U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

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

SOIL SURVEY OF THE GRASS VALLEY AREA, CALIFORNIA.

BY

E. B. WATSON, OF THE U. S. DEPARTMENT OF AGRICULTURE, IN CHARGE, AND J. B. HAMMON, OF THE UNIVERSITY OF CALIFORNIA.

MACY H. LAPMAM, INSPECTOR, WESTERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1918.]

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1921.

[PUBLIC RESOLUTION—No. 9.]

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

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

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

Approved, March 14, 1904.

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

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 24, 1920.

SIR: I have the honor to transmit herewith the manuscript report and map covering the soil survey of the Grass Valley area, California, and to recommend that they be published as advance sheets of Field Operations of the Bureau of Soils, 1918, as authorized by law. This work was done in cooperation with the University of California Agricultural Experiment Station.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. E. T. MEREDITH,
Secretary of Agriculture.

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SOIL SURVEY OF THE GRASS VALLEY AREA, CALIFORNIA.

By E. B. WATSON, of the U. S. Department of Agriculture, In Charge, and J. B. HAMMON, of the University of California.—Area Inspected by MACY H. LAPHAM.

DESCRIPTION OF THE AREA.

The Grass Valley Area lies mainly in Nevada County, Cal., covering the western third of this county, but includes also a few square miles in Yuba County, thus joining with the areas mapped in the Reconnoissance Soil Survey of the Sacramento Valley.[1] The present area, which comprises practically all the agricultural land in Nevada County, is situated on the western foothill slope of the Sierra Nevada Mountains. It is bounded on the west by the great Sacramento Valley and on the northwest by the Yuba River. Its eastern part is bounded on the north and east by arbitrary lines marking the approximate occurrence of the higher nonagricultural ridges of the Sierra Nevada foothills and mountains, and its southern boundary is formed by the Bear River. The area contains 439 square miles, or 280,960 acres.

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

The western margin of the area along the border of the Sacramento Valley has an elevation of 200 to 300 feet. The surface rises gradually but not uniformly to the eastern boundary, where the elevation ranges between 3,000 and 4,000 feet above sea level.

There is a distinct difference in the topography of the western third of the area and that of the middle and eastern parts. The western part consists of the lower foothills, with slopes which are mostly gentle, and comparatively shallow stream valleys. Both the main streams and secondary streams have reached a uniform grade and the same state of erosion of the surface reaches to all parts of the country. The upper limit of this part of the area lies just above Penn Valley and at about 2,000 feet elevation. The surface is nowhere level, but consists of rolling hills and ridges, with a few scattered rough hills reaching an elevation of 500 to 700 feet above the general level.

[1] Field Operations of the Bureau of Soils, 1913.

The eastern part of the area has more the aspect of a high elevated plateau sloping gently westward, with the main streams deeply intrenched and secondary streams yet to reach a uniform grade. The canyons of the larger streams, the Bear River and the Yuba River with its South Fork, are deep, narrow, and rugged, with steep-sided slopes which in many places are rough and stony. Away from these streams the country more rolling. (Pl. I, fig. 1.) The secondary streams on this plateau over most of their courses have a moderate fall, but where they approach the main streams become very steep. The roads crossing this part of the area wind around the hills on low to moderate grades on the plateau surface, but where they cross the major streams they drop down a steep incline for 1,000 feet or more and then climb again to the original elevation on the other side. The peculiar physical features are probably due in part to the covering of lava that, extending over portions of this country, protected the surface in a measure against erosion produced by all except the main streams. Remnants of this covering remain in Harmony Ridge, the unnamed ridge just west of it, Town Talk Ridge, the ridge running from north of Grass Valley west nearly to Rough and Ready, in Osborn Hill southeast of Grass Valley, and other ridges. These have noticeably flat tops which slope toward the southwest. Only one hill which was not covered by the lava flow, Banner Hill, rises above these ridges, with an elevation of 3,904 feet.

The drainage from this area is carried by the Yuba River and its Middle Fork, which border the area on the northwest and flow toward the southwest; by the South Fork of the Yuba River, which cuts across the northern part of the area, flowing toward the west; and by the Bear River, which borders the area on the southeast and south and which also flows toward the west. The main tributaries of these rivers are Shady Creek, which drains the country north of the South Fork of the Yuba River; Deer Creek, which drains the central part of the area and flows west into the Yuba River; Wolf Creek, which flows south from Grass Valley into Bear River; and the Greenhorn River, which drains the eastern margin of the area. All these streams have relatively high gradients and flood plains have been developed only on some of the smaller streams.

Previously to the discovery of gold there were no white settlers in this area. A very few men prospected in this section in 1848, but did not stay over the winter. In 1849, however, a great flood of miners came and they continued to come for several years, because gold in great abundance was discovered in many places. Nevada County was organized in the spring of 1851 with Nevada City as the county seat. In 1852, three years after the county was first settled, a census was taken, which, as reported in a History of Nevada County,

by Thompson and West, gave a total population of 21,365 for the county. Of these, 13,368 were native whites, 782 were foreigners, 3,226 were Indians, and 3,886 were Chinese. By 1860 the Indian population had dropped to 5 and is now practically extinct. The Chinese have gradually decreased, until there are now less than 1,000. On the other hand, the foreign-born have increased. In 1890 there were 5,676. Of these, 1,997 were English, mainly from the mining district of Cornwall, and 895 were Irish. Since 1852 the population has fluctuated as the interest in mining waxed and waned, but it has never since equaled that of the early date. The census of 1910 showed a population of 14,955 in Nevada County.[2]

Gold mining has been carried on from the time of the first settlement and is still the main industry. It is impossible to say what percentage of the present population is strictly agricultural, but there are a great many miners, and they, with the merchants and mechanics who supply their wants, make up the bulk of the population. The census for 1910 reported 544 farms in Nevada County; estimating 5 persons to a farm would give a total strictly agricultural population of 2,720. Settlement is thin and scattering. At the lower elevations, where the large stock ranches are located, the houses are very far apart. In the better developed sections, as at Penn Valley, Pleasant Valley, and Chicago Park, settlement is fairly dense, but these places are separated by wide stretches of very thinly populated country.

The heyday of hydraulic mining was in the seventies. The waste material from the pits or workings of that and earlier days was washed into the streams and by them carried to the lowlands of the Sacramento Valley, where it caused much trouble by filling up the river beds. Laws were finally passed forbidding the dumping of the tailings into the streams. These laws did not forbid hydraulic mining itself, but most of the mines had no place to dump their tailings except into the streams and therefore had to suspend operations. The old "You Bet" mine in the eastern part of the area is still in operation and the tailings are collected in a small ravine adjoining, but the placer and hydraulic mines are now practically abandoned.

You Bet, Red Dog, Scotts Flat, Tyler, North San Juan, Sebastopol, Sweetland, Birchville, French Corral, Mooney Flat, Smartville, and Rough and Ready all were flourishing mining camps at one time, but are now only remnants of what they once were. Other old mining towns have entirely disappeared from the map, but the development of quartz mining has resulted in the prosperous town of Grass Valley. Nevada City owes its present existence largely to the

[2] The Grass Valley area does not include all of Nevada County, but does include a small area outside this county, so that these figures on population are substantially correct for the area within the survey in the year to which they refer.

Since this report was written the preliminary announcement of the population of Nevada County and its civil divisions in 1920 has been issued by the Bureau of the Census, of follows: Nevada County, 10,850; urban, 4,006; rural, 6,844; Grass Valley, 4,006; Nevada City, 1,782.

fact that it is the county seat. The agricultural development has resulted in permanent rural settlements. Grass Valley, with a population of 4,520 in 1910, is the largest town in the area. Nevada City had 2,689 population in 1910; North San Juan, Chicago Park, Rough and Ready, French Corral, Smartville, and Spenceville are small trading centers.

