALLUMCHEEN CLAY

Description

Except for ravines cut by streams tributary to the main valley, there is little waste land in the Clay areas. Originally these areas were grass-covered priairies surrounded by forest. The moisture-rententive soil was easily brought under cultivation and the land was soon taken up by early settlers.

The colour of the surface soil is black to greyish black, shading to greyish brown and grey in the lower part of the solum. The structure begins with small angular crumbs at the surface which grow with depth to angular lumps with prismatic columnar arrangement. The lower part of the B horizon is marked with white spots and thread-like webs of lime accumulation. At the bottom of the solum there is greater lime accumulation and gypsum crystals in pockets. A more detailed description of this profile is as follows:

Horizon	*Depth*	*Description*
A_1	0–4″	Black to greyish black heavy clay, small angular crumb structure which varies to platiness in the lower part near forest boundaries. pH 6.8
B_1	4–20″	Black heavy clay with brownish mottling in the lower part. Angular crumbs of increasing size with depth, arranged in prismatic columns. pH 7.5
B_2	20–28″	Greyish brown clay, spotted and threaded with lime accumulations. Less dense and less strongly columnar than B_1 and more flocculated. pH 7.9
B_3	28–48″	Transition to horizon C. Flocculated grey clay, dense, plastic, with broken lamination, structureless, with accumulated lime and many gypsum crystals. pH 8.0
C		Greyish brown to grey stratified clay, heavy, dense, plastic when wet and brittle when dry. In some places distinctly varved. pH 8.3

Agriculture

The name "Spallumcheen" is an Indian word signifying beautiful or bounteous prairies, and areas of the type were among the first lands to be farmed in the Okanagan Valley. On cultivation, the Clay produced heavy crops of grain, which it continues to do after about 70 years of cropping. The Spallumcheen Clay is the most productive of the dry farmed soils in the Black Soil zone. It is drought resistant, with great natural fertility. Crops best suited for the type are fall grains, which take advantage of the high June rainfall and the fine harvesting weather in August. Mainly this is a wheat growing soil and the numbers of livestock are limited, but alfalfa and field peas are also produced. The farms are fairly large, with an average of about 160 acres under cultivation. The farm buildings are good, and the domestic water supply is secured mainly from domestic pipelines.

SPALLUMCHEEN CLAY LOAM

Description

Several small areas of this fertile soil occur near the west end of Coldstream Valley. The topsoil is black clay loam with granular structure, changing to greyish brown subsoils.

In parts of each area, the mixture of sediments giving the soil its texture has been spread thinly over the parent material of Spallumcheen Clay. In such places the solum and substratum have different texture and porosity, and the substratum is called horizon D.

In other parts of the same areas the coarser sediments that form the solum were deposited in greater thickness and the stratified clay is absent or at an undetermined depth. Under these conditions, the solum, and the stratum beneath it, are composed of the same material and the substratum is designated horizon C.

No doubt the parent materials are closely related as to their chemical composition, the distinction in texture being due to a different degree of water sorting. Areas with a clay substratum close to the surface have mixed profiles, but such areas are too small for separate classification.

A description of the profile is as follows:

Horizon	*Depth*	*Description*
A_1	0–6″	Black clay loam high in organic matter, granular structure, mellow and rich. pH 6.8
A_2	6–8″	Black clay loam with platy structure. pH 7.2
B_1	8–22″	Dark brown shading to greyish brown clay loam or silt loam. Gradual loss of granular structure and no accumulated lime. pH 7.6
B_2	22–31″	Greyish brown clay loam or silt loam, structureless, floury with accumulated lime. pH 8.4
C		Finely banded grey stratified silt, with thicker bands of coarse and fine silts and occasional thin layers of fine sand. pH 8.2
D		The parent material of Spallumcheen Clay. pH 8.2

Agriculture

This type is irrigated and is very productive. It is mainly used for orchard fruits and the yields are large in well-drained locations. Tomatoes and many varieties of vegetables can also be made to give heavy yields.

The greatest problem with the soil is drainage. The topography consists mainly of a gentle slope to the valley centre, and the underlying clay, which may occur at various depths, is often the factor which forces excess irrigation water towards the surface. This groundwater accumulates to the greatest extent in the lower lying areas. Sufficient slope exists for the use of intercepting drains, which can often be placed on the semi-impervious clay. By means of such cut-off drainage, the water-table can be lowered in orchards to the desired depth, with resulting increases in the yield of orchard fruits.

KALAMALKA SERIES

In the Black Soil areas there are numerous colluvial fan aprons of sufficient size and agricultural importance for differentiation into a separate soil series. The bottom of the Coldstream Valley, near Vernon, has been largely filled by a number of coalescing fans which spread from the toe of the valley slopes.

The fans are a post-glacial formation and their materials are spread over the stratified terraces and other deposits formed during the decay stage of glaciation. Characteristically, each fan has an area of angular rock debris at the coulee mouth. Downward on the slope, the material is of progressively finer texture, yielding several soil classes of agricultural value.

The topography resembles a fan cone, the main directional slope being towards the valley centre, with minor slopes to right and left of the main slope. The rounded back of the cone has been built up by additions from the coulee at times of outwash, the changing course of the temporary stream often streaking the top of the cone with lenses of gravel. The slopes are gentle and ideal for irrigation.

The surface soils are black, shading into a subsoil which ranges from yellowish brown on the upper, best drained part of the fan, to grey on the lower part where drainage may be restricted. On the upper part of the fan the profile contains a normal supply of lime, but lower down where seepage water may fluctuate in the lower part of the solum, the subsoil often becomes highly calcareous. The maximum amounts of angular rock occur along the upper boundary of the Sandy Loam. Finely divided mica is a conspicuous feature in all of the soil types.

The series occurs at elevations ranging from 1,400 to 1,900 feet, the toal area being about 6,990 acres. Its classes are: Sandy Loam, 3,766 acres; Loam 2,344 acres; and Clay Loam, 890 acres.

KALAMALKA GRAVELLY SANDY LOAM

Description

This type occurs in the vicinity of Vernon and Oyama, its largest extent being in the Coldstream Valley. The black surface soil is highest in the finer separates. Silt and clay content decreases and there is an increase in angular rock debris and sand with depth. Mica schist, the most common rock material, is undergoing rapid decomposition, adding fine-textured particles of rock and large amounts of mica to the soil.

The amounts of angular rock that occur in the profile are variable with the location. The upper boundaries of the Sandy Loam border concentrated rock debris in the necks of fans, while the lower boundaries are in contact with finer-textured soils. The rock content of the profile decreases rapidly between the upper and lower boundaries. The texture of the profile grades downhill from coarse to fine with the grading of rock material, the texture at the lower boundary being somewhat heavier than at the top. Drainage is generally good in the Sandy Loam, the subsoil colour being yellowish brown with only a small indication of accumulated lime. The profile is described as follows:

Horizon	*Depth*	*Dexcription*
A_1	0–8″	Black to dark brown sandy loam, fine grained structure, dusty when dry. Angular grit and gravel. Loamy and friable, with much finely divided mica. pH 7.0
B_1	8–26″	Dark brown sandy loam, scattered angular stones, gravel and grit. Structureless; much mica and no accumulated clay. pH 7.3
B_2	26–50″	Yellowish brown to greyish sandy loam, the colour depending on drainage. Structureles, with much angular grit, gravel and stones. Finely divided mica and free carbonates. pH 8.4
C		Light brown to grey sandy loam with increased content of angular grit, gravel and stones, structureless, with much finely divided mica and greater evidence of accumulated lime. pH 8.4

The reaction is neutral at the surface, gradually becoming more alkaline with depth. Reaction at depth, amounting to pH 8.4 — 8.6, is probably due to downhill percolation of mineral-rich water during the spring run-off.

Agriculture

This type is irrigated and very productive, the upper limit of cultivation on the fan slope being governed by the amount of rock in the profile. The crops are diversified mainly on account of local climatic conditions. The Coldstream Valley lies east and west, with a shaded north slope and a sunny south slope. The north slope is best adapted for orchards, and tree fruits give good yields. The south slope is subject to temperature fluctuations which may winter-kill the trees, and the Sandy Loam in this part of the valley is used for production of alfalfa, tomatoes, peppers, cucumbers, corn, onions, cabbages, and similar crops.

The natural fertility of the soil is great, but intensive cropping makes fertilizer necessary. Alfalfa and sweet clover cover crops are used to maintain organic matter in orchards, and ammonium sulphate and boron are required for good fruit production. For vegetables, a complete fertilizer may be used, together with manure.

KALAMALKA LOAM

Description

Areas of the Loam type occur in the Coldstream Valley, between Kalamalka Lake and a point about three miles east of Lavington. The relationship of this type to the Sandy Loam is very close, the main difference being a greater accumulation of silt and clay at the surface and a low content of angular gravel and grit in the profile.

The Loam areas were formed by secondary sorting of fine material weathered partly from the Sandy Loam and in part from tumultuous outwash. The surface soil is black, and the B horizon is brown, yellowish brown or grey, depending on the drainage. The brown and yellowish brown subsoils are mostly confined to the higher altitudes, whereas the grey colour is generally found at the lower levels, where excessive amounts of lime have accumulated. In low-lying areas, the concentration of carbonates is higher than in the corresponding horizons of the Sandy Loam because the main seepage through the fan slope is closer to the surface. Subdrainage is good to fair with the probability that a few small areas should be underdrained. Following is a description of the profile:

Horizon	*Depth*	*Description*
A_1	0–7″	Black to dark brown loam, friable, with fine grained structure, dusty when dry. Scattered angular grit and much finely divided mica. pH 6.8
B_1	7–25″	Loam to sandy loam, light brown to dark grey, depending on drainage. The structure is fine grained at the top, becoming structureless with depth. Slightly compact, stray angular grit and much fine mica. pH 7.5
B_2	25–50″	Loam to silt loam, light yellowish brown to grey, depending on drainage. Structureless, scattered angular grit; free carbonates. pH 8.0
C		Light yellowish brown to grey sandy loam to silt loam. Scattered angular stones and grit, greater lime accumulation than in horizons above. pH 8.4

Agriculture

The Loam is irrigated and has proved to be an excellent soil for general purposes. Where drainage is good it is superior to the Sandy Loam, owing to the absence of rock in the profile. On slopes that do not face the sun, which have good air and soil drainage, the Loam is one of the best orchard soils, capable of giving high yields of apples.

On sunny south slopes that are not suitable for orchards, the type is used for the production of alfalfa, tomatoes, cabbage, cucumbers, and similar crops. The soil is naturally rich, but it would gradually be exhausted without suitable fertilization. In orchards, leguminous cover crops are used together with ammonium sulphate when added nitrogen is necessary. The tilled crops should receive barn-yard manure and a complete commerical fertilizer applied at different times.

KALAMALKA CLAY LOAM

Description

Scattered areas of the Clay Loam lie in the vicinity of B.X. Creek and in the Coldstream Valley. This type forms the lower parts of the same fan aprons which contain areas of Sandy Loam and Loam. The general profile characters are the same as its companion types, the surface soil being highest in clay, and the subsoil losing clay content with depth. In some sections, the soil profile is free of gravel, while in others varying quantities are found, mostly in the subsoil horizons.

The Clay Loam is situated at the lower elevations near the valley bottom. The surface soil is black, firm, and sometimes gritty. Where clay content is less than 25 per cent, it is often difficult to note the difference between Clay Loam and Loam, due to the presence of grit and the high content of organic matter. Where the clay content is from 25 to 30 per cent, however, the surface appears fine textured and firm. The black surface soil shades into a brownish subsoil where drainage is good and to greyish or grey where seepage-water occurs, the greyish horizon being rich in lime. A more detailed description of the type is as follows:

Horizon	*Depth*	*Description*
A_1	0–8″	Black clay loam, firm, sometimes gritty. Fine granular structure, matted with grass roots, much finely divided mica. pH 7.0
B_1	8–26″	Dark brown loam shading to yellowish brown, granular at the top, becoming structureless in the lower part. Firm but friable, with scattered angular gravel and much mica. pH 7.4
B_2	26–44″	Silty clay loam, yellowish brown or greyish brown depending on drainage. Firm and structureless scattered fine gravel and much finely divided mica. Accumulation of lime in the lower part. pH 8.4
C		Greyish brown to grey silty clay loam, structureless and firm, scattered gravel and much finely divided mica. Rich in lime accumulated from seepage. pH 8.4

Agriculture

The Clay Loam is irrigated and used for general purposes. Where slope, soil, and air drainage are favourable it is excellent orchard land, capable of high yields.

On south slopes and where subdrainage is restricted the land is not so well suited for orchards as for tilled crops. Under such conditions, the type is used for production of alfalfa, ensilage corn, cabbage, and other crops. The soil is very fertile, but it is capable of exhaustion without treatment. In orchards, leguminous cover crops supply organic matter and nitrogen, the latter being enhanced when necessary with ammonium sulphate. The tilled crops generally follow alfalfa, which takes care of their organic matter and nitrogen requirements.

