

SOIL SURVEY OF THE LOS ANGELES AREA, CALIFORNIA.

By **LOUIS MESMER.**

LOCATION AND BOUNDARIES OF THE AREA.

The Los Angeles area lies between the parallels of $33^{\circ} 39'$ and $34^{\circ} 10'$ north latitude and the meridians of 118° and $118^{\circ} 30'$ west longitude. It is confined by three natural physiographic boundaries. On the north are the Santa Monica Mountains and the Rapelto and Puente hills,

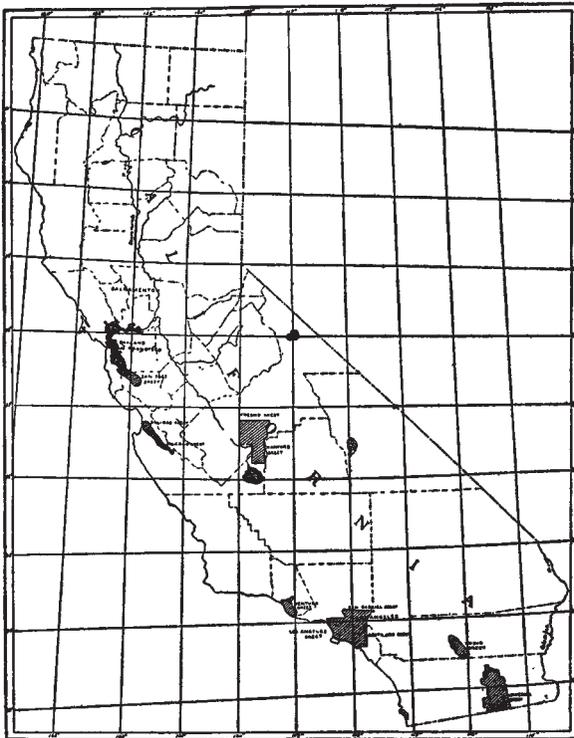


FIG. 61.—Sketch map showing location of the Los Angeles area, California.

and on the west and south is the Pacific Ocean. The eastern boundary is formed by the arbitrary boundary lines of the San Gabriel Valley and Santa Ana soil surveys. About nine-tenths of the area is in Los Angeles County and the remainder in Orange County. Los Angeles City, around which the area lies, has a population, according

to the Twelfth Census, of over 102,000. It is not only the largest town in the area, but in the southwestern part of the State as well. Other towns have populations of less than 5,000.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The city of Los Angeles was founded in 1781, by order of Philippe de Neve, Spanish governor of California. The settlers were chiefly soldiers from the San Gabriel Mission, who continued to draw pay and rations from the Government. Lands were taken up close to Los Angeles River, and so situated as to be readily irrigated. The settlers were given conditional possession of agricultural lands and building sites in the pueblo near by, but the title was subject to forfeiture if the fields were left uncultivated for two years, or the buildings were unoccupied or allowed to fall into decay. Each head of a family was also furnished with work stock and other cattle, and the common settler with a cart-maker's tools. These articles were to be paid for in small installments deducted from their pay by the Government.

To increase the live stock the slaughter of female animals was forbidden, and with the abundance of pasturage and this restriction the number of animals greatly increased until 1825 (three years after the sovereignty of the territory passed from Spain to Mexico), when they became so numerous that the pastures were inadequate. To relieve this situation corrals were built, and the wild horses, which then were numbered by thousands, were driven into these inclosures and killed.

Soon after the founding of Los Angeles the first large grants of public lands were made. The San Pedro, Los Metos, and the San Rafael ranches were among the earliest of such privileges. Other grants of large areas were made at subsequent times both by the Spanish and the Mexican governments.

The early industry was chiefly stock raising, but the success of the missions in the cultivation of fruit was well known to the early settlers of Los Angeles, and vineyards were planted almost at the outset. The first oranges were planted in 1834, and before 1840 olives, peaches, figs, apricots, pears, and quinces were introduced. The period between 1831 and 1834 was also marked by an influx of immigrants from New Mexico, who came in search of homes. At later dates other settlers found their way from the same territory. The census of 1836 shows 46 foreigners and 20 Americans in the Los Angeles community.

In 1846 the city was occupied, without bloodshed, by American forces under Commodore A. F. Stockton and Lieut. J. C. Fremont, this being one of the series of events that brought the territory under the sovereignty of the United States. There had been comparatively little growth in the Los Angeles country in the preceding ten years, but now

a steady advance began and during the next thirty years the agriculture made rapid progress. The status of the industry is clearly indicated by the report of the county surveyor for 1876, giving the number of fruit trees then in orchards, the yield of the principal crops, and other agricultural statistics. From this report it appears that the total area under cultivation was 64,500 acres. Of this 4,950 acres were occupied by vineyards containing in all 4,500,000 vines. In orchards there were 36,700 bearing orange trees, 6,900 lime and lemon, 6,000 English walnut, 3,600 fig, and over 2,000 olive trees, besides large numbers of the other deciduous fruits. The value of the fruit crop reached a half million dollars. From the same source the rapid growth of the animal industry is also made plain. The number of sheep, for instance, increased from 282,000 head in 1865 to 508,757 head in 1875. In the latter year the wool clip reached 2,034,828 pounds.

This was the condition a quarter of a century ago, and the railroad had but just become a part of the machinery of the area, the Southern Pacific reaching Los Angeles in 1874. The Santa Fe Pacific was completed in 1885 and the rush of settlers to the region became phenomenal. The price of land rapidly rose and Los Angeles passed through a period of inflated values and wild speculation, during which much land changed hands and much money was made and lost. Since then the growth, while rapid, has been upon a healthy basis.

Within the last two years the building of numerous suburban electric railways and the placing of much desirable property on the market has attracted people from all parts of the country. To-day the area is in a most prosperous condition and is being rapidly settled by a most desirable and energetic class, and the prospects for the future are exceptionally bright.

CLIMATE.

The remarkable development of the area is due more to the influence of the climate than to any other factor. The winters are mild and equable, and thousands of tourists, attracted by this delightful season, come here for health and recreation. The summers are characterized by few warm days and by cool nights, especially along the seacoast.

The rainy season occurs during the winter and spring, very little precipitation ordinarily taking place in the autumn and less in the summer. Official records of the Weather Bureau were not begun until 1877. Private records were kept previous to this date for a number of years. These are believed to be reliable and indicate an average annual rainfall at Los Angeles of about 16 inches.

Fogs, particularly during the spring and summer, drift inland from the sea in the early afternoon or evening and ordinarily remain until

about 8 or 9 o'clock the following morning, when they gradually disappear. The fogs are generally more frequent in June, but in some years they occur as often in July. They are more common near the coast, their frequency and density decreasing with the distance inland and also with the increase in altitude.

Throughout the entire year the winds blow alternately from the land and sea. Their movement is stronger and more regular in spring and summer and their influence extends much farther inland than in fall and winter, when it is confined to the coast.

The following table, compiled from Weather Bureau records, shows the normal monthly and annual temperature and precipitation at Los Angeles, Santa Ana, and Whittier:

Normal monthly and annual temperature and precipitation.

Month.	Los Angeles.		Santa Ana.		Whittier.	
	Tempera- ture.	Precipi- tation.	Tempera- ture.	Precipi- tation.	Tempera- ture.	Precipi- tation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.
January.....	53.1	2.93	54.3	2.31	56.7	2.54
February.....	54.4	3.27	57.2	2.46	58.5	2.13
March.....	56.3	2.98	59.3	2.49	61.1	2.67
April.....	58.9	1.36	64.2	.32	65.4	.24
May.....	62.1	.43	68.8	.37	68.6	.66
June.....	65.7	.10	72.2	.05	78.2	.06
July.....	69.3	.02	75.0	.00	77.4	.00
August.....	70.4	.03	75.4	.06	76.9	.08
September.....	68.5	.08	73.3	.07	74.3	.02
October.....	63.7	.74	68.4	.74	67.7	.89
November.....	59.2	1.23	61.8	.74	63.5	1.22
December.....	55.4	3.98	57.5	2.45	57.9	1.56
Year.....	61.4	17.20	65.6	12.06	66.8	12.07

The prime climatic factor controlling the extension and development of agriculture is that of the severity and frequency of frosts. Records from Los Angeles are the most complete available, but it must not be understood that these records are characteristic of the entire district. In fact great differences exist, some areas being practically frostless while other areas are subject to frequent and severe frosts.

Dates of first and last killing frosts in fall and spring.

Year.	Los Angeles, Cal.		Year.	Los Angeles, Cal.	
	First in fall.	Last in spring.		First in fall.	Last in spring.
1894.....	Nov. 13	Jan. 6	1897.....	Nov. 25	Mar. 31
1895.....	Nov. 24	1898.....	Dec. 10	Mar. 19
1896.....	Nov. 27	Apr. 20	1899.....	Dec. 9	Mar. 8

Around Hollywood and in a few other well-protected localities pineapples can be grown, while over much of the area the frosts are so severe that citrus fruits are severely damaged. Along the coasts frosts are less severe, and here tomato vines have been known to live three years. This coast country, however, has a much more humid climate than that of the portion farther inland, and for that reason fungus diseases and scale insects which thrive in damp atmosphere are much more destructive.

PHYSIOGRAPHY.

Beginning at the northwest corner of the survey and extending along the base of the Santa Monica Mountains to Ivanhoe is a sloping plain more or less disfigured by erosion. From Ivanhoe the area extends north to about Redcastle, thence east to the San Gabriel Valley, thence south to the south side of the Rapelto Hills, embracing in the northwest corner a territory containing some 50 square miles which is largely made up of hills interspersed with small valleys. The most important of these valleys is that extending along Los Angeles River, taking in the region around Glendale, the Eagle Rock Valley, and the valley along the Arroyo Seco.

East from Los Angeles the area is composed of the gentle slopes of the Rapelto Hills, and in the vicinity of Whittier, similar slopes of the Puente Hills. A range of hills begins north of Palms and extends in a southeasterly direction, including the hills north of Inglewood, Howard Summit, Dominguez, Cerritos, Bolsa Chica, and Las Bolsas and forming an anticlinal fold which terminates in a few places in rather high, rugged hills. The most conspicuous of these lie north of Inglewood.

Between this range of hills, which has been cut through in places by the streams, and the Rapelto and Puente hills lies the coastal plain—the most extensive physiographic feature of the area. This plain contains, if the small mesas and local valleys be excepted, all the level land of the area. In the gaps cut by the streams the plain in five different places is separated from the coast only by a ridge of low sand dunes.

SOILS.

There is a wide variation in the character and texture of the materials forming the surface of the Los Angeles area, and the survey shows seventeen more or less distinct soils. A number of these include minor variations which, where of sufficient importance, are described as phases of the closely related type.

The table following shows the extent of the several types, and the percentage which each forms of the total area surveyed.

Areas of different soils.

Soil.	Acres.	Percent.	Soil.	Acres.	Percent.
Placentia sandy loam.....	66,048	18.1	Fullerton sandy adobe.....	7,040	1.9
Fresno sand.....	58,112	15.9	Sierra adobe.....	6,976	1.9
Santiago silt loam.....	39,360	10.8	Maricopa gravelly loam.....	5,952	1.6
Fresno fine sandy loam.....	38,656	10.6	Galveston clay.....	4,800	1.3
San Joaquin black adobe.....	37,440	10.3	Dunesand.....	3,264	.9
Oxnard sand.....	35,840	9.8	Riverwash.....	1,664	.5
Oxnard loam.....	19,520	5.4	Peat.....	1,088	.3
Fresno fine sand.....	16,128	4.4	Total.....	364,800
Maricopa sandy loam.....	13,888	3.8			
Los Angeles sandy loam.....	9,024	2.5			

MARICOPA GRAVELLY LOAM.

