U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA AGRICULTURAL EXPERIMENT STATION, THOMAS F. HUNT, DIRECTOR; CHARLES F. SHAW, IN CHARGE SOIL SURVEY.

SOIL SURVEY OF THE SAN FERNANDO VALLEY AREA, CALIFORNIA.

BY

L. C. HOLMES, IN CHARGE, E. C. ECKMANN, AND G. L. HARRINGTON, OF THE U. S. DEPARTMENT OF AGRICULTURE, AND J. E. GUERNSEY AND C. J. ZINN, OF THE UNIVERSITY OF CALIFORNIA.

MACY H. LAPHAM, INSPECTOR, WESTERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1915.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., November 28, 1916.

SIR: During the field season of 1915 a soil survey was made of the San Fernando Valley area, California. This work was done in cooperation with the University of California Agricultural Experiment Station, and the selection of the area was made after conference with State officials.

I have the honor to transmit herewith the manuscript report and map covering this area and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1915, as provided by law.

Respectfully.

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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MAP.

SOIL SURVEY OF THE SAN FERNANDO VALLEY AREA, CALIFORNIA.

By L. C. HOLMES, In Charge, E. C. ECKMANN, and G. L. HARRINGTON, of the U. S. Department of Agriculture, and J. E. GUERNSEY and C. J. ZINN, of the University of California.—Area inspected by MACY H. LAPHAM.

DESCRIPTION OF THE AREA.

The San Fernando Valley area, California, covers 274 square miles, or 175,360 acres, embracing practically all the San Fernando Valley and a part of the lower mountain slopes and foothills that rise along its margins. The area is roughly rectangular in shape, with an extreme length from east to west of about 24 miles and a width from north to south of 13 or 14 miles. The eastern boundary if extended southward would pass through the city of Los Angeles, which is about 8 miles from the area. This area along a part of its eastern boundary adjoins the Pasadena area,[1] which in turn farther east adjoins the Riverside area.[1] Topographic sheets prepared by the United States Geological Survey were used as bases in the preparation of the accompanying soil map, being revised to show recent changes in culture.

FIG 1.—Sketch map showing location of the San Fernando Valley area, California.

The San Fernando Valley is a mountain-inclosed basin, the sides and floor of which are covered with material laid down in coalescing alluvial fans by streams issuing from the mountains. It is one of the most striking of the many basins of this kind occurring in the State. The Santa Monica Mountains, a range roughly paralleling the coast, lie between the area and the Pacific Coast on the south. Cahuenga Peak, near the southeastern corner of the area, with an elevation of 1,825 feet, and Calabasas Peak, near the southwestern corner, with an elevation of 2,169 feet, mark the highest points of this range. Between these peaks the crest of the range preserves a

[1] Field Operations of the Bureau of Soils, 1915.

remarkably uniform east-and-west direction, with elevations ranging from about 1,000 to 2,000 feet. The southern boundary of the area follows the crest of the range in a general way, so that a strip along the northern slopes of the Santa Monica Mountains from 1 to 3 miles wide, comprising hills, ridges, and slopes, is included. The break to the valley floor along the southern boundary of the area usually is sharp, and in general it follows regular lines. A large part of the included hills is rough and broken and unsuitable for agriculture, but large areas of the more gentle slopes are tillable. A strip of mountainous country 6 or 7 miles wide intervenes between the southwestern part of the area and the ocean, but farther east the coast line trends southward and the Santa Monica Range narrows. The Cahuenga Pass, with an elevation of about 790 feet, leads through the range into the broad open country between Los Angeles and the ocean.

The area is bounded on the west by the Simi Hills and some minor ridges, the greater elevations of which average about 2,000 feet. Some of the valleyward slopes and hills are included in the area, together with some isolated outlying hills rising from the floor of the valley. Both rough and rocky lands and tillable areas are included in this belt. Near the northwestern corner of the area the Santa Susana Pass, at 1,604 feet elevation, leads into the Simi Valley, a small valley outside the area. The Santa Susana Mountains rise abruptly from the northwestern part of the valley to elevations of more than 3,000 feet. Their lower margins extend into the area through some intermediate elevations occupied by eroded younger formations. Some of these lands are agricultural. The area is bounded on the northeast by the western extension of the San Gabriel Mountains (see Pl. I, fig. 1), and a part of this rugged and rocky range, with elevations of over 4,000 feet, the highest in the survey, is included in the area. Most of these mountainous extensions within the area are nonagricultural. One of the most prominent topographic features of the area consists of the Verdugo Mountains in the eastern part. This is an oval range, having a southeast-northwest trend, about 9 miles long by 3 miles wide, which rises boldly from the valley floor to elevations of over 3,000 feet. It is largely rough, stony, and nonagricultural.

The valley itself, inclosed as described above, constitutes the main part of the survey, both in extent and in agricultural importance. In general it is a somewhat oval basin, tilted to the southeast, with its trough much nearer the southern than the northern edge. The rim of the valley proper is rather regular in outline, with minor irregularities at points where ridges jut into the main valley or where minor valleys recede within the hill line. Remarkably sharp

changes in topography separate the basin slopes from the encircling hills. (See Pl. I, fig. 2.) The northern or upper margin of the valley adjoins the hill line at elevations ranging from about 1,000 to 1,500 feet above sea level for most of its length, but the minor valley lying behind the Verdugo Mountains reaches an elevation of over 2,000 feet. (See Pl. II, fig. 1.) From this northern margin the surface slopes away to the south and east by long, gradually decreasing gradients to the trough of the basin along its southern edge. Most of the alluvial filling of the valley has been accomplished by streams entering its northern side, and their varying activities have resulted in modifications of the valley slopes within their influence. In the northwestern part the slopes are rather uniform and gradual. The north-central part has some very steep alluvial fans around the base of the mountains, which soon flatten to the normal slope of approximately 40 to 70 feet per mile. Some very steep fans occur in the Sunland and Burbank regions, lying. respectively, on the north and south sides of the Verdugo Mountains. (See Pl. I, fig. 1.) Relatively little filling has occurred from the west and south sides of the valley, the deposition of material from the north having lengthened the slopes so that in the southeastern corner of the area they reach entirely across the valley, their lower extensions adjoining the southern hill line. Farther west a narrow belt of low coalescing fans has been built by streams from the Santa Monica Mountains and the hills to the west of the valley. The southern margin of the valley floor ranges from about 500 to 850 feet in elevation, while the trough of the valley has an elevation of about 500 feet in the southeastern corner of the area and about 800 feet at Owensmouth, in the western part.

The valley's surface, as a whole, is without many sharp breaks or irregularities, since the steep parts of the fans give way gradually to their more gentle slopes and individual fans merge almost imperceptibly with others.

The continuity of the valley slopes and floor is broken, however, in several places by low hills or ridges, which plainly differ in character from the main valley floor. Such hills and ridges occur in the southern and western parts of the area and between Zelzah and San Fernando, with still more prominent developments west and north of San Fernando and east of Pacoima. Some of these, together with others around the edge of the area, are remnants of older valley surfaces. These constructional surfaces, made up of an aggregate of alluvial fans, and the destructional surfaces described above as comprising the eroded upland or mountainous outer margins of the area, not only differ in topography but represent two main provinces of soil-forming material, as described later.

The entire area is drained by the Los Angeles River, and with the exception of Verdugo Creek, which drains a few square miles in the northeastern part of the survey, this stream forms the only drainage outlet of the area. Tujunga, Little Tujunga, and Pacoima Creeks have their sources in the western part of the San Gabriel Mountains, north and northeast of this area. The first two emerge from their canyons in the northeastern part of the valley and join on the upper valley slopes to form Tujunga Wash. The broad, stony bed of this stream swings a little westward around the Verdugo Mountains through subdividing indistinct channels which then trend southeastward. Many of these shifting surface washes further subdivide and disappear on the sandy slopes, while others continue as distinct sandy channels to the Los Angeles River. Pacoima Creek, known as Pacoima Wash after it emerges on the valley slopes, occupies a broad, stony bed, which passes just east of San Fernando and continues in a southwesterly direction until well down the valley slopes, where it turns southward and gradually disappears in dividing channels.

The above streams constitute the principal drainage ways of the area. Except during periods of heavy rainfall their waters usually disappear in the sands and gravels of the valley slopes soon after they emerge from their narrow canyons. During unusual floods they become destructive torrents, which often cause great damage to the valley slopes. In addition to these streams there are a great many small creeks, averaging almost one to every mile, which discharge around the edge of the entire valley and almost all of which disappear soon after leaving the hills. The larger creeks, such as that west of San Fernando, the one in the northwestern corner of the area near Chatsworth, and Arroyo Calabasas in the southwestern corner, together with a number of the smaller streams, sometimes overflow their fan deposits, as do the larger washes, but damage is not extensive or enduring. The drainage of the valley, except during short periods when the streams are at flood stage, is largely by subsurface flow. The trough of the valley in its western third does not contain an open, well-defined waterway, but beginning near Reseda, a shallow stream gradually deepens and broadens to the east to form the Los Angeles River. This stream gathers the underground waters which are forced to the surface in the lower valley, with considerable surface water in times of flood, hugs the hills on the south side of the lower valley, and leaves the area through a broad, sandy bed in the gap between the Verdugo Mountains and the eastern extension of the Santa Monica Range. It continues southward from this point through Los Angeles and finds an outlet in San Pedro Bay between San Pedro and Long Beach.

The San Fernando Valley area is well drained from an agricultural standpoint, except when excessive volumes of water are emptied on its slopes during flood times. The areas subject to cutting and filling are local. The water table usually is not high except along the Los Angeles River bottom and in small areas elsewhere. As a consequence, alkali soils are not found to any important extent. The high, stony slopes usually are excessively drained.

The area surveyed is much less densely populated than the remainder of the region of southern California contiguous to Los Angeles. This is due to several factors, chief among which is the holding of lands in extensive individual tracts and the scarcity or lack of development of irrigation water for these holdings, as well as for most of the other lands. The large ranches are now being subdivided, sold, and settled, however, new towns are being established, and irrigation is being extended.[1] Owing to the recent development of the area, the census statistics of 1910, the latest available, are not indicative of the present population.

Many of the present settlers are acquiring small tracts for farming on an intensive scale, and a large number of retired business men are developing suburban homesteads.

The most important towns are San Fernando, in the northern part, and Burbank, Lankershim, Van Nuys, and Owensmouth, in the southern part. In addition there are many smaller towns, such as Calabasas, Chatsworth, Sunland, Littlelands, Zelzah, and Pacoima, the first four of which are located around the margins of the valley. Schools, libraries, rural mail delivery, telephones, electric lights, and many other modern conveniences are being provided to meet the needs of the rapidly increasing population.

One of the main lines of the Southern Pacific Railroad enters the lower southeastern part of the area. At Burbank this separates into three branches. One of these continues northwestward along the upper valley slopes through San Fernando and leaves the area on its northern side. Another runs more nearly westward across the center of the valley through Chatsworth, and the third extends along the southern part to Owensmouth and thence northward to Chatsworth. The Pacific Electric Railway from Los Angeles enters the area through Cahuenga Pass to the southeast and extends through Lankershim to Van Nuys, from which point one branch extends northward to San Fernando and another westward to Owensmouth. The steam and electric lines afford good transporta-

[1] In the interim between the completion of the field work and the publication of this report a great deal of the San Fernando Valley has been included within the corporate limits of the city of Los Angeles. Irrigation water supplied by the Los Angeles city aqueduct has been made available and utilized for the growing of many crops.

tion in all parts of the area. Several good boulevards extend the entire length of the valley and with a large number of cross-roads make all parts of the area directly and easily accessible. Automobile routes are being established throughout the valley.

Some agricultural products are marketed locally, and others are shipped out of the area, depending upon their character. The citrus fruits, dried fruits, olive products, wines, and similar articles are shipped to various parts of the country and abroad. Canned fruits, beans, nuts, and sugar-beet products also are largely shipped to more or less distant markets, but the garden crops, dairy products, and green fruits usually are consumed locally or sold in near-by markets.

CLIMATE.

The climate of the area covered by this survey is identical in its main features with that of the adjoining valleys to the east and southeast, the whole of which is popularly known as southern California, or the Los Angeles region. The winters are wet, relatively, and cool, and the summers are dry, with moderate temperatures. This differentiation in seasons is true in practically all parts of the State, but local areas have greater extremes in temperature from winter to summer than other sections, or wider variations in rainfall, occurrence of fog, and other features, so that different climatic conditions prevail in different localities. These local differences are sometimes sensibly greater than might be inferred from a comparison of general climatic data.

In general, the summer temperatures of the area are lower than those of the valley lying farther in the interior of the State, but higher than those of the San Francisco Bay region or areas similarly located along the coast. On the other hand, the winter temperatures are higher than in a large part of the main interior valley or much of the northern coast sections, and there is less fog.

Climatic records are not available for points within the area surveyed, but the records of Weather Bureau stations near the valley are indicative of the local climatic conditions. The following table gives the precipitation as recorded at various stations situated in areas adjacent to the San Fernando Valley:

Mean monthly and annual precipitation at various stations near the San Fernando Valley.

Month.	Los Angeles, 1877–1915; elevation, 293 feet.	Azusa, 1897–1915; elevation, 540 feet.	Riverside, 1880–1915; elevation, 851 feet.	San Bernardino, 1870–1915; elevation, 1,054 feet.	Newhall, 1877–1915; elevation, 1,200 feet.
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
January	2.93	3.91	2.01	3.33	2.93
February	3.27	3.25	1.98	2.99	3.28
March	2.98	4.28	2.34	2.91	3.37
April	1.36	1.00	.68	1.17	1.04
May	.43	.93	.35	.60	.54
June	.10	.15	.05	.08	.07
July	.02	T.	.02	.04	.00
August	.03	.08	.14	.15	.03
September	.08	.28	.14	.14	.40
October	.74	1.01	.54	.60	.73
November	1.38	1.56	.77	1.39	1.37
December	3.98	1.41	1.57	2.57	3.13
Year	17.30	17.86	10.59	15.97	16.89

Los Angeles is several miles southeast of the area, while Azusa, Riverside, and San Bernardino are farther east. Newhall is located several miles north of the area, across the Santa Susana Mountains. The distribution of the rainfall is well illustrated by the records of these stations. The greater part occurs from November to April, inclusive. From May to October the amount is practically negligible, and there are long periods without even a trace of rainfall. The yearly precipitation varies greatly. The stations report several years with less than 10 inches, and in some cases an annual rainfall of less than 5 inches has been recorded. There are many high records of 25 or 30 inches, and more than 40 inches has been recorded. It is probable that the rainfall of the area averages about 15 inches per year, the northern and higher part of the valley having a somewhat greater rainfall than the southern part. The monthly distribution is similar to that shown in the table above. Snow, hail, and thunder storms occur in the high mountains northeast of the area, but have little direct influence on the valley.

The temperatures and frost conditions within the area vary sufficiently in different parts to influence the distribution of the citrus fruit and other crops. The northern, more elevated side of the valley along the base of the inclosing mountains is, in general, warmer and more nearly free from frosts than the lower parts.

The following table gives the temperatures as recorded at the several Weather Bureau stations:

Mean monthly and annual temperature for stations near the San Fernando Valley.

Month.	Los Angeles, 35 years.	Azusa, 10 years.	Riverside, 30 years.	San Bernardino, 20 years.	Newhall, 35 years.
	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*
January	53.1	53.0	51.1	51.5	47.9
February	54.1	53.7	52.7	53.7	50.2
March	55.6	56.3	55.9	55.5	54.1
April	57.6	60.1	60.4	59.8	58.9
May	60.5	62.5	65.2	63.7	64.1
June	64.5	68.0	70.6	69.8	70.7
July	67.4	73.4	76.3	75.6	76.6
August	68.6	73.8	76.4	75.7	77.3
September	66.5	71.0	72.1	71.1	71.5
October	62.3	65.6	64.2	64.2	62.1
November	58.4	59.0	58.2	57.4	54.8
December	55.3	53.9	53.4	52.4	49.5
Year	60.3	62.5	63.0	62.5	61.5

The figures in the above table are representative of conditions in the area surveyed. The average date of the first killing frost in the fall is December 19 at Azusa, December 16 at Riverside, November 18 at San Bernardino, and November 14 at Newhall. The average date of the last killing frost in the spring is February 15 at Riverside, March 14 at San Bernardino, and March 19 at Newhall.