The Nevada County Narrow Gauge Railroad connects Nevada City and Grass Valley with Colfax, on the main line of the Southern Pacific Railroad. An automobile stage line runs from Nevada City through Grass Valley and Rough and Ready to Marysville, 12 miles west of the area, carrying passengers, mail, and light packages. A similar stage line runs from Nevada City to North San Juan. A branch from the State Highway is being built from Auburn, 10 miles south of the area, to Grass Valley. This will give a much-needed good automobile road to the improved roads of the Sacramento Valley. On account of the physical difficulties of the county, the existing roads are rough and stony and many of them have heavy grades. The northern part of the area is quite isolated on this account and the whole area suffers considerably from the same conditions.

Most of the agricultural products are consumed in the area. All the garden truck, potatoes, the grain and hay, and a considerable part of the fruit is so disposed of. The market for these products is protected by the cost of getting similar goods in, and prices are consequently high.

All freight which comes in over the railroads has to be reloaded into other cars at Colfax on account of the difference in gauge of the railroads and this makes freight rates high.

There is a surplus of some of the fruits, notably pears, cherries, plums, prunes, and peaches, and these, where adjacent to the railroad, are shipped to outside markets.

Beef cattle and dairy products and sheep and wool are also produced in excess of local needs and are taken to outside markets.

CLIMATE.

The climate of the Grass Valley Area varies with the altitude, in which there is a wide range. The western part of the area, with an elevation of 200 feet above sea level, borders on the Sacramento Valley, and the climate is practically identical with that of the valley. It is characterized by a dry, hot summer and a mild winter with only a moderate rainfall. There is a gradual change from the conditions existing in this lower part of the area as the elevation increases, until in the eastern part lying at 4,000 feet above sea the summer is very moderate and the winter is accompanied by heavy rainfall and some snow and ice.

As stated, the change in climate passing from west to east across the area is gradual, but for clearness of discussion and to aid in the study of the effect of climate on the agriculture and development of the region, it seems well to divide the area into three zones

The first zone extends from the western boundary of the area, where the elevation ranges from 200 feet to 400 feet, eastward to include country with elevations up to 1,000 feet. The climate in this belt may be judged with a good deal of accuracy by a study of the climatological data from Marysville, which is given herewith. Marysville is 12 miles west of the western boundary of the area, and is 67 feet above sea level. The records of the Weather Bureau show that it has a mean annual rainfall of 19.93 inches, practically all of which falls in the months October to April, inclusive. The mean annual temperature is 64° F., that for the three summer months is 78.4° F., and that for the three winter months is 49.9° F. The lowest zone has a semiarid climate departing somewhat from the above figures, but with a rainy season in the winter and a dry season extending from the middle of April to the middle of October.

The second zone extends from an elevation of 1,000 feet to that of 2,500 feet. The climate here may be judged by studying the data given for Grass Valley and Nevada City, which lie in the upper limits of this zone, and more particularly by studying the estimated conditions for Penn Valley, taken from an unpublished report on the "Duty of Water on Lands Irrigated by the Excelsior Water and Mining Company in Nevada and Yuba Counties, California," by J. B. Brown, 1917 [3]

Records of rainfall and temperature for this valley cover only one year, but the estimates are probably approximately correct. Penn Valley has an elevation of 1,400 feet. According to the authority quoted, it has a mean annual precipitation of 37.59 inches, nearly double that of Marysville, and mean annual temperature of 58.8° F., which is about 4° cooler. The average for the three winter months is 46.1° F. and for the three summer months 72.4° F. The records for Grass Valley show a mean annual precipitation of 53.55 inches, nearly three times that of Marysville, and an average annual temperature of 55.6° F.

The third zone extends from an elevation of 2,500 feet to the highest elevation in the area, approximately 4,000 feet. The climate here may be judged by studying the data given for Grass Valley, just discussed, which lies on its lower limits, and that given for Deer Creek, which lies 1 mile east of the eastern boundary of the area, at an elevation of 3,700 feet. The precipitation at Deer Creek is 76.61 inches, or a little more than double the estimated rainfall of Penn

[3] United States Department of Agriculture, Office of Public Roads and Rural Engineering, Cooperative Irrigation Investigations in California. (Cooperation with Excelsior Water and Mining Company and Nevada-Yuba Counties Water Consumers' Association).

Valley, and the mean annual temperature is 49.8° F., or 9° lower than that for Penn Valley. In this higher zone frost has occurred every month in the year.

The effect of the variations in climate is seen in the depth of the weathering of the rock in the different zones. In general the depth of the weathering is apparently in direct proportion to the amount of rainfall. In the western part of the area, where the elevation is the lowest, the residual soils are shallow, being from a few inches to a foot or two deep, with frequent outcroppings of the bedrock. The second zone has soils that are noticeably deeper, usually averaging 2 feet, and in the areas of softer or more readily weathered rocks 3 or 4 feet deep, and outcrops are less numerous. In the third and highest zone the weathering of all the formations is much deeper. The granites have weathered to a depth of 2 to 6 feet and the andesitic rocks to depths of 5 to 10 feet or more.

However, it should be said that the climate is probably not the only factor influencing the depth of the weathering of the rock. Another very important factor is the character of the rock. One cause of the very shallow soils in the first zone is that the rocks here are largely those which are apparently resistant to weathering, while the deeper soils in the third zone are largely from rocks which weathered more rapidly. But there are certain rocks, such as the grano-diorites, that occur in all the zones, and these plainly show the relation between climate and depth of soil.

The depth of the soil, in connection with the variation in rainfall and temperature, has profoundly influenced the vegetation, and all these together have influenced the agricultural development of the different zones.

In the first zone, with light rainfall, high temperature, and shallow soils, the vegetative covering of the hills is largely grass. The scattered trees are mainly oak and digger pine. This parklike covering has favored the use of land for grazing and the shallow soils have hindered tillage. As a consequence, this is a stock section with very large ranches and houses few and far apart. (Pl. I, fig. 2.)

In the second zone, the timber is much heavier and the pastures correspondingly poorer. Stock raising has not developed to as great a degree as in the first zone. General farming has taken hold in a small way on the better areas of residual soil and in the small alluvial valleys, and here are the dairy farms and fruit farms.

In the third zone the timber is heavy and dense. There is practically no pasture, and agricultural development has been greatly retarded by the high cost of clearing the land. In fact, it is only in very recent years that there has been any development whatever. This zone is probably to see the greatest future development of the area, because its soils are deep and fertile and there is much undeveloped land. But here again the climate is a limiting factor, not

on account of the amount of rainfall, but on account of frosts. An elevation of about 3,500 or 4,000 feet is the limit of successful general agriculture in this area. Above this point much of the soil is quite deep and fertile, but frosts are likely to occur during all months of the year, and neither fruits, vegetables, nor grains can be successfully grown. About all that remains possible is grass for hay and pasturage. The better soils are all densely forested and it would not be profitable, under present conditions, to clear the land for these purposes.

In general, it may be said that the climate for any particular locality in the area or any particular farm depends not alone on its location in the zones above mentioned, but on local influences, among which are air drainage and direction of exposure or slope and protection from winds.

The prevailing wind is from the west and southwest. Occasionally the velocity is high, but usually it is moderate. Fog is rather unusual.

Following are the normal monthly, seasonal, and annual temperature and precipitation records for Grass Valley, Nevada City, Marysville, and Deer Creek, obtained from official records of the Weather Bureau. The data for Penn Valley are estimates.