The Maricopa gravelly loam is a sandy loam, brown to dark brown in color—the greater part being brown—containing 10 per cent or less of well-rounded, waterworn gravel of granitic rocks. The gravel, the greater proportion of which is solid and quite hard, ranges in size from small pebbles up to cobbles several inches in diameter. The depth of the surface soil varies from 3 to more than 6 feet. The subsoil is composed of a bed of waterworn granitic sand and gravel, the latter ranging in size up to a foot in diameter. Occasionally the bowlders are in an advanced stage of decomposition and a blow or two of the hammer suffices to crumble them. Like the subsoil of the Montebello sandy loam, the underlying gravel of this type is used for surfacing roads and walks.

Beginning in the center of the city of Los Angeles and extending in a southwesterly direction the largest area of the type occurs. This, together with an area near Palms, two at Tropic, several lesser ones along the Arroyo Seco, and two small areas east and one south of Ivy, includes the whole area covered by the type.

The areas along the Arroyo Seco occupy a comparatively level terrace, as do also, to a certain extent, the areas at Tropic and Los Angeles. The area at Palms terminates in a small bluff on Ballona Creek. Beginning at a point 1 mile south of Cienega and following around the north side of the hills is an area about one-half mile wide forming a sloping plain extending up the hills. It is covered with a dark-colored sandy loam which extends to a depth of 6 feet, with little variation except in color. Here the soil does not contain as much gravel as is found in the type, nor is it—except, possibly, in its western extremity—underlain by this material. The variation in general appearance and character was not of sufficient importance to class it as another type.

The Maricopa gravelly loam is composed largely of granitic material, brought down from the mountains by Los Angeles River and

its tributaries. No doubt as deposited it was chiefly sand and gravel, and the present texture is due to subsequent weathering. The area southwest of Cienega was largely built up from the coarse washings from the hillsides.

Citrus and deciduous fruits, including grapes and strawberries, and alfalfa and grain hay constitute the present crops. As much of the land lies within the city limits of Los Angeles and is used for residential purposes its agricultural value is of minor consideration. The areas at Tropic are largely planted to strawberries, to which the type is admirably adapted. Here, too, grapes, oranges, peaches, and apricots are grown, but excepting the grapes, only on a small scale. This is not because the other fruits do not thrive, but because the profit realized at present from growing berries is attracting more attention. In the vicinity of Palms alfalfa is grown under irrigation and yields large crops. While the yield of the land dry farmed to grain is occasionally good, the small amount thus grown makes the crop of minor importance.

The following table shows the texture of the fine earth of the soil and subsoil of this type:

Mechanical analyses of Maricopa gravelly loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8238	1 mile E. $\frac{1}{4}$ N. of Cienega.	Brown gravelly loam, 0 to 36 inches.	0.84	2.58	6.58	5.30	20.64	25.00	28.74	11.14
8240	Highland Park...	Brown gravelly loam, 0 to 42 inches.	.47	3.00	6.18	5.06	18.86	24.78	29.38	12.74
8239	Subsoil of 8238....	Sandy gravelly loam, 36 to 66 inches.	.38	2.04	5.98	5.44	23.66	26.14	25.10	11.20
8241	Subsoil of 8240....	Brown gravelly loam, 42 to 72 inches.	.26	9.42	14.88	11.60	25.22	13.84	13.08	11.94

DUNESAND.

The Dunesand is composed of medium-textured sand, of a light-gray color, and 6 feet or more in depth. It occurs along the ocean front in the form of low bars or dunes. The sand is loose, porous, and unretentive of moisture—a portion of the area being devoid of vegetation, while the remainder is covered with a scant vegetation of no economic value.

The type here consists of beach sand which has been picked up by the winds and gradually driven inland. It has no agricultural value.

OXNARD SAND.

The Oxnard sand consists of a yellowish-gray, dark-gray, or grayish-brown sand varying from medium to fine texture. It is of a loose, open character, in places being shifted by the winds. The material extends to a depth of 6 feet and grades into an indurated sand of much the same texture as the soil.

A number of local modifications of the type are found. East of Santa Monica, with the exception of the first range of hills, the soil has a brownish color, is of medium texture, exhibiting slight loamy properties, and packs in the roads. It grades into light-brown, coarse-textured sand, at a depth of from 2 to 3 feet, and in road cuts the material is seen to be underlain by the typical subsoil of indurated sand. A body of several square miles in the northeastern part of the Redondo area is very similar to the one east of Santa Monica. Here the sand is grayish brown, of medium texture, very friable, and does not pack as much as that near Santa Monica. It grades into reddish-brown sand which is also underlain by the typical indurated material. As the area stretches south and approaches the coast it becomes more yellowish in color and looser in texture. Here the soil is shifted by the winds, and the texture to a depth of about 6 feet is about the same. Generally speaking, the texture of the sand east of Redondo varies with the distance from the coast, growing finer as one proceeds inland. In the areas near Wiseburn the sand grades at 6 feet or less into indurated sand or sandy loam. This is also true of a large part of the area around Wilmington, where the sand overlies material like the Placentia sandy loam or other soils at various depths below 3 feet. In general, east of Redondo, both north and south, and east as far as Wilmington, the soil is shifted by the winds, crops being occasionally uprooted. The area southeast of Longbeach resembles the area near Santa Monica, both in color and depth of soil, except on top of high hills, where the sand has been largely removed by erosion.

The type is found in the most extensive areas of any of the soils of the survey. It extends more than 9 miles north of Redondo and as far south and east as Wilmington. There are about 4 square miles in the area east of Santa Monica, and a like area near Longbeach. The areas mentioned are largely made up of hills, with some mesa and sloping plain lands. In the vicinity of Wilmington and to the north the surface is comparatively level. All the areas are well drained and free from alkali.

The Oxnard sand is largely of æolian origin, and consists of beach-worn sands which, particularly in the area around Redondo, were piled up and driven inland by the winds. Disintegration and wind

action are largely responsible for its modified character, as compared with a true beach sand.

Grain, corn, beans, pease, beets, and grapes are grown without irrigation on this type, while with water deciduous and citrus fruits, berries, truck, and flowers are produced. A great part of the area is sown in barley, which in seasons of average rainfall produces a fair crop. The Oxnard sand is less retentive of moisture and usually less productive than the heavier soils of the area. Next to small grain corn probably occupies the largest acreage. The yield of this crop is light, averaging about 30 bushels to the acre. Beans—the Lima, blackeye, and kidney varieties—and pease are also grown, giving fair yields. These crops are generally more remunerative than either corn or grain. Only a very small acreage was in sugar beets in the season of 1903, and the crop had been partially destroyed by the winds and was generally neglected. It is doubtful whether, under the best conditions, the light crops obtained from beets would be profitable. Citrus and deciduous fruits are grown principally near Longbeach and Santa Monica, some fine lemons being produced near the former place. The deciduous fruit crop is unimportant. North of Wilmington wine grapes are a remunerative crop. Berries, particularly strawberries, are grown to some extent at Cerritos Hill and at Santa Monica with marked success. Trucking is carried on only at Redondo to supply the local demands. The commercial growing of flowers, chiefly carnations, is a profitable industry at Redondo, Longbeach, and Santa Monica, where fields containing as many as 10 acres are devoted exclusively to that purpose.

The following table shows the texture of the soil and subsoil of this type:

Mechanical analyses of Oxnard sand.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8258	3½ miles S. of Moneta.	Gray loose sand, 0 to 72 inches.	0.36	0.00	0.40	0.70	59.10	25.90	8.52	5.32
8254	1¼ miles E. ½ S. of Santa Monica.	Gray sand, 0 to 24 inches.	.76	.50	20.78	31.88	16.90	8.90	11.96	8.18
8256	¼ mile S. of Mesmer.	Friable sand, slightly loamy, 0 to 27 inches.	1.53	.70	9.60	22.20	26.80	13.76	16.60	10.30
8255	Subsoil of 8254....	Brown sand, 24 to 72 inches.	.15	.80	24.18	38.18	17.78	4.86	7.66	6.60
8257	Subsoil of 8256....	Brown coarse sand, 27 to 72 inches.	.30	.30	10.08	25.70	30.90	9.70	13.12	10.10

FRESNO SAND.

The Fresno sand is composed of a light to medium gray sand, ranging in texture from coarse to a medium fine grade. It is generally loose and friable and in very few instances shows any tendency to clod in cultivation. The soil is generally 6 feet or more in depth. In many cases, however, it is found overlying material of the Fresno fine sandy loam and occasionally, in the lower areas, a silty material.

While in the greater proportion of the area the sand is of medium texture, there are a few areas where a finer or coarser phase predominates. Immediately southeast of Los Angeles and around Norwalk the sand is rather coarser than the typical material, while the coarsest texture is found in the areas lying between Buenapark and Westminster. In these areas some angular gravel is occasionally present. North of Norwalk there is a small area of grayish sand which exhibits a slightly loamy property and packs to a certain extent in the roads, and a somewhat similar area east of Ballona Creek, containing a few gravel, was also included in the type. In numerous instances, but largely south of Cerritos Hill, a fine, light-gray sand was also classed as the Fresno sand.

The Fresno sand, like the Fresno fine sandy loam, is found over a large territory south and east of Los Angeles. It occurs generally in level tracts and occasionally in ridges or bars from 1 to 5 feet higher than the intervening Fresno fine sandy loam. The prevailing slope of all the territory covered is toward the south. The texture of the sand being very open, it is well drained, except in a comparatively few small areas, where the water table is sufficiently close to the surface to interfere with the production of ordinary crops.

The Fresno sand is a recent sedimentary deposit. The material is to a large extent quartz, and mica and feldspar are prominent components. Almost all of the material is of granitic origin, having been transported from the mountains by the rivers. In a few localities this soil is shifted by the winds, but it is not ordinarily thrown up into dunes, although slight accumulations are found around obstructions. The small area east of Ballona Creek is of local origin, the sand having been washed down from a loose deposit on the hillside.

Generally speaking, this type is free from alkali. A few alkaline areas occur in the vicinity of Clearwater and Hynes, where the water table comes close to the surface.

Citrus and deciduous fruits, truck, alfalfa, corn, pumpkins, citrons, sugar beets, and grain are grown. One of the first soils to attract the early settler's attention as adapted to fruit culture was the Fresno sand. Centered around Rivera is said to be the largest English walnut district in the country. Many of the orchards have been in bearing a long time, while young orchards are being continually set out. Other

walnut orchards are found south of Los Angeles, and individual trees are seen around the farmhouses in various parts of the area. Peaches and apricots are successfully grown. A large acreage of this soil is devoted to the culture of grapes, principally the wine varieties. Around Norwalk and Artesia the industry is receiving considerable attention, and a large number of cuttings have been recently set out. Truck and, to a more limited extent, berries are among the most important crops in the areas southeast of Los Angeles. Citrus fruits, particularly oranges, are not extensively grown. Alfalfa gives good crops, while sugar beets ordinarily yield light crops, in which there is very little profit. Corn and grain were grown without irrigation ordinarily produce very light crops, and on some of the coarse, loose phases of the soil they are at best of little importance.

The following table gives mechanical analyses of the typical samples of this type:

Mechanical analyses of Fresno sand.

No.	Locality.	Description.	Organic matter.							
				Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.06 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8227	4½ miles due S. of Buenapark.	Gray coarse sand, 0 to 72 inches.	0.34	3.06	16.76	23.66	44.12	8.78	2.42	1.20
8228	1½ miles NE. of Watson.	Loose, incoherent sand, 0 to 72 inches.	.40	-----	1.10	8.66	57.60	27.32	3.86	1.30
8226	1¼ miles SW. of Rivera.	Gray sand, 0 to 72 inches.	.46	.42	5.42	13.86	49.00	21.98	7.64	1.64

The following samples contained more than one-half per cent of calcium carbonate (CaCO₃): No. 8226, 0.60 per cent; No. 8228, 0.60 per cent.

MARICOPA SANDY LOAM.

The Maricopa sandy loam represents a group of soil conditions rather than a definitely fixed soil type. It ranges from a light-gray, loose and almost incoherent sandy loam to a brown, medium-textured sandy loam which grades, along the boundary below Hollywood, into adobe. The greater part of the soil is, as first described, loose and friable, and there the soil contains angular granitic fragments as large as a pea or larger. The soil sometimes reaches a depth of 6 feet with little variation in texture, or it may grade at 3 feet or so into a more compact mass of the same material.

