

# SOIL SURVEY OF THE MADERA AREA, CALIFORNIA.

By A. T. STRAHORN, H. L. WESTOVER, L. C. HOLMES, E. C. ECKMANN, J. W. NELSON, and CORNELIUS VAN DUYNÉ.

## DESCRIPTION OF THE AREA.

The Madera area, California, covers the western third of Madera County, which lies very nearly in the geographical center of the State, a little south of the center of the Great Interior Valley. It is about 200 miles south of San Francisco and Sacramento and 300 miles north of Los Angeles.

The Interior Valley, comprising the Sacramento and San Joaquin Valleys, is a long, relatively narrow depression between the Sierra Nevada Mountains on the east and the Coast Range Mountains on the west. It extends from Red Bluff on the north to Caliente on the south, a distance of about 500 miles. The northern portion of the valley—Sacramento Valley—is drained southward by the Sacramento River, which receives its waters mainly from

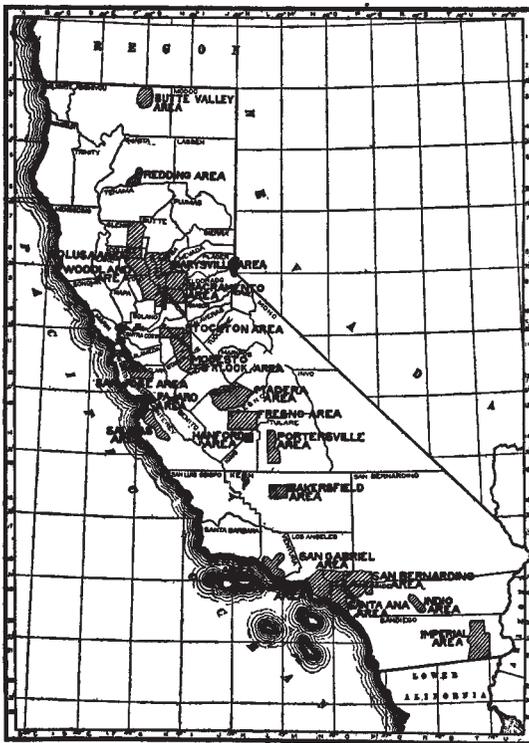


FIG. 52.—Sketch map showing location of the Madera area, California.

the Sierras on the east and from the Klamath Mountains on the north. The southern part of the valley—San Joaquin Valley—is drained to the north by San Joaquin River and numerous tributaries rising in the Sierra Nevada Mountains on the east. The two rivers unite near the Montezuma Hills and empty into Suisun Bay.

The Madera area extends from the San Joaquin River on the west eastward to the rough stony land forming the approach to the mountains. The southern boundary is also formed by the winding course of the San Joaquin River, while the northern boundary is marked mainly by the Chowchilla River—a small intermittent stream flowing from the foothills.

The area is roughly rectangular in shape, is about 36 miles in length, 25 miles in width, and covers about 919 square miles, or 588,160 acres.

No satisfactory map of the county was available and the base upon which the soil areas are outlined was constructed from plane-table traverse work carried on in conjunction with the soil survey. A portion of the area extending a few miles along the San Joaquin River was covered by high water or was in a swampy condition, making it impracticable to survey portions of the course of the stream. This was filled in later from data secured from a county map and from Government charts.

In the extreme eastern portion of the area, high rolling hills, sharply elevated plateaus, masses of rock outcrop, and deep ravines constitute the land surface, and make this portion of the area of little value for agricultural purposes. Adjoining this broken region on the west there is a considerable extent of land where the topography is characterized by many intermittent stream courses of varying size, low knolls, and irregular ridges. Farther west the ridges and knolls gradually become less prominent, until they merge into a vast level plain which extends to the western boundary of the area.

For about half the distance along the southern boundary of the area the San Joaquin River flows between bluffs from 20 to 100 feet in height, and the meandering of the stream between these bluffs has left many irregular areas of rich alluvial bottom lands, excellently adapted to several types of farming. West of Skaggs Bridge the land surface drops more rapidly, and for the remainder of the distance the river is but a few feet below the surrounding country. Along the lower courses of the stream occasional shallow lagoons mark former channels of the stream, and shallow, poorly defined sloughs indicate former overflow channels. Fresno River, flowing through the central part of the area, is a small stream rising in the eastern Sierras. It carries water only during the late winter, spring, and early summer months. But little of this water ever reaches the San Joaquin River, as it is largely diverted for the irrigation of fruit and alfalfa lands near Madera, and is spread over the plains in the western part of the area, where grass grown for grazing purposes. The Chowchilla River, which forms the northern boundary of the area, is similar to the Fresno River, and its flow is used for the irrigation of fruit and grazing lands along its course. In addition to these larger streams there are many small intermittent

streams issuing from the foothills or rising in the dissected plains below the rough stony country. These streams carry water only during the rainy season and rarely have any connection with larger streams, but disappear on reaching the more level plains.

Dense growths of willow, cottonwood, and sycamore, with a tangle of underbrush, occur along the San Joaquin River, while the larger intermittent streams are usually fringed with a growth of cottonwood or sycamore. On the higher lands in the eastern part of the area a scattering growth of oak is usually found. The remainder of the area is treeless, except for such plantings as have been made by landowners.

Prior to the construction of the Southern Pacific Railroad down the east side of the valley the population of the area was very small, consisting of two small settlements, Berenda and Borden, the former being a stage station and supply point for wandering stockmen and miners and the latter a small agricultural settlement. The county is still sparsely settled. Large individual holdings of land have been and still are the rule in this area.

After the building of the railroad, the town of Madera sprang up. This is now the county seat and commercial center of the county. It is a town of about 3,000 population and has a lumber mill, sash and door factory, banks, and numerous substantial business firms. Its position is such that it will be the principal town of the area, and any increase in the agricultural prosperity of the county will result in increased business for this town. Minturn, a station just inside the area, near the Chowchilla River, is a shipping point for grain and cattle and for the products of a near-by winery. Berenda, 6 miles north of Madera, is a station on the Southern Pacific Railroad at the junction of the main line and the Raymond Branch. No other towns occur within the area surveyed, but warehouses along the lines of railroad serve as shipping points for grain.

Good transportation facilities are offered by the Southern Pacific and Atchison, Topeka & Santa Fe Railroads, which give an outlet to all large commercial centers. A branch line of the Southern Pacific leaving the main line at Berenda traverses the northeastern part of the area and affords service to that section and to the foothill region to the eastward.

#### CLIMATE.

The climate of this section is in general features similar to that of the rest of the interior valley. It is characterized by two seasons, the dry or summer season, and the wet or winter season. The first is marked by a period of bright, warm, sunshiny days, with an entire absence of rain. The wet season consists of periods of cool, rainy days and foggy mornings, broken by intervals of clear, warm weather.

No records of temperature or precipitation are available for this immediate section of the valley. Weather Bureau records at Fresno and Merced for a number of years give data which probably represent approximately the conditions which exist in this county. The temperature at Fresno has varied between 115° and 24° F., the mean annual temperature being about 62° F. At Merced the mean annual temperature (for 10 years) is about 61.5° F., with extremes of 116° and 16° F. The average annual rainfall for 10 years past at the above stations is 9.2 inches for the former and 12.17 inches for the latter. Below are given climatological data for Fresno and Merced, compiled from records of the Weather Bureau:

*Climatological data for Fresno.*

Years.	Temperature.			Precipitation.		Sky.			Prevailing direction of winds.	Frost.	
	Mean annual.	High-est.	Low-est.	Year.	Great-est monthly.	Clear.	Partly cloudy.	Cloudy.		Last in spring.	First in fall.
1898.....	63.1	114	24	4.98	1.14	262	52	51	NW.	.....	.....
1899.....	62.4	111	24	10.53	2.90	226	57	89	NW.	.....	.....
1900.....	62.8	109	26	11.06	4.61	216	54	95	NW.	.....	Nov. 31
1901.....	63.5	110	27	8.07	2.35	227	77	61	NW.	Jan. 1	Dec. 11
1902.....	62.2	110	24	7.91	2.44	284	83	78	NW.	Feb. 1	Dec. 14
1903.....	62.2	108	25	6.19	2.28	238	52	75	NW.	Feb. 16	Dec. 5
1904.....	63.7	109	28	13.33	3.21	229	54	83	NW.	Jan. 26	Dec. 6
1905.....	63.0	115	26	7.27	2.04	234	61	70	NW.	Mar. 31	Nov. 22
1906.....	63.2	111	27	16.04	4.10	237	52	76	NW.	Jan. 20	Nov. 19
1907.....	62.5	103	30	9.01	3.35	227	36	102	NW.	Mar. 13	Dec. 29
1908.....	63.0	114	29	7.00	1.75	278	6	82	S.	Jan. 8	Nov. 28

*Climatological data for Merced.*

Years.	Temperature.			Precipitation.		Sky.			Prevailing direction of winds.	Frost.	
	Mean annual.	High-est.	Low-est.	Year.	Great-est monthly.	Clear.	Partly cloudy.	Cloudy.		Last in spring.	First in fall.
1898.....	61.1	112	26	5.69	1.34	289	37	39	N.	.....	.....
1899.....	61.6	112	26	12.66	2.64	204	76	85	NW.	.....	.....
1900.....	60.7	108	25	11.09	4.16	221	66	78	NW.	Mar. 21	Dec. 30
1901.....	61.7	111	24	9.30	3.15	268	34	63	NW.	Mar. 28	.....
1902.....	60.0	114	23	9.17	2.26	250	41	74	NW.	Mar. 3	Nov. 28
1903.....	60.5	108	16	11.03	6.41	.....	.....	.....	.....	Feb. 24	Dec. 5
1904.....	62.6	110	20	12.84	2.99	280	0	86	N.	.....	.....
1905.....	63.3	116	22	9.18	2.05	276	13	76	NW.	.....	.....
1906.....	62.3	111	21	19.65	6.62	288	3	74	NE.	.....	.....
1907.....	61.2	101	23	15.23	4.22	264	11	90	NE.	.....	.....
1908.....	60.2	112	27	8.45	2.63	276	0	90	.....	.....	.....