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Marysville (elevation, 67 feet; length of record, 47 years).					
	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1877).	Total amount for the wettest year (1906).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	49.9	82	20	3.58	1.55	9.63
January	48.4	90	19	4.19	3.60	7.14
February	51.3	91	27	3.07	1.57	4.81
Winter	49.9	91	19	10.84	6.72	21.58
March	57.4	88	30	2.81	0.92	7.23
April	62.0	98	35	1.40	.12	2.23
May	68.8	105	39	.89	.81	3.19
Spring	62.7	105	30	5.10	1.85	12.65
June	76.2	109	42	.25	.42	1.01
July	80.0	118	42	.....	.....	.....
August	78.9	113	45	.01	.....	.....
Summer	78.4	118	42	.26	.42	1.01
September	74.0	112	42	.34	.....	.21
October	65.3	103	32	1.09	.50	.....
November	56.4	92	27	2.17	1.68	1.23
Fall	65.2	112	27	3.60	2.18	1.44
Year	64.0	118	19	19.80	11.17	38.68

Normal monthly, seasonal, and annual temperature and precipitation—Continued.

Month.	Deer Creek (elevation, 3,700 feet; length of record, 11 years).[4]						
	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1909).	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	36.4	68	8	11.85	5.98	16.88	28.2
January	36.0	65	2	23.08	10.13	56.32	67.2
February	38.0	71	6	9.97	7.40	17.12	27.2
Winter	36.8	71	2	44.90	23.51	90.32	122.6
March	43.0	85	12	10.54	9.85	7.12	35.6
April	48.2	84	20	3.86	2.92	.32	3.8
May	51.9	94	26	4.59	.34	1.33	1.4
Spring	47.7	94	12	18.99	13.11	8.77	40.8
June	58.2	92	20	1.24	.10	.55	.....
July	65.6	107	27	.11	.....	.....	.....
August	65.1	104	25	.03	.....	.....	.....
Summer	63.0	107	20	1.38	.10	.55	.....
September	58.9	104	21	.94	2.72	.86	.....
October	51.9	94	14	3.12	2.72	6.13	.3
November	44.1	74	16	6.58	4.64	16.68	6.0
Fall	51.6	104	14	10.64	10.08	23.67	6.3
Year	49.8	107	2	75.91	46.80	123.31	169.7

Month.	Nevada City.[5] (Elevation, 2,580 feet.)						
	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1898).	Total amount for the wettest year (1867).	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	42.4	80	12	10.00	2.27	41.95	4.3
January	41.5	79	4	11.31	1.92	14.21	11.0
February	43.1	86	7	7.99	9.91	10.00	7.1
Winter	42.3	86	4	29.30	14.10	66.16	22.4
March	44.8	92	12	8.50	.87	6.23	8.3
April	50.5	94	22	4.30	.95	6.88	1.0
May	55.6	101	25	2.47	2.73	1.93	.1
Spring	50.3	101	12	15.27	4.55	15.04	9.4
June	62.7	99	30	.65	1.27	.....	.....
July	68.8	102	35	.04	.....	.....	.....
August	68.1	104	35	.04	T.	.....	.....
Summer	66.5	104	30	.73	1.27	.....	.....

[4] Frost has occurred every month in the year.

[5] Temperature records cover a period of 26 years and rainfall records a period of 54 years.

Normal monthly, seasonal, and annual temperature and precipitation—Continued.

Month.	Nevada City. (Elevation, 2,580 feet.)						
	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1898).	Total amount for the wettest year (1867).	Snow average depth.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
September	62.2	101	25	.75	.37	1.91	.....
October	55.7	96	24	2.48	1.96	3.63	.....
November	47.8	85	18	5.82	3.49	16.11	.4
Fall	55.2	101	18	9.05	5.82	21.65	.4
Year	53.6	104	4	54.35	25.74	102.85	32.2

Month.	Grass Valley. (Elevation, 2,690 feet; length of record, 46 years.)						Penn Valley, Calif.[6] (Elevation, 1,400 feet.)	
	Temperature.			Precipitation.				
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1898).	Total amount for the wettest year (1909).	Mean temperature.	Mean precipitation.
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*	°F.	*Inches.*
December	41.8	71	18	8.35	2.73	13.84	46.2	6.97
January	41.2	72	11	11.42	1.82	38.34	45.0	7.75
February	43.0	68	16	7.88	8.64	13.65	47.2	5.53
Winter	42.0	72	11	27.65	13.19	65.83	46.1	20.25
March	48.2	86	20	8.04	.66	6.27	51.1	5.66
April	52.0	87	25	4.20	.97	.48	56.2	2.85
May	57.5	98	30	2.40	2.76	1.15	62.2	1.68
Spring	52.6	98	20	14.64	4.39	7.90	56.5	10.19
June	64.8	97	35	.73	1.27	49	69.4	.45
July	72.5	102	41	.05	T.	.....	74.4	.02
August	72.7	99	42	.04	T.	.....	73.5	.02
Summer	70.0	102	35	.82	1.27	.49	72.4	.49
September	65.3	94	37	.85	.61	.51	68.1	.55
October	58.7	87	31	2.80	2.08	3.73	60.5	1.89
November	49.2	74	19	5.60	4.31	10.08	52.1	4.22
Fall	57.7	94	19	9.25	7.00	14.32	60.2	6.66
Year	55.6	102	11	52.36	25.85	88.54	58.8	37.59

[6] U. S. Department of Agriculture, Office of Public Roads and Rural Engineering, Cooperative Irrigation Investigations in California. (Cooperation with Excelsior Water & Mining Co. and Nevada-Yuba Counties Water Consumers' Association.)

"Records for Marysville, Nevada City, and Auburn were studied. Penn Valley is at an elevation of 1,400 feet above sea level and Pleasant Valley at 1,200 feet, Smartville is at about 700 feet, Marysville at 67 feet, and Nevada City at 2,580 feet; by taking means of the records of precipitation and temperature of Marysville and Nevada City and calling those means the records for precipitation and temperature for the Penn Valley and Pleasant Valley sections, the approximate results thus found seem reasonable. A further comparison of these results with those of Auburn (elevation 1,360 feet) shows that they are substantially correct."

Killing frost, Nevada City: Average last in spring, May 11; average first in fall, Oct. 15; latest in spring, June 11; earliest in fall, Sept. 27.

Killing frost, Grass Valley: Average last in spring, Apr. 19; average first in fall, Nov. 9; latest in spring, May 30; earliest in fall, Oct. 2.

AGRICULTURE.

The first settlers in this area were gold seekers, not farmers, but some of the disappointed miners began to turn their attention to farming even at a very early date. The high prices paid by the miners for all agricultural products were a great incentive to production and agriculture developed quite rapidly for a time. By 1860, or 11 years after the first settlement, 30,000 acres of land are reported to have been under cultivation, but there was a rapid falling off after that time and this acreage has never since been equaled or even approached.[7]

The cultivated areas were largely in the lower foothills, where timber was thin or lacking and clearing easy, but a few years' trial convinced most of the farmers that grain growing was unprofitable on the shallow soils developed in this region.

The agricultural interests in these early days centered mostly in the growing of barley, wheat, hay, oats, and potatoes. It is reported that about one year out of five the rainfall would be sufficient to make a good crop of grain on the more shallow soils. Fruit trees and grape vines were also set out in numbers at this time. The county assessors reported 22,000 apple trees, 32,400 peach trees, and 9,000 grape vines in 1860. The number of fruit trees declined very rapidly, but the number of grape vines increased until in 1870 there were 450,000 vines, the vineyards occupying about a square mile. The acreage in grapes also decreased rapidly after this date, and the census of 1910 reports only 94,338 vines. The same authority places the number of apple trees in 1900 at 32,236 and of peach trees at 23,238. These numbers are considerably larger than those reported by the census of 1890 or the census of 1910. There has been a further decline in recent years, until now there are less than 10,000 trees of either of these fruits in the area.