A phase of this type occurs in the vicinity of Prospect Park, where the material, while having much the same general character, is not so

loose and friable as in the typical soil. It has a tendency to pack, and in places the color has a slightly reddish cast. It is underlain by more compact material of the same general character. Where the Hollywood boulevard cuts through this area some extremely compact soil, requiring blasting, was encountered. A very small area of this reddish-colored soil was found on the north side of Eagle Rock Valley. A gravelly phase of the type also occurs, occupying an extensive gently sloping plain around Glendale and narrow areas along the Arroyo Seco.

Two distinct areas of the soil were mapped; the larger occurs in the vicinity of Hollywood, extending along the base of the Santa Monica Mountains both east and west of the town, the other in Eagle Rock and adjoining small valleys. The area flanking the Santa Monica Mountains is a sloping plain built up in the main by the many small drainage courses that traverse it. In Eagle Rock Valley the soil occupies the entire valley as well as the slopes and small hills, while in the adjoining valleys it is confined principally to the slopes.

The Maricopa sandy loam where it occurs on the hills and mountain sides is residual; the greater part of the area, however, is a colluvial deposit, the detritus from the granite and closely allied rocks being carried down and spread out along the slope by the many small streams which run only during heavy rains.

Citrus and deciduous fruits, truck, and hay are the crops now grown on this soil. Of the citrus fruits the lemon is the most important, considerable attention being given to its culture in the country about Hollywood, known as the Cahuenga Valley. Truck growing, while carried on throughout the year, is more especially confined to the production of winter vegetables, such as pease, beans, tomatoes, eggplant, squashes, potatoes, and peppers. Coming into the market at a time of comparative scarcity of such products they command fancy prices. The acreage in vineyards is small and is confined principally to the production of wine grapes. The tonnage of grain hay is small and the crop is of minor importance.

A new industry, the growing of pineapples, has been recently introduced on this soil. The location of this soil at the base of the mountain slopes makes it more secure from frost than other soil areas. Experiments with different varieties have been made, and while no great number have as yet been produced enough has been done to make it seem a practicable matter to grow this fruit commercially in the area. Other tropical fruits have been introduced, also, but their cultivation has not been attended with marked success.

The following table shows the texture of the fine earth of this soil:

Mechanical analyses of Maricopa sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8231	½ mile E. of Hollywood.	Friable sandy loam, 0 to 42 inches.	0.83	10.20	18.66	11.90	22.44	11.96	16.10	8.74
8233	E. end of Eagle Rock Valley.	Mellow sandy loam, 0 to 72 inches.	1.03	9.92	19.46	11.14	19.52	12.84	18.12	8.96
8232	Subsoil of 8231...	Reddish compact sandy loam, 42 to 72 inches.	.69	7.62	13.70	8.28	18.20	12.84	25.32	14.02

FRESNO FINE SAND.

The Fresno fine sand is a mellow, loose, loamy sand, ranging in color from gray to brown, the predominating color being brown. The texture varies from a typical sandy loam to a very loose, open sandy material containing but a slight admixture of clay and silt. It is 3 or more feet deep and underlain by a sand or a lighter phase of the materials forming the surface soil.

The type is well distributed over the area, several square miles being found around Gardena, a similar amount south of Inglewood, a large area south of Los Angeles, and several smaller areas in the vicinity of Tropic and Glendale. All the territory thus embraced is comparatively flat with only a slight slope to the south or west.

The Fresno fine sand is made up of transported material. That which is found around Tropic was carried there by the local streams, while that below Los Angeles was laid down by Los Angeles River. This may also be true of the material in the area south of Inglewood and around Gardena. As the drainage of the rivers is principally from granitic mountains the soil is composed largely of that material, but the sediments have been to a certain extent modified by the washings from the sedimentary rocks. The area immediately south of Los Angeles was in all probability largely laid down as Fresno sand. Since the time of its deposition, however, it has been sufficiently modified by weathering to change it into a sandy loam. Along the eastern edge of this area the soil grades into Fresno sand. Here the boundary is very indistinct, there being a very gradual change from one type to the other, and the material in the zone of transition can, with almost equal propriety, be classed as either type.

Some coarse, loose, sandy soil immediately south of Inglewood was also included with the Fresno fine sand.

Berries, truck, deciduous and citrus fruits, alfalfa, and grain constitute the important crops. Around Gardena and Moneta an extensive berry (mainly strawberry) industry has been developed. Below Los Angeles trucking is one of the most important industries. This is also one of the important lines of agriculture in the section below Inglewood. During the summer all kinds of vegetables are grown, but in the winter the land is largely devoted to the production of cabbage and cauliflower. Citrus fruits are grown successfully on the area near Verdugo, while farther south near Tropic there is a small acreage successfully devoted to the culture of wine grapes. In the areas about Los Angeles and Gardena the deciduous fruits—walnuts, peaches, apricots—together with citrus fruits, mostly oranges, are of some commercial importance. The oranges, however, as around Inglewood, are largely seedlings, and do not ordinarily command a very good price. The walnuts do very well, and a more extensive planting below Inglewood and around Gardena can be recommended. Alfalfa is grown in some cases in large tracts below Los Angeles and in the areas about Inglewood and Gardena. It does well on this type of soil, and the yield of hay is heavy. The land dry-farmed is sown largely to barley. This is grown for the grain or cut for hay.

The following table gives mechanical analyses of the soil:

Mechanical analyses of Fresno fine sand.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8246	¼ mile NW. of Gaston.	Brown sandy loam, 0 to 52 inches.	0.59	4.26	11.84	10.50	29.60	17.80	19.00	6.76
8248	2¼ miles S. ¼ W. Centinella.	Brown loose sandy loam, 0 to 42 inches.	.77	2.50	8.62	7.86	21.42	20.86	28.84	9.90
8244	2 miles E. ¼ S. Cienega.	Mellow gray sandy loam, 0 to 52 inches.	.78	.68	4.70	7.66	23.86	20.90	31.68	10.50
8245	Subsoil of 8244....	Sandy loam, 52 to 72 inches.	.26	.82	6.40	9.44	31.92	19.82	25.04	6.52
8247	Subsoil of 8246...	Loose sandy loam, 42 to 72 inches.	.30	5.56	13.82	11.44	28.98	16.12	17.44	6.64
8249	Subsoil of 8248....	Brown loose sandy loam, 42 to 72 inches.	.27	2.32	11.70	10.02	20.96	17.08	25.68	12.16

SIERRA ADOBE.

The Sierra adobe consists of a reddish-brown sandy loam, ranging in texture from the medium to fine grades, and having a depth of from 1 to 3 feet. The surface soil has a tendency to pack and become very hard. The subsoil consists of a loam or gravelly sandy loam having a color slightly redder than the surface soil. In exposures the profile shows, at a depth of a foot or so, a zone from 1 to 2 feet thick cracking irregularly like the adobe soils. This in turn is underlain by decomposing granitic sand and gravel which grades with increasing depth into similar material in a less advanced state of disintegration. The subsoil when removed and packed becomes exceedingly hard and for this reason is used to surface roads and walks. The soil occupies a part of the city of Los Angeles, extending from the east side of Los Angeles River to the San Gabriel River. In general this area is a sloping plain at the foot of the Rapelto Hills, and in some cases covering some of the outlying slopes. A small area in the city of Los Angeles west of the river is found capping Fort Hill.

The Sierra adobe is composed principally of granitic materials, which were probably laid down in much the same manner and in much the same condition as the Maricopa gravelly loam. During the elevation of the land surface the material was raised considerably above its former level, since which it has been subjected to greater wash and weathering and has been greatly changed in appearance and texture. The present reddish color of this soil is doubtless due to the oxidation of the iron.

Outside of the city limits the land is held in large tracts and, as it is unsupplied with irrigation water, is dry-farmed in grain, principally barley. Recently some water has been developed by means of wells, and a large tract has been subdivided and placed upon the market. Orchards of citrus and deciduous fruits and patches of berries have been set out and truck growing has been tried. All the crops look well and the returns already received from some of the plantings are encouraging. Within the city limits there are no large tracts devoted to the culture of any crop, but many gardens are seen and the soil seems well adapted to the production of vegetables, flowers, and ornamental shrubs. The location of this type along the foothills gives it a certain exemption from frosts, and with water the citrus fruit and winter truck industries have a bright future.

The table following gives mechanical analyses of typical samples of the soil.

Mechanical analyses of Sierra adobe.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8242	1½ miles N. of Manhattan.	Reddish sandy loam, 0 to 30 inches.	0.94	0.94	3.20	3.88	10.26	17.42	45.42	19.28
8243	Subsoil of 8242.....	Brown heavysandy loam, 30 to 72 inches.	.33	2.56	4.66	4.48	12.70	14.38	33.24	27.50

LOS ANGELES SANDY LOAM.

The Los Angeles sandy loam is composed of a brown to light-brown material, with a texture ranging from sandy loam to a loam, the greater part being a sandy loam. The depth varies from less than a foot to 6 or more feet, the average probably being about 2 or 3 feet. The subsoil consists of a partially decayed rock into which the soil grades more or less gradually. Decomposition has taken place in this to such an extent that it is easily penetrated by the soil auger for a depth of 1 to 3 feet. The material is of a light-yellow or yellowish-gray color, and varies in texture from a sandy loam to a fine sandy loam or loam.

The type is all found on the hills around Los Angeles and on both sides of the river. The hills have a comparatively rough physiography and are of various heights, the extreme elevation being 400 or 500 feet above the surrounding valley lands. They are intersected by many draws and canyons. The native vegetation of the hills is clover, alfalaria, mustard, and related plants, and to a more limited extent sage and other brush. This does not afford much protection to the soil, and the rain waters are largely lost in surface drainage. The soil is formed in situ by the disintegration of sandstone and shale, and as the texture of the rock varies so does the texture of the soil. In the Elysian Hills the sandstone is for the most part medium in texture, as is the case to a certain extent in some of the hills east of the river, but not in all, there being in many places layers of shales interbedded with the sandstone. The shale is of fine texture, and where it predominates the resulting material is a loam. The loam is generally of a darker color and grades into the black adobe. On account of their rough character the hills are used principally as natural pastures. A small part of the better situated areas are sown with grain, which is mostly cut for hay. Within the city limits parts of the hills

are in the residential section and are supplied with water. Here the soil is planted to flowers and ornamental shrubbery, which with care do well.

The following table gives mechanical analyses of typical samples of this type of soil:

Mechanical analyses of Los Angeles sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
				P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8234	2 miles S. of Tropic.	Brown sandy loam, 0 to 22 inches.	1.27	1.62	6.84	8.50	29.46	17.18	20.30	16.10
8236	1 mile E. of Los Angeles.	Fine sandy loam, 0 to 36 inches.	1.27	.36	.64	1.52	6.90	15.60	54.76	19.98
8235	Subsoil of 8234.....	Yellow sandy loam, 22 to 52 inches.	.25	1.48	7.88	10.28	33.86	16.54	17.92	11.96
8237	Subsoil of 8236.....	Sandy loam, 36 to 60 inches.	2.62	.52	3.30	2.44	7.30	16.14	55.64	14.60

The following sample contained more than one-half per cent of calcium carbonate (CaCO₃) No. 8236, 4.60 per cent.

PLACENTIA SANDY LOAM.

The surface soil of the Placentia sandy loam is composed of a light-brown or brown loam with a medium to fine texture. Ordinarily it is comparatively loose, friable, and easily cultivated, except in certain localities where it has a tendency to bake or pack. It is underlain by a more compact subsoil which is lighter in color, having a slight reddish cast. In certain places the underlying material packs harder than in others, and is locally known as hardpan. Where the subsoil is exposed in cuts, in the upper 2 or more feet it cracks in irregular lines like adobe. Beneath this stratum the material grades into sand or into a material much like the surface soil.