The rainy season normally extends from November to March, but little rain (too little to be of any value to growing crops) occurring outside of this period. There is considerable variation from year to year in the distribution of the rainfall, and nonirrigated crops frequently suffer from a lack of moisture in the spring even when the total amount of rain has been up to or above normal.

During the winter season killing frosts may generally be expected at any time between the middle of November and the middle of March. Fruit is seldom injured by spring frosts, but winter-grown vegetables are frequently damaged or killed. During the summer months, June, July, and August, the mean daily temperature at Fresno is somewhat above 80° F. and daily temperatures not unfrequently rise considerably above 100° F. These temperatures are seldom oppressive, owing to the lack of moisture in the air. With the intense sunshine the conditions are extremely favorable for the rapid maturing of all crops. The nights, even after the hottest days, are usually cool. This is due to what is locally known as the "sea breeze," which is a light cool breeze which springs up soon after sunset, and which affords a welcome relief from the glaring heat of the day.

Hailstorms are unknown, electrical storms are rare, and the velocity of the winds never sufficient to injure fruits or trees.

#### AGRICULTURE.

The first comers to this section of the valley were Americans and Mexicans who engaged in stock raising upon the valley lands, where native grasses grew in abundance. With the exception of a few miners who prospected along the streams and in the foothills, the stockmen were the only settlers until, in the early seventies, they were gradually succeeded by those who farmed the plains for grain. About this time a number of settlers moved into the valley near the present site of Madera, where they soon constructed a canal to divert the flood waters of the Fresno River for purposes of irrigation. From time to time various attempts have been made to colonize other portions of the area, but for one reason or another these attempts have resulted in partial or total failure. During the time of the early settlement of Madera County a few individuals secured nearly all of the western third of the county and constructed canals from the San Joaquin and Chowchilla Rivers, by which they flooded thousands of acres to produce grass for grazing. Some alfalfa was planted and used for stock feeding. The construction of the canal to furnish water to lands near Madera, and the advent of the railroad, resulted in the development of a prosperous farming community, where grain, alfalfa, and various fruits are produced. This is the only portion of the area where small farms are found, and, excepting for a tract of grape lands near the Chowchilla River, is the only place where high

returns are received from the land. At the present time the remainder of the tillable soils of the area are devoted to the dry farming of grain or to grazing.

A study of the agricultural development of this area shows that it is far behind practically every other section in the San Joaquin Valley, although as far as fertile soils is concerned no such difference exists. The lack of progress in Madera County is due primarily to one factor—the inability to secure an adequate supply of irrigation water, which is necessary for the highest development of these lands. Other contributing causes, although essentially minor ones, are the large individual holdings of land, a lack of knowledge of the efficiency of pumping plants for irrigation purposes, and the high cost of reservoirs for the storage of flood waters of the various streams.

The inability to secure irrigation water for the present grain lands is due to the conditions which make it possible for one or a few individuals to control the entire flow of water in a stream. The main annual discharge of the San Joaquin River is estimated at about 2,000,000 acre-feet, and this is sufficient to cover the entire area surveyed to a depth of 3 feet and still allow nearly a half million acre-feet for canal systems farther down the stream. As conditions now stand not a foot of this water may be used, excepting by large landowners in the western part of the county, and thousands of acres of grain land must remain undeveloped when they are capable of supporting a family to every 20 acres. The other conditions mentioned—large holdings, etc.—would shortly disappear were irrigation possible, as the owners of the large holdings could not withstand the high prices that would be offered for their land under the improved conditions.

As has been mentioned, the larger part of the dry lands in the area are devoted to grain farming. According to the assessors' figures for 1907-8 over 240,000 acres were planted to grain crops, from which a return of nearly \$900,000 was secured. In the early days of grain farming wheat was grown almost exclusively, but owing to decreased yields barley has been gradually substituted for wheat until at the present time the yield of the former is nearly four times that of wheat.

The average yields of grain are small, and to farm profitably large tracts of land must be handled by a single person. This has led to the development of numerous labor-saving devices, which make it possible to work over extensive areas at a very small cost. The ground at seeding time in the fall is plowed very shallow with a 5 or 6 gang plow drawn by 8 to 12 mules, and seeding and harrowing the grain is accomplished at the same time by machines following and attached to the plow. In some cases a traction engine is used, which draws 2 gangs of 5 or 6 plows. The grain is usually sown in the fall as soon as the first rains have moistened the soil so that it

can be worked. Grain is sometimes sown early in the spring, but it is only in exceptionally favorable seasons that anything is secured. The fall-sown grain ripens late in May, and when dead ripe is harvested with a combined harvester, which cuts, threshes, and sacks the grain, leaving the straw on the field. In case no grain is to be sown in the fall the usual practice in this area is to plow deeply in the fall and follow this with a shallow plowing in the spring, the object being to conserve the moisture until the next fall by creating a surface mulch and at the same time keeping down the weeds.

The yields obtained by this system of farming vary greatly, depending upon the amount and distribution of rainfall, the nature of the soil, and the preparation of the land. In seasons with very favorable moisture conditions and upon the better soils, barley may yield as high as 16 sacks and wheat 12 to 14 sacks. On poorer soils with less favorable moisture conditions the yield may drop so low as not to pay the expense of harvesting and marketing.

For many years past the average yield of grain has been steadily decreasing, while the cost of operating has as steadily increased, and the average returns (gross) have reached a very low figure. According to the figures given for Madera County by the California State Board of Agriculture for 1908, the average value per acre returned for wheat was about \$2.13 and for barley about \$5.

With the agricultural development of the county the larger part of the present grain soils will be devoted to more remunerative crops, but on account of peculiar soil or topographic conditions some of this land will be devoted to grain for a very long time to come. For this reason some means should be taken to increase or at least to prevent any further decrease in the yields of grain. The peculiar climatic conditions of the Interior Valley render it difficult if not impracticable to practice a rotation of crops, which is an effective method in maintaining the fertility of the soil in humid and irrigated sections. Improved methods of cultivation, planting, selection of seed, etc., alone can be looked to as means for maintaining the productiveness of the soils.

Land values vary widely according to the nature of the soil, location in the area, adaptability to crops, and whether irrigable or not. The foothill lands—largely Rough stony land—which are used mainly for grazing, are the cheapest lands in the area, seldom having a value over \$5 an acre and often selling for less, particularly when large tracts are purchased. The present grain-farming lands sell for from \$15 to \$50 an acre, the price being governed by both character of soil and convenience of location. The values of irrigated land range from \$50 to \$200 an acre, depending upon soil, location, and improvements. In general land prices are very reasonable, as based upon the earning power of the soil, and in many cases much cheaper than similar lands in other parts of the valley.

On the larger farms and ranches the labor is performed by itinerant farm hands, and there is rarely any trouble in securing the help needed. On smaller farms the question of labor is sometimes serious, particularly when large crops of fruit ripen suddenly and require immediate handling. This labor is performed largely by Italians and Japanese.

The highest development of the agricultural resources of the Madera area depends upon the securing of irrigation for the extensive area of lands at present dry farmed, and also upon the subdivision of the large estates and individual holdings and the substitution of the small, intensively operated farm. With these changes in the existing order of things and with the proper method of cultivation the soils of the region are capable of producing abundantly almost any agricultural product suited to the climatic conditions. A beginning has been made and a summary of the crops now grown in the area and of the soils on which they seem to do best is given here to indicate the lines along which development may most safely proceed when the limitations cited above shall have been removed.

Alfalfa is grown on the soils of the Hanford, Fresno, and Madera series, under irrigation, the yield depending largely upon the preparation of the land and subsequent care of the fields. Excepting areas where hardpan is close to the surface or where a considerable quantity of alkali is present, there seems to be but little choice between the soils as regards their use for this crop.

Where the land is comparatively free from grass and weeds, alfalfa is usually sown in the fall after the soil has been thoroughly plowed and harrowed. Where grass and weeds are present, seeding is done in the spring. The land is irrigated during the summer after each cutting, and when the soils are very light an irrigation is given between cuttings. In the first year one cutting may be secured and a yield of about 1 ton may be expected. After that cuttings are made five or six times a year, the yield running from three-quarters of a ton to over a ton to the acre at each cutting. If the hay is sold from the farm the price received ranges from \$6 to \$15 a ton. Much of the alfalfa grown near Madera is used to feed dairy stock, which is commonly held to be more profitable than selling the hay.

Grapes for either wine, table, or raisin purposes are grown on the Hanford soils near Madera and along the Chowchilla River in the northern part of the area. The vines are started from cuttings in the spring, which are transplanted to their permanent place in the field the following year. During the winter weeds and grasses are allowed to grow between the vines and are plowed under in the early spring. During the rest of the year the surface of the vineyards is kept clean by frequent cultivation, until the vines prevent the passage of teams and implements through the field. Varieties like the Muscat

and Malaga are pruned back each spring to one or two buds to a shoot and require no stakes or trellis for their support. Other varieties, like the Thompson Seedless and Emperor, require either a wire trellis or tall stakes.

The quantity of table grapes shipped from the area is small, practically all of the fruit being either converted into raisins or sold to the local wineries.

