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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS—MILTON WHITNEY, Chief.

SOIL SURVEY OF THE REDDING AREA, CALIFORNIA.

BY

MACY H. LAPHAM AND L. C. HOLMES.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., April 24, 1908.

SIR: A soil survey of the Redding area, California, was instituted in the summer of 1907 at the request of the Shasta County Board of Trade for the purpose of determining the extent and varieties of the soils and the possibilities of the further agricultural development of the area. This work is a part of the extension of the soil surveys in the Sacramento Valley called for by numerous resolutions from boards of trade of all the representative cities of the valley, the Sacramento Valley Development Association, California Water and Forest Association, etc., which have been indorsed by Hon. George C. Perkins and Hon. F. P. Flint. I have the honor to transmit herewith the report and map covering these investigations and to recommend their publication as advance sheets of the Field Operations of the Bureau of Soils for 1907, as provided by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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SOIL SURVEY OF THE REDDING AREA, CALIFORNIA.

By MACY H. LAPHAM and L. C. HOLMES.

DESCRIPTION OF THE AREA.

The Redding area covers about 200 square miles, embracing the principal agricultural district of Shasta County, Cal. It is irregular in outline and extends north from Cottonwood Creek, which here forms the southern boundary of Shasta County, a distance of some 20 miles. From east to west its greatest breadth is slightly less than 16 miles.

It occupies the upper or northern part of the great depression known as the Sacramento Valley. This depression, constituting the most important agricultural region of the northern half of the State, is about 4,000 square miles in extent. It is inclosed by the Sierra Nevada and the Lassen Peak Ridge of the Cascade Mountains upon the east, the Coast Range upon the west, and the Klamath Mountains, formed by the coalescing of these ranges, upon the north.

FIG. 1.—Sketch map showing location of the Redding area, California.

The extreme northern part of this depression is cut off from the main valley of the Sacramento River by a low, wooded ridge extending outward from the foothills upon each side of the valley, through which a short distance north of the town of Red Bluff the Sacramento passes by a narrow gorge known as Iron Canyon. The valley proper

has been eroded by the Sacramento River from the stream deposits of clays, sands, and gravels laid down at an earlier period in this depression. The valley within the area surveyed is from a half mile to 3 miles in width. In the vicinity of the town of Anderson it attains its maximum width and greatest agricultural importance, and it is here known as the Anderson Valley. The Sacramento River, which traverses the area in a southeasterly direction and flows through a wide and generally shallow channel, often marked by riffles formed by gravel bars, is frequently bordered by sand bars and wooded bottoms, or by bluffs sometimes rising to nearly 100 feet in height. The valley bottoms support a vigorous growth of valley oak or a dense covering of cottonwood and sycamore, with an almost impenetrable undergrowth of "willows," brush, and vines. The adjacent valley slopes are usually dotted with groves or individual oaks and support during the winter and early summer a good growth of nutritious grasses.

West and southwest of the Sacramento River and its recent valley the survey embraces a comparatively large tract of rolling or sloping plateaulike country, often greatly dissected by streams, and made up of earlier stream deposits from 100 to 200 feet or more above the recent valley floor, from which it is generally separated by well-marked bluffs or terraces. This rolling or elevated plateaulike country extends beyond the western boundary of the area and merges in the foothills of the Klamath Mountains. Its numerous minor stream valleys are generally more or less forested with live and deciduous oaks and digger pines, and are often covered with a dense growth of chaparral consisting of manzanita, coffee berry, and ceanothus. East from Anderson, where this region becomes important agriculturally, it is known as Happy Valley. The main tributary streams of the Sacramento in this section of the area are Cottonwood and Clear creeks, which traverse narrow valleys and maintain a small flow of water throughout the dry season. The Clear Creek bottoms, as is the case in other parts of the area, have been more or less disturbed by hydraulic mining operations and the stream courses partially filled or obstructed by debris.

The northern half of that portion of the area lying east of the Sacramento River is similar in character to the Happy Valley section, but is rougher, more deeply dissected by stream courses, and has somewhat shallower soils. It is bounded upon the north and west by a region of shallow, rocky, residual soils of the mining district of the Klamath Mountains and adjacent foothills. In the southern half of this section these wooded rolling hills gradually give way to gently sloping treeless plains known locally as the Stillwater Plains. Here is found a shallow, gravelly soil, which, in the vicinity of the narrow stream valleys or minor stream courses, supports some timber.

The northern and eastern parts of the area are drained principally by Churn, Stillwater, and Cow creeks, which flow south. It is principally in the narrow valleys of these streams that the farming lands of this district are located.

By far the greater part of the agricultural population is confined to the Anderson and Happy valleys, where in places the country is quite thickly settled. In other parts of these districts, where the farms are larger and farm dwellings some distance apart or where the land is uncleared of timber and brush and used only for grazing, the population is rather sparse. In the rougher and more hilly districts and upon the treeless plains of the southeastern part of the area the population is confined to a few small clearings or cultivated farms upon the uplands and in the minor stream valleys. The farming class is of a cosmopolitan character, drawn not only from the various parts of the United States but from foreign countries.

Redding, the county seat of Shasta County, now has a population of about 5,000, and is the principal town. It is a shipping center and outfitting point for near-by mining camps, which have contributed greatly to its development. Anderson, having a population of about 1,000, is the main fruit-shipping point and agricultural center. Cottonwood, a smaller town near the southern boundary, is the center of a small fruit district. Bellavista, a little town near the northeast boundary, is the site of a lumber mill and box factory of considerable size.

Transportation is furnished principally by the Portland and San Francisco branch of the Southern Pacific Railway. The Anderson and Bellavista Railway, connecting Anderson with Bellavista, is used mainly for lumber and ore shipments.

The Redding area is well provided with public roads, which in the more thickly settled districts are of excellent character.

Fruits and other farm products are shipped to the East, to San Francisco and vicinity, and to Portland and other cities to the north. The towns and mining camps of northern California and Oregon also afford excellent markets for fruits, vegetables, hay, poultry, and dairy products.

CLIMATE.

The climate of the Redding area is characterized by a long, warm, dry summer season, followed by a mild, rainy winter season.

The normal annual precipitation at Redding, at an elevation of 552 feet, is reported by the United States Weather Bureau as 36.11 inches. This is somewhat in excess of the rainfall reported for the more southern Sacramento Valley points, the precipitation, for instance, at Red Bluff—elevation, 309 feet—at the head of the main valley, being 26.11 inches. Owing to slightly greater elevation and proximity to the mountains it is probable that at Redding it is somewhat greater than

at Anderson and over the principal agricultural section of the area, but no data covering the latter district could be obtained. At Shasta, outside the limits of the survey, 5 miles northwest of Redding, in the foot hills, at an elevation of 1,148 feet, the precipitation is 49.90 inches.

During the summer local showers, sometimes accompanied by thunder and lightning or hail, are of occasional occurrence. Very little rain falls from May to October. During the winter showers and rainy spells, sometimes continuing for two or three days, alternate with periods of fair weather. The rains are usually gentle, but the pronounced slopes carry off much that might be absorbed by the soil. During the long dry period the native grasses dry up and the country appears somewhat barren. Much of this naturally cured grass, however, is quite nutritious. The first fall rains start a new and abundant growth of pasture grasses. In the more elevated parts of the valley snow sometimes falls, but this is rare, and it never remains on the ground for any length of time.