The texture of the surface soil varies in different parts of the survey. In the area extending west of Los Angeles the texture is mostly that of medium sandy loam, with occasional local modifications where it contains some coarse material. This is also the character of the area on the San Antonio ranch around Santa Fe Springs and Inglewood. The soil in the territory around Bixby, Longbeach, Landing Hill, Bolsa, and Las Bolsas is largely fine in texture. Much of the Placentia sandy loam around Bixby is quite shallow, the heavy subsoil coming within a foot of the surface. A small area of medium-textured, grayish-colored sandy loam running into a lighter colored or yellowish

sandy loam at Buenapark was also included in the type. Some local modifications occur along the ocean, particularly southeast of Wilmington, where the surface has been changed by shifting sand.

The type is widely distributed over the area, and occupies low rolling hills, mesas, and sloping plains. It is well drained and free from alkali, excepting a small area near Wilmington and one near Anaheim Landing. The Placentia sandy loam is the weathered product of anciently transported granitic material. The washings were elevated by a movement of the earth's crust, and have since been much modified by weathering and, along the coast, by wind action. There is only a comparatively small proportion of the type, largely in the vicinity of Whittier, that is the result of recent sedimentary washings.

The crops at present grown are the tree fruits, walnuts, olives, grapes, truck, berries, beans, alfalfa, and grain. On the soil in and around Whittier is found the greater part of the most important citrus orchards in the survey. They are principally orange, with a small proportion of lemon and pomelo orchards. In the vicinity of La Mirada, Santa Fe Springs, Montebello, Jeffries, Pico Heights, Palms, Inglewood, Gardena, and Longbeach citrus fruits are also grown. Walnuts are grown chiefly near Whittier, and with marked success. Of the other deciduous fruits small quantities are planted, the most important being the apricot and peach. The olive, with the exception of an orchard east of Santa Fe Springs, and one at Sunnyside, is largely confined to the vicinity of La Mirada. There are several vineyards near Santa Fe Springs, and one or two west of Los Angeles. The vines are not irrigated, and the crop varies much with the season. With good care, however, fair crops are obtained almost every year. A good quality of truck is grown in the Rancho San Antonio, and to a more limited extent at Longbeach and Whittier. Berries of different kinds are grown with success near Longbeach, Whittier, and on the Rancho San Antonio. Lima beans were tried on a small area east of Santa Monica, where they did well. Alfalfa is grown in the Rancho San Antonio, at Hydepark, and on several farms south and east of these places. Plenty of water is the chief requisite for a good crop. The greater part of the area of this type is without water, and is dry-farmed to barley, which in ordinary seasons produces good yields of hay and grain.

The following table shows the texture of typical samples of this soil:

Mechanical analyses of Placentia sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
				P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8252	½ mile NE. of La Mirada.	Brown sandy loam, 0 to 30 inches.	0.72	0.74	5.32	6.00	18.74	19.20	38.72	10.48
8250	½ mile S. ½ W. of Centinella.	Brown sandy loam, 0 to 24 inches.	1.02	.26	2.64	4.36	18.84	19.84	39.06	13.96
8253	Subsoil of 8252.....	Brown sandy loam, 30 to 72 inches.	.23	.96	5.92	6.76	21.84	16.02	33.42	15.08
8251	Subsoil of 8250.....	Sandy loam, 24 to 72 inches.	.32	.34	2.52	4.80	20.50	17.34	36.24	18.22

FRESNO FINE SANDY LOAM.

The surface soil of the Fresno fine sandy loam consists of light to dark gray micaceous fine sandy loam, ranging in texture from the medium to the fine grades. It is mellow and easy to cultivate. The soil has an average depth of about 3 feet, and is generally underlain by sand, though layers of silt and fine sandy loam in places constitute the subsoil. This is particularly the case in lower areas, where in boring to a depth of 6 or more feet various deposits of different thickness of the surrounding soils were passed through.

Some local modifications of the type occur. Extending from Wil-dasin to the south and east of Compton the soil is usually dark colored and decidedly loamy. This also is true of a few small spots in the vicinity of Downey, and a part of the area lying north of Santa Fe Springs, while in the area below Cerritos and Norwalk the soil is very light in character and in many instances is little more than fine sand. A peculiar phase of the latter character was found near Carmenita, where the soil has a tendency to pack, and sheds water to a rather remarkable degree. On examination it was found to consist largely of fine light gray sand with a high content of mica. There is included with this type a very small area of rather coarse soil of the same general character and origin as the Fresno fine sandy loam. It was found near Buenapark, north of Westminster, and also on the Cudahy ranch southeast of Los Angeles.

The soil is found widely distributed in the coastal plain south and east of Los Angeles. The areas are frequently bordered on each side by the Fresno sand, and generally, where this is the case, the Fresno fine sandy loam is in a swale, the sand area being from 1 to 5 feet higher.

The surface is, on the whole, very flat, the prevailing slope being toward the south. While a large proportion of this type is well drained, there are some areas where the water table comes very close to the surface. In the majority of instances this condition obtains only at certain seasons of the year, but in some it is a permanent condition.

The Fresno fine sandy loam is a recent sedimentary deposit of material largely granitic in origin. All the material, excepting a very small amount brought down by local drainage, has been transported by the Los Angeles, San Gabriel, and Santa Ana rivers and laid down in their flood plains. Originally the sediments were free from alkali, but with disintegration and a permanent or periodically high water table an excess of the soluble salts is frequently found not only diffused through the soil, but also accumulated on the surface. The quantities present are sometimes sufficient to interfere with plant growth.

Fruit, sugar beets, alfalfa, corn, pumpkins, truck, grain, and berries are grown. Walnuts are an important product, especially in the vicinity of Los Alamitos and Downey. Where the water table is not too near the surface and salts are not present in excessive quantities it is one of the best soils in the area for their culture, being excelled only by the Fresno sand in areas used for this crop. Next to walnuts, apples and pears are the most important deciduous fruits. The former have been recently attracting much attention, especially in the vicinity of Downey and Longbeach, where a number of young orchards have been set out. The results so far indicate that the soil is better adapted to the culture of this fruit than any other soil in the area. Trucking is extensively carried on, especially below Los Angeles. The winter truck crops are principally cabbage and cauliflower, while in summer the gardens contain a great variety of vegetables. As a truck soil the type ranks high, and it is the soil most extensively used for the purpose. In fact, with the exception of the Peat and lighter phases of the silt soils it is the best truck soil in the area. Berries of different kinds are successfully grown in connection with the truck crops, or as a specialty. In very few instances are citrus fruits grown commercially. Their chief importance is in the family fruit garden.

The ease with which this type of soil can be cultivated commends it especially to crops requiring much care, as, for instance, sugar beets, of which a large acreage is planted annually. This crop gives excellent yields. Alfalfa, corn, pumpkins, and grain are also extensively planted, and good yields are obtained, the product going largely to supply the demands of the local dairies.

The following table gives the texture of samples of this soil:

Mechanical analyses of Fresno fine sandy loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8222	½ mile E. of Compton.	Gray fine sandy loam, 0 to 36 inches.	1.21	0.06	0.14	0.26	21.30	39.18	33.92	5.14
8224	½ mile N. of Downey.	Gray fine sandy loam, 0 to 48 inches.	.79	.04	.42	.90	17.56	41.02	34.40	5.64
8223	Subsoil of 8222.....	Gray fine sandy loam, 36 to 72 inches.	.32	.12	.38	.46	41.48	31.06	21.48	5.02
8225	Subsoil of 8224.....	Gray fine sandy loam, 48 to 72 inches.	.56	.70	9.14	17.18	28.88	15.54	22.28	6.28

The following samples contained more than one-half per cent of calcium carbonate (CaCO₃): No. 8222, 1 per cent; No. 8223, 3 per cent; No. 8224, 2.80 per cent; No. 8225, 0.60 per cent.

OXNARD LOAM.

The Oxnard loam is a dark-brown loam of medium to fine texture, having an average depth of about 2 feet, and underlain by a heavier, more compact brown subsoil of the same general character as the soil. There is a stony phase of this type indicated on the map by gravel symbol, containing angular and subangular fragments of black slate. Over the greater part of the territory occupied by this phase the gravel content forms less than 10 per cent of the soil. In a few places, however, especially in the depressions cut out by streams, the content is higher, and in exceptional cases as much as 50 per cent or more of the material is found. In the washes and below them, where the water they carry during rains spreads out on the plains, the soil is sandier and not so dark colored. Another phase where the soil is heavy is found on portions of the Padre de Las Aguas and La Ballona ranches. It is more plastic and sticky when wet, and, like adobe, has a greater tendency to bake and crack upon drying than the typical soil.

In many exposures the soil is shown to have a depth of 10 feet or more, with little variation in general character of material, except that the subsoil is more compact and heavier. The gravelly phase extends to an unknown depth, the proportion of gravel varying at different depths. In one instance the soil was found overlying a bed of slate gravel at 3 feet, while in another a similar bed was observed at from 6 to 9 feet. These beds were in turn underlain with gravelly loam.

The Oxnard loam is all found in one large area, extending from Santa Monica in an easterly direction to a point close to Sherman. It is bounded on the north by Santa Monica Mountains and on the south by a very irregular outline which reaches to Machado on the Santa Fe Railway. In general this area is a southerly sloping plain which heads well up on the base of the Santa Monica Mountains. This plain was at one time much more uniform than it is to-day. Many water courses, flowing down steep gradients, traverse it, and these have cut local valleys often as much as a quarter of a mile, in some cases more, in width. These depressions, in the vicinity of the Soldiers' Home, give the country a hilly or rolling aspect.

The material forming the Oxnard loam came originally from the Santa Monica Mountains, being composed of slate and other closely allied rocks and the weathered product of such rocks. The detritus was carried down and deposited by the streams. This area has since been elevated, and later erosion has worn down the plain and mountains south and thus extended the area. Beans, alfalfa, fruit, barley, corn, and truck are grown. Up to within the last two years barley for both hay and grain covered a very large proportion of the area, but since that time the success attained in a few trial patches of beans has brought about a change of the agricultural practice, and this season beans have largely displaced the grain. Chiefly the lima bean is grown. Walnuts, particularly in the southern part of the area, have been cultivated for some time. The recent installation of an irrigation system there has stimulated the industry and many young trees have been set out. As the soil is one of the best in the survey for the culture of this crop a still more extensive planting can be recommended. The quantity of citrus and other deciduous fruits is as yet small. The former, particularly the lemon, do well, and with the development of water for the higher lands the acreage in orchards may be expected greatly to increase. Barley in good seasons is allowed to produce grain, but in seasons of scant rainfall the crop is cut largely for hay. Alfalfa is grown to a limited extent with irrigation. The yield ordinarily is large. Corn is grown by few farmers, and except where under irrigation, or in seasons of good rainfall, makes little grain. A few acres in the southern part of the area are devoted to the growing of truck. These crops are also grown in a small area on a sandy phase of the type at Soldiers Home. The gardens at the latter place contain a great variety of choice vegetables, and show, to a marked degree, what can be done on this soil where proper care is used in the selection of seed and in cultivation.

The table following shows the texture of this soil as determined from mechanical analyses of the fine earth of a number of typical samples.

Mechanical analyses of Oxnard loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8266	½ mile W. of Soldiers' Home.	Rich loam, 0 to 24 inches.	1.27	1.20	2.70	2.72	9.90	21.50	40.26	21.70
8268	¾ mile E. of Santa Monica.	Brown loam, 0 to 27 inches.	1.36	1.12	3.30	2.30	7.12	18.70	42.86	24.60
8264	¼ mile SW. of Soldiers' Home.	Brown loam, 0 to 24 inches.	2.19	.30	2.26	3.16	6.36	9.56	38.98	39.20
8265	Subsoil of 8264.....	Heavy loam, 24 to 72 inches.	.60	.90	2.60	2.00	9.20	18.30	37.16	29.90
8267	Subsoil of 8266.....	Heavy loam, 24 to 72 inches.	.60	1.10	3.10	2.08	6.00	13.32	36.90	37.34
8269	Subsoil of 8268.....	Heavy clay loam, 27 to 54 inches.	.82	Tr.	2.40	4.40	10.64	6.44	29.06	47.22

SANTIAGO SILT LOAM.