The central and lower parts of the valley are sometimes swept by rather strong winds. The windy periods usually are not of long duration, and their disagreeable features are considerably decreased over the broad valley slopes and floor as the planting of ornamental trees and orchards is extended. Some of the citrus groves around San Fernando are protected by windbreaks.

The climate of the valley is suited to many crops and is very favorable to general agricultural development. It is agreeable and healthful, with very few unpleasant features.

AGRICULTURE.

The earliest agriculture of any consequence in the area seems to have been that initiated by the Mission fathers and their associates. The Mission of San Fernando, located southwest of the present town of that name, was founded in 1798. Apparently, as was usually the case where these missions were founded, one of the first endeavors was toward the establishment of permanent forms of agriculture and the direction of the natives to assist in farming. Grapes, figs, olives, and garden crops were the most important special crops grown, while attention was given also to grain and a small number of other prod-

ucts necessary to meet the needs of the primitive communities. Irrigation was practiced as far as the local, intermittent water supply permitted, and some remains of the original irrigation works may still be seen. Although this early agriculture was very localized and was developed under great difficulty, it is noteworthy that the most modern agriculture of the region, consisting of the growing of irrigated special crops, is but an extension and improvement of the earliest efforts.

Cattle raising and horse raising were extensive industries for many years after agriculture became established, continuing of great importance to about 1850. Sheep raising was also given considerable attention during the latter part of the period when live-stock production was the main industry of the area. Practically all the area came into private ownership at an early date through extensive land grants ranging in size up to many thousands of acres. Some of these original grants were either joined or divided in ownership, while others have remained intact up to the present time. Large individual holdings prevailed from the beginning, and this influenced settlement and the agricultural practices. An important transition in the industries of the area occurred at about the middle of its history, when stock raising gave way to the production of dry-farmed grain, largely wheat and barley. The original acreages devoted to irrigated or specialized crops remained small or increased very slowly. The change from cattle raising to grain farming finally became so complete that practically all the tillable part of the area was devoted to grain production, all other industries being comparatively negligible.

Subsequently some of the larger holdings were subdivided where it was apparent that water for irrigation was available or that dry-farmed fruits could be grown successfully. In this way the localities surrounding San Fernando, Burbank, and Lankershim became centers of small land holdings and intensive agricultural methods in advance of the remainder of the valley. While these subdivisions were important, and a considerable acreage of good soils came to be used for the more advanced types of agriculture, by far the greater part of the valley remained in large holdings and was farmed to grain. It is only within the last 10 years, and largely in the latter part of that period, that most of the western two-thirds of the valley has been subdivided and made available for farming in small tracts. The broad valley slopes, formerly continuous grain fields, are now being rapidly divided into small farms or home acreages, and the improvements ordinarily accompanying a rapid increase in population are being made. An important part of the valley has in this way reached the hands of the small owner and is being developed along the lines of intensive agriculture. In this area the change is a

remarkable one, consisting of a sudden break from a region of enormous land holdings, mainly in its original condition, to one of very intensively cultivated small acreages.

With the exception of the several older communities mentioned, most of the valley is now in the transition stage wherein grain and grain hay are being rapidly displaced by fruit and garden crops. The western two-thirds of the valley is, in point of present acreages, distinctly a grain and hay region, probably four-fifths of that part of the area being devoted to these crops. A very important belt through the center of the valley from Owensmouth to Van Nuys is rapidly changing from grain to sugar beets, beans, melons, pears, apricots, peaches, and many other crops. Grain and grain hay are grown on an extensive acreage, mainly in the western part of the valley, and will no doubt continue to be grown under the system for many years to come in those sections where water for irrigation is not available or, if available, not easily applied. The southeastern part of the area has reached the stage where grain and grain hay are minor crops. The prevailing small holdings are devoted to peaches, apricots, walnuts, grapes, melons, alfalfa, and a wide variety of garden crops and fruits. The northern part of the valley around San Fernando and east and west of that place includes the most important plantings of oranges and lemons in the area. There are also extensive plantings of olives, grain, and many of the crops grown in the southeastern part of the area. The uncultivated lands usually are areas of inferior soils or unfavorable topography. Several square miles of the valley slopes between San Fernando and Burbank remain untilled; the same is true of a part of the continuous rim of hilly land surrounding the valley or partly included with it, as the Verdugo Mountains.

Practically all the crops of the area are income crops. In the descriptions of the individual soil types in subsequent pages of this report mention of the distribution of the various products is made. The relative importance, distribution, and uses of the various crops are dependent on a number of factors, including soil, moisture, and frost or other weather conditions and markets.

Grain and grain hay, which are more extensively grown than any other crops, consist almost entirely of barley and wheat. They are grown without irrigation both under continuous-cropping and under summer-fallow methods. The grain is sowed in the late fall and matured by the winter and spring rains, the weather conditions often determining whether it is to be cut for hay or for the grain. In general these crops are grown on soils that are unsuited to more intensive crops because of a lack of irrigation water. In consequence they cover a wide range of soils, from hill to valley soils, or soils of

local variations in texture, with corresponding variations in yields. Land values have advanced to the point where these crops can hardly be considered profitable on the valley soils, yet they will no doubt continue as the most profitable crops possible until water is supplied for the irrigation of others. The hill soils and parts of the valley where water can not be supplied probably will remain in grain or hay, but with development the grain acreage is generally decreasing.

There are important plantings of a wide variety of fruits, some of which are being somewhat localized while others are distributed in individual orchards scattered through regions of diversified farming.

The citrus fruits are not as yet relatively so important in the San Fernando Valley as they are farther east in the region extending from Pasadena to Riverside and San Bernardino. The northern part of the valley within a radius of several miles from San Fernando contains nearly all the plantings. Smaller plantings occur near Sunland and Burbank. Oranges and lemons are grown to about an equal extent, each probably on about 2,000 acres. These fruits are grown largely on loam and sandy loam soils, irrigation being invariably necessary (see Pl. II, fig. 2, and Pl. III, figs. 1 and 2). The location of citrus orchards is limited by frost conditions, and it appears that only a small percentage of the area is suited to the production of these fruits. The northern part of the valley, around the bases of the encircling hills, is most favorable, and the present acreages are being extended as water is made available for irrigation. Protected localities elsewhere in the area will no doubt be found suitable for growing the citrus fruits, but it is not likely that the main valley slopes will be utilized for these crops. Windbreaks are planted for protection from cold winds north of San Fernando. Organic matter is supplied by making applications of manure or by plowing under cover crops, and some commercial fertilizer is used. The production of citrus fruits is a highly specialized form of agriculture. It is highly developed elsewhere in California, and an important industry may become established in the San Fernando Valley.

Peaches are an important crop in the southeastern part of the area, with smaller plantings farther west and north. They are grown for the most part on soils of sand, sandy loam or fine sandy loam texture, both with and without irrigation. Some of the very sandy soils retain water remarkably well, considering their texture, and give very good results with this fruit even without irrigation (see Pl. IV, fig. 1). Several table, canning, and drying varieties are grown, and the yields and profits vary widely.

Apricots have about the same distribution and acreage as peaches, orchards of the two fruits often being seen together. Apricots, like the peaches, are grown both with and without irrigation. The fruit is canned, dried or sold fresh, the disposition of the crop sometimes being influenced by market conditions at the times of ripening.

A few small apple orchards occur southeast of Lankershim and elsewhere in the area, but it is not likely that this fruit will be extensively planted, for it is probable that climatic and other conditions will make other crops more profitable.

There are several newly planted orchards of pears between Owensmouth and Van Nuys, with a smaller acreage in the southeastern part of the valley, and it is possible that this fruit will be found worthy of more attention.

Walnuts are grown on an aggregate of several hundred acres, mainly in the southeastern part of the area, with smaller acreages scattered through the region west and north of Van Nuys. The crop is grown without irrigation on the moister soils, but with irrigation in other places, soils of sandy loam and fine sandy loam textures predominating where plantings have been made. Intertilled crops are often grown during the early life of the orchard. It is considered one of the most consistently profitable crops of the area.

An exceptionally large olive grove is located northwest of San Fernando, and this grove and several others of relatively small size elsewhere in the valley constitute about 1,500 acres of bearing trees. Most of the olives are grown without irrigation, and yields are somewhat variable. The Nevadillo is the principal oil olive, while the Manzanillo and Mission are the main pickling varieties, although small sizes of the latter kinds are also used for oil. The olive industry does not seem to be increasing in the San Fernando Valley. Many of the present plantings are on very light textured soils where most other tree crops can not be produced without irrigation.

There is a large number of vineyards in the valley, their total extent being between 2,000 and 3,000 acres. They are largely localized in the vicinity of Burbank and in the Sunland region, with smaller acreages elsewhere. (See Pl. I, figs. 1 and 2.) Grapes usually are grown without irrigation in this area and are nearly always located on rather sandy, gravelly or stony soils that are hardly capable of producing any other fruit without irrigation. Table, raisin, and wine varieties are grown, but the wine grapes predominate.

About 2,000 acres are devoted to alfalfa, nearly all this acreage occurring in the southeastern part of the area. The soils are deep and moist, so that it is possible to produce the crop with a minimum of irrigation, or even without irrigation. The acreage of this crop

S7824

FIG. 1.—VIEW NEAR SUNLAND LOOKING TOWARD LITTLELANDS AND THE SAN GABRIEL MOUNTAINS.

Alluvial fan slopes of valley occupied by soils of the Hanford series.

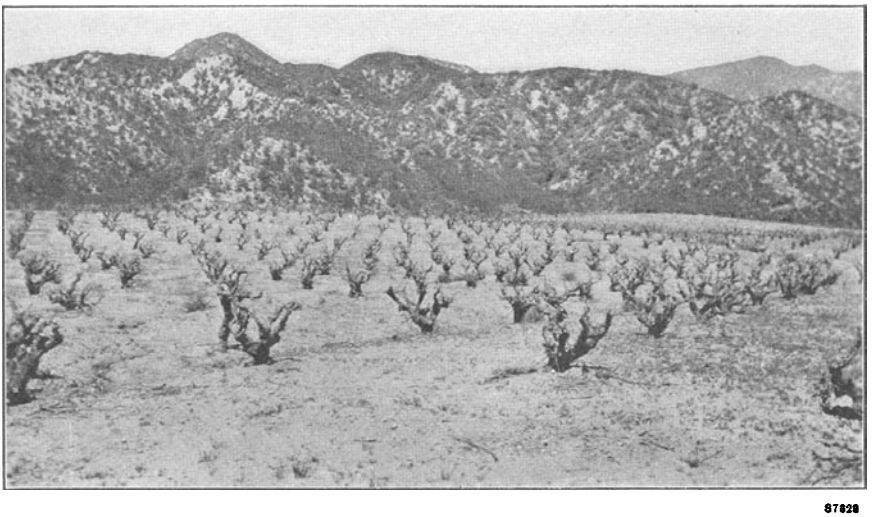

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FIG. 2.—NONIRRIGATED VINEYARD ON HIGH ALLUVIAL FAN OCCUPIED BY SOILS OF THE HANFORD SERIES, NEAR PACOIMA CANYON.

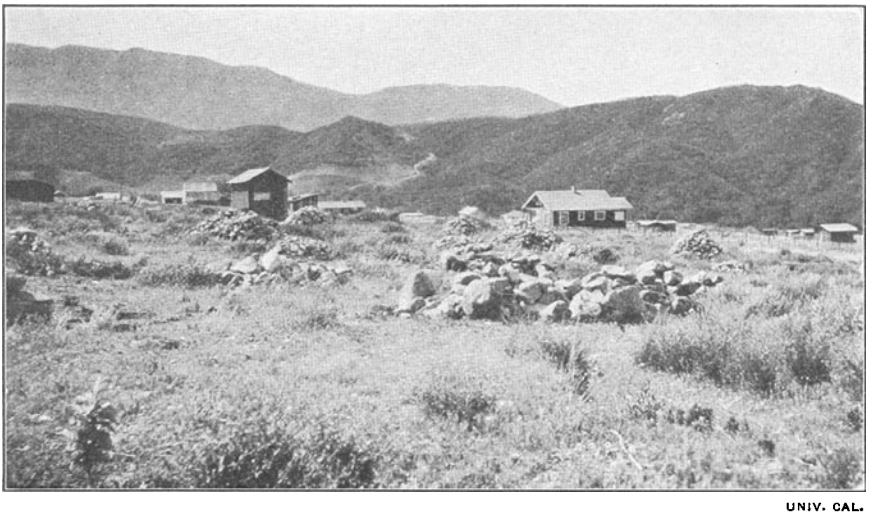

FIG. 1.—HIGH ALLUVIAL FAN OCCUPIED BY STONY SOILS OF THE HANFORD SERIES, NEAR LITTLELANDS. VERDUGO MOUNTAINS IN DISTANCE.

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FIG. 2.—ORANGES ON SOILS OF THE HANFORD SERIES, NEAR SAN FERNANDO.

is not likely to increase greatly, owing to its heavy water requirements on all the more sandy, thoroughly drained soils. It appears probable that in most parts of the valley where sufficient water is available the land can be more profitably used in the growing of some of the fruit and garden crops. The alfalfa is grown mainly in support of dairying and hog raising, although some of the crop is baled and sold.

Probably somewhat less than 2,000 acres were devoted to sugar beets in 1915. The general appearance of the crop and the yields seem to be satisfactory, although the industry is practically new to the section in which the largest acreages are grown, viz, between Owensmouth and Van Nuys. The crop is irrigated, but the retentive nature of the soils utilized reduces the necessity of applying large quantities of water.

In addition to these main crops a large number of garden and truck crops, such as beans and various kinds of melons, are grown, sometimes in considerable quantities. Strawberries and various bramble berries, nursery stock, and other crops are often grown between the rows in young orchards or separately.

There is a decided tendency in this area toward the development of smaller farms and a more intensive utilization of the land. Similar soils under similar climatic conditions have been farmed for long periods in near-by parts of Southern California, and the experience in these sections is of value in the development of the newer and well suited to local conditions.

and well suited to local conditions.

SOILS.

The soils of the San Fernando area are identified with three main provinces or groups of soil-forming materials, which differ not only in origin, mode of formation, and other features, but are further differentiated by rather striking contrasts in topography and in the character of the underlying material. The soils of the first group are derived from the weathering and disintegration in place of consolidated rocks and are designated as residual soils. The soils of the second group are derived from the weathering and modification of old unconsolidated water-laid deposits, designated as coastal-plain and old valley-filling soils, and those of the third group have been deposited as recent alluvium on valley slopes and floors without appreciable subsequent weathering or internal modifications, and are designated as recent-alluvial soils.

As regards location and topography, the first group is coextensive with the hilly or mountainous belt encircling the area. The second group occupies low hills, ridges or remnants of older valley sur-

faces which sometimes are detached from the surrounding mountains, but more often occur as low projecting shoulders or fragments of old alluvial fans around the valley's edge, and are intermediate in elevation between the first and third groups. The third group, by far the most important both in extent and agricultural value, covers all the central part of the area as broad coalescing alluvial fans forming the sides and trough of the valley.

Each of these three provinces contain different kinds of soils, which are recognized as belonging to different series, each series having not only the common characteristics of the province but also a similar color, subsoil, and parent material. The soil series is further subdivided, on the basis of texture, into soil types, the latter being the unit of classification.

The residual soils are represented in this survey by four series, including seven types; the coastal-plain and old valley-filling soils by one series, with four types, and the recent-alluvial soils by four series, including 22 types. In addition three groups of miscellaneous material are shown.

Classification of Soil Series.

RESIDUAL SOILS.

The residual soils lie on foothill ranges and mountainous slopes, which reach into this survey as lower extensions of larger areas beyond its limits. In the present survey two main classes of rock contribute to the formation of the soils of this Province, igneous rocks, mainly granite and gneiss, and sedimentary rocks, mainly shale and sandstone. The granitic rocks occur in the Verdugo Mountains and most of the strip bordering the northeastern part of the survey, while the sedimentary rocks occur along its southern, western, and northwestern margins.

The occurrence of the granitic rocks is largely in rough mountainous districts, where erosion is severe and only a scant soil covering is present. (See Pl. II, fig. 1.) A large part of these sections is mapped as Rough stony land. Some of the lower, more deeply weathered mountain slopes, on which the granitic rocks give rise to soils of the Holland series, have some agricultural value.