The normal monthly and annual temperature and precipitation, as published in the official records of the United States Weather Bureau for stations at Redding and Red Bluff, are given in the following table:

Normal monthly and annual temperature and precipitation.

Month.	Redding.		Red Bluff.		Month.	Redding.		Red Bluff.	
	Temperature.	Precipitation	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	In	°F.	In.		°F.	In.	°F.	In.
January	45.2	7.29	44.9	4.67	August	81.0	.09	81 1	.02
February	49.3	4.22	49.0	3.70	September	74.0	.67	73.8	.67
March	53.8	4.75	54.5	3.27	October	64.5	2.48	63.5	1.36
April	60.2	3.01	59.3	2.16	November	54.1	3.79	53.9	3.10
May	67.2	2.19	67.0	1.33	December	47.0	6.74	46.7	5.31
June	75.6	.79	74.4	.49					
July	82.3	.09	81.8	.03	Year	62.9	36.11	62.5	26.11

The normal annual temperature, as will be observed from the above table at Redding, is 62.9° and at Red Bluff 62.5° F. At Sacramento, upon the south and 160 miles distant from Redding in an air line, it is 60° or 2.5° less than at Red Bluff. July is usually the hottest month, the thermometer during the summer frequently having a daily maximum of more than 100° F. At Red Bluff the highest recorded temperature is 114° F. While the summer temperature is sometimes extreme the nights are usually cool and pleasant, the relative humidity low, and hot winds less frequent than to the south in the main valley.

The minimum temperature recorded at Red Bluff is 18° F. The frosts, which are of frequent occurrence during the winter, are, however, usually not severe, and hardy vegetables remain in the ground uninjured during the winter. The dates of first and last killing frosts at Redding and Red Bluff as reported by the Weather Bureau follow:

Dates of first and last killing frosts.

Year.	Redding.		Red Bluff.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1897	.....	.....	Mar. 30	Dec. 20
1898	Mar. 27	.....	Mar. 18	Dec. 9
1899	May 1	Dec. 14	Feb. 7	Dec. 19
1900	Feb. 9	Dec. 3	.....	Dec. 30
1902	Mar. 14	Nov. 20	.....	.....
1903	.....	Dec. 5	Mar. 9	Dec. 7
1905	May 1	Oct. 17	Apr. 4	Nov. 28
1906	Mar. 15	Nov. 18	Mar. 15	Nov. 24
Average	Mar. 27	Nov. 23	Mar. 14	Dec. 11

There is in general a well-marked wind movement, the prevailing directions being north and southeast. Violent storms or gales are rare.

Fogs are infrequent and are generally confined to local stream valleys. There is an unusually high percentage of fair weather throughout the year, the average number of clear days at Red Bluff being given as 218, and the average number of rainy days 75.

The climate is, upon the whole, healthful, favorable to crop production, a long growing period, and to the summer curing of fruits. Farming operations suffer comparatively little interruption from frosts or other climatic conditions throughout the year.

AGRICULTURE.

Prior to the discovery of gold there were few white settlers in northern California and agriculture had hardly been attempted. In 1844 the San Buenaventura grant, consisting of 26,632 acres, lying along the western side of the Sacramento River and almost wholly within the limits of the Redding area, had been acquired from the Mexican Government by Maj. P. B. Reading, a central figure in the early settlement of this part of the State. This grant covered the greater part of the most productive section of the Anderson Valley, and the first ranch house was established in this valley near the mouth of Cottonwood Creek. As wild oats and native grasses were abundant the early agriculture consisted mainly in the raising of stock.

The discovery of gold in 1849 and 1850 brought prospectors into northern California, and the town of Shasta was soon after founded and became the center of the mining industry and the principal settlement of this section of the State, although smaller mining towns soon sprang up.

The settlement of the country by prospectors created a demand for hay, grains, fresh and dried fruits, and vegetables, which was only supplied by the limited number who refrained from the search for gold and undertook the production, by primitive methods, of these crops. Fresh vegetables were considered luxuries at this time, and wild hay from the Cow Creek bottoms is said to have been sold in the mining camps for $150 per ton.

With the building of the railroad in the early seventies the new town of Redding increased in importance and became the metropolis of the district and Shasta was abandoned. Shipment of fruits and farm produce to a distance was now possible and the agricultural resources were rapidly developed. The production of green and dried fruits, consisting of prunes, peaches, and pears, became of much importance in the Anderson Valley. Fruit production was soon taken up by the Happy Valley section, which came into prominence about 1883 and 1884, and the fruit industry has been steadily developed in both places.

In the Anderson and adjacent minor stream valleys prunes are the leading crop, followed by peaches, pears, and, to a much less extent, by grapes and small fruits. Fig trees bear abundantly, but figs are grown only for home use. Alfalfa is produced to a small extent, and with proper care and irrigation should produce 5 tons per acre. Even without irrigation three crops can be cut each season in some sections of the bottom lands well suited to its production. It is usually baled at a cost of about $2 per ton and generally brings from $12 to $15 per ton baled, on the ground. The trucking industry is locally of considerable importance and is largely controlled by Chinese. Grains, consisting of wheat and barley, are grown quite extensively, but much less than in the more southern part of the Sacramento Valley, the greater proportion of these crops being cut green for hay. Dairying and poultry raising are carried on only to a limited extent. The products of these industries, however, bring good prices.

In the Happy Valley district general farming is practiced on a small scale, the valley being essentially a fruit-producing section. Peaches are the leading crop, followed by table grapes, strawberries, and bramble fruits. The peaches are well colored and of particularly fine flavor. Strawberries and bramble fruits yield abundantly.

The value of orchard products for Shasta County, according to the United States Census for 1900, was $110,276, a sum which has been

greatly increased by more recent development of the fruit-producing industries. The season is in general somewhat later than that of the Santa Clara and more southern Sacramento Valley points. The products are shipped in both the green and dried states, in carload lots, to the Eastern States and to Europe.

Prunes probably constitute the leading crop, the production for the season of 1907 being estimated at 2,200 tons, or 110 carloads at 20 tons per car. The crop usually brings from 3 to 3½ cents a pound. The French prune is the leading variety, and the harvesting begins about September 1, at which time weather conditions are favorable, although showers sometimes occur during the curing period. Peaches are next in importance. The fruit is shipped both green and dried. Most of the smaller express shipments of the green fruit go to northern California and Oregon. The leading varieties are the Muir, Crawford, Imperial, and Foster, the Muir and Crawford predominating. For drying the Muir is reported to be the favorite. The total production of dried peaches in favorable seasons is in the neighborhood of 500 tons.

Pear growing, both for shipment green and for drying, has been an attractive and important industry, but owing to ravages of the blight production in this section has of late fallen off. Many of the orchards have ceased bearing and are being replaced by other crops. This disease, of a bacterial nature, can be checked and eradicated only by persistent and vigorous cutting. Mr. Chris Thorsing, horticultural commissioner of Shasta County, reports excellent success in combating the blight in his orchard, located 5 miles southeast of Anderson.[a] With the certainty of a scarcity of pears, the grower who is able to maintain clean and productive orchards of this fruit should be able to obtain a very good profit. Many, however, prefer to replace pear trees with prune and peach trees.