The Santiago silt loam is a light to dark gray, micaceous silt loam, varying from a loose, friable, easily cultivated soil to one having a heavy texture and a tendency to pack, bake, and crack open when dry. The soil texture generally varies with the color; the light being friable, the dark heavy. The depth varies from a foot to more than 6 feet, and the surface soil grades into layers of sand, fine sandy loam or silt. It is thus seen that the type is quite a variable one, and because of this a statement will be given of the prevailing characteristics of the largest area.

In the area southeast of Santa Monica, known as the Ballona country, the soil ranges in color from gray to almost black and in texture from an ordinary loam to a heavy loam. In the vicinity of Ballona Creek the lightest material is found. Here the soil is underlain by sand, while along Centinela Creek the soil is very heavy, with a depth ranging up to 6 or more feet. The area in what was formerly known as Nigger Slough is very fine textured, gray or light gray in color and 6 feet deep. Extending from Nigger Slough, east and south, almost to the ocean, the type is all light colored, friable, and easily cultivated, the depth varying from 1 to 6 feet, and the soil being underlain by deposits of sand, fine sandy loam, and silt. The large area northwest of Dominguez contains all the variations in depth up to 6 feet, and ranges in texture from light to heavy. The area on the San Antonio rancho, that south of Whittier, and the one east of Carmenita range in texture from medium to heavy, while the area around Alamitos is to a great extent heavy, the greater part of it being nearly 6 feet

deep. In this area the soil in the vicinity of the river and east of Alamitos is not generally as heavy as that lying southeast of the town site, although some heavy soil was observed next to the river.

From the many borings made the subsoil also was found to vary greatly. In one it would consist of 2 feet of silt, a like thickness of sand, grading perhaps into fine sandy loam or silt, while in the next the arrangement of material might be in exactly the reverse order. Taking in the entire area covered by the type there is probably a greater proportion where the soil is 6 feet deep than where it is less. The texture of the soil where the full depth of 6 feet is attained varies little, the chief difference being in the color, which always grades with depth into gray or light gray.

The physiography of the different areas is very similar and very simple, being a flat plain, level or at most with only a slight fall. As the soil is heavy and the surface so nearly level the drainage is not always good, and in certain instances soluble salts have accumulated in sufficient quantities not only to injure plants, but almost to prevent their growth.

The Santiago silt loam is of alluvial origin. It is made up of the fine material, mostly granitic, brought down by the rivers in flood seasons and deposited along their lower reaches in comparatively still water. The recent deposits are mostly of light texture, while the older ones, which have had more opportunity to weather and to become incorporated with organic matter, are darker and heavier. The soil in Nigger Slough is somewhat unique in its formation, the material having been carried into the lake by the streams, chiefly by Los Angeles River, and there deposited. It may therefore be considered a lacustrine deposit.

Sugar beets, alfalfa, truck (including celery, potatoes, etc.), corn, grain, and deciduous fruits are the crops at present grown on this type of soil. It is considered the best in the area for growing beets. A large acreage is planted to this crop, and the yield is, on the average, heavy. Celery culture is confined to the vicinity of Smeltzer, where good crops, comparing favorably with those produced on the Peat, are grown. Truck, particularly cabbage, potatoes, cauliflower, and onions, is grown with success near Cienega, and also at Smeltzer. Alfalfa, corn, and small grain are widely grown over the type. The yields of these crops are ordinarily large. The production of corn and grain, especially, probably exceeds the amount produced on an equal area of any of the other soils of the area. Successful apple orchards are seen in a few places.

The following table gives the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Santiago silt loam.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.	P. ct.
8275	1½ miles S. ¼ E. of Cienega.	Gray silty loam (light phase), 0 to 36 inches.	1.74	0.06	0.26	0.40	6.04	28.54	53.20	11.34
8277	Eastern side of Nigger Slough.	Gray silty loam, 0 to 36 inches.	1.98	.12	.40	.28	3.20	6.36	64.04	25.60
8278	1½ miles S. ¼ W. of Alaunta's sugar factory.	Gray silty loam (heavy phase), 0 to 36 inches.	2.36	.00	.42	.30	1.20	9.14	58.08	31.04
8276	Subsoil of 8275.....	Fine sandy loam, 36 to 72 inches.	.51	.06	.80	1.64	21.08	39.04	32.18	5.16
8274	Subsoil of 8278.....	Silty loam, 36 to 72 inches.	.59	.06	.88	.20	1.86	15.70	67.10	14.70
8278	Subsoil of 8277.....	Gray silty loam, 36 to 72 inches.	1.35	.08	.32	.26	1.42	5.30	69.44	23.18

The following samples contained more than one-half per cent of calcium carbonate (CaCO₃): No. 8275, 1 per cent; No. 8277, 8 per cent; No. 8278, 2.20 per cent; No. 8276, 1.60 per cent; No. 8274, 5.60 per cent; No. 8273, 6 per cent.

FULLERTON SANDY ADOBE.

The surface soil of the Fullerton sandy adobe is brown to dark brown in color and varies in texture from a sticky sandy loam to a more plastic loam. This soil represents a type intermediate between the Placentia sandy loam and San Joaquin black adobe. The soil differs from the black adobe principally in that it contains a greater proportion of coarse material, is ordinarily not as sticky and difficult to till, and when dry, probably owing to the inclusion of a less amount of organic matter, does not crack so extensively. A portion of the type mapped around Whittier is very dark colored and heavy, differing but little from the true San Joaquin black adobe. The soil on the average is about 3 feet deep and is underlain either by a lighter colored phase of the same material, or by a yellowish-gray indurated sand or sandy loam.

The soil is found in the vicinity of La Mirada, Whittier, Bixby, and Smeltzer. All the areas excepting those around Whittier occur principally in the form of rolling hills, while at that place it occupies southerly sloping plains.

The Fullerton sandy adobe, like the Placentia sandy loam, is largely anciently transported granitic material, intermingled with a lesser proportion of recent sedimentary washings. The areas it covers have

been elevated since the original deposition and have been subjected to a long period of increased erosion, resulting in the draws and gullies which now disfigure the surface.

Citrus fruits, walnuts, olives, beans, and grain are the important crops. The citrus fruit culture is confined to the vicinity of Whittier, where the industry thrives. Walnuts are planted on some of the heaviest phases of the type in the same locality, where with the proper care they do exceptionally well. Olive culture is almost exclusively confined to the Windmere ranch at La Mirada. The orchards are as yet young and the crops so far have been very light. Only a small acreage is at present devoted to beans, the land being largely sown to barley, which in seasons of average rainfall yields abundantly.

The following table gives the mechanical analyses of samples of this soil type:

Mechanical analyses of Fullerton sandy adobe.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8229	1 mile W. $\frac{1}{2}$ S. of Bixby.	Brown sandy adobe, 0 to 36 inches.	0.84	0.04	0.30	0.78	17.28	21.46	29.16	30.88
8230	Subsoil of 8229.....	Light gray sandy loam, 36 to 72 inches.	1.80	.34	.72	1.40	24.22	26.58	25.82	21.38

The following samples contained more than one-half per cent of calcium carbonate (CaCO_3): No. 8229, 0.80 per cent; No. 8230, 1.20 per cent.

SAN JOAQUIN BLACK ADOBE.

The surface soil of the San Joaquin black adobe consists of a black or dark-brown loam or a clay loam, plastic and very adhesive when wet and baking and cracking in irregular checks when dry. As the season advances and the soil becomes drier the cracks in places attain the width of an inch or more and extend to a depth of 2 or 3 feet. The soil is in its most friable state and is easiest to cultivate when first moistened after it has been thoroughly dried—that is, after the first rains. Later it is more plastic and difficult to till. The soil varies in depth from 2 to 4 or more feet and is underlain by a brown-colored phase of the same or a sandier material, by decomposing shale, or, in a few instances, by sand.

In the widely separated areas, occupied by this type of adobe soil there are naturally some local differences in the character of the soil. North of Buenapark the soil resembles, to a certain extent, the heav-

ier phase of the Santiago silt loam. It is, however, coarser and at the same time a little more plastic and sticky. It is not the typical black adobe, nor is it the silt, but it bears a closer relation to the former and is therefore included with it. It is underlain by a lighter textured subsoil of a gray or yellowish-gray color. North of Moneta the San Joaquin black adobe when dry has a gray color, but this is only on the surface, the black material being found immediately below it. In various localities lime nodules were found both in the soil and subsoil. In some cases the concretions are quite plentiful and the soil in such places is somewhat more friable. Chemical tests of the different phases of the type failed, however, to show any relation between the texture and the lime content of the soil.

The San Joaquin black adobe is widely distributed over the territory mapped. The largest areas lie south of Colegrove, extending in irregular outlines east and west from that place, west of Moneta, around Wiseburn, and south of Walteria. In the last-named area there is a slight admixture of shale gravel in the soil.

The physiography of the type varies considerably. West of Moneta it covers a part of the valley floor and is quite level, while in the hills around Los Angeles it may be found in any position from the tops of the hills to the intervening swales. With the exception of a comparatively small tract north of Moneta, a lesser area due north of Machado, and an area south of Sherman, the soil is naturally well drained. It is free from alkali in every case, except in the last-mentioned area, where there is a small accumulation, only sufficient to injure the crops in spots.

The San Joaquin black adobe is the product of disintegration of shale in situ, the weathering of transported material from sedimentary or crystalline rocks, or a mixture of the two. The greater proportion embraced in the present survey is the weathered product of transported material.

The crops are grain, alfalfa, sugar beets, corn, and fruit. Grain is probably the most important, a large acreage being sown each year. In seasons of average rainfall very large crops of hay and grain are harvested. Alfalfa with irrigation does exceptionally well. Unless the land is low lying or can be irrigated corn ordinarily gives a light yield. As the adobe is difficult to till, very few attempts have as yet been made to grow sugar beets on it. The acreage planted to citrus and deciduous fruits, with the exception of a small area near Colegrove, mostly lemons, is limited and the crop quite unimportant. Small fruits, principally strawberries, have recently been set out on some of the heaviest soil in the vicinity of Moneta. While there is not as yet a large acreage, the plants have been given close attention and look equally as well as those on the Fresno fine sand.

The following table gives mechanical analyses of typical samples of this soil:

Mechanical analyses of San Joaquin black adobe.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>	<i>P. ct.</i>
8260	2 miles W. $\frac{1}{2}$ N. of Rosewans.	Stiff clay loam, 0 to 36 inches.	1.04	0.60	3.00	4.00	11.90	14.28	25.86	40.32
8262	$\frac{1}{2}$ mile E. $\frac{1}{2}$ N. of Hydepark.	Black heavy loam, 0 to 48 inches.	1.02	.30	1.10	.96	3.80	20.70	30.92	42.24
8263	Subsoil of 8262.....	Brown heavy loam, 48 to 72 inches.	.61	.70	1.60	1.00	3.52	17.40	34.06	41.80
8261	Subsoil of 8260.....	Clay loam, 36 to 72 inches.	.26	.70	3.20	3.40	8.30	14.24	27.02	43.04

The following samples contained more than one-half per cent of calcium carbonate (CaCO_3): No. 8260, 1 per cent; No. 8261, 0.60 per cent; No. 8262, 0.80 per cent; No. 8263, 2.80 per cent.

GALVESTON CLAY.

The Galveston clay consists of organic matter intermixed with silt. It has a brownish-gray color and is more or less thoroughly saturated with water, being subject to the influence of tides. The depth varies from a foot to more than 6 feet. The greatest quantity of organic matter is found near the surface, the proportion gradually decreasing with the depth. It is underlain by gray or grayish-blue silt. The surface is generally covered with a short growth of thickly matted pickle weeds. Saltwort and several other salt-resisting plants are also found. The thick growth of vegetation protects the surface to such an extent that one can walk upon it. It, however, is very soft and spongy, and a person standing where the material is deep can shake the surface for a radius of 10 feet. Where the surface is not covered with pickle weeds the exposed spots are of a dark-brown color.