The residual soils derived from the sedimentary rocks are separated, mainly on the basis of color, into the Altamont, Sites, and Diablo series. They are confined to the foothills around the margin of the valley or to small knobs rising from its floor, and are associated with some steep, broken surfaces mapped as Rough broken land (see Pl. IV, fig. 2). These soils are mainly used for grain and hay production and do not differ essentially from the soils of these series mapped elsewhere in the State.

The residual soils are relatively unimportant in this area, but the series they represent have been mapped extensively in other parts of the State. As a class they are diversified in topography, often excessively drained, and are used only locally for intensive farming. They usually are elevated above sources of irrigation water and contribute but little to the production of fruit and truck crops. At the same time they do not conserve soil moisture well enough to be used generally for dry farming and remain very largely in grain and hay.

Holland series.—The soils of the Holland series are brown, or slightly reddish brown when wet, micaceous, and usually friable. They sometimes extend to the parent rock with little variation, but a lighter brown or yellowish-brown subsoil is often present. A reddish-brown, compact, and heavier textured subsoil is prominently developed in some localities. The depth of the soil varies from a few inches to several feet, with the parent rock usually partially disintegrated in its upper part. The Holland soils are residual from granitic rocks, and the character of the parent material is indicated by frequent massive rock outcrops or scattered bowlders. The surface is rolling, hilly, or mountainous. Drainage is well established and is excessive in the steeper areas. The soils are extensive in some parts of the State where granitic rocks are prominent. They have a small total area in this survey and are of little agricultural importance. Three members of the series are mapped, the Holland stony loam, coarse sandy loam, and loam.

Altamont series.—The soils of the Altamont series are brown or dark brown, with variations of reddish brown. Gravel and rock fragments are present in places in both soil and subsoil. The subsoils usually are lighter colored than the surface soils, being light brown or yellowish brown. The soils apparently are lower in lime and organic matter than those of the Diablo series, but the subsoils occasionally are rather calcareous. The total depth of soil and subsoil varies considerably, bedrock often being encountered at less than 3 feet from the surface, although depths of 6 feet or more in the deeply weathered areas are not uncommon. These soils occupy rolling, hilly, or even mountainous locations and are eroded in places on the steeper slopes. Rock outcrop is not so abundant as in the soils derived from igneous rocks, but is locally prominent. The soils are generally well drained and retentive of moisture where of average depth, but shallow, droughty variations occur. They are residual in origin and are typically derived from shales and sandstones, or in some cases from conglomerates. The parent material is in some places only feebly consolidated. This series is one of the most extensive in the State. One type, the Altamont clay loam, is mapped in this area, but it includes variations in texture and in

color, being dark in places and resembling Diablo material. Grain and hay are by far the most important crops, but fruits and other special crops are grown in some localities.

Sites series.—These soils are typically light red or red, with variations to reddish brown. They usually are underlain at a depth of less than 30 inches by heavier textured, very compact subsoils which are redder than the surface material. Gravel and rock fragments are present in but few places, though rock outcrops are locally abundant. The soils are residual in origin, typically from consolidated sedimentary rocks. In many places they are derived from sandstone. They are differentiated from the associated Altamont and Diablo series by differences in color. The surface usually is rolling or hilly, the topography and the drainage being comparable with those of the Altamont series. The Sites soils are not extensive in this area, only one type—the sandy loam—being recognized. This soil is used mainly for the production of grain and hay.

Diablo series.—The soils of the Diablo series are dark gray to black in color, becoming darker when wet. Lighter colored, grayish phases on shallow slopes are not infrequent. They grade by brownish transitions into the soils of the associated Altamont series. The dark-colored surface soils often rest directly upon the rock, but typically they are underlain by lighter colored, grayish, brownish or yellowish subsoils. The soil apparently is high in organic matter, and both soil and subsoil are rather calcareous. Shallow variations in which the rock lies within a few inches of the surface are locally prominent, while in some cases the soil and subsoil together have a depth of several feet. The soils are residual from consolidated sedimentary rocks, usually shales and sandstones of calcareous nature. The series is extensive in many parts of the State. The soils are well drained and occupy foothills and mountains. The topography is rolling to steep, although usually smoothly rounded. The Diablo series is represented in this survey by two types, the clay loam and clay adobe. As mapped in this survey they include some material closely related to the Altamont. These soils are used largely for grain and hay, and locally for fruit and garden crops.

COASTAL-PLAIN AND OLD VALLEY-FILLING SOILS.

The remnants of old alluvial fans and unconsolidated deposits give rise to one series of soils in this area, the Ramona. This series constitutes only a small part of the area of the valley. The Ramona series typically occupies old fans or valley surfaces, the material of which was originally derived from granitic rocks. Owing to changes in stream levels and the consequent erosion of the older deposits, these soils are elevated above the recent-alluvial soils, and are subject to slow but continuous erosion. They occur mainly around the

edge of the area or as occasional knobs within the valley. A number of old deposits, derived in part at least from sedimentary rocks, are included with the series in this survey.

The soils derived from this class of material are typically brown, with heavier textured, compact subsoils. The difference between soil and subsoil is not distinct in the stony areas. As with the residual soils, those of the old valley-filling deposits are not nearly so important as the recent-alluvial soils. They are more prominent elsewhere in the State, where many other series of the same province are encountered. They are essentially old-alluvial soils, or old water-laid deposits which have remained unconsolidated, yet have been weathered and internally modified. Hardpan layers, distinct subsoils, and changes in color are some of the main characteristics that differentiate the various series of this province from the recent-alluvial soils. The unconsolidated character of the parent material distinguishes them from the residual soils. They are often lower in value for agriculture than the recent-alluvial soils but higher in value than the residual soils, although their agricultural value is widely variable.

Ramona series.—The Ramona soils are typically brown; in places they are slightly reddish brown or grayish brown. They are separated, on the basis of color, from the Placentia series, which have red soils of similar origin but which do not occur in this survey. The Ramona soils usually are not micaceous, but the breaking down of granitic fragments sometimes yields considerable mica. A heavier textured and often very compact, reddish-brown or reddish subsoil usually is present at depths of less than 24 inches. In the case of the gravelly or stony types this distinct subsoil may be absent. The material comprising the series originally occupied alluvial fans, which probably were at one time like the present alluvial fans of the Hanford series. Elevation of the deposits or changes in stream levels left them subject to erosion and weathering, and they now occupy elevations intermediate between the recent-alluvial soils and the higher lying residual soils. The material seems to have been originally derived largely from granitic rocks. The topography usually is uneven, with a tendency toward a hog-wallow surface in certain places. Drainage is good except during rainy seasons, when the heavy subsoils restrict percolation.

RECENT-ALLUVIAL SOILS.

The soils of this province are the most important of the area, both in extent and in agricultural value. They occupy the recent alluvial fans which make up practically all the valley slopes, and are derived as wash from the rocks giving rise to the residual soils, with possibly some additions from other rocks outside the area. A

rather close association is sometimes apparent between the character of the parent rock and the recent-alluvial soil on the valley slopes below. This group includes four series, the Hanford, the Tujunga, the Yolo, and the Dublin. The Hanford and the Tujunga soils are derived mainly from granitic rocks. The western half of the valley is bounded by foothills and mountains largely composed of shale and sandstone, and the valley slopes are largely covered with recent alluvium derived as wash from the sedimentary rocks, representing the Yolo and the Dublin series.

The recent-alluvial soils grade into one another, usually without distinct changes in topography, color or character of soil material, so that it is often difficult to establish definite boundaries. These soils produce most of the agricultural products, not only in this area but throughout the State. They usually are friable, with no consistent difference between soil and subsoil, and because of their position they are the most easily irrigated soils of their locality. In this survey the types on the average are relatively sandy, with some stony soils which are practically nonagricultural, but most of the valley is covered by good agricultural soils.

Hanford series.—The soils of the Hanford series are typically light brown, light grayish brown or buff in color. They are micaceous, friable, and porous, and may extend without distinct subsoils to a depth of 6 feet or more. The subsoils are often characterized by colors slightly lighter than those of the surface soils, and frequently are made up of strata of various textures. These soils are typically recent alluvial in character and have been deposited both as alluvial-form and stream-bottom or low, recent-terrace materials. They sometimes occupy very steep alluvial fans which descend to the valley floors by decreasing gradients. There are marked contrasts in texture and agricultural value between the stony types of the upper fans and the finer sediments of lower deposition. In general the series is well drained. Drainage is locally restricted, and some areas along the streams are subject to overflow. Granitic rocks yield the main part of the transported material making up this series, but there are also local contributions from other sources.

The Hanford series in this area is found largely on alluvial fans, the upper, steeper parts comprising excessively stony types which differ widely in value from the other soils of this series (see Pl. II, fig. 1). The greater part of the series has a high value for crop production (see Pl. I, figs. 1 and 2, and Pl. II, fig. 2). The soils of the Hanford series occupy a north and south belt through the center of the valley, with many detached areas elsewhere in the survey. Six types are mapped. The lighter colored variations pass by imperceptible degrees into the Tujunga soils.

Tujunga series.—The soils of the Tujunga series are light gray or light brownish gray in color, the brownish variations being comparable with the Hanford soils. They are usually micaceous, are easily tilled, and, with the exception of the coarse-textured and stony types, are retentive of moisture. There is no consistent difference between the soil and subsoil, owing to the irregular methods of deposition. The soil section may include variable strata of material ranging in texture from very fine to very coarse, but in important areas the texture is rather uniform to a depth of 6 feet or more. These soils occupy recent alluvial fans, stream bottoms, and low terraces, and are deposited by present streams. In mode of formation, source of material, and topographic features they do not differ essentially from the Hanford soils, from which they are separated on the basis of color.

In this survey some of the Tujunga soils are very stony and practically nonagricultural, but on the lower valley slopes the finer textured soils of the series are among the most valuable of the area (see Pl. IV, fig. 1). They cover an extensive area in the eastern third of the valley. Five members of the series are recognized.

Yolo series.—The Yolo soils are brown, light brown, or dark grayish brown. This series is separated from the associated Dublin series on the basis of color. The subsoils are typically lighter in color than the surface material, varying from a lighter brown to yellowish brown, although the difference in color is not always marked. There is no consistent difference in texture between the surface soil and subsoil, and the latter may be similar to, heavier than, or lighter than the surface material, or it may be made up of alternating strata of different textures. The soils are recent alluvial in origin and occur as alluvial fans, sometimes merging to form broad valley slopes, or as stream-bottom and low, recent-terrace deposits. The material is typically derived and transported from a rather wide range of sedimentary and metamorphosed sedimentary rocks as wash, but as mapped in this area it is in part derived as wash from upland unconsolidated deposits of old water-laid character. The surface is gently sloping, smooth or only slightly uneven. Drainage usually is good. These soils are among the most valuable in the State, and under various conditions of climate produce a very wide range of crops (see Pl. III, fig. 2). The Yolo series is represented in this area by eight types.

Dublin series.—The Dublin series includes dark-gray to black soils, which often merge through brownish transitions with the soils of the Yolo series. They are typically nonmicaceous. The subsoils are grayish or brownish and lighter in color than the surface material, although the dark-colored soil extends to a depth of 6 feet or more in some places. These soils are recent alluvial in origin and occupy alluvial form, stream bottoms, flats or terraces, and in places an ag-

gregate of low, stream-built ridges. The drainage is good over most of the lighter textured types, but the heavy members often occupy somewhat depressed areas where surface drainage is stagnated during the rainy season. The Dublin soils are derived as transported material typically from sedimentary or metamorphosed sedimentary rocks, but as mapped they are mixed in places with alluvium from other sources. A more calcareous nature and a higher organic-matter content seem to distinguish these soils from the associated Yolo series. They are locally valuable agricultural soils, and are extensive in the State. Some of the clayey types are difficult to till, but the lighter textured soils are productive and are well suited to a wide range of crops. (See Pl. III, fig. 1.) As mapped in this survey the Dublin series includes a variation of browner color, with calcareous and marly subsoils and derived from older modified material related to the old valley-filling deposits. If more extensive this would have been recognized and mapped as a distinct type of the Antioch series of the old valley-filling group of soils.

MISCELLANEOUS MATERIAL.

Three classes of miscellaneous material are mapped in this area, Rough broken land, Rough stony land, and Riverwash. These are essentially nonagricultural in character, the first two making up the areas of stony and broken land associated with the residual soils, while the last occupies the flood-swept beds of streams crossing the alluvial fans.

The following table gives the actual and relative extent of the various soils of the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Rough stony land	24,064	13.7	Hanford silt loam	2,880	1.6
Rough broken land	19,968	11.4	Yolo gravelly loam	2,624	1.5
Yolo loam	15,680	8.9	Hanford stony sandy loam	2,368	1.4
Tujunga fine sandy loam	10,432	6.0	Dublin loam	2,240	1.3
Altamont clay loam	8,512	4.9	Diablo clay loam	2,176	1.2
Hanford sandy loam	6,976	4.0	Yolo silty clay loam	2,112	1.2
Tujunga sand	6,848	3.9	Hanford loamy coarse sand	1,664	1.0
Hanford fine sandy loam	6,528	3.7	Dublin clay adobe	1,664	1.0
Hanford gravelly sandy loam	6,464	3.7	Ramona loam	1,600	.9
Yolo sandy loam	6,208	3.5	Ramona sandy loam	1,472	.8
Yolo gravelly sandy loam	6,016	3.4	Holland coarse sandy loam	1,088	.6
Diablo clay adobe	5,120	2.9	Tujunga stony sand	1,024	.6
Yolo silt loam	4,544	2.6	Holland loam	960	.6
Yolo clay loam	4,416	2.5	Ramona fine sandy loam	704	.4
Yolo fine sandy loam	4,032	2.3	Sites sandy loam	448	.3
Dublin clay loam	3,584	2.2	Ramona stony sandy loam	384	.2
Brown phase	320		Holland stony loam	128	1
Tujunga gravelly sand	3,584	2.0			
Riverwash	3,392	1.9	Total	175,360	
Tujunga sandy loam	3,136	1.8			

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FIG. 1.—YOUNG LEMON ORCHARD ON DUBLIN CLAY LOAM, LOOKING DOWN ALLUVIAL FAN SLOPE, NEAR SAN FERNANDO.

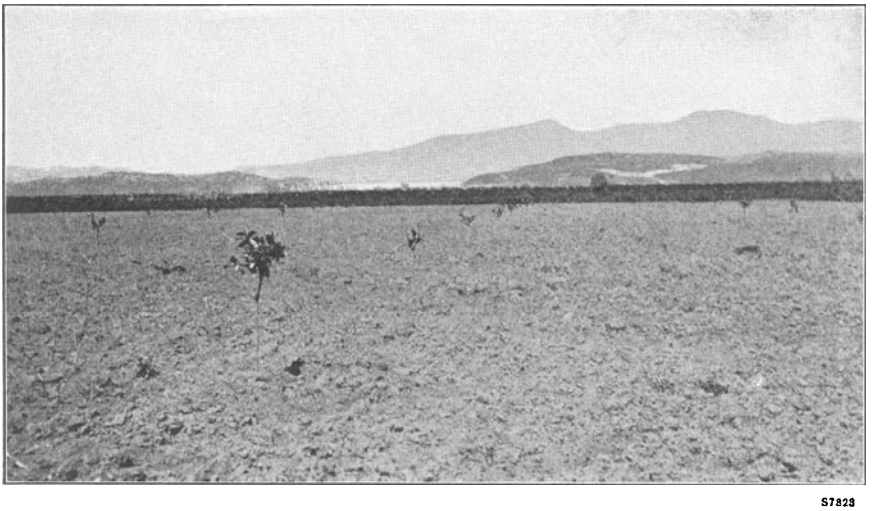

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FIG. 2.—YOUNG LEMON ORCHARD ON SOILS OF THE YOLO SERIES, NEAR SAN FERNANDO MISSION.

DESCRIPTION OF SOIL TYPES.

HOLLAND STONY LOAM.