In 1867 the silk industry was started in the county and by 1870 there were 129,000 mulberry trees set out. The industry did not prove profitable and was later abandoned.

While the growing of grains and other fruit and orchard crops on the shallow soils of the first climatic zone has been practically abandoned, their production in Penn Valley, Pleasant Valley, and numerous other small valleys, usually only a few acres in extent, in which the soils are in part alluvial and relatively deep, has been profitable and has continued to the present time.

As a new stage in the agricultural development of the area, a fruit-growing industry has been developed on the rolling lands in the Chicago Park district at a relatively high elevation, and planting has also started on the deep andesite soils of the highest elevations of the area.

[7] Reports of the county assessors. The strict accuracy of these reports is questioned, but statements made by early settlers would tend to substantiate them in the main. Many fields now in pasture were once in grain.

However, the main interest in the county since its first settlement has been and still is mining. Agriculture has always been of secondary importance. At the present time it has reached a stable condition over much of the area, but is developing along the lines of fruit culture on the deeper, heavily timbered and higher lying soils.

On the lower lying hills in the western part of the area where the rainfall is light, the timber scattering and open or even lacking, and the soils shallow, stock raising is the prevailing industry. In this industry the production of beef cattle stands first, followed by sheep, also of considerable importance. The sheep are moved up to the higher altitudes east of the area in June and brought back to the foothills in October. Horses, goats, and hogs are also kept in smaller numbers. Occasional small fields of grain are grown in favored spots, and usually there is a garden and orchard located near the homes and irrigated from local water supplies. The only improvement which can be expected to develop in this general section would follow the extension of the irrigation systems. The farms here are very large, deserted farmsteads are frequently seen, and many of the houses and barns remaining have a neglected appearance.

In Penn Valley and similarly situated smaller valleys a somewhat different development has taken place. This has been due not only to the greater rainfall and deeper soils, but also and especially to the existence of available water for irrigation. Grain fields are more numerous in these valleys, some clover and alfalfa are grown, and there are several excellent fruit orchards. Here dairying largely takes the place of raising beef cattle, and corn and other silage crops are grown for feed. Numbers of silos have been built in these valleys. The milk is sold to creameries in Penn Valley and in Grass Valley. The dairy herds are small, usually less than a dozen cows in each, but they contain some very good animals.

The fruits grown in this part of the area are peaches, pears, grapes, figs, and in a smaller way cherries, apples, plums, and prunes. This fruit is produced mainly on the soils of the Sierra and the Holland series, which are here of moderate depth. A very high quality of fruit, especially of peaches, is grown. The industry is being extended here to a moderate degree, several young orchards having been set out lately. The amount of water available for irrigation is limited, and no great development can take place until a larger source of supply is made available. This is considered one of the best developed sections of the county, but the percentage of land under cultivation is very low, the few cultivated fields and orchards being separated by wide stretches of uncultivated land.

The Chicago Park section in the eastern part of the survey, at an elevation from 2,200 feet to 2,600 feet, has had a different development from that of any other part of the area. Here the growing of fruits without irrigation has been established on rolling hill lands.

This section is served by the Nevada County Narrow Gauge Railroad, which gives it an outlet to outside markets, and this has been a large factor in its development. About 450 acres are planted in pears, peaches, apples, grapes, plums, prunes, cherries and walnuts, and nearly half the fruit grown in the county is shipped from this section. This development has taken place on the Aiken clay loam, which, in this instance, has been derived from diabase. Extension of the orchard area continues.

The North San Juan district, or the region between the two forks of the Yuba River, has very scant agricultural development. It was formerly an extensive mining section, but the old mining settlements have either disappeared or are slowly crumbling to ruins. This section is very isolated, and the roads into it are poor. There are a few scattered stock ranches, the cattle on which are allowed to range over the hills, and a little grain and forage is grown to provide feed during periods of scarcity. A large source of cattle feed all over the upper part of the area is a species of ceanothus, locally called sweet birch, which makes excellent browsing during the early summer. The cattle also eat the hazel brush. Scattering fruit trees planted by the early settlers give evidence of the possibilities along lines of fruit culture. An Anjou pear tree over 50 years old is regularly yielding heavy crops, and some cherry trees of enormous size, and probably as old as the pear, bear heavily and consistently. There is, however, no commercial development of the fruit industry in this part of the area, owing mainly to lack of transportation. Only a small proportion of this country is suited to orchards, on account of the rough topography and shallow soils.

The part of the area that gives most promise of successful development is the northeastern section, underlain by andesitic rocks. Development has already begun, and it has been demonstrated that this region is well adapted to the production of fruit of high quality. These ridges are occupied by the deeper, better variations of the Aiken clay loam, which is almost invariably derived from an andesitic breccia. They comprise several ridges, principal of which are Harmony Ridge, Blue Tent Ridge, Town Talk Ridge, the ridge north and northwest of Grass Valley, and the extensive ridge lying north, northeast, and southwest of Banner Hill. A smaller ridge lies southeast of Grass Valley, extending thence to Cedar Crest. This has been in the past a mining region and practically no agricultural development has taken place, except in the little valleys below these ridges. It was originally covered with a heavy growth of yellow pine and other trees which were cut off at an early date and now is covered with a heavy second growth suitable for mine props and firewood. The development of this country has been retarded by this heavy forest cover, the isolation and poor roads, the lack of water for irrigation, and the lack of interest in farming operations. Within recent years,

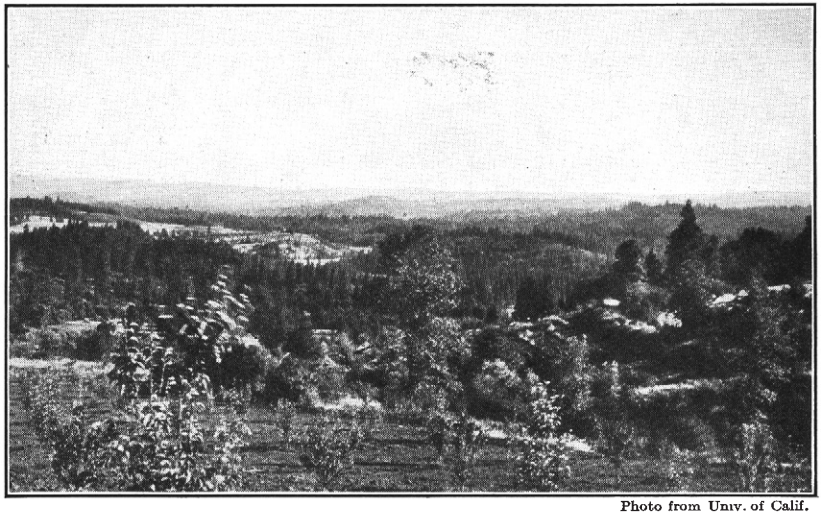


Photo from Univ. of Calif.

FIG. 1.—GENERAL VIEW OVERLOOKING DEER CREEK VALLEY, SHOWING THE TYPE OF TOPOGRAPHY OVER MUCH OF THE AREA.

Young pear orchard on Aiken clay loam in foreground.