When freshly gathered the soil looks as though it was made up of about equal proportions of silt and yellowish-brown organic matter, consisting of twigs, stems, roots, etc. The samples collected for the Bureau laboratory shrunk a great deal in drying and became hard. The organic matter, which was so prominent a feature in the field, lost much of its color and changed its form, the mass appearing to be largely silt.

The Galveston clay areas are situated on the coast, and in fact are coastal swamps with only a slight elevation above sea level. They are traversed by many small waterways, including several river channels. At high tide some parts of the area are covered with water.

Lying at such a low elevation, the reclamation of the Galveston clay areas will be an expensive undertaking. A very large part of the drainage water will have to be removed by pumping. After the land is thoroughly drained it may be expected to settle, the depression depending upon the depth and character of the muck. The soil is the result of a long-continued deposition of silt by the rivers during flood times, combined with remains of a rank swamp vegetation. These floods occur periodically and the formation of this soil is still going on.

In its present condition this soil is too saline to permit the profitable growing of any crop, but when thoroughly reclaimed it would no doubt be a valuable soil for the production of such crops as are successfully grown on the surrounding lowlands.

PEAT.

The Peat consists of organic matter derived from aquatic and moisture-loving plants and in various stages of decomposition. It generally overlies silt, except in a few places where the subsoil consists of fine sandy loam or sand. The areas occur either in shallow fresh-water lakes or ponds, or around springs and other marshy places. Where the deposits occur in former lake beds the areas lie below the surrounding soils, but near springs the beds are built upon the land surface and have a slightly higher elevation than the contiguous types. The Peat areas are of very limited extent. Several are found south of Los Angeles near Cienega, and the remaining areas in the Las Bolsas country, south and west of Westminster. South of Los Angeles the areas occur principally in depressions and have a comparatively level surface. Some of the areas of the Las Bolsas country are also of this character, the remainder consisting of irregular patches standing some feet above the surrounding land.

Before the Peat can be utilized drainage is necessary. This was accomplished in some of the earlier essays at using this soil by open drains, but later by tile, which has proved to be more satisfactory. As a result, covered drains are gradually taking the place of the open drains throughout these areas.

In the ponds and lakes the Peat owes its origin almost entirely to accumulation of the remains of tules, rushes, and other aquatic plants, while in the vicinity of the springs and marshy spots all kinds of water-loving vegetation, including, in addition to the tules, etc., pampas grass, nettles, willows, and the like, have entered into the formation of the soil. The formation here is somewhat unusual, as the accumulation has taken place upon the surface of the soil and the areas stand above the level of the surrounding types. The springs have been entirely surrounded and the water has from time to time forced new

outlets, thus extending the areas. In this way irregular areas were built up to various heights, the extreme being about 7 feet.

In draining the high areas the same level is used as in the surrounding lands, and in consequence they become a little too dry. In general the material composing the higher areas is not so thoroughly decomposed as in the depressions, and in consequence the soil is more difficult to subdue. To a very limited extent burning has been practiced to dispose of the surface foot or so of less disorganized material.

The Peat is naturally free from alkali and when well drained and thoroughly subdued produces very large crops. The ease with which it is handled especially adapts it to plants which require a high state of cultivation. It is largely devoted to celery culture, the quality of the product ranking first in the area. Potatoes, cabbages, onions, and other truck crops are also grown and give very large yields.

RIVERWASH.

The Riverwash consists of coarse sand and gravel of a light-gray color and 6 feet or more in depth. It is found in the Arroyo Seco and Los Angeles river beds. It is composed mainly of material derived from crystalline rocks of the Sierra Madre Mountains and is carried down and distributed in flood season principally by the Arroyo Seco.

The soil is loose, porous, and poor, and, occupying as it does only a small area in the stream channels, it has no agricultural value.

WATER SUPPLY FOR IRRIGATION.

The water supply of the area is derived both from streams and wells. The wells are artesian, some flowing, but others available only by pumping. The principal stream supply comes from the San Gabriel River, the Rio Hondo, and Los Angeles River. The Verdugo, Coldwater, and one or two other mountain canyons furnish small quantities of water. The total amount thus furnished in low water is ordinarily in the neighborhood of 200 second-feet. Following a period of drought this may be reduced to about 160 second-feet, or by a series of wet seasons increased to about 250 second-feet. All of this water is used on what might be termed the upland. Ballona and Compton creeks and a little return water in Los Angeles River are used entirely on the lowlands. Water from the San Gabriel River and Rio Hondo is taken out in various places and used to irrigate the intervening territory to a point about $1\frac{1}{2}$ miles below Downey. A portion of the San Gabriel water is also used in irrigating the land on the east side of the river as far as Whittier and south to a point several miles below Studebaker. A small quantity of water from the Rio Hondo may be used to irrigate lands along its west bank. Los Angeles River is used almost entirely for domestic supply, the

remainder going to the irrigators south of the city. About one-half the small amount furnished by Verdugo Canyon goes to supply the irrigators in the vicinity of Glendale, the remainder being used outside of the area. Coldwater and other canyons in the Santa Monica Mountains, which in the aggregate furnish less than 2 second-feet, are used on the lands immediately below. Ballona Creek is used to irrigate a small portion of the original Ballona grant. The return water of Los Angeles River is taken out $1\frac{1}{2}$ miles east of Cerritos, and possibly at a lower point, and used on the adjacent lands. The amount of water running in Compton Creek is very small, furnishing little for irrigation, which is occasionally attempted along its lower course.

The supply of water from wells in the aggregate probably equals the water drawn from the streams. In the lowlands artesian wells are numerous and supply a large amount of water. Some of the deep wells are under great pressure and flow as much as 4 second-feet, and in a few instances more. Where irrigation is practiced in the district not supplied by flowing wells or streams—and it is a large one—the water is pumped from wells. These may be in the artesian belt, or what is commonly spoken of as “water-bearing” land, and the water transported by flume or pipe line to the place where it is to be used, or they may be on the premises or in the immediate vicinity where used. The pumping plants and wells are of various sizes, some furnishing not more than 1 second-foot, others lifting as much as 12 second-feet, and in three or four instances even more than this quantity. Many distributing systems carry the water from its source to the land where it is used through pipes or cement ditches, a serious effort being made in the majority of cases to lose as little of the water as possible in transit. To this end cement, vitrified redwood stave, sheet steel, and cast-iron pipes are used for the covered ways, while cement, wooden flumes, etc., are used in the open ditches. The several pipe lines, pumping plants, and wells, together with the entire water supply, represent a value of millions of dollars.

All the irrigation water is of good quality excepting that from some of the wells receiving their supply from the deeper formations, and one or two obtaining water from the recent river gravel.

An important supply of irrigation water—one which is increasing annually—is the sewage from the city of Los Angeles. At present it seems that this important source is not appreciated as it should be. This is probably due to the prejudice which prevails against its use.

Considerable information regarding the use of sewage waters for irrigation has been published recently, and the consensus of opinion is in favor of much more extensive use of these valuable waters which now go to waste. In this connection see Farmers Bulletin No. 43, United States Department of Agriculture.

UNDERGROUND AND SEEPAGE WATER.

In the low-lying lands the underground water comes in places very near the surface, and while it does no serious damage during the summer it frequently injures the crops in winter. The lands thus affected are comparatively flat with only a slight fall, and the surface drainage is not generally good. The water often collects in the swales and depressions. During the past season beds of celery, cabbage, alfalfa, etc., were either partly or in places wholly destroyed by such surface accumulations. This condition existed in several localities, but especially south and southwest of Westminster. To a more limited extent the gardens suffered from an excess of water in the vicinity of Mesmer. In the area south of Westminster the Bolsas drainage ditch has been put in, and recently a similar ditch has been installed draining land about 1 mile farther west. The heavy losses sustained by some planters during the last two seasons have awakened all to the necessity of drainage. Many lateral ditches of tile were in course of construction during the survey. Work was in progress on the Smeltzer ranch, said to contain 1,000 acres, under all of which tile drains were to be installed. In the vicinity of Mesmer an open ditch with laterals extending into the various low spots would materially benefit the land and prevent any loss from water standing on or close to the surface. Other lands similarly affected, only parts of which are now used for pasturage, would be likewise benefited and made much more valuable.

Almost equal in importance to the drainage of the low-lying lands is the installation of two ditches or canals sufficiently large to carry the water that is occasionally sent down in flood season by Los Angeles and San Gabriel rivers. At present there are no definite channels for the flood water. Most of it leaves Los Angeles River on the San Antonio ranch, covers a wide extent of territory and runs in a southerly direction across the fields, uprooting crops or covering them with sand and silt. During high water the San Gabriel River leaves its bed a short distance below Downey, and spreads over a wide area, cutting out the roads, uprooting the shallow-rooted crops, and otherwise doing much damage. Hundreds of acres of beets were seriously damaged in this way in 1903. In one instance a single field of 90 acres had to be entirely replanted.

ALKALI IN SOILS.

The alkali of the Los Angeles area is practically confined to those parts of the area of recent sedimentary origin. The types comprise the Galveston clay, the Santiago silt loam, the Fresno fine sandy loam, and the Fresno sand, which carry an excess of soluble salts in the order given. The only exceptions where the other soil types are found to

be alkaline are an area extending north from Ivy, containing about 2 square miles, about one-half square mile on the south side of Nigger Slough and a similar area north of Bixby Slough, in the San Joaquin black adobe, and about 1 square mile at Wilmington and a lesser amount at Anaheim, found on the Placentia sandy loam.

The alkali map is based upon the results of borings taken to a depth of 6 feet and upon observations made in the field. The quantity of salt was determined by the electrical method usually used by the Bureau and by qualitative tests by titration. The alkali lands are shown in 6 distinct grades, showing land containing 0 to 0.20 per cent, 0.20 to 0.40 per cent, 0.40 to 0.60 per cent, 0.60 to 1 per cent, 1 to 3 per cent, and more than 3 per cent, this scale representing the average of the quantity of salts contained in each foot to a depth of 6 feet.

There are so many things which have a direct influence on the crop in a section of soil 6 feet deep—the depth considered by the Bureau of Soils most representative of conditions as affecting plants—that it is impossible to make any positive statement that will apply to all parts of the area. In his survey of the Fresno area, California, Means concludes that on land with less than 0.20 per cent all classes of plants will grow; on 0.20 to 0.40 all but the most sensitive plants will grow, but near the higher limit of the grade all classes of plants, excepting those truly alkali resistant, show signs of distress, and if the condition remain unchanged the death of the plants results. Alfalfa when well started grows on this class of land, but it is difficult to secure a good stand. The grade 0.40 to 0.60 per cent contains a little too much salt for the common crops. Alfalfa will seldom grow, even where it has been established before the conditions became so bad, and it can not be seeded on the land when in such condition. The land is worthless for ordinary fruit farming. The grade from 0.60 to 1 per cent is practically worthless for general farming or fruit growing. Much work along this line has also been done by various experiment stations, particularly by California, Arizona, and New Mexico, and by the Bureau of Plant Industry of the Department of Agriculture. The quantity of salts that a plant can withstand varies with the composition of the salts and also with the species of the plant. It should also be pointed out that recent investigations of irrigation practices in Algeria^a show that with the different methods employed there the limit to the quantity of salt in soil and irrigation water, in which plants, even the more sensitive sorts, will thrive, is much higher than the limit set by authorities in this country, under the methods practiced here.

In the Los Angeles area in many instances the results obtained indicate the greatest amounts that plants can withstand. It was also noted, and in numerous instances, that field conditions were contra-

^aSee Circ. No. 10, Bureau of Soils, U. S. Dept. of Agr.

dictory to the ordinary results expected by laymen to be shown by an alkali map. The subject was given some attention and the following explanation bringing the results into harmony with the views expressed by other investigators is given. The quantity of alkali a plant will stand varies directly with the amount of moisture in the soil; in other words, in a soil containing 0.50 per cent soluble salt with 20 per cent moisture the solution is as strong as in one with 1 per cent salt and 40 per cent moisture, and plants growing under these conditions would do about as well in one as in the other. Crops are also influenced by the position of the salts, whether near the surface or far below it. In reference to the first foot it was observed that barley germinated in lands where the salt content was above 2 per cent in the surface foot, and the plants were doing well. Later in the season, as the solution began to concentrate, the plants showed signs of distress, turned yellow, ceased to grow, and gradually died. In fields where there was a 3 per cent concentration in the first foot the seed germinated, except in small spots where the concentration was locally greater. The grain grew about 6 inches high and as the season advanced turned yellow and died. It may be stated that the grain was favored in germinating by a period of heavy rainfall followed by cool weather, affording time for the plants to grow before the soil solution became concentrated.