The Holland stony loam consists of a brown or reddish-brown, light-textured loam carrying considerable quantities of gritty material and a small percentage of mica. This type is moderately loose in structure and only fairly retentive of moisture. It includes some sandy loam material, which differs from the loam only in texture. Excessive quantities of stones, largely of granite and gneiss, ranging in size up to several feet in diameter, are scattered through the soil mass and over the surface. A part of the type seems to be derived from masses of granite and gneiss bowlders with finer interstitial material, and in this variation there is little difference between surface soil and subsoil except that the latter is reddish brown in places. The type generally grades by varying degrees of disintegration into the underlying granites at depths ranging from a few inches to several feet.

The type is of small extent, occupying one small area west of Sunland and another southeast of Littlelands. The surface is hilly and uneven by reason of the stone content, and the type has excessive drainage.

The Holland stony loam usually is covered with brush, and most of the type remains in its native state. Some grain and grain hay are grown, but the agricultural value of the type is at best low, and the very stony areas are practically nonagricultural.

HOLLAND COARSE SANDY LOAM.

The Holland coarse sandy loam consists of a brown or slightly reddish brown, coarse-textured sandy loam of rather friable structure. The soil usually is micaceous, and its origin is indicated by the presence of small quantities of undecomposed granite. Loose granite rocks and massive rock outcrop are of frequent occurrence in some parts of the type, but absent in others. Where the soil has good depth it is fairly retentive of moisture, but the greater part of the type is shallow. The soil in places grades into disintegrating granite at a depth of 12 to 36 inches or more without a distinct subsoil. Another variation has a heavier textured, compact, reddish-brown loam or clay loam subsoil overlying the parent rock. The subsoil in this area is not usually so distinct and heavy textured as is characteristic of the series in some other places.

The Holland coarse sandy loam is not extensive, being practically confined to some irregular areas on the lower slopes of the Verdugo Mountains in the eastern part. The boundaries separating it from the alluvial soils on its lower margin usually are distinct, but it is more arbitrarily separated from the associated Rough stony land.

The boundary is likewise not very distinct in places between it and the Altamont clay loam.

The type has a rolling and somewhat dissected topography, which becomes steeper as the areas of Rough stony land are approached. Drainage is nearly always excessive, and run-off is rather rapid, although the type is not injured by erosion. Much of the type can be tilled only with great difficulty owing to its steep surface and shallow character. A part of this type is derived from the weathering of masses of unconsolidated granitic bowlders and finer material, and to this extent departs from the typical origin of the series, which is granitic rocks in place.

Untilled areas of the Holland coarse sandy loam support a growth of brush. Some areas have been cleared and planted to orchards, but the total extent of these is small. A few small citrus groves are located on the type, being in some instances the continuation of larger plantings on the lower lying recent-alluvial soils. Some apricots and peaches are grown, with a variety of garden and truck crops and grain and grain hay. Tillage can probably be extended over some of the "hogbacks" and slopes now covered with brush, but irrigation will usually be necessary for most of the crops other than hay and grain. The position of this soil above sources of irrigation water tends to restrict its intensive use.

HOLLAND LOAM.

The Holland loam typically consists of a brown or slightly reddish brown, light-textured loam, usually carrying small quantities of mica. Like the sandy loam member of the same series, it often contains gritty material or partially decomposed granitic rock. Outcrops and scattered rocks are numerous in some places and almost entirely absent in others. The texture is somewhat variable; locally the type approaches in texture the Holland coarse sandy loam. In some instances the soil grades into the underlying disintegrating granite with little change in color or texture. In other places the soil rests at a depth of 12 to 36 inches upon a reddish-brown or red, very compact loam or clay loam. This denser subsoil layer is fairly permeable to roots and water, and it grades in turn into the partially disintegrated granite or gneiss. The total depth of soil and subsoil ranges from 1 or 2 feet to more than 6 feet, but usually is less than 6 feet.

The Holland loam occupies some irregular areas in the northeastern part of the survey, along the lower northern slopes of the Verdugo Mountains, with an area of less importance east of Littlelands. The total extent of this soil is not great.

This type is rather similar to the Holland coarse sandy loam in topography and drainage. It occupies the lower slopes and ridges

of mountains, along the contact with the recent-alluvial soils. The surface is sloping, sharply rolling or hilly, and some of the higher, rougher areas are separated rather arbitrarily from Rough stony land or Rough broken land. Most of the type as mapped can be tilled only with difficulty, and there are included many steep slopes and sides of ravines that are untillable. Drainage is adequate, and the run-off is excessive during the rainy period, although the type readily absorbs water.

Comparatively little of the Holland loam is farmed, although it is probable that the cultivated area will gradually be extended. A few small citrus and deciduous fruit orchards are located wholly or in part upon this soil, and where sufficiently watered they give good results. Small acreages are devoted to dry-farmed hay and grain, but the rough character of the type has discouraged development, except in patchy fields contiguous to lower lying soils that are more easily farmed.

ALTAMONT CLAY LOAM.

The Altamont clay loam consists typically of a brown to dark-brown rather friable clay loam, which has a slight tendency toward an adobe structure over much of its extent and a good water-holding capacity. The type, as mapped in this area, is subject to many local variations in both color and texture. Material of dark-gray color and heavier texture, properly belonging to the Diablo series, is often included, but such variations were not sufficiently heavy to warrant separation. The opposite tendency toward lighter textures is also frequent, and small patches of the Altamont loam are included. In some places the included areas of Altamont loam are quite well defined, and if more extensive these would be shown on the map by separate color.

A part of the area of this type just northeast of Cahuenga Peak consists of a brown clay. This variation is particularly noticeable on some of the lower, more deeply weathered slopes. The surface soil of the Altamont clay loam sometimes extends to bedrock, but it is typically underlain at depths of several inches to 2 or 3 feet by lighter colored, yellowish-brown or light-brown subsoils of variable texture but approximately a clay loam. The combined depth of the surface soil and subsoil is sometimes 6 feet or more. Usually the underlying shales and sandstones are encountered at less than 6 feet and often at less than 4 feet. Local shallow areas are common, and the depth of soil usually decreases up the hill slopes, although a moderate depth may occur on the tops of the ridges or hills. Rock outcrop is not frequent, but ledges of more resistant sandstone occasionally show over small areas. The area near Cahuenga Peak

contains locally some granite outcrop. This is not typical. Local slopes or ridges are sometimes slightly gravelly, and small quantities of angular cherty material or shale fragments and disintegrating sandstone fragments occasionally are scattered over the surface near the tops of knolls. Although the type is typically derived from shales and sandstones, some of the areas lying west of San Fernando and near Calabasas are underlain by only partially consolidated or unconsolidated clays, sands, and gravels.

The included loam areas typically consist of a brown, friable loam extending to a depth of 12 to 24 inches and usually underlain by a lighter brown or yellowish-brown subsoil resting on the parent rock ordinarily at depths of less than 5 feet. The soil of this variation sometimes carries small quantities of shale fragments, but usually it is free from gravel. Minor fine sandy loam or sandy loam variations are included, the area south of Calabasas being largely of the latter texture. Some of the soil is shallow and of low water-holding capacity in this survey.

The Altamont clay loam occupies some rather extensive areas along the southern margin of the survey, and also in its northern part, both east and west of San Fernando. Small, scattered areas are mapped elsewhere. Rough broken land contains some agricultural land which if differentiated would be recognized as this type.

The included areas of loam texture are of very limited extent, occurring as a number of small bodies about 1 mile south and southwest of Calabasas, with several others of very small extent northeast of Pacoima.

The Altamont clay loam is prevailingly rolling or hilly. Drainage is well developed. In the southern part of the survey the type includes some steep slopes of untillable character. Some of the areas in the northern part of the survey have a rather choppy surface with frequent steep slopes, and the tillable areas are smaller in extent than farther south. Local slopes and sides of ravines throughout the type are like Rough broken land, but most of the type as mapped is tillable. Drainage is good to excessive, and erosion is active in some places.

The untilled part of the type is largely covered with brush. The farmed areas are usually irregular in outline and nearly always are devoted to grain and grain hay. A few orchards are scattered over the type, as in the locality west of Sunland. These consist in part of citrus fruits, but more often of apricots and peaches. With irrigation the type probably could produce heavy yields of intensively farmed crops, but its uneven surface, the scarcity of water, and its elevation above water sources tend to retard its use for such crops.

SITES SANDY LOAM.

The Sites sandy loam consists of a reddish-brown to red, non-micaceous, friable sandy loam, ranging in depth from 6 to 24 inches. The texture is often heavier than typical and approaches a light loam or fine sandy loam. It is normally free from gravel or fine stone fragments, but rock outcrops and sandstone ledges are common. The surface soil passes rather sharply into a heavier, compact, reddish-brown or red subsoil of loam or clay loam texture. This in turn grades into the parent brown sandstone at depths of 2 feet or more. The compact subsoil is sometimes rather dense for easy root and water penetration.

A part of the type is shallow, and while fairly retentive of moisture, is not deep enough for dry farming. The deeper parts seem as well suited to water storage as similar soils of the Altamont series.

This type is confined to several small areas in the western part of the survey near Chatsworth. It occupies foothill slopes or rolling to uneven areas associated with Rough stony land. Drainage is generally good and is excessive on the steeper slopes. While local areas of rough and stony land occur, nearly all the type is suited to cultivation.

A part of the type is cultivated, its principal use being for the production of grain and grain hay. A few small orchards indicate that it is well adapted to a wide variety of fruits, but irrigation seems necessary for their best growth. The elevation of the type above sources of irrigation water will no doubt tend to restrict its use to hay and grain, with only local areas in more profitable crops.

DIABLO CLAY LOAM.

The Diablo clay loam typically consists of a dark-gray to black, friable clay loam, which usually is free from gravel or rock fragments. The type as mapped in this area includes some light-gray or brownish-gray variations, which even when wet are lighter colored than the typical soil. It merges through brownish variations into the associated types of the Altamont series. Areas of loam and silty clay loam of minor extent are also included. In the heavier textured, deeper parts the soil approaches the Diablo clay adobe in structure. The soil varies considerably in depth within short distances. It usually is deepest on the gentle slopes and shallowest on the abrupt slopes and along the edges of ridge crests. In places the dark-colored soil rests directly upon the parent rock at a depth of 10 to 30 inches, but usually it grades at 10 to 24 inches into a grayish or brownish-gray subsoil which varies in texture according to the

character of the parent rock. The subsoil is sometimes fairly compact, but is usually permeable to roots and water. In rare instances the surface soil and subsoil have a combined depth of 6 feet or more, but usually the partially decomposed and sometimes very marly parent rock is encountered at less than 5 feet. The soil appears to be fairly high in lime and organic matter.

The Diablo clay loam occupies some irregular areas south of Van Nuys and southwest of Chatsworth. Three small bodies are mapped in the hills just east of Pacoima. In these the soil is browner than typical and does not differ greatly from the surrounding Altamont clay loam.

The Diablo clay loam has a rolling or hilly topography. Drainage is well developed and erosion is not severe. The lower foothills south of Van Nuys and elsewhere include some steep slopes incapable of tillage; and while much of the remainder is difficult to cultivate, the average slope is not too great for cultivation. This type, like the others of the series, is derived from rather calcareous shales and sandstones, but includes some soil derived from unconsolidated material.

There are a few small orchards on this soil, but its principal utilization is for the production of grain and grain hay, with the untilled parts used as pasture. Under irrigation quite a wide variety of crops could be produced, including fruits and garden crops, but it is not likely that much intensive development will occur while lower lying, more easily irrigated soils are available.

DIABLO CLAY ADOBE.

The Diablo clay adobe consists of a dark-gray to black clay, which has a very pronounced adobe structure upon drying. The type in places has a brownish cast, or it may include small undifferentiated areas which properly belong to the Altamont series. Some small spots, due to partial exposure of the underlying parent material, occur. Although the texture usually is rather heavy, the type includes some undifferentiated Diablo clay loam. The adobe structure is a marked feature of the type, and the cracks often extend to the subsoil. Gravel usually is absent, but shale fragments are sometimes found. Although the dark-colored soil sometimes rests directly upon shales and sandstone, it is typically underlain at 10 to 36 inches by a lighter colored, yellowish, grayish, or brownish subsoil, which often cracks upon exposure, but is sometimes lighter textured and more friable than the surface material. The parent rock may be found at any depth below about 18 inches; usually it is encountered at about 3 to 5 feet. The soil and subsoil seem to be very calcareous, and the surface soil has a high organic-matter content.

The Diablo clay adobe occupies some important areas in the southwestern part of the survey. It covers low ridges and rolling foothills which lead from the valley slopes into higher and rougher regions. In some cases slopes are included which are probably untillable, but most of the type has a somewhat rounded surface without much rock outcrop. Drainage is thorough, but the type is absorptive and retentive of water where properly cultivated.

The type is extensively farmed to grain and grain hay, with good yields. There are a few vineyards and some deciduous orchards, but these industries are not developed in a commercial way, and results do not seem to be very satisfactory. Parts are uncultivated and used for pasture, with an unusually good growth of forage. Under irrigation a wider range of crops probably would be possible, but the rolling topography and heavy, intractable nature of the type are unfavorable for many crops.

RAMONA STONY SANDY LOAM.

The Ramona stony sandy loam is indicated on the soil map by stone symbols over the Ramona sandy loam color. It is subject to considerable variation, but its average composition is that of a rather coarse, gritty, light-textured sandy loam. The color of the fine-earth material is brown or, where more thoroughly weathered, slightly reddish brown. It usually carries excessive quantities of gravel and granite bowlders, and in some places the rock content constitutes the greater part of the soil mass, rendering it practically or wholly nonagricultural. The type is very porous and is not retentive of moisture. The distinct subsoil of heavier textured material typical of the heavier members of the series usually is absent in this type, and the stony, sandy soil extends to a depth of 6 feet or more, the lower layers being rather compact.

The soil occupies some small areas northeast of San Fernando and in the extreme northeastern part of the survey in the Sunland region. It is inextensive. In addition to the areas shown there is some undifferentiated material included with the Holland coarse sandy loam.

The Ramona stony sandy loam occurs on elevated knobs or remnants of high, dissected alluvial fans, and the drainage usually is excessive. The more stony and dissected parts are marked by many minor irregularities, and tillage would be difficult even if the stones were removed. It is similar to the other members of the series in origin, being the weathered product of old water-laid deposits, which in this case were very stony and comparable with those included with the stony types of the Hanford and Tujunga series.

Practically none of the type is tilled, although water has been elevated in pipes for irrigating small orchards of citrus fruits. It is probable that most of the type will remain uncultivated. Its stony character and porous structure materially decrease its value, and it is almost nonagricultural, except in a few of the more nearly stone-free patches.

RAMONA SANDY LOAM.

The Ramona sandy loam consists of a brown sandy loam extending to a depth of 10 to 24 inches. It usually is friable and absorptive of water. A part of the type is quite gritty and carries some gravel and stones, while other parts are slightly heavy textured and approach the Ramona loam. The subsoil usually is more compact and heavier than the surface material, and is often a reddish-brown loam to clay loam. The subsoil and substrata usually crack and become flinty when exposed to the air, and under field conditions they are much less favorable for plant-root development than the friable surface soil. True hardpan layers are not typically present, but occur locally.

This type is largely confined to the regions northeast and northwest of San Fernando, with smaller areas elsewhere, such as that near Sunland.

The surface usually is gently rolling or uneven, with general elevations distinctly above the recent-alluvial soils. The surface drainage is good, but the compact subsoil, where most pronounced, serves to arrest percolation for short periods after heavy rainfall. One or two areas have a low elevation and merge with the surrounding recent-alluvial soils. Here as elsewhere a tendency toward a hog-wallow surface is sometimes found.

Most of the type is used for grain and grain hay or remains untilled as pasture land. Some successful vineyards and citrus groves are located upon it, the former usually without irrigation and the latter watered by means of pumping. The use of the soil could be diversified under irrigation to embrace many crops, but such development is slow, owing to the scarcity of water and the elevation of the type.

RAMONA FINE SANDY LOAM.

The Ramona fine sandy loam consists of a brown or slightly reddish brown, friable fine sandy loam of slightly gritty character, often approaching a sandy loam in texture. Local variations in color are common, and the type is yellowish brown or grayish brown in places. The soil is rather absorptive and retentive of moisture except in a few slightly gravelly areas, which are more porous than typical. It grades at a depth of 12 to 24 inches into a more reddish brown loam

or clay loam, which is typically compact and flinty and cracks when exposed to the air, but without a true hardpan. The subsoil is less permeable to roots and water than the surface material and by its compactness decreases the power of the soil to store moisture.