Of the truck crops produced, tomatoes are of particularly fine quality and large size and bear abundantly.

The raising of cattle, sheep, goats, and hogs is an industry of considerable importance and yields good returns, although improvement in breeds and types and in care of the stock is to be desired. The herds are usually grazed in the mountains during the dry summer season.

The adaptability of certain soils to particular fruits is usually well recognized. The prune industry is practically confined to the deeper friable loams of the Sacramento and other stream bottoms. Pears are mostly grown upon soils of a similar character, although those

[a] See Report of Thirty-first Fruit Growers' Convention of California, 1906. See Pear Blight, Cause and Preventative, Reprint of United States Department of Agriculture, 1906; Commercial Pear Culture, Reprint of the United States Department of Agriculture, 1900.

grown on the shallower red soils of the Happy Valley section are less succulent and of less vigorous growth, but are not so liable to attack by blight. Peaches are usually planted on gravelly sloping valley lands or on the more elevated shallow soils of the Happy Valley district. It is believed that the influence of the shallower and somewhat less productive soils of this district tends to smaller tree growth and lower yields, but the fruit is exceptionally fine in color, size, and flavor.

Grain and grain hay are grown by a system of dry farming and summer fallowing. Little attempt is now made to grow alfalfa or other deep-rooted crops upon the shallow upland soils, and considerable loss has been met with in the past from planting fruit upon shallow dry lands. Such injury has been particularly apparent in the case of young orchards at first irrigated, but to which water was later denied, or where attempts were made to produce orchard fruits entirely without irrigation in unfavorable locations. Grapes do well upon the deeper phases of the shallow upland soils when irrigated or even without irrigation if intensively and thoroughly cultivated. It is quite possible that a profitable field awaits the development of this industry upon much of the upland part of the area now utilized only for grazing purposes, if attended with care in the selection of soils and systematic and thorough cultivation.

Rotation of crops and the use of commercial fertilizers are practiced to a limited extent, but barnyard and green manures should be more generally used. The better and more profitable orchards are usually well cultivated, but in many places the importance of frequent and clean cultivation is little appreciated. Throughout the northern part of the area, over which small unirrigated orchard and vineyard tracts are frequently found, much of the loss from the "going back" or dying of the trees or vines is commonly attributed to the poisonous effects of fumes from the smelters of the mining district. The evidence, however, seems to point rather to unfortunate selection of soils and lack of careful cultivation as the real causes of the trouble, although much injury to the native vegetation from smelter fumes has taken place to the northwest of the area.

During the fruit-harvesting season labor is very badly needed and the prices paid are correspondingly high. The work of packing the fruit is done largely by women and children. A large part of the labor of harvesting and handling the fruit in the orchards is generally performed by Indians, who are provided with camping places in or adjacent to the orchards.

Little effort is being made to bring in new settlers or to place farming lands upon the market. Land can be purchased from a few dollars to $100 or more an acre, depending upon its condition of improvement and adaptability to the production of fruit. Very little

good orchard land is now for sale, and when offered high prices are asked. Unimproved land suitable for alfalfa, truck crops, or orchard crops can be secured at moderate prices. In the Happy Valley district wooded land well adapted to the production of peaches, grapes, or other products of the section can be secured at a cost of $10 to $15 or more an acre. While the expense of clearing off the brush and timber is high, stove wood commands good prices and will in many cases repay the cost of clearing.

In the Happy Valley district the size of the farms and orchards is generally small, often consisting of 10, 20, or 40 acres, while in the Anderson Valley and other sections some of the orchard lands are held in larger tracts of 200 acres or more. The average size of farms in Shasta County, according to the United States census for 1900, was 284.3 acres, 77.1 per cent of which were operated by the owners.

In order to increase profits from fruit production, clean and frequent cultivation is necessary so as to conserve soil moisture during the long dry season. Upon the shallower soils of the uplands this is of particular importance, and it is believed some of the failures in the growing of vines and trees might have been avoided had a more thorough system of tillage been followed. The control of diseases and insect pests by pruning and spraying is also necessary in successful fruit production.

SOILS.

The soils of the Redding area fall into three natural divisions, viz, the soils of the uplands, of the valley slopes, and of the stream bottoms. These natural divisions are based upon physiographic, geologic, and agricultural differences, although sharp lines of demarcation do not always exist.

As previously stated, the upland section of the area is elevated somewhat above the Sacramento and minor stream valleys. It is rolling or sloping in character and is dissected by narrow, flat-bottomed gulches and valleys. Except in the vicinity of the Stillwater Plains, the uplands are generally wooded or covered with brush. The section is naturally well drained and somewhat subject to erosions, with consequent loss of organic matter and of the finer mineral materials. The soils, however, are rather heavy in texture and are underlain by dense, compact subsoils containing a large percentage of plastic, tenacious clay and more or less indurated hardpan, which, together with the usual protective covering and the admixture of roots, native grasses, and leaves from forest vegetation, resist the wearing action of water coursing down the slopes.

The soils of the uplands are of deep-red color, gravelly, and in certain sections carry considerable quantities of cobbles and small bowlders. The gravels and cobbles are largely igneous and metamorphic material and are usually well rounded or flattened.

The soils of this part of the area are derived mainly from the Red Bluff formation. This formation has a maximum thickness of more than 200 feet and consists of clays, sands, gravels, and cobbles, representing alluvial material deposited over the valley by the Sacramento and its tributary streams in former times, subsequent uplift having elevated the valley and caused the carving of the more recent stream valleys. In the vicinity of the Cow Creek Valley small areas of the upland soils are derived largely from volcanic tuff, ranging in character from light gray and often pumiceous dust and finely abraded material to andesitic bowlders, the finer material predominating upon the western side of the valley.[a]

Considerable modification in the soil material derived from the Red Bluff formation has recently taken place by the weathering of the gravels, which are frequently so well decomposed as to be readily broken up with a light blow or crushed with the fingers. In parts of the upland plains exposed to the winds much fine material has been blown away, with consequent concentration of the coarser soil particles and gravels at the surface.

The formation of the hardpan, of general occurrence in this group of soils, has taken place subsequently to the original deposition of the soil material. It is due to concentration of the finer clay particles in the subsoils by percolating waters and to the partial cementing of this claylike material by mineral salts, largely silicates and other salts of iron.

This hardpan is red to yellowish-gray in color, from a few inches to several feet in thickness, and is usually found at a depth of 18 inches to 5 feet, although it may occur at greater depths or, upon the other hand, even outcrop at the surface. It may consist entirely of fine material or of a mass of gravels and cobbles inclosed and held together by the finer material.

Three types of soil occur in the uplands—the Redding gravelly loam, the Redding loam, and Rough stony land. These soil types merge gradually into one another and into other adjacent types. The separating of these soils was therefore more or less arbitrary. The soil types differ widely in adaptation to crops and in agricultural value, depending upon adaptability to and the facilities for irrigation, and the occurrence, character, and position of the hardpan.