4.—INTERMOUNTAIN PODSOL SOILS

This is a minor division of the podsol zone. It occupies areas on the humid side of the Black Soils in the northern part of the Okanagan Valley bottom. To the southward, it covers northern slopes in the region of the Black Soils. It is probably a forested transition type which lies between the Black Soils and a division of the humid zone in which podsolization is more strongly expressed.

Its width is known to vary with the degree of slope, but owing to a lack of agricultural importance, the upper limits of the type have not been determined.

The Intermountain Podsol is distinguished by the nature of its profile and vegetative types. The soil profile was studied near the valley bottom in the vicinity of Salmon Arm, where moisture conditions are close to the minimum for the growth of forest.

The main features of this profile are as follows:

Horizon	*Depth*	*Description*
A_0	0–1″	A surface mat of dark brown forest litter, undecomposed at the top and well rotted at the bottom. This is the acid raw humus horizon.
A_2	1–2″	A thin layer of grey leached mineral soil found mainly in excessively drained profiles.
B_1	2–10″	Brown in colour, shading to yellowish brown, spotted with iron stains and a few small hard concretions.
B_2	10–30″	Rust brown in well drained sandy soils with nodules and soft irregular masses of dark brown humus-iron. Precipitated lime in specks, streaks and bands in the lower part. Lime also occurs occasionally as a coating around dead roots.

Comparable sandy soils are less drought resistant than in the Black Soil zone, and dry farming of light soils is marginal. Greater success with dry farming has been achieved in clay loam and clay, where orchards are established. The reaction in well-drained profiles is from pH 5.6 to 7.0 at the surface and from pH 7.2 to 8.4 in the subsoil horizon of lime accumulation.

Production from the light-textured soils has been greatly increased in several small areas by irrigation from mountain streams. This indicates that the soils are fertile and that the comparatively large area in the vicinity of Salmon Arm could be made to produce in quantity and quality when provision is made for a water supply.

Vegetation of the Intermountain Podsol Soils

The Podsols support a forest of mixed type in which Douglas fir (*Pseudotsuga taxifolia*) is most abundant and widely distributed. Other trees common in certain parts of the region include western red cedar (*Thuja plicata*), lodgepole pine (*Pinus contorta*), yellow pine (*Pinus ponderosa*), western white pine (*Pinus monticola*), western larch (*Larix occidentalis*), aspen (*Populus tremuloides*), western white birch (*Betula occidentalis*), and willow (*Salix sp.*).

The principal shrubs are wild rose (*Rosa nutkana*), snowberry (*Symphoricarpos racemosa*), thimbleberry (*Rubus parviflorus*), soopolallie (*Sheperdia canadensis*), false box (*Pachystima myrsinites*), dwarf spirea (*Spiraea lucida*), kinnikinnick (*Arctostaphylos uva-ursi*), and Oregon grape (*Berberis aquifolium*). Common herbaceous plants include pine grass (*Calamagrostis rubescens*), bracken fern (*Pteris aquilina*), wild strawberry (*Fragaria sp.*). rough aster (*Aster conspicuus*), and giant fireweed (*Epilobium angustifolium*).

The character of the soil and climate are reflected in the mixed type of vegetation, which is noteworthy for the presence of cedar and other trees requiring considerable moisture, for the abundance of deciduous trees, and for the relatively small amount of pine grass as compared with the typical forests of the dry interior belt.

Most of this forest area has been logged, and much of it burned since settlement began, so that few mature trees of any kind remain. It would appear that originally Douglas fir was the principal tree over this area, with cedar, larch, and white pine common in the more humid, and yellow pine in the more arid, portions. The present abundance of aspen, birch, and willow seems due mainly to the effects of cutting and fire. These trees are pioneer types, which are shaded out once a stand of conifers becomes established. Lodge-pole pine and snowbush (*Ceanothus velutinus*) are common on burned areas where the soil is sandy.

Among the plants of the undercover, thimbleberry and bracken fern are particularly characteristic of the moister portion of the region and are rare or lacking in the drier part.

Soil Series and Types

The soils in the Intermountain Podsol zone were classified into 4 series and 6 types as follows: Sicamous Gravelly Sandy Loam, Glenemma Gravelly Sandy Loam, Shuswap Sandy Loam and Loamy Sand, Broadview Clay and Clay Loam. The topography is separated into a kettle phase and a mixed phase in which the land may be undulating, sloping, or almost flat.

SICAMOUS GRAVELLY SANDY LOAM

Description

The Sicamous series is derived from glacial till similar to the parent material of the Armstrong and Kelowna series, and it lies above the elevations of stratified materials which line the valley bottom.

The topography consists of valley sides and the surfaces of low hills which lie in the main valley depression. In the region of the Black Soils, the type occupies north slopes of hills and coulees. About 36,000 acres were mapped at the north end of the Okanagan Valley, where small arable acreages are scattered among large areas of land that is rough and mountainous.

Beneath a thin layer of forest litter, the surface soil is dark brownish red, becoming more brown or brownish grey in the lower part. While stones are common, the finer aggregates predominate at the surface, the stones and gravel becoming more numerous with depth. On the valley slopes, this unsorted material is underlaid, at a depth of about 2 feet, by indurated till having the same textural composition as the soil above.

Small lakes, springs, and seepages occur under the different conditions of relief. The drainage of the soil profile is often restricted by the "strike" and nearness of the parent material to the surface. The parent till is sufficiently firm to prevent penetration of roots and the downward movement of water. The groundwater table thus formed permits the accumulation of lime in the lower part of the B horizon.

The degree of podsolization is increased from the comparatively dry valley bottom to the more humid, cooler, and higher elevations. Since these changes take place within short distances, the series is transitional. In many parts of the Okanagan, it lies between the Black Soil region and regions in which the podsol process has greater development.

A profile description is as follows:

Horizon	*Depth*	*Description*
A_0	0–2″	Dark brown partly decomposed forest litter, to some extent mixed with mineral soil. pH 5.6
A_2		A thin ashy line, not measureable.
B_1	2–8″	Dark brownish red sandy loam. Fine grained structure, scattered stones and iron plated gravel. pH 6.6
B_2	8–16″	Colour shades from dark brownish red to brown in the lower part. Structureless sandy loam with stones and gravel. Loose and porous. pH 6.8
B_3	16–24″	Greyish brown sandy loam, structureless, with accumulated lime and a mat of roots in the lower part. pH 7.8
C		Cemented, sandy boulder till containing rounded and angular stones and gravel. Grey, limey at the top, with fissures and root channels filled with lime. pH 8.4

Agriculture

In the north end of the valley, where agricultural development of this type is possible, the topography is mountainous with occasional gentle slopes and small areas of rolling land. The soil is drought resistant and precipitation is sufficient for mixed farming. A farm unit should have about 60 acres or more of arable land, but very few farms of this size could be developed except in the form of scattered fields.

About 10 per cent of the mapped area of this soil has topography suitable for cultivation, mainly as small acreages that are isolated from one another. Where cultivated, good crops of alfalfa, hay, grain, vegetables, and small fruits are produced. The type can be used for pasture and dairying, and a farm water supply can be secured from springs and wells.

The main difficulties in the way of development are the small size of areas with topography suitable for cultivation and the heavy forest cover. These two factors combine to keep the size of farms below the subsistance level. Such conditions make necessary the provision of outside employment, which may be partly supplied by pole, fence post, and wood cutting and employment in the adjacent valley. However, these limitations are believed to be such that development of independent farm units in this type of soil is not feasible.

At present, the development within the series is scattered over a large area, which adds considerably to the cost of roads and social services. The only economic development that has taken place is on the slopes near the valley bottom, where small areas have been cleared and added to the valley farms. Aside from the latter type of development, it is believed that the Sicamous Gravelly Sandy Loam should be used for forestry purposes.

GLENEMMA GRAVELLY SANDY LOAM

Description

The Glenemma series is derived from gravelly and stony terraces that occur in 20 scattered areas between Salmon Arm and Cherryville. These different terraces lie between 1,130 and 1,800 feet elevation, with the exception of an included area in the valley of B.X. Creek, near Vernon, which has an upper limit of about 2,500 feet.

The topography is somewhat variable. There are gently undulating, gently sloping, and steeply sloping terraces which have been classified separately from terraces with kettle surfaces. The total area of the series is about 15,704 acres, with approximately 8,629 acres of undulating to sloping terraces and about 7,075 acres of kettle terraces.

Beneath a light covering of forest litter the solum consists of a thin layer of dark brown sandy loam, with varying amounts of gravel and stones on the different terraces. While the average thickness of the solum is from 14 to 18 inches, in parts of terraces or on whole terraces, it may be as much as 2 feet thick.

The substratum compares with the Skaha, Rutland, and Nahun series. It is a grey, open, stratified mixture of coarse sand, gravel varying from fine to coarse, and stones ranging up to about 8 inches in diameter. The size of the gravel and stones and the amount of sand in the mixture varies to some extenti n each terrace. The coarse material which forms the bulk of these terraces was probably supplied by erosion of glacial till at the close of the glacial epoch, when rejuvenated streams discharged into a former glacial lake. Scattered areas of cemented till occur in the substratum of both rolling and sloping terraces. Since the texture of the substratum differs widely from the solum, it is not regarded as the parent material of the surface soil, although the geological source is the same and there is some degree of admixture.

The thin solum and open substratum afford excessive subdrainage and ability of the soil to dry quickly after rains. Ponds are absent and the gravelly terraces are the driest soils of the region. The following profile description indicates in more detail the characters which determine the best land-use for the type:

Horizon	*Depth*	*Description*
A_0	0–½″	A thin surface covering of forest litter, partly decomposed. pH 5.6
A_2	½–3″	A bright, ash-grey podsolized layer. pH 5.6
B_1	3–10″	Dark brown sandy loam with no visible structure. Loose and porous, with scattered stones and gravel. pH 6.8
B-D	10–17″	Brown sandy loam, shading to grey with depth, increasing amounts of stones and gravel. Loose, porous and structureless. Lime plated stones in the lower part. pH 7.8
D		Grey stratified layers of mixed sands, gravel and stones of considerable thickness and variety, but evidently not the material from which the solum weathered directly. Scattered areas of indurated till. pH 7.6

Horizon A_2 has greater thickness than in any other type in the region. While an A_1 horizon is barely visible in some locations, it is not sufficiently consistent nor well marked to be included in the profile description. At the surface the soil is acid, but horizon B-D is weakly alkaline with lime plating on occasional stones.

Agriculture

The profile description identifies the type with a thin gravelly solum and a porous, gravelly, excessively drained substratum. Here and there are small pockets of sand, only a few acres in extent, which have the profile of the Shuswap Sandy Loam. Such areas are arable if irrigated, but they are scattered and hardly worth developing.

Attempts have been made in the past to dry farm this type of soil, but without any real success. The exception to this general rule applies to a bench with deeper than average solum, which occupies about 2,120 acres on the south side of the Coldstream Valley, opposite Lavington. Part of this terrace is served by an irrigation canal and part contains several non-irrigated farms. The dry farmed part would be greatly benefited by irrigation and the irrigated part can be made to produce good crops. Selected locations in this terrace have a solum sufficiently deep to warrant further extension of the irrigation system.

In the type as a whole, the cost of clearing the land of timber and brush is high and a water supply can be secured only from occasional springs and streams which drain from the hills. While such land will not repay a large reclamation cost, the similar types in the other soil regions have been irrigated with success where the solum has a depth of 2 feet or more. The type should not be dry farmed, and irrigation, except where it can be cheaply installed on favourable locations, would be a doubtful investment. Aside from these possibilities and for occasional poultry and fur farms, the best use of the Glenemma series is for forestry purposes.

SHUSWAP SERIES

Shuswap series is derived from sandy terraces in the region of the Intermountain Podsols. It occurs mainly at the north end of the Okanagan Valley, between Salmon Arm and Enderby. Smaller areas lie in the Salmon River and Coldstream Valleys and in the Lumby district. With few exceptions, the areas of these soils are in association with the Glenemma series, at elevations between 1,130 and 1,800 feet.

The total area of about 21,096 acres has variable topography. Kettle areas cover about 7,195 acres, and mixed topography consisting of narrow terraces cut by deep ravines, broad and gently undulating or sloping terraces cover about 13,900 acres. In the kettle topography, cemented till occurs at various depths in the substratum. Groundwater is generally absent and the soils are well drained.

A distinctive character of the Shuswap profile is the colour, which shades from brown to yellowish brown with depth. Throughout the solum are numerous little brown spots or little round iron stains ranging from very small sizes up to a quarter inch in diameter. There are scattered concretions of iron-cemented sand, which begin with a few in horizon B_1 and increase in size and number with depth. In horizon B_3 large irregular concretions of iron-bound sand are often found, together with specks of lime. The stratified sandy parent materials are brownish grey and similar to those of the Osoyoos, Oyama, and Grandview series.