Practically all this type is included in the two areas mapped several miles southwest of San Fernando. The other types of the series contain small undifferentiated areas of this soil.

The Ramona fine sandy loam has an undulating, slightly eroded surface, rising quite distinctly above the surrounding recent-alluvial soils, although the boundaries are sometimes not sharp. Surface drainage is generally well developed, although a slight tendency toward a hog-wallow surface with inclosed minor depressions is sometimes present. Subsurface drainage is poor where the subsoil is heavier, and a somewhat boggy condition may occur during the rainy season.

One or two orange groves extend into this type and garden crops are grown on small acreages, but its principal use is for grain and grain hay. Yields of the latter crops are satisfactory, but seem to be lower on the average than the recent-alluvial soils of the same texture. The type is capable of producing a wide range of intensively farmed crops under irrigation, and its deeper, moist areas produce truck crops satisfactorily without irrigation.

RAMONA LOAM.

The Ramona loam typically consists of a brown, light-textured, rather friable loam, usually with a low percentage of mica. It extends to a depth of about 8 to 24 inches, and typically passes into a heavier textured, more compact subsoil, of reddish-brown or red color and ranging in texture from a heavy loam to clay loam. This subsoil is often very flinty or compact and is not favorable for root development. Minor variations, differing somewhat from the typical soil, are included. A gravelly variation occurs in several areas near Chatsworth and southeast of Van Nuys, the latter also containing local patches of clay loam texture.

In addition to the areas already mentioned, the type occurs in several small areas in the vicinity of Sunland, and westward along the base of the mountains bordering the survey. The type is also mapped in several places along the edge of the foothills in the southern part of the area, or as detached bodies within the valley.

The greater part of the type is of the same derivation as other members of the series, but those areas in the southern part of the survey and near Chatsworth seem to be wholly or partly derived from sedimentary rocks rather than from granites. The gravelly soil included with this type is often underlain by strata or beds

of rather coarse material, with rock fragments, gravel, and frequent rounded bowlders. In some places the gravel indicates a derivation from siliceous shales, and in others a derivation from mixed sedimentary and igneous rocks.

This type occupies higher elevations than the recent-alluvial soils, which usually border it on at least one side and often entirely surround it. Some of the areas along the edge of the mountains east of San Fernando occur as remnants of old alluvial fans, which in some places retain their original surface and in others are dissected. The same is true of some of the areas in the southern part of the survey. The type near Chatsworth, southeast of Van Nuys, and in other scattered areas, rises above the recent-alluvial soils as small hills or areas of irregular surface. It consists in these places of remnants of older alluvial deposits now more or less eroded and removed by modern streams. Drainage is good, and even excessive in some of the steeper or more gravelly areas. The soil is boggy during the rainy season wherever the heavy subsoil is most distinctly developed.

A part of the type is occupied by irrigated citrus and deciduous fruit orchards. Some other intensive crops and vegetables are produced, but the main part of the type is used for grain or grain hay. Some of the gravelly areas are used for pasture. Much of the soil is well suited to irrigated intensive crops, but the difficulties of irrigation are almost prohibitive over about 50 per cent of it.

HANFORD STONY SANDY LOAM.

The Hanford stony sandy loam is indicated on the map by stone symbols over the Hanford sandy loam color. It consists of a light grayish brown or light-brown, rather coarse and gritty sandy loam of light texture. The soil is micaceous, but less so than the finer textured types of the series. It is very stony and gravelly, this feature being a much more important factor than the slight variations in color and texture that are common. The soil mass to a depth of 6 feet or more is often largely composed of rock material ranging in size from small gravel to granitic bowlders 2 feet or more in diameter. It is probable that the stones present in the 6-foot section average more than 50 per cent of the soil mass (see Pl. II, fig. 1). In exceptional instances bowlders 5 or 6 feet in diameter are found on the upper, steeper parts of the fans. There are no essential variations between soil and subsoil, although roughly assorted strata are sometimes found. The soil as a whole is leachy and porous, apparently very low in plant food, and in places is simply a mass of stones, with the interstices filled with gravelly sandy loam. Along the lower extensions of the areas, where this type merges with the

Hanford gravelly sandy loam, the stone content becomes lower, and the soil has a higher moisture-retaining power.

The type occupies several moderately extensive areas, the largest extending southeastward from Littlelands. Other areas occur near Burbank, along the southern edge of the Verdugo Mountains.

The Hanford stony sandy loam occupies the upper part of alluvial fans and has some of the steepest slopes of any of the recent-alluvial soils in the State. There are few surface irregularities except the scattered stones and the channels of intermittent torrential streams. The type is thoroughly drained, although near the streams it may be overflowed and covered with débris or eroded in times of heavy rains. The soil is derived from the same rock materials and is deposited by the same character of streams as the other types of the series. Its exceptionally steep surface, stony character, and consequent low agricultural value are accounted for by its position at the mouths of canyons where the heaviest loads of débris are dropped. In years of ordinary rainfall little of the rocky material is deposited, but at times of heavy precipitation on the rather barren mountain slopes large quantities of débris are swept from the steep mountain canyons and spread along the edge of the mountain mass. Some of the type has a fall of 500 feet or more per mile.

A large part of the type remains in its native brush and cactus covered condition. By a considerable expenditure of time and effort some areas have been sufficiently cleared of rock to permit cultivation. Reclamation of this kind has been accomplished at the town of Littlelands. Water has been piped for irrigating small orchards of citrus and deciduous fruits and garden crops. The soil requires heavy applications of fertilizer in addition to the water. Southeast of Littlelands there are one or two citrus groves of fair appearance. The soil northwest of Burbank is of higher value than in its average occurrence. Grapes, peaches, and apricots cover important acreages in this locality, but yields are not very heavy. Much of the type is almost nonagricultural in character, and it is doubtful whether it can be farmed at a profit owing to its poor and stony character.

HANFORD GRAVELLY SANDY LOAM.

The Hanford gravelly sandy loam as mapped in this area usually consists of a coarse sandy loam carrying considerable waterworn gravel derived from granitic rocks. The soil is micaceous, brown or light grayish brown in color, and very friable in structure. The gravel present ranges from quantities sufficient to influence tillage but not materially to lower the agricultural value of the type to quantities sufficiently high to render the soil leachy and porous and of low value. The subsoil is extremely variable and ranges within

short distances from a heavy sandy loam free from gravel to gravelly beds which have a low water-holding capacity and constitute a poor medium for root development.

The type occupies some important areas south of San Fernando and Pacoima and east and southeast of Sunland. Several smaller areas lie near the northern boundary of the survey, and an extensive area is mapped in the vicinity of Burbank.

The Hanford gravelly sandy loam usually occupies parts of sloping alluvial fans, and often occurs midway down their slopes as material borne a little farther valleyward than the material of the stony sandy loam, yet less well assorted than that of the Hanford fine sandy loam and types of heavier texture. The surface in places is quite steep for alluvial-fan deposits, and usually it is marked by stream channels. Drainage is nearly always excessive, owing to the porous structure of the soil material. Intermittent streams overflow contiguous areas when swollen by unusual rainfall. The type is largely farmed, but some parts, such as the areas southeast of Littlelands, remain in brush. Grain and grain hay and some grapes and olives are grown without irrigation. Most of the other crops require irrigation. Water is supplied by pumping over a part of the type, and oranges, lemons, peaches, apricots, alfalfa, and miscellaneous garden crops are grown. The type is suited to a wide range of crops, but is a little less productive on the average than the heavier textured types of the series. Some of the coarser, more gravelly variations of the type are distinctly inferior to the typical soil.

HANFORD LOAMY COARSE SAND.

The Hanford loamy coarse sand consists of coarse, gravelly sandy material of slightly loamy texture which extends with irregular variations to a depth of 6 feet or more. Fine gravel ranging up to 1 inch or more in diameter constitutes an important part of the soil mass. The finer material consists mainly of coarse sand of slightly loamy character. The soil mass is of heterogeneous character and seems to have a water-holding capacity greater than might be supposed from an inspection of the soil column. The fine soil material is brown, micaceous, extremely friable, and permeable. The type varies in places to a very light textured, gravelly coarse sandy loam. The narrow, elongated area near San Fernando contains less fine soil material and is more gravelly and leachy than other areas.

The type is represented by several moderately extensive bodies occurring north of San Fernando, another just east of that place, and still another north of Pacoima. It usually occupies rather steep alluvial fans of uniform slope and is subject to little surface variation, but near San Fernando some of the type consists of stream-

bottom material. The shallow beds of minor intermittent streams cross the alluvial-fan slopes and in flood periods overflow a part of the surface, deepening or changing their channels in an irregular manner. The soil is excessively drained, and there is little run-off.

A large part of the type is planted to olives, which are produced both with and without irrigation. Some grapes, alfalfa, and grain are grown. A few orange and lemon groves are maintained by irrigation. The soil is more productive than might be inferred from its coarse texture, but irrigation is necessary for a very wide or intensive utilization. With an adequate water supply it is suited to a wide range of crops.

HANFORD SANDY LOAM.

The Hanford sandy loam consists of a brown, light-brown or light grayish brown, micaceous sandy loam, which extends in places to a depth of 6 feet or more without change in the subsoil material. It ranges in texture typically from a light to medium heavy sandy loam, and sometimes possesses a light brownish gray color approaching or regarded as undifferentiated material of the Tujunga sandy loam. It also includes a pronounced and well-defined variation of coarse sandy loam texture which if of greater extent would be differentiated as areas of the Hanford coarse sandy loam type, consisting of a brown, micaceous, gritty coarse sandy loam. It is quite similar to the typical Hanford sandy loam, except that it is coarser and is not quite so retentive of moisture. The soil and subsoil may extend to a depth of 6 feet without change, or may pass through strata of material of variable texture, ranging from coarse sand to fine sandy loam. The subsoil averages a little lighter in color than the surface material. It is encountered usually at about 20 to 36 inches.

A part of the area of the Hanford sandy loam at San Fernando is slightly reddish brown, with a somewhat more compact subsoil, and no doubt represents a slightly older, more weathered variation. The type is normally very friable, being easily penetrated by roots and water and quite retentive of moisture. Where less than 6 feet deep, the sandy loam is underlain by the strata of material of variable texture typical of the Hanford series. A part of the area south of Pacoima is quite gravelly in the subsoil, and, together with similar phases elsewhere, is somewhat less valuable for agriculture than the typical soil. Occasionally appreciable quantities of gravel are present, and in places this type merges gradually with the Hanford gravelly sandy loam. In general the areas of lower gradient, somewhat removed from active or abandoned stream channels, have a finer texture and are relatively free from coarse strata, and constitute the best part of the type.

The most extensive area of this type occurs near and north of San Fernando. Several others are mapped in minor valleys issuing from the Verdugo Mountains and in the Sunland region. A large area occurs in the vicinity of Burbank, and two small ones of the coarse sandy loam variation of the type about 1 mile from San Fernando, one lying north, the other northwest, of the town. They conform in general features of topography and surface drainage to the Hanford silt loam and the typical Hanford sandy loam of the locality. The sloping surface shows some evidence in places of overflow and the addition of fresh material during exceptional storms. The internal drainage of the variation is a little more rapid than that of the typical Hanford sandy loam.

The Hanford sandy loam as encountered in this area is almost entirely an alluvial-fan type, and occupies areas of more moderate gradient than the coarser textured types of the series. There is little variation in topography. The gentle slopes are occasionally marked by waterways, which usually are shallow and sometimes consist only of gentle depressions that carry intermittent flood waters. The soil is typically well drained and retentive of moisture.

Nearly all the Hanford sandy loam is under cultivation. It supports some vineyards, olive groves, and orchards of deciduous fruits and produces various other crops, including grain and hay, without irrigation. Water has been supplied by pumping over important areas, and extensive groves of citrus fruits are found near San Fernando and elsewhere. Nearly every crop common to the section is being produced profitably on this type, with indications that the area in cultivation will be steadily extended.

Practically all the areas of the coarse sandy variation are intensively farmed with the aid of pumped irrigation water. Oranges are the most important crop, with yields apparently similar to those on the typical Hanford sandy loam. A part remains in grain and hay, and some garden crops are produced. The soil is of high agricultural value and is favorable to intensive development.

HANFORD FINE SANDY LOAM.

The Hanford fine sandy loam is subject to some variation, but typically consists of a brown, light-brown or grayish-brown, very friable fine sandy loam. Like the other soils of the series, it is micaceous, but it becomes less so where it merges with the adjoining types of the Yolo series, which are typically nonmicaceous. The lower parts of the type do not vary widely in texture to a depth of 6 feet or more, but the higher parts, where the type is associated with coarser textured soils, are variable. In places fine sandy loam is interstratified with sandy loam or gravelly sandy loam, and the

surface may be streaked with material of the same textures. In such places also the subsoil may be rather coarse in texture or made up of alternating strata of different textures. There is usually no marked difference in color between the soil and subsoil where the texture remains uniform, but the subsoil averages slightly lighter in color. The best parts of the type are those where the fine sandy loam texture extends to a depth of 6 feet or where the surface soil is underlain by heavier material. In such places the type is very retentive of moisture and is favorable to deep root development. All gradations occur between this best part of the type and the poorest, the latter consisting of a few inches of fine sandy loam underlain by gravelly beds of low water-retaining capacity.

The main occurrence of this type is in a large area of irregular outline extending in a general north and south direction between Van Nuys and San Fernando. Several other detached areas are mapped, such as that northwest of San Fernando. The type is not distinctly separated from associated soils.

This soil is located mainly on the broad valley slopes, and its surface is generally regular. The slope is sufficient to provide good surface drainage, and the material is sufficiently permeable for good internal drainage. In occasional years, when the poorly defined drainage ways are forced to carry more water than usual, some local erosion and deposition of fresh material occurs.

Excepting its shallow variations, this soil is one of the best of the area, nearly all of it being farmed. About 50 per cent is devoted to grain and grain hay, while the remainder is used to an increasing extent for a wide variety of intensive crops, both with and without irrigation. Parts of the type where the soil is deep and the moisture conditions favorable produce apricots, peaches, melons, and many other crops without irrigation, but irrigation seems necessary for the best results. The higher lying areas are used to some extent for orange groves, but the greater part of the type in this survey does not seem climatically suited to citrus fruits. Walnuts, pears, truck, alfalfa, and other crops are produced around Van Nuys and elsewhere. The soil is adapted to many different crops and is especially suited to deep-rooted crops.

HANFORD SILT LOAM.

The Hanford silt loam typically consists of a light-brown or brown, micaceous, friable silt loam averaging a little darker in color than the lighter textured members of the series. In some small depressions near Van Nuys and in the southern part of the large area near that place the color is darker than typical. The type varies somewhat in color, texture, and mica content where it grades into adjoining types of the same and other series. Small patches and

streaks occur within the main area of the type which vary considerably in texture owing to the irregular deposition of the soil material, and the type as mapped includes some soil of loam texture, recognized as undifferentiated material of the Hanford loam. Gravel or rock fragments are not usually found but may be present in some of the included lighter soils. The soil apparently contains a fair percentage of organic matter. It grades at 20 to 30 inches into a slightly lighter colored subsoil which may be of the same texture as the surface soil or vary from it irregularly. In places the subsoil consists of strata of material of different texture, but its general character is rather favorable for penetration by roots and water. It is retentive of moisture, and, although occasional layers of gravel or coarse sandy material are present, the soil section is without hardpan or similar dense layers.

The included areas of Hanford loam consist typically of a brown or light-brown micaceous loam of friable structure. As mapped in this survey it is rather silty and contains strips of overwash which are relatively sandy and carry small quantities of gravel. At a depth of 18 to 36 inches the soil usually becomes a little lighter in color, passing into strata of variable texture. In places the loam texture continues to a depth of 6 feet or more. Some areas near San Fernando are not typical, having a heavier textured, compact, and slightly reddish brown subsoil, probably representing a slightly older variation of the type. Both soil and subsoil are normally retentive of moisture and favorable for deep root development, without such frequent gravelly layers in the substrata as characterize some of the other types of the series.

The typical Hanford silt loam is practically confined to one large area near Van Nuys and a much smaller area southwest of San Fernando. Small areas of the type are included with some of the other types of the series. The loam variation is not extensive, occurring near San Fernando and to the northwest.