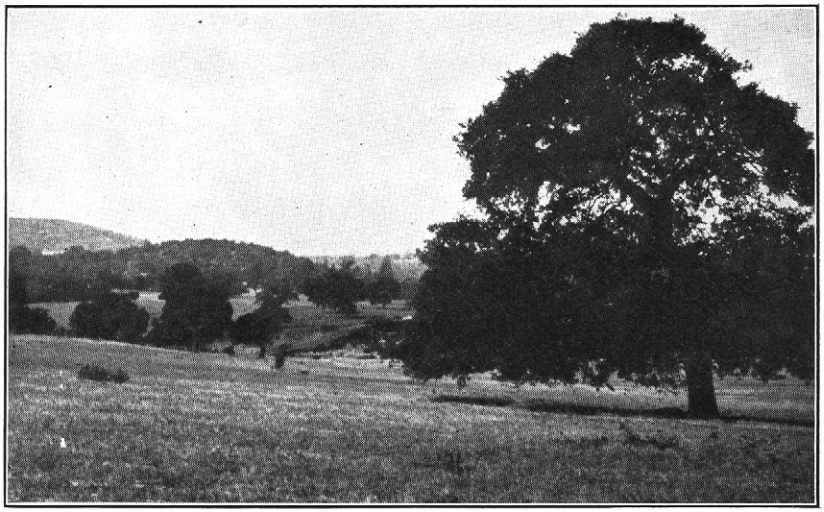


Photo from Univ. of Calif.

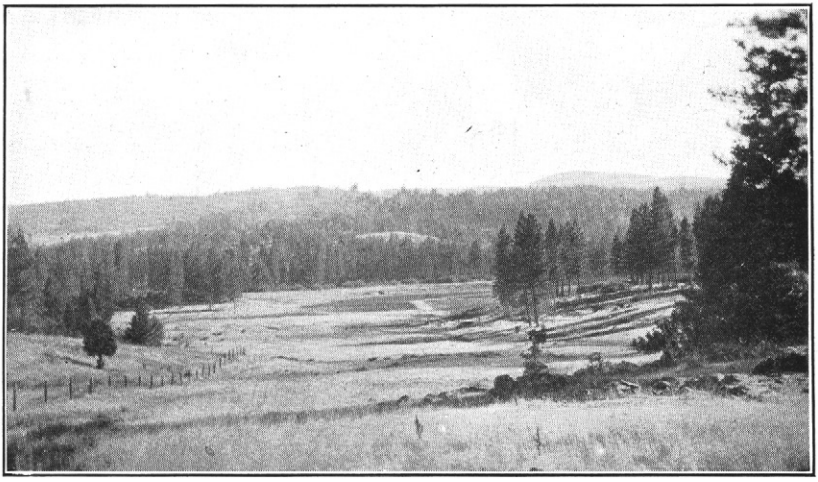
FIG. 2.—VIEW SHOWING TOPOGRAPHY, SCATTERED OAKS, AND COVERING OF NATIVE GRASSES IN WESTERN PART OF THE AREA.

The soil is the Aiken clay loam.

S. 9583

FIG. 1.—SHALLOW SOILS OF THE AIKEN SERIES, SHOWING OPEN GROWTH OF OAKS.

Note the bowlders and outcropping ledges of rock.



S. 10017

FIG. 2.—VIEW NEAR BUENA VISTA SHOWING IN FOREGROUND SOILS OF THE AIKEN SERIES WITH OUTCROPPING BEDROCK.

however, a few orchards of pears, peaches, plums, and other fruits set out in the vicinity of Grass Valley have proved very profitable. Considerable interest is being manifested at the present time and new orchards are being planted, mostly to the Bartlett pear, though other fruits and walnuts are being set out. Future development will depend largely on the available water supply and on transportation facilities.

The following table gives information regarding farms, crops, fruit, and live stock in Nevada County since its settlement. The figures for 1917 and 1918 were gathered by the farm bureau organization and kindly furnished by the farm advisor of the county. The other figures are from the reports of the Federal Census.

Agricultural statistics for Nevada County for the census years 1880 to 1910, and for 1917 and 1918.

	1880	1890	1900	1910	1917	1918
Number of farms	356	601	522	544	.....	.....
Average size of farms...acres	214	196	231	322	.....	.....
Acres in farms	76,184	117,796	120,582	175,385	.....	.....
Total acres cultivated	.....	.....	.....	.....	.....	4,286
Average acres improved	91	55	48	45	.....	.....
Total acres improved	44,296	33,055	25,056	24,534	.....	.....
Wheat...acres	304	65	274	95	127	85
Rye...do	224	10	72	0	14	22
Oats...do	1,165	70	299	119	59	65
Barley...do	543	109	224	30	184	285
Hay (grain hay, clover, alfalfa), acres	9,049	12,294	11,851	6,996	3,344	2,395
Silage crops...do	.....	.....	.....	.....	51	98
Corn...do	32	5	73	5	65	74
Apples...trees	.....	23,084	32,236	20,223	9,391	9,700
Peaches...do	.....	4,368	25,232	17,873	9,027	9,536
Pears...do	.....	.....	.....	36,800	48,640	65,040
Plums...do	.....	.....	.....	6,955	10,248	13,109
Prunes...do	.....	.....	.....	.....	3,645	3,664
Cherries...do	.....	.....	.....	1,727	1,761	1,949
Figs...do	.....	.....	.....	1,468	832	883
Walnuts...do	.....	.....	.....	.....	1,526	1,559
Grapevines	.....	.....	155,772	94,338	60,000	.....
Cattle, all kinds...number	.....	.....	.....	.....	5,604	.....
Dairy cows...do	.....	.....	.....	.....	1,139	.....
Sheep...do	.....	.....	.....	.....	7,419	.....
Hogs...do	.....	.....	.....	.....	1,563	.....
Poultry...do	.....	.....	.....	.....	12,027	.....

The rental value of the grazing lands in the lower lying western parts of the area range from 25 cents to $1 an acre. Practically none of the land changes hands, but the price is reported to range from $5 to $20 an acre. The land suitable for tillage generally varies greatly in agricultural value and as offered for sale usually includes

land suitable only for pasture. Prices range from $25 to $100 an acre. The best of the Aiken series suitable for orchard land can be bought uncleared for $25 to $75 an acre. The cost of clearing in some cases amounts to $100 an acre and will probably average half this sum. From this should be deducted the value of the firewood obtained, which in some cases is considerable. Large areas of the Aiken soils are held by lumber and mining companies, and as yet have had no agricultural value placed on them.

SOILS.

The soils of the Grass Valley Area are almost exclusively residual in origin. They have been formed by the weathering in place of the various rocks and the classification of the soils is therefore closely related to the geology of the region. On account of the gold found in many of these rocks they have been studied by the U. S. Geological Survey, and where the gold is most abundant, which is around Grass Valley and Nevada City, they have been mapped in great detail. The character of these rocks and their geologic history are thus well known, and these reports[8] have been freely consulted and drawn upon in the field identification of the geologic formations and in references made to the geology of the region in this report.

The older rocks, called the Bed-rock series, consist of sedimentary formations which were forced into a nearly vertical position at or before the post-Juratrias upheaval, together with the associated igneous rocks.

The sedimentary rocks of this series consist of clay shale, quartzitic sandstone, limestone, and chert, all of which have been metamorphosed near the granitic contact to schist and quartzite. All are greatly disturbed in position. The igneous and metamorphosed or altered igneous rocks consist largely of granitic and dioritic rocks and in part of diabase, gabbro, perioditite, serpentine, porphyrite, and the schistose forms of these rocks.

The younger rocks are called the Superjacent series, and these include the Neocene and Pleistocene sedimentary rocks and lava flows. They comprise auriferous gravels, rhyolite tuffs, and andesitic breccia.