The soils of the valley slopes consist of three types—two of the Anderson series and one local type, the Bellavista sandy loam. They usually are found adjacent to the soils of the uplands, occupying the higher valley slopes, flat-bottomed gulches, and the valleys of intermittent streams. They are usually gray to reddish gray in color,

[a] For further description of this formation and other geologic features, see Redding Folio, Geologic Atlas of the United States, published by the U. S. Geological Survey.

well drained, sometimes slightly gullied, usually wooded or covered with brush, gravelly, and generally free from hardpan.

The soils of this group are formed by direct wash from the adjacent upland slopes and by deposition, in the narrow stream valleys, of material carried down by flood waters, the material having been transported for only short distances. While often of a pervious and leachy character they are usually fairly well adapted to agriculture.

Five types of the stream-bottom soils were encountered, four being soils of the Sacramento series, the remaining one a nonagricultural type, Riverwash. These soils occupy the lower bottoms of the Sacramento and minor stream valleys, varying in texture from coarse sands and gravels to rather compact silt loams, and in color from light gray to dark brown. They are generally well drained but subject to overflow, which in case of some of the types occurs annually. They may be barren of vegetation in spots, but are generally wooded, are often gravelly but free from hardpan.

The soils of this group consist of recent stream deposits, occurring along present or recent stream flood plains, made up of a variety of mineral constituents which have been transported considerable distances. The soil bodies are often small in size, having an elongated outline extending in the direction of stream channels, and are sometimes subject to considerable modification by the erosive effects of floods or the further deposition of material by flood waters. In agricultural importance they range from relatively worthless to the most important and valuable soils of the area.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Redding gravelly loam	57,216	44.7	Sacramento loam	4,480	3.5
Anderson gravelly loam	14,528	11.4	Riverwash	4,480	3.5
Redding loam	14,272	11.1	Anderson fine sandy loam	3,520	2.8
Sacramento gravelly sandy loam	8,384	6.5	Bellavista sandy loam	3,328	2.6
Sacramento silt loam	7,680	6.0	Sacramento fine sandy loam	2,752	2.2
Rough stony land	7,360	5.7	Total	128,000	

REDDING GRAVELLY LOAM.

The Redding gravelly loam varies greatly in texture, structure, depth, and in agricultural importance. Typically it consists of a heavy sticky loam of fine silty texture, red to dark red in color, extending to a depth of 6 to 15 inches, and carrying small to relatively large quantities of subangular, rounded, or flattened cobbles,

pebbles, or fine gravelly material. In limited areas the accumulation of cobbles and gravel in the surface is sometimes excessive, due to the removal of the fine earth by wind action or by erosion.

Although the soil is of a heavy tenacious character, the finer clay material is generally flocculated; which condition, together with the large quantity of gravel, renders the soil friable, readily cultivated, and capable of maintaining an excellent tilth.

A compact and usually adobelike heavy loam of deep-red color, carrying a moderate quantity of gravel, usually underlies the soil at a depth of 6 to 15 inches or less. Beneath this, at a depth of 18 inches to 5 feet, a partially indurated hardpan, of deep-red color sometimes mottled with patches of light-gray clay, is found, although in some places the heavy loam may extend to a depth of 6 feet. The hardpan carries a large quantity of rounded gravel and cobbles, sometimes becoming very dense and hard and resembling conglomerate rock. Outcrops of this material occur along eroded surfaces or as ledges bordering ravines and gulches carved by intermittent streams. Upon the other hand, it often consists entirely of partially indurated or cemented fine claylike material of a soft nature, quite readily penetrated by roots, and frequently easily broken up by the fingers.

The Redding gravelly loam, which is the prevailing soil of the uplands and the most extensive type of the survey, occurs as large bodies occupying much of the northern and western parts of the area, although smaller and irregular bodies are found in various other parts of the uplands. It is of considerable extent upon the higher ancient valley plains and lower foothills bordering the more recent valley of the Sacramento River. The surface is usually gently rolling or gently sloping, often minutely dissected by deep narrow ravines and gulches in which flow intermittent streams. It usually supports a moderately heavy growth of scrub pine, oak, and chaparral brush of the mountains and foothills, mainly ceanothus and manzanita.

The soil is generally well drained, except in local depressions where percolation is hindered by underlying hardpan. The cost of clearing is sometimes high, but is often nearly repaid by the value of the wood removed.

The Redding gravelly loam is derived from early Pleistocene alluvial material deposited in the older Sacramento Valley to a great depth. Owing to its friable structure and heavy subsoil, the Redding gravelly loam has great water-holding capacity. This condition is important and should be augmented by frequent cultivation and the maintenance of a loose surface-soil mulch. Upon the other hand, in some places presence of more or less impervious hardpan strata near the surface arrests percolation of rainfall and decreases the water-holding capacity of the soil. Where the hardpan is very com-

pact roots do not penetrate deeply, rendering the trees and plants particularly sensitive to drought if not irrigated.

The agricultural value of this soil type and its adaptation to crops is thus in a great degree dependent upon the occurrence and position of the hardpan. The soil is not adapted to the culture of prunes or other deep-rooted trees. If the hardpan is nearer the surface than 4 or 5 feet the planting of peaches or vines is attended with considerable risk, unless the layer is soft enough to permit the roots to penetrate it or unless irrigation is practiced. With adequate facilities for irrigation the deeper phases of the soil type are among the most valuable soils for peach culture in the Redding area. Grapes could undoubtedly be produced profitably in such areas in commercial quantities without irrigation by proper care and frequent cultivation during the dry season. Strawberries and bramble fruits yield abundantly, and if irrigated the shallower phases of this soil not adapted to tree fruits could be utilized for these small fruits.

Where orchards are to be set out the shattering of the underlying impenetrable hardpan by the use of moderate charges of explosives is sometimes resorted to in other districts with beneficial results. For this purpose Hilgard[a] recommends the use of from one-half to three-fourths pound of No. 2 dynamite placed from 3 to 5 feet below the surface. Enough should be used thoroughly to break up the formation, otherwise in particularly dense strata of considerable thickness the explosion may merely form potholes in which percolating soil waters may collect, and give rise to water-logging and unsanitary conditions about the roots.

The careful examination of the soil with reference to hardpan and adaptability for irrigation is obviously of great importance for fruit growing in the uplands. It may be said, however, that with proper irrigation and cultural methods the fruit industry in the Happy Valley section and in other upland districts where the deeper soils are found is a reasonably safe and profitable investment.

A fine silty phase of this soil type occurs in which surface gravel is absent, the color of the soil ranging from a light yellowish gray to dark brown. This material is shallow and underlain by the typical soil or by hardpan. The surface is frequently puddled and in the dry season baked and checked. Such soil bodies occur upon the elevated upland plains in small potholes or local drainage depressions, usually a few rods in diameter and rarely covering an acre in extent. In such local depressions percolation of rain or drainage waters is usually arrested by the underlying hardpan, leading to the formation of pools during the rainy season followed by a baking of the soil when dry.

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[a] See "Soils" by E. W. Hilgard, p. 181.