Sandy Loam and Loamy Sand types were mapped. In a total area of about 15,089 acres, the Sandy Loam has 7,195 acres of kettle topography and about 7,894 acres of mixed terrace topography. The Loamy Sand, which covers about 6,008 acres, has gently undulating or sloping surfaces.

SHUSWAP SANDY LOAM

Description

The most important areas of Shuswap Sandy Loam occur in the vicinity of Salmon Arm. In this district, the topography of the type consists of kettle and sloping surfaces. The drainage is good and there are possibilities for the development of an irrigation project.

In the Salmon River Valley and around Gardom Lake, the possibilities for development are limited by the topography, which takes the form of narrow terraces and rough rolling land. In these sections only selected parcels are suitable for cultivation. In the Coldstream Valley, a small area is irrigated for orchard fruits, which give satisfactory yields, and near Lumby are several terraces, parts of which may be irrigated when water is available.

Stones and gravel occur to a minor extent along the boundaries of other soil types and where the Sandy Loam occupies narrow terraces along the sides of steep slopes.

A profile, taken in second growth near Salmon Arm, is described as follows:

Horizon	*Depth*	*Description*
A_0	0–1″	Dark brown forest litter, partly decomposed. pH 5.6
A_1	1–1½″	Mixture of decomposed organic matter and mineral soil. pH 5.6
A_2	1½–3″	Brownish grey, podsolized, structureless sandy loam. pH 5.6
B_1	3–13″	Tan brown sandy loam, structureless and compact. High proportion of medium and very fine sands. Rusty spots and occasional small brown concretions of iron cemented sand. pH 5.7
B_2	13–25″	Yellowish brown sandy loam, structureless and compact. High proportion of medium and very fine sands. Scattered rusty spots and brown concretions of iron cemented sand which are larger and softer then those in B_1. pH 6.8
B_3	25–32″	Rust brown sandy loam, structureless and compact. Many dark brown concretions of iron bound sand, some large and irregular in shape. Specks of lime and occasional lime crusted dead roots. pH 7.4
C		Light brownish grey shading to grey stratified micaceous sand of medium texture. Thin lenses or layers of fine gravel. pH 7.2

Agriculture

The Shuswap Sandy Loam is a mellow deep soil well adapted to cultural practice in topographically favourable locations, but local experience in the Salmon Arm district indicates that moisture-holding capacity is too low for successful dry farming. Without irrigation it is a marginal soil, best suited for pasture when cleared, or for foresty purposes.

With irrigation the type would produce excellent yields of field crops, with tree fruits in favoured locations, as proved by small areas watered from mountain streams. The soil is deficient in nitrogen and organic matter, both of which could be increased, under irrigation, by the use of leguminous crops. The soil may also benefit from small applications of lime in locations where the surface has an acid reaction.

Possibilities for irrigation are related to a cheap source of pumping power and water from Shuswap River and Shuswap Lake. With pumping power, approximately 25 per cent of the Sandy Loam would be irrigable.

Where settlement exists, a farm water supply is secured mainly from creeks, springs along the mountain sides, and from wells dug in coulee depressions, the availability of water for domestic use being a primary factor in the selection of a holding. Over most of the area the underlying strata are not favourable for the finding of well-water, and this would involve the development of a domestic pipeline if irrigation projects are at any time installed.

SHUSWAP LOAMY SAND

Description

Shuswap Loamy Sand is located in the northern part of the Okanagan region in 5 scattered areas. In some areas the topography is gently undulating or gently sloping towards the valley centre. In others it is more rolling with included small flats and deep coulees. Moisture-holding power is low and subdrainage is excessive. A natural water supply from springs, wells, or lakes is absent except for occasional springs that come from adjacent mountain slopes.

The Loamy Sand is free from stones, but fine gravel often occurs in the deep sandy substratum. Beneath a light covering of organic litter the light brown topsoil is open, single-grained, and porous. The solum grades into greyish brown parent material that is almost pure sand. In some of the terrace-like areas the topsoil varies to a thin covering of light sandy loam, but where the land is rolling this erodes from the knolls, giving a variety of textures between the hill-tops and the depressions.

The Loamy Sand profile is somewhat featureless, one horizon shading into another without clearly marked boundaries. Evidence of a B horizon is based on the change of colour and the accumulation of iron. A profile taken in second growth is described as follows:

Horizon	*Depth*	*Description*
A_0	0–1½″	Dark brown forest litter, sometimes with a coat of living moss; decomposed in the lower part. pH 5.6
A_2	1½–2″	Ash grey, podsolized mineral soil. pH 5.6
B_1	2–12″	Brown single-grained loamy sand, shading to light brown with depth. Scattered fine gravel, slightly compact but porous. pH 6.2.
B_2	12–36″	Light brownish grey loamy sand. Nodules and irregular concretions of brown iron cemented sand, which are most numerous in the lower part. No stones or gravel, compact but porous. pH 6.5
C		Clean grey stratified sand, loamy, loose and porous, with occasional layers of fine gravel. pH 6.7

Agriculture

In most of the mapped areas, the Loamy Sand is too excessively drained for dry farming, and very little development has taken place. In one area covering about 1,889 acres, to the north of Armstrong, there appears to be better moisture relationships than in the Shuswap Sandy Loam, a finer-textured soil. This is probably due to the shape of the valley at this point, permitting rainfall that does not occur elsewhere. There is no doubt that rainfall variations do occur within short distances in the Okanagan Valley bottom. This area is about 30 per cent cultivated for winter grain and alfalfa, with small fruits and vegetables in the hollows. The area as a whole was at one time covered by light sandy loam which has eroded from the knolls, spotting the fields with different moisture relationships. A farm water supply is secured from a pipeline. This is only a subsistance agriculture, and the area is not recommended for any further development.

The Shuswap Loamy Sand is not recommended for farming without irrigation. It would become productive if irrigated, particularly for mixed farming, but in its dry state it should be used only for forestry purposes.

BROADVIEW SERIES

This series is derived from glacio-lacustrine sediments deposited in temporary lakes, during the decay of glaciation. It occupies about 40,891 acres at the north end of the Okanagan region, between Salmon Arm and the Lumby district. On the soil map it has been differentiated into Clay and Clay Loam, with a coverage of 31,748 acres of Clay and about 9,143 acres of Clay Loam. The Broadview soils occupy the valley bottoms at elevations between 1,130 and 2,500 feet.

The average topography of the Clay is gently sloping towards the valley centre. These slopes have been trenched by post-glacial streams which run at right angles to the main valley and down the valley centre, the general effect being a series of broad, well-drained terraces carved from the original clay deposits.

The topography of the Clay Loam varies from gently undulating and gently loping to rolling and steeply sloping in the different scattered areas. Subsurface water in the Broadview series is not continuous or general. Well-water is obtained in the lower lying areas, such as those in the Spallumcheen Valley, and elsewhere from springs draining the Sicamous series.

The texture of the profiles is variable from place to place along with the changing composition of the parent material, which is geologically similar to the stratified sediments underlying the Spallumcheen and Glenmore series. Variations in the substratum yield loam, silt loam, light, medium, and heavy clay textures in the Clay type, and silt loam and loam textures in the Clay Loam. These are minor variations, not suitable for differentiation with the present map scale.

BROADVIEW CLAY

Description

The Broadview Clay occupies a large part of the Spallumcheen Valley, between Enderby and the north end of Okanagan Lake. The topography is uniform and almost flat, with a gentle slope towards the valley centre. Elevation is between 1,200 to 1,400 feet and drainage is provided by Fortune and Otter Creeks, which flow northward and southward respectively.

The A horizon is thin, hence the important horizon for cultural practice is horizon B_1. This greyish brown layer has small angular crumb structure at the top. As depth is increased the small aggregates bind together into groups of increased size and hardness. In the lower part angular nut-like groupings are formed and these are arranged in columns. A detailed profile description is as follows:

Horizon	Depth	Description
A_0	0–1″	Dark brown undecomposed forest litter. pH 6.0
A_1	1–1½″	A thin layer of decomposed organic matter mixed with mineral soil. pH 6.0
A_2	1½–2″	A thin ashy grey layer, often occuring as a greyish brown coloration at the top of horizon B_2. In second growth A_0, A_1 and A_2 are frequently too thin or damaged to be recognized as individual layers. pH 5.8
B_1	2–14″	Greyish brown clay, small angular crumb structure, the crumbs growing in size with depth; prismatic-columnar. pH 7.1
B_2	14–18″	Greyish brown clay, structureless, with accumulated lime in the lower part. pH 7.8
C		Heavy greyish brown shading to grey stratified clay, plated, often varved, brittle when dry. The upper part of this horizon is rich in lime leached from the solum. pH 8.2

Agriculture

Since the time of the first settlement in the northern part of the Okanagan Valley, areas of Broadview Clay have been cleared of brush and farmed without irrigation. For many years good crops of hay, alfalfa, grain, corn, soybeans, roots, potatoes, vegetables, and small fruits have been produced. The greatest deficiency of the soil is organic matter, and the best use of the type is for mixed farming and dairying. Over a large part of the area a farm water supply is secured from wells and creeks, but in some places a domestic pipeline is necessary.

Because of its uniform topography the Broadview Clay contains little waste land, other than a few creek ravines. The forest cover is heavy and the cost of clearing is high. These factors have retarded development and only about 60 per cent of the land is cultivated, but it is all privately held and about 90 per cent arable.

BROADVIEW CLAY LOAM

Description

This type occurs near Salmon Arm and in the Mabel Lake, Creighton, and Lumby districts, the topography being more variable than in the Broadview Clay.

Beneath a thin horizon of organic litter the soil is greyish brown and variable into loam, silt loam and silty clay loam textures in areas too small to differentiate with the present scale of mapping. The B horizon has the greatest content of clay at the higher elevations, where the soil receives the most precipitation. Unlike the clay type, occasional stones and gravel are found in the profile, but not in sufficient quantities to make the land undesirable for cultivation.

The variation of surface texture follow similar changes in the parent material. In most areas the parent material is stratified, but in one place a massive unstratified silty deposit was observed to underlie the solum and also to underlie a thin layer of stratified sediments. The following is a more detailed description of the Clay Loam profile:

Horizon	Depth	Description
A_0	0–1″	Dark brown undecomposed forest litter. pH 5.8
A_1	1–2″	Thin black layer of decomposed organic matter mixed with mineral soil. pH 5.6
A_2	2–4″	Greyish white clay loam with platey structure. pH 5.6
B_1	4–14″	Greyish brown clay loam with angular crumb structure, fairly dense and compact. pH 6.8
B_2	14–30″	Greyish brown clay breaking into large angular fragments, with columnar structure, dense and hard. pH 7.2

Horizon	Depth	Description
B_3	30–36″	Grey silty clay, structureless, floury with accumulated lime. pH 8.2
C		Grey stratified silty material with texture variable from loam to clay. A few scattered stones occur in the solum and in the parent material. pH 8.3

Agriculture

Precipitation is slightly higher over the Clay Loam than over the Broadview Clay, and where other conditions are favourable tree fruits have replaced mixed farming as the main enterprise. At Salmon Arm, an important area of Clay Loam lies near Shuswap Lake, which governs temperature fluctuation sufficiently for apple production. Success in this field is limited by moisture relations, which are at the minimum for the purpose. The trees are small and production is low when compared with the irrigated districts to the south. The need of moisture economy makes it necessary to dispense to some extent with cover crops and practise clean cultivation. Since manure of good quality is never available in sufficient quantities to replace leguminous cover crops, the result may be a breakdown of soil structure and eventual failure of the orchard district. Orchard fruits, however, would be important in this favoured locality if irrigation water were made available by pumping from Shuswap Lake or from a source in the nearby hills.

In the Lumby district, the elevation of the Clay Loam is higher, with about the same precipitation as at Salmon Arm. The land is less suitable for tree fruits, owing to the absence of a nearby body of water. Under these conditions, mixed farming may be practised, with due regard for spring frosts.

At the mouth of Deep Creek Valley is another area of about 2,413 acres. There are scattered farms with good buildings and the land is cultivated for fall grains and hay. For grain growing, the soil organic matter should be kept up by means of a legume rotation and application of manure. Light additions of superphosphate would increase the yields of grain.

The farm water supply is a problem throughout the Clay Loam type. The area to the east of Salmon Arm requires a domestic pipe line, similar to the one serving the area at the mouth of Deep Creek Valley. The locality on the west side of Salmon Arm may be at least partly served by springs from the hills. In the Lumby district, ground water is equally erratic and should be found before holdings are taken up. In both districts, the Clay Loam is capable of greater development; the Salmon Arm areas being about 60 per cent cleared and cultivated with 80 per cent potentially arable; and in the Lumby district only a small part of the available area has been brought under cultivation.