The area covered by this survey has remained above sea level since Juratrias times at least. Toward the end of the Neocene the period of volcanic activity began. The rhyolite flowed down from the high Sierras as mud flows, but did not cover extensive areas in the present survey. After a considerable interval the volcanoes along the summit of the range began to pour out masses of the moderately basic lava, known as andesite, which covered most of

[8] See Geologic Atlas of the United States. U. S. Geological Survey, Smartville Folio, by Waldemar Lindgren and H. W. Turner, and Colfax Folio and Nevada City Special Folio, by Lindgren.

the area, reaching Smartville and beyond, the deposit having a maximum thickness of 300 feet. However, it seems certain that Banner Hill and most of the southwestern part of the area, including the higher hills, were not covered. Later most of this andesitic covering was eroded away, leaving only some prominent ridges at the present time.

The soils of the area are intimately related to the geology, but in soil classification the age of the parent rocks is disregarded and only their lithological character is taken into consideration. For instance, the Aiken soils are derived from basic igneous rocks, and this includes both the diabase of the Bed-rock series and the andesite of the Superjacent series. However, minor differences in classes of rocks, owing to differences in character or rate of weathering may produce soils differing in depth, texture, and agricultural value, which are recognized in the soil classification as representing different types in the soil series, or, if of minor character, different phases in the soil type. Thus the diabase above mentioned almost invariably produces in the area of this survey a much shallower soil and one with more fragmental rock than does the andesite. It is classed as the Aiken stony clay loam, and most of the soil from the andesite as the Aiken clay loam, the soils falling into the same series on account of their similarity in color, depth, and other physical characteristics, and not alone on account of the rocks from which they are derived. The soil classification is based on the characteristics of the soil itself.

The soils of the Grass Valley Area have been divided into three general divisions: First, the residual soils; second, the old valley-filling soils; and, third, the recent alluvial soils.

The residual soils have been derived by weathering or breaking down in place of the underlying consolidated rocks. They have been divided into three groups: First, soils derived from basic igneous rocks, or rocks containing a small amount of free quartz; second, soils derived from acid igneous or quartz-bearing rocks; third, soils derived from consolidated sedimentary rocks. The soils derived from basic igneous rocks include the Aiken series, which are red soils, and the Olympic series, which are brown soils. The soils of the second group, derived from acid igneous rocks, are placed in the Sierra series—a series of red soils—and the Holland series, the soils of which are brown. The soils derived from the sedimentary rocks are red in color and have all been classed with the Sites series.

The second general division includes the soils derived through weathering of unconsolidated sedimentary or alluvial deposits. The soils of this group are of small extent in this survey. They all have the same general characteristics of color, origin, and topography and have been classed in the Corning series.

The third general division consists of soils derived from recent stream-laid deposits. They are also inextensive and have been classified in a single soil series, the Honcut series.

Besides the above soils there have been differentiated and shown on the soil map accompanying this report the following classes or types of miscellaneous materials, namely: Rough broken and stony land, Placer diggings, and Riverwash.

The following table indicates the classification and relationship of the different soil series in the Grass Valley Area:

A. *Residual soils:*
- I. From basic igneous rocks.
  - *a*. Red—Aiken series.
  - *b*. Brown—Olympic series.
- II. From acid igneous rocks.
  - *a*. Red—Sierra series.
  - *b*. Brown—Holland series.
- III. From sedimentary rocks.
  - *a*. Red—Sites series.

B. *Old valley-filling soils:*
- I. From mixed rocks.
  - *a*. Red—Corning series.

C. *Recent alluvial soils:*
- I. From mixed rocks.
  - *a*. Brown—Honcut series.

The surface soils of the Aiken series are red. The subsoils have the same or a somewhat lighter color, and are normally slightly more compact and heavier in texture than the surface material. The rock from which the soils of this series are derived in this area is found at depths varying from a few inches to many feet below the surface. The topography is sloping to hilly and steep, and surface drainage usually is excessive. The native vegetation varies with the altitude and the depth of the soil material. In the areas lying at lower elevations, where the soil is prevailingly shallow, the timber consists mostly of valley oak and is open, with little underbrush. As the altitude increases, digger pine appears, then yellow pine, fir, cedar, and several species of oaks, and the underbrush is thicker. The soils of the Aiken series are residual in origin and are typically derived from igneous and metamorphosed igneous rocks of basic or quartz-free character. As occurring in this survey they are derived from andesite, diabase, porphyrite, serpentine, amphibolite, and schistose forms of some of these, and to less extent from several other kinds of rocks. Two types of the Aiken series, the clay loam and the stony clay loam, are mapped in this area.

The soil of the types included in the Olympic series is brown to somewhat reddish brown and the subsoil typically brown or light brown. The subsoil is somewhat heavier in texture and more compact in structure than the soil. The bedrock in this area lies not far below the surface and in most places within the 3-foot section. The topography is rolling to steep and hilly and the drainage thorough to excessive. Yellow pine, fir, digger pine, several species of oaks, and various kinds of underbrush form the characteristic vegetation. The Olympic soils are residual in origin and are derived from basic

igneous rocks which in this survey consist of andesite, diabase, serpentine, and gabbro-diorite. They are thus similar in origin to the Aiken soils, but are separated from them on the basis of color. Only one type, the Olympic stony clay loam, is mapped in the present survey. Like the Aiken soils, some of the material included with this type is of rather grayish or yellowish-brown color, and where this color is more pronounced some material of a distinct series of soils may occur.

The Sierra series includes types with light-red to dull-red or reddish-brown soils, in many places micaceous. The soil material sometimes extends to the underlying parent rock without much change, but typically in the areas of the smoother topography the surface soil is underlain by a reddish-brown to red, compact, heavier subsoil, passing gradually into the bedrock at depths commonly less than 6 feet. These soils are in many places shallow, and some contain rock fragments or are marked by rock outcrop. Rough rocky areas unsuitable for agriculture are included. The types occupy gently rolling to high steep hills, and are also developed in basinlike depressions. The surface is smooth, except where broken by rock outcrops. The native vegetation varies with the elevation and the depth of soil. At the lower altitudes the forest is open and parklike, but as elevation increases the stand of trees is heavier and there is a dense growth of brush over a great part of the land. Yellow pine, digger pine, valley oak, black oak, cedar, and fir are the more plentiful species. The soil as occurring in this survey is derived mainly from grano-diorites. One type, including a phase, is mapped in the area.

The soils of the Holland series are brown or slightly reddish brown, typically micaceous, and friable. The material sometimes extends to the underlying parent rock with little change, but a lighter brown or yellowish-brown subsoil is developed in places. Here and there, particularly in localities of smoother or flatter topography, the subsoil is more nearly a reddish brown than a yellowish brown and more compact and heavier than the surface soil in texture, the depth of the soil covering ranges from a few inches to several feet. The parent rock immediately below the soil material is normally partly disintegrated. Massive outcrops or scattered bowlders of granite mark the surface. The topography in places is gently rolling, consisting of low rounded hills and gentle depressions, but in others it is rough and steep. The drainage is complete, being excessive in all the steeper parts of the area. The forest cover varies from open and parklike to a heavy stand of pine, cedar, and oak, with abundant underbrush. These soils are closely related to the Sierra soils in origin, but are distinguished from them by differences in color. One type, the Holland fine sandy loam, and a shallow phase of this type are identified and mapped in this area.

The Sites series includes types with light-red or red to reddish-brown soils, resting at depths normally less than 30 inches on a heavier textured, compact subsoil of a more pronounced red than the surface material. Gravel and rock fragments commonly are present, but outcropping ledges of rock are rare. The series is residual in origin, and derived typically from sedimentary rocks. In this area the parent rocks have all undergone more or less alteration or metamorphism. The soils are differentiated from the other red residual soils in the area on the basis of origin from sedimentary rather than from igneous rocks. The topography is rolling or hilly and drainage good to excessive. Two types, the Sites clay loam and the Sites stony loam, are mapped in the present survey.