The fine silty material in these depressions is formed by the accumulation of wash from the higher slopes. This phase of the Redding gravelly loam is nearly or entirely barren, and is naturally unproductive owing to poor drainage and unfavorable soil structure. To make these depressions productive they must be drained and the compact puddled condition of the soil alleviated by the addition of large quantities of barnyard manure or other coarse organic matter. In cases where the construction of drains is difficult or impossible, blasting the underlying hardpan strata, as in setting fruit trees, would probably promote percolation of the surface waters and lead to a permanent improvement of the soil.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Redding gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17851	Soil	4.9	8.3	4.8	11.0	13.2	33.9	24.2
17852	Subsoil	4.9	8 1	5 1	14.6	12.0	32.6	22.0

REDDING LOAM.

The Redding loam is quite similar in texture and color to the Redding gravelly loam, differing mainly in depth to hardpan and in agricultural importance. It consists typically of 8 inches to 12 inches of light-red or reddish-gray loam, usually of fine and somewhat silty texture, but sometimes of light sandy character. It is sticky when wet, somewhat compact in structure, and carries a moderate quantity of small rounded pebbles.

The surface soil is underlain by a heavy, compact, tenacious dark-red clay loam, with little gravel, extending to a depth of 10 inches to 3 feet. In eroded districts the subsoil may appear very close to the surface.

The subsoil is underlain by a clay or sandy clay hardpan, red or yellowish gray in color, mottled with reddish yellow, or by a heavy dark-red or yellow clay containing hardpan layers. The hardpan may or may not contain cobbles or gravel, and is similar to that of the Redding gravelly loam except that it is generally more dense and impervious and usually nearer the surface, sometimes outcropping where the surface soil has been eroded.

The Redding loam occurs in a few moderately extensive bodies in the southeastern part of the area, and merges almost imperceptibly into the adjacent bodies of the Redding gravelly loam or is separated from the lower lying soils of the valley slopes and the stream bottoms by bluff or terrace lines. The areas of this type occupy slightly slop-

ing, treeless sections of the upland plain. The surface is frequently marked by the presence of hog wallows and small drainage depressions occupied by pools of water or by areas of checked and puddled soils.

Redding loam is a sedimentary soil derived from ancient alluvium, once filling the greater part of the Sacramento Valley to a great depth.

Owing to the occurrence of hardpan, the shallow nature of the soil, and to its position in unirrigated sections of the area, this soil type is of secondary agricultural importance, being usually devoted to grazing or to dry farming to wheat. In a few favorably located districts, where the deeper soil is found, small fruits and tree fruits could be profitably grown under irrigation, while table and wine grapes could probably be grown in limited areas by thorough cultivation.

Numerous attempts at fruit culture upon the shallow phase of the Redding loam without irrigation have resulted in failure, led to discouragement, and given an erroneous impression of the Redding area for fruit production.

The average results of mechanical analyses of the fine earth of the soil and subsoil of the Redding loam are given in the following table:

Mechanical analyses of Redding loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17847, 17849.....	Soil.....	4.4	11.4	5.5	13.1	14 4	34 8	16.6
17848, 17850.....	Subsoil.....	3 9	9.2	5.5	12.5	16.7	32.9	19.1

ROUGH STONY LAND.

Rough stony land of the Redding area in the character of the soil material is similar to the bodies of the Redding gravelly loam and the Redding loam into which it merges.

It consists of a few inches to 18 inches or more of a light-red, gray, or yellowish-red to deep-red loam or clay loam carrying a relatively large quantity of waterworn cobbles, small bowlders, and gravel. It is underlain by yellow or red to gray clays, indurated clay hardpan frequently carrying an excessive quantity of gravel and cobbles or by beds of volcanic ash and breccias.

It occurs in the northern and northeastern parts of the area as irregular or narrow elongated bodies bordering stream valleys. It is usually separated from the soils of the valley slopes and the stream bottoms by high bluffs and rough, stony slopes. It occupies the higher, hilly, and more deeply dissected sections of the uplands and is generally wooded or covered with more or less brush, although barren in some places.

The Rough stony land is derived from the ancient alluvial deposits of the older valley and from the underlying volcanic muds and breccias.

Owing to the shallow nature of the soil, the presence of hardpan, and the rough, unirrigable, and stony character of the country, it is devoted only to grazing and is generally unadapted to fruits or farm crops.

ANDERSON GRAVELLY LOAM.

The Anderson gravelly loam typically consists of a moderately heavy, sticky loam of light-red color, extending to a depth of 8 to 12 inches and carrying a moderate quantity of small flattened or rounded pebbles, or cobbles, and considerable fine subangular or rounded gravel. It is somewhat compact in structure but friable when cultivated. It is sometimes, however, very gravelly and of lighter color, and in such cases usually grades into the Sacramento gravelly sandy loam. In other locations it is of a fine, silty, compact character, of deeper red color, and grades into the adjacent more elevated soils of the dissected plains and lower foothills.

It is sometimes underlain by rounded cobbles and stream gravels or by heavy, compact clay loam partially indurated and cemented by lime and iron salts, and forming a relatively soft hardpan. Usually, however, it extends to the depth of 6 feet or more, the lower portion of the section being somewhat finer in texture, of more compact structure, and of a deeper red color. Occasionally it is underlain by a compact, deep-red clay loam. The subsoil is often relatively free from gravel and occasional layers or lenses of partially indurated clay or sandy clay material form a soft hardpan quite readily penetrable by roots.

This type occurs in numerous bodies of irregular or elongated outline of moderate size occupying the more elevated valley plains adjacent to the upland soils, or the narrow valleys of small intermittent streams dissecting the uplands. The more extensive and typical bodies occur in the vicinity of Anderson and in the northwestern part of the area extending southward from Redding to Clear Creek. Other bodies of more gravelly character and of considerable extent are found in the valley of Stillwater Creek north of Loomis Corners.

The surface is nearly level or gently sloping, with minor irregularities. It is usually well drained and is sometimes scored by erosion or cut by intermittent stream channels.

The Anderson gravelly loam usually supports a more or less vigorous growth of timber and chaparral brush. Except where shallow or of porous, leachy character it is fairly well adapted to irrigation and to crop production.

The Anderson gravelly loam is derived mainly from the adjacent and more elevated formation of the early stream gravels and sediments giving rise to the soils of the uplands. It is of rather recent alluvial origin, the material forming it having been transported only short distances and distributed by the flood waters of intermittent streams. Under irrigation it is well adapted to peaches and grapes, and if well cultivated in favorable locations produces fair yields of these crops without irrigation. Alfalfa is also grown to a very limited extent on some of the irrigated parts of the type. Much of this soil is, however, utilized only for grazing.

With thorough cultivation, supplemented when practicable by irrigation from private reservoirs or by the pumping of ground water, considerable areas of the less gravelly and porous bodies of this soil type, now used only for grazing, can eventually be rendered productive and brought under cultivation.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Anderson gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17224	Soil	5.4	10.5	6.4	21.9	8.1	37.5	9.9
17225	Subsoil	3.7	11.0	8.9	20.4	6.4	37.6	11.7

ANDERSON FINE SANDY LOAM.

The Anderson fine sandy loam consists typically of a fine sandy loam of light-red to grayish-red color, generally carrying a moderate amount of rather small subangular or waterworn gravel, and extending to a depth of 3 to 6 or more feet. It is somewhat porous and friable and easily maintained in a good condition of tilth. When less than 6 feet in depth it is generally underlain by river sands and gravels, although occasionally by hardpans, clays, or volcanic tuff.