5. —GROUNDWATER SOILS

In the valley bottom, the Groundwater Soils are of considerable importance as to the area they occupy and their utility for agriculture. In the Okanagan district, they have been differentiated into; (A) a group of mineral soils with a fluctuating groundwater table, and (B) Bog Soils.

The first division is a soil complex that exists where the water-table fluctuates at different levels within the solum. These conditions occur in many small to comparatively large areas on the lower fringes of post-glacial fan aprons and on the second bottoms of streams.

These soils exist within the several soil zones and their profiles vary accordingly. In a more ideal classification, the distinctions would be recognized by grouping such soils as groundwater associates of the different zonal soils. Owing to their complexity, however, the minimum of differentiation is necessary and they have been grouped as Mara and Nisconlith series.

The Bog Soils have a water-table at or near the surface. They occupy the sites of former sloughs, which were gradually filled by the partly decayed remains of rushes, sedges, and similar plants. The final product is a well-decayed muck, some of which has been drained and cultivated.

The Groundwater Soils are so affected by seepage-water that they have not acquired the normal characteristics of the adjacent zonal soils. While restricted drainage is the character they have in common, their distinguishing features are due to the different positions attained by the annual rise and fall of the groundwater level. The main levels of groundwater for a significant period each year are; (1) in the lower part of the solum, (2) in the upper part of the solum, and (3) at or above the surface.

Where the water-table fluctuation is confined to the lower part of the solum for a comparatively short period during the freshet season, the surface soil and part of the subsoil is not saturated. This permits the growth of a heavy forest and the development of an A-B-G-C- profile. These are the main features of the Mara series, which occurs on the floodplains of the Salmon and Shuswap Rivers.

The second type is found around the lower fringes of colluvial fans and in the low flood-plains of streams, where the water-table is within a few inches of the surface for short periods during the freshet season. These conditions promote a cover of deciduous trees and shrubs and the development of an A-G-C profile. In place of the horizon B of well-drained soils there is a G horizon, limey and mottled with rusty brown and grey stains. These conditions are the main features of the Nisconlith series.

The concentration of soluble salts in the groundwater increases from the Podsols to the Brown Soils and the kind of salt dominant in the mixture is different in each region. This character could be used as the basis for further differentiation of the groundwater soils.

The groundwater table at or above the surface provides for swampy conditions and the formation of the bog type. This has been classified as Muck, owing to the degree of decomposition. A feature of the profile is a marley substratum between the layer of plant remains and the mineral soil beneath. This is caused by the movement of mineral carrying water from the upland to the valley bottom.

The relationship of the zonal and groundwater soils to one another are illustrated by an ideal cross-section of the Okanagan Valley in Fig. 5.

Vegetation of the Groundwater Soils

In the Mara series, where the groundwater table fluctuates in the lower part of the solum, the vegetation has some resemblance to that on the Nisconlith series, but the growth is stronger and coniferous trees become important at an earlier stage in the succession.

The principal deciduous trees are willows, cottonwood and birch, while the main conifers include red cedar (*Thuja plicata*), Douglas fir (*Pseudotsuga taxifolia*), and Engleman spruce (*Picea Engelmani*). The shrub cover is well-developed in the early stages and it includes dogwood, Rocky Mountain maple, hawthorn, Saskatoon, chokecherry (*Prunus demissa*), and hazel (*Corylus*). The herbaceous layer resembles that found in the Intermountain Podsol.

There has been much disturbance of this type by cutting, burning, and clearing, and most of the tree cover consists at present of a mixed stand of young deciduous and coniferous species. Apparently the original stands on the older portions of the Mara series resembled luxuriant portions of the Intermountain Podsol, with cedar dominant and reaching a size rarely attained in the associated well-drained soils.

On the low floodplains and fans of the Nisconlith series, where the water-table comes close to the surface in the freshet season, most areas support a medium stand of deciduous trees. The principal species are willow (*Salix*), cottonwood (*Populus trichocarpa*), white birch (*Betula occidentalis*), aspen (*Populus tremuloides*), and alder (*Alnus sitchensis*). Common shrubs include dogwood (*Cornus stolonifera*), Rocky Mountain maple (*Acer glabrum*), and hawthorn (*Crataegus*),

Newly formed floodplains are occupied chiefly by willows, which are the pioneer species in the vegetation of such areas. On slightly older and drier ground the willows have been replaced by cottonwood and birch. Aspen is important on still drier portions, along with coniferous trees, chiefly yellow pine. The development of this type of vegetation is uniform throughout the Okanagan from Vernon south, indicating the dominant influence of the soil conditions with which it is associated.

In the Okanagan Muck bogs, formed with a water-level at or above the the soil surface, areas which have not been disturbed are occupied mainly by sedges (*Carex*) and moisture-tolerant grasses. In the submerged parts, cat-tail (*Typha latifolia*) and rushes (*Scirpus*) occur. Older, drier parts of the bogs are occupied by trees, of which willows and alders are the pioneer types.

Due to the cultivation of the more mature bogs only traces were seen of the forest type which occurred on them. Apparently it was dominated by cedars, many of which grew to greater size than in the Intermountain Podsol. Recognizable plant remains obtained by boring into the muck layer, often to a depth of many feet, consisted mainly of sedges along with a few fragments of alder and cedar wood.

Soil Series and Types

The Groundwater Soils were classified into 3 series and 8 types as follows: Mara Loam and Clay, Nisconlith Sandy Loam, Loam, Silt Loam, Clay Loam, Clay and Okanagan Muck.

A. —MINERAL SOILS WITH RESTRICTED DRAINAGE

MARA SERIES

In the Mara series are included about 25,787 acres of alluvial soils derived from material transported by rivers and deposited along their courses and at their mouths in post-glacial time. The series occupies valley bottoms at elevations between 1,130 and 2,000 feet. The topography is flat, with shallow trench-like depressions that were formerly arms of the streams. In the deeper and larger parts of these depressions are shallow sloughs, some of which have become muck bogs.

The texture of the profile varies in different parts of a valley with the speed of the stream at the time of deposition. The substratum was associated with conditions of flow in the river bed, and most of it consists of stratified sands which vary from fine to coarse, but here and there silts and clays with intervening bands of sand form the substratum. This represents a reinvasion by the stream of an area that formerly collected fine sediments. Buried layers of organic matter also occur where areas were flooded.

The finer textured topsoil was formed after the rivers had abandoned parts of their valleys except for freshet overflow, which laid down a final covering of fine sediment ranging in texture from loam to clay. The thickness of the fine textured topsoil varies from place to place, and it has a tendency to merge into fine sands in the lower part.

The whole area of the series consists of first bottoms and low second bottoms, the second bottoms being higher and better drained. In the first bottoms the groundwater level is about 2 feet deep and the solum consists of the first 14 to 18 inches. Under these conditions the soil structure is very weak and a B horizon is scarcely noticeable.

In the second bottoms, the water-level is about 5 feet deep in the dry season and the horizons of the profile are more clearly defined. The surface soil is brown to brownish grey and feebly podsolized, beneath which there is a slightly compact brownish grey B horizon. The groundwater level moves up and down with the seasons and the height of the rivers, iron staining the profile in the region of fluctuation, which is situated just below the B horizon. Iron staining takes the form of brown and orange mottling on a grey background, the amount of grey, and sometimes blue, depending on texture, aeration, and the length of the submergence period. Lime concentration is mainly at the upper limit of groundwater fluctuation. The reaction varies from pH 7.0 at the surface to pH 8.0 in the subsoil. Loam and Clay textures, free from stones and gravel, were differentiated.

MARA LOAM

Description

About 11,933 acres of this type occur in part of the Salmon River Valley and in the Lumby district. In the Salmon River Valley the loam is upstream from the Mara Clay in the form of narrow first and low second bottom floodplains about 18 miles in length. The extent of this area amounts to about 3,250 acres with elevation between 1,150 and 1,400 feet. In width, the area ranges from an eighth of a mile at the upstream end to about a half a mile at the downstream boundary.

This long, narrow, floodplain area is variable both in texture and in the height of the groundwater level, the first bottoms being the most poorly drained. In the better drained part, the light brown, slightly podsolized topsoil varies from loam to sandy loam in areas too small to be mapped. Where best developed, the loam topsoil is about 8 inches thick, followed by sandy loam to a depth of 18 inches, beneath which there is iron-stained stratified sand. Here and there are lenses of gravel which were formerly bars in the stream beds.

In the Lumby district, a deeper and richer Mara Loam covers about 8,683 acres in the bottoms of Bessette Creek and the Shuswap River. The Bessette Creek bottoms contain the greatest depth of fine-textured material. The Shuswap River bottoms are more variable, with some gravel bars and sandy substrata at a depth of about 30 inches. In this area the elevation of Mara Loam is between 1,300 to 2,000 feet above sea level.

The following is a description of an average profile taken in the Lumby district in second growth forest:

Horizon	*Depth*	*Description*
A_0	0–1″	Dark brown undecomposed forest litter. pH 6.0
A_2	1–1½″	Dark greyish brown loam. An indistinct representation of feebly developed A_1 and A_2 horizons. pH 6.0
A_3	1½–6″	Brown loam, slightly darkened with organic matter, compact with granular structure. pH 7.0
B	6–30″	Greyish brown loam or silt loam, slightly compact, friable and structureless. pH 7.2
G	30–38″	Greyish iron-stained sandy loam, structureless and porous. pH 8.0
D		Coarse greyish brown stratified sand with lenses of gravel. pH 7.8

Agriculture

About 75 per cent of the total area of Mara Loam has been cleared of brush and brought under cultivation. Alfalfa is grown on the higher and better drained ground and the remainder of the land produces timothy, red top, alsike clover, and fall grains. Roots and vegetables do well. In the Lumby area there are large numbers of beef cattle and some dairying. The farms are large, with good buildings.

The Mara Loam in the Salmon River Valley has a more restricted development, with 40-acre farms and a mixed agriculture. This area has more waste land, resulting from gravel bars and abandoned arms of the stream. Dairying has been developed to some extent and the land is also used for vegetable growing. In places the groundwater level is close to the surface, in others the ground is higher and small irrigation systems would increase production in localized areas. Some of the low floodplains in the upper part of the valley produce sedges and cultivated hay.

A farm water supply is obtained from wells and creeks. Flooding occurs in some of the low and flat first bottoms, but they drain quickly when the freshet is past its peak. The freshet on Shuswap River, however, is delayed in the spring by slow melting of high mountain snows, and Mabel Lake reaches high water-level later in the season, sometimes bringing flood conditions to the flats along the river at seeding time.

MARA CLAY

Description

The Mara Clay covers about 13,854 acres near the mouth of Salmon River and in the Spallumcheen Valley between Enderby and Mara Lake, with elevation between 1,140 and 1,300 feet.

The type extends upstream for about 6 miles above the mouth of the Salmon River, where it enters Shuswap Lake. Over this area of about 4,630 acres, the soil is a light, feebly podsolized clay, becoming sandy at a depth of about 28 inches. This fine-textured material overlies coarse, stratified, grey sand, mottled in the upper part by brown and orange compounds of iron. The surface soil is somewhat dense, with a weak granular structure. Between Enderby and Mara Lake in the Spallumcheen Valley, a larger area covering about 8,921 acres is very similar to the Salmon River bottoms. The surface is brownish grey, feebly podsolized, with weak, granular structure, the texture being slightly heavier than in the Salmon River Valley. The subsoil is grey and mottled with orange and brown stains. The depth of the clay varies, with an average of about 36 inches, and the substratum consists of stratified sand, silt, and clay. In both areas the surface horizon is almost neutral in reaction, with free lime in the region of the fluctuating water-level.

The following is a profile description of Mara Clay from an area having second growth vegetation and the best drainage conditions:

Horizon	*Depth*	*Description*
A_0	0–2″	Deciduous leaf on top, decomposed at the bottom, dark brown in colour. pH 6.0
A_2	2–3″	Light grey feebly posolized clay with granular structure, many small roots. pH 6.8
A_3	3.5″	Light grey clay in large lumps one inch or more in diameter, which break down to granular structure, slightly compact. pH 7.2
B	5–13″	Brownish grey clay, breaking into angular fragments of medium hardness. pH 7.6
G	13–29″	Grey very fine to medium sands having sandy loam texture, mottled with brown and orange stains. Structureless, slightly compact, micaceous, occasional nodules of iron-bound sand. Free lime carbonate. The horizon of groundwater fluctuation. pH 8.2
D		Grey stratified sands of varying texture in different parts of the area, with some areas of stratified silts and clays having intervening layers of sand. pH 8.0

Agriculture

The Mara Clay is dependable for mixed farming and one of the most productive soils in the north Okanagan Valley. The land is privately owned and almost completely developed, with individual holdings that range between 100 and 200 acres.