Aside from the question of varieties, about the only caution necessary in starting vineyards is to avoid alkali soils and soils where the hardpan is close to the surface. Grapes are very susceptible to alkali, and a shallow soil makes it difficult to keep the plant supplied with the proper amount of moisture.

In the soils of the Hanford and Fresno series, where unfavorable soil conditions do not exist, the Sultanina (Thompson Seedless), Muscat (Muscat of Alexandria), Malaga, and Almeria are varieties well adapted to local conditions. In the red plains soils (San Joaquin and Madera series) the Emperor, Flame Tokay, Alicante Bouschet, and Val de Piñas will be found to give good results.

The growing of figs has not been extensively developed, although there are a large number of trees in the area. A few small commercial orchards are to be found, but the larger number of trees are planted around farmhouses or around the boundaries of fields. Fig trees (with irrigation) will grow and do fairly well on many of the poorer soils, but they attain the best development and give the most fruit on the lighter well-drained soils of the area. The fig grows readily from cuttings, and this is the method generally used in starting new trees. Cuttings are transplanted in the field the second spring, setting the trees either in 20 or 40 foot squares. In the first instances alternate rows are removed in later years as the trees develop, and in the second case other fruits are planted between the rows and removed when the trees reach a considerable size. Some fruit is secured the third year, but profitable yields should not be expected before the fifth.

The principal varieties of the fig are the Mission, Adriatic, and Smyrna, all of which thrive in this section.

Like the fig, the olive is found scattered throughout the area. The product is used largely for home consumption. The only commercial grove of any size in the area is a 20-acre tract southwest of Madera, planted on the Hanford sandy loam. The average yield is said to be slightly over 2 tons per acre, the fruit bringing from \$25 to \$50 a ton, according to the variety and quality.

The olive has been grown in the State since the time of the early missions, and has been found to succeed on soils ranging from stony hillside lands to rich alluvial river bottoms. Although it will survive on apparently poor soils, its commercial planting should be confined

to the deeper, more level soils where irrigation is possible, as larger and more profitable yields will be secured under such conditions. Alkali soils or shallow soils underlain by hardpan should be avoided in olive culture as in grape culture.

Olives are propagated either from seeds or cuttings, the latter being the better method, as the trees came into bearing sooner. Varieties recommended for this section are the Mission, Manzanillo, Queen, Nevadillo, and the Ascolano.

No attempt has been made to grow citrus fruits on a commercial scale in this area, but citrus trees are very widely distributed, occurring around practically every farmhouse. It is probable that with the agricultural development of the county the growing of citrus fruits will receive considerable attention, and to secure commercially profitable groves the plantings should be confined to the higher lands in the eastern part of the area, where the danger of killing frost is reduced to a minimum. It is held by some that the entire eastern half of the area is adapted to the growing of citrus fruits. In the light of the present knowledge this opinion is erroneous. It is true that the trees will grow in almost any part of the area, but it is very certain that they will not meet the requirements of successful trees, i. e., the production of a large quantity of fruit of good or high commercial grade. The average minimum temperatures of the winter season will usually result at least in injury to the new growth, if nothing worse, the vitality of the tree will be impaired, and the crop will be small and of only medium quality.

In the higher, warmer locations of the area plantings of the Washington Navel and Valencia late varieties should be made. Plantings of seedling varieties—Mediterranean Sweet, Parson Brown, and Joppa—may be made, but these are not as profitable as the first-mentioned varieties.

The almond is not extensively grown in this area, although suitable locations exist for its culture. It requires a deep, well-drained soil, not too heavy, and as it is a very early bloomer, a location where there is little danger from late spring frosts. The level, elevated areas of the Madera sandy loam in the eastern part of the area should prove excellently adapted to this crop. The tree may be grown farther to the west with good success, but profitable yields would be less certain, as there is more danger from killing frosts in this section. The Nonpareil, IXL, and Ne Plus Ultra are among the leading varieties.

Peaches are grown extensively in the irrigated section of the area near Madera, and the returns have been very satisfactory. With few exceptions the soils of this part of the area are very well adapted to this fruit, and with the extension of irrigation systems some of the lighter soils of the Fresno and Madera series farther south will be found suitable for this fruit.

The larger part of the peach crop is dried and sold to packing companies, who process and pack the fruit for the trade. Varieties which will do well in this area are the Crawford, Muir, Tuscan, Phillips' Cling, and Elberta.

The intense dry summer heat of the valley acts as a bar to the production of desirable shipping apples, and the planting of these trees is not recommended, except as such may be desired to furnish a fruit for home and immediate local consumption. It is possible to produce apples of good appearance, but the fruit does not possess the firmness which is a prime requisite of commercial apples, nor the flavor and attractive coloring of apples grown at greater elevations or along the cooler more humid coast country.

Some plums and prunes are grown in the area, but the output of these fruits is small and of little commercial importance. The trees will do well on the better grade of heavier soils in the western part of the area and along the river bottoms, and when grafted on suitable stocks will do well on many of the soils in the central part of the area.

The matter of growing small fruits has received little attention and the market situation allows of considerable development along this line.

The larger part of the small fruit consumed in this area is shipped in from outside points, and there is no reason why this demand should not be supplied by local farmers. Along with the small fruits there is a lack of vegetables, melons, sweet potatoes, etc. Soils very well adapted to this class of products are at hand and their use for these crops would be profitable.

The growing of Eucalyptus is worthy of much more attention than is now given to it. The magnificent growths which have been made by individual trees and by small groves leave no room for doubting that the Eucalyptus will succeed admirably in this section. This tree is unexcelled for use as windbreaks, produces a large amount of wood for fuel in a very short time, and is desirable for planting in large tracts to furnish a supply of lumber for commercial purposes in a comparatively few years.

#### SOILS.

Beginning at the eastern boundary of the area, the soils first encountered are those occupying the high, rolling foothills and the somewhat lower rolling lands. These soils occur in a continuous body, from 1 to 6 miles in width, entirely across the eastern end of the area, and are mainly residual in origin, resulting from the disintegration of the underlying granitic and metamorphic rocks. These soils are usually highly colored, contain considerable sharp angular sand (excepting in case of the heavier types) and rest

directly upon the more or less decomposed bed rock. Much of this area is unsuitable for agriculture, and is used for grazing, the thin growths of oak being cut for fuel. The lower and more level areas with deeper soil are devoted to grain farming, although the yields are not usually as heavy as on the soils to the west.

This class of soils includes types of the Media series, together with several soil types representing the Daulton and the Portersville series and Rough stony land.

Lying below the area occupied by the residual soils, and extending westward beyond the line of the Southern Pacific Railroad, there occurs a large body of soils locally known as the "red plains" soils. During a former geological period the entire valley was under water, being an arm of the sea, and in this there was deposited a large amount of eroded material carried by streams from the mountains on the east. This material, modified by ages of weathering, to-day forms the vast body of red soils extending along the eastern side of the San Joaquin Valley. Changes in the composition of the material has resulted in the formation of a dense, impenetrable red hardpan in the subsoil, and the long-continued effect of atmospheric agencies has given to these soils an irregular surface, generally prominently marked by innumerable small mounds, known as "hog wallows." The soils are red to a yellowish red, and grade imperceptibly into soils of closely related series. This body of old sedimentary soils includes the members of the San Joaquin series.

Lying within the above body of soils, and extending to the westward, is a body of soil closely related to the San Joaquin soils. The material is largely the same as the San Joaquin material, though it generally shows the admixture of other materials. The entire mass has undergone more or less physical and chemical change. Where this altered body of soil extends beyond the main body of San Joaquin soils, the reworking is more evident, as shown by the color and the presence of numerous bodies of soil of alluvial formation. Hardpan is generally present in the subsoil, but instead of occurring in a compact uniform body, the upper few inches often shows a shaly structure, is much lighter in color, and often carries a thin coating of calcareous material in the cleavage fissures or on the surface. This modified San Joaquin material gives rise to the Madera series, and in this area embraces five types of soil ranging in texture from a coarse sand to a clay loam.

Extending through the western and southern part of the area and eastward to beyond Lanes Bridge is a body of material resulting largely from the breaking down of beds of cemented sands and loams often interstratified with a grayish white volcanic ash. The distribution of this material, together with more or less foreign alluvial material, has resulted in the formation of an extensive body

of soils. In the eastern extension of these soils the surface is very level, while to the westward small hog wallows, invariably accompanied by alkali and a few pronounced dunes, are common features of the topography. A compact slaty blue hardpan is usually present ranging from an inch or so to several inches in thickness. The soils comprising this division constitute the Fresno series.

The remainder of the area, with the exception of the type indicated as Riverwash, occupying the beds of intermittent streams, is formed by soils of comparatively recent origin derived from materials eroded in the mountains and foothills and deposited by the older streams. These soils have a level to rolling surface, a loose friable structure, are highly micaceous, and prevailingly of a light grayish brown or light-brown color. Hardpan does not occur in these soils. The members of this division are mapped with the Hanford series.