This soil type is not extensive and occurs mainly as narrow, elongated bodies occupying the bottoms and slopes of the narrow valleys of Churn and Stillwater creeks, often grading quite imperceptibly into the adjacent soil types.

The surface is slightly sloping but often scored or pitted by erosion, or marked by minor surface irregularities or low terrace lines. It usually supports a vigorous growth of timber and brush. Parts of the lower lying bodies are sometimes subject to overflow during flood periods.

The soil consists largely of the reworked material derived from the adjacent red soils of the uplands, transported and deposited by the flood waters of the minor streams along which it occurs.

The Anderson fine sandy loam where not subject to overflow is well drained, moderately retentive of moisture under cultivation, and well adapted to the production, with or without irrigation, of grapes, peaches, pears, small fruits, and alfalfa, although irrigation is advised where practicable. It is, when cleared, usually devoted to dry farming to grain, or to peaches, prunes, pears, and grapes. The yield is generally somewhat less than upon the soils of the Sacramento series, but the fruits produced are of excellent quality.

A considerable part of this type is still uncleared of timber and brush and could be brought under profitable cultivation.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of the Anderson fine sandy loam are given in the following table:

Mechanical analyses of Anderson fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17855	Soil	0.9	4.0	5.2	29.8	19.0	31.6	10.2
17856	Subsoil	1.1	6.5	8.4	33.6	14.6	26.4	9.9

BELLAVISTA SANDY LOAM.

The Bellavista sandy loam is subject to wide variation in texture, depth, and character of underlying material. Typically it consists of a light ash-gray sandy loam of rather fine texture and of somewhat sticky character, extending to a depth of 1 to 3 feet, and underlain by a compact, sandy clay of adobelike structure. In the vicinity of adjacent hill slopes it is generally gravelly, the gravel consisting of small subangular particles to large rounded cobbles, and the soil is of a slightly coarser and lighter character, occasionally extending to the depth of 6 feet or more.

Where it merges into the Redding gravelly loam and the Anderson gravelly loam it has a reddish color and its structure is more compact and its texture is finer and heavier. In the valley bottoms it is often fine and somewhat silty in texture, and compact in structure, while upon the more elevated slopes the sandy material is rather coarse and the soil sometimes extends to the depth of 6 feet or more. The more elevated bodies are frequently underlain by a coarse, partially indurated sandy clay or clay hardpan, or by beds of volcanic ash and tuff. The soil is generally friable under cultivation, although numerous, small, puddled depressions of heavy compact structure and fine texture occur.

The Bellavista sandy loam is not extensive, occurring only in the northeastern part of the area in the depression of the Cow Creek Valley, as irregular bodies adjoining outcrops of volcanic ash and

tuff. It occupies nearly level or gently sloping narrow valley plains or lower rolling hill slopes. It is generally well drained and often covered with a heavy growth of oaks or chaparral. The more elevated bodies are sometimes broken by outcrops of the underlying material or marked by the presence of cobbles and bowlders and are shallow and unproductive.

The Bellavista sandy loam owes its formation to the erosion of the adjacent beds of volcanic ash and tuff and the distribution by intermittent streams of this material mingled with gravels and other soil material derived from the more elevated soils of the uplands.

The lower bodies are generally devoted to grazing or to dry farming to grain, although such areas could probably be planted to alfalfa or to other irrigated crops or fruits. The latter are produced only to a limited extent upon this soil type. The more elevated areas are usually suited for and devoted only to grazing.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are shown in the following table:

Mechanical analyses of Bellavista sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17853	Soil	0.0	6.6	20.1	44.6	4.8	15.0	7.9
17854	Subsoil	4.0	12.1	6.6	17.0	13.0	31.2	15.8

RIVERWASH.

Riverwash of the Redding area varies greatly in character of material, consisting of coarse to fine river sands, waterworn gravels, and cobbles, and extending to the depth of 6 feet or more. Generally these materials are more or less intermingled, and either the sandy or gravelly material may predominate or may be nearly lacking in local areas.

It is an inextensive type, occurring near or occupying present or abandoned stream channels of the Sacramento River and its tributary creeks, the more extensive bodies lying in the vicinity of and southeast from Redding. The lower lying bodies of finer texture occurring adjacent to the Sacramento River frequently support a moderately heavy or dense growth of the brush and timber usually found in the stream bottoms, The surface is frequently more or less scored by erosion and the type is generally subject to overflow during flood periods.

It is of recent alluvial origin, and, owing to its position and its loose, leachy, or stony character, is unsuited to crop production, being of no agricultural value except for grazing.

SACRAMENTO GRAVELLY SANDY LOAM.

The Sacramento gravelly sandy loam varies considerably in the quantity and character of its gravel content. From 10 to 30 inches it consists of a light-brown or sometimes slightly reddish-brown, light sandy loam or slightly sticky sandy loam. Subangular or rounded particles of fine gravel and sometimes large quantities of flattened or waterworn pebbles or cobbles of many varieties of rocks, those of volcanic and metamorphic origin predominating, are found mingled with the finer materials.

It is underlain by beds of waterworn cobbles and gravels intermingled with sands and finer sediments. Both soil and subsoil have an open, porous structure and leachy character.

This soil is in general of somewhat lighter color and heavier texture than the Sacramento gravelly sandy loam of the Colusa area.[a]

It occurs as inextensive and irregular bodies adjacent to the Sacramento River, as long. narrow strips in the bottoms of the smaller valleys, and in the numerous gulches and ravines traversing the higher valley plains and lower foothills, extending sometimes for a distance of several miles and being cut by meandering courses of intermittent streams. The most extensive body, which is, however, intermingled somewhat with the heavier soil material of the Anderson gravelly loam, and is not entirely typical of the Sacramento gravelly sandy loam, occupies a large part of the Clear Creek Valley. The surface is often uneven and eroded by flood waters and frequently supports a moderately heavy growth of small timber and brush. It is of recent alluvial origin, being a deposit from the flood waters of streams.

When well irrigated, fair yields of peaches or other fruits and alfalfa may be obtained on the heavier phases of the soil. It is, however, of slight agricultural importance, the heavier and more productive bodies being marked by very gravelly, unproductive spots, and it is generally utilized for grazing.

The results of a mechanical analysis of a fine-earth sample of the soil is given in the following table:

Mechanical analysis of Sacramento gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17859	Soil	8.0	15.0	9.0	21.4	15.4	23.9	7.5

SACRAMENTO FINE SANDY LOAM.

The Sacramento fine sandy loam consists typically of a loose, uniform light gray, micaceous fine sandy loam, usually but not always

[a] See Soil Survey of the Colusa Area, California. Field Operations, Bureau of Soils, 1907.

extending to a depth of 6 feet or more. When less than 6 feet in depth it is underlain by river sands and gravels. In some places it becomes somewhat darker in color, resembling the Sacramento silt loam, and the gradual merging of these two soil types renders indefinite the exact boundaries between them. The soil is frequently gravelly, the gravel consisting of either waterworn pebbles or cobbles. Some bodies found along the Sacramento River or its overflow channels are coarse in texture and carry considerable gravel.