Drought is not a limiting factor, owing to the high water-table, except in dry years on the best drained parts of the area. The good farm buildings are evidence of a permanent agriculture. In the mixed farming practice crop rotations are important and sod crops do well. The most extensively grown crops are alfalfa, clover, timothy, wheat, oats, barley, field peas, ensilage corn, roots, and potatoes, which give good yields. Livestock are important, many farms having dairy cattle, sheep, hogs, and poultry.

The farm water supply is secured from wells, which should be located away from barnyard contamination. The Salmon River flats are not subject to flooding, but the Shuswap River drains from high mountains, with some variation of flow from year to year. Although dyking has not been undertaken, the high water during exceptional freshets has flooded some of the low lying areas. The Shuswap River flows through Sugar and Mabel Lakes, which lie above the floodplains occupied by Mara Clay. The lakes act as control reservoirs which prevent a sudden rise or fall of the river level and keep the stream within moderate limits of high and low water in average years.

NISCONLITH SERIES

This series occurs throughout the Okanagan and Similkameen Valleys. The conditions necessary for its formation are found in the lower parts of colluvial fans and on low floodplains of rivers where drainage is restricted or poor. The topography is gently sloping or flat and the elevations at which the series is found vary between 903 and 1,700 feet above sea level.

The profile is characterized by a layer of deciduous leaf at the surface, where the land is covered with trees, and a deep A_1 horizon. This is followed by a structureless horizon G, wherein the groundwater rises and falls during the freshet season, leaving rusty brown, yellowish, and greyish staining or mottling due to different iron compounds.

The unweathered material beneath may be part of the debris from which the solum has formed or a foreign statum over which the lower fringe of a fan has spread. Where it forms an older part of a fan it is coarser textured than the topsoil. On low floodplains of streams where the series in found, the solum may differ widely in texture from the coarser unweathered substratum. The colour of the substratum may be grey, rusty brown, or blue, depending on the drainage.

The material which underlies the solum along the lower fringes of colluvial fans is important inasmuch as it influences the height attained by groundwater. In cases where fan materials have spread over stratified clay of the Glenmore type or other materials whose texture is finer than the soil above, the substratum acts as a semi-impervious floor on which freshet and excess irrigation water may move and sometimes reach the surface.

Most of the seepage from valley slopes must pass through the colluvial fans before reaching an outlet, and lime and more soluble salts accumulate to some extent in the lower part of the solum. Where groundwater reaches the surface and evaporates, a white efflorescence is often formed. Various salts are found in the Okanagan Valley from north to south in the order of solubility and climatic dryness. Average reaction varies from about pH 7.4 at the surface to pH 8.4 in the subsoil.

Damage to crops and trees due to increased alkali accumulation during the period of irrigation has not been demonstrated except in a few isolated cases.

Greater damage is generally done to crops by over-irrigation and stimulated seepage, which should be ameliorated by underdrainage.

In the Nisconlith series, 5 types were mapped which cover a total of 41,027 acres. These are Sandy Loam, 18,316 acres; Loam, 2,424 acres; Silt Loam, 12,568 acres; Clay Loam, 3,697 acres, and Clay, 4,021 acres.

NISCONLITH SANDY LOAM

Description

In scattered areas, the Sandy Loam occurs from Salmon Arm to Oliver and in the Similkameen Valley. In the Okanagan, it is derived mainly from fan materials at least partly laid down under subaqueous conditions, the rock material being more or less closely confined to a limited area at the toe of the slope. It is found next to the area of rubble and has scattered gravel along the upper boundary. There are lenses of gravel throughout its mass, due to former freshet outwash. Better drained parts often support grass and yellow pine in place of the deciduous trees in poorly drained areas.

Along the Similkameen River, between Hedley and Cawston, the bottom lands are Sandy Loam about 30 inches deep and underlaid by clean washed sands and gravels. In this area the fluctuations of the water-table follows the rise and fall of the river.

A profile description is as follows:

Horizon	*Depth*	*Description*
A_0	0–1″	Dark brown partly decomposed leaf litter, chiefly deciduous. pH 7.0
A_1	1–8″	Dark brown sandy loam, finely granular to structureless. pH 7.4
G	8–32″	Structureless sandy loam or loam, colour varying with drainage. With fair drainage yellowish brown with scattered iron stains. Grey mottling and many rusty stains where drainage is poor. Moderate amounts of accumulated lime. pH 8.4
C		Clean greyish iron stained sand, bluish when permanently saturated, generally micaceous. pH 8.2
D		River gravels and coarse sands on low flood plains or stratified clay beneath fan aprons where horizon C is absent. pH 8.2

Agriculture

The higher parts of the type have a gentle slope towards the valley centre and large areas have been irrigated successfully. The use of the land for orchards is dependent on the height of groundwater. In some areas, the groundwater level can be held at a depth of 4 to 5 feet by underdrainage, which makes the production of tree fruits possible.

In lower lying areas, where the water comes closer to the surface, the land is irrigated for shallow rooting crops. Tomatoes of excellent quality and vegetables of all kinds, together with corn, wheat, oats, and alfalfa give heavy yields. In areas where irrigation is unnecessary owing to a high water-table, the land is mainly used for hay and pasture.

The surface soil is generally rich in organic matter, which should be maintained, but where heavy crops are grown, commercial fertilizers and boron are sometimes essential for the maintenance of crop yields.

NISCONLITH LOAM

Description

The largest areas of Nisconlith Loam occur in the vicinity of Winfield, Scotty Creek, and Kelowna; a very calcareous area lies in the Coldstream Valley, and smaller areas were mapped in the southern part of the Okanagan district.

The Nisconlith Loam is down farther on the fan slopes than the sandy loam, and is generally subject to more restricted drainage. Originally the Loam supported a growth of deciduous trees. The topography is almost flat and the land is stone-free.

A cross section of this type is as follows:

Horizon	*Depth*	*Description*
A_0	0–1″	Dark brown leaf litter, chiefly from deciduous trees. pH 7.0
A_1	1–8″	Dark brown heavy loam, finely granular to structureless, with a high content of very fine sand. pH 7.6
G	8–28″	Heavy loam high in the very fine sand fraction, glittering with finely divided mica. Structureless, coloured greyish brown with gray mottling and brown stains; some lime accumulation. pH 8.2
C		Continuation of the loamy materials mostly derived from the weathering of micaceous rocks. Grey with rusty mottling to blue; limey. pH 8.6
D		Grey, clean, coarse to medium sands, bluish where saturated and lime rich in the upper part where horizon C is absent. Under some conditions the D horizon may be stratified clay. pH 8.6

Agriculture

Nisconlith Loam is seldom well enough drained for tree fruits, but some areas have been irrigated for shallow rooted crops. Under irrigation, it produces heavy yields of tomatoes, corn, onions, peppers, and alfalfa. In non-irrigated areas it is used for roots, hay, and pasture.

The water-table rises and falls with the growing season, particularly if excess irrigation water is added to amounts accumulated during the spring run-off. In the Dark Brown soil zone where excess irrigation water brings a continuous rise of the groundwater level during the growing season, evaporation spots accumulate black alkali. In such places the possibilities of underdrainage should be investigated, and the accumulated alkali may be treated with heavy applications of gypsum. Permanent treatment requires drainage and gypsum application.

The soil is rich in organic matter and the soil management program should provide for its upkeep. Where intensive cropping is practised, applications of commercial fertilizers and boron are essential in addition to organic manures.

NISCONLITH SILT LOAM

Description

The main areas of Nisconlith Silt Loam are in the vicinity of Vernon, Kelowna, and in the Similkameen Valley to the south of Keremeos. They occur in valley bottoms as the low floodplains of streams.

Near Vernon and Kelowna, the Silt Loam areas are composed of fine sidements underlaid by sand and finally by more impervious material. Seepage comes from irrigated land at higher elevations and also from irrigation of the Silt Loam. Under such conditions the water-level continues to rise from spring to fall and only small scattered acreages on better drained locations will support tree fruits.

In the Similkameen Valley there is a silty solum about 30 inches thick, which overlies river sands and gravels. In this area the groundwater level is governed by the annual rise and fall of the stream.

The profile of this type is as follows:

Horizon	Depth	Description
A_0	0–1″	Dark brown organic leaf litter, mainly deciduous. pH 7.0
A_1	1–9″	Dark brown to greyish brown silt loam, crumbly and firm. pH 7.4
G	9–30″	Silt loam, compact, structureless, brown to yellow brown with fair drainage, grey mottling and rusty stains where drainage is poor. pH 8.4
D		Clean grey very fine to coarse sands with layers of gravel. Bluish when permanently saturated. pH 8.6

Agriculture

In the Okanagan Valley, large areas of this type are irrigated and used for the production of hay, legumes, pasture, grain, tomatoes, and vegetable growing. The Silt Loam is a very rich and productive soil for shallow rooted crops, but only on rare sites can orchards be grown. Orchard locations are generally found to have some special drainage feature which enables the trees to survive. This may be a very porous substratum, which permits a quick rise and fall of the water-table during the freshet season and comparative dryness thereafter.

In the Similkameen Valley there is an orchard area on the type between Cawston and Keremeos. Orchards on the best drained locations are showing good growth. In such locations the wells are reported to rise in the spring and drop with the fall of the river. Apparently a quick rise and fall of the water does not injure the trees. Other orchards have been planted in less favourable locations, where drainage is more restricted and alkali salts are contributed by drainage from adjacent fan cones. Some of these orchards are in poor shape.

South from Cawston, numerous drainage channels meander through the bottom land. At present most of the area is Indian reserve and development consists of scattered hay meadows and grain fields. Planning for future agricultural development in this area requires careful study. Orchards should be confined to the best drained sites, crop land has an intermediate position as to drainage, and some of the land is suitable only for hay or pasture without irrigation.

NISCONLITH CLAY LOAM

Description

This type occurs in small widely scattered areas in the Okanagan district in the lower parts of fan aprons and along the courses of small creeks.

Drainage is more restricted than in the Sandy Loam, Loam or Silt Loam of the same series, and it closely approaches the conditions of water saturation necessary for the formation of half-bog soils. In valley bottoms, it receives percolating groundwater that has passed through the coarser textured types on the fan slopes, and in the more arid soil regions the subsoil accumulates large quantities of lime. The topography is almost flat and the land is stone-free.

The profile is as follows:

Horizon	Depth	Description
A_0	0–1″	Dark brown organic leaf litter chiefly deciduous. pH 7.0
A_1	1–12″	Black to dark brown clay loam, crumbly granular structure. pH 7.4
G	12–30″	Silt loam to loam, the colour depending on drainage. The better drained parts are yellowish brown with a few iron stains. Areas that do not drain quickly have a G horizon with grey mottling and rusty stains. Rusty blue in the lower part where almost permanently saturated and very limey in some areas. pH 8.4
D		Coarse to medium sands with layers of gravel. Grey to blue, depending on period of saturation, with a few rusty stains in the upper part. Very limey in some areas. pH 8.4

Agriculture

This deep, rich, well-flocculated soil is ideal in some areas for vegetable growing and it has been irrigated for that purpose. The drainage is too restricted for the production of tree fruits.

The greater part of the mapped area is used for the production of alfalfa, grain, hay, and pasture for which most of the scattered areas of the type are best suited.

In the Dark Brown soil zone the Clay Loam is subject to accumulation of black alkali by evaporation in small spots where groundwater approaches the surface. Under such conditions, the possibilities of underdrainage should be explored and where drainage is feasible it may also pay to ameliorate small areas with heavy applications of gypsum.

NISCONLITH CLAY

Description

The main areas of Nisconlith Clay lie in the vicinity of Kelowna and on the Okanagan River upstream from its mouth at the north end of Osoyoos Lake.

On the Benvoulin Flats near Kelowna, a large part of the 1,900 acres of Nisconlith Clay is characterized by poor drainage conditions. In the lowest lying areas, groundwater reaches the surface and evaporates to cause the accumulation of white and black alkali.

On the first bottoms of the Okanagan River the Clay type is low lying, with a high water-table. Swampy conditions in some parts of this area result from hillside seepage.

The profile description is as follows:

Horizon	*Depth*	*Description*
A_0	0–1″	Dark brown leaf litter, chiefly deciduous. pH 7.0
A_1	1–10″	Dark greyish brown light textured clay, with granular structure. pH 7.6
G	10–24″	Greyish brown mottled silty clay, iron-stained, compact, structureless, limey. pH 8.4
D		Grey coarse to medium sand, compact but porous, bluish in areas of permanent saturation. pH 8.6

Agriculture

The higher parts of the area in the vicinity of Kelowna have been irrigated and planted to apples, pears, and cherries with satisfactory results. Such areas have better drainage than the average for the type as a whole, but the lower parts of these orchards develop sickly trees. Other fairly well-drained sections are used for the production of alfalfa, grain, tomatoes, squash, pumpkins, and root crops. The poorly drained areas are near Kelowna and in the city limits. Their main use is for pasture and for building sites.