The following table gives the name and extent of each of the soil types mapped in the Madera area:

*Areas of different soils.*

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
San Joaquin sandy loam.....	137,664	23.4	Riverwash.....	5,248	0.9
Fresno fine sandy loam.....	84,672	14.3	Fresno sand.....	3,584	.6
Madera sandy loam.....	74,368	12.6	San Joaquin clay loam.....	3,520	.6
Hanford sandy loam.....	65,024	11.1	Media coarse sandy loam.....	3,392	.6
Fresno loamy coarse sand.....	41,344	7.0	Hanford coarse sandy loam...	3,392	.6
Hanford fine sandy loam.....	41,216	7.0	Madera clay loam.....	2,048	.3
Rough stony land.....	32,960	5.6	Portersville clay adobe.....	1,792	.3
Hanford clay loam.....	14,080	2.4	Fresno coarse sand.....	1,280	.2
Fresno clay loam.....	13,824	2.4	Madera fine sandy loam.....	1,152	.2
Daulton clay loam.....	9,280	1.6	San Joaquin gravelly sandy loam.....	1,152	.2
Hanford coarse sand.....	9,216	1.6	Daulton clay adobe.....	960	.2
Madera sand.....	8,640	1.5	Hanford fine sand.....	896	.2
Media sandy loam.....	7,168	1.2	Media clay adobe.....	448	.1
Madera coarse sand.....	7,168	1.2			
Media fine sandy loam.....	6,656	1.1			
Daulton sandy loam.....	6,016	1.0	Total.....	588,160	

**HANFORD COARSE SAND.**

The Hanford coarse sand consists normally of 6 feet or more of a very micaceous coarse sand of a light-brown or grayish-brown color. In bodies immediately adjacent to stream courses or to bodies of coarser soils some fine gravel is frequently present.

This soil occurs in many small elongated bodies west of Madera and along the Fresno, Chowchilla, and San Joaquin Rivers. The soil is of alluvial origin, having been deposited by former streams or by the present streams during flood stages. The material may be traced ultimately to granitic rocks in the mountains east of the area.

In this area the Hanford coarse sand is of little agricultural importance at the present time, owing to the lack of facilities for irrigation.

With an abundant supply of water it is adapted to various fruits and alfalfa.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Hanford coarse sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23318.....	Soil.....	10.0	28.7	16.4	19.6	8.2	12.2	4.8

HANFORD FINE SAND.

The Hanford fine sand consists of 6 feet or more of a buff to light-brown micaceous fine sand. In a few cases, near the San Joaquin River, the sandy subsoil is frequently displaced below 36 inches by beds of coarse sand or gravel, but the area showing this variation is too small materially to affect the mapping of the type.

With one or two exceptions, this soil occurs in the low bottom lands along the San Joaquin River, where it has been deposited by earlier overflows of that stream. The surface is generally somewhat uneven and more or less dissected by former overflow channels.

This type is not under cultivation at the present time. Where the water table is sufficiently close to the surface or where water may be had for irrigation, it is capable of producing truck crops and alfalfa.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Hanford fine sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23319.....	Soil.....	0.0	1.7	3.9	54.1	25.2	8.9	6.1

HANFORD COARSE SANDY LOAM.

The Hanford coarse sandy loam consists of 6 feet or more of light-brown or buff-colored micaceous coarse sandy loam. The characteristic occurrence of this soil, as in case of the Hanford coarse sand, is in scattered irregular bodies in the plains west of Madera and south of the Chowchilla River. In origin and formation it is similar to the types already described.

The surface is generally quite level and the soil is free from alkali. Without irrigation the type produces fair crops of grain in seasons when the rainfall is well distributed or unusually abundant. West

of Madera several areas are under irrigation. Here alfalfa, peaches, and grapes are grown, and the soil is well adapted to these crops. It is also adapted to truck crops and small fruits.

HANFORD CLAY LOAM.

The soil of the Hanford clay loam consists of 6 feet or more of heavy clay loam, gray to dark gray when dry and nearly black when wet. Both soil and subsoil contain considerable amounts of fine mica particles. In some cases there is a thin covering of sand over the soil, and pockets of fine and coarse micaceous sands are frequently encountered at varying depths below the surface. Near adjoining bodies of Fresno clay loam the soil sometimes becomes much lighter in color at about 3 feet.

The Hanford clay loam consists of recent alluvial deposits derived mainly from areas of granitic rock, with a relatively unimportant admixture of material from metamorphic and eruptive rocks.

Two bodies of the type have been recognized. These occur in the extreme western and southwestern parts of the survey. The smaller area embraces less than one-half square mile. The larger body covers many square miles and occurs as a strip nearly 20 miles in length and with an average width of 1 to 1½ miles along the San Joaquin River.

As a whole the surface is fairly level, being broken only by a few elongated depressions, or swales, which are the nearly obliterated remnants of former stream channels, or cut by sloughs formed in times of flood.

The drainage is only fair. The water table is rather high, usually within 6 feet of the surface. When not protected by levees, a considerable proportion of the area is subject to overflow during the spring and, at rare intervals, during the summer months.

Only a small part of this type carries alkali in sufficient quantities to be injurious to most cultivated crops, although occasionally the amount is larger than surface conditions would indicate.

Some of this type is used for the production of alfalfa, but the larger part is valued only for grazing. An extensive development is not to be expected until means are taken to prevent the annual overflow and to reduce the content of alkali below the danger point.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Hanford clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
2323.....	Soil.....	0.0	0.6	0.7	6.8	24.0	36.8	31.1

## HANFORD SANDY LOAM.

The Hanford sandy loam consists of 6 feet or more of light-brown, grayish-brown, or buff-colored micaceous sandy loam.

This type occurs along all the principal stream courses and in bodies of varying size throughout a considerable part of the area west of the Southern Pacific Railroad. Along the present stream courses the surface is often cut by channels of former overflows and sloughs are not uncommon, while on the plains the surface is level to slightly rolling.

The soil is alluvial in origin, the material having been derived largely from material brought from the mountains.

Alkali is not often present in large quantities. Where present, it is found largely in the surface foot. On the plains the type is treeless and carries a fair growth of native grasses, while along the stream courses growths of timber and underbrush are not uncommon.

In the irrigated sections this type is devoted to alfalfa, grapes, figs, olives, and peaches. Besides being adapted to these crops, it is also suitable for small fruits, melons, and truck crops.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Hanford sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23322.....	Soil.....	4.0	10.7	10.9	29.8	19.5	16.2	9.0

## HANFORD FINE SANDY LOAM.

The Hanford fine sandy loam consists of 6 feet or more of a buff, light-brown, or grayish-brown very micaceous fine sandy loam, possessing a loose friable structure and having a velvety feel. This soil is remarkably uniform in texture for a depth of several feet, the only variations noted being in the southwestern part of the area, where the subsoil sometimes grows heavier as heavier soils of either the Hanford or Fresno series are approached.

The Hanford fine sandy loam is found in small areas paralleling the larger stream courses and in bodies often of considerable size on the plains in the western half of the area.

Along the San Joaquin and Chowchilla Rivers the surface is frequently gullied by former overflows or intersected by sloughs, while on the plains the level surface is broken by half obliterated beds of former drainage ways and by the channels of present intermittent streams. Under natural conditions the drainage of this

soil is good, but in the southwestern part of the area, where flooding to produce grass for grazing has been carried to excess, swampy conditions have developed, and various water grasses and tules have gained a foothold on the lower-lying areas.

Some alkali is present in this soil. It occurs in relatively small bodies and in varying quantities.

Under irrigation this type is devoted to a variety of fruits. It is also well adapted to general farming.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Hanford fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23321.....	Soil.....	1.0	2.5	2.6	24.9	41.1	18.0	9.7

FRESNO SAND.

The Fresno sand consists of from 3 to 6 feet or more of incoherent sand consisting largely of the finer grades underlain at varying depths below 4 feet by a bluish to light-gray fine-textured calcareous hardpan. The soil is of light-gray or yellowish-gray and grayish-brown color. The density of the underlying hardpan is generally sufficient to interfere with the penetration of plant roots and to prevent drainage. In irrigated sections in other parts of the valley this hardpan has frequently been found to soften and disappear under irrigation. Wherever exposures of this hardpan have been observed in this area it has been several feet in thickness, and it is doubtful if irrigation water will accomplish much toward softening so thick a stratum.

The Fresno sand occurs on the plains south and west of Madera in small bodies, generally with a very level surface. In the southwestern part of the survey several areas of this type of soil occur as pronounced dunes.

This type of soil has its origin in the breaking down of the underlying hardpan, to which has been added fine granitic material carried in by former streams. No alkali is found in this soil.

The larger part of the type is devoted to grain farming, and, as the hardpan retains the moisture for the use of the crop, in seasons of favorable moisture conditions very good crops are secured. That part of the soil not used for grain is devoted to the grazing of cattle or sheep. Under irrigation the Fresno sand is adapted to a wide range of fruit and truck crops.

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

*Mechanical analyses of Fresno sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
23312, 23313.....	Soil.....	<i>Per cent.</i> 3.7	<i>Per cent.</i> 14.2	<i>Per cent.</i> 11.6	<i>Per cent.</i> 33.7	<i>Per cent.</i> 20.6	<i>Per cent.</i> 12.3	<i>Per cent.</i> 3.5

FRESNO COARSE SAND.

The Fresno coarse sand consists of a light-gray or yellowish-gray sand which usually changes with depth to a light-brown color. The texture of the material is uniform to depths of 6 feet or more.

The principal area of this type occurs as a narrow strip extending from Greenleaf to Irrigosa. Two other smaller bodies are found in this part of the survey. No hardpan was encountered within 6 feet of the surface and the drainage is excellent.

Grain is usually sown on this type, but on account of the lightness of the soil and the absence of hardpan the yields are usually very low. No surface supply of irrigation water is available for this type at the present time, but a pumping system is being installed to irrigate some of the area near Irrigosa, the land being planted to peaches. With an abundant supply of irrigation water and with the proper handling of the soil it is adapted to peaches, vines, and alfalfa.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Fresno coarse sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
23314.....	Soil.....	<i>Per cent.</i> 12.0	<i>Per cent.</i> 29.7	<i>Per cent.</i> 18.4	<i>Per cent.</i> 23.6	<i>Per cent.</i> 8.8	<i>Per cent.</i> 4.3	<i>Per cent.</i> 3.1

FRESNO LOAMY COARSE SAND.