The Hanford silt loam occurs on sloping fans, in association with other types of the same character and largely of similar topography. It is less subject to overflow by intermittent flood waters than some of the lighter textured types occupying the valley slopes and has a smaller number of minor channels or distributaries. Drainage is very good except in a small part of the type on the lower slopes bordering the Los Angeles River. Alkali is not present except in one or two very local spots, and there only in small percentages. The type does not differ essentially in origin from the other members of the series, except that it was deposited by slower currents than those active in the formation of the stony and gravelly types lying along the higher valley slopes. The included variation, which is somewhat

older and has a heavier subsoil than the typical, is marked by slight hummocks, and subdrainage may be retarded during the rainy season.

This type is very valuable for agriculture and is being more intensively farmed as irrigation water becomes available. Much of the typical silt loam has been planted to peaches, apricots, walnuts, and other fruits. Beans, sugar beets, melons, and a wide variety of other crops are produced with good yields, and the results indicate that the type will continue as one of the most valuable soils of the area. Alfalfa and olives also are grown. A few citrus groves are located on the type southwest of San Fernando. The area of the loam variation north of San Fernando is largely planted to oranges, including some of the best groves of the locality. One of the other included loam bodies is largely planted to olives. The loam areas are well suited to these and other fruits and to various garden crops. Irrigation is necessary for their best development.

TUJUNGA STONY SAND.

The Tujunga stony sand is indicated upon the soil map by stone symbols over the Tujunga sand color. It typically consists of a light-gray or light brownish gray sand or coarse sand, which usually is micaceous. This sandy material is relatively unimportant, owing to the fact that it occurs simply as interstitial material between gravel, granite cobbles, and bowlders, which usually constitute much more than one-half the soil mass. The sand or other filling material varies in texture, but such variation has little effect upon the value of the soil, owing to its extremely stony character. The color also varies, and much of the type as mapped is light brown or grayish brown and is considered as undifferentiated material of the Hanford stony sand. Some areas are relatively stone free and show stratification in the soil column, but consist essentially of an irregular mass of stony material upon which minor variations of texture and structure have little influence. The soil is very leachy and is poorly adapted to crop production.

The type occurs in several areas along Pacoima Wash and Tujunga River, near the mountains. A small area somewhat different from the remainder of the type lies just north of Chatsworth.

The topography of the Tujunga stony sand does not show much variation other than that resulting from abandoned or partially filled stream channels. The surface is very rough because of the bowlders and cobbles that occur on the type. This soil is not usually subject to overflow except along the partially abandoned stream channels. In other places it is excessively drained. It usually is bordered by

Riverwash, which has only a slightly lower elevation. This type is quite similar to the coarsest, stoniest areas of Riverwash, but differs from this material in occupying fan slopes rather than the flood-swept channels of streams.

The type supports a growth of brush in which species of cacti are prominent. The soil has little agricultural value, and very little attempt has been made to farm it. A few small fields have been cleared of brush and some of the surface stones, but such improvement requires considerable labor. Even after clearing, crops can be grown only with heavy fertilization and irrigation.

TUJUNGA GRAVELLY SAND.

The Tujunga gravelly sand consists of a light-gray or brownish-gray, variable sand. Typically it is a rather coarse, leachy sand, bearing gravel and sometimes granitic bowlders in quantities sufficient to influence the agricultural value of the type. The Tujunga gravelly sand is somewhat similar to the Tujunga stony sand, except that its average content of stone and gravel material is lower and its general texture is not so coarse. Strata of fine sandy loam, fine sand, and other fine material are a little more frequent in the gravelly sand type, but the type is mainly coarse, leachy, and poorly suited to plant growth. The type has a better water-holding capacity and a higher agricultural value where it occurs on the middle valley slopes in association with heavier textured soils. Usually it is low in organic matter. The soil section is irregularly stratified without consistent differences between soil and subsoil. Some light-brown or light grayish brown variations are included with this type. They include Hanford material, but are too small to be separated satisfactorily on the soil map.

The type occupies important areas on the upper parts of the alluvial fans deposited by Pacoima Wash and Tujunga River with smaller detached areas on lower parts of the same fans. It occurs in a smaller way near the mouths of many minor streams, some of the small areas being included with the predominant types of the locality. The region extending from Roscoe to Villa Vista and a short distance north and south is largely occupied by this type and its associated types of coarse texture. The boundaries between this type and other soils are not very distinct, and long gravelly overwash strips, some of which are not shown on the map, often extend across adjoining types.

The Tujunga gravelly sand conforms in general surface features to the rather distinctly sloping upper parts of the alluvial fans. It is often dissected by channels of bifurcating waterways, which carry

water during flood times, but for the most part the surface is rather smoothly sloping and without marked surface irregularities. Drainage is excessive except for local intermittent overflow, owing to the coarse, leachy character of the soil mass. When flood waters of unusual volume flow across the type the streams often change their channels, and considerable erosion and deposition occur.

The origin of the type is typical of the series, but its rather unassorted and gravelly character renders it different agriculturally from the finer textured soils deposited on the more gentle lower slopes of the alluvial fans.

The Tujunga gravelly sand usually is covered with brush and cactus, and much of it has not been cleared. It possesses greater average agricultural possibilities than the Tujunga stony sand, but where the soil is coarsest the agricultural value is very low. Some land has been cleared, and small acreages are used for the production of alfalfa, corn, grapes, and even oranges, with varying results, crops frequently failing where the soil and subsoil are coarse and porous. Some of the narrow strips of this soil between other types of heavier texture are farmed in conjunction with the better soils. Irrigation is necessary, and probably heavy applications of fertilizer will be required to maintain the productiveness of the soil. The use of this type depends largely on local subsoil conditions. The parts underlain with a coarse, leachy subsoil probably will remain nonagricultural. With liberal irrigation the better areas with rather loamy subsoils can be made to produce a wide variety of crops.

TUJUNGA SAND.

The Tujunga sand is subject to considerable variation in texture. Typically it consists of a gray or brownish-gray sand, which usually is micaceous and has a depth of 2 or 3 feet or more. It often extends to a depth of 6 feet or more with little variation in soil or subsoil, but probably the greater part of the type is underlain by strata of variable texture below about 3 feet. The subsoil varies widely in texture, and ordinarily the material is finer on the lower parts of the fans. Gravelly beds are common in the subsoil west and southwest of Roscoe, but decrease in number until the areas east of Van Nuys and southward rarely have strata coarser than sand. A large part of the type as mapped consists of a fine sand having in places a slightly loamy texture. This material grades into the Tujunga fine sandy loam.

The Tujunga sand occupies several elongated areas in the eastern third of the survey. It is associated with the other members of the Tujunga and Hanford series, and owing to the methods of deposition is separated from them with difficulty.

The soil is rather closely associated with the general courses of the channels which carry flood waters across the large alluvial fans. The surface is rather regular and does not differ materially from that of the bordering types of the sloping alluvial deposits. (See Pl. IV, fig. 1.) Wind action has modified the surface to a small extent. Some of the uncultivated land is marked by small hummocks that have developed about growths of vegetation, and some of the main washes are bordered by strips in which the soil has drifted into a slightly undulating surface. A part of the type as mapped occupies low positions along the stream ways and in exceptional floods may be overflowed. A part farther removed from the main channels is also subject to intermittent overflow and to considerable erosion by water which escapes from the channels at points higher up in their courses. Some of the soil in the southeastern part of the survey, where it borders the Los Angeles River or its main tributary washes, has a high water table. Except in these areas, the type is excessively drained by reason of its porous structure.

A part of the Tujunga sand is utilized for crop production, while other parts remain uncleared and support a growth of brush. The medium or finer textured areas of the type, free from coarse, leachy subsoils, produce grapes, peaches, apricots, and various other crops without irrigation, but where irrigation is practiced heavier yields are obtained. Alfalfa, melons, walnuts, and a variety of other crops are grown both with and without irrigation. The use of this type without irrigation is influenced materially by the character of the subsoil.

TUJUNGA SANDY LOAM.

The Tujunga sandy loam consists of a gray or brownish-gray, micaceous, friably sandy loam, which in places extends to a depth of 6 feet or more with little change. It is sometimes slightly gravelly, with a tendency toward a coarse sandy loam, and in places it merges through finer variations with the Tujunga fine sandy loam. Near Villa Vista and southward the subsoil is often an irregularly stratified, rather coarse textured material in which gravelly layers are common. In this case the type is porous, with a tendency to droughtiness, though ordinarily it has a good water-holding capacity. While the color is typically gray, the soil as mapped includes some grayish-brown material similar to the Hanford sandy loam. A part of the type is very sandy and consists of a loamy sand which grades into the Tujunga sand.

This soil occupies several important areas between Villa Vista and Lankershim and near Dundee. It is similar in topography and

drainage to the other types making up the broad alluvial fans. It is marked occasionally by intermittent stream courses which deliver sufficient water in exceptionally wet seasons to overflow a part of the surface for short periods. Drainage is good to excessive.

The greater part of the type is farmed with irrigation, water being supplied by pumping. Peaches, grapes, grain, grain hay, and apricots, with some melons and other crops, are produced without irrigation, but give heavier and more certain yields where irrigated. The areas with gravelly or coarse subsoils are distinctly of lower value than the remainder of the type, but most of the type is valuable for a wide range of crops.

TUJUNGA FINE SANDY LOAM.

The Tujunga fine sandy loam typically is a light-gray or light brownish gray, micaceous, fine sandy loam of friable structure. It may extend without a distinct subsoil to a depth of 6 feet or more. The typical light-gray color merges with the grayish brown of the Hanford series in places so that separation of the materials is difficult, and it is probable that the type as mapped includes some undifferentiated areas of the Hanford fine sandy loam. The type is slightly brownish when wet, but many of the fields have an ashen-gray appearance when dry. Particularly is this true of a part of the type near Lankershim. In this locality the soil and subsoil material is often 6 feet deep, with little variation, but farther north on the fan coarse strata become more pronounced in the subsoil, and in some areas only the surface 12 or 14 inches of material is the typical fine sandy loam, and even this may be slightly gravelly, while the subsoil is very coarse and much like the Tujunga gravelly sand. The areas near Tujunga and to the northwest are the poorest agriculturally, the value of the type increasing southward. As with the other types of the series, local variations in texture are common. Streaks and overwash layers of sandy or gritty texture are common, constituting important local variations. Where free from coarse strata in the subsoil, the type is retentive of moisture. A loamy fine sand variation is included, which is often 6 feet or more in depth and of slightly lower water-holding capacity than the typical fine sandy loam. It is subject to the same subsoil variations as the remainder of the type.

The Tujunga fine sandy loam occupies some important areas in this survey. Beginning with small areas of shallow soil southeast of Pacoima, the type increases in extent down the valley slopes until it is the principal soil in the locality between Lankershim and Burbank.

The broader and more typical areas show little variation in surface features. A few partially abandoned stream ways occur and in places

give the surface a gently undulating appearance. Very little of the type in the lower part of the valley is subject to overflow, except along the Los Angeles River, and here overflows occur only in years of exceptionally heavy rainfall. The shallow areas farther north have a more irregular surface and in places are severely eroded. Drainage in these areas is excessive, and the soil is incapable of storing sufficient water to produce crops without irrigation. The deep areas, however, while well drained, are retentive of moisture and as well adapted to dry farming as any soil of the area surveyed.

The type supports a large part of the most intensive agriculture of the area. Irrigation is practiced over much of it by means of pumped underground water, and a wide variety of crops is produced, both with and without irrigation. Fruit culture is an important industry. Peaches, apricots, walnuts, prunes, grapes, and pears are grown successfully, and alfalfa, berries, melons, sweet potatoes, and various other intensive crops are important. Most of the type is very valuable for an unusually wide range of crops and, except where the gravelly subsoil occurs, produces heavy yields. Only the higher areas are climatically suited to citrus fruits, and such areas usually are shallow and leachy.

YOLO GRAVELLY SANDY LOAM.

The Yolo gravelly sandy loam is quite similar to the sandy loam member of the same series except for its gravel content. Typically it consists of a brown or grayish-brown, medium-textured sandy loam carrying variable quantities of gravel. It includes a darker colored variation which is brownish gray when moist, but is rarely as dark colored as the related and associated Dublin soils. The type is friable, and absorptive and retentive of moisture. The gravel present generally consists of angular or semirounded fragments of siliceous shale, but the area south of Encino carries fragments of dark-colored rock, apparently of igneous or metamorphic character. The gravel content varies from quantities too small to have any marked influence on the soil to quantities large enough to affect tillage and the water-holding capacity. The gravelly surface soil may extend with little change to a depth of 6 feet or more, or it may grade into slightly lighter or heavier textured strata, in some places relatively free from gravel, and in others much more gravelly than the surface soil. Important parts of the type have a subsoil slightly heavier in texture than the surface material, averaging a gravelly loam, and occasionally noticeably heavier and slightly more compact than the surface. Some areas of the type bordering the streams or occurring as narrow alluvial strips within the lower foothills are much more porous and gravelly than typical and of lower agricultural value.

This type forms considerable areas between Owensmouth and Chatsworth, and others east of the latter place, with smaller areas in the general region of the Yolo series. The separation of this soil from the Yolo sandy loam is based principally on its gravel content and is sometimes difficult. Each of the two types as mapped includes undifferentiated material properly belonging to the other.

The topography of the Yolo gravelly sandy loam is similar to that of the Yolo sandy loam. The type usually is well drained and is free from alkali, although subject to occasional overflows by streams traversing the valley slopes. The more gravelly areas are porous and excessively drained.

Most of the type is well suited to a wide variety of crops. It is largely utilized for grain and grain hay, but is being brought under irrigation for the production of more profitable crops. In situations free from frost the type seems well suited to citrus fruits, small plantings of which have been made. Some apricots, olives, and peaches and small acreages of corn, alfalfa, and miscellaneous garden crops are grown. These crops will no doubt be extended.

YOLO GRAVELLY LOAM.

The Yolo gravelly loam is indicated on the soil map by gravel symbols in the Yolo loam color. The fine earth of the surface soil is a brown or grayish-brown, light-textured, friable loam, which is absorptive and retentive of moisture. A darker grayish brown variation which represents transitions toward the color of the Dublin series is included. There is a wide variation in the quantity of gravel present in both surface soil and subsoil. Over large areas it is not sufficient to interfere with tillage or to render the soil porous enough to decrease its water-holding capacity. In other places both soil and subsoil are very gravelly, and the strata from a few inches downward are composed largely of coarse materials. Angular fragments of siliceous shale and waterworn or subangular gravel or other rocks usually constitute the gravelly material, the area south of Encino carrying some gravel from dark-colored igneous or metamorphic rocks. The subsoil, aside from its gravel content, is about the same as that of the Yolo loam.

The type occupies an important area near Encino, a smaller area southwest of Owensmouth, and several others east of Chatsworth. Some of the slightly gravelly areas included with the Yolo loam, if of greater extent, would have been mapped as the Yolo gravelly loam.

The type occupies gently sloping alluvial fans which are occasionally marked by intermittent stream channels and low ridges, the latter usually comprising material of somewhat earlier deposition Both surface drainage and subdrainage are normally good. The area

lying about 2¼ miles northeast of Chatsworth is elevated somewhat above the present stream ways, but does not seem to be sufficiently weathered and modified to be classed with the soils of the old valley-filling group.

Nearly all the type is farmed, and, with the exception of small acreages of sugar beets and a few other minor crops, it is devoted to hay and grain production without irrigation. It is valuable for the production of diversified intensive crops, but irrigation probably will be necessary for most uses, and its crop possibilities are about the same as those of the Yolo loam.

YOLO SANDY LOAM.

The Yolo sandy loam consists of a brown or grayish-brown, friable sandy loam. The texture varies along the washes to a slightly gravelly sandy loam, in other places to a fine sandy loam, or in sections where the surface is flatter, toward a loam. The soil is absorptive and retentive of moisture. It contains a few variations of slightly darker material, which, however, is not so dark as the related Dublin soils. The type extends to a depth of 6 feet or more with little consistent difference between soil and subsoil, though the latter usually is slightly lighter colored than the surface material. Below a depth of about 10 inches the subsoil may be irregularly stratified, containing materials either heavier or lighter in texture than the surface soil. In the lower lying areas the subsoil may be distinctly heavier than the surface soil. The same condition exists on some of the slightly elevated ridges, where the material is older and consequently more weathered than usual.