The bottom lands along the Okanagan River are marked by spring seepages and meandering water courses, some portions having developed an organic layer comparable to half-bog. The drier and most useful part is meadow, covering about 60 per cent of the area, and used for the production of wild hay as winter feed for range cattle.

B. —BOG SOILS

OKANAGAN MUCK

Description

The Muck soils occur in bogs variable in size, and covering a total of about 3,633 acres. Small bogs are scattered throughout the Okanagan Valley at from 1,150 to 1,700 feet elevation, the greater number being to the north of Vernon.

Important features common to all of the bogs include the similarity of the plant remains and a more or less uniform degree of decomposition. The thickness of the organic material varies from a few inches to many feet, the deepest deposit being in the Deep Creek Valley, to the west of Enderby. In this bog, the partly decomposed plant remains attain a thickness of about 16 feet, with an underlay of marl.

The Muck Soils are slightly alkaline, with reaction varying from pH 7.0 at the surface to pH 8.0 in the lower part of the deposit. As a general rule, the marl accumulates in the lower part of the bog, or near the entry of springs carrying a large supply of carbonates. Some parts of a bog may have no marl stratum between the organic material and the underlying mineral soil.

A description of the average profile is as follows:

Horizon	*Depth*	*Description*
1.	0–24″	Black well decomposed muck containing a small proportion of recognizable leaf and stem remains of rushes, sedges and trees. pH 7.0
2.	24–48″	Dark brown well decomposed muck, small amounts of decomposed but recognizable stems and woody remains. pH 7.4
3.	48–60″	A layer of marl, with or without small snail shells. This horizon is sometimes absent. pH 8.4
4.		Bluish underlying mineral soil, generally fine textured.

Agriculture

Most of the Muck areas have been developed to some extent. There is specialized use of Muck soils for truck farming on Otter and Fortune Creeks, near Armstrong, and also at Okanagan Mission, near Kelowna. These bogs produce heavy yields of celery, lettuce, cabbage, and other vegetables of excellent quality. This has been accomplished by adequate drainage and fertilization. With proper drainage and fertilization, the area devoted to truck crops could be greatly increased.

Some of the Muck bogs have been partly drained and used for the production of grains and timothy hay, which give good yields when the land is fertilized. Other bogs that remain undrained are useful for the production of swamp hay and wild pasture.

In shallow parts of the bog, the marl may be turned up by the plough, with poor results for vegetable growing. Satisfactory treatment of this condition is not possible, and areas where marl approaches the surface too closely should be used for hay and pasture.

MISCELLANEOUS AREAS

COLLUVIAL FAN RUBBLE

A total of about 17,758 acres in the Okanagan and Similkameen Valleys is occupied by the stony sections of colluvial fans, which have been given a separate colour and symbol on the soil map. Each area consists of angular rock fragments and water-rounded stones and gravel mixed with varying amounts of soil. A few of the smaller fans were not differentiated, and the lower parts of some of these have cultivated land amounting to a few acres. Natural vegetation consists of the grasses or trees of the zone in which the fan occurs. As a general rule, the density of growth is light, owing to the excessive drainage.

There is a reduction in the stone content from the coulee neck downward on the slope and an increase in the content of soil. The boundary between the fan rubble and the sandy loam on the slope is based on the upper limit at which the land may be ploughed.

Colluvial fan deposits in the Okanagan and Similkameen Valleys are of post-glacial origin, and probably date from a period when violent storms were more frequent and spring freshets more pronouned than they are today. For some time past, the annual contribution of debris to many fans has been small, and soil horizons can be traced almost to the coulee neck. While this feature gives some value to the land for range or forest, the stony nature of the type prevents cultivation.

ROUGH MOUNTAINOUS LAND

The Rough Mountainous Land includes the valley slopes that cannot be cultivated, low hills in the main valley depression, and the mountainous region above the valley rim.

Although this region is not arable, it is complementary in many ways to the valley district as a source of natural wealth. Most irrigation systems are dependent on the precipitation which falls on the mountainous land, where it is collected and stored in dammed lakes and reservoirs.

It has great value for grazing. Southward from Armstrong, the south slopes are occupied by the Black Soils up to an elevation of about 4,500 feet, which provides spring and fall range for cattle and sheep. Higher up is the alpine region, some of which has grazing value.

The yellow pine, Douglas fir, and Engelman spruce from Rough Mountainous Land, supplies the sawmills with timber for box making and building. The slabs, box ends, and sawdust are important by-products used as the main source of domestic fuel. In addition, the forest supplies fence posts, poles, orchard tree props, and cordwood for local use.

A number of lakes in the mountainous district are kept well-stocked with Kamloops trout, which provide recreation for valley sportsmen and many visitors. In season, the mountain country is also a good hunting ground for willow grouse, blue grouse, and mule deer, and trap lines are operated in many parts of the area.

CHEMICAL COMPOSITION OF SOILS

During the Pleistocene epoch, the country was over-ridden by a great ice sheet. The moving ice scraped up the Tertiary soils and mixed them with new debris of all textures derived from the abrasion of many kinds of rock formations. This was a process of rejuvenation, in which fresh minerals were added to old soils and a mass of unconsolidated glacial material was produced. ([8]).

On deglaciation, this glacial till was both sloughed and washed into the valley depressions; the washed debris being sorted into a number of textural classes. After completion of glacial decay, the post-glacial erosion cycle began its work of reducing the glacial till and its stratified products to the form of colluvial and subaqueous fans and flood-plains.

The work of accumulation by the ice sheet and the distributing agencies of deglaciation and post-glacial erosion are responsible for the final arrangement of the materials from which the Okanagan soils are derived. The Kelowna, Armstrong, and Sicamous series weathered directly from the glacial till, their parent materials being the same, but they occur in different climates. Sixteen other soil series derived from transported materials have the same ancestry.

The parent glacial till is a general mixture, whose mineral characters have been inherited by all of the soils, but water-sorting has affected the degree of inheritance in regard to some constituents. The total analyses show that water-sorting has endowed the loamy sands with a high content of silica by removing iron, aluminium, and magnesium. No doubt a large part of the sesquioxide and magnesium content was contained in particles of small size, because the clays are low in silica and comparatively high in total iron, aluminium, and magnesium. The other constituents, shown in appended table 7, are not so clearly influenced by textural grading.

The content of organic matter and nitrogen in the soil profile varies in response to climatic distinctions, the Black Soils being most favoured for accumulation and fixation under well-drained conditions. From the Dark Brown to the Brown Soil zones, the amount of organic matter and nitrogen stored in the soil is progressively smaller, owing to more limited rainfall and more scanty vegetation. In the Intermountain Podsol, there is an organic mat on the surface, but the soil itself contains less organic matter and nitrogen than the grassland types.

Organic matter is of primary importance for the maintenance of a desirable soil structure and nitrogen is essential as a growth factor. Both substances, however, are relatively unstable and their maintenace in the soil calls for continuous effort in crop land. In the podsol region, the best crops are grown where the original store of organic matter and nitrogen has been increased, while in the grassland soils good results are secured where the original supply of these constitutents has been maintained.

Phosphorus is the least mobile of the important soil minerals, and its greatest concentration in the soil profile is usually at or near the surface. This is due to the action of plants which draw a part of their supply from the subsoil. As vegetation decays, the phosphorus is held in combination with organic matter. Apparently the return of this substance to the subsoil by leaching is at a slower rate than its accumulation in the topsoil under natural conditions. Where crops are grown and shipped away, however, this cycle is interrupted and sooner or later the actual loss of phosphorus from the soil must be replaced by the use of fertilizer.

While relative abundance of the more common mineral substances in Okanagan soils is evident, there is equally strong proof that some of the most important minor elements exist in extremely low concentrations in the parent glacial till and its derivatives. The low boron content of Okanagan soils is perhaps sufficient to serve the needs of the native vegetation, but proved to be inadequate for cropping. ([14]). Iodine deficiency is even more strongly apparent, with an incidence of thyroid enlargement of from 30 to 92 per cent in some of the school districts before treatment was established. ([9]) In addition to the treatment of school children, there is evidence that thyroxine can be used to the advantage of a significant percentage of adults. Chlorine is found only as a trace in the drainage waters, and the deficiency of this element alone would soon depopulate the valley if salt importations were stopped. Dental caries, amounting to 87 per cent in high school children, suggests the need of investigating the nature of an additional deficiency, which may at some time be traced to the absence of another minor element, such as fluorine.

Soluble salts move in the groundwater from uplands to lowlands in every climatic region and some of them are retained in the profiles of the Groundwater Soils that lie in the valley bottom. This accumulation is related to humidity and solubility, the greatest number and amount of salts being leached into the streams and rivers in the most humid climate. As the climate becomes less humid, more and more of these salts are retained in the poorly drained soils.

In a humid climate, such as the Lower Fraser Valley, there is no storage of available alkali earths in the soil profiles. ([7]) Lime and more soluble salts are leached into the drainage waters, but the less soluble iron moves into the poorly drained soils to form accumulations of bog iron.

The most humid Okanagan climate in the map-area prevails in the Intermountain Podsol region. In this zone, the bases have greatest liberation and the topsoil is rendered slightly acid by the sinking of soluble salts. Available sodium, potassium, and magnesium are more or less leached from the profile.

The free lime has been removed from the surface soil, but there is some accumulation in horizon B, making it slightly alkaline. The presence of carbonates has a depressing effect on podsolization and only a small amount of iron moves downward to form stains and irregular concretion in the lower part of the solum.

Iron does not leave the profile of the upland soils, but part of the lime is removed and this accumulates in the Groundwater Soils of the region. In the Groundwater Soils, the salts more soluble than lime do not accumulate in amounts sufficient to affect the growth of plants. They are almost completely removed into the streams and rivers by the drainage water.

In the Black Soil zone, precipitation and evaporation are more nearly equal, and calcium in carbonate form is more freely distributed. While iron moves to some extent in the Podsol there is no corresponding downward movement in the Black Earth. Lime, which is leached from horizon A and partly leached from horizon B in the Podsol, is also leached from horizon A in the Black Soils, but there is a more marked accumulation in horizon B and gypsum puts in an appearance beneath the horizon of lime accumulation. Not so easily traced are soluble salts of magnesium, potassium, and sodium. In the more humid parts of the Black Soil zone these are probably leached out, but near the boundary of the Dark Brown Soils part of the sodium salts is retained. This is indicated by the following analysis of horizon B_1 from 7 locations in Grandview Sandy Loam, in the area between Long Lake and Okanagan Lake:

Water Soluble Salts	Quantity in per cent
Sodium Suplhate	0.03
Sodium Carbonate	0.11
Sodium Chloride	trace
Magnesium Sulphate	trace
Acid soluble Calcium Carbonate	3.00

In the more humid parts of the Black Soil zone, no observational evidence appears of sodium salts in the Groundwater Soils, but near the boundary of the Dark Brown Soils the effect of black alkali was noted in one poorly drained area. With the exception of poorly drained areas in the vicinity of limestone outcroppings, accumulated lime is less abudant than in the region of the Intermountain Podsol.

In the Dark Brown Soil zone, the volume of run-off is less and the movement of the more soluble salts is restricted to a point where sodium carbonate accumulates in poorly drained areas. No movement of iron has taken place and the horizon of lime and gypsum accumulation is closer to the surface.

The nature of water soluble salts other than lime, in seepage from Glenmore Clay near Kelowna, is as follows:

Water Soluble Salts	Quantity in per cent
Calcium Sulphate	0.1181
Sodium Carbonate	0.0441
Sodium Sulphate	0.1174
Magnesium Sulphate	0.2189
Sodium Chloride	0.0073

Groundwater Soils in the vicinity of Winfield and Kelowna have accumulated black alkali to a concentration that affects plant growth in localized areas, but less lime moves into these soils than in the Black Soils. Drainage of the terraces and lower lying lands has been stimulated by excess irrigation water, which leaches considerable quantities of salts into Long Lake and Okanagan Lake, giving them a reaction of pH 8.0.

Conditions of greatest aridity in the map area are found in the Brown Soils. In this region, the volume of run-off is low and the movement of salts from well-drained soils is more restricted than in the more humid regions.

In poorly drained areas, the accumulation of lime is no greater than in the Dark Brown Soils, but a remarkable increase in the quantity of gypsum appears in the south Okanagan and Similkameen Valleys. This may be due in part to local rock formations. There is limited evidence of sodium carbonate, which would appear to be retained in well-drained soil profiles. Any areas of black alkali are at higher elevations, near the region of Dark Brown Soils.

A profile was sampled in a salty fan near Osoyoos Lake, in the Brown Soil zone, to ascertain the nature and relative quantity of salts other than lime. The analysis is as follows:

	0–24″	24—30″
Calcium Sulphate	1.666 per cent	1.887 per cent
Magnesium Sulphate	0.399 " "	0.240 " "
Sodium Sulphate	1.415 " "	0.449 " "
Alkaline Carbonates	Trace	Trace
Chlorides	Trace	Trace
pH	8.65	8.50

There is an abundance of calcium sulphate, magnesium sulphate, and sodium sulphate. The deficiency of chlorides would appear to be general in the Okanagan Valley. In view of the fact that the total analyses of Brown Soils do not show any significant change in the composition of the parent materials, the abundance of sodium sulphate and absence of sodium carbonate are probably climatic effects.