The Fresno loamy coarse sand consists of from 1 foot to 6 feet or more of very light-brown or grayish coarse-textured loamy sand with a relatively large content of very fine sand. The bluish hardpan, characteristic of soils of the Fresno series, may occur at any depth below 12 inches and often varies considerably in depth within very short distances. Aside from the fact that this type merges gradually into the adjacent soils, there is practically no variation in the texture, although the color is frequently somewhat darker in the subsoil.

Areas of this type of varying extent are found throughout the southern and western parts of the survey. The surface of the eastern bodies is generally very uniform, but to the westward irregularities occur. These are the result of former and present stream channels and sloughs and more or less general surface erosion. The eastern bodies of this type possess fair drainage, as the hardpan is rarely within 4 feet of the surface. In the western part the hardpan is much closer to the surface, drainage is restricted, some alkali is present, and excessive flooding of the country has given rise to semiswampy conditions.

Excepting those portions of this type which are flooded to produce grass for grazing, only about 3 square miles of this type is under irrigation. Within the irrigated section some alfalfa is grown, but grapes are the principal crop. The remainder of the soil is devoted either to grazing or to grain farming, and where alkali or hardpan are not present this type ranks high among the grain-producing soils. The better phases of the Fresno loamy coarse sand with irrigation are adapted to alfalfa, grapes, peaches, figs, olives, and small fruits.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Fresno loamy coarse sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23316.....	Soil.....	8.1	22.3	12.7	21.7	25.8	5.6	3.8

FRESNO FINE SANDY LOAM.

The Fresno fine sandy loam consists of from 6 inches to 6 feet or more of light grayish-brown or light-brown fine sandy loam. This is underlain by a bluish, rather compact hardpan, which in this area, so far as could be determined, is several feet in thickness and will probably not soften under irrigation sufficiently to improve the depth of the soil. Within the bodies of this type the texture of the soil is very uniform, but it changes gradually along the borders, and the division between the types is usually indistinct.

The usual occurrence of this type is in extensive bodies, often several square miles in extent, and it is distributed generally throughout the southern and western parts of the area.

The surface of the better bodies of the type are level, and along the San Joaquin River a sharp high bluff forms the southern boundary. In the western part of the area the surface is more rolling, frequently dissected by former overflow channels, and more or less marked in many places by hog wallows.

In the Madera area there is in the soils of the Fresno series generally an intimate relation between the topography, alkali conditions, drainage, vegetation, and the depth to the hardpan, and this relation is strongly brought out on the Fresno fine sandy loam. Where the hardpan is rather deep seated, the soil is fairly level, free from alkali, and supports good growths of native grasses or dry-farmed grain. As the hardpan approaches the surface traces of alkali appear, alkali-resistant plants replace more desirable grasses, and the surface becomes more uneven. The most worthless condition is reached when the hardpan approaches within a foot or less of the surface, as only the most alkali-resistant plants remain, or the the surface of the soil may be devoid of vegetation and covered with a glistening crust of alkali salts. In such places the hog-wallow formation is common.

The more eastern bodies of this type owe their origin to the breaking down of the underlying hardpan and to the incorporation with this of fine material carried by former streams. The more westerly bodies are probably derived solely through the disintegration of the hardpan.

At the present time the Fresno fine sandy loam is not irrigated and is devoted to grazing or to grain farming, the deeper areas of this soil forming some of the more desirable grain lands of the area. The shallow areas of the type are, and probably always will be, used as pasture. With irrigation, this soil is adapted to alfalfa, fruits, melons, etc.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Fresno fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23315.....	Soil.....	0.3	1.3	1.7	14.3	41.2	33.6	7.3

FRESNO CLAY LOAM.

The Fresno clay loam consists of from 2 to 6 feet or more of fine silty clay loam, generally of compact structure, and rather sticky. The color of the surface soil is a very dark brown or black grading into a light brown below 18 inches. The characteristic bluish hardpan may be encountered at any depth below 2 feet, and is sufficiently compact to act as a bar to root development and to drainage.

The type grades imperceptibly into the Hanford clay loam, but the contact with other members of the Fresno series is usually well defined, either by the difference in color, in topography, or in texture of the surface soil.

The Fresno clay loam occurs in the western part of the area in several bodies lying nearly parallel with the San Joaquin River.

The surface is somewhat uneven, owing principally to the existence of many sloughs and the courses of intermittent streams. The drainage of this type, under present conditions, is poor, owing to the damming of many of the sloughs and excessive flooding of the surface.

Practically all of this soil carries alkali, and in a large part of it the content is too high to permit the growing of cultivated crops. A small acreage is planted to alfalfa, but by far the larger part is devoted to grazing. Where alkali and hardpan do not forbid this soil is adapted to alfalfa, and possibly to prunes, plums, and pears.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Fresno clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23317.....	Soil.....	0.4	2.3	2.5	8.0	22.1	40.4	24.2

MADERA SAND.

The Madera sand consists of from 3 to 6 feet of light-brown medium-textured sand, which is light and friable under any condition of moisture. The color is fairly uniform as far down as the sand extends, being somewhat darker in the subsoil when the moisture content is high. The sand is underlain by a red hardpan, similar in general appearance to the hardpan associated with soils of the San Joaquin series, but of a less dense and impervious character, lighter color, and sometimes marked by the presence of calcareous material.

The Madera sand occurs in the vicinity of Berenda, and northwards usually as long narrow bodies near and parallel to shallow watercourses. With few exceptions it lies on the south side of the streams. The surface is usually rolling, and generally somewhat higher than that of the surrounding types. A slight hog-wallow surface is not uncommon.

The origin and processes of formation of the soils of the Madera series are not always plain, but in the case of this type it seems to have been largely due to the blowing out of material from dry stream courses.

All of this soil is devoted to grain farming. It gives fair yields in seasons of favorable moisture conditions. The irregular surface and the lightness of the soil will probably restrict the use of much of the type to these crops for some time to come.

With a good supply of water the more level portions, where hardpan is not too close to the surface, may be profitably planted to alfalfa, grapes, figs, olives, and stone fruits.

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

*Mechanical analyses of Madera sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23324.....	Soil.....	1.5	21.4	25.7	27.6	9.5	9.4	4.2
23325.....	Subsoil.....	.9	18.4	22.2	27.4	12.1	9.7	9.3

MADERA COARSE SAND.

The Madera coarse sand consists of 4 to 6 feet or more of a light-brown to dark-brown coarse sand. Fine water-worn gravel is occasionally present in the lower lying areas of the type, and throughout the soil generally there is a large proportion of rather coarse angular sand. Mica is also frequently present, but is not a distinctive feature of the soil. The soil rests directly upon the characteristic hardpan of this series, which may occur at any depth below 4 feet and which is sometimes separated from the soil by a thin stratum of clay loam.

This soil occurs scattered through the eastern half of the survey, either as narrow bodies following the meanderings of intermittent streams, as knolls or ridges between such waterways, or as small inconspicuous areas among other soils of the Madera or San Joaquin series.

The Madera coarse sand has apparently resulted from the reworking of a soil originally occupying the position now held by this type, and apparently the former soil was closely related to soils of the San Joaquin series.

This type is devoted to grain farming, the yields varying largely with the topography. The higher bodies, where drainage is excessive, give low yields, while the lower bodies usually produce fair crops. Under irrigation the more level, deeper areas of this soil would be adapted to alfalfa and small fruits, but only a part of the type is suitable for anything except grain farming or grazing.

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

*Mechanical analyses of Madera coarse sand.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23326, 23327.....	Soil.....	10.7	25.6	15.3	21.1	12.8	6.9	7.6

MADERA SANDY LOAM.

The Madera sandy loam consists of from 1 foot to 6 feet of a light-brown to dark-brown sandy loam, which is inclined to be sticky when wet and is very hard and compact when dry. This soil rests directly upon the usual hardpan, which is sometimes found within a foot of the surface. Gravel is not a usual constituent of this type, but in the country west of Table Mountain (Rs. 19 and 20 E.) waterworn gravel is occasionally present and is indicated on the soil map by appropriate symbols.

The Madera sandy loam occurs throughout the eastern and central parts of the area, either in bodies of considerable extent or as small elevated or depressed areas among soils of the San Joaquin series. The more western bodies are level, or slightly rolling, the surface irregularities becoming greater to the eastward and culminating in a sharply rolling, dissected plain, dotted with hog-wallow depressions and occasional outcroppings of red hardpan.

The soil is apparently due to the reworking of a former soil and to the incorporation of more or less foreign material from higher levels.

With but one or two exceptions, the areas are used for grain farming and grazing, and considerable areas are valueless for other purposes on account of the topography and hardpan. The uneven surface, the nearness of the hardpan, and the cost of irrigating such areas prevent the development of more intensive farming. In the more level areas of the soil the hardpan is always deeper, and with a supply of irrigation water these would be well adapted to vines, figs, olives, berries, and alfalfa, and fairly well adapted to the production of various stone fruits and almonds.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Madera sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23320.....	Soil.....	1.7	22.0	18.5	21.1	9.6	19.1	7.9

MADERA FINE SANDY LOAM.

The Madera fine sandy loam consists of from 50 inches to 6 feet or more of a light-brown fine sandy loam, underlain by a dense red hardpan.

This type occurs in several small bodies occupying comparatively low land bordering various streams in the area. All of it is devoted to grain farming, with fair results. With irrigation, it would be adapted to alfalfa, grapes, and small fruits, but on account of its low

elevation and the consequent danger of spring frosts it is not so well adapted to the larger fruits.

The following table gives the results of a mechanical analysis of a sample of the soil of this type:

*Mechanical analysis of Madera fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23328.....	Soil.....	0.4	1.4	3.1	23.5	42.8	18.9	9.6

MADERA CLAY LOAM.