The soil of the types in the Corning series is pale red, yellowish red, or dull or brownish red, and the subsoil pale red or red, in places yellowish, and characteristically heavier and more compact than the surface soils. In exposed sections stratified beds of cobbles, stones, gravel, sand, and finer grades of material, compact or partly cemented, occur at 2 to 4 feet below the surface. The series is derived from weathered and modified old valley-filling material having its source in a variety of rocks, both igneous and sedimentary. In this survey the material seems to have been deposited by rivers existing prior to the later lava flows. The later rivers have eroded new channels in most places and these old river deposits now occupy elevated areas subjected to a long period of weathering. The soils occupy gently sloping areas or rolling hills or terraces. The surface is usually smooth. The vegetation consists of yellow pine, cedar, and oaks, with a dense growth of underbrush. Only one type of the Corning series, the gravelly clay loam, is mapped in this area.

The surface soil of the types included in the Honcut series is typically brown to reddish brown. The subsoil is similar in color to the surface soils and characteristically no heavier in texture, though irregular strata of variable texture may occur. These soils occupy small valleys and bottoms, where the soil material has been laid down by streams. The deposits represent wash from igneous, metamorphic, and sedimentary formations. The topography is gently sloping to nearly level and the surface smooth. These soils differ in color from the Corning soils. They are also younger and have not undergone changes due to weathering in place, as have the types in the Corning series. One type, the silty clay loam, was mapped in this area.

In the following pages of this report the soils of the area are described in detail and their relation to agriculture discussed. The accompanying map shows their distribution in the area, and the following table gives the name and the actual and relative extent of each type:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Aiken stony clay loam	125,440	44.6	Olympic stony clay loam	5,760	2.0
Sierra clay loam	9,472	16.1	Placer diggings	2,816	1.0
Shallow light-textured phase	35,584		Honcut silty clay loam	1,728	.6
Aiken clay loam	44,928	16.0	Corning gravelly clay loam	1,344	.5
Rough broken and stony land	27,968	9.9	Riverwash	896	.3
Holland fine sandy loam	1,024	4.7	Sites clay loam	832	.3
Shallow phase	11,968		Total	280,960	
Sites stony loam	11,200	4.0			

AIKEN STONY CLAY LOAM.

The Aiken stony clay loam is a red, brownish-red, or dark-red clay loam from 1 to 2 feet deep. It is of comparatively heavy texture, but this is masked to some extent by the presence of a relatively large proportion of angular particles of rock of the grades of sand, coarse sand, and fine gravel. This coarse material makes the soil somewhat friable and granular and more easily cultivated than it otherwise would be.

The type is low in organic matter and apparently low in lime. It is not very retentive of moisture and contains enough small stones to affect its physical character and to influence cultivation.

A true subsoil is often absent, the surface soil extending without change to the bedrock, but where present the subsoil consists of a layer of red or reddish yellow clay loam or clay, from a few inches to 2 feet thick. In a few places this material is so compact as to be almost impervious to water and roots. It invariably contains fragments of the parent rock, and bedrock lies in most places from 1 to 4 feet below the surface. It consists of diabase, gabbro-diorite, amphybolite, serpentine, and other basic igneous rocks with their upper surfaces either massive and unweathered or well disintegrated.

Some of the material included with this and the following type is of yellower color and not typical of the Aiken. If more widely developed, some of these yellowish variations would have been recognized as a distinct series of soils. Some of the included material also merges with the associated brown soils of the Olympic series, and small undifferentiated areas of Olympic material may be included.

The Aiken stony clay loam is quite variable in character and value. The largest bodies are situated in the southern and western parts of the area at the lower elevations and the soil here does not conform to a stony loam, in the usual sense of containing a large amount of loose stone, but consists of shallow soil material with scattered large stones in the soil and protruding from the surface. (Pl. II, fig. 1.) The soil in

this part of the area supports a parklike forest of oak, and digger pine, with little or no underbrush, and a good growth of grass during the rainy season; this is the region of the large pastures and scattered houses with practically no plowed land. The native vegetation on the more elevated parts of this type consists of yellow pine, cedar, fir, several species of oak, with a good growth of underbrush. (Pl. II, fig. 2.)

At McCourtney Bridge, where the parent rock is an amphibolite schist, the hills are smooth and gently rolling, with practically no rock showing upon the surface, but the soil here also is very shallow, the bedrock lying less than a foot below the surface.

A quite shallow and poor variation of this type, covering several square miles, extends from near Rough and Ready south and east to Wolf Creek Mountain. It is derived mainly from massive amphibolite and diabase and probably to some extent from serpentine. The soil is from 3 to 12 inches deep, with frequent outcrops of bedrock. The rocks occurring in the soil are angular and comparatively small. It approaches Rough broken and stony land in character, but has some agricultural value. The vegetation consists of digger pine and chaparral. No yellow pine or fir is found on this variation and there is practically no pasturage. The topography is rolling.

Near Rough and Ready and Grass Valley, small selected valleys, constituting a very small proportion of the whole, are cultivated, and where irrigated small gardens and orchards are productive.

This type is well distributed over the area. It occurs in large continuous bodies in the southern and western parts, and in smaller disconnected bodies in the central, eastern, and northern parts, where it is usually associated with the Aiken clay loam. It is gently rolling to steep in topography, the gently rolling areas lying at the lower elevations and the surfaces gradually becoming steeper as the elevation increases.

The surface is smooth or broken by the protruding rocks. Erosion on the uncultivated area is not very active, notwithstanding the topography, but land under cultivation washes badly. Surface drainage is good to excessive; the internal drainage is slow.

This is the most extensive soil type in the area, but it is of low to moderate agricultural value. Very little is plowed, owing to its shallowness. Where the forest is not too thick the land is used for pasture, which has a rental value of 25 cents to 75 cents an acre. Over most of its extent the land is held in large ranches.

Pasturage seems to be the best use for most of this land, and the only suggested improvement would be irrigation in localities where practicable, to promote and extend the growth of native grasses, or to water local garden and orchard tracts.

AIKEN CLAY LOAM.

The Aiken clay loam, where typically developed, is a red clay loam from 18 to 30 inches deep, containing in many places a relatively large proportion of coarse sandy material. This gives a more granular structure, greater permeability, and easier cultivation than commonly found in types of clay loam texture. The soil is rather low in organic matter. Some of the areas are stone free, but over much of the land there are scattered bowlders, ordinarily from 6 to 30 inches in diameter. Similar fragments are embedded in both the soil and subsoil, but the quantity is not large enough to make the type a stony loam. These bowlders were carried by the parent rock, an andesitic breccia, and are left as the matrix weathers.

The soil is low in lime and there are field indications that much of it is slightly acid. Water enters the soil very readily, but does not seem to be retained very well. Parts of the soil type occupy nearly level areas or gently rounded ridges and are very easy to cultivate. Other areas lying on the slopes of ridges and in the more deeply dissected country are very steep and cultivation would be difficult and costly or impracticable. The soil also varies in depth with the rock from which it is derived. That from the andesitic tuffs is the deepest and most desirable. That from the diabase and associated porphyrite and the gabbro is shallower and more apt to be steep in topography, and for these reasons is not so desirable. Bedrock in these areas often occurs at a depth of 4 or 5 feet, but the rock, where encountered, is in a soft and poorly disintegrated condition.

The subsoil is typically a red clay loam or clay and over much of the type extends to a depth of 6 feet or more. In places the lower subsoil is a yellowish red and lighter in texture than the upper subsoil, and in other places, where the parent rock is diabase, the subsoil is yellow. Bedrock in more shallow areas of this soil lies within 3 or 4 feet of the surface, but ordinarily it lies well below 6 feet.