The subsoil consists of gravels, rounded or flattened by stream activity, sometimes intermingled with coarse to fine sand. In places where erosion has been heavy this subsoil outcrops at the surface in streaks, and is worthless except for grazing.

The Sacramento fine sandy loam appears only as small irregular or narrow elongated bodies lying near the stream channels of the Sacramento River and a few of its tributaries, and merges into the Sacramento silt loam or other adjacent soil types. In extent and in the agriculture of the area it is one of the less important types. It frequently supports a considerable timber growth and is often scored by erosion and subject to overflow. It is of recent alluvial origin, the material being transported for considerable distances and deposited by the shifting of streams in time of floods.

The loose, porous nature of this soil allows good drainage where not subject to overflow. The same characteristics render it easy to maintain in good tilth. It does not retain very much moisture, and frequent cultivation during the dry season is of great importance in the successful growing of fruits. Where irrigation is adequate the more elevated bodies of finer texture are well adapted to alfalfa, or to peaches, prunes, or vegetables. This soil is generally used for pasture, although fruits and alfalfa are grown to a limited extent.

The results of mechanical analyses of the fine earth of the soil and subsoil of the Sacramento fine sandy loam are given in the following table:

Mechanical analyses of Sacramento fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17152	Soil	0.0	0.9	3.9	52.3	12.9	24.6	6.0
17153	Subsoil	.0	.3	2.2	41.4	12.1	37.9	6.7

SACRAMENTO SILT LOAM.

The Sacramento silt loam varies in color from a light or somewhat yellowish-brown to dark-brown or nearly drab. It consists typically to 6 feet or more of a friable, moderately porous micaceous loam to silt loam, often gravelly, the gravel consisting of small flattened or well-rounded pebbles.

It is of moderate extent, and in the southern half of the area is the prevailing type of the stream bottoms. The soil bodies are usually elongated in outline and extend parallel to the courses of the Sacramento River and its tributaries. It supports a moderately heavy native growth of oaks, or in the river bottoms the typical "jungle" growth of cottonwood and sycamore trees, with a dense undergrowth of bushes and vines. It is generally well drained, although occasionally subject to overflow by floods. The surface is usually level and well adapted to irrigation, but is sometimes marked by slight unevenness due to erosion by flood waters.

The Sacramento silt loam, like the other soils of the Sacramento series, is of alluvial origin, the soil material having been transported and deposited by stream flood waters.

It is friable under cultivation and is easily maintained in good tilth, and in such condition has well-marked moisture-retaining properties. Owing to its deep friable nature and productive character, it is well adapted to the growing of prunes, peaches, pears, grapes, alfalfa, and vegetables, the two last-mentioned crops being more successfully grown upon the lower lying and more moist bodies, or where the soil is irrigated.

Prunes, peaches, and pears are the leading crops grown upon the Sacramento silt loam, the more productive orchards being in a high state of cultivation.

This soil has played a very important part in the development of the fruit industry in the Anderson Valley and is the leading prune soil of the area.

The results of mechanical analyses of fine-earth samples of the soil and subsoil are given below:

Mechanical analyses of Sacramento silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17150	Soil	0.1	1.2	3.0	25.4	11.8	47.9	10.3
17151	Subsoil	.0	.7	2.9	26.3	12.8	47.5	9.2

SACRAMENTO LOAM.

The Sacramento loam is typically a light brown to drab, moderately sticky loam extending to a depth of 6 feet or more. In its native condition it is somewhat compact in structure and bakes slightly during the dry season, but under irrigation it is friable and capable of maintaining a good tilth. It is not extensively developed in the Redding area, being found only as a few small irregular bodies, the largest of which occurs near the center of the area.

The surface is nearly level or gently sloping, and the soil is generally well drained, except in the case of some of the smaller bodies subject to occasional overflow, which frequently support a heavy growth of timber and brush.

In origin and in mode of formation it is similar to the other soils of the Sacramento series.

It is well adapted to prunes, pears, and under irrigation to alfalfa, sugar beets, and truck crops. It is principally devoted to grazing and dry farming to grain and is well suited to the culture of irrigated crops. It is the most promising soil type of this area for the production of alfalfa and sugar beets.

The following table gives the results of mechanical analyses of the soil and subsoil of the Sacramento loam:

Mechanical analyses of Sacramento loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17864	Soil	0.1	0.9	2.1	19.2	21.7	42.2	13.6
17865	Subsoil	.0	.9	1.8	22.1	30.2	32.0	13.4

IRRIGATION.

The development of irrigation in the Redding area has been somewhat retarded and is practiced only to a limited extent. In the uplands this is due largely to the expense of constructing distributing systems in the hilly sections or to a limited water supply. In the deeper moist soils of the nearly level valley districts irrigation is generally unnecessary for the profitable production of the leading fruit crops. The extension of irrigation facilities is, however, greatly to be desired, and no insurmountable difficulties present themselves, at least in the most important sections of the area.

While in the Happy Valley and other upland districts attempts have been made from time to time to produce fruits without irrigation, failures have resulted and the necessity of irrigation for successful fruit growing is now generally recognized.

The Happy Valley district is the most extensively irrigated section of the area. The water is obtained from the creeks of the adjacent mountains upon the west and is distributed by a private company, largely by means of a system of small canals and ditches formerly used for conveying water for mining purposes. The water is of good quality for irrigation. On account of the extension of the fruit industry in this section, however, the water supply during the dry summer months has become entirely inadequate, and as the cost of water is increasing much dissatisfaction is expressed by patrons of the system. This condition has created a demand for an investigation of

water resources and the possibilities for the storage of water in reservoirs and its distribution under the Federal reclamation act. Some preliminary investigations looking to this end have consequently been carried on. A complete irrigation system for this section would call for long, sinuous canals excavated through shallow rocky soils and in the more hilly districts for the construction of expensive flumes or pipe lines. Owing, however, to the ordinarily impervious nature of the subsoils, only slight loss would result from seepage. Where the production of choice fruits plays so important a part as it does here, the extension of irrigation facilities should commend itself as a field for investment of private capital or as worthy of Federal aid, even where the first cost of installing irrigation works is relatively great.

In the valley districts only a few small isolated irrigation systems exist. These consist of an inextensive gravity system, irrigating a few small fruit and alfalfa tracts, in the vicinity of Bellavista, along the western side of the Cow Creek Valley and a number of pumping plants, under private ownership, which irrigate a few acres of vegetables or alfalfa along the Sacramento River and its tributary creeks from which water is taken. The operation of these plants has generally proved profitable. The available supply of water for pumping in Stillwater Creek and other small streams during the summer months is limited, though there is a considerable underflow in the channels of the streams which might be rendered available by sinking wells or pits. One small steam pumping plant in the Stillwater Creek bottoms used for irrigating a small tract of alfalfa is reported to be capable of throwing 1,000 gallons per minute.

Throughout the valley of the Sacramento and along some of the tributary creeks considerable bodies of gently sloping land, admirably adapted to irrigation but now devoted only to grazing or to dry farming to grains, could be furnished with water by gravity systems or by pumping, so that the production of truck, alfalfa, sugar beets, or forage crops on the deep valley soils would be greatly increased. Near the central part of the area irrigation of the deep, gently sloping lands is quite feasible, and its development should be encouraged. It is probable that irrigation in the valley as well as in the upland portions of the area will be given greater consideration in the future.