The Madera clay loam consists of from 3 to 6 feet or more of light grayish-brown to dark-brown sticky loam, underlain by red hardpan. Only a few small bodies of this type occur in this area. These, with one or two exceptions, are found along the smaller stream courses. In present uses and adaptability this type is similar to the Madera fine sandy loam.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Madera clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23331.....	Soil.....	0.8	4.5	3.7	10.1	11.7	40.6	28.2

SAN JOAQUIN SANDY LOAM.

The San Joaquin sandy loam consists of from 18 inches to 6 feet or more of reddish-brown to yellowish-brown sandy loam, underlain by a dense impenetrable red ferruginous hardpan. The soil usually contains quantities of medium coarse granitic sand, and small quantities of water-worn gravel are occasionally present in the higher-lying areas of the type. When wet, owing to the saturation of the soil above the hardpan, the areas are boggy and impassable except on well-traveled roads, and when dry the soil is exceedingly hard and compact.

The surface of this type is rarely level or uniform, the inequalities ranging from slight hog-wallow mounds to pronounced hills and ridges. The surface is more uneven in the eastern and central parts of the area than in the western part. As a rule, the drainage is poor, the inequalities of the hardpan preventing the movement of water in the subsoil.

The San Joaquin sandy loam owes its origin to the deposition of soil material in the waters of an inland sea, once covering the area. The irregularities of surface are due to subsequent erosive agencies. It constitutes the prevailing soil type in the eastern plains portions of the area. The San Joaquin sandy loam is devoted entirely to grain farming, the yields varying greatly, and being dependent upon the distribution and amount of rainfall, cultivation, and depth to hardpan. When the hardpan is not too close to the surface or the topography too rough, this soil under irrigation is adapted to figs, olives, grapes, and small fruits.

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

*Mechanical analyses of San Joaquin sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23334, 23335.....	Soil.....	6.3	14.4	9.3	14.9	12.3	31.1	11.7

SAN JOAQUIN GRAVELLY SANDY LOAM.

The San Joaquin gravelly sandy loam consists of from 2 to 6 feet or more of a dark-red sticky sandy loam, carrying considerable quantities of rounded waterworn gravel, which varies in size from very fine pebbles to large cobbles. Hardpan occurs in this soil type, but its average depth is somewhat greater than in other soils of the San Joaquin series.

Only two bodies of this type were encountered in the survey of the area. These lie to the south and southwest of Table Mountain, where they occur as pronounced ridges rising above the surrounding soils. The surface, although having considerable slope, is free from minor irregularities.

The soil is devoted to grain farming, but with facilities for irrigation it would be adapted to grapes, figs, olives, and probably to citrus fruits.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of San Joaquin gravelly sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23333.....	Soil.....	6.6	17.7	9.0	13.1	8.8	31.9	12.9

## SAN JOAQUIN CLAY LOAM.

The San Joaquin clay loam consists of from 2 to 4 feet of sticky red or reddish-brown clay loam, underlain by the usual dense red hardpan. The soil resembles the sandy loam with respect to moisture conditions, and in local depressions frequently cracks upon becoming very dry and loses the usual red color, changing to a dark brown or black.

No extensive bodies of the San Joaquin clay loam occur in the area. The surface of the type is dotted with the usual hog-wallow mounds, but otherwise it is not as irregular as much of the sandy loam.

The soil is now used for the production of grain, usually giving somewhat higher yields than the sandy loam. In general the two types have the same crop adaptations.

The following table gives the results of mechanical analysis of the soil of this type:

*Mechanical analysis of San Joaquin clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23336.....	Soil.....	1.9	4.9	3.6	10.7	24.6	29.1	25.2

## MEDIA COARSE SANDY LOAM.

The Media coarse sandy loam consists of from 6 inches to 4 feet of a dark-gray very coarse sandy loam, tinged reddish brown, carrying considerable quantities of coarse angular sand composed mainly of feldspathic fragments mingled with more or less micaceous material. The soil is underlain either by partially disintegrated or weathered rock, generally of granitic character. Rock outcrops are common, but loose boulders or stones are rarely present. The surface is always uneven, consisting of sharply rounded hills, often capped with outcropping rock.

This soil is largely residual, resulting from the disintegration of the underlying rocks, but some of the soil in the lower elevations owes its position to colluvial agencies and soil creep on the steeper slopes.

The larger part of this soil is of little agricultural value, owing to the occurrence of outcropping rock or to nearness of the rock to the surface, to the light texture of the soil, and to the difficulty of irrigation. Some of the type may be used for dry farming, but the larger part is of value only for grazing.

The table following gives the results of a mechanical analysis of the soil of this type.

*Mechanical analysis of Media coarse sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
23308.....	Soil.....	<i>Per cent.</i> 14.6	<i>Per cent.</i> 19.0	<i>Per cent.</i> 10.6	<i>Per cent.</i> 18.0	<i>Per cent.</i> 14.0	<i>Per cent.</i> 17.3	<i>Per cent.</i> 6.5

## MEDIA SANDY LOAM.

The Media sandy loam consists of from 2½ to 6 feet or more of a compact grayish-red to bright-red sandy loam, carrying a considerable amount of angular feldspathic fragments and micaceous material, which is underlain by more or less decomposed rock, at varying depths below 30 inches.

The texture of the subsoil is somewhat variable, particularly near adjoining types, where it is either lighter in color or texture or heavier and possessing the same color as the surface soil. Areas of rock outcrop are common and some wash gravel occurs near the stream courses.

The Media sandy loam occurs in the rolling lands in the eastern part of the area, below the Rough stony land. The topography varies from slightly to sharply rolling, and the areas are traversed by numerous intermittent stream courses.

The soil of this type is made up of material derived from the country rock, and occurs either where it has been formed or in lower places to which it has been transferred by wash and soil creep.

At present this soil is devoted to grazing and grain farming and without irrigation is valueless for other cultivated crops. When the soil is not too shallow, the surface too irregular, and where irrigation is possible, it will be adapted to grapes, figs, olives, alfalfa, and, in especially favored locations, possibly to citrus fruits.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Media sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
23337.....	Soil.....	<i>Per cent.</i> 6.4	<i>Per cent.</i> 12.9	<i>Per cent.</i> 7.3	<i>Per cent.</i> 24.5	<i>Per cent.</i> 25.2	<i>Per cent.</i> 16.5	<i>Per cent.</i> 7.2

## MEDIA FINE SANDY LOAM.

The Media fine sandy loam consists of from 2 to 6 feet of compact bright-red to dark-red fine sandy loam carrying angular feldspathic fragments. Beneath this material is found either a heavy compact

bright-red clay loam or the more or less decomposed bedrock. The clay loam subsoil may be absent, but when present the stratum is rarely over 24 inches in thickness. Outcrops of the parent rock are common.

The surface of this type is always rolling, sometimes sharply so. Drainage is supplied by small intermittent streams. In origin, formation, agricultural value, and adaptations the Media fine sandy loam is similar to the sandy loam of the same series.

The following table gives the results of a mechanical analysis of the soil of this type.

*Mechanical analysis of Media fine sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23338.....	Soil.....	1.7	2.5	1.7	12.3	41.6	17.6	22.5

MEDIA CLAY ADOBE.

The Media clay adobe consists of from 36 inches to 6 feet or more of a heavy clay adobe, which sometimes carries a little fine waterworn gravel, generally of siliceous character. The soil is either a dark red or reddish brown in color, and upon drying cracks badly, leaving the surface a mass of large hard clods. The surface material is underlain at varying depths below 36 inches by unaltered or partially decomposed granitic rock.

Three small bodies of this type occur in the area. These are situated in the rolling country below more elevated areas of Rough stony land. The surface is uniform, but usually has considerable slope. The soil is both colluvial and residual in formation and is derived chiefly by wash from higher lying adjacent soils.

This type ranks as one of the poorer grain soils on account of its adobe structure and is largely used for grazing. It is of little value without irrigation, and as its elevation would make irrigation expensive only high-class crops could be profitably grown.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Media clay adobe.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23339.....	Soil.....	2.3	7.1	4.8	10.2	10.3	34.7	30.6

DAULTON SANDY LOAM.

The Daulton sandy loam consists of from 6 inches to 4 feet of a grayish to rather dark brown compact and rather fine sandy loam, which is underlain by more or less decomposed rock of metamorphic or granitic character. Rock outcrops are not uncommon, and boulders and smaller rock fragments occur on slopes below the outcropping ledges.

This type occurs in the eastern part of the area and occupies level or eroded areas below the Rough stony land. But little of it is of much agricultural value, the larger part of the level areas being shallow and the higher portions too eroded or steep to permit cultivation and irrigation.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Daulton sandy loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23309.....	Soil.....	3.5	9.9	9.0	24.3	22.4	16.5	14.5

DAULTON CLAY LOAM.

The Daulton clay loam consists of from 24 inches to 6 feet of light-brown to light reddish brown compact clay loam, which is underlain by schist, quartz, or sometimes by granitic rocks. Rock outcrop is commonly present, particularly in the larger body north of Daulton, and the surface is very rolling. This type is largely used for grazing, only the most level areas being devoted to grain. Portions of the soil would be of some value when irrigated for fruit, but the type as a whole is not a very desirable soil.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Daulton clay loam.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23310.....	Soil.....	1.5	1.9	1.9	11.3	34.0	24.3	25.2

DAULTON CLAY ADOBE.

The Daulton clay adobe consists of 6 feet or more of dark-red to brownish-red clay adobe, usually carrying considerable quantities of angular and subangular rock fragments generally quartz of siliceous character.