The Aiken clay loam includes a number of color variations. While most of the surface soil is of a deep-red or intense-red color, in some places having more than the normal content of organic matter, it is a dark brownish red, in other places it shades off into light red or even yellowish. There are also a few small spots of brown color which, if more extensive, would have been mapped as Olympic clay loam, and some of the yellowish variations probably represent material of the Brownsboro series. These, owing to their small extent, are not sufficiently important to warrant separate mapping.

Small parts of the soil, as mapped, include material derived in part from sedimentary rock belonging to the Calaveras formation, but these rocks are intimately associated with igneous rocks and the soils have all the characteristics of the Aiken clay loam and are therefore not differentiated.

The Aiken clay loam is situated in the more elevated parts of the area, being found in large bodies near Grass Valley and Nevada City, and in the eastern part, extending to Chicago Park and south of that town. The areas derived from the andesite forms high, broad ridges with a gentle slope to the southwest. Those derived from the other basic rocks lie at lower elevations, but even so mostly above 2,000 feet elevation. A few small bodies occur in the southern and western parts of the area, but these are hardly typical, being partly modified by alluvial deposits and lacking the depth of the higher lying areas.

The topography varies from gently sloping to steeply sloping and hilly. The surface in detail is smooth and surface drainage is excellent, but the heavy subsoil restricts subdrainage. Under natural conditions these soils are not badly eroded, but when cleared and brought under cultivation, unless especial care is taken they wash badly, and some old fields have had the surface soil entirely removed.

The vegetation consists of yellow pine, incense cedar, Douglas fir, with a small admixture of oaks of various species and an undergrowth of manzanita and ceanothus. The virgin forest was removed soon after settlement, and the present timber is second growth.

This is probably the best farming soil in the area, but only a small part of it is in use and much of this has been cleared and improved within the last few years. (Pl. III, fig. 1.) The heavy growth of timber and the fact that this land is largely owned by mining and lumber companies are probably the causes for the neglect of the soil. Practically all the land cleared is being planted to fruit trees, consisting principally of pears, followed in order of importance by plums, prunes, apples, and cherries. The soil around Chicago Park has been longest under cultivation and fruit is grown there very successfully. The soil in that section is derived from diabase and occupies rounded hills. Practically no commercial fertilizers have been used on these soils. The tillage methods are not always of the best, and where dry farming is practiced the moisture is not conserved as carefully as it should be.

The growing of cover crops to increase the supply of organic matter is coming into favor. Some of the better fruit growers are practicing the best modern methods of culture—irrigation, pruning, spraying, and care of their orchards. These methods are amply justified by the results.

The roads in the cleared and settled parts of this type are sufficient in number, but owing to the topography and the nature of the soil are often steep and rough or very dusty in the summer time. In the unsettled parts the roads are at present far apart. All the land is, however, accessible.

Uncleared land of this type can be bought at prices ranging from $25 to $60 an acre. The cost of clearing and removing stumps and rocks has in some cases run as high as $100 an acre, but most of the land probably can be cleared for about $50 an acre.

Suggestions for improvements would lie along better cultural methods, development of irrigation where practicable, the increase of the supply of organic matter, and steps to prevent erosion.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Aiken clay loam:

Mechanical analyses of Aiken clay 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.*
574801	Soil	2.0	7.0	3.5	14.0	12.6	35.2	25.6
574802	Subsoil	2.1	6.0	2.8	12.4	11.2	28.8	36.3

OLYMPIC STONY CLAY LOAM.

The surface soil of the Olympic stony clay loam consists of a brown clay loam, in places rather fine and silty in texture, containing considerable quantities of angular rock fragments. The fine soil material contains a conspicuous amount of sharp, coarse sand particles, and these make it comparatively friable, permeable, and easy of cultivation. The content of organic matter and apparently of lime is low. The color of the soil varies and in places is reddish brown, yellowish brown, or grayish brown. The subsoil is a yellowish-brown or grayish-brown heavy loam or clay loam, somewhat compact, and containing considerable stone. In most places the bedrock is from 2 to 4 feet below the surface. It is usually hard and the subsoil rests directly upon it, without an intervening zone of weathered material. The formations giving this soil are mainly igneous rocks, mostly gabbro-diorite, but some other rocks are represented. Outcrops are more or less plentiful, especially on the steeper slopes.

This type is not extensive. The largest area occurs north and east of Newtown, and small bodies lie at Rough and Ready, on the Greenhorn River near Red Dog, near the Union Hill Mine, on the south slope of Harmony Ridge, in the northeast corner of the survey, and on the ridge between Grass Valley and Nevada City. The topography is sloping to hilly, and for the most part steep and rough. Erosion is active and drainage is good to excessive. The larger vegetation on this type consists of yellow pine, digger pine, and species of chaparral or brush. The Olympic stony clay loam is an unimportant type. It is entirely uncultivated, except for some small patches of fruit and garden truck near Rough and Ready and Newtown. The yields of these crops, which are mostly irrigated, are fair to good. More of the soil could apparently be profitably brought under cultivation if water for irrigation were available but much of it is of very low agricultural value, owing to its shallow nature, the high content of stones, and the steep topography.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Olympic stony clay loam:

Mechanical analyses of Olympic stony clay 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.*
574823	Soil	2.7	6.6	3.5	11.9	13.0	40.7	21.7
574824	Subsoil	2.4	5.4	2.7	7.6	7.5	44.8	29.6

SIERRA CLAY LOAM.

The soil of the Sierra clay loam typically consists of 12 to 30 inches of pale-red, dull-red, or red clay loam, containing a relatively large percentage of coarse gritty material of the grades of sand, coarse sand, and fine gravel. It has a fair to low supply of organic matter and is fairly loose and open in structure. Some of the included material is of rather light texture and may represent undifferentiated areas of the Sierra loam. There is in places a small amount of stone fragments in the soil, but not enough to interfere with cultivation. The lime content is low, the soil being mildly acid. It retains moisture fairly well and is easy to cultivate.

The subsoil is a red, yellowish-red, or yellow clay loam, usually compact and slightly heavier in texture than the surface soil. Some rock fragments occur in this zone, in part of the type. The subsoil may rest directly upon the bedrock or it may be underlain by a foot or two of material lighter in texture and of less pronounced red, being a yellow or a mottled reddish-brown or grayish-brown color. The parent rock occurs ordinarily at depths of 3 to 5 feet. The upper part of this, from a few inches to a foot, is well weathered and consists of a soft grayish-brown material which resembles the rock but permits the easy penetration of water and roots. Outcrops of the rock in this area, mainly grano-diorite, cut the surface in some places.

This type, as well as its shallow, light-textured phase to be described later, has included spots of the closely related brown Holland soils, with which it merges and which are too small to show separately upon the map. The type varies a great deal in agricultural value. Many of the hillsides are too steep for easy cultivation and in such situations the soil is not very desirable, while areas in small swales or valleys, 2 to 5 acres in extent with a nearly level surface, are much preferred. The soil in such cases is partly alluvial and of more than average depth, but it is still essentially a residual soil and is so mapped.

This is not an extensive type. It is found at elevations above 2,000 feet. There is a fair-sized body south of Grass Valley and several east, south, and north of Nevada City. There is one north and one south of the Oak Tree Ranch in the northern part of the area.

The type is developed on gentle slopes and rolling to steep hills, but the topography of the Sierra clay loam, or its shallow light-textured phase, is more gentle than that of the Aiken soils which may lie adjacent to it. The Sierra soils are more nearly