Fine stands of barley were observed on land containing on the average 3 per cent for 6 feet, the salt being concentrated in the fourth, fifth, and sixth foot, while in places where the amount was distributed evenly the crops were absolute failures. Instances were also noted where the salts were concentrated in the surface foot, and while the average for 6 feet did not exceed 0.20 to 0.40 per cent, there was enough on the surface or in the first foot to kill the small plants. Ordinarily on lands containing 0.20 to 0.40 per cent it was observed that all crops such as corn, alfalfa, beets, and grain would grow without any apparent injury. In lands of this character the one thing to guard against is surface concentration; otherwise such land is remarkably fertile. On lands containing 0.40 to 0.60 per cent the above-mentioned crops were also doing well, and an instance was noted where land of this character produced 40 sacks of barley to the acre. When the moisture content, especially in the upper limit of the grade, becomes low there may be a check to the plant growth and consequent injury, but while the investigations were being made none was noted. In areas of the 0.60 to 1 per cent grade well established alfalfa was found to be growing, but before the upper limit of the amount was reached almost all plants showed signs of distress and their success or failure was dependent on the amount of moisture. In land containing 1 to 3 per cent barley and beets grew near the lower limit, but when 2 per cent was reached their life depended on high

moisture content of the soil, and when the soil solution concentrated they gradually succumbed. Land containing 3 per cent or more, and that in the surface foot, is worthless for farming under the methods employed and valued only for the scant pasturage it affords.

In consulting the alkali map it should therefore be borne in mind that the map was made to show the average quantity of salt contained in each foot to a depth of 6 feet, that this amount was obtained by dividing the total quantity found in the several feet by the number of feet examined, that alkali lands are often spotted, good spots being found in bad fields, and bad spots not infrequently in comparatively good fields, and that rarely are the salts evenly distributed in the soil, but in fact very much more commonly concentrated in some zone either at the surface or below it. Therefore should good crops be raised on lands showing a high salt content, the alkali is in the lower depths, and vice versa should failures be observed on lands of ordinarily low salt content the concentration is at or near the surface. Also it is to be remembered that the same amount of salt in a coarse-textured soil is more injurious than a like amount in a fine-textured one.

The presence of certain alkali-resistant vegetation is commonly associated by some with fixed amounts of alkali in the soil. While the vegetation may be taken to indicate conditions in a general way, experience in this area leads the writer to believe that this is not as good evidence of what the soil will grow, or its salt content, as the absence of more common plants of average resistance.

All the black alkali (sodium carbonate) in the Los Angeles area, excepting some patches too small to be shown on a map of the scale used, is found in the east central part of the area, and for the reason that the affected areas were not extensive no map was constructed for this alkali. The black alkali occurs almost entirely in the surface foot, little as a rule being found in the second foot, and seldom more than a trace below the third foot. Its presence is generally indicated by a black or brown coloring matter on the surface of the soil grains and small objects lying on the surface. Unlike the white alkali, which tends to form a mulch on the surface, black alkali causes the soil to set or pack. Drainage water from the areas in which it occurs is very dark colored, in some places almost black. This salt is much more injurious than white alkali. On lands containing 0 to 0.05 per cent all ordinary crops grow without any apparent injury. On the second grade, 0.05 to 0.10, the plants begin to show signs of distress, and about the upper limits of the grade the concentration is about all they can stand. In the third grade, from 0.10 to 0.20 per cent, under ordinary conditions 0.10 per cent is the limit of endurance of all young plants, and only the resistant plants exist, while before the upper limit is reached salt grass and some of the most resistant weeds are the only vegetation.

The greater part of the alkali in the Los Angeles area has accumulated through evaporation of the soil water at the surface, and this has been made possible through a rise in the water table under the influence of irrigation. The principal exceptions to this rule are in Nigger Slough, where the alkali was the result of evaporation of a large volume of water, and in the tidal marshes, which owe their salt content to the sea water. Other causes than the rise of the water table have probably in a measure caused the accumulations in the small area near Wilmington and near Anaheim.

The composition of the salts varies in different localities; generally back from the coast and away from the tide lands the sulphates predominate, gypsum being present in most all of the alkaline areas in which black alkali is not found. The preponderance of chlorides in the tidal marshes needs no explanation.

RECLAMATION OF ALKALI LANDS.

Several methods have been suggested for the reclamation of alkali lands; underdrainage and heavy irrigation to dissolve the salts and wash them out of the soil and carry them away in the drains; periodic surface flooding to wash the salts into the subsoil, there to be removed by the natural movement of the underground water; the application of gypsum to correct chemically black alkali conditions, and the growing of alkali resistant plants. None of these methods is to be compared with the first mentioned in universality or efficiency. Washing the salts into the subsoil without artificial drainage can only be successful where the water table is removed a sufficient distance from the surface, the texture of the soil is open, and the movement of the underground water comparatively free, all of which conditions are likely to be wanting in alkali areas. The application of gypsum is only of temporary benefit, and the original conditions may revert at any time, while the growing of alkali resistant plants, though undoubtedly a valuable adjunct to economical reclamation by the underdrainage method, has never been shown to be a successful method of reclamation taken by itself.

The whole question narrows itself down to thorough artificial drainage and heavy applications of water, and where these can be provided there is no uncertainty whatever in the final outcome.

In experiments carried on by the Bureau at Fresno^a in 1902-3, land so alkaline as to be thrown out of cultivation was sufficiently sweetened in four and a half months after the water was turned on to allow the planting of sorghum and Egyptian clover, and all but a few small patches, amounting to about 2 acres out of the total 20 acres, was in condition for alfalfa. The cost of the work at Fresno, exclu-

^a See Circ. No. 11, Bureau of Soils, U. S. Dept. of Agr.

sive of the cost of pumping plant, which may be ignored, as gravity drainage is practicable in most cases, was about \$16 an acre. The cost will vary, of course, with each particular problem, but with land as high priced as that in southern California the economy of the method is self-evident, even if the cost should be many times that in the Fresno demonstration.

Drainage may be accomplished either by open or tile drains. Covered drains, while more expensive to install, will be found more satisfactory, as they do not divide up the fields or offer any obstruction to cultivation, and when installed are permanent and seldom require cleaning, whereas in the open drains vegetation often grows and checks the water flow, and, except in heavy soil, they are continually filling up with washings from the sides of the ditch, or caving in of the banks. With a good system of drains, copious flooding, accompanied by frequent deep cultivation, will afford a speedy reclamation.

The recent severe droughts brought about the sinking of many artesian and shallow wells in the lower part of the valley, and as a result the water table over a very large part of the Los Angeles area has been indirectly lowered. Some of these are flowing wells and in some pumping is necessary. The amount of water developed in this way for irrigation is very great. As irrigation from these two sources is increasing, the water table will be to a certain extent permanently lowered. On lands affected by alkali, most of which have a free and open subsoil, irrigation and rain will gradually wash the old surface accumulations of salts down into the subsoil, and on all alkali lands where the water table has dropped to 7 feet more or less, depending on the capillary power of the soil, flooding, accompanied by cultivation, can be recommended as probably the cheapest method of reclamation though not so permanent as where underdrainage is used. Once reclaimed, should the water table rise in seasons of exceptional rainfall, the land should be given close attention to prevent the possible return of the salts. This may be accomplished either by mulching or by keeping the surface well covered with vegetation.

The prevention of the accumulation of alkali need be considered only in the artesian belt, where much water is wasted. Throughout almost the entire artesian belt there are many wells, almost every landowner having one and often more. These in many instances are allowed to flow year in and year out. Comparatively few are capped, and even when capped they frequently leak badly. In the vicinity of Hynes and Clearwater the water table is thus kept close to the surface, and much land has in this way been damaged, and the damage is on the increase. Practically all the areas of heavier soil are already badly alkaline, and the accumulation is now encroaching on the sandy soils. As this type is of loose and open texture, with only slight capillary power, the advance is slow. To recommend to this community a more

limited use of water is useless, because as soon as the water is turned off the alkali land the grass, which it now supports—furnishing considerable pasturage for dairy cattle and other stock—would be checked almost entirely in its growth and be of little or no value. The creation of a drainage district and the installation of a complete drainage system is therefore the only thing to recommend. This would not only protect the lands now unaffected, but would enable the reclamation of areas now badly alkaline.

AGRICULTURAL METHODS.

In the Los Angeles area the citrus fruits, including orange, lemon, and pomelo orchards, are irrigated from six to ten times a year, the average number of irrigations being probably eight. The furrow method is the one most generally used, a very few growers practicing surface or basin flooding. During the winter and spring following each rain, and later in the season after each irrigation, the land is thoroughly cultivated, the idea being to make a fine mulch and conserve all the moisture possible. Fertilization is generally considered necessary, and practically all the best orchardists resort to it. Both commercial and barnyard manures are used, sometimes separately and sometimes in combination. To keep the trees healthy and fruit free of blemishes the injurious effects of scale and red spider are combated by fumigation with hydrocyanic gas, or by spraying with kerosene emulsions and other preparations. Fumigation, notwithstanding that it costs more, is considered the more satisfactory method, as there are no portions of the tree that escape the gas, while in spraying it is more than likely that some crevices will not be reached. The cost of fumigation depends on the size of the tree. In budded orchards, for ordinary trees in full bearing, the cost varies from 10 to 15 cents, sometimes going as high as 20 cents a tree.

When mature, the oranges and pomelos are cut from the branches with hand clippers and hauled loose in the boxes to the packing house, where they are graded in size and washed if necessary. The fruit is then packed, either wrapped in paper or not, in the regulation-size boxes. Lemons are cut when they are half to three-fourths colored, sorted, washed if necessary, and stored to sweat and cure. After being cured they are ready for packing.

Unlike oranges, lemons bear the year around. The largest crop, however, comes in winter when there is little demand for the fruit. To cure the fruit satisfactorily and keep it until warm weather is a matter of considerable difficulty. Many different methods have been experimented with. Sometimes remarkable success is attained, and again the curing is a partial failure. On the whole the loss in curing is very large, running well up into the thousands of dollars annually. In view of the remarkable success of the Bureau's experiments in tobacco

fermentation, it would seem that a close study of the curing of lemons might result in saving to the growers a part or all of this loss.

The nut crop consists chiefly of English walnuts and almonds, other nuts not being grown on a commercial scale. Shipments of nuts from Los Angeles for 1901 amounted to about 5,227 tons, all of which, with the exception of about 50 tons of almonds, consisted of walnuts. The prices ranged from 8 to 10 cents a pound. Nine to 9½ cents is considered about the average price. The walnut acreage around Rivera, in the Los Metos Valley, is said to be the largest in the country. The trees are set from 40 to 60 feet apart, the latter distance being the better when the trees are mature. In a few instances crops of pumpkins, melons, corn, or winter truck, are grown between the trees. All the important orchards in bearing are, however, given clean culture. Such cultivation allows little humus to accumulate in the soil, and as the greater part of the land devoted to their culture is sandy the deficiency of organic matter is marked. It is suggested that nitrogenous crops, such as pease, should be more extensively grown. These should be planted so as to mature and be turned under in the spring before the trees begin to grow. Barnyard manure should be more generally applied, and in the dairying district below Downey much cheap manure of this description can be obtained. This, because of the short haul, could in almost every case be used to advantage. It would not only improve the texture of the soil, but it is thought that, by increasing the vigor of the trees, it would help prevent the forming of deadwood found in so many of the tree tops. A large majority of the trees are grown under irrigation, the water being applied in early spring and summer. As many as six irrigations are given by some growers, while others do not give more than two or three, and for the area at large the average probably does not exceed four times a year. Both the surface flooding and the furrow methods are used.

The nuts are gathered when they drop, and after being hulled are generally dipped in a solution of chloride of lime, or treated with fumes of sulphur, to brighten and bleach the shells. They are then put into 2-bushel jute sacks and are ready for shipment.

The other deciduous fruits—peaches, apples, apricots, pears, and, to a limited extent, plums, prunes, and nectarines—are grown both with and without irrigation. The crop, when matured, is packed and either hauled to the cannery, dried on trays, or else goes to supply the local fresh-fruit market.

The biennial report of the State horticultural board makes the shipment out of the State, green, for 1901 as follows: From Los Angeles, 175.3 tons; from Orange County, 14.4 tons. Apricots, peaches, pears, and nectarines are sulphured before and sometimes after drying. The fumes blanch the fruit and give it a much more attractive appearance. Before drying, prunes are generally dipped in a hot solution of caustic

lye to crack the skin. After they are dry they are graded into six different sizes. The largest and choicest are often dipped into glycerin to impart the glossy appearance desired by the trade. The fig crop of the area is of very little importance, as this fruit is chiefly grown for family use. A very small pack is successfully crystallized by a firm in Hollywood. Olives are mostly grown without irrigation. The fruit is picked green or ripe for pickling, and ripe for oil.

Grapes are also generally grown without irrigation. The vines are pruned each season while dormant, about six or eight canes with two or three nodes being left to each vine. In the case of a few varieties, grown only on a very small scale, more wood is left. The vineyards are given clean cultivation until the runners interfere. When mature the grapes are cut from the vines, packed in boxes, and hauled to the winery or railroad station. In the latter case they are either dumped into large tanks on flat cars or shipped in boxes. The fertilization suggested for walnuts would also be advisable for grapes. The Anaheim disease, which annihilated so many vineyards at its outbreak, is still present, but is not nearly so violent as at one time, and only a few vines, particularly in the older vineyards, are lost from year to year. Estimates place the production for Artesia and Norwalk, where grapes are most extensively grown, at 3,100 tons in 1902.

Strawberries are becoming a very important minor crop. For 1902 the production is given as 42,695 crates, grown on 515 acres. As the acreage given does not include that near Longbeach and various other places, particularly in the truck gardens, and as many vines have been set out during the last year, it probably does not represent more than two-thirds or three-fourths the present acreage in this fruit. The berries are grown both in single and matted rows, and during the warm months are watered every day and otherwise given close attention. The fruit is picked and packed on the farm for shipment or for local consumption. During the season of plenty the surplus goes to the cannery. Loganberries, blackberries, raspberries, dewberries, and, to a more limited extent, currants and gooseberries, are grown under irrigation and given much care. The crops of those most extensively grown are large, and go to supply the local markets and canneries.

Beans, principally Lima beans, are dry farmed. The land is plowed deep in the fall and given continuous cultivation to keep down the weeds and conserve the moisture. In April or May it is occasionally replowed. The seed is drilled in during the latter part of May and June. Close cultivation is given the young beans until the runners interfere, when horse cultivation ceases. The fields are subsequently gone over occasionally with the hoe to cut out any weeds that may spring up. When the vines begin to mature they are cut

with knives attached to a sled drawn by horse power, cured in the cock and stack, and thrashed like grain. From sixteen to twenty 85-pound sacks per acre is considered a good yield for the Oxnard loam, although the Oxnard sand will not ordinarily produce more than half this quantity.

The land for sugar beets is prepared in the same manner as for beans, being in some instances irrigated just before planting. This crop, which occupies an estimated acreage of 8,000 or 9,000 acres, is sown early in the spring, the greater proportion of the area in March and April. The seed is drilled in rows at intervals of from 14 to 18 inches. When the seedlings are well up they are thinned by hand to about 4 inches in the row. Cultivation continues until the leaves interfere. When mature the roots are loosened with a plow, topped by hand, and hauled to the factory or station. Almost all of the hand work—thinning, hoeing, topping—is done by Japanese or Mexican laborers, under contract, at a fixed price per acre or ton, or a part—one-third or one-fourth—of the crop delivered at the factory. The beets are sold at \$4.25 a ton on a basis of a 15 per cent sugar content, with a deduction or addition of 25 cents a ton for every per cent below or above this standard. The factory also exacts from the producer one-half the cost of railway transportation.

The trucking industry is almost entirely in the hands of Chinese, excepting in the Las Bolsas, Sherman, and Hollywood districts, where it is also engaged in by whites. The crop is large and goes to supply the local, neighboring State, and more distant outside markets. According to the State reports, Los Angeles is the largest shipping point of vegetables in California. In all 26,397 tons were shipped from this area to points outside the State during the season of 1901.

The commercial growing of flowers is carried on in several places in the area. The Oxnard sand seems to be particularly suited to carnations. Two gardens—one at Redondo and the other at Santa Monica—shipped in 1902 about 2,000,000 flowers. Nursery, ornamental, and exotic plants are also grown and go to supply both local and outside markets.

Alfalfa, except on the moister lands, is irrigated or flooded after each cutting. From six to eight crops are cut annually. The average yield amounts in the aggregate to 7 or 8 tons to the acre. On the other hand grain is dry farmed, whether grown for hay or seed. The fields are usually plowed after the first rains. Gang plows operated by steam or horse power are used, and the grain may be sown broadcast before plowing or afterwards, in which case it is covered with a harrow. The hay is cut with a mower and the grain harvested with a header. The heavy fogs make it impracticable to use a combined header and thrasher in gathering the grain, and it is therefore thrashed

with the ordinary separator, run by steam power. Barley is the principal hay and grain crop. It yields on the average from 1 ton to 2 tons of hay, or from 10 to 20 sacks of grain per acre. Twenty sacks is considered a very good crop.

AGRICULTURAL CONDITIONS.

On the whole the farming class in the Los Angeles area is in a prosperous condition. The degree of prosperity, however, depends on local differences of soil, tenure, and methods of farming. As a rule, the farmers engaged in the production of citrus, deciduous, and small fruits, alfalfa, truck, and other products under irrigation are in the best condition financially. While the crops do not always bring large returns they are comparatively certain every year. Under the system of dry farming in some years the crops are very large, though in such years prices are generally low, and there may be one or more successive years of partial or total failure of the crops, and this uncertainty often bears heavily on the farmer. Naturally in the dry-farmed areas the prosperity is not so great as where irrigation is practiced.

The land farmed without irrigation is mostly in the hands of tenants who pay from one-third to one-fourth the crop as rental. A system of tenantry also prevails to a certain extent on the irrigated lands, but there a very large majority of the farmers own their farms. The principal exceptions to this rule are found in the large ranches owned by one or more individuals, and in the land used by the Chinese to grow garden truck. For this land they pay an annual rent of from \$8 to \$16 an acre.

The farms range in size from an acre, devoted to the culture of berries, nursery stock, or flowers, to the large ranches containing thousands of acres, representing the whole or a part of the old Spanish or Mexican land grants. These, together with several individual holdings of a thousand or more acres, cover a very large part of the dry-farmed and irrigated land. The Cerritos and Alamitos grants include the largest individual holdings of irrigated land. This is watered largely by artesian water drawn from local wells. These grants are gradually being laid off in tracts, subdivided into 5, 10, 20, and 40 acre lots, supplied with water and placed on the market, and it is only a question of time when a very large portion of the land to which water can be brought will be dotted with small farms.

In irrigated lands the farms do not ordinarily exceed 100 acres. Where intensive farming is carried on lots of from 5 to 40 acres are in the majority. In the areas dry farmed where grain is grown as many as 1,000 acres are often found under the management of one farmer, and in producing beans 200 or 300 acres is not an uncommon size for a single farm.

In the citrus and deciduous fruit orchards the better class of American and foreign labor is used. As the care of the trees requires some skill, careful and intelligent hands are in demand. The usual wage is about \$30 a month and board. For nonresident owners there are generally a few people who contract to do team work, irrigation, etc., at so much a month or year, or at a fixed amount per day or acre for the different character of work performed. In the truck areas where the industry is carried on by Chinese they employ their own people. When whites carry on the work they hire either Chinese or Japanese laborers. The same labor is also used largely in the production of strawberries and other small fruits. Both the Chinese and Japanese laborers are very efficient. The wage paid is about \$1.50 a day, exclusive of board. Hand work on the beet crop is done almost entirely by Japanese and Mexican laborers under contract. In the dairying industry the labor is drawn chiefly from the American, German, Swedish, and French population. During the grain and bean harvest and in the fruit-gathering season all classes of labor are used. Often the greater number of the work crews are made up of transients. On the whole the labor situation is at present serious, not only in the area, but throughout the State, and notwithstanding the high wages paid for unskilled labor, there is a great scarcity. The fruit growers are giving the matter much consideration in their conventions.

In addition to the growing of fruit and other crops enumerated in preceding chapters, dairying is an important industry. The principal district devoted to this extends from Compton to Buenapark. A part of the milk and cream is shipped to the towns and cities and the remainder is taken up by the different creameries and made into butter and cheese, or condensed milk. The creameries are nearly all operated on the cooperative plan, the stock being owned by the patrons. Some neat cattle, horses, and hogs are also raised. Sheep are kept by very few farmers, but generally in flocks of a thousand or two. In the spring they are grazed on the hills, later, on the stubble and other fields. Poultry raising, both for eggs and meat, is said to be profitable.

The success which has accompanied the recent introduction of Lima beans is certainly very encouraging, and the industry will no doubt prosper. In view of the fact that this bean, which is so widely grown in Ventura County, flourishes on all the different kinds of soil, large crops being produced even on sand, it is recommended that experimental fields be tried on the Fresno fine sand around Gardena, on the Placentia sandy loam, near the coast, and on such areas of the Fresno sand as have the water table close to the surface or are under irrigation. This crop might also do well on the Fresno fine sandy loam and the Santiago silt loam where there is not much alkali.

Citrus fruit culture, which is now so successful around Whittier, with a good water supply should extend along the more or less frostless foothills to Los Angeles. The foothills area extending west from Sherman to the coast is also free from severe frosts, and with water should offer good opportunities for lemon culture. Along the foothills under irrigation winter trucking may be expected to increase. Walnuts may be planted with profit on the Fresno fine sand, on low-lying areas of Oxnard loam, and on level areas of Placentia sandy loam, where irrigation water can be obtained in numerous instances. The irrigated area of the Oxnard loam and the area in the valley south of Inglewood as far as Gardena, situated on the Fresno fine sand, where water can be obtained, offer opportunities for walnut culture. The Fresno sand is in many places well adapted to peach and apricot culture. The grape industry on the same soil may be expected to increase rapidly, as long as the vineyards are not seriously affected by disease. All the above possibilities in the extension of old and new lines of agricultural industry are recognized and the cultivated area is being greatly increased.

The area is well supplied with means of transportation. The Southern Pacific, the Santa Fe, and the San Pedro, Los Angeles and Salt Lake railroads run into Los Angeles, and branches of these lines extend thence to the coast and the many smaller towns. Frequent minor stations and sidings on these lines afford shipping points convenient to almost all parts of the area. The electric railways also carry freight. There are now seven lines running from Los Angeles to various points on the immediate coast, and a line to Downey, Whittier, and other points is now building.

Freight rates are ordinarily high, and on the whole are a serious drawback to the development of the section.

The local markets consist of Los Angeles and the surrounding or near-by towns. The fruits and vegetables consumed in 1902, according to the estimate of the Los Angeles Chamber of Commerce, alone reached a value of \$3,000,000. The quantity of dairy products, poultry, eggs, and live stock consumed is also large and the demand is in excess of the local supply. Meat, butter, cheese, poultry, and eggs are shipped in, not only from the near-by States, but from more eastern markets. The fruit, nuts, truck, and derivative products are shipped to different parts of the United States, and, to a limited extent, to foreign countries.

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