This type occurs as a few small irregular bodies in the north-eastern part of the area, and is usually characterized by having a greater elevation than the surrounding soils. It is devoted to grain farming with only fair results, as the elevation and cracking of the soils cause it to dry out rapidly. With irrigation it should be well adapted to grapes, fruits adapted to a heavy soil, and probably to citrus fruits when provided with wind breaks.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Daulton clay adobe.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23311.....	Soil.....	2.0	4.5	2.8	6.7	6.1	25.3	52.7

PORTERSVILLE CLAY ADOBE.

The Portersville clay adobe consists of from 3 to 6 feet of a heavy black clay adobe typically carrying some small subangular calcareous nodules. Below 3 feet the subsoil may be a yellowish sticky clay loam carrying a high percentage of lime. This soil type as it occurs in this area is, however, not always calcareous or exactly true to type as it occurs in the Portersville area. When wet the soil settles into a heavy tenacious mass, and upon drying cracks badly and becomes "puffy."

The Portersville clay adobe occurs in restricted bodies in the eastern part of the area, and usually occupies lower elevations than the surrounding soils. It is made up largely of material washed from higher soils, and deposited in areas of deficient drainage. The color is due largely to organic matter resulting from the rank growth of vegetation usually flourishing in a wet soil. The type is not very desirable as a grain soil, because of its tendency to crack and dry out, and is used largely for grazing. On account of its topographic position and consequent poor drainage it has little value as a possible fruit soil. Some alfalfa might be grown. Irrigation would be necessary during a part of the year. On the whole the soil is not a very desirable one.

The following table gives the results of a mechanical analysis of the soil of this type:

*Mechanical analysis of Portersville clay adobe.*

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>						
23332.....	Soil.....	2.3	5.9	4.9	11.9	7.5	26.9	40.6

## ROUGH STONY LAND.

The Rough stony land consists of the rough hilly areas and elevated plateaus in the eastern part of the area. The soil is residual, varies somewhat in texture from loam to sandy loam, and masses of rock outcrop, ledges, and boulders are numerous. A scattering growth of oak covers a large part of the type and is cut for firewood. Aside from this, and as fair grazing land, the soil has no agricultural value.

## RIVERWASH.

The Riverwash consists of the gravels, sands, and fine sands occupying the beds of intermittent streams and a few small, low areas along the San Joaquin River. These are overflowed during several months of the year, when the streams are at the highest stages, and are dry during the remainder of the year. Riverwash has no agricultural value.

## HARDPAN.

Hardpan is characteristic of soils of the San Joaquin, Madera, and Fresno series, and from the extent of these soils it is evident that this formation occurs in the subsoil of at least three-fourths of the area surveyed. Since the presence of hardpan in a soil introduces conditions which materially affect its agricultural value and adaptation, and may even render areas of soil absolutely worthless for agricultural purposes, it is plainly a factor which must be carefully considered by the landowner or prospective farmer if success is to follow the cultivation of such lands.

The hardpan underlying the soils of the San Joaquin and Madera series is compact, dense, of a red or reddish-brown color, and in texture and appearance resembles a red sandstone. It absolutely controls the drainage of the soil and the downward development of plant roots, and does not break down when the soil is irrigated. Its average depth is about 30 inches, and there are extensive areas where it is covered by only a foot or less of soil.

In some sections of the Interior Valley, where the hardpan is only a few inches or at most a foot in thickness, conditions have been improved by blasting and filling the holes with soil. In this way good returns have been secured from plantings of grapes and fruits. The shattering of the hardpan results in better drainage for the soil, and the vines and trees grow and produce as though no hardpan were present.

It is not probable that this procedure will be of much value in this area, excepting possibly in the most western extensions of these soils, as the exposures of the hardpan along the San Joaquin River and the smaller streams invariably show it to be many feet (10 to 20 feet) in

thickness, and the expense of breaking the hardpan to this depth and refilling cavities formed by blasts would not be justified by the crop returns.

Practically the entire area underlain by this hardpan is at present devoted to dry farming, and the growing of cultivated crops is not recommended, unless water is secured for irrigation, and then only when the hardpan is not nearer than 3 or 4 feet of the surface. It is true that in some sections of the valley success has attended the culture of some crops without irrigation. This is due to peculiar soil conditions existing in those sections, but lacking in this area, and the attempt to grow fruits without irrigation is practically certain to result in failure. Where the hardpan occurs at less than 3 feet, only small fruits may be grown with certainty. The attempt to grow larger fruits is hazardous, owing to the danger of killing the trees or vines either by an excess or by a deficient supply of water. The planting of trees can not be safely recommended where the hardpan is closer than 5 feet to the surface.

The hardpan underlying the soils of the Fresno series is very different from that under the soils above referred to, being much softer and finer in texture, bluish-gray in color, and not uncommonly carrying some alkali. In some of the irrigated sections of the valley this hardpan has, after a few years of irrigation, softened sufficiently to improve the underdrainage and to enable the penetration of roots. So far as it has been possible to observe, the hardpan in this area is several feet in thickness, and it is not likely that it will ever break down sufficiently to give much internal drainage. The depth of this hardpan is subject to considerable variation, even within very short distances, and large areas where the hardpan lies 12 inches or less beneath the surface are not uncommon. As a general rule, the hardpan is found to be most deeply buried in the eastern areas of Fresno soils, and comes closer to the surface to the westward. When the hardpan is relatively close to the surface alkali is always present, and these two conditions frequently render extensive areas of soil worthless for anything save grazing. With the exception of a very small acreage of irrigated alfalfa, in the western part of the area, all of the soils underlain by hardpan are devoted to grazing or grain farming, and for these purposes the hardpan is, when not too close to the surface, a material assistance, as it prevents the loss of moisture through the subsoil. Under irrigation, however, the presence of hardpan may be detrimental, as has been demonstrated in other sections of the valley. Where drainage facilities are not provided, the water table often rises and kills the crops, and, in the case of the Fresno soils the rise of the water table is accompanied by an accumulation of alkali salts in the upper part of the soil. The same conditions will develop in the greater

part of the area underlain by hardpan in the present survey when irrigation water is supplied, unless the greatest care be taken in the use of water and adequate drainage facilities to remove the excessive amounts of water and alkali be provided.

#### IRRIGATION.

The land in this area which is supplied with water for irrigation consists of an area of about 30 square miles south and west of Madera, a few square miles in the southeastern corner of the area, and several small vineyards and alfalfa fields along the Chowchilla River. The causes responsible for the lack of development are the cost of conserving the winter and spring floods of the Chowchilla and Fresno Rivers, and the inability to secure water from the San Joaquin River.

The Chowchilla River, forming the northern boundary of the area, is an intermittent stream, flowing during the winter, spring, and early summer months. It has an estimated mean annual discharge of about 62,000 acre-feet. During the flood stage, some water is diverted onto alfalfa and vineyard lands, but only a part of the flow can be utilized, and the larger part passes beyond the area. No data are available regarding the flow of the Fresno River, but during the latter part of the rainy season, a large volume of water passes away to the lowlands in the western part of the area, or to the northward beyond the limits of the survey. It is believed to be practicable to construct reservoirs in the foothills, which would retain the flows of these streams, and if such is the case, several thousand acres could be added to the irrigated sections of the valley, and the land made much more valuable than at the present time.

With the San Joaquin River the conditions are very different. The flow of this stream is constant, but none of it may be used for the higher lands of the area, as it is controlled by a few individuals, holding practically all of the lowlands of the area.

The entire area is underlain by a vast body of underground water which is available for irrigation, but which has not been extensively utilized for that purpose. This body of water lies at varying depths below 25 feet from the surface, and whether the irrigation of crops by pumping will prove profitable will depend upon the crop to be irrigated and upon the height which the water must be pumped. Throughout the area west of the Southern Pacific Railroad, the groundwater is rarely deeper than 40 feet, and water may profitably be pumped for all crops grown in that section, excepting grain. East of the Southern Pacific Railroad, with few exceptions, the level of the land surface rises rapidly, the depth to the groundwater becomes greater, and only crops which insure high

and regular returns can be irrigated at a profit by pumping. A third source of water lies in the development of artesian wells. So far some 30 flowing wells have been developed, the total flow of which is estimated at a little less than 8 cubic feet per second.<sup>1</sup> The wells are comparatively shallow, rarely being over 400 feet in depth, and the flow is used for watering stock on the Chowchilla and Miller and Lux ranches. It is held by some that a large supply of cheap water may be secured for irrigation through the development of this artesian belt.

In the irrigated sections in the northern and western parts of the area the irrigation of the grazing, alfalfa, and vineyard lands is accomplished by private canals. In the irrigated section near Madera the canal of the Madera Land & Canal Co. takes water from the Fresno River, and several pumping plants augment the area covered by the canal.