THE EFFECT OF IRRIGATION ON AVAILABLE MINERALS

The relationships of available minerals in the several soil zones are natural ones capable of being upset by prolonged and excessive use of irrigation water. Irrigation may be likened to a climatic change from dry to moist conditions in which the more soluble salts, including lime, would eventually be washed from well-drained soils. Under such conditions, the general trend in irrigated parts of the Black, Dark Brown, and Brown Soil regions is towards a set-up as free from accumulated soluble salts as the Podsol. The Groundwater Soils in the same regions will receive the washed-out materials, but accumulation of salty areas may be offset by land drainage. After many years of irrigation, it would seem probable that the soil reaction will change from neutral to acid, and in some cases lime applications may become necessary.

The first soils to show signs of leaching will be the excessively drained and gravelly Skaha, Rutland, and Nahun series, followed by the Osoyoos, Oyama, and Grandview loamy sands. Greater economy in the use of water is possible in the fine-textured profiles and these will resist the effects of leaching for the longest period of time.

The first general effect of irrigation and cropping is the breakdown of soil structure, which may be held in check by the lavish use of manure and cover crops. The second stage of decline is the loss of essential minerals, which will be followed by more common use of commercial fertilizers.

SOIL MANAGEMENT

In orchards, the general practice is to maintain a permanent cover crop of alfalfa, sweet clover, or grass. Occasionally vetch and rye are used as cover, and clean cultivation is sometimes practised. A minority of growers simply use grass and weeds as orchard cover, but where grass is used, an increased application of nitrogenous fertilizer is necessary.

The cover crop is shallow cultivated in fall or spring with a tractor disk. This is done to control insect pests, to work trash into the soil, and to clear the land for the making of irrigation furrows. Occasionally cover crops are ploughed, but this depends on the need.

The furrowing implement is a device drawn by team or tractor, which strikes two furrows spaced 3 or 4 feet apart. Furrowing is a necessary operation after each cultivation.

Soils used for vegetable crops are ploughed in spring or fall and disked or harrowed according to need. Vegetable seeds are sown by horse and hand seeders. Plants are set out by hand and with the help of machinery. Horse cultivators and push hoes are used for weeding. Some crops must be weeded or thinned by hand and also harvested by hand work.

District Horticulturists of the Provincial Department of Agriculture and the staff of the Dominion Experimental Station at West Summerland, maintain an excellent advisory service concerning the use of fertilizers for various crops. The data are constantly improved as more information is made available from continuous experimental work. Contact with one of these sources is advised when specific recommendations are required.

In a more general way, experimental evidence points to organic matter upkeep in all climatic zones, and systematic cover cropping in orchards has been established for this purpose. Next to organic matter deficiency, the lack of nitrogen is often a limiting factor, and nitrogenous fertilizers are more extensively used than any others. Unduly large applications of nitrogen, however, are likely to produce orchard fruit of poor quality.

The use of superphosphate is not general, which points to good availability in average well-drained soils. However, in muck soils, in well-manured mineral soils where intensive crops are grown, or in any field where the organic matter and nitrogen content of the soil has unduly promoted vegetative growth and lengthened the growing season, phosphates may be used.

Aside from its evident need in muck soils, the status of potassium is comparable to the phosphates, and its use is required only under special conditions. Boron exists in Okanagan soils in quantities insufficient for crops and its general use has been recommended.

Boron has been applied successfully to orchards and crop lands at the rate of 15 to 30 lb. per acre. This is done during the dormant period between fall and spring. Since the use of boron is in the development stage, long-time recommendations are not given. It is now known, however, that a second application of 15 to 30 lb. per acre is advisable after 3 years have elapsed. Lawns and gardens should receive 20 lb. per acre, followed by a similar amount in 2 years. Potato land requires 15 lb. per acre of boric acid repeated in 2 years.

Severe damage results from faulty application or over-treatment with boron, and more detailed instructions are necessary for the best results. Detailed information as to the rates for different crops and the method and times of application should be secured from a District Horticulturist or the Experimental Station.

APPENDIX

TABLE 1: AVERAGE MONTHLY AND ANNUAL TEMPERATURES FOR THE PERIOD SHOWN.(5)

(Degrees F.)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	No. of Years
Salmon Arm.....	24	27	37	47	56	62	68	66	57	46	35	27	46	35
Armstrong.......	22	25	36	47	54	63	66	64	55	44	34	26	44	33
Vernon..........	24	27	38	48	56	63	69	67	57	46	36	29	47	27
Kelowna.........	26	29	38	47	55	62	67	65	56	47	37	30	47	32
Summerland.....	26	30	39	49	57	64	70	68	60	49	37	29	48	30
Penticton........	27	31	40	48	56	63	68	66	58	48	38	32	48	39
Oliver...........	26	32	41	51	60	66	74	71	61	50	37	30	50	23
Keremeos........	25	30	41	51	59	64	71	70	60	50	36	28	49	30

TABLE 2: LENGTH OF GROWING SEASON AND FROST FREE PERIOD

(Length of Record—10 years or more)

	Salmon Arm	Armstrong	Vernon (Coldstream)	Kelowna	Summerland	Penticton	Oliver	Keremeos
First day of growing season..........	Apr. 6	Apr. 7	Apr. 4	Apr. 7	Mar. 31	Mar. 27	Mar. 16	Mar. 22
Earliest final spring frost.............	Apr. 16	Apr. 19	Apr. 8	Apr. 14	Apr. 18	Apr. 8	Apr. 5	Mar. 12
Latest spring frost....................	June 26	June 10	June 10	May 31	May 8	May 26	May 9	Apr. 30
Earliest fall frost....................	Sept. 14	Aug. 1	Sept. 15	Sept. 18	Oct. 9	Sept. 15	Sept 7	Oct. 6
Latest fall frost....................	Nov. 3	Oct. 10	Nov. 12	Nov. 10	Nov. 1	Oct. 29	Oct. 21	Nov. 13
Last day of growing season..........	Oct. 22	Oct. 18	Oct. 21	Oct. 24	Oct. 29	Oct. 30	Oct. 28	Oct. 29
Longest frost-free period..............	194 days	154 days	195 days	190 days	206 days	195 days	199 days	206 days
Shortest frost-free period..............	91 days	77 days	123 days	120 days	156 days	110 days	121 days	168 days
Average frost-free period..............	143 days	115 days	157 days	150 days	176 days	149 days	162 days	188 days
Length of growing season..........	199 days	194 days	200 days	200 days	212 days	217 days	226 days	221 days

TABLE 3: AVERAGE MONTHLY AND THE ANNUAL PRECIPITATION FOR THE PERIOD SHOWN.(5)

(Inches)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	No. of Years
Salmon Arm.....	2.58	1.53	1.19	1.04	1.31	1.82	1.18	1.13	1.34	1.63	1.99	2.49	19.23	35
Armstrong.......	1.92	1.13	0.86	0.85	1.23	1.84	1.14	1.07	1.35	1.70	1.67	1.97	16.73	35
Vernon..........	1.71	1.03	0.98	0.78	1.16	1.79	0.96	1.11	1.26	1.56	1.42	1.87	15.63	27
Kelowna.........	1.23	0.88	0.71	0.62	0.94	1.13	0.76	0.77	1.11	1.21	1.20	1.61	12.17	32
Summerland.....	0.93	0.67	0.67	0.71	0.97	1.17	0.69	0.65	0.81	0.91	1.00	1.29	10.47	30
Penticton........	1.00	0.76	0.63	0.73	1.14	1.33	0.80	0.81	0.98	0.94	0.94	1.08	11.14	38
Oliver...........	0.79	0.81	0.58	0.58	0.77	1.22	0.58	0.51	0.72	0.85	0.95	1.06	9.42	23
Keremeos........	0.85	0.65	0.51	0.62	0.94	1.06	0.63	0.77	0.85	0.83	1.02	1.03	9.76	31

TABLE 4: SUMMARY OF CLIMATE.(5)

Hours of Bright Sunshine	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year	No. of Years
Salmon Arm.....	39	74	124	176	225	232	300	258	180	108	41	26	1783	34
Vernon..........	49	94	134	185	242	246	320	286	191	126	57	38	1968	34
Summerland.....	49	91	143	194	241	244	324	281	202	142	58	41	2010	30
Oliver...........	40	80	148	191	228	235	308	264	195	120	54	35	1898	23
Relative humidity Percentage Vernon Average	89	84	72	58	55	56	48	54	66	79	87	88	70	17

TABLE 5: NUMBER OF TREES AND ACREAGE OF TREE FRUITS, 1945.(12)

Salmon Arm to Osoyoos, Including the Similkameen Valley

Tree Fruit	Irrigated		Non-Irrigated*		Total Trees	Total Acres Tree Fruits
	Trees	Acres	Trees	Acres		
Apples	934,493	18,689.8	76,103	1,522.0	1,010,596	20,211.9
Pears	225,364	2,253.4	4,017	40.2	229,381	2,293.8
Plums	16,038	160.3	967	9.7	17,005	170.0
Prunes	130,229	1,302.3	5,025	50.2	135,254	1,352.5
Sweet Cherries	65,705	1,314.8	2,512	50.2	68,217	1,365.0
Sour Cherries	378	7.6	492	9.8	870	17.4
Apricots	84,887	849.0	427	4.2	85,314	853.2
Peaches	297,483	2,974.9	264	2.6	297,747	2,977.5
Totals	1,754,577	27,552.1	89,807	1,688.9	1,844,384	29,241.5

*Includes the Non-irrigated area from Larking to Salmon Arm and Sorrento.

TABLE 6: APPROXIMATE AREAS OF DIFFERENT SOILS

SOILS	Topography		Total
	Undulating Sloping, Flat (Acres)	Rolling & Kettle (Acres)	(Acres)
Skaha Gravelly Sandy Loam	6,012	6,551	12,563
Osoyoos Sandy Loam	88	3,232	3,320
Osoyoos Loamy Sand	11,783	3,880	15,663
Penticton Silt Loam	7,265	——	7,265
Similkameen Gravelly Sandy Loam	989	——	989
Similkameen Silt Loam	3,058	——	3,058
Kelowna Gravelly Sandy Loam	——	1,342	1,342
Rutland Gravelly Sandy Loam	13,352	13,045	26,406
Oyama Sandy Loam	5,419	637	6,056
Oyama Loamy Sand	6,498	897	7,395
Glenmore Clay	12,645	——	12,645
Glenmore Clay Loam	3,209	——	3,209
Armstrong Gravelly Sandy Loam	——	5,658	5,658
Nahun Gravelly Sandy Loam	3,322	4,948	8,270
Grandview Sandy Loam	9,280	——	9,280
Grandview Loamy Sand	769	——	769
Spallumcheen Clay	12,091	——	12,091
Spallumcheen Clay Loam	661	——	661
Kalamalka Gravelly Sandy Loam	3,766	——	3,766
Kalamalka Loam	2,334	——	2,334
Kalamalka Clay Loam	890	——	890
Sicamous Gravelly Sandy Loam	——	36,000	36,000
Glenemma Gravelly Sandy Loam	8,629	7,075	15,704
Shuswap Sandy Loam	7,894	7,195	15,089
Shuswap Loamy Sand	6,008	——	6,008
Broadview Clay	31,748	——	31,748
Broadview Clay Loam	9,143	——	9,143
Mara Loam	11,933	——	11,933
Mara Clay	13,854	——	13,854
Nisconlith Sandy Loam	18,316	——	18,316
Nisconlith Loam	2,424	——	2,424
Nisconlith Silt Loam	12,568	——	12,568
Nisconlith Clay Loam	3,697	——	3,697
Nisconlith Clay	4,021	——	4,021
Okanagan Muck	3,633	——	3,633
Colluvial Fan Rubble	——	——	17,758
TOTALS	237,299	90,469	345,526