SUMMARY.

The Redding area has an extent of about 200 square miles and lies at the northern extremity of the depression of the Sacramento Valley, being separated upon the south from the Sacramento Valley proper by a low ridge of hills. It consists of rolling or dissected uplands, often wooded, traversed by the Sacramento River and its tributary creeks. The greater part of the area is occupied by the upland section.

The agricultural population of the northern and northeastern parts is relatively sparse, the most important agricultural districts of the area consisting of the Anderson Valley district and the Happy Valley district of the uplands, lying in the southwestern part of the area.

Transportation facilities are fair and the mining centers upon the north afford excellent local markets for agricultural products.

The summers are long, warm, and dry, and the winters mild and moderately rainy. The climate is generally healthful and favorable to crop production and to the curing of green and dried fruit products.

The settlement of the Redding area was due mainly to the mining excitement of 1849–50, the early agricultural products being grown to supply demands of the mining camps. The construction of the railroad furnished an outlet for agricultural products and the production of fruits soon became an industry of considerable commercial magnitude, developing first in the Anderson and later in the Happy Valley district.

Green and dried fruits are the principal products, prunes and peaches leading in commercial value, followed by grapes and small fruits. Alfalfa is grown to a limited extent and commands excellent prices. Grains are produced on a considerable scale under the dry farming system, but the bulk of the crop is cut green and cured for hay.

The growing of pears has been a profitable and important industry, but is now suffering a decline owing to the ravages of the pear blight, which can be checked and eradicated only by the systematic and persistent cutting and the removal of the infected parts of the tree.

The production of prunes is confined to the deeper, moist soils of the valleys, while peaches find most favorable conditions upon the gravelly and more shallow lands of the valley slopes and uplands. In the upland sections there is some possibility that commercial grape culture may be extended to the deeper soils without the need of irrigation if thorough cultivation is practiced.

Many failures in the growing of grapes and tree fruits have resulted from the selection of thin and stony soils, the lack of irrigation facilities, and lack of proper care and cultivation.

Labor conditions during the fruit-harvesting season sometimes become serious, labor frequently being scarce and commanding high wages.

Little effort is made to induce settlers to enter the area or to effect the subdivision and sale of the larger tracts of farming lands. Improved valley lands may be purchased, however, at fair prices, while in the upland section in the Happy Valley district wooded lands can be bought at a low figure. The cost of clearing is high and the products must be hauled some distance to market or to the nearest shipping point, but the cost of clearing is largely offset by the value of the wood removed, and the country roads are generally in good condition during the fruit-shipping season.

The soils of the area fall into three natural divisions, viz, the soils of the uplands, of the valley slopes, and of the stream bottoms.

The soils of the uplands are generally red in color and of moderately heavy texture, somewhat gravelly or stony, and underlain by adobe subsoils. Where clay-iron hardpans are found the soils are frequently shallow and unproductive, and are derived from ancient valley sediments modified by subsequent weathering, by erosion, and by wind action. The three upland soil types consist of two soils of the Redding series and one nonagricultural type—Rough stony land.

The surface of the Redding gravelly loam is generally wooded or covered with brush and is of rolling or sloping character, dissected by numerous stream valleys. It is the prevailing soil type of the uplands, and varies greatly in agricultural value and in adaptation to crops. Where the hardpan does not too closely approach the surface and where irrigable, as in the Happy Valley district, it is especially adapted to the production of peaches, grapes, and berries, or to grape culture without irrigation. Peaches are the leading fruit crop of this soil type.

The Redding loam is similar in general features to the Redding gravelly loam, but is usually of somewhat lighter texture, and the underlying hardpan is of more general occurrence and lies nearer the surface. It is a relatively inextensive soil, and owing to its thin character and to the lack of irrigation facilities is usually devoted only to grazing or to dry farming to grains, and is of secondary agricultural importance.

Rough stony land is similar in character of soil material to the soils of the Redding series, but owing to the occurrence of hardpan, its rough topography, stony character, and lack of irrigation facilities, it has no present agricultural importance.

The soils of the valley slopes consist of two types of the Anderson series and the Bellavista sandy loam. These are formed mainly by wash from adjacent upland slopes and are fairly well adapted to peaches, pears, grapes, and, under irrigation, to alfalfa.

The Anderson gravelly loam occurs upon the gently sloping higher valley plains adjacent to the soils of the uplands or in narrow valleys of minor intermittent streams. Several productive orchards occur upon this soil type.

The Anderson fine sandy loam occurs as small, narrow bodies in the vicinity of Churn and Stillwater creeks. The surface is frequently uneven and often thickly covered with brush and timber. It is an inextensive soil type, but supports a number of small orchards producing a good quality of peaches, prunes, and pears.

The Bellavista sandy loam occurs as inextensive bodies only in the northeastern part of the area in the vicinity of Cow Creek, and is usually devoted only to grazing or to dry farming to grain.

The soils of the stream bottoms consist of four types of the Sacramento series and of one nonagricultural type—Riverwash. They consist of recent alluvial stream sediments occupying the lower parts of the valleys.

Riverwash is a mixture of fine to coarse sands, cobbles, and gravels, occupying old or present stream channels. It is a relatively inextensive soil type, is subject to overflow, and is of no agricultural importance.

The Sacramento gravelly sandy loam occurs as inextensive bodies in the vicinity of the Sacramento River and as narrow strips in sandies and in the valleys of intermittent streams. It is usually devoted to grazing and is of minor agricultural importance, although fruit is produced to a small extent in favorable localities, and alfalfa might be grown under copious irrigation.

The Sacramento fine sandy loam occurs as small bodies in the vicinity of the Sacramento River and its tributary creeks. While under irrigation it is fairly well adapted to alfalfa and to fruits, it is usually devoted to grazing and is of secondary agricultural importance.

The Sacramento silt loam is easily maintained in a fine condition of tilth and is well adapted to the production of prunes, peaches, pears, grapes, vegetables, and alfalfa. It is the leading soil type of the area in the production of prunes, and is in point of extent and agricultural value the most important soil of the stream bottoms.

The Sacramento loam is friable under cultivation, occurring only as rather small bodies near the center of the area. While it is totally devoted only to pasture or to dry farming to grains, it is excellently adapted to irrigation and to the culture of alfalfa, sugar beets, or other irrigated crops, as well as to fruits.

The development of irrigation has, owing to natural difficulties, been somewhat slow. In the valley districts irrigation is usually unnecessary in the production of fruits, but upon the upland part of the area it is essential to successful and profitable fruit culture

The Happy Valley district is the most extensively irrigated section of the area, but the present system is inadequate and the cost of water is high. The extension of irrigation systems in this district will be costly, but as the profits realized from the intensive production of choice fruits will be large, further development of irrigation should be undertaken.

In other upland districts of the area water resources are limited and the development of irrigation improbable.

In the valley sections there are a few small irrigation systems operated by gravity or by pumping, but the production of vegetables and alfalfa could be greatly increased by their extension.

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