#### ALKALI.

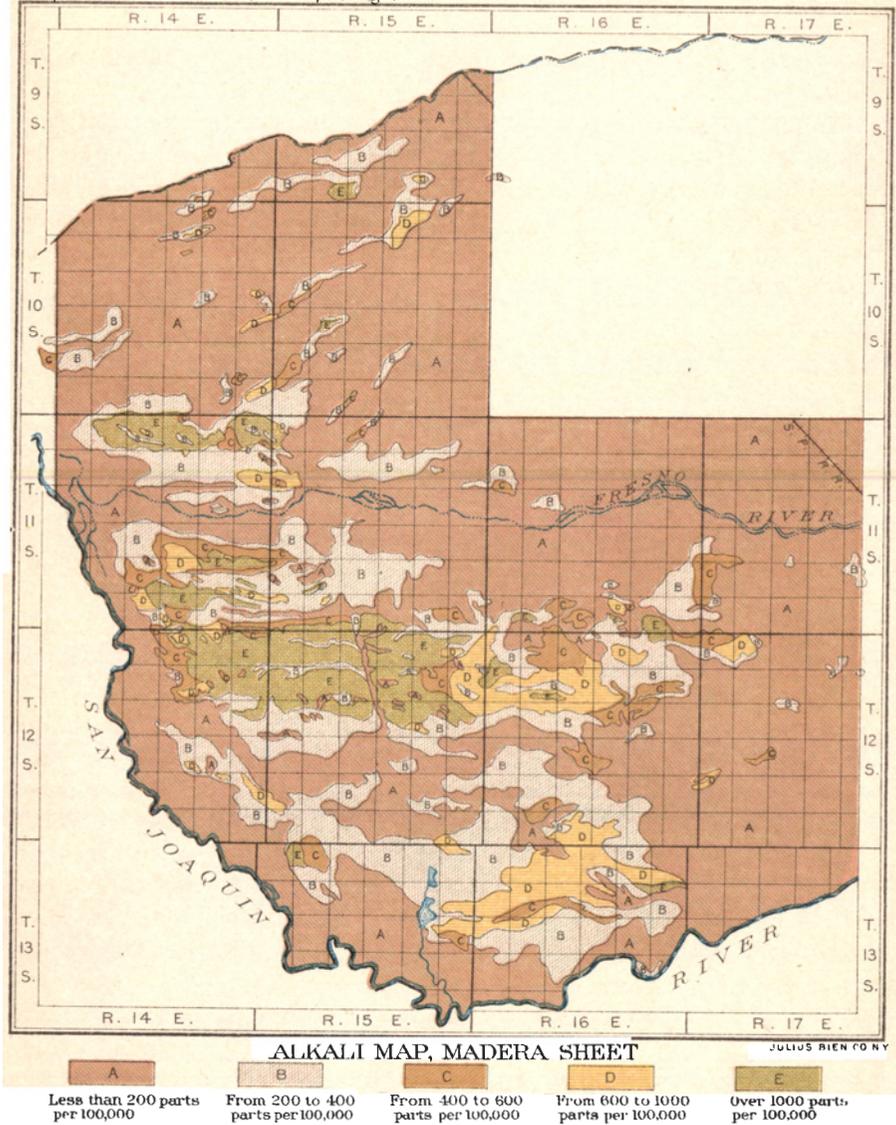
The alkali in this area is confined entirely to those parts of the area occupied by soils of the Fresno and Hanford series, and scarcely any alkali occurs east of the line between ranges 16 and 17 east. West of this line the location of the bodies of alkali is very irregular and is apparently governed largely by the types of soil and by the presence of hardpan. In the northwestern part of the area, where soils of the Hanford series predominate, the bodies of alkali follow closely the soil boundaries, and not uncommonly the heavier the soil the larger the content of soluble salts. In the southern part of the area, where the Fresno soils predominate, the hardpan apparently exercises more effect upon the location of the alkali than does the texture of the soil. The drainage of these soils hinges entirely upon the location of the hardpan. As the hardpan approaches the surface, the drainage becomes poorer and the amount of alkali increases.

Throughout the western half of the area there are extensive areas of land where the surface is dotted with small circular areas of alkali, while the larger part of the soil is absolutely free. In these alkali patches the alkali is usually concentrated at or near the surface, and when good drainage is afforded will probably be easily washed out by irrigation. (Pl. B.)

Where the Hanford soils are affected, the presence of alkali is due to defective drainage, which has resulted in the evaporation of water in the soil and the gradual accumulation of salts which the water carried in solution. The alkali found in soils of the Fresno series has, for the larger part, been derived from the breaking down of the underlying bluish hardpan, the alkali in this case also being retained in the soil through inadequate internal drainage.

---

<sup>1</sup> U. S. G. S. Water Supply Paper No. 222—Mendenhall.





The content of alkali in the soils varies from mere traces to considerably over 2 per cent. The areas of high concentration are found principally in that part of the area west of the Aliso Canal and north of T. 13 S. Here the alkali occurs in extensive bodies in poorly drained soils and is broken by small bodies of soil of lower content where either a greater elevation or deeper hardpan has given better drainage. Outside of this area of high concentration the alkali generally occurs in bodies of smaller extent and lower concentration. Such areas are often surrounded by large areas of alkali free soil.

When conditions have not been affected by flooding, irrigation, or seepage, the alkali is composed of the chlorides, sulphates, and bicarbonates of calcium, sodium, and magnesium. These salts, in their varying combinations, are commonly known as "white alkali" on account of the whitish crystals or incrustations which appear on the surface of the dry soil wherever these salts are present in any considerable quantity. Whenever sodium carbonate, in addition to the other salts, is present, the alkali is known as black alkali. Where this salt occurs in appreciable quantities, the surface of the soil and the water in stagnant pools have a dark-brown or black color, due to the corrosive action of the alkali upon organic matter.

Practically all of the alkali lands of this area are used for grazing; but in a few cases in the western part of the survey some alkali is found within the section devoted to alfalfa, and a few small alkali spots are present in the grain section southwest of Madera.

The practicability of reclaiming these alkali lands depends, with few minor exceptions, upon the location of the hardpan in the soil and the securing of an adequate supply of irrigation water. Where the hardpan is 4 feet or more in depth, reclamation can be accomplished either by flooding or by combined flooding and drainage. With hardpan at less than that depth, successful reclamation is doubtful. In the central and northern parts of the area there are extensive areas of soil where the total amount of alkali is not large, but where nearly all of the alkali present is concentrated at or near the surface. In these sections the larger part of the land can be brought into good condition without drainage, as there is no hardpan in the subsoil, and cultivation and irrigation would distribute the alkali, so that crops would thrive and eventually the alkali would be completely removed from the soil.

The matter of reclaiming alkali lands is of no present importance, as practically all of the affected areas occur within the large ranches or estates where the land is used for grazing and the matter of reclamation will be of no concern until these holdings are disposed of in small farms and the land placed under cultivation.

## SUMMARY.

The Madera area is located near the center of the San Joaquin Valley and occupies all of the valley lands of Madera County.

The larger part of the area is nonirrigated, the land being devoted to dry farming of grain and stock raising. In the irrigated sections alfalfa, deciduous fruits, grapes, vegetables, and truck crops do well.

There is an abundant supply of irrigation water nearby, but which for several reasons is not now available for use on the higher lands of the area. When irrigation is secured, these lands will become valuable, as they are capable of yielding abundant crops of alfalfa and fruits.

Land values are, as a rule, low and the better lands of the area are rising in price.

Transportation is afforded by two transcontinental railroads, which afford facilities for reaching all of the large commercial centers of the country.

Madera is the county seat of Madera County, and is the only town of any size in the area. Minturn and Berenda are small settlements along the line of the Southern Pacific.

The soils of the Madera area are represented by a number of series, the most important of which are the San Joaquin, the Fresno, the Madera, and the Hanford.

The San Joaquin series includes those red to reddish-brown soils which have been derived from old Pleistocene deposits. They are usually underlain by hardpan. In this area the series embraces three types—a gravelly sandy loam, sandy loam, and clay loam. For the most part they are dry farmed to grain or used for grazing purposes. Under irrigation, the more level bodies should be well adapted to olives, figs, small fruits, berries, alfalfa, and in favorable localities to citrus fruit.

The Fresno series occurs mainly in the western half of the area and embraces five types—coarse sand, sand, loamy coarse sand, fine sandy loam, and clay loam. These soils occur as older alluvial and colluvial deposits, derived principally from granitic rocks, but carrying some material from volcanic, sedimentary, and metamorphic rocks. They are prevailingly of a light-gray color, are usually underlain by a bluish or grayish calcareous hardpan, and frequently carry considerable amounts of alkali salts.

At present the soils of this series are used principally for grazing or else are dry farmed to grain. When free from alkali and the underlying hardpan is not too near the surface they are well adapted to a variety of fruits, truck, and alfalfa under irrigation.

The Madera series includes those soils which are made up from old Pleistocene deposits, as represented by the San Joaquin series, but

which in the Madera series have been subjected to more advanced weathering and modification brought about by admixture of alluvial material from intermittent streams. These soils are usually underlain by hardpan, but seldom carry any great amount of alkali salts. The series embraces five types—a coarse sand, sand, sandy loam, fine sandy loam, and clay loam. At present a large part of the series is used for grazing purposes or dry farmed to grain, the yields being fair on lower bodies but on the higher, excessively drained bodies, they are very low. Under irrigation the more level and deeper phases are well adapted to alfalfa, small fruits, olives, figs, and stone fruits.

The soils of the Hanford series consist of recent alluvial stream deposits, derived from granitic rocks, but with a relatively unimportant admixture of other material derived from metamorphic and eruptive rocks. They are usually a light gray or light brown to a depth of 6 feet, and are very micaceous. The areas are fairly level and usually well drained. Some alkali salts are found in these soils. The series embraces six types—coarse sand, fine sand, coarse sandy loam, sandy loam, fine sandy loam, and clay loam. Under irrigation the sands and sandy loams are adapted to truck crops, alfalfa, peaches, olives, grapes, figs, and small fruits. The clay loam is well adapted to alfalfa and grain. At present these soils are used chiefly for grazing purposes, although there is a considerable acreage in alfalfa.

Alkali is present in the most of the soils in the western third of the area. A considerable part of the alkali lands may be reclaimed, when desired, and made valuable for farming purposes.

# **NRCS Accessibility Statement**

---

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at [ServiceDesk-FTC@ftc.usda.gov](mailto:ServiceDesk-FTC@ftc.usda.gov). For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at <http://offices.sc.egov.usda.gov/locator/app>.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotope, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.