TABLE 7: CHEMICAL ANALYSIS OF SOIL PROFILES

Group 1: Brown Soils

Soil	Horizon	Depth (ins.)	Ignition Loss (per cent)	Organic Carbon (per cent)	Organic Matter (per cent)	N p.c.	CO_2 p.c.	P_2O_5 p.c.	SiO_2 p.c.	Fe_2O_3 p.c.	Al_2O_3 p.c.	CaO p.c.	MgO p.c.	K_2O p.c.	Na_2O p.c.	pH
Osoyoos Loamy Sand...	A_1	0–8	1.54	0.46	0.79	0.050	0.0	0.13	71.87	4.33	12.90	2.39	1.28	2.67	1.53	7.30
	B_1	8–24	0.87	0.14	0.24	0.019	0.0	0.28	73.43	4.01	13.94	2.34	1.40	2.70	1.91	8.10
	B_2	24–30	0.74	0.19	0.33	0.019	0.41	0.26	69.94	5.78	15.38	3.51	1.84	2.68	1.46	8.80
	C	30–	1.73	0.11	0.19	0.008	1.06	0.14	69.37	4.19	12.90	3.23	1.23	2.82	1.53	9.25
Penticton Silt Loam..................	A_1	0–10	3.63	1.08	1.86	0.114	0.22	0.21	62.93	5.17	18.45	2.42	2.21	2.65	2.45	7.73
	B_1	10–20	3.06	0.71	1.22	0.073	0.79	0.21	62.61	4.94	18.49	3.26	2.05	2.69	2.46	9.05
	B_2	20–42	2.97	0.69	1.19	0.046	2.97	0.22	57.48	5.91	18.10	5.44	2.91	2.62	2.27	8.87
	C	42–	3.74	0.35	0.60	0.022	2.39	0.24	57.11	7.58	13.93	6.27	2.95	3.15	2.51	8.49
Similkameen Silt Loam.............	A_1	0–10	5.86	1.15	1.98	0.113	1.91	0.41	56.87	8.50	14.34	1.73	4.11	2.12	2.49	8.52
	B_1	10–19	4.38	0.77	1.33	0.080	4.67	0.33	52.94	8.49	11.73	7.37	3.67	1.86	2.38	8.68
	B_2	19–25	3.73	0.51	0.88	0.044	3.59	0.30	51.98	8.49	15.60	6.63	4.41	1.95	2.42	8.82
	C	25–	3.16	0.35	0.60	0.028	4.64	0.34	49.59	9.31	15.55	7.23	5.61	1.87	1.93	8.30

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TABLE 7: CHEMICAL ANALYSIS OF SOIL PROFILES. (Continued)

Group 11: Dark Brown Soils

Soil	Horizon	Depth (ins.)	Ignition Loss (per cent)	Organic Carbon (per cent)	Organic Matter (per cent)	N p.c.	CO_2 p.c.	P_2O_5 p.c.	SiO_2 p.c.	Fe_2O_3 p.c.	Al_2O_3 p.c.	CaO p.c.	MgO p.c.	K_2O p.c.	Na_2O p.c.	pH
Kelowna Gravelly Sandy Loam...........	A_1	0–8	4.46	1.70	2.93	0.144	0.35	0.26	65.30	6.02	15.59	2.62	1.90	2.31	2.36	7.48
	B_1	8–20	1.81	0.55	0.95	0.044	0.86	0.20	70.05	4.75	13.21	3.96	1.65	1.95	2.89	8.24
	B_2	20–28	0.78	0.36	0.62	0.019	2.47	0.18	68.63	3.68	13.56	4.89	1.41	1.70	2.88	8.94
	C	28–	0.72	0.15	0.26	0.010	1.32	0.16	72.11	3.68	12.98	3.65	1.36	2.22	3.03	8.82
Oyama Loamy Sand...........	A_1	0–8	2.04	0.51	0.88	0.060	0.35	0.17	67.71	4.25	15.21	3.00	1.33	3.03	3.21	6.99
	B	8–20	1.77	0.07	0.12	0.015	0.31	0.21	69.11	4.42	14.29	3.27	1.38	2.58	3.46	7.63
	C	20–	0.67	0.08	0.14	0.012	0.33	0.18	69.22	4.32	12.85	3.17	1.55	2.34	3.34	7.95
Glenmore Clay.........	A_1	0–8	5.89	1.95	3.36	0.167	0.00	0.24	57.43	7.55	19.44	2.19	3.08	3.44	1.89	7.50
	B_1	8–24	4.64	0.65	1.12	0.077	0.30	0.27	53.19	9.60	20.56	2.52	4.29	3.52	1.15	8.50
	B_2	24–37	3.87	0.38	0.66	0.042	2.91	0.20	49.20	7.89	20.17	5.37	4.37	3.26	1.40	8.75
	C	37–	3.66	0.26	0.45	0.033	2.09	0.22	51.70	8.36	17.51	4.93	3.95	3.37	2.14	8.20

Moisture Free Soil.

TABLE 7: CHEMICAL ANALYSIS OF SOIL PROFILES (Continued)

Group 111: Black Soils

Soil	Horizon	Depth (ins.)	Ignition Loss (per cent)	Organic Carbon (per cent)	Organic Matter (per cent)	N p.c.	CO_2 p.c.	P_2O_5 p.c.	SiO_2 p.c.	Fe_2O_3 p.c.	Al_2O_3 p.c.	CaO p.c.	MgO p.c.	K_2O p.c.	Na_2O p.c.	pH
Armstrong Gravelly Sandy Loam..........	A_1	0–12	6.72	2.69	4.64	0.240	0.19	0.27	64.33	5.79	13.16	2.63	1.82	2.47	2.04	7.34
	B	12–32	1.28	0.27	0.47	0.033	0.30	0.14	72.33	3.85	12.24	2.22	1.40	2.31	2.28	7.20
	C	32–	0.66	0.08	0.14	0.015	0.40	0.13	74.73	4.09	11.37	2.54	1.33	2.91	2.38	7.42
Grandview Sandy Loam...........	A_1	0–7	5.71	2.48	4.28	0.206	0.47	0.33	62.87	5.70	13.86	3.77	2.86	2.38	2.08	7.20
	B_1	7–17	4.15	1.77	3.05	0.137	0.38	0.31	63.75	5.87	14.73	3.86	2.82	2.48	2.61	7.32
	B_2	17–31	2.10	0.56	0.97	0.050	0.42	0.33	64.77	6.28	15.38	3.11	3.16	2.54	2.59	7.45
	B_3	31–44	1.58	0.34	0.59	0.034	0.52	0.28	64.58	6.62	15.64	4.09	3.40	2.71	2.61	8.32
	C	44–	1.79	0.24	0.41	0.029	2.67	0.25	60.00	6.19	15.53	5.25	3.47	2.58	2.81	8.68
Spallumcheen Clay	A_1	0–4	10.62	4.22	7.28	0.393	0.34	0.39	54.94	7.71	17.17	2.40	3.34	2.81	1.70	6.48
	B_1	4–20	6.30	1.13	1.95	0.123	0.35	0.27	50.13	11.37	19.66	2.15	5.41	3.12	1.61	7.54
	B_2	20–28	5.11	0.90	1.55	0.063	2.73	0.29	44.08	10.81	18.82	6.61	5.69	2.75	1.73	7.98
	B_3	28–48	3.67	0.62	1.07	0.028	3.74	0.26	43.22	10.34	18.55	6.69	6.69	3.15	1.74	8.15
	C	48–	3.95	0.16	0.28	0.036	1.50	0.23	48.88	10.84	20.35	3.05	5.31	4.06	1.73	8.28

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TABLE 7: CHEMICAL ANALYSIS OF SOIL PROFILES (Continued)

Group IV: Intermountain Podsol Soils

Soil	Horizon	Depth (ins.)	Ignition Loss (per cent)	Organic Carbon (per cent)	Organic Matter (per cent)	N p.c.	CO_2 p.c.	P_2O_5 p.c.	SiO_2 p.c.	Fe_2O_3 p.c.	Al_2O_3 p.c.	CaO p.c.	MgO p.c.	K_2O p.c.	Na_2O p.c.	pH
Sicamous Gravelly Sandy Loam	A_0	0–2	12.82	6.11	—	0.300	0.34	0.16	63.25	4.56	12.42	2.65	1.44	2.09	2.13	6.09
	B_1	2–8	1.55	0.41	0.71	0.030	0.30	0.11	69.95	5.63	13.42	2.37	1.59	2.92	2.64	6.69
	B_2	8–16	2.95	1.09	1.87	0.060	0.02	0.20	68.70	4.72	12.78	2.48	1.51	2.78	2.57	6.50
	B_3	16–24	1.77	0.93	1.60	0.036	0.87	0.19	68.13	4.51	12.26	3.23	1.84	3.01	2.32	7.81
	C	24–	1.24	0.20	0.34	0.015	4.22	0.13	63.72	4.44	11.47	6.91	1.41	2.95	2.25	8.40
Shuswap Sandy Loam	A_0–A_2	0–3	5.35	2.38	—	0.145	0.01	0.36	66.28	5.18	13.53	2.66	1.35	1.65	1.23	5.62
	B_1	3–13	1.79	0.33	0.57	0.031	0.0	0.18	69.78	6.04	13.31	2.57	1.30	1.57	2.02	5.68
	B_2	13–25	0.73	0.08	0.14	0.015	0.0	0.12	71.87	5.29	14.04	2.33	1.43	1.98	2.09	6.80
	B_3	25–32	0.98	0.16	0.27	0.019	0.0	0.19	70.52	6.59	12.74	3.13	1.74	2.32	2.73	7.09
	C	32–	0.96	0.11	0.19	0.016	0.0	0.20	68.67	6.20	13.42	3.14	1.42	2.27	2.48	7.22
Shuswap Loamy Sand	A_0	0–2	3.49	1.88	—	0.066	0.06	0.24	71.90	4.33	10.79	2.22	1.88	2.12	2.32	7.00
	B_1	2–12	1.76	0.37	0.64	0.020	0.0	0.20	72.46	4.12	11.46	2.08	1.29	2.00	2.42	6.56
	B_2	12–36	0.95	0.17	0.29	0.013	0.04	0.13	72.73	4.24	12.44	2.42	1.66	1.62	2.54	6.56
	C	36–	1.26	0.39	—	0.014	0.0	0.23	72.69	4.01	11.57	2.11	1.58	1.65	2.28	6.70
Broadview Clay	A_0	0–2	4.97	1.01	1.74	0.100	0.0	0.19	54.06	9.16	20.80	2.02	3.67	3.94	2.24	7.04
	B_1	2–14	3.10	0.46	0.79	0.056	0.02	0.22	55.59	10.47	21.58	2.04	3.73	3.60	1.74	7.10
	B_2	14–18	3.08	0.31	0.53	0.052	0.0	0.27	56.15	10.26	20.44	2.43	3.95	3.32	1.81	7.36
	C	18–	2.66	0.34	0.59	0.043	4.19	0.26	49.67	9.49	17.92	7.39	4.40	3.39	1.99	8.35
Broadview Clay Loam	A_0–A_2	0–4	3.14	1.10	—	0.096	0.0	0.39	61.13	6.51	18.42	2.75	2.02	2.94	2.46	7.02
	B_1	4–14	2.59	0.46	0.69	0.055	0.0	0.17	59.54	8.86	17.08	2.13	3.03	3.42	2.09	6.82
	B_2	14–30	2.55	0.51	0.88	0.044	0.06	0.21	60.40	9.06	16.67	2.27	3.10	3.19	2.19	7.42
	B_3	30–36	2.64	0.48	0.83	0.046	5.58	0.20	51.48	7.46	14.39	9.52	3.30	2.57	2.16	8.93
	C	36–	1.63	0.31	0.53	0.027	2.69	0.21	55.96	7.74	16.12	5.62	3.65	3.44	2.53	9.05

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LIST OF REFERENCES

1. Agricultural Statistics Reports, Department of Agriculture, Victoria, B.C.

2. Atlas of American Agriculture, United States Department of Agriculture, 1936.

3. Bouyoucos, G.J., The hydrometer as a new method for mechanical analysis of soils. Soil Sci. 23: 343, 1927.

4. Clemens, W.A., D.S. Rawson, and J.L. McHugh, A biological survey of Okanagan Lake, B.C. Bul. LVI, Fisheries Research Board of Canada. Ottawa, 1939.

5. Climate of British Columbia, Department of Agriculture, Victoria, B.C., 1946.

6. Davis, R.O.E., and H.H. Bennett, Groupings of soils on the basis of mechanical analysis. Cir. 419, United States Department of Agriculture, 1937.

7. Kelley, C.C., and R.H. Spilsbury, Soil Survey of the Lower Fraser Valley, Tech. Bul. 20, Department of Agriculture, Ottawa, 1939.

8. Kelley, C.C., The nature of soil parent materials in Southern British Columbia, Sci. Agr. XX: 5, Jan. 1940.

9. Kelowna Rural Schools Health Association, Kelowna, B.C., 10th annual report, July, 1937 to May, 1938.

10. Laing, F.W., Early agriculture in British Columbia, Unpublished. Department of Agriculture, Victoria, B.C.

11. Middleton, M.S., Production of tree fruits in British Columbia, C.S.T.A. Review, No. 28, March, 1941.

12. Orchard survey of the Okanagan horicultural district, Department of Agriculture, Victoria, B.C., 1945.

13. Ormsby, M.A., The history of agriculture in British Columbia, Sci. Agr. XX:1, Sept., 1939.

14. Woodbridge, C.G., The boron content of some Okanagan soils, Sci. Agr., XX:5, Jan. 1940.

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