The Yolo sandy loam occupies several areas in the western part of the survey, from south of Owensmouth to the vicinity of Chatsworth, and eastward from the latter place. Others occur in the northern part of the survey, both east and west of San Fernando. The type occurs also on the main valley slopes near Zelzah. It merges with associated soils, and the other types of the Yolo series include isolated local areas of this soil. The soil occupies valley slopes and recent-alluvial fans of smooth surface and gentle gradient. Aside from an occasional shallow stream way and a slight modification by wind action, the surface presents few irregularities. The intermittent water courses in exceptionally wet years carry enough water to overflow some strips for a short time. Both surface and internal drainage are generally good.

Nearly all the type is farmed. Dry-farmed hay and grain are the most extensive crops, but these are rapidly being displaced by apricots, peaches, alfalfa, beans, beets, corn, and a wide range of

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FIG. 1.—PEACHES ON TUJUNGA SAND NEAR LANKERSHIM.

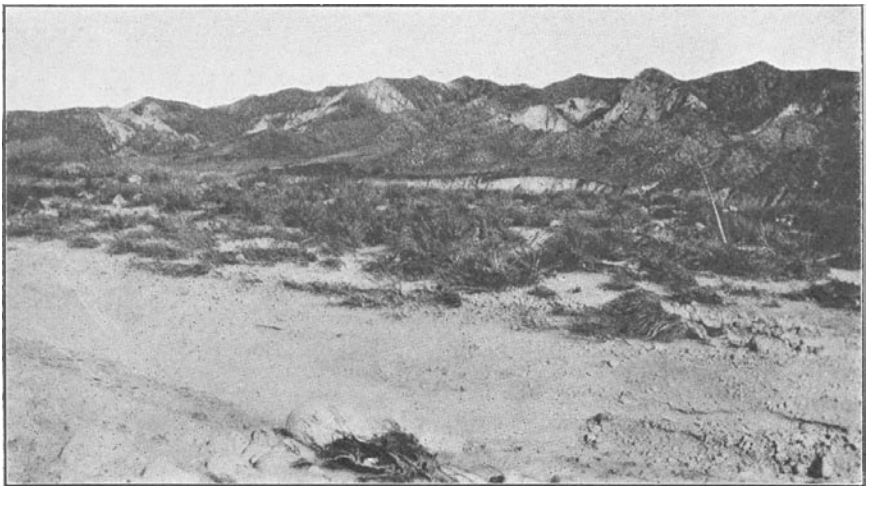

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FIG. 2.—ERODED HILLS MAPPED AS ROUGH BROKEN LAND ALONG NORTHEAST SIDE OF THE TUJUNGA VALLEY.

Riverwash occupying bed of Tujunga River in foreground.

other crops. The type is well suited to these crops, and good yields are obtained without irrigation, although usually the yields are heavier and surer with irrigation. Some of the higher lying, more frost free positions are suited to citrus fruits and are in bearing groves of both lemons and oranges, with more extensive plantings of young trees. This is a valuable agricultural soil.

YOLO FINE SANDY LOAM.

The Yolo fine sandy loam typically consists of a brown, light brown or grayish-brown, friable fine sandy loam, which usually is nonmicaceous. Local developments of a loamy fine sand or sandy loam sometimes occur in areas too small to be shown satisfactorily on the soil map, with a slight overwash of sand or slightly gravelly areas along present or abandoned waterways. The type includes one well-defined gravelly area which, if of greater extent, would be mapped as the Yolo gravelly fine sandy loam.

The soil of the typical Yolo fine sandy loam areas is rather absorptive and retentive of moisture. At depths ranging from 12 to 36 inches or more the texture may become lighter and slightly gravelly. In the flatter parts of the type the material may be a light loam or silt loam. There is no great distinction in color between the soil and subsoil, but the latter usually is a little lighter or more yellowish brown in color.

This type occupies an area extending from about 2 miles west of San Fernando in a broken manner southward almost to the southern boundary of the survey. Another area lies about 2 miles southwest of Van Nuys, and others are encountered in the western part of the survey. Usually it is associated with other types of the Yolo series, and merges with them through gradual textural changes.

The included Yolo gravelly fine sandy loam typically consists of a friable fine sandy loam carrying moderate quantities of angular or partially waterworn gravel. The rock fragments are largely dark colored and apparently of igneous or metamorphic character, although the rocks about the headwaters of the streams are predominantly sedimentary. Like the other soils of the series, the soil is brown, but a little darker where low lying. The gravel content is, in places, of minor importance, but in others, usually along the stream courses, it increases with depth, and the subsoil is quite porous. Thin layers of sandy or gravelly material usually alternate with layers of material of heavier texture to a depth of 6 feet or more. The soil absorbs water readily. It is only fairly retentive of moisture, however, except in some of the lower areas which have a heavier subsoil.

This type occurs on gently sloping recent alluvial fans or on valley slopes, and the surface is fairly regular. Shallow, intermittent waterways are sometimes encountered, occasionally bordered by slightly elevated stream-built ridges. Both surface drainage and subdrainage are generally good. At times of heavy rainfall the type may be overflowed in a small way by water discharged across the surface of the fan by minor distributaries.

One area of the gravelly phase of the type is mapped south and east of Reseda. This occupies an alluvial fan and merges with adjoining soils. It has a generally smooth surface, but a few small ridges, which are partially subdued remnants of older alluvial deposits, occur, with an occasional present or abandoned stream channel. The phase is overflowed in places immediately along the main streams, but otherwise drainage conditions are good.

Nearly all the type is farmed, mainly to hay and grain. Oranges and lemons are successfully produced southwest of San Fernando. Nearly all the fruit and garden crops common to the region are grown where irrigation is possible.

Some sugar beets, corn, and miscellaneous garden crops are produced on the lower part of the gravelly area.

The Yolo fine sandy loam is well adapted to a wide range of both deep and shallow rooted crops, which are rapidly displacing grain and hay.

YOLO LOAM.

The Yolo loam, as mapped in this area, is subject to considerable variation in color. Typically it consists of a brown or grayish-brown, nonmicaceous loam of friable structure. It occasionally extends without change to a depth of 6 feet or more, but generally is underlain by a lighter brown or more yellowish brown subsoil, commencing at a depth of 16 to 36 inches. The subsoil may be a slightly heavier loam or even a clay loam, and in places it contains gravelly or sandy strata. The structure of both soil and subsoil are typically favorable to agriculture, being easily penetrated by roots and water and retentive of soil moisture. In a few small areas (undifferentiated Yolo gravelly loam) gravel is encountered in small quantities. The type between San Fernando and Chatsworth includes some ridges or elevated fans of slightly reddish brown color and more weathered than typical. The soil in such positions has in places a subsoil of heavier texture than the surface material and to this extent approaches the soils derived from older valley-filling materials. The large areas of the type on the valley slopes northwest of Van Nuys and northeast of Owensmouth, contain sandy streaks of overwash material, much like the Yolo sandy loam.

The type is comparatively extensive. It occurs along the margin of the valley and on the valley slopes in the western part of the survey. Typically it forms smooth, gentle slopes unmarked by inequalities except the occasional shallow channels of intermittent streams. A part of the type northeast of Chatsworth is somewhat elevated above the present streams and has a gently undulating or ridged surface. Drainage usually is good, and the topography is well adapted to irrigation.

The Yolo loam is well suited to a wide range of crops, and nearly all of it is tilled. Grain and grain hay occupy the greatest acreages and give good yields, but are rapidly giving way to more profitable diversified crops. Some of these are produced without irrigation, but with irrigation heavier and more certain yields are obtained. For some crops irrigation is necessary. Lemon and orange plantings are being extended in favorable areas. An important acreage is devoted to walnuts, apricots, pears, peaches, and grapes. Alfalfa, corn, beets, and many garden crops are grown with success.

YOLO SILT LOAM.

The Yolo silt loam consists of a friable, smooth-textured silt loam, typically of brown or grayish-brown color. It usually is nonmicaceous and free from gravel, although coarse, gritty streaks are sometimes present. A part of the area south of Van Nuys contains variations that are darker colored than typical and more variable in texture. The soil occasionally extends to a depth of 6 feet or more without marked change in color or texture, but the subsoil at depths varying from 12 to 36 inches is normally somewhat lighter colored than the surface material and contains strata of material both lighter and heavier in texture than the surface soil. Gravelly subsurface layers of low water-retaining power are not so frequent as in many of the other recent-alluvial soils. Both soil and subsoil are very retentive of moisture, and their structure is well suited to tillage and root development.

The Yolo silt loam occurs in important areas between Owensmouth and Van Nuys and south of Van Nuys. It occupies the almost level or gently sloping sides and floor of the valley or occurs as alluvial fans adjoining the foothills. The channels of a few intermittent streams cut the latter, but elsewhere the surface is smooth. Drainage is good, except that small areas are overflowed for short periods after heavy rains.

This is a valuable soil, and practically all the type is tilled. Grain and grain hay occupy about 50 per cent or more of its area. These crops formerly were more extensive, but are rapidly being displaced by other crops. Owing to the deep, moist nature of the soil some

crops can be grown profitably without irrigation. For the highest development of the type and the greatest diversification of crops irrigation is necessary. Frost conditions seem unfavorable for citrus fruits over much of the type, but aside from these crops the soil has as wide possibilities as any other in the area. Pears, apricots, peaches, beets, beans, corn, and other fruit and garden crops are grown successfully.

YOLO CLAY LOAM.

The Yolo clay loam consists of a brown, grayish-brown or dark grayish brown, nonmicaceous clay loam. It is sticky when wet, but is fairly easily tilled except when extremely wet or dry. It seems to be fairly well supplied with organic matter. The type as mapped includes some variations in texture, such as occasional more clayey patches, with slight tendencies toward adobe structure, or areas having a thin overwash of more sandy material. The type is normally free from gravel, but marginal phases or local areas may be slightly gravelly, the coarse material being similar to that present in other members of the Yolo series.

The soil occasionally extends to a depth of 6 feet or more without change in color, but typically it becomes lighter brown or more yellowish brown at depths ranging from 12 to 36 inches. The change in color may be accompanied by a slight variation in texture to a loam or silty clay or rarely a clay, but the subsoil averages about the same in texture as the surface material and gravelly, porous strata are uncommon. Compact layers do not occur in the substrata, and both soil and subsoil are easily penetrated by roots and water. The type includes a variation in which the subsoil is darker colored than the surface material.

The Yolo clay loam occurs in important areas near Owensmouth, in the southwestern part of the survey, and in several other areas elsewhere. It occupies alluvial fans or parts of the more nearly level valley floor and has practically no surface irregularities. The topography is favorable for irrigation, and drainage usually is good. A few flat areas have poor drainage during the rainy season.

Practically all the type is under cultivation. Until recently hay and grain, grown without irrigation, have been the principal crops. More intensively farmed crops aided by irrigation are now, however, becoming important. Citrus fruits are perhaps possible on some of the more favorably situated areas. Many different kinds of deciduous fruits are already grown, and the acreage is being extended. Peaches, pears, walnuts, alfalfa, sugar beets, beans, corn, and various garden crops do well and are grown to an important extent. These crops and others will no doubt be extended and will finally displace the less profitable hay and grain crops.

YOLO SILTY CLAY LOAM.

The Yolo silty clay loam consists of a brown or grayish-brown, smooth-textured silty clay loam, which usually is nonmicaceous. The structure is rather friable for a silty clay loam, but the soil has a tendency to clod or to assume a slight adobe structure where the clay content is high. It is very retentive of moisture. Like the other members of the series it may extend to a depth of 6 feet or more without change, but normally the subsoil is somewhat lighter in color at a depth of 20 to 36 inches. The subsoil may be either a little heavier or lighter in texture than the surface material, but is fairly friable and retentive of moisture. The type includes a variation in which the subsoil is slightly darker colored than the surface material. Small areas of Yolo silt loam and clay loam are also included.

The Yolo silty clay loam occupies an area southwest of San Fernando and others west of Van Nuys. It is not distinctly separated by changes in topography from the associated types making up the valley slopes. The soil is normally well drained, except in the flatter parts, which in times of heavy rainfall have poor drainage conditions. The topography is favorable to irrigation, there being practically no surface irregularities.

This is a valuable type, well suited to a wide range of fruits and truck crops. Probably more than 50 per cent of it is used for hay and grain, although these are being displaced by more profitable irrigated crops. Citrus fruits are grown where frost conditions are favorable, as southwest of San Fernando. Grapes, walnuts, peaches, olives, alfalfa, and sugar beets are grown successfully.

DUBLIN LOAM.

The Dublin loam consists of a dark brownish gray or dark grayish brown, friable loam, often of rather silty texture. The dry fields usually present a brownish appearance, but become distinctly darker colored when wet, the soil being separated with difficulty from the darker phases of the Yolo loam. It is at times slightly gravelly and presents other local variations in texture so common in the soils of the recent-alluvial fans. A rather good condition of tilth prevails, and the soil is permeable, though retentive of moisture. In exceptional cases the surface soil extends to 6 feet or more without change, but it is usually underlain at 12 to 30 inches by a brown or light-brown, friable loam or clay loam. Gravelly or sandy strata may occur in the subsoil, and they are of limited extent. The type does not differ essentially from the Yolo loam except in its slightly darker color.

Two areas of the Dublin loam occur east and northeast of Zelzah, several others northwest of San Fernando, and others northeast of Pacoima. In addition to these the Yolo loam mapped along the margin of the foothills in the southern part of the survey contains dark-colored variations, some of which are quite similar to the Dublin loam.

The topography does not vary much from that of the associated Yolo soils. The slope is usually appreciable and drainage adequate, although in a few places where the surface is flat drainage is sluggish during rainy periods. The area at Sunland is in part micaceous and influenced by wash from granitic rocks, and to this extent not typical.

Practically all this soil is under cultivation. Although most of it is utilized for the production of dry-farmed hay and grain, citrus fruits, grapes, and other intensive irrigated crops are grown to some extent. The area devoted to citrus fruits, peaches, apricots, alfalfa, sugar beets, and other crops of the region is being extended.

DUBLIN CLAY LOAM.

The Dublin clay loam typically consists of a dark-gray or dark brownish gray, friable clay loam, which becomes distinctly darker when wet. The dry fields usually have a brownish cast, and the type does not average as dark colored as in its typical occurrences in other parts of the State. Much of the type in this area is intermediate in color between the typical Dublin and the Yolo series and might be considered as a light-colored variation of the one or a dark variation of the other. A pronounced brown phase with calcareous subsoil is shown separately on the map and described on a subsequent page. In places a slight adobe structure exists, the type approaching the Dublin clay adobe. Gravel and rock fragments are rarely encountered. The subsoil usually is of lighter color than the soil and ranges from brown to light grayish brown. It is sometimes similar to the surface soil in texture, but may be either heavier or lighter, and is usually friable in structure, with only occasional compact clayey strata. Both soil and subsoil are readily penetrated by roots and water and are retentive of moisture. The subsoil in particular often seems rather calcareous.

Several areas of this type are mapped, the principal ones lying between Chatsworth and San Fernando. Others of smaller size occur several miles east of San Fernando and in the western part of the area.

The Dublin clay loam occurs on the local alluvial fans of the valley slopes. The gradient usually is sufficient for good drainage, but erosion is not serious. The very gentle slopes or partially inclosed flatter parts of the type are wet for some time in the rainy season

and may receive considerable run-off from slightly higher adjoining soils. Soon after the rains cease in the spring, however, the type is capable of cultivation.

Nearly all the type is under cultivation, grain and grain hay covering the greatest acreages. The yields are good, largely because of the moisture-holding power of the soil. West and southwest of San Fernando there are some large plantings of oranges and lemons which are irrigated by pumping (see Pl. III, fig. 1). The type is valuable for a wide variety of crops, but the normal rainfall must usually be supplemented by irrigation for most of the fruits and other specialized crops. Corn, alfalfa, sugar beets, beans, and several kinds of fruit are now grown in small acreages and do well. It is probable that the fruits will be confined to the better drained parts of the type.

