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Soil Survey of Marion County, Oregon

By

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and
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U. S. Department of Agriculture

Bureau of Chemistry and Soils
In cooperation with the Oregon Agricultural Experiment Station

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SOIL SURVEY

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CONTENTS

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By E. F. TORGERSON, Oregon Agricultural Experiment Station, in Charge, and T. W. GLASSEY
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COUNTY SURVEYED

Marion County is in the northwestern part of Oregon. (Fig. 1.) The northernmost point of the county is about 25 miles south of Portland. Salem, the State capital and second largest city in Oregon, is in the extreme west-central part of the county. Willamette River forms the western boundary; Pudding River and Butte Creek, the greater part of the northeastern boundary; the crest of the Cascade Mountains, the eastern boundary; and Santiam and North Santiam Rivers, the southern boundary. This survey, which covers an area of 847 square miles, or 542,080 acres, includes all except the mountainous forest-covered area in the Santiam and Mount Hood National Forests in the eastern part of the county.

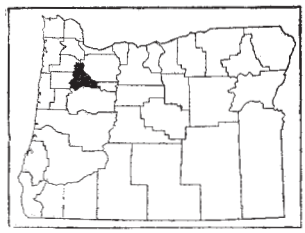


FIGURE 1.—Sketch map showing location of Marion County, Oregon

Most of the rough and mountainous eastern part of the county lies at an elevation of more than 5,000 feet. Mount Jefferson in the extreme southeastern corner has an elevation of 10,523 feet. The elevation of the rest of the county ranges from 5,000 feet to about 100 feet in the bottom lands along Willamette River. In the mountainous eastern part of the surveyed area long narrow ridges are separated by deep precipitous canyons which are from 100 to 500 or more feet deep and cut down almost perpendicularly in the solid basalt rock that forms the mountainous part of the area. The ridges have a gradual or rather steep slope in a general northwesterly direction. They become wider as they approach the bench land to the west and northwest. Most of the foothills between Silverton and Sublimity are rolling and in a few places are too steep for cultivation.

The outlying extension or spur of the lower rolling foothill area north of Aumsville and Turner is known as the Waldo Hills and is a prominent physiographic feature of the county. The more elevated southern extension of the hilly area extending southeast from Salem and south of Turner is known as the Marion Hills and the more northerly part as the Ankeny Hills.

Drainage is carried by Willamette River and its tributaries, chief of which are Santiam, North Santiam, and Pudding Rivers. Little North Santiam and North Santiam Rivers are swift flowing and offer opportunity for power development. The perpetual snows and glaciers of Mount Jefferson provide a steady supply of water for these streams, along the upper reaches of which drainage is well developed.

On the bottom and terrace soils west of Mehama drainage is somewhat restricted. The central parts of the county are, with few exceptions, excellently drained by small swift-flowing streams emptying into Pudding River. The streams are low during the summer, and possibilities for developing water power are limited. Pudding and Little Pudding Rivers become winding and sluggish after they emerge from the Waldo Hills. The bottoms along these streams are poorly drained, as also are the bottom lands and terraces along the streams flowing into Willamette River north of Salem.

Agricultural development of the land now included in Marion County began with the settlement in Mission Bottom in 1834 near the present site of Wheatland Ferry. Champoeg had been founded several years earlier by the employees of the Hudson's Bay Co. On September 3, 1849, Marion County was formed from Champoeg County, and the present boundaries were established in 1856. Salem was founded in 1841 and became the capital of the State in 1864.

Nearly all the population of Marion County is native born. In certain localities the people are of German or Scandinavian birth or parentage. The western part of the county is well settled and is traversed by main and branch lines of tne Oregon Electric and Southern Pacific Railroads and by numerous roads and highways, the more important of which are surfaced or paved. Salem, Silverton, and Woodburn are the principal towns. In the more hilly eastern part towns are scattered, improved roads are few, the rural districts are sparsely settled, and farming as a means of livelihood is supplemented or superseded by the lumbering industry.

A part of the staple farm crops, orchard fruits, vegetables, berries, and dairy products find sale in local markets, but most of them are marketed in Portland or are shipped to outside points.

CLIMATE

Marion County has a mild, temperate climate characteristic of the northwest Pacific coast region. In the western part, which embraces the main agricultural portion of the county, the summer nights are usually cool, even when the days are comparatively warm. The winters are characterized by cool temperatures and a rainy season beginning in November and continuing until March, more than half the rainfall for the year occurring during this period.

The distribution of rainfall is apparently favorable for most crops, although experiments conducted at the Oregon Agricultural Experiment Station show that irrigation of land for certain late-season crops is profitable. The dry summers are very favorable for harvesting hay crops, and the fall and spring rains promote the growth of winter grain.

Continued hot spells in summer are practically unknown, although the temperatures mount fairly high for periods of two or three days. The region is free from high winds, tornadoes, earthquakes, and electrical storms.

According to the records of the Weather Bureau station at Salem, the average date of the last killing frost is April 3, and of the first is

November 1, making a very long frost-free season (212 days) which is favorable for the production of a great variety of farm crops. The amount of rainfall in March and April is comparatively low, giving an opportunity for field work in those months.

Weather conditions at Mount Angel, near the base of the Cascades, are similar to those at Salem, except that the rainfall is greater. The mean annual rainfall for Mount Angel is 47.62 inches, or practically 10 inches more than at Salem.

The records of the Weather Bureau station at Detroit, in the eastern unsurveyed part of the county, are representative of climatic conditions of the mountainous area of the county. The mean annual rainfall is 69.80 inches and the average snowfall is 93.1 inches a year. The frost-free season is much shorter than in the central and western parts of the county.

Table 1 shows the normal, monthly, seasonal, and annual temperature and precipitation as recorded at the Weather Bureau station at Salem, which is located in the western part of the county, and Table 2 shows the precipitation records at Detroit, in the eastern part.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Salem, Oreg.*

[Elevation, 191 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1903)	Total amount for the wettest year (1896)	Snow, average depth
	°F.	°F.	°F.	Inches	Inches	Inches	Inches
December	40.9	65	−6	5.90	1.95	8.31	3.0
January	29.9	68	1	5.56	4.56	6.35	3.0
February	42.5	68	−4	4.49	.88	3.31	1.3
Winter	41.1	68	−6	15.95	7.39	17.97	7.3
March	46.2	77	22	3.79	2.73	2.69	.1
April	50.9	87	27	2.61	1.20	6.12	.0
May	56.2	94	31	2.08	1.09	5.54	.0
Spring	51.1	94	22	8.48	5.02	14.35	.1
June	61.7	98	32	1.23	1.30	.99	.0
July	66.8	102	35	.41	.40	.00	.0
August	66.7	105	30	.45	.29	1.00	.0
Summer	65.1	105	30	2.09	1.99	1.99	.0
September	60.8	96	32	1.84	.23	.66	.0
October	53.9	89	23	2.91	1.65	2.97	.0
November	45.8	69	12	6.22	8.28	16.99	.4
Fall	53.5	96	12	10.97	10.16	20.62	.4
Year	52.7	105	−6	37.49	24.56	54.93	7.8

TABLE 2.—*Normal monthly, seasonal, and annual precipitation at Detroit, Oreg.*

[Elevation, 1,452 feet]

Month	Precipitation			
	Mean	Total amount for the driest year (1918)	Total amount for the wettest year (1912)	Snow, average depth
	Inches	*Inches*	*Inches*	*Inches*
December	11.29	4.22	12.61	17.3
January	12.28	15.18	18.79	31.1
February	7.14	7.17	11.99	19.0
Winter	30.71	26.57	43.39	67.4
March	6.84	.76	5.68	16.6
April	4.74	1.40	5.43	4.2
May	3.93	1.41	5.60	.7
Spring	15.51	3.57	16.71	21.5
June	2.16	.07	4.08	.0
July	.78	.77	.65	.0
August	.81	.45	5.33	.0
Summer	3.75	1.29	10.06	.0
September	3.35	.00	2.60	.0
October	4.91	4.28	7.90	.2
November	11.57	5.84	12.29	4.0
Fall	19.83	10.12	22.79	4.2
Year	69.80	41.55	92.95	93.1

AGRICULTURE

The first settlers of Marion County produced only sufficient crops and livestock for their own use, but with the discovery of gold in California in 1849 a market was provided for surplus products. Fruit growing began in the Waldo Hills in 1851, but the area as a whole was predominately a grain-growing section and remains so to this day. Nearly all the prairie section of the county was devoted to grain by the first settlers, and the hilly forested eastern part was utilized as range for cattle and sheep.

Wheat was the dominant crop for many years and yields of 30 or 40 bushels to the acre were common, but owing to continual cropping to grain, the yields declined until the average yield for wheat was only 16.4 bushels an acre in 1879.

In 1880, according to the census reports, there were 1,445, farms in Marion County with an average of 249 acres each, of which 53.6 per cent was improved land. In 1879 wheat occupied 64,519 acres, oats 23,673 acres, barley 391 acres, total hay crops 8,273 acres, and hops 37 acres. The total yield of hops was 57,580 pounds.

By 1890 the number of farms had increased to 1,766, and the average size was 200 acres. Wheat continued to be the leading crop, being grown on 50,902 acres in 1889 and producing an average yield of 22.9 bushels to the acre. Large increases were shown in the acreage of oats, barley, hay, and potatoes. Hops made the greatest increase in acreage, occupying 974 acres with a yield of 1,169,657 pounds. The average value of all farm property was $7,037. There was a

great increase in rural population during this period, but the urban population remained almost stationary.

The next decade saw an increase in the total area in farms and a large increase in the number of farms. The size of the average farm in 1900 was 143.8 acres. The rural population increased 6,422 whereas the towns lost 1,743 of their inhabitants. Wheat still retained its lead among the crops with a yield of 1,094,150 bushels, and oats ranked second with 1,059,220 bushels. The production of clover made possible a great increase in the dairy and livestock industry. Fruits began to assume importance.

Between 1900 and 1910 there was a decrease in the total acreage in farms although the number of farms increased. The average size of farms was only 113 acres. The value of land increased from $25.82 to $73.40 an acre. This period saw a great increase in the acreage of oats and barley, but the acreage in wheat was reduced more than one-half. There was a great increase in hay production, and the total value of livestock trebled. Hops attained their greatest acreage, 10,223 acres producing 6,119,739 pounds of dry hops in 1909. Plums, prunes, pears, cherries, and English walnuts first became important crops during this period. These, together with the already established fruits, placed horticultural products among the important crops. The decade was one of considerable growth in towns and cities, but increase in the farm population was slight.

The census of 1920 showed the average size of farms to be 99.9 acres, of which 58.4 per cent was improved land, and the average value of farm land was $107.23 an acre. The increasing importance of fruit growing and truck gardening caused a great increase in expenditures for labor and fertilizer. Labor costs averaged $548.90 for each of 2,205 farms. Fertilizer expenditures on 518 farms amounted to $54,865, or an average of $105.92 on each farm. Feed to the amount of $617,474 was purchased on 2,443 farms. There was a big increase in the acreage of wheat and rye, and a decline in the oat acreage. Partly owing to prohibition, there was a tremendous falling off in the hop acreage.

The value of cereals was $3,896,402, of domestic animals $2,926,393, of fruits and nuts $2,128,639, of hay and forage $1,578,765, of vegetables $1,392,721, of dairy products, excluding those used at home, $1,014,501, of poultry and eggs $763,722, of wool, mohair, and goat hair $87,211, of other grains and seeds $210,131, and of all other crops $1,384,112. The value of livestock and livestock products more than doubled during this 10-year period.

According to the preliminary census figures for 1930 the number of farms in the county is 4,821, with an average size of 82.9 acres.[1] The percentage of farms operated by owners is 81.2 per cent, the highest since the first census was taken in 1880. The average value of farm land rose to $127.41 an acre. In 1929 the wheat acreage dropped to 26,525 acres and the production to 730,425 bushels. The 35,406 acres in oats produced 1,257,521 bushels.

At the present time the main cash crops of Marion County are wheat, oats, flax for fiber, potatoes, prunes, apples, strawberries, Logan blackberries, cherries, pears, Evergreen blackberries, walnuts, filberts, celery, onions, and peppermint oil.

[1] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given whenever possible.

Both wheat and oats are marketed at local flour mills and shipped to Portland. The Waldo Hills section is devoted almost exclusively to these crops. There they have been grown year after year, with fallow every third year, ever since the county was settled, but they are grown less extensively in other sections of the county. The main winter wheats grown are Kinney, Rink, and White Winter on the Willamette and Amity soils, and Prohibition on the Aiken and Olympic soils. For spring wheat Defiance and Huston varieties are grown, the latter on the "red hill" soils. Winter Turf (Oregon Gray Winter) is the main variety of oats grown, and it is largely used for the production of oatmeal for human consumption. Oats are generally grown on wetter areas than wheat, although they are grown on all types of soil devoted to grain growing. Small amounts of Victory and Three Grain (a variety of the Silvermine type) spring oats are grown.

Flax for fiber is becoming one of the important and more profitable cash crops for this county. The crop is entirely under the control of the State Flax Industry, which contracts for all flax grown according to the facilities for retting and scutching the straw. The average cost of producing pulled flax in average seasons is $40 an acre, including taxes, interest, and wages. Prices paid are according to the length of the fiber, ranging from $33 a ton for pulled flax 27 inches long and $40 for that 36 or more inches long. Mowed flax brings only $20 a ton. In 1926 the average amount received by the growers was $63.35 an acre. The Willamette Valley is the smallest fiber-flax area in the world, yet it is the most up-to-date in the use of machinery in the production of the crop. In 1928 flax was grown on 3,250 acres in Marion County, practically a 50 per cent increase over 1927. Formerly it was thought that flax was more instrumental in depleting soil fertility than other crops, but the data at present indicate that it removes about the same amount of plant food as do oats or barley.[2] It is estimated that there are approximately 30,000 acres in Marion County suited to the growing of flax. The Willamette, Amity, Chehalis, and Wapato silt loams, clay loams, and silty clay loams appear to be well suited to this crop. These are soils with average or good drainage, with the exception of the Wapato soils which have restricted drainage.

The potato acreage varies considerably from year to year. The average acreage is about 5,000 acres, and the average annual yield is 450,000 bushels. The local and Portland markets take a large amount of the crop, and some potatoes are shipped to California. The production of seed potatoes is of considerable importance in the Howell Prairie section west of Silverton and in the Crooked Finger section southeast of Scotts Mills, from 30 to 40 carloads of seed potatoes being grown annually in these two sections. The main varieties grown for seed purposes are Russet Burbank, Garnet Chili, and Burbank Seedling. Some Up-to-date (British Queen), Charles Downing, and American Wonder are produced.

The prune acreage has averaged about 8,000 acres the last few years. There has been a tendency to decrease owing to low prices obtained for the fruit. The main change in the prune industry has been the increase in the amount shipped fresh to the eastern markets and in

[2] HYSLOP, G. R. FLAX IN OREGON. Oreg. Agr. Expt. Sta. Circ. 60, 10 p. 1925.

the large amount of dried prunes exported to Europe. Yields of 2,000 pounds of prunes of large size or of 3,000 pounds of medium-sized fruit an acre are better than average, and under ordinary economic conditions are satisfactory to the grower. It is very important that bearing orchards should be brought up to a high state of production. Early spring plowing (late March or early April) is essential for the proper conservation of soil moisture in the orchards. An annual cover crop of winter barley and common vetch, or any other legume crop that will make a good growth, seeded late in August and plowed down in March or early April is necessary to maintain the organic-matter content of the soil.

Orchards producing yields equal to those named may be maintained in part through cover cropping. If orchards are to produce heavy yields consistently, however, it will be necessary to supplement cover crops with commercial fertilizers containing from 200 to 300 pounds of nitrate of soda or its equivalent. It is essential that the orchard be planted on the higher areas that are free from the danger of killing frosts in late spring or early fall. A number of plantings made in lower situations on the valley floor suffered injury during the last year (1927), whereas no record of winter injury or killing occurred on the hill soils during the same period.

Walnuts should be planted on soil which is at least 6 feet deep, new land that has been under cultivation for a brief period being preferred. The Franquette walnut grafted on the northern California black rootstock and grown locally is undoubtedly the best variety at the present time. Trees from 6 to 8 feet in height grown on a 2-year-old rootstock are the most satisfactory for planting. Walnut trees should be spaced from 40 to 60 feet apart each way. Soils for filberts should be at least 4 feet deep and should be fertile and well drained. River-bottom land and the so-called "red hills" are suited to filberts. The trees should be planted from 25 to 30 feet apart each way. The Barcelona is the best variety to plant at present for commercial production, with Du Chilly the second choice. For best results cultivation should be the same as for orchard fruit trees. Filberts are at present grown on a rather large scale, and it is questionable whether a great increase in acreage should be recommended.

Crop rotations, including the use of legumes, have proved very profitable,[3] and the practice of growing wheat and oats only should be discontinued. At least one legume crop should be included in each rotation. Red clover is the best legume for supplying nitrogen and organic matter for short rotations on land having good drainage, alsike clover is good on moderately wet land, and vetch is especially good as a cover crop.

On soils that are known to be acid, of heavy texture, and medium fertility, applications ranging from 1 to 2 tons of ground limestone to the acre give very satisfactory returns with clover or alfalfa. Lime should be evenly distributed and harrowed in after plowing when the soil is dry enough to crumble. The best returns are usually realized from lime when it is used in combination with barnyard manure. Valley floor soils that have been cropped to grain for a long time

[3] Powers, W. L., and Ruzek, C. V. CROP ROTATION AND SOIL FERTILITY. Oreg. Agr. Expt. Sta. Circ. 44, 12 p., illus. 1923.

respond to soluble phosphate fertilizers. Superphosphate at a rate ranging from 250 to 300 pounds to the acre for field crops and from 300 to 600 pounds for special crops is recommended. Nitrates may be used as a starter and applied early in the spring on nonleguminous crops or on unmanured land. Manure and other forms of refuse contain nitrogen and are usually worth several dollars a ton as a fertilizer. Gypsum applied early in the spring at a rate ranging from 40 to 80 pounds to the acre as a top-dressing on clover or alfalfa has proved profitable.

SOILS

The soils of Marion County are classified into soil series and soil types. Each soil series includes soil types which are closely related as to surface configuration, weathering processes under which they have developed, drainage, chemical reaction, and color of the surface soil and subsoil. The soil types which constitute the soil series differ from one another only in the texture of the surface soil.

In this survey 32 soil types and 9 subordinate phases, representing 21 soil series, have been mapped. In addition 4 classes of miscellaneous material have been differentiated.

The arable soils of the county have been grouped in three major divisions as follows: (1) Recent alluvial soils, (2) soils developed on old valley-filling materials, and (3) soils developed on consolidated rocks of the hill and mountain areas and commonly designated as residual soils.

The recent alluvial soils occur along the main rivers and streams of the county and in narrow bodies following the courses of the drainage channels in the lowest land depressions. They are subject to frequent overflow, and surface accumulations of fresh alluvial material are periodically being deposited. The recent alluvial soils include the Chehalis, Newberg, Wapato, Camas, Courtney, and Cove soils.

The soils of the Chehalis series have brown, light-brown, or rich reddish-brown surface soils resting on light-brown, rich-brown, or somewhat yellowish-brown subsoils. They occupy undulating areas which slope in the direction of stream flow. They are well drained except at seasons of high water, when they are partly or wholly covered by water for very short periods.

The surface soils of the Newberg soils are of medium-brown or light-brown color and are underlain by brown or light-brown stratified layers of fine sandy loam or loamy sand. The surface is undulating and is cut up by stream channels in many places. These soils also occur along streams but generally occupy the lower terraces or first bottoms where frequent overflows leave new deposits of sediment.

The Wapato soils are poorly drained. Their surface soils are grayish brown, mottled with rust brown and gray, and have a very dark appearance when wet. The subsoils are brown or brownish gray, very highly mottled with brown, rust brown, gray, blue, and orange. The Wapato soils, in general, lie near streams and are partly waterlogged most of the time.

The surface soils of the Camas soils are dark brown or brown and in most places contain a large amount of waterworn gravel ranging from less than an inch to 5 inches in diameter. Owing to this gravel

the soils are of minor agricultural value. The subsoils are light brown and contain a much greater amount of waterworn gravel than the surface soils. They are very loose and porous and consequently are droughty. The soils of this series generally occur in small strips and knolls lying higher than other recent alluvial soils.

The soils of the Courtney series are characterized by dark dull-brown or black surface soils which in most places contain various amounts of waterworn gravel. The subsoils have a large amount of waterworn gravel embedded in a compact impervious clay layer that prevents the movement of water. The surface soils and subsoils are generally mottled. The soils of this series commonly occur in low places, in swales, and bordering small intermittent streams on the flat upper benches.

The soils of the Cove series have very dark-colored or black heavy plastic surface soils and suboils, in some places slightly mottled with rust-brown iron stains. These soils shrink and crack into irregular blocks during prolonged dry summer periods. They occupy flat poorly drained areas and are of minor agricultural importance.

The soils developed on old valley-filling materials occur extensively on the terraces and flats of the valley floor, occupying positions higher than the recent alluvial soils and lower than the residual soils of the hills. They range in stage of development from moderately young to mature. The colloidal clay has been carried down into the subsoil, making it more compact and heavy textured than the surface soil. These soils are derived from materials of mixed origin brought in by streams from the adjacent hills and mountains. The Salkum, Waldo, Willamette, Amity, Concord, Dayton, Holcomb, Salem, Sifton, and Clackamas soils are included in this group.

The soils of the Salkum series have rich-brown or reddish-brown surface soils in which a gray or yellow cast is apparent in places. The subsoils are rich reddish brown, dull red, or yellowish brown, becoming grayish brown near the deeper parent material which is composed of soft weathered gravel embedded in weathered fine soil material. The gravel, which can be easily cut with a knife, are waterworn and range from an inch to several inches in diameter. They range in color from gray, yellow, brown, and yellowish brown to red. The Salkum soils are developed on the more elevated terraces and foot slopes, lying lower than the Olympic soils and higher than the rest of the old valley-filling terraces and flats.

The Waldo soils are characterized by rich-brown, dull-brown, or dark-brown surface soils, underlain by compact, tight and comparatively impervious, heavy-textured grayish-brown or yellowish-brown subsoils which are highly mottled with rust brown, yellow, and gray, and which contain streaks of light-gray plastic clay. They occur from 100 to 200 feet above the main old valley-filling floor in depressions into which the parent materials have been washed from the adjacent residual soils of the hills.

The surface soils of the Willamette soils are brown or rich brown, becoming somewhat grayish brown when dry. The subsoils are light brown or yellowish brown and are moderately compact but well drained. The underlying substratum is more friable, is yellowish brown, and has a higher content of sand and less colloidal clay. The Willamette soils occur on well-drained slopes and on the valley terraces and valley floor.

The soils of the Amity series are characterized by grayish-brown surface soils overlying lighter-brown or brownish-gray subsoils which are highly mottled, due to lack of complete drainage, and which have a somewhat compact layer intermediate in character between that of the better-drained Willamette soils and the very poorly drained Dayton soils. The deeper substratum is more friable and better drained than the layers above. The soils of this series generally occur in level or slightly undulating areas between areas of the Dayton and Willamette soils.

Closely related to the Amity soils are the Concord soils which have light-gray or light brownish-gray, mottled with rust brown, surface soils overlying light-gray or brownish-gray subsoils which are highly mottled with rust-brown iron stains. The surface is flat, and drainage is poorly developed. The soils are similar to those of the Dayton series but have no heavy compact clay layer in the subsoil which resembles that of the Amity series. The Concord soils occur on the flatter parts of the bench land.

The Dayton soils have dark bluish-gray or gray surface soils from 10 to 14 inches deep overlying bluish-gray heavy plastic clay upper subsoil layers from 12 to 18 inches in thickness, below which is highly mottled brownish-gray or yellowish-gray looser and more friable material. These soils have developed from mixed materials on the flats and low-lying depressions where drainage conditions are poor.

The Holcomb soils are brown counterparts of the Dayton soils. They have grayish-brown slightly mottled surface soils overlying bluish-gray heavy plastic clay ranging from 12 to 15 inches in thickness. Underneath the clay layer is grayish-brown, mottled with rust brown, lighter-textured friable material. Like the related Dayton soils the Holcomb soils are derived from water-laid deposits of mixed origin. Imperfect drainage conditions have retarded normal development, but because of the more undulating relief and higher position better surface soils have developed than on the surrounding soils.

The Salem soils are similar in color to the Willamette soils, but differ from those soils in having gravelly subsoils and substrata. The surface soils are brown or light brown and may or may not contain gravel. The subsoils are light brown and have a high content of waterworn gravel resting on loose or slightly compact gravelly substrata. The surface soils are slightly compact, and the subsoils are more compact, but weathering has apparently not progressed so far as in the Willamette soils. The Salem soils occur on small knolls and in irregular bodies, most of them lying higher than the surrounding more poorly drained Clackamas soils.

The Sifton soils occupy low ridges and knolls near watercourses traversing the terraces and are well drained. The surface soils are dark-brown or nearly black loose sootlike gravelly material containing a large amount of finely divided organic matter. The gravel are waterworn and of mixed origin. The subsoils are light brown or yellowish brown, are of loose structure, and have a high content of waterworn gravel. A very loose and porous grayish-brown substratum, composed principally of gravel and sand, underlies these soils.

The Clackamas soils have dark-brown somewhat compact surface soils containing various amounts of waterworn gravel. The subsoils are grayish brown or light reddish brown, highly mottled with rust brown and gray. They are very compact and contain a very large

amount of waterworn gravel held tightly in place by sandy clay loam which is very high in iron compounds. This compact layer restricts drainage to a considerable extent. The substratum, which extends to undetermined depths, is very compact and contains more gravel than the layer above. The gravel are held in a tight compact mass by sandy loam or sandy clay loam material high in compounds of iron, but drainage is less restricted than in the overlying subsoils. The soils are developed on old valley-filling deposits of mixed origin.

The residual soils developed on consolidated rocks are derived mainly from basic igneous rocks consisting of basalt and diabase. In some parts of the county strata and ledges of sandstone, limestone, and shale occur locally, but the areas of soils derived from them are very small and they were included in mapping with the soils derived from basic rocks. The weathering of the residual soils developed on consolidated rocks is less advanced than of the soils derived from the old valley-filling materials, but they show the translocation of clay from the surface to the subsoil to some extent. This group includes the Olympic, Aiken, Polk, Carlton, and Viola soils.

The surface soils of the Olympic soils are brown, chocolate brown, or light reddish brown, with dark-brown inclusions in some of the virgin areas lying at the higher elevations. The subsoils are light brown, reddish brown, or yellowish brown. Typically they contain an appreciably higher content of clay than the surface soils and are moderately compact. The depth of weathered soil material ranges from 3½ to 6 feet. Throughout these and other residual soils of the hill and mountain areas stones and bowlders of various sizes occur in the original unweathered state.

Closely associated with the Olympic soils are the Aiken soils, which have brownish-red, dull-red, or red surface soils, below which the color becomes red or deep red with purplish-red stains. These soils are derived from basic igneous rocks and have weathered to as great a depth as the Olympic soils. In general, they occupy the higher hills, knolls, and ridges above the Polk and Olympic soils.

Intermediate in color between the Olympic and Aiken soils are the Polk soils which have brown or dark-brown surface soils overlying brownish-red or red moderately compact subsoils. The surface soils contain a large amount of iron concretions or pellets the size of buckshot. Like the Aiken and Olympic soils these soils are derived from basaltic material. They have weathered as deeply, but contain more gravel, stones, rock fragments, and bowlders throughout.

The Carlton soils as mapped in this county are developed almost entirely on basic igneous rocks instead of sedimentary rocks as are the Carlton soils mapped in previous soil surveys in this region. The surface soils are grayish brown or brownish gray mottled with rust brown. The subsoils are brownish gray, are heavier and more compact than the surface soils, and grade into light-brown or yellowish-brown more friable material. These soils occur along the lower slopes of the hills between the soils developed on old valley-filling materials and the Olympic soils. They are poorly drained, owing to seepage from the higher slopes.

The Viola soils are the least important and most poorly drained soils of the hill group. They are characterized by a brownish-gray surface soil overlying a gray or brownish-gray plastic clay layer which extends from a depth of 15 or 18 inches to 30 or 36 inches. Below this

is more friable mottled material or bedrock. The surface soils are much like those of the Amity soils, both in color and compactness, and the subsoils are similar to those of the Dayton soils. The Viola soils are derived principally from basalt, but probably some small included areas have developed on sedimentary rocks.

The miscellaneous materials include peat, rough mountainous land, river wash, and rough broken and stony land. Peat includes the material high in organic matter and low in mineral matter which has developed in low wet places where moist conditions have prevented the decay of plant remains. Rough mountainous land includes comparatively inaccessible areas, and river wash and rough broken and stony land are practically worthless for agricultural purposes.

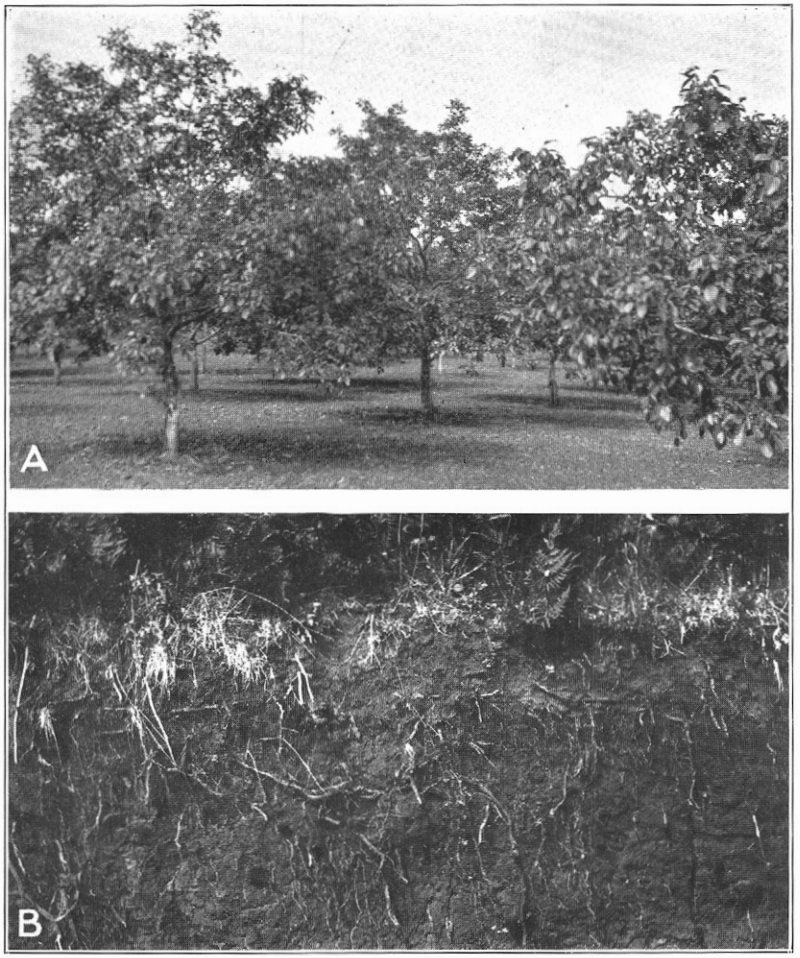
In the following pages of this report the various soils of Marion County are described in detail and their agricultural importance is discussed. The accompanying soil map shows their distribution in the county, and Table 3 gives their acreage and proportionate extent.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in Marion County, Oreg.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Aiken clay loam	28,096	5.2	Amity silty clay loam	51,072	9.7
Polk clay loam	20,416	3.8	Reddish-brown phase	1,728	
Olympic clay loam	48,192	12.3	Amity silt loam	21,504	4.0
Stony phase	14,784		Dayton silty clay loam	10,624	2.7
Shallow phase	3,968		Dark-colored phase	3,968	
Olympic silty clay loam	15,616	3.3	Holcomb silty clay loam	1,536	.3
Shallow phase	2,176		Chehalis clay loam	12,544	2.4
Olympic loam	13,568	2.7	Compact-subsoil phase	448	
Shallow phase	1,088		Chehalis silt loam	6,080	1.1
Carlton clay loam	1,536	.4	Chehalis loam	3,648	.7
Brown phase	512		Newberg fine sandy loam	7,168	1.3
Viola clay loam	3,776	.7	Newberg sandy loam	4,224	.8
Willamette silt loam	65,920	12.2	Newberg silt loam	5,376	1.0
Willamette clay loam	10,752	2.0	Wapato silty clay loam	20,416	3.9
Salem gravelly loam	2,432	.4	Gravelly subsoil phase	512	
Salem gravelly clay loam	2,368	.4	Camas gravelly loam	5,056	.9
Salkum clay loam	1,664	.3	Courtney gravelly silty clay loam	4,928	.9
Waldo clay loam	1,280	.2	Cove clay	2,048	.4
Sifton gravelly very fine sandy loam	3,200	.6	Rough mountainous land	99,008	18.3
Sifton gravelly loam	2,304	.4	Rough broken and stony land	8,320	1.5
Clackamas gravelly loam	2,112	.4	River wash	2,624	.5
Clackamas gravelly clay loam	7,936	1.5	Peat	2,368	.4
Concord clay loam	13,184	2.4	Total	542,080	

AIKEN CLAY LOAM

The surface soil of Aiken clay loam to a depth of about 16 inches consists typically of brownish-red or red heavy clay loam or clay of pronounced granular structure. Under favorable conditions of moisture and cultivation the soil mass breaks into rather loose permeable material. The topmost surface soil in virgin areas appears browner and has a somewhat higher organic-matter content than in areas which have been farmed for some time. On the higher elevations the surface soil has a more pronounced red color than on the slopes where this soil merges into the Olympic soils. Brown or rust-black pellets or iron concretions about the size of a pea or smaller are rather common in the surface soil. Locally the soil is called "red shot soil" or "red hill soil." Angular fragments of the underlying basaltic parent rock are common on the surface or embedded in the soil. Below the sur-



A, Walnut orchard on Aiken clay loam; B, profile of Polk clay loam showing granular structure and development of fern roots characteristic of the more heavily forested areas of the Aiken, Polk, and Olympic soils

face horizon and extending to a depth of about 3 feet is dull-red clay or heavy clay loam which is rather compact and has a coarse granular or cloddy structure. In many places the color of this layer becomes deep red with rust-purple stains. The lower part of the subsoil is deep-red or red clay or heavy clay loam with purplish-red stains. Partly decomposed rock fragments occur in this layer which grades into the bedrock.

The largest areas of Aiken clay loam are just south and southwest of Salem. Other fairly large areas are east of Macleay, and small areas occur throughout the east-central part of the surveyed area.

The relief ranges from rolling to rough and broken. Most of the areas now under cultivation occur on the smooth tops of rolling hills and have good air drainage which is very essential in the production of fruit crops. The soil has excellent surface and subsurface drainage. It is high in colloidal clay, yet is usually friable and can be readily put in good tilth.

Prunes, walnuts (pl. 1, A), cherries, small fruits (especially strawberries), wheat, and oats are the principal crops grown on this soil. Prunes are the most important commercial crop.

Aiken clay loam is one of the most desirable fruit soils of the county, but a very large proportion of the land is devoted to wheat and oats. Little or no crop rotation is practiced, and this is largely responsible for the reduction of the organic-matter content of the soil. Although the soil is still productive, the growing and turning under of green-manure crops in orchard culture is becoming a very common practice on the best farms. The green-manure crops supply the soil with active organic matter which in turn supplies nitrogen and liberates other plant nutrients.

Where wheat and oats have been grown continuously for a number of years organic matter may be restored by sowing vetch as a winter cover crop and turning it under in the spring. This practice is also recommended for improving orchards. Good results are obtained when cultivated crops such as potatoes, beans, or corn are included in the rotation. Long-cropped soils are greatly benefited by the application of 200 to 300 pounds of superphosphate (acid phosphate) for small grains, clover, potatoes, and corn. Good results are obtained with superphosphate used once in a 3-year rotation, just previous to planting the cash crop. The addition of organic matter and lime will also aid in making available the natural supply of phosphorus in the soil. Land plaster sown broadcast on clover in the spring at a rate ranging from 40 to 80 pounds to the acre has increased yields.

The Oregon Agricultural Experiment Station obtains increased yields of clover on Aiken soils by applying from 1 to 1½ tons of limestone to the acre, but it is questionable whether the addition of limestone at this rate is profitable for crops other than clover.

Ferns are abundant and troublesome, especially on newly cleared land, and their eradication is a serious problem. Crop rotation including a number of cultivated crops for several successive seasons is the only sure method of exterminating them.

The current value of prune orchards and walnut groves on Aiken clay loam ranges from $400 to $1,000 an acre. Ordinary grain land is valued from $100 to $150 an acre.

The results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of Aiken clay loam are given in Table 4.

TABLE 4.—*Mechanical analyses of Aiken clay loam*[1]

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
561877	Surface soil, 0 to 14 inches	1.0	2.0	2.1	4.0	4.3	30.7	55.9
561878	Subsurface soil, 14 to 36 inches	.9	1.6	1.8	3.7	3.7	28.4	60.0
561879	Subsoil, 36 to 54 inches	.9	1.7	3.0	6.7	4.6	27.4	55.8

[1] After treatment with hydrogen peroxide.

POLK CLAY LOAM

The surface soil of Polk clay loam to a depth ranging from 8 to 15 inches consists of brown, chocolate-brown, or reddish-brown friable granular clay loam having a high organic-matter content and containing numerous iron pellets or concretions, especially in the virgin state. This layer is underlain by brown or reddish-brown clay loam or heavy clay loam. The material becomes redder and more compact with depth but breaks into granules and small clods when dry. (Pl. 1, B.) The red color is intensified under moist field conditions. At a depth ranging from 20 to 40 inches, brownish-red or red compact heavy clay loam, clay, or silty clay occurs. This is underlain by a layer of brownish-red or red granular silty clay loam or clay which in many places is less compact than the material above. Partly weathered rock fragments of basaltic and similar basic rocks and breccia material occur in this layer.

The brown surface soil of Polk clay loam is similar to that of the Olympic soils, and the red subsoil is similar to that of the Aiken soils. In many places it is difficult to separate these soils in the field, although under normal conditions they are rather distinct. Polk clay loam generally occupies the higher parts of the lower foothills. The relief is favorable for agricultural operations, and drainage is very good throughout.

This is a rather extensive soil in Marion County. Some of the largest areas occur in the vicinity of Center View School, near Fern Ridge School, and northeast of Davis School in the eastern part of the surveyed area.

This is considered one of the most desirable and most productive hill soils of the county. Like the Aiken and Olympic soils it has been farmed for many years, and the organic-matter content has been considerably reduced. On some of the less worn-out areas, wheat is reported as yielding from 15 to 35 bushels and oats from 30 to 50 bushels to the acre. The land is held at prices ranging from $80 to $135 an acre. Where walnut or fruit orchards are established, land prices are similar to those of the Aiken and Olympic soils.

Recommendations for the improvement of this soil are similar to those given for Aiken clay loam.

OLYMPIC CLAY LOAM

The surface soil of Olympic clay loam consists of an 8 to 10 inch layer of chocolate-brown or slightly reddish-brown friable finely granular clay loam or clay containing shotlike pellets or concretions. In the virgin state this layer is well supplied with organic matter. It

is underlain by rich-brown or reddish-brown clay or heavy clay loam. Below this, where well weathered, the material is reddish-brown smooth-textured moderately compact granular clay or clay loam containing partly weathered rock fragments and in many places mottled with yellowish-brown material. Bedrock may occur within this zone, usually at a depth ranging from 4 to 6 feet.

Olympic clay loam is extensively developed in a broad belt extending from Scotts Mills in a southwesterly direction across the county. Large areas occur in the Fern Ridge district, in the vicinities of Union Hill School, Scotts Mills, Silverton, Shaw, and Marion, and between Salem and the southern boundary of the county. The surface relief ranges from hilly to steep and broken, but most of the soil occupies low rounded hills. In some sections, a number of steep slopes have been included with this soil in mapping.

In the western part of the county, especially south of Salem in what is locally called the red-hill section, this soil is extensive and is cropped to prunes, walnuts, small fruits, cherries, Logan blackberries, and general farm crops and produces yields of these crops similar to those obtained on Aiken clay loam. Some of this soil has been farmed approximately 75 years, and where it has been continually cropped to wheat the yields have been reduced considerably.

It is difficult to give accurate information regarding the productiveness of this soil owing to the varying conditions throughout the county. Yields of 25 or 30 bushels of wheat and 40 or 50 bushels of oats are reported in some sections, whereas from 5 to 20 bushels of wheat and from 5 to 25 bushels of oats are reported in other parts of the county. As a whole, where crop rotation is practiced and where cover crops are grown and turned under or liberal applications of manure are made, the soil appears to give very satisfactory yields. It is naturally productive, and where the organic-matter content is improved excellent yields are obtained. The land is naturally well drained and is very suitable for the production of orchard crops where air drainage is good.

Current values of improved Olympic clay loam range from $90 to $150 an acre for ordinary farm land and from $500 to $800 an acre for orchard land. Recommendations for the improvement of this soil are practically the same as for Aiken clay loam.

Olympic clay loam, stony phase.—The fine material of the stony phase of Olympic clay loam is similar to that of the typical soil, but it contains a large amount of angular stones and bowlders of various sizes. The subsoil consists of brown, light reddish-brown, or chocolate-brown clay loam or clay which contains a great number of basaltic bowlders of various sizes. Basaltic bedrock occurs at a depth ranging from 25 inches to 6 feet.

This stony soil occupies the higher knolls, and much of it occurs along streams, especially where the smooth areas break off into the steeper side slopes. The surface is somewhat broken and steep. In most places rocks are scattered throughout the soil. The surface rocks may be removed and the soil farmed, but for most purposes soil of this kind is considered of little agricultural value and is used mainly for grazing land.

The stony phase of Olympic clay loam is rather inextensive and occurs mainly in the eastern part of the surveyed area. Conspicuous areas are north of Bridge Creek School, and in narrow strips

bordering Drift Creek, North Santiam River, and Little North Santiam River.

Olympic clay loam, shallow phase.—Olympic clay loam, shallow phase, consists of brown or dark-brown clay loam from 7 to 24 inches deep, overlying unweathered basaltic bedrock, and in many places containing fragmental bowlders. Small areas occur north of Turner, west of Marion, between Silverton and Scotts Mills, and in other parts of the county. This shallow soil has little agricultural value, much of it being unimproved and supporting a small growth of trees. During the dry months, vegetation is scanty owing to lack of soil moisture. The land is usually sold with adjoining areas of other soils.

In Table 5 are given the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of typical Olympic clay loam.

TABLE 5.—*Mechanical analyses of Olympic clay loam* [1]

No.	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
561859	Surface soil, 0 to 10 inches	2.7	4.4	3.6	6.6	6.4	34.2	42.2
561860	Subsurface soil, 10 to 28 inches	2.7	4.2	3.3	6.1	6.0	32.7	45.2
561861	Subsoil, 28 to 51 inches	2.0	3.3	2.6	5.3	6.4	33.6	46.8
561862	Subsoil, 51 to 60 inches	2.0	5.1	4.4	11.5	15.7	35.7	25.5

[1] After treatment with hydrogen peroxide.

OLYMPIC SILTY CLAY LOAM

Olympic silty clay loam has a surface soil ranging in depth from 8 to 14 inches of brown or rich-brown fine-granular friable silty clay loam containing a considerable amount of iron-cemented concretions or pellets locally known as "shot." The subsoil to a depth of about 26 inches is moderately compact light-brown or light reddish-brown clay loam or silty clay loam. The deeper part of the subsoil consists of light-brown or light yellowish-brown rather compact clay loam, heavy clay loam, or clay. Bedrock may occur within a depth of 48 inches but in most places is deeper.

Olympic silty clay loam differs from Olympic clay loam in having a slightly heavier and finer-textured surface soil. The surface configuration of the two soils is similar.

Most of this soil occurs in the section of the county lying between Scotts Mills and Sublimity in parts of the Waldo Hills section. Fairly large areas are around Silver Falls School, in the vicinity of Mehama, and south of Scotts Mills.

The soil is well suited to a wide range of crops, especially orchard fruits, walnuts, corn, potatoes, strawberries, wheat, and oats. Yields, land values, and recommendations for the management of this soil are similar to those of Aiken clay loam.

Olympic silty clay loam, shallow phase.—Olympic silty clay loam, shallow phase, is similar in color and character of surface soil to typical Olympic silty clay loam, but bedrock occurs within a depth of 25 inches in most places. Fragmental bowlders are numerous.

This shallow soil is very inextensive, and it is of little agricultural value. A few small areas occur in association with Olympic silty clay loam.

OLYMPIC LOAM

Olympic loam to a depth of about 8 inches typically consists of dark-brown or brown, loose, very friable loam containing a large quantity of iron pellets or concretions. Below this the material becomes brown heavy loam of smooth silty texture, slightly granular and compact. The deeper part of the subsoil extending from a depth of 20 to 36 inches is brown or light-brown heavy moderately compact clay loam. The underlying material is light-brown or grayish-brown light clay loam containing a small amount of partly decomposed rock fragments. This material is lightly mottled and is specked with yellow or black spots. Bedrock occurs within a depth ranging from 50 to 72 inches.

Olympic loam has one of the most friable surface soils of the hill group of soils, but it contains enough clay to give it fairly good water-holding capacity.

Most of this soil occurs in the section between Scotts Mills and Mehama. Large areas are on the high divide between Butte Creek and Abiqua Creek, and between Abiqua Creek and Silver Creek southeast and south of Scotts Mills. The surface ranges from hilly to broken.

Probably about 15 per cent of the total area of this soil is in cultivation and is at present in a high state of fertility. A large part supports a heavy stand of fir timber, a small proportion has been cut over and is used for pasture, and many small areas are cleared. Dairying and sheep grazing are the main industries at present. A number of landowners are growing small fruits, especially strawberries, and are setting out walnut and prune orchards on a small scale. Those who have planted orchards are getting excellent returns, as most of the soil lies at elevations having good air drainage. It would seem that orcharding could be expanded whenever market conditions warrant. Many of the Olympic loam areas are rather far from market. As the roads are being gradually improved, and farm lands are very reasonable in price, areas of Olympic loam offer excellent opportunities for new settlers.

Olympic loam has a very desirable texture and is suitable for a wide range of farm crops. In a number of areas, however, many bowlders are in the subsoil and, in some places, scattered over the surface. In most places these do not interfere seriously with ordinary farm operations. As mapped the soil includes a few small and less desirable stony areas which are indicated on the map by stone symbols.

Olympic loam, shallow phase.—The surface soil of Olympic loam, shallow phase, is dark-brown loose friable loam, high in organic-matter content, and of light fluffy character. This layer extends to a depth of 16 or 18 inches and grades into heavier less friable loam or light clay loam that rests on bedrock at a depth ranging from 20 to 25 inches.

This shallow soil occurs along the breaks of the hills bordering stream courses north and east of Sublimity. The soils in this section have a tendency toward shallowness, are of low grade, and are only partly under cultivation. Land of this kind is used almost entirely for sheep pasture. The natural forest growth consists of oak and to less extent of fir, with a few bushes of hazel, elder, and poison oak.

The only crop grown on this soil is strawberries. The surrounding soils are mostly in wheat, oats, some clover, vetch, prunes, and Logan blackberries.

As mapped, soil of this phase includes a few small areas in which the surface soil is of somewhat lower organic-matter content and of lighter-brown color. Such areas occur mainly on the comparatively low flats southeast of Center View School and south of Silverton. Other small areas are included in which the surface soil is reddish brown, contains protruding basaltic bowlders, and is underlain at a slight depth by basaltic bedrock. Neither of these variations is of agricultural importance.

CARLTON CLAY LOAM

Carlton clay loam consists of grayish-brown or brownish-gray mottled clay loam to an average depth of about 15 inches. The upper part of this layer is somewhat granular and the lower part is coarse granular. The subsoil to an average depth of about 30 inches is brownish-gray moderately compact silty clay loam or silty clay containing rust-brown and gray mottlings, and it is of vesicular structure. The substratum in most places extends to a depth of about 50 inches and is light-brown or light yellowish-brown clay loam which is slightly compact but moderately friable, apparently owing to the content of fine sand.

The character of the parent material is not definitely known. Some areas are undoubtedly derived from igneous rocks as well as from shale and sandstone. Carlton clay loam is associated with the Olympic soils on the lower slopes of foothills. It differs from Viola clay loam, into which it grades, in that it has a browner surface soil, better drainage, and a less compact, wet, waxy subsoil. As mapped each of these two soils may include some undifferentiated material of the other.

Carlton clay loam areas have rather smooth and undulating surfaces, less rough and broken than those of the Viola soils.

This is not an extensive soil. It occurs mainly south of Salem. A large part of the land is under cultivation, mainly to prunes, cherries, wheat, oats, corn, and small fruits. The soil is only moderately productive. It requires drainage and replenishment of the organic matter which may be supplied either by liberal applications of barnyard manure or by turning under green-manure crops at least once in each crop rotation. It responds readily to such treatment and is adapted to a wide range of crops. Where clover is to be seeded, to obtain best yields ground limestone should be applied at a rate ranging from 1 to 2 tons to the acre.

Carlton clay loam, brown phase.—The brown phase of Carlton clay loam differs from typical Carlton clay loam in that it has a more pronounced brown surface soil and a somewhat more yellowish subsoil. Several of the areas are underlain at a slight depth by the parent bedrock.

Land of the brown phase occurs in only a few small scattered areas south of Salem, in association with areas of typical Carlton clay loam.

The soil is of minor agricultural importance, being utilized only for pasture during a few months of the year.

VIOLA CLAY LOAM

The surface soil of Viola clay loam to a depth of about 16 inches consists of brown or grayish-brown clay loam slightly mottled with rust brown. In the virgin state the topmost surface layer appears rather brown as it is well supplied with organic matter. The upper subsoil layer to a depth of about 36 inches is gray or grayish-brown heavy plastic compact tight clay, containing slightly purplish brown and rust-brown stains. This layer is underlain at a depth of about 45 inches by brownish-gray slightly granular silty clay loam or clay which is less compact and more friable than the layer above. As occurring in Marion County the surface soil appears somewhat browner than in the typical Viola soils mapped in previous Oregon surveys.

This soil occurs in the western part of the surveyed area along the hills bordering Willamette River north and south of East Independence, in the Waldo Hills northeast of Turner, and northwest of Marion. It occurs on the foot slopes of hills occupied by the Aiken and Olympic soils. The surface is very uneven. In places this soil extends practically to the river banks. As mapped it includes areas of the Carlton soils.

Most of the land supports a forest growth. It is of little agricultural value, as it is low in fertility and organic matter. Although most of it has good surface drainage, internal drainage is poor owing to the impervious compact clay layer in the subsoil. During the rainy season, the soil receives a large amount of surface drainage and seepage water from higher lands and therefore is wet late in the spring. The first prerequisite to its utilization is drainage.

WILLAMETTE SILT LOAM

The surface soil of Willamette silt loam when moist is brown or rich-brown friable smooth-textured slightly compact silt loam to a depth ranging from 8 to 15 inches. In most areas the material shows a gray tint when thoroughly dry. The upper subsoil layer, to a depth of 30 or 36 inches, is light-brown or yellowish-brown moderately compact heavy clay loam or silty clay loam. The underlying material is light-brown or yellowish-brown clay loam having a friable consistence due to a high content of fine sand. This friable layer extends downward to a depth ranging from 8 to more than 10 feet in many places, and in some places it becomes sandier with depth. The soil particles of the subsoil have a somewhat gray coating that disappears when the particles are crushed. The yellow color evident in most of the subsoil increases with depth.

Willamette silt loam is one of the most extensive soils in Marion County. It is closely associated with the Amity soils into which it grades, and may include some undifferentiated areas of those soils. The surface is slightly rolling or undulating, and drainage is well developed.

Probably 95 per cent of Willamette silt loam is located on the higher terraces in the northwestern part of the county. One small area lies east of Marion, two east of Stayton, and a large number are northwest of Jefferson in the direction of Sidney and around Talbot.

As mapped this soil includes small areas of somewhat less silty soils of loam or clay loam texture. These are friable and productive and differ but slightly from typical areas of Willamette silt loam. The principal included areas are east of Woodburn, west and northwest of Aurora, and northeast of Butteville. An included area of loam texture joins Willamette loam of Clackamas County north of Aurora.

Willamette silt loam is recognized by the farmers as one of the best soils of the county for general farm crops. Wheat, oats, and clover are the three main crops, and a large amount of corn is also grown. Other crops grown are prunes, peaches, strawberries, blackberries, raspberries, potatoes, flax, peppermint, Logan blackberries, gooseberries, grapes, cherries, walnuts, filberts, hops, nursery stock, and home garden truck.

Wheat produces from 15 to 35 bushels to the acre, oats from 30 to 70 bushels, clover from 2 to 3¼ tons of hay and from 2 to 6 bushels of seed, corn from 30 to 70 bushels, prunes from 1½ to 2½ tons of dried fruit, and peaches from 75 to 115 bushels. Strawberries, especially the Ettersberg 121 variety, produce from 1½ to 3½ tons to the acre on this soil, with known instances of 5 tons being produced on one acre of especially good soil. Logan blackberries yield from 2 to 5 tons, peppermint from 15 to 25 pounds of oil, potatoes from 100 to 250 bushels, hops from 1,000 to 1,800 pounds, and flax from 1½ to 4 tons of pulled flax to the acre. Seed potatoes are grown on Howell Prairie on the Willamette soils. The main varieties of potatoes are the Russet Burbank and Garnet Chili. A large part of the potato crop is shipped to California.

Ninety per cent of the Willamette silt loam is in crops, the remainder being in fir timber and some oak trees and brush. Many farms still have a small grove of fir timber for home use.

Where a crop rotation is practiced the one commonly followed includes wheat or oats, clover, and corn or potatoes. The area in orchards is either clean cultivated or a cultivated crop such as corn or berries is grown between the trees.

In addition to barnyard manure, small quantities of land plaster are used on clover, or phosphate and limestone on clover and vetch. This soil has been under cultivation from 50 to 70 years, so that the supply of organic matter has been considerably reduced, and the soil would be benefited by plowing under green-manure crops.

Land devoted to general farm crops and having from good to fair improvements is valued at prices ranging from $100 to $200 an acre. Near Salem, land which has been laid out in 5 or 10 acre home sites and is in berries and other fruits is held at prices ranging from $500 to $1,000 an acre, especially near the main paved highways. Orchard land commands from $400 to $600 an acre, and that in walnut and filbert groves is held at a higher price.

Legumes such as Grimm alfalfa, red clover, and vetch give excellent yields on this soil. Where clover is to be seeded on winter grain, lime should be applied and disked in after the plowing and before the seeding of grain. Fall liming is more certain to give the fullest benefit to the coming crop than spring applications. The cost of inoculating alfalfa seed is low, and this should be done to insure a stand.

WILLAMETTE CLAY LOAM

The surface soil of Willamette clay loam to a depth ranging from 14 to 18 inches consists of rich-brown or brown smooth silty clay loam. The upper subsoil layer, extending to a depth of 26 inches, consists of light-brown or grayish-brown moderately compact granular heavy clay loam or silty clay loam, in places slightly mottled with gray and with iron stains. The lower subsoil layer, which extends to a depth of about 50 inches, consists of light-brown moderately compact silty clay loam, in places having a yellow or rich-brown color. The deeper parent material is rather friable.

This soil is similar to Willamette silt loam in relief, drainage, and productivity. It is adapted to wheat, oats, corn, red clover, small fruits, and orchards. It has been farmed for a great many years to wheat and oats and therefore much of it is lacking in active organic matter. Where this is supplied, yields are very satisfactory. Wheat yields on this soil range from about 25 to 40 bushels, and oats from 40 to 70 bushels to the acre. Much of the land is held at $200 an acre, depending on improvements and nearness to markets.

Recommendations for the management of this soil and the fertilizer treatment are similar to those for Willamette silt loam.

Willamette clay loam occurs east and northeast of Salem, the largest areas being in the vicinity of Fruitland, northwest of Loganville, and around Woodburn.

SALEM GRAVELLY LOAM

Salem gravelly loam has a surface layer, from 10 to 15 inches in thickness, of brown heavy fine granular gravelly loam. Waterworn gravel from one-half to 2 inches in diameter are found in this layer, and generally the material in the upper 8 inches is moderately loose. The subsoil to a depth of about 30 inches consists of light-brown moderately compact gravelly clay loam or heavy gravelly clay loam containing a large amount of waterworn gravel from 2 to 4 inches in diameter. The deeper material is somewhat loose and porous light gravelly loam or gravelly clay loam containing a very large proportion of gravel from one-fourth to 2 inches in diameter. As mapped this soil includes small undifferentiated areas in which gravel is not present in the surface soil.

Salem gravelly loam is similar to the Camas soils, but it occurs at higher elevations, usually from 25 to 50 feet above the river and from 5 to 25 feet above the Camas soils. The compaction of the subsoil is in most places more pronounced than in the Camas soils.

Salem gravelly loam is differentiated from Sifton gravelly loam in that it is lighter brown, less smooth and fluffy, and less uniform in texture.

Salem gravelly loam is inextensive. It occurs chiefly in the southern part of the county, associated with the Courtney soils. The principal areas are in the vicinity of Stayton, south of Aumsville, and in the vicinity of Jefferson. The surface of Salem gravelly loam is flat or slightly undulating.

This soil is moderately productive, and practically all the farm crops commonly grown in the county are produced. Orchards give fair returns when properly managed. Under favorable conditions of moisture and fertilization the soil is well suited to potatoes, clover,

and truck crops. Because this soil occurs in small areas, it is usually sold with other soils which in a large degree regulate the selling price.

The principal requirement for the improvement of this soil is the liberal application of barnyard manure. If manure is not available, cover crops should be grown and turned under to build up the organic-matter content and thus increase the water-holding capacity of the soil. Where this soil is heavily cropped, a light application of nitrate of soda early in the spring, especially for grain crops, is desirable. Superphosphate, applied at the rate of about 250 pounds to the acre, increases the yield of grain crops.

SALEM GRAVELLY CLAY LOAM

The surface soil of Salem gravelly clay loam to a depth ranging from 10 to 16 inches is brown clay loam containing various amounts of waterworn gravel from one-half to 3½ inches in diameter. The color of the surface soil is somewhat darker than is typical of the Salem soils. The greater part of the soil does not contain an excessive amount of gravel in the surface material but has too much to be classed as a gravel-free soil. The subsoil is brown or light-brown silty clay loam, either free of gravel or containing a few scattered waterworn gravel. The subsoil is moderately compact and extends to a depth ranging from 28 to 36 inches, where it rests on a substratum of light-brown gravelly clay loam or gravelly sandy loam containing a large amount of waterworn gravel.

Although rather compact the soil is in general fairly well drained, though in places subdrainage is restricted causing slight mottling in the subsoil. The surface is undulating or almost flat, similar to that of the adjoining Clackamas soils. This soil occupies higher elevations than the Clackamas soils, is better drained, and is adapted to a wider range of farm crops.

The main bodies of this soil occur along the terrace bordering North Santiam River east of Stayton and between Stayton and Marion. Other areas are northwest of Stayton extending to Turner.

Approximately three-fourths of the land is cleared, and the greater part of the cleared area is in crops, mainly wheat, oats, vetch, corn, clover, prunes, strawberries, and some other berries. Wheat produces from 15 to 25 bushels to the acre, oats from 20 to 40 bushels, and corn from 40 to 50 bushels. Vetch and oats yield from 1 to 2½ tons and clover from 1 to 2¼ tons of hay to the acre. Strawberries give good yields.

Uncleared land is held at prices ranging from $50 to $70 an acre, and improved land sells from $75 to $125 an acre. Due to the small size of the individual areas this soil is generally farmed only in connection with other soils.

The original content of organic matter in the soil was never high and has been reduced by continuous cropping. Barnyard manure and other fertilizers are required to maintain crop yields. Dairying and sheep raising are carried on rather extensively on the gravelly soils, so that a large amount of manure is available for keeping up the fertility of the land. Corn seems to do especially well on this and the other gravelly soils.

SALKUM CLAY LOAM

The surface soil of Salkum clay loam to a depth ranging from 8 to 12 inches is brown or rich-brown slightly compact clay loam having a yellowish cast. The underlying subsoil to a depth ranging from 18 to 24 inches is rich-brown or pronounced reddish-brown moderately compact clay loam. Below this layer is grayish-brown or reddish-brown clay loam or silty loam containing large amounts of soft rust yellowish-brown or red waterworn gravel which are highly weathered and easily cut with a knife or spade. Below a depth of 30 inches the proportion of gravel increases. The gravel are gray, yellow, brown, and red and are embedded in brown or light reddish-brown clay loam interstitial material. The lower part of the substratum is more compact than the surface soil or subsoil.

As mapped Salkum clay loam includes a small area of soil 1 mile west of Sublimity in which the surface soil is darker than typical, the tough plastic subsoil is grayish brown and highly mottled with gray and iron stains, and drainage is very poorly developed.

The typical soil occurs on the edge of the hills above the other old valley-filling soils at an elevation between 400 and 500 feet, and it lies below and adjacent to the Olympic soils. The land is rolling or undulating and is well drained.

Salkum clay loam occurs mainly around Sublimity and west toward Aumsville along the foothills. The greater part of the land is cleared and under cultivation. The uncleared part is in fir trees and stumps and wild blackberry vines.

The main crops are wheat, oats, prunes, corn, clover, and walnuts, and some strawberries are produced. The wild blackberries are gathered and canned. The method and type of farming are the same as on the adjoining Olympic soils. Wheat yields from 15 to 30 bushels, oats from 30 to 50 bushels, clover from 1 to 1¾ tons of hay, and prunes from 1½ to 2½ tons of dried fruit to the acre.

Barnyard manure is used for enrichment of this soil. It is common custom to burn the straw stacks, and consequently much valuable fertilizing material is lost. The organic-matter content of the soil has been greatly reduced and should be replenished in order to obtain large yields. Field tests indicate a strongly acid condition of the soil and subsoil. From 1 to 2 tons of ground limestone to the acre would be required to correct the acidity.

WALDO CLAY LOAM

The surface soil of Waldo clay loam to a depth of 7 or 8 inches is reddish-brown, dull-brown, or dark-brown clay loam, underlain to a depth ranging from 12 to 15 inches by light-brown, rich-brown, or reddish-brown somewhat compact heavy clay loam having a trace of rust-brown mottling. The subsoil to a depth of 20 or 22 inches is light yellowish-brown or dull-yellow slightly compact heavy clay loam or clay mottled with light gray, rust brown, and yellow. This layer is underlain to a depth ranging from 28 to 35 inches by grayish-brown, yellowish-brown, or yellow clay loam or clay highly mottled with gray, rust brown, and yellowish brown, and containing irregularly distributed streaks of gray clay. This layer is very compact,

plastic, and comparatively impervious. The substratum is grayish-brown or dull-yellow clay loam or clay, highly mottled with rust brown, brown, and yellow, together with streaks of light-gray heavy plastic clay. The substratum material is very compact and difficult to bore into with a soil auger.

This soil occurs in low flat areas at an elevation between 400 and 500 feet above sea level, and it is surrounded by low rolling hills occupied by soils of the Olympic series. The surface and underground waters of the higher-lying adjacent soils drain onto this soil, and subdrainage is much restricted by the heavy subsoil. The soil shows more compaction in the subsoil than the most compact soils on the valley floor 200 feet below.

The principal area of this soil occurs along the railroad between Shaw and Macleay, and several small bodies lie west and southwest of the larger area. About half of the land of this kind has been allowed to revert to pasture, owing to poor yields when farmed. Some of the soil, which has been tile drained and to which ground limestone has been added, produces good crops of grain, vetch, and clover. Part of the undrained land was at one time planted to apples, but results were poor. Alfalfa is grown where 3 or more tons of ground limestone have been used. Wheat produces from 15 to 20 bushels to the acre, oats from 20 to 35 bushels, and vetch and oats from 1 to 2½ tons of hay.

SIFTON GRAVELLY VERY FINE SANDY LOAM

The surface layer of virgin areas of Sifton gravelly very fine sandy loam as occurring in Marion County consists of about 1½ inches of very dark brown smooth-textured gravelly very fine sandy loam which is high in finely divided partly decomposed organic matter. The underlying material to a depth of about 16 inches is dark dull-brown loose fluffy gravelly very fine sandy loam, high in sooty organic matter which when moist feels smooth and powdery. Gravel of various sizes, ranging from half an inch to 2 inches in diameter, is scattered throughout the surface soil. Below this and extending to a depth of about 35 inches, is dark grayish-brown or brown loose gravelly sandy loam or gravelly fine sandy loam containing a moderate amount of organic matter. This layer is underlain by light-brown or yellowish-brown very loose and porous gravelly sandy loam.

The soil has a higher content of finely divided dark-colored organic matter and is of looser and more fluffy consistence than Sifton gravelly loam which is mapped in the adjoining county. The dark color and high organic-matter content continue in many places to a depth of at least 3 feet, whereas in other Sifton soils the organic-matter content is high in the surface material, but, as a rule, does not extend to a depth of more than 15 or 20 inches.

This soil occupies the higher parts or knolls of the old valley flats or terraces. It is commonly known as "loose land."

Typical areas of Sifton gravelly very fine sandy loam are very dark brown or black when moist. When the dry soil is cultivated it raises a cloud of dust which in settling leaves a sooty deposit.

This is an inextensive soil, and it is of minor agricultural importance. Practically all the land is cleared of forest growth, and a large proportion is in cultivation. It occurs only in the southern part of

the county, principally east of Stayton, around West Stayton, and in the section between Stayton and Turner.

When properly farmed with the aid of supplemental irrigation and barnyard manure to activate the organic matter present, this soil has produced good yields, especially of strawberries, watermelons, and other truck crops.

SIFTON GRAVELLY LOAM

The surface soil of Sifton gravelly loam to a depth of 14 inches consists of dark-brown loose slightly granular gravelly loam or silty loam which is somewhat fluffy when dry. The subsoil, extending to a depth of 30 inches, consists of light-brown or yellowish-brown loose gravelly fine sandy loam, containing a considerable amount of waterworn gravel which is somewhat weathered but not soft. The substratum to a depth of 43 or more inches consists of grayish-brown very loose and porous gravelly sandy loam containing numerous small waterworn gravel. As mapped, the surface soil is somewhat variable in texture, and small silty areas are included. This soil generally occurs at an elevation intermediate between that of Sifton gravelly very fine sandy loam and Clackamas gravelly clay loam and has some characteristics of each of these soils.

The main crops grown are truck crops, principally strawberries. Prunes, wheat, and oats are produced. The soil has average or medium fertility. It is droughty, but has a better water-holding capacity than Sifton gravelly very fine sandy loam as it has a higher content of silt and clay. For best yields it must have supplemental irrigation during the dry season.

This is an inextensive soil and occurs only in the southern part of the county between Marion, Stayton, and Aumsville, and in a few small areas between Turner and Salem.

CLACKAMAS GRAVELLY LOAM

Typical Clackamas gravelly loam has a 12 or 15 inch surface soil of brown or dark-brown gravelly loam or heavy loam containing a considerable amount of organic matter, especially in the upper 6 inches, and waterworn gravel and stone ranging from 2 to 4 inches in diameter. The subsoil to a depth of 32 inches consists of light-brown or dull-brown moderately compact or compact gravelly clay loam high in waterworn gravel. The substratum to a depth of 60 or more inches is light-brown moderately compact gravelly loam or gravelly sandy loam containing various amounts of waterworn gravel which range in diameter from one-half inch to 4 inches.

Clackamas gravelly loam is inextensive and unimportant agriculturally. The main areas are near Jefferson, West Stayton, and Turner.

Wheat, oats, corn, potatoes, and oats and vetch hay are the principal crops grown. Recommendations for the improvement and utilization of this soil are similar to those for Clackamas gravelly clay loam.

A few small areas in which the surface soil is free from gravel, except a few on the surface, are included in mapping. The principal area of this included soil extends east from Aumsville for a distance of about 2 miles along the highway. The subsoil is very tight and highly mottled with gray and rust brown. Water stands on the surface during the winter, and the area is devoted to pasture only.

CLACKAMAS GRAVELLY CLAY LOAM

Clackamas gravelly clay loam to a depth ranging from 10 to 15 inches consists of dark-brown, brown, or grayish-brown moderately compact heavy gravelly clay loam or gravelly silty clay loam which is almost black when moist. It contains a large amount of gravel of various sizes. The subsoil to a depth of 30 inches is brown or light reddish brown mottled with rust brown and gray. It is very compact, and contains waterworn gravel held firmly in place. This layer is responsible for the poor drainage of the soil. The deeper substratum, extending to a depth of 50 inches, consists of brown compact gravelly sandy clay loam containing a large amount of waterworn gravel from one-half to 2 inches in diameter. This layer is somewhat permeable in contrast to the material directly above it.

This soil is closely associated with Courtney gravelly silty clay loam. Both soils are poorly drained, and both have very much the same color. The Clackamas soil, however, is somewhat older and more mature than the Courtney soil and is better drained and more fertile.

Clackamas gravelly clay loam has a flat or slightly undulating surface, fair or poor surface drainage, and poor subdrainage. It occurs only in the southern part of the county. The largest areas are south and southwest of Marion, north of West Stayton, and along Mill Creek between Turner and Salem.

Drainage is the prerequisite in the management of this soil. Successful drainage requires large outlet ditches, and this must be a community project.

Where proper drainage has been provided, the soil seems to be productive. Wheat, oats, corn, beans, flax, oats and vetch, and oat hay, with some clover, are grown. Wheat averages 20 bushels, oats 30 bushels, and corn 50 bushels to the acre. On land that has been tile drained, one farmer reported a yield of 70 bushels of yellow dent corn. Vetch and oats yield 2½ tons of hay. Dairying is one of the important industries at present. Much of this soil is provided with subirrigation which is helpful in the production of many types of crops.

CONCORD CLAY LOAM

Concord clay loam has a surface soil, from 10 to 14 inches thick, of light brownish-gray granular clay loam mottled with rust brown. The surface soil is of smooth silty texture and may include some silty clay loam material. The subsoil is light-gray slightly granular moderately compact heavy clay loam highly mottled with rust-brown iron stains. The underlying material between depths of 30 and 50 inches consists of brownish-gray moderately friable clay loam.

The principal areas of Concord clay loam are developed on the prairies west of Gervais, south of St. Paul, and northeast of Silverton. The soil occupies flat or depressed poorly drained areas.

In surface appearance this soil is similar to soils of the Dayton series, but it does not have the heavy waxy bluish-gray clay subsoil which is characteristic of the Dayton soils. It resembles the Amity soils, having a similar subsoil but a grayer surface soil.

Approximately one-half the total area of Concord clay loam is under cultivation to a wide range of crops, including corn, wheat,

oats, oats and vetch hay, clover, potatoes, blackberries, and strawberries. Yields are generally less than those obtained on the Amity soils. Drainage is necessary before other permanent improvements can be made, and best results are obtained by tiling. In many places surface drainage is obtained by making dead furrows. Recommendations for the improvement of this soil are similar to those for Dayton silty clay loam.

AMITY SILTY CLAY LOAM

The surface soil of Amity silty clay loam ranges in depth from 12 to 20 inches and consists of gray-brown or brown silty clay loam, in many places mottled with reddish-brown stains. The subsoil consists of brownish-gray compact heavy silty clay loam highly mottled with rust brown and gray. Below this layer the material is brownish-gray or yellowish-gray friable clay loam or silty clay loam, somewhat mottled and much less compact than the material above it. As mapped in this county small areas are included in which the subsoil materials contain gravel.

Amity silty clay loam occupies flat or very slightly undulating areas usually between associated flat and more rolling lands. In the Willamette Valley this soil is referred to as " half-white land," as it is intermediate in color and in drainage between the brown Willamette soils which have excellent drainage and the gray Dayton soils which have poor drainage.

Amity silty clay loam is closely associated with the Willamette soils. Soils of these two series intergrade considerably and it is difficult to make definite field separations. Amity silty clay loam is similar to Concord clay loam, but it has a richer-brown surface soil and is more productive.

Large areas of this soil occur in all parts of the valley floor, principally in the vicinities of Salem, Silverton, Mount Angel, Gervais, Woodburn, Broadacres, and St. Paul. Small areas are in the southwestern part of the county.

Practically three-fourths of the land is now under cultivation. It is adapted to a wide range of crops. The principal crops grown are wheat, oats, oats and vetch for hay, red clover, corn, barley, potatoes, flax, and small fruits. Wheat yields from 20 to 30 bushels to the acre, oats average about 40 bushels, and clover yields from 1½ to 3 tons. The soil has fair or good fertility and responds well to treatment. Its first requirement is drainage.

Amity silty clay loam, reddish-brown phase—Amity silty clay loam, reddish-brown phase, has a brown or chocolate-brown surface soil to a depth of 12 or 15 inches, and in many places it appears grayish brown. The subsoil to a depth of about 35 inches is chocolate brown or almost reddish brown, mottled with dark-red or almost black particles. Some lighter-red and yellow mottlings are also apparent. The subsoil is rather compact. The lower substratum is brown, yellowish-brown, or reddish-brown silty clay loam which is somewhat more friable than the layer directly above.

This reddish-brown soil occurs on the lower slopes below areas of Olympic clay loam along the foothills northwest of Marion and southwest of Turner. It lies just above the associated old valley-filling soils, and the land slopes but slightly. Surface drainage is

fair, but subsoil drainage is restricted owing to the compactness of this layer.

The main crops grown are wheat, oats, corn, and potatoes.

Drainage is the first step in the improvement of this soil. A large amount of water can be diverted from the soil by ditches or tile at the base of the adjacent higher-lying soils.

AMITY SILT LOAM

Amity silt loam has a brown or grayish-brown slightly mottled silt loam surface soil ranging in depth from 9 to 18 inches. The upper subsoil layer consists of brownish-gray or brown clay loam which is highly mottled with rust brown and gray, is moderately compact, and is slightly granular and vesicular in structure. The deeper subsoil layer, between depths of 25 and 46 inches, consists of grayish-brown or yellowish-brown friable clay loam which is highly mottled with rust brown and gray. This layer contains a considerable amount of very fine sand and is therefore much less compact than the overlying layer. Amity silt loam is similar to Amity silty clay loam, but it has a more friable surface soil.

This is a fairly extensive soil. Large areas are mapped between Salem and Mount Angel, east of Mount Angel, south of Gervais, and north of Hubbard extending to the county line. Smaller areas are scattered over other parts of the county.

Amity silt loam occurs in flat or slightly undulating areas having only fair natural surface drainage. This soil is associated with the Willamette soils, usually occupying the lower positions.

In a number of places, the surface soils of the Amity and the Willamette soils are similar, especially in the nothern part of the county, but the subsoils are different. Typical Amity silt loam has a gray mottled subsoil which is an indication of development under restricted drainage conditions.

The soil is moderately productive, and where properly farmed gives very satisfactory yields. Practically all the farm crops common to the region are grown, including wheat, oats, corn, vetch, clover, small fruits, hops, flax, and some orchard fruits. In the vicinity of Mount Angel, yields of oats range from 35 to 40 bushels, of wheat from 20 to 35 bushels, and of clover from 2 to 2½ tons. Where drainage has been provided, this soil is adapted to the growing of truck and dairy feed crops.

Recommendations for the management and handling of this soil are similar to those for Amity silty clay loam.

DAYTON SILTY CLAY LOAM

Dayton silty clay loam has a surface soil from 13 to 20 inches thick of rather dull-gray, light-gray, or brownish-gray silty clay loam containing rust-brown, yellow, and gray stains and small brown or dark-colored iron concretions. Plowed or cultivated areas when fairly dry have a very light gray or dingy white appearance as compared with adjoining soils. This soil is commonly called "white land." The surface soil when moist has a grayish-brown appearance, and a very smooth, velvety, floury, and powdery feel. It contains a high proportion of silt but is low in organic matter. The upper subsoil layer is gray or bluish-gray heavy waxy plastic clay, in places mottled with

dark brown or black, and is very compact and impervious to water. The deeper subsoil layer, extending to a depth of 50 inches, is yellowish-gray or brownish-gray light silty clay loam mottled with rust brown and is much less compact and more friable than the layer just above. Small undifferentiated areas in which the subsoil materials are somewhat gravelly, are included with this soil in mapping.

The principal areas of Dayton silty clay loam are just south of Sidney in the Ankeny Bottom, between Marion and Turner, and in the vicinities of Gervais and Woodburn. A number of small areas, which do not conform to type so well as the more level and broader areas, occur as narrow strips or low depressions following channels or stream courses.

Areas of Dayton silty clay loam are prevailingly flat. They occur in the lower depressions on the valley floor and have very poor surface drainage. The impervious subsoil retards the downward movement of water, and water stands on the surface throughout the winter and until very late in the spring. Tile placed in the lower friable subsoil layer just below the compact layer has provided effective drainage in many places. The Oregon Agricultural Experiment Station recommends that, on this type of land, drainage tiles be placed at a depth of about 36 inches and about 4 rods apart in the friable layer. Where the impervious layer is less than 6 inches thick, tile lines may be placed farther apart.

The results of fertilizer experiments on "white land" at the Corvallis station show that maximum crop yields are obtained where manure at the rate of 10 tons and superphosphate at the rate of 250 pounds to the acre are applied. Fertilizers will be more effective after drainage has been established. Following drainage, vetch is a suitable first crop and may be followed by winter grain and then seeded to clover, with an application of lime at the rate of 1½ tons to the acre disked in after plowing. Grain, clover, and some row crops, leaving the clover one or two years according to the stand, should with some manuring maintain the organic matter and nitrogen content of this land. To keep up the mineral plant food, sulphur or gypsum may be applied to the young clover and superphosphate to the cultivated crop. A suitable application of superphosphate is 300 pounds to the acre with manure.

Probably 50 or 60 per cent of the land is under cultivation, and the remainder is used chiefly for pasture or hay land. The principal crops grown are oats, alsike clover, cheat hay, and oats and vetch hay. Yields on this soil are rather low. In some sections this kind of land is pastured almost entirely.

Dayton silty clay loam, dark-colored phase.—The surface soil of Dayton silty clay loam, dark-colored phase, is dark bluish-gray or dark brownish-gray silty clay loam ranging in depth from 6 to 18 inches. The surface of plowed ground has a bluish cast, in spots ranging from gray to grayish blue. In some areas, especially in the Ankeny Bottom, the soil is very dark, approaching the color of the Cove soils. In most places the material is mottled with rust-brown stains. The subsoil, which usually lies between depths of 10 and 25 inches, consists of dark-gray or bluish-gray heavy plastic clay containing rust-brown and purple mottlings. The substratum to a depth of 42 inches consists of brownish-gray or yellowish-gray moderately friable silty clay loam having dark-brown, yellow, and rust-orange stains. Soil of this

phase closely resembles typical Dayton silty clay loam, but the surface soil is darker and undoubtedly contains more organic matter and seems to be more productive.

Soil of the dark phase is inextensive in Marion County. The largest areas are in the Ankeny Bottom northeast of Talbot, where this soil merges with typical Dayton silty clay loam and the two are difficult to differentiate in mapping. Other areas are south of Turner and southeast of Looney Butte. Recommendations for the management and the handling of typical Dayton silty clay loam are applicable to the phase also.

In Table 6 are shown the results of mechanical analyses of samples of the surface soil, subsurface soil, and subsoil of typical Dayton silty clay loam.

TABLE 6.—*Mechanical analyses of Dayton silty clay loam*[1]

No	Description	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
561845	Surface soil, 0 to 13 inches	0.4	1.0	0.5	1.2	5.1	68.3	23.6
561846	Subsurface soil, 13 to 30 inches	.1	.4	.4	1.4	3.9	43.6	50.1
561847	Subsoil, 30 to 39 inches	.1	.4	.4	1.5	7.0	51.9	38.7
561848	Subsoil, 39 to 50 inches	.0	.1	.3	2.6	10.6	62.2	24.2

[1] After treatment with hydrogen peroxide.

HOLCOMB SILTY CLAY LOAM

Holcomb silty clay loam to a depth ranging from 8 to 20 inches consists typically of dull-brown or dark grayish-brown silty clay loam slightly mottled with rust brown. The surface soil when moist resembles the surface soils of the Willamette soils. Holcomb silty clay loam differs from Dayton silty clay loam in having a more pronounced brown surface soil. The upper subsoil layer is brownish-gray or bluish-gray heavy plastic clay to an average depth of about 35 inches. The material in this layer is very much like that in the impervious layer in Dayton silty clay loam. It is high in colloidal clay. The deeper subsoil layer consists of grayish-brown heavy silty clay loam which is much more friable than the compact layer above.

Holcomb silty clay loam is developed on deposits of old valley-filling material which have flat or gently sloping surfaces. It appears to have been formed under poor drainage and subsequently to have developed better drainage, particularly on the surface. This soil is usually associated with the Amity and Willamette soils. It is much more poorly drained than Amity silty clay loam. Owing to its very small extent, it is of comparatively little agricultural importance. Several areas are mapped in the Ankeny Bottom, the largest being about a mile east of Sidney.

Although this soil is poorly drained, like Dayton silty clay loam, it is more productive than that soil, as the surface soil contains more organic matter. Crops suitable and means of improvement for this soil are similar to those for Dayton silty clay loam. Wheat, oats, corn, and alsike clover are grown with only fair success. The value of this soil is between that of Dayton silty clay loam and Amity silty clay loam.

CHEHALIS CLAY LOAM

The surface soil of Chehalis clay loam is brown or rich-brown clay loam ranging in depth from 12 to 15 inches, and the subsoil is light-brown or yellowish-brown clay loam or silty clay loam formed of stratified sediments.

The surface varies from flat to undulating. The soil is subjected to frequent overflows for short periods, but at other times the drainage is excellent. The soil as mapped may include small undifferentiated bodies of Newberg soils along Willamette River where the soil types are intricately mixed. In two small included areas, one, containing about 100 acres, just north of the State Institution for the Feeble Minded, the other along Battle Creek south of Salem the soil material consists of alluvial outwash from the Aiken and Olympic soils and is of more pronounced red color than typical.

The largest areas are west of Champoeg, west of Talbot in Ankeny Bottom, and west and north of Silverton along Pudding River. Smaller areas occur southwest of Salem, south of East Independence, south of Aurora, and along Butte Creek north from Scotts Mills.

More than half of Chehalis clay loam is cleared and in crops; the remainder is covered by fir, ash, vine maple, and oak, together with stumps and brush. The crops grown most extensively are hops, prunes, peaches, Logan blackberries, wheat, oats, corn, and clover, with smaller amounts of strawberries, blackberries, flax, alfalfa, potatoes, pears, apples, and filberts. Dry hops yield from 1,500 to 2,500 pounds to the acre, prunes from 1 to 2½ tons of dried fruit, wheat from 20 to 40 bushels, oats from 35 to 60 bushels, clover from 2 to 3 tons of hay and from 3 to 5 bushels of seed, and flax from 1½ to 2½ tons of fiber.

Prices of uncultivated cleared land range from $75 to $150 an acre, and improved berry, hop, and orchard land brings from $400 to $600 an acre. Uncleared land ranges in value from $40 to $70 an acre.

Manure is used for hops and land plaster for the clover crop. All available manure not utilized for hops is applied to berries and prune trees. Very little commercial fertilizer is used on this soil.

Chehalis clay loam, compact-subsoil phase.—The compact-subsoil phase of Chehalis clay loam has a 10 to 14 inch surface soil of brown, grayish-brown, or dark-brown clay loam overlying a heavier somewhat compact and mottled subsoil. An area including about 100 acres, which has a dark-brown surface soil and a darker and somewhat more friable subsoil than typical, occurs southeast of Sublimity along Mill Creek. Here the soil has a tendency to bake if plowed when too wet but under favorable moisture conditions is readily worked to good tilth.

Areas of this soil lie at higher elevations than the rest of the bottom soils but are from 25 to 50 feet lower than the upper bench soils. Two small bodies, totaling around 100 acres and all in fir stumps and grass, occur northwest of Champoeg. Current prices of this land range from $40 to $60 an acre. Soil of this phase is about equal to the typical soil in productiveness and may be handled in a similar way.

CHEHALIS SILT LOAM

Chehalis silt loam has a brown smooth silt loam surface soil from 9 to 14 inches deep overlying a stratified subsoil which ranges in texture from clay loam or silt loam to fine sandy loam. Small undiffer-

entiated areas of Newberg soils are included near the streams where mixed streaks of sandy subsoil occur. The surface is undulating, and excellent drainage is developed except at seasons of high water, when the soil may be covered by water for a short period. The organic-matter content is not high and is soon depleted by cultivation and should be replenished by manure, by crop residues, or by plowing under green-manure crops.

Many areas of this soil occur along Willamette River, Pudding River, Santiam River, Butte Creek, and Silver Creek. The largest areas are west of St. Paul and east and south of Wheatland Ferry.

Probably less than half this soil is under cultivation; the rest is covered by fir, ash, maple, and oak trees, together with brush and stumps. The main crops grown are hops, prunes, vetch and oats, corn, Logan blackberries, wheat, oats, clover, alfalfa, flax, strawberries, peaches, pears, potatoes, filberts, and apples. The soil is suitable for almost all crops grown in the county and is very productive. It is one of the best soils for hops, flax, and alfalfa. Hops yield from 1,500 to 2,500 pounds of dry hops to the acre, prunes from 1 to 2½ tons of dried fruit, oats from 35 to 60 bushels, wheat from 20 to 40 bushels, alfalfa from 2½ to 5 tons of hay, potatoes from 150 to 250 bushels, clover from 1 to 3½ tons of hay, vetch from 400 to 900 pounds of seed and from 2 to 4 tons of hay when combined with oats, and peaches from 100 to 120 bushels.

Some commercial fertilizers and barnyard manure are used, especially on hops and fruits. Land plaster is commonly applied to clover and sometimes to vetch. Phosphate fertilizers are used mostly on clover.

CHEHALIS LOAM

Chehalis loam is characterized by a surface layer from 10 to 18 inches thick of light-brown or brown friable loam overlying light-brown silt loam or clay loam sediments. The land is undulating or rolling, and some channels pass through it. The areas mapped include small undifferentiated areas of Newberg soils, and a few bodies of sandy loam texture are also included because of their small extent. The soil is well drained except when subjected to overflow for short periods of high water.

Chehalis loam is inextensive, the largest body occurring southwest of Talbot along Santiam River.

Most of the land is under cultivation. Some is covered by an undergrowth of brush and trees of fir, maple, oak, and balm-of-Gilead poplar. The principal crops are hops, corn, barley, wheat, potatoes, and strawberries. Hops yield from 1,000 to 2,000 pounds dry weight to the acre, corn from 25 to 50 bushels, barley from 25 to 45 bushels, wheat from 20 to 40 bushels, potatoes from 150 to 250 bushels, strawberries from 40 to 80 crates of 24 boxes, or 24 pounds each.

Supplemental irrigation during the dry summer season is being tried on this soil, and yields are being increased from 25 to 100 per cent. Water is pumped on the land by gasoline or electric power from wells, lakes, and streams.

Manure, complete fertilizer, and nitrate of soda are used on this soil. Hops receive the greater part of the fertilizer.

NEWBERG FINE SANDY LOAM

Newberg fine sandy loam has a surface soil of brown or light-brown loose friable fine sandy loam from 10 to 15 inches deep, overlying light-brown fine sandy loam or loamy sand stratified sediments. This soil generally occurs along the river banks at a lower elevation than the Chehalis soils. It is frequently overflowed and is continually being reworked by the water. The land is rolling and is cut in many places by stream washes. Surface drainage is good, except when the land is covered by high water for short periods.

Extensive areas of this soil occur along Willamette River north and southwest of Salem, near Wheatland Ferry, along Santiam River, and along North Santiam River from its mouth to a point above Mill City.

Probably 65 per cent of the land is in crops, and the rest is in brush and a scattered growth of maple, ash, and balm-of-Gilead poplar trees The main crops are prunes, hops, peaches, strawberries, Logan blackberries, blackberries, corn, wheat, oats, clover, alfalfa, walnuts, filberts, and truck crops, and some tulip and other bulbs are grown. This is the most favorable soil for peach growing because it is early and is easily worked. Uncleared land ranges in value from $35 to $70 an acre, improved general-farming land from $75 to $150, and improved orchard and berry land from $250 to $600, all depending on nearness to market and condition of improvements.

Prunes yield from 1½ to 2½ tons of dried fruit to the acre, peaches from 100 to 125 bushels, hops from 1,500 to 1,600 pounds dry weight, spring wheat from 20 to 30 bushels, winter wheat from 25 to 40 bushels, oats from 30 to 60 bushels, alfalfa from 2½ to 4 tons of hay, clover from 1 to 2½ tons, potatoes from 150 to 250 bushels, corn from 25 to 60 bushels, mixed vetch from 1½ to 3½ tons, and strawberries from 40 to 125 crates.

The small amount of available manure is used for hops, fruit, and general farm crops. Some commercial fertilizer is used. Superphosphate is applied to clover, and nitrates are used on fruit and hops. The original organic-matter content of the soil was not very high, and cultivation has reduced it to a marked extent. Green-manure crops and legume-crop residues would increase the fertility and water-holding capacity of the soil.

Irrigation during dry periods is being practiced to some extent, especially for the hopyards along Willamette River where water is easily obtained by a pumping lift of 15 to 25 feet. Most of the soil lies from 15 to 30 feet above the level of the rivers and small lakes. Electricity is the main source of power used in pumping irrigation water.

This soil is generally favored for the production of peaches. In the bottom south of Jefferson most of the land is devoted to the production of prunes and strawberries. Small plantings of tulip and other bulbs are made.

NEWBERG SANDY LOAM

Newberg sandy loam has a loose brown sandy loam surface soil from 9 to 15 inches deep. The subsoil extending to a depth ranging from 3 to 4 feet is loose friable light-brown sandy loam or fine sandy loam. The surface is rolling or billowy and is characterized by long low ridges.

The texture of the soil varies very markedly within short distances in some fields. In the bottom south of Jefferson the soil is underlain by a gravel layer at a depth ranging from 30 to 40 inches, and small areas in which gravel occurs in the surface soil are also included. Small included areas a short distance east of North Santiam and west of Mehama are of light sand texture. These lie only a few feet above the stream channels and are utilized only for pasture.

The soil occurs along streams or stream channels and lies at elevations ranging from 15 to 30 feet above the river level. Most of the land is covered by water during flood periods, and the surface soil has been reworked to some extent. Except when overflowed by flood waters the soil is well drained. The loose sand in the subsoil prevents the rise of capillary moisture, so that the land tends to be droughty especially where the gravel is near the surface as along Santiam River below Jefferson.

Prominent areas of this soil occur along Willamette River, south of Independence Ferry, and in Mission Bottom from Wheatland Ferry southward to the vicinity of Spongs Landing. Other areas are along Santiam and North Santiam Rivers. More than half the land is in cultivation, and the uncultivated part is in hazel and other brush and vine maple, fir, and balm-of-Gilead poplar.

The most important crops are prunes, hops, Logan blackberries, wheat, oats, corn, potatoes, peaches, small fruits, truck, and nursery stock. Crop yields are probably slightly lower than on Newberg fine sandy loam.

This soil requires organic matter to increase the water-holding capacity. Nitrate fertilizer is used on hops. Land plaster and superphosphate are used on clover.

NEWBERG SILT LOAM

The surface soil of Newberg silt loam is brown smooth-textured silt loam or loam from 8 to 18 inches deep, underlain by light-brown stratified sediments ranging from fine sandy loam to sandy loam or sand. The land is undulating or billowy with long narrow ridges and intervening swales and with watercourses through some of the low places. This soil lies from 5 to 30 feet above the river and is farther back from the river than the lighter-textured soils of the Newberg series. It is subject to flooding under high-water conditions, but except in flood periods drainage is excellent. The soil occurs in association with Chehalis silt loam.

In some areas the lower part of the subsoil is coarse textured and is loose. This condition interferes with capillary action, with the result that in some places the soil is rather droughty.

Areas of this soil occur along Willamette River in Mission Bottom north of Salem, along Santiam River, and along North Santiam River almost to Mehama. A small area north of Butteville joins with an area of the same soil in Clackamas County.

The greater part of the land is cleared, and the remainder is in brush and trees. The low-lying bodies near the rivers are mostly covered with fir, oak, vine maple, hazel, elder, and rosebushes. About 75 per cent of the land is under cultivation to hops, prunes, wheat, barley, peaches, strawberries, cane berries, walnuts, cherries, clover, corn, and truck crops. More barley and other cereals are

grown on this soil than on the lighter-textured Newberg soils. Hops yield from 1,200 to 2,200 pounds to the acre, prunes from 1½ to 2½ tons, wheat from 25 to 50 bushels, barley from 30 to 60 bushels, peaches from 100 to 140 bushels, strawberries from 1,500 to 4,000 pounds, clover from 1 to 2½ tons of hay, and corn from 25 to 60 bushels.

Nitrates are used on hops, phosphates and land plaster on clover, and the available manure is applied to intensively farmed crops. The soil is low in organic matter and would be benefited by plowing under clover or other leguminous crops. Irrigation is being introduced on this soil.

Land is held at prices ranging from $35 to $60 an acre for uncleared land and from $75 to $175 for improved land. Orchard and hop lands bring from $200 to $400 an acre.

WAPATO SILTY CLAY LOAM

Where typically developed the surface soil of Wapato silty clay loam to a depth ranging from 8 to 15 inches consists of grayish-brown, dark grayish-brown, or dark dull-brown silty clay loam mottled with rust brown and gray. The surface soil is well supplied with organic matter which gives it a dark color, especially when wet. The subsoil is light grayish brown or grayish brown, and it is highly mottled with brownish-gray, bluish-gray, yellow, and brownish-red stains. It is low in organic matter, and the texture ranges from clay loam or heavy silty clay loam to clay.

This soil occurs along small streams and low drainage ways where seepage and run-off from the upper slopes have maintained a moist or very wet condition conducive to certain plant growth. Poor aeration has caused mottling and the accumulation of partly decayed plant material. The surface is generally smooth or flat and consequently unfavorable for surface run-off.

As mapped the soil includes a few small undifferentiated areas having a clay texture. In such bodies the surface layer is from 7 to 12 inches thick and consists of brownish-gray clay mottled with rust brown. Below this to a depth ranging from 20 to 24 inches is a layer of dark dull-gray or dark grayish-brown heavy silty clay loam or clay highly mottled with rust brown. The lower subsoil layer is dark brownish-gray or dark-gray silty clay with much rust-brown mottling. These areas occur in low flats having very poor natural drainage, but some of them have been drained through open ditches.

The larger areas of this soil are west and northwest of Waconda, around Champoeg, southwest of Skookum Lakes, and along Pudding River to and near Mount Angel. Other areas occur along Battle Creek south of Turner, along Beaver Creek north of Aumsville, and along Mill Creek north of Stayton. Small strips lie along the small perennial and intermittent streams through the surveyed area, especially in the northern and central parts.

The areas of clay texture are inextensive and of little importance. The largest bodies are southwest of Mount Angel and southwest of Skookum Lakes. Several small areas are northeast of Chemawa along Lake Labish Ditch toward Parkersville School, east and southeast of Woodburn, east of Champoeg, and northeast of Wheatland Ferry.

Some areas of Wapato silty clay loam contain gravel from one-fourth to 3 inches in diameter. Small gravelly areas occur north of Marion, northwest of the State Hospital farm, and south of the State Training School south of Salem. Other small areas are of somewhat darker color and of higher organic-matter content than typical. Small areas of lighter-textured soil have been included, the more prominent of which are at Spongs Landing and 2 miles southeast of that place.

The soil as a whole is in need of drainage. Some of the land has been tile drained, and this has made better tillage operations possible and has resulted in increased crop yields.

Most of the land is in brush and grass, with some maple, oak, and balm-of-Gilead poplar trees. The land in cultivation is cropped to wheat, oats, corn, Logan blackberries, strawberries, mint, cucumbers, beans, flax, blackberries, clover, and cabbage. Wheat yields from 15 to 35 bushels to the acre, oats from 35 to 45 bushels, corn from 25 to 50 bushels, oats and vetch hay from 2½ to 3½ tons, clover from 1 to 2½ tons, flax from 1½ to 3½ tons of fiber, mint from 15 to 40 pounds of distilled oil, and strawberries from 1 to 2½ tons. Cucumbers are being grown on this soil more than on any other, as the large amount of moisture present is a big factor in producing a large crop. Flax does very well where the surplus water has been removed by drainage.

More than 50 per cent of the included clay areas is in its natural state of brush and grass. The main crops are oat and vetch hay, oats, and alsike clover.

The use of barnyard manure is the principal method of fertilizing the soil. Some limestone is used. Tests made in the field indicate that from 1 to 2 or more tons of ground limestone to the acre would be required to correct the acidity. Most of the areas are in need of drainage to remove the excess water and make possible the earlier working of the ground in the spring. Liming is more beneficial on drained than on undrained land.

Wapato silty clay loam, gravelly subsoil phase.—The gravelly subsoil phase of Wapato silty clay loam is represented by small areas having the typical Wapato silty clay loam surface soil over a gravelly more or less compact subsoil. The subsoil is light-brown or reddish-brown gravelly clay loam or gravelly sandy clay loam highly mottled with rust brown and gray and somewhat impervious to water. It has a high content of waterworn gravel from one-half to 3 inches in diameter and extends downward to an undetermined depth.

Areas of this soil occur in the lower places adjoining gravelly soils of the Salem and Clackamas series and along or near streams. Small areas are west of Aumsville along Beaver Creek, north of Turner, northwest of the State Training School, and northeast of Marion.

The land is farmed in the same manner as typical Wapato silty clay loam but is considered less valuable on account of the gravelly subsoil.

CAMAS GRAVELLY LOAM

Where typically developed the surface soil of Camas gravelly loam is brown or dull-brown loose gravelly loam from 12 to 18 inches deep. The gravel are waterworn, range from one-half to 4 inches in diameter, and are derived from basaltic and other rocks. The subsoil is light-brown very loose and porous gravelly sand or gravelly fine sand

containing a higher proportion of waterworn gravel than the surface soil. The amount of gravel increases with depth.

The soil occurs principally in the bottoms of Santiam and North Santiam Rivers. It lies near the river and from 10 to 25 feet above the river level. Drainage ranges from good to excessive except during flood periods, when the land is overflowed. The larger areas are west of Mehama and southeast of West Stayton. Smaller areas occur east and west of Mill City, near Elkhorn School on Little North Santiam River, and southwest of North Santiam.

As mapped small areas containing no gravel in the surface soil are included. These lie southwest of Stayton, east of Spongs Landing, south of Clear Lake, near Goose Lake, and northwest of Abiqua School. Small areas of gravelly sandy loam texture are also included. The more conspicuous of these are near Mill City, west of Mehama, south of Marion, and near Talbot. A more important included variation is one of somewhat heavier texture. It has a brown or dark-brown gravelly clay loam surface soil overlying a light-brown gravelly clay loam subsoil which contains a larger proportion of gravel than the surface soil material. In this included soil, drainage is well developed but is not so excessive as in the lighter-textured material. Areas of this kind occur only along Silver Creek and other tributaries of Pudding River. The principal areas are in Silverton, northwest and south of Mount Angel, northeast of Silverton, and east of McLaughlin School on Abiqua Creek.

About 70 per cent of the total area of Camas gravelly loam is in woodland pasture which supports a growth of fir, oak, maple, and balm-of-Gilead poplar trees together with hazel, willow, and elderberry brush. The remainder is devoted to wheat, oats, and clover. Crop yields are less than on the Newberg and Chehalis soils.

As most of this soil lies higher than the surrounding recent alluvial soils and is less frequently overflowed, it provides favorable building sites.

COURTNEY GRAVELLY SILTY CLAY LOAM

The surface soil of Courtney gravelly silty clay loam to a depth ranging from 9 to 14 inches is brown or dark-brown silty clay loam which appears very dark brown or black when wet. It contains various quantities of waterworn gravel of mixed origin ranging in size from one-half inch to 3 inches and a few rust-brown iron stains. The subsoil to a depth ranging from 20 to 25 inches is tough compact dark-gray, dark dull-brown, or black gravelly clay which retards downward movement of water. This clay layer differentiates the Courtney from the Clackamas soils which are less compact and impervious. Below the dark clay layer and extending below a depth of 4 feet in places the material is light-gray heavy clay loam or clay loam highly mottled with rust brown, yellowish brown, and purplish red, and it contains a higher proportion of waterworn gravel than the layer above. The mottling decreases with depth. The subsoil material is moderately compact, and the gravel are held tightly in place by the clay loam which has a high content of sand and fine sand making it more friable than the overlying material. The gravel are derived from basaltic and mixed rock materials.

This soil normally occurs on the flats in association with the Clackamas soils and in the low depressions along the streams and channels

of intermittent streams. Drainage is very poorly developed, and water stands on the land the greater part of the year.

The principal areas are south of Aumsville between West Stayton and Turner, following the drainage ways and low depressions. An area of gravelly clay texture northwest of Turner along Battle Creek and an area of clay loam texture southeast of Turner are included in mapping.

Ash and willow trees and underbrush cover 50 or 60 per cent of the land. The remainder is in corn, wheat, oats and vetch for hay, and beans. Corn yields from 30 to 55 bushels to the acre, wheat from 15 to 25 bushels, and oats from 20 to 40 bushels.

Most of the cultivated land is tile drained and can be worked early enough to grow spring crops. Although the soil is naturally high in organic matter, cultivation has reduced this to such an extent that farmers find it necessary to apply barnyard manure or commercial fertilizer to maintain productiveness. The land is held at prices ranging from $35 to $100 an acre.

COVE CLAY

The surface soil of Cove clay is very dark dull-brown, brownish-black, or black clay or heavy plastic clay to a depth ranging from 10 to 15 inches. The subsoil is black heavy plastic clay to a depth of 25 or 30 inches, at which depth it changes to dark-gray or almost black heavy plastic clay. In places the surface soil and subsoil contain a trace of mottling, generally rust brown.

This soil occurs in low flat places near streams and lakes, and it is the most poorly drained soil in Marion County. The surface is practically flat, and water stands on it during a large part of the wet season. Seepage from higher ground keeps the land wet late in the season after better-drained soils have dried. When dry the surface soil cracks into rectangular blocks several inches in diameter, with the cracks from one-fourth to one-half inch wide. Owing to the impervious clay subsoil tile drains do not function well. Surface drainage is the practical method of removing the water. Tile drains are used to intercept the water from higher ground.

The largest bodies of this soil occur northwest of Champoeg, west of Mount Angel, north of Salem, and northwest of Monitor along Butte Creek.

Probably one-fifth of the land is in crops, and the remainder is in water grasses and brush. Ground that has been drained is cropped to oats and vetch for hay, oats, corn, and alsike clover. Oats and vetch hay yields from 1½ to 3 tons to the acre, alsike clover from one-half to 2½ tons, and oats from 35 to 55 bushels.

ROUGH MOUNTAINOUS LAND

Rough mountainous land in Marion County is mainly forested. Most of the areas are comparatively inaccessible and are mainly nonagricultural. Under present economic and agricultural conditions, it is not considered expedient to attempt a detailed classification and mapping of the soils in such areas. The soils are mainly of residual origin, belonging principally to the Olympic and Aiken series. Throughout the rough mountainous land are small scattered areas capable of being farmed.

Rough mountainous land occurs almost exclusively in the southeastern part of the surveyed area. Large areas are mapped along Abiqua and Silver Creeks southeast of Silverton and along Butte Creek from about 3 miles southeast of Scotts Mills to the boundary of the surveyed area. The main body of this land extends from a point about 2 miles north of Mehama northward to Butte Creek, with the exception of about a 2-mile strip east of Mehama along North Santiam River.

Lumber companies own large tracts of rough mountainous land and are operating mainly on lands included under this classification. The sheep industry is one of the important industries on the cut-over land. Grazing is profitable in many places and will continue to grow more important as the timber is removed.[4]

ROUGH BROKEN AND STONY LAND

Rough broken and stony land comprises steep rough, stony, and broken areas which are entirely unsuitable for agriculture.

This class of miscellaneous material occurs almost entirely in the eastern part of the surveyed area, the principal bodies being north of the highway between Stayton and Mill City and along North Santiam River north and east of Mill City. This land is suitable for grazing purposes. Where timber is removed the land should be reforested.

RIVER WASH

River wash consists of a miscellaneous mixture of sand, gravel, and cobblestones. It occupies stream channels and narrow strips adjacent to the larger streams.

This material occurs chiefly along Willamette, Santiam, and North Santiam Rivers, the largest areas being immediately north of Wheatland Ferry and west of Mission Bottom School. The land has practically no agricultural value as it rarely supports any vegetation and is under water for a considerable period annually. During the summer, when the water is low, the coarse material does not hold sufficient moisture to support plant growth.

PEAT

Peat, locally known as "beaver-dam soil," consists mainly of accumulated organic matter in various stages of decomposition. The surface soil to a depth ranging from 12 to 16 inches in most places is medium-brown or rich-brown in color, and it is almost black when wet. The material is considerably decomposed but is highly fibrous, containing easily recognizable plant remains. Moist soil when rubbed between the fingers feels much like fine sawdust. The subsoil to a depth of 5 or more feet consists of brown partly decomposed highly fibrous organic matter showing much less decomposition than the material in the upper layer. The substratum in nearly all places has a lighter-brown color, undoubtedly owing to the absence of air.

The main area of peat extends northeast from Chemawa Indian School and is known as Lake Labish. This area is about 9 miles long and ranges in width from an eighth to a quarter of a mile.

[4] JARDINE, J. T., LINDGREN, H. A., and POTTER, E. L. MANAGEMENT OF RANGE GRAZING LAND Oreg. Agr. Col. Ext. Bul. 366, 15 p. 1923.

The surface of the Lake Labish peat is practically level. This area is bordered in many places by narrow areas of Wapato silty clay loam and by extensive areas of Willamette silt loam. Other areas of peat are in the northern part of the county, northwest of Woodburn along Champoeg Creek, and east of Hubbard along Pudding River. Most of the peat in these areas is less than 40 inches in depth, and in many places only a 12 or 16 inch surface layer of peat overlies a subsoil of heavy bluish-gray impervious clay.

Onions, celery, peppermint, and to a small extent, tomatoes, carrots, potatoes, peppers, and beets are grown on this soil. By far the largest acreage is devoted to onions. Celery and peppermint occupy about equal acreages. Celery is generally grown following lettuce. Peppermint is a new crop and is being grown extensively. Several mint stills are in operation. One ton of mint will yield from 2 to 3 gallons of oil. Yields of mint range from 15 to 90 pounds of oil to the acre depending on the character of the soil. Celery yields from 300 to 460 crates containing 6 dozen bunches each. The main crop is a late one for marketing after the eastern crop has been frosted. The peat northeast of Butteville produces 300 sacks of onion sets and 600 sacks of matured onions to the acre. The Lake Labish area is devoted mainly to onion culture, and yields range from 250 to 350 sacks to the acre.

Fertilizers are necessary to obtain maximum crops. Horse manure is used and is considered very effective. Potassium sulphate at the rate of 225 pounds and superphosphate at a rate ranging from 500 to 700 pounds to the acre are used. These are usually added in March and disked into the soil.

Improved peat land is valued by owners at $1,000 an acre, but prices range from $700 to more than $1,000. Very little peat land is being sold at present. The average rent is $50 an acre or one-fourth of the crop.

SOILS AND THEIR INTERPRETATION

The soils of Marion County have developed under humid climatic conditions, with a mild temperature, moderately heavy rainfall during the winter, and limited precipitation during the summer.

In the normally developed soils which have weathered under conditions of favorable drainage, the relative stage in weathering is indicated by the degree of formation of a distinct illuviated layer in the subsoil. Although this illuviated layer is not always identified with a high degree of clay accumulation in the normally developed more mature soils of this county, it shows distinct compaction and structural features representative of the podzolic processes. This illuviated layer is developed to the greatest degree in soils which have developed on old unconsolidated sediments and to less degree in the so-called "red hill" soils which have developed by the weathering in place of consolidated rocks. It is least developed or not developed at all in the more recent alluvial soils of the stream bottoms. Some of the soils lying in flat areas have developed compact, tight, and comparatively impervious heavy-textured subsoil layers as a result of abnormal development under conditions of restricted drainage.

Variations in character and in degree of leaching that have taken place in the surface layers, in the accumulation of organic matter, and

in the development of illuviated layers reflect not only age or stage of maturity but also variations in the environment under which the soils have developed and to which they have become adjusted or are in process of adjustment, such as relief, drainage, and character of natural vegetation. The relief ranges from steep to flat, drainage ranges from excessive to very poor, and the vegetative conditions under which the soils of the county have developed include open prairie, mixed prairie and open forest, and heavy coniferous forest.

Most of the soils range from slightly acid to distinctly acid in reaction, owing both to their noncalcareous parent materials and to the climatic and vegetative conditions under which they have developed.

Well-drained soils of normal development on the older alluvial materials of the valley floor are most typically represented by the Willamette soils, of which Willamette silt loam is the more extensive and important.

The surface layer of this soil consists of brown silt loam which is predominantly of rather high clay content. The material is somewhat thinly laminated in the upper 2 or 3 inches and is granular and friable below. Under cultivation the soil is easily maintained in excellent tilth. The color is predominantly rather dull brown or grayish brown when dry, becoming richer brown under moist field conditions. The color of the soil aggregates is generally uniform, the organic-matter content being greatest and the color darkest in the laminated surface layer in undisturbed areas.

The surface soil is underlain at a depth ranging from 8 to 15 inches by a lighter-brown layer which is noticeably more compacted, sufficiently so in most places to retain insect and worm tunnels and cavities, many of which are slightly lined or coated with a thin film of gray material indicative of leaching processes. The structural soil aggregates in this layer are irregular in shape, range from less than an inch to several inches in diameter, and are typically slightly coated with darker-colored organic matter or colloidal stains. The soil aggregates tend to be slightly lighter in color when crushed, though some of them, where surfaces are determined by breakage planes, are slightly coated with gray. This layer represents the B horizon of illuviation. It is only slightly higher in clay content than the surface layer. It is typically free or nearly free from iron stains or other evidence of irregular oxidation. Although noticeably compacted the material is readily permeated by water and plant roots.

Underlying the B horizon at an average depth between 30 and 36 inches is more friable and nearly structureless material of uniformly lighter-brown color, which appears to represent the C horizon, or parent material. The yellowish-brown color becomes more pronounced with depth.

This soil is developed on old stream-laid deposits representing in lithological character a mixture of materials eroded and transported from regions of basaltic and sedimentary rocks. It is most extensively and typically developed on the lower valley terraces adjacent to the first-bottom lands, or in areas traversed by drainage ways which afford good drainage and maintain the water table at considerable depth.

The utilization of soils of the Willamette series is brought out in a recent publication of the Oregon Agricultural Experiment Station.[5]

In textural classification the surface soil ranges between silt loam and silty clay loam. The subsoil exhibits a slight accumulation of clay and falls under the textural classification of clay loam. Chemical analyses of Willamette soils made at the Oregon Agricultural Experiment Station indicate that these soils are well supplied with potassium and phosphorus and have a variable content of calcium, ranging from 0.43 to 2.03 per cent in a series of eight samples taken from scattered areas of Willamette clay loam in Benton County, Oreg.

Exchangeable bases and results of pH determination of samples of virgin Willamette loam from Lane County, Oreg., are shown in Table 7.

TABLE 7.—*Exchangeable bases and pH value of Willamette loam (virgin soil), in Lane County, Oreg.*

Description	Exchangeable calcium	Exchangeable magnesium	pH value
	Per cent	*Per cent*	
Surface soil, 0 to 9 inches	0.3317	0.0302	5.56
Subsurface soil, 9 to 24 inches	.3714	.0258	5.99
Subsoil, 24 to 38 inches	.3464	.0282	6.24
Substratum, 38 to 60 inches	.4046	.0323	6.49

The natural vegetation under which the Willamette soils have developed differs from place to place. Prairie areas predominate, but areas timbered by fir and by open groves of oak are also included. The character of the soil profile, however, as well as the testimony of early settlers, indicates or at least strongly suggests that the timbered areas are at present encroaching on the prairie lands and that the soil has developed under prairie conditions.

The Salem soils are closely related to the Willamette soils. They differ from the Willamette soils mainly in that the subsoils and substrata contain large amounts of waterworn gravel, mainly of basaltic origin, embedded in fine soil material. The subsoils are slightly compacted but have no pronounced structure or colloidal accumulation and are readily permeable. These soils appear to have reached a somewhat less mature stage of development than the Willamette soils.

The Salkum soils, which occupy the more elevated terraces and valley slopes, are also characterized by a gravel substratum. The gravel is, however, much more completely weathered than in the Salem soils, indicating the parent materials to be geologically much older. Judged by their profile development, these soils do not appear to be sharply differentiated from the Willamette soils.

In the soils developed on the consolidated rocks on the hill and mountain slopes there is a tendency toward slow and almost insensible removal of weathered soil material coincident with the processes of weathering and lowering of the parent C horizon. The soil profile does not, in general, exhibit such advanced stages of maturity as in soils developed on the older of the lower-lying valley areas

[5] POWERS, W. L., RUZEK, C. V., and STEPHENSON, R. E. SOILS OF WILLAMETTE SERIES AND THEIR UTILIZATION. Oreg. Agr. Expt. Sta. Bul. 240, 28 p., illus. 1928.

which are less subject to erosion. They are developed typically under coniferous forest, predominantly Douglas fir.

The soils of this group are represented by Aiken clay loam, which has a dull-red surface soil having a superficial surface layer of darker color and of moderately high organic-matter content. The material is of remarkably granular structure, owing partly to a conspicuous amount of small spherical cemented shotlike pellets. The pellets are reddish brown, usually dark colored on the inside, and may include both concretions or accretions of soil material, cemented by iron and organic matter, and residual particles of partly weathered parent basaltic rock. The soil readily absorbs and retains moisture and is not easily eroded. Although of high clay content the soil is friable, is not readily puddled, and under cultivation has the physical properties of a much lighter-textured soil. The B horizon, occurring at a depth of 12 or 15 inches, is red or dark dull-red material, typically of slightly higher clay content than the A horizon. It is moderately firm but readily penetrated by roots and moisture and is of rather coarse granular or small cloddy structure. The soil aggregates are slightly coated with dark stains but tend to be of slightly brighter color when crushed. The material in this layer is sufficiently compacted that root cavities and small pore spaces are not readily collapsed or deformed. These cavities are slightly coated with gray siliceous material indicating incipient leaching by acid solutions, or podzolization. The deeper material is red or purplish red and is without definite structure. It contains embedded fragments of parent rock and grades into partly weathered basaltic bedrock.

The results of the chemical analysis of a sample of the surface soil of typical Aiken clay loam are given in Table 8.

TABLE 8.—*Chemical analysis of the surface soil (0 to 20 inches) of Aikenclay loam*[1]

Chemical constituent	Per cent	Chemical constituent	Per cent	Chemical constituent	Per cent	Chemical constituent	Per cent
SiO_2	40.41	CaO	0.63	P_2O_5	0.50	CO_2 from carbonates	None.
TiO_2	3.72	MgO	.46	SO_2	.21		
Fe_2O_3	17.59	K_2O	.53	Ignition loss	12.62	Organic matter	------
Al_2O_3	23.20	Na_2O	.88	Total	101.00	H_2O at 110° C.	4.55
MnO	.25			N	.15		

[1] Sample No. 35048, taken 5½ miles south of Salem.

The mechanical analyses of this soil (p. 14) indicate that the soil should be classified as clay, but owing to its friable character it is classified in this county as clay loam.

The Olympic soils have a granular structure and resemble the Aiken soils but are apparently less completely weathered and oxidized, and the surface soils and subsoils are browner.

The Polk soils represent a transition or intermediate soil development between the Aiken and Olympic soils. The surface soil is brown like that of the Olympic soils, and the red subsoil material resembles that of the Aiken soil. (Pl. 1, B.)

The typical Aiken, Olympic, and Polk soils range from slightly to distinctly acid in reaction. The results of pH determinations are given in Table 9.

TABLE 9.—*pH determinations of soils in Marion County, Oreg.*

(1:2 soil-water ratio)

Sample No.	Soil type	Depth in inches	pH value	Sample No.	Soil type	Depth in inches	pH value
561809	Olympic loam	0–1	5.90	561813	Olympic loam	56–72	4.74
561810	do	1–8	5.68	561877	Aiken clay loam	0–14	5.72
561811	do	8–20	5.01	561878	do	14–36	5.20
561812	do	20–56	4.78	561879	do	36–54	5.33

The soils of the flatter valley areas which support prairie or open groves of scrub oak or brush and in which normal development has been inhibited by poor drainage are most extensively and typically represented by the Dayton soils. These soils are characterized by a gray surface soil underlain by dark bluish-gray tough heavy waxy clay, mottled with rust-colored iron stains. The clay layer is of variable thickness and is generally underlain by lighter yellowish-brown friable material highly mottled with rust brown at a depth ranging from 24 to 26 inches.

The Amity soils have developed under somewhat better drainage conditions than the Dayton soils. They have slightly compacted upper subsoil layers in which lack of uniform oxidation is indicated by mottling with iron stains, but they do not have the tough gray layer found in the Dayton soils. The deeper material is mottled and friable.

The Holcomb soils have brown surface soils, similar to those of the Willamette or Amity soils, and a tough waxy clay layer like that of the Dayton soils. These soils have developed in the flatter areas having restricted subdrainage.

In the recent alluvial soils of the stream bottoms the soil profile shows a geological accumulation rather than soil development. Such distinctive layers as occur are those of stratification or sedimentation incident to accumulation of the materials. The lower-lying areas are subject to periodical or occasional overflow and accretion or deposition of fresh sedimentary material. Areas above overflow have not been exposed to weathering agencies a sufficient period of time to show changes in the soil material.

Some of these soils occur under favorable drainage conditions except during brief periods of overflow, and are entirely or in part timbered. They contain a moderate amount of organic matter and are of granular structure. Soils of this group are represented by the Chehalis and the Newberg soils. The Chehalis soils generally occupy slightly higher positions than the Newberg and are characterized by rich-brown soils and subsoils. The Newberg soils are subject to more frequent overflow and have lighter-textured and more porous subsoils. The soils of these two series characteristically occur along the bottoms of the larger streams.

Flat valley areas occupying less definite stream bottoms and traversed by minor stream channels which are subject to overflow or in which drainage is restricted are represented by soils of the Wapato, Courtney, and Cove series, which occur in both timbered and prairie areas, the forest growth consisting mainly of scrub oak and brush of various species. The soils of these series are dark

colored and are mottled with iron stains. They are generally of moderately heavy or heavy texture and are less granular and friable than soils of the other groups. Normal soil development has been prevented both because of the recent accumulation of the materials and because of the unfavorable drainage conditions.

The soils developed in place on consolidated rocks show in their color and in chemical and physical characteristics the influence of the parent materials, and those developed on the older valley sediments or those consisting of recent alluvial sediments are derived from a mixture of parent materials and appear to be much more strongly influenced by environmental conditions of accumulation, drainage, vegetation, and weathering.

SUMMARY

Marion County is in the northwestern part of Oregon. The part of the county surveyed covers an area of 847 square miles. The more mountainous eastern part of the county within the boundaries of national forests is not included in this survey.

The surface is marked by a variety of topographic features ranging from narrow canyons to wide stream bottoms and from broad smooth valleys to rolling hills and steep mountain slopes. Elevations range from about 5,000 feet in the mountain areas to about 100 feet above sea level in the lower stream bottoms. The county is drained by Willamette River and its tributaries, chief among which are Santiam and North Santiam Rivers. This survey covers one of the most important agricultural districts of the Willamette Valley and of the State.

Settlement dates from 1834. The western part of the county is well settled and is provided with good transportation facilities by means of steam and electric railways and by a system of highways, the most important of which are paved. Salem, the State capital, is the most important city. The eastern part of the county is sparsely settled, and few highways cross it.

The climate is temperate, with mild rainy winters and comparatively dry summers. At Salem the mean annual temperature is 52.7° F. and the mean annual precipitation is 37.49 inches. The mean annual rainfall increases eastward.

The soils of Marion County are grouped in three major soil groups in addition to which four classes of miscellaneous materials, which are mainly nonagricultural, have been mapped.

The recent alluvial soils occupy the bottoms of the stream and drainage channels, and are subject to more or less overflow. The better soils are utilized in the production of a wide range of farm crops, for dairying, and for special fruit, small fruit, and truck crops, and hops, and the less important soils are used mainly for general farming and pasture.

Soils developed on the weathered older alluvial sediments occupy the terraces and main valley areas. The Willamette and Amity soils are moderately well drained and are utilized for a wide range of staple farm crops, for dairying, and for fruit and truck crops. The Sifton and Clackamas soils are less important. The Concord, Dayton, Holcomb, amd Waldo soils occur under poor drainage conditions and are utilized mainly for general farming and pasture.

Soils developed on consolidated bedrock are derived almost entirely from basaltic materials and include the Aiken, Olympic, and Polk soils. These are well-drained soils and are utilized extensively for fruit and special crops as well as for general farm crops. Of these the Olympic and the Aiken soils are most extensive and important.

For many years following settlement the agriculture of the area was dominated by wheat growing and livestock raising. By 1900 dairying and the growing of hay crops, hops, and fruits had become definitely established.

In 1919 the value of farm products had reached a total of more than $5,000,000. Present cash crops consist mainly of wheat, oats, fiber flax, potatoes, apples, cherries, prunes, strawberries, walnuts, blackberries, and other bramble berries, celery, onions, and peppermint for oil.

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[PUBLIC RESOLUTION—No. 9]

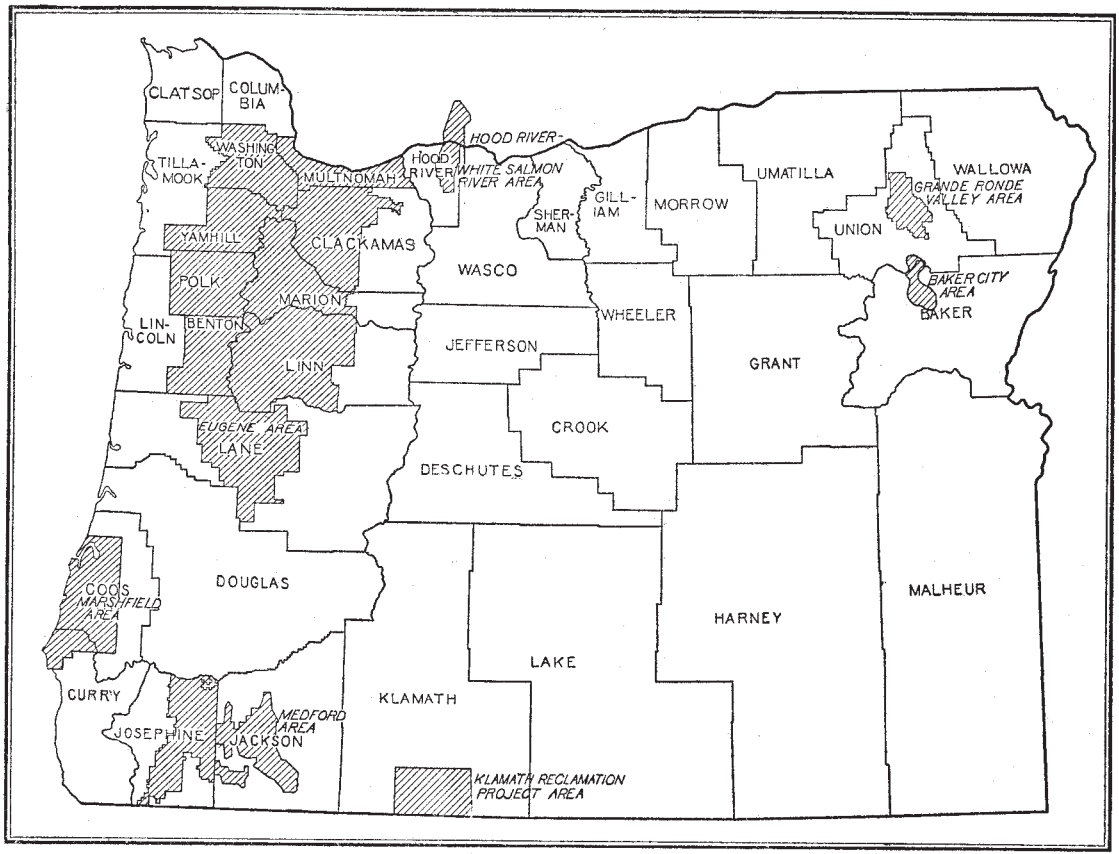
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils, and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.



Areas surveyed in Oregon, shown by shading

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