Dublin clay loam, brown phase.—The Dublin clay loam, brown phase, as mapped in this area, consists of a dark-brown, friable, light-textured clay loam, including inextensive areas of dark-gray material. The soil has a tendency toward an adobe structure, which occasionally is quite pronounced in the darker colored, heavier textured variations. At a depth of 10 to 36 inches the soil rests upon a yellowish-brown or brown, compact subsoil which is extremely variable and usually calcareous. Some of the substrata contain angular fragments of siliceous shales and other rocks, and frequently the material is semicemented and carries large, calcareous, pipy concretions. Some of the areas are gravelly, and occasional slopes show outcrops of the underlying calcareous material.

This phase properly represents small areas of brown calcareous soils and subsoils of the Antioch series and would be so recognized and indicated upon the soil map if more extensive. It occurs in small areas between San Fernando and Chatsworth, with one small area northwest of San Fernando. It is distinctly elevated above adjoining soils and occupies some hills and ridges with rolling surfaces. Some of the areas consist of individual small hills surrounded by recent-alluvial soils. The drainage is good.

The greater part of the phase is farmed to grain and grain hay, while the remainder is used for pasture. Little attempt has been made to grow fruits and garden crops, but the production of such crops may follow up irrigation, if experiment shows this to be profitable.

DUBLIN CLAY ADOBE.

The Dublin clay adobe is subject to considerable variation, but typically consists of a dark-gray to black clay which has a pronounced adobe structure and cracks and checks upon drying. It is tillable when moist, but very sticky when wet, and hard when dry.

It is capable of storing considerable moisture where properly cultivated. It sometimes carries a few shale fragments, but is otherwise rather free from coarse material. This type often merges with the Yolo soils through brownish-gray variations, and areas surrounded by the Yolo series are browner than typical.

This soil may extend with practically no variation to a depth of 6 feet or more, but usually it becomes lighter in color at about 20 to 36 inches, where the subsoil may be yellowish brown or grayish brown and frequently is somewhat lighter in texture and more friable than the surface material. Both soil and subsoil apparently are calcareous, particularly the subsoil, and the soil seems high in organic matter.

Several important areas of this type, associated with Yolo soils, are mapped in the southwestern part of the survey, and several less extensive areas in the other sections. In the area about 2 miles north of Zelzah the soil is brownish gray. The Dublin clay adobe occupies rather level positions on the floor or the gentler slopes of the valley. There are few inequalities of surface except an occasional intermittent stream way. Drainage is fair where the type occurs on slopes near the base of higher lying residual soils, but is periodically restricted in the larger areas of flat topography. These receive some run-off, and the soil is too sticky and tight for free percolation. The soil rarely remains wet long enough to prevent tillage.

Practically all this type is farmed, mainly to grain and grain hay, with heavy yields. It produces some beans and sugar beets, but difficulties of tillage discourage the growing of such crops. It is rather poorly suited to fruit, owing to its texture and structure, but many crops more intensive than hay and grain are possible with irrigation.

ROUGH BROKEN LAND.

Rough broken land consists of areas having a topography mainly too rough, steep, or broken for tillage (see Pl. IV, fig. 2). It does not normally have abundant rock outcrop or large quantities of stone, differing in this respect from Rough stony land. The soil material of Rough broken land varies considerably. The somewhat continuous area along the southern edge of the survey consists of broken hills and ridges derived almost entirely from sedimentary rocks. The soil here is comparable with the material of the Altamont and Diablo series. It consists of brown or dark-gray to black loams, clay loams or adobes, which usually are shallower than in their typical occurrences. Soil of this character forms minor slopes, ridges, or narrow alluvial strips which are capable of cultivation. The boundaries between Rough broken land and adjoining soils, considered largely tillable, are in many cases necessarily arbitrary.

The large body in the northwestern part of the survey is much like that in the southern part, but a part of it is underlain by unconsolidated deposits. In the area 1 mile west and those several miles north of San Fernando the material is also partially derived from unconsolidated deposits, but, unlike the areas previously mentioned, the old deposits are derived, in part at least, from granitic rocks. Some of them are eroded, transported deposits of old terraces filled with granitic bowlders, while others are deep, eroded deposits of material of fine texture and partially consolidated. Southeast of Sunland the Rough broken land is rough and rather stone free, being derived from the granite or gneiss yielding the Holland series of that locality.

The steep and broken topography of Rough broken land is accompanied by a rapid run-off of the rainfall, with some rather destructive erosion. The moisture-retaining capacity varies considerably in the different areas, the parts underlain by consolidated sedimentary rocks being in general the most retentive of moisture, while those derived from the coarser unconsolidated materials are the most porous and leachy.

Rough broken land usually is covered with a growth of brush and in places is being reforested with oaks and other trees. It is typically nonagricultural by reason of its unfavorable topography, but the heavier soils furnish good pasture. Small areas within the type may be cleared and farmed, hay and grain being their principal possibilities under dry farming. If irrigation can be supplied the local patches so farmed will have crop possibilities approximating those of the Altamont and Diablo series.

ROUGH STONY LAND.

Rough stony land occupies areas of mountainous topography, and typically is unfit for agriculture by reason of both the stony, shallow character of the soils and the steep, broken surfaces. It includes two classes of material, as mapped in this area, that derived from igneous rocks, largely granite or gneiss, and that derived from sedimentary rocks. The type in the eastern part of the survey, and a part of that north of San Fernando, consists of mountainous masses through which the underlying granite rocks protrude in large outcrops. Soil erosion is very rapid, and the recent-alluvial types of the Hanford and Tujunga series are derived from these mountainous bodies and others of similar nature beyond the boundary of the survey. Occasional rather stone free and less precipitous areas occur, and these properly belong to the Holland series, but are very inextensive and unimportant. West of Chatsworth and Owensmouth the type forms precipitous and extremely stony

areas. Sandstone cliffs and hills are common, and even the land of smoother surface is marked by many rock outcrops.

The Rough stony land, except in the most mountainous districts, which are practically barren of soil and inaccessible, is used for pasture. It includes minor bodies of tillable land.

RIVERWASH.

Riverwash, as it occurs in this survey, is subject to considerable variation in its principal features. It consists mainly of very coarse alluvium in the beds of the streams issuing from the high mountains bordering the northeastern part of the survey. For several miles valleyward from the edge of the mountains it is a coarse gravelly sand carrying cobbles and bowlders ranging upward to 2 or 3 feet in diameter. In this coarser and more stony part the finer sandy material constitutes only a small percentage of the soil mass. As the stream beds proceed down the valley slopes the gravel and stone content decreases gradually, until finally the material consists principally of sand or even a slightly loamy sand carrying small quantities of fine gravel. The finer material ranges in color from gray to light grayish brown and does not differ much in color from the coarse-textured members of the Hanford and Tujunga series. The soil section in the steepest areas shows a sand with included bowlders to a depth of 6 feet or more, but in areas of lower gradient farther from the mountains more distinct stratification is apparent, with some layers of sandy loam and similar material. A coarse sand often extends to a depth of 6 feet or more.

Riverwash occurs as strips in the flood-swept bottoms of Tujunga River and Pacoima Wash (see Pl. IV, fig. 2). Smaller areas occur in the western part of the survey. Riverwash typically occupies the beds of intermittent streams and usually lies in well-defined channels several feet below the adjoining soils. It normally has an uneven surface and is marked by abandoned channels and by a main stream channel, which carries annual flood waters. In places the boundary between Riverwash on the one hand and the Tujunga stony sand and Tujunga gravelly sand on the other is not readily determined. The main channels sometimes divide and reunite at lower levels, giving rise to areas of other types surrounded by strips of Riverwash. The type is normally flood swept and severely eroded in seasons of average rainfall. In seasons of exceptionally heavy precipitation its extent may be increased or decreased by erosion, and in places the original Riverwash is covered by finer sediments, derived from the surrounding soils. Drainage is excessive, owing to the coarse, porous nature of the material.

Riverwash is practically nonagricultural. Some of the finer-textured areas along the stream channels of the lower valley slopes are farmed in years of light rainfall, although the yields are not high, and the fields are frequently damaged by heavy rainfall. It is possible that the control of storm waters may make some areas of Riverwash tillable.

IRRIGATION.

Most of the valley lands of the area can be fully and intensively used only by the aid of irrigation, yet up to the time of this survey comparatively little has been accomplished in this direction. This delay in development has been due primarily to a scarcity of available water. The streams entering the area do not have large or continuous surface flows available for diversion, but periodically contribute important quantities to the underground supply by percolation. The underground source, so important in many parts of the State, has not largely been made available in the San Fernando Valley, partly because of the great depths in many instances from which the water must be lifted, but mainly because the city of Los Angeles uses these underground flows in the lower part of the valley for city water and in certain localities has successfully resisted any attempt to use them for agriculture.

In 1913 the irrigated land of the valley is reported as 10,010 acres,[1] the water being derived from both the canyon streams and underground sources. Since that time pumping has been extended, and water is becoming available also from the Los Angeles aqueduct, which traverses the area, conveying water from the Owens River to Los Angeles, a distance of over 200 miles. The general plan embodies the use of surplus waters from this system in the San Fernando Valley, and its irrigated acreage will no doubt be increased greatly, although the exact scope and details of the project in its relation to the valley are not yet definitely determined. It is likely that much of the western part of the valley, with its good soils, admirably adapted to irrigation, will be watered.

The total acreage of irrigated lands stated above is distributed through several sections. One of the larger of these is that surrounding San Fernando, where pumping plants are numerous. The Sunland region also includes some irrigated lands with an increasing acreage being brought under pumped water along the base of the mountains both east and west. The lands between Lankershim and Burbank are largely watered in the same manner. The lift by pump varies throughout the area, ranging from less than 50 to over

[1] "Irrigation Resources of California and their Utilization," U. S. Dept. Agr., Office of Experiment Stations, Bul. No. 254

200 feet. The character of the substrata influences the courses and freedom of movement of the underground waters and has a direct and important bearing on the effectiveness and economy of pumping. In addition to the aqueduct water, it is probable that further increases in the acreage watered by pumping and storage will take place until the valley more nearly approaches the intense development it deserves.

SUMMARY.

The area surveyed comprises the San Fernando Valley, California, with a small part of the surrounding hilly and mountainous lands. The survey is roughly rectangular in outline; it is about 24 miles in extreme length east and west, and about 14 miles in extreme width north and south. It covers 274 square miles, or 175,360 acres. Its southwestern boundary is a few miles northwest of the city of Los Angeles.

Physiographically, the valley, or the main part of the area surveyed, is an oval basin, its northern part being more elevated and having longer side slopes, so that its trough lies under the southern boundary. The somewhat regular and smooth side slopes consist of merging alluvial fans which usually are very sharply differentiated in topography from the hills and mountains flanking their upper sides.

Many streams issue on the valley slopes from the inclosing mountains, Pacoima and Tujunga Washes being the largest. Except during flood periods, the water of these and minor streams is lost in the soils of the upper valley slopes, there being few open channels to the valley trough. The drainage reappears in the southeastern part of the area, and with occasional flood water flows into the Los Angeles River, which drains the area through an outlet between the Verdugo and Santa Monica Mountains.

The population of the area is increasing rapidly, but it remains sparse as compared with that of most of the other valleys near Los Angeles. San Fernando, Burbank, Lankershim, Van Nuys, and Owensmouth are the principal towns; none of these has a population of over 5,000. The area is very well supplied with railroads, roads, schools, and other public conveniences.

Most of the agricultural products are shipped to distant markets, but the more perishable products usually are consumed within a few hundred miles of the area.

The climate of the area is marked by the wet winter season and dry summer season characteristic of other parts of the State. Local variations in frost conditions within the area have an influence on the production of certain crops, but in general the climate favors the growth of a wide range of crops.

Agriculture is the main industry of the area, grain, hay, citrus fruits, peaches, apricots, olives, walnuts, grapes, alfalfa, sugar beets, beans, and numerous other crops being produced. Some of the area remains untilled because of lack of irrigation water, large land holdings or unfavorable soil conditions.

The soils of the area are classified broadly with three main provinces—(*a*) residual soils or those occupying the hills and mountains and derived by weathering in place from consolidated rocks; (*b*) coastal-plain and old valley-filling soils or those derived from unconsolidated yet old, weathered, water-laid deposits; and (*c*) recent-alluvial soils or those of the recent-alluvial fans and valley slopes, this group being by far the most important.

The first group is represented by four series—the Holland, Altamont, Sites, and Diablo, which include a total of seven types. The second group has one series—the Ramona—represented by four types, and the third four series—the Hanford, Tujunga, Yolo, and Dublin—with a total of 22 types. In addition to the soils of the three groups named above, three miscellaneous classes of material are mapped—Rough broken land, Rough stony land, and Riverwash. These are mainly nonagricultural.

Lack of irrigation water and the predominance of large land holdings have been the two principal factors in retarding the development of intensive farming. Local sections have been irrigated with water pumped from an underground source for some time, and this development is being extended. The irrigation of a part of the valley by diverting the surplus water from the Owens River, through the Los Angeles City aqueduct, will no doubt give a great impetus to agricultural development. Most of the good soils of the valley will probably be watered eventually from this and other sources, but progress will necessarily be slow in some sections.

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[PUBLIC RESOLUTION—No. 9.]

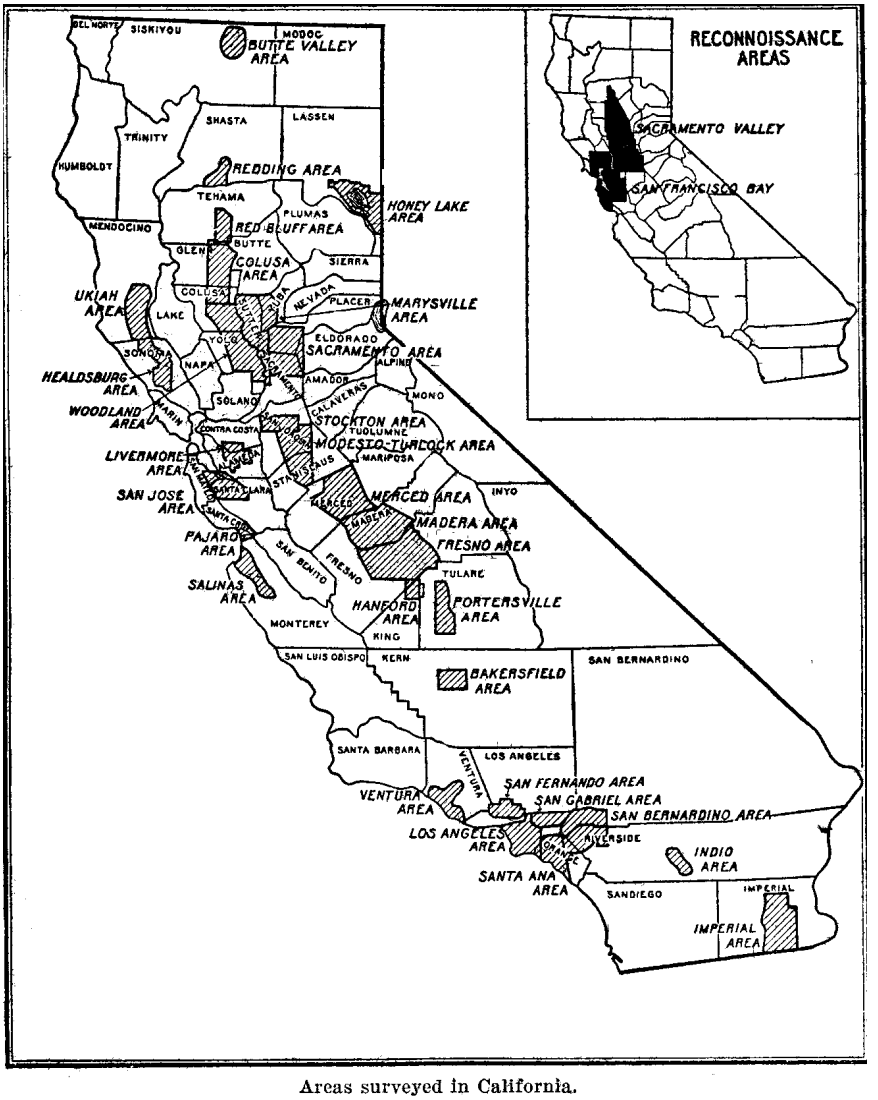
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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

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

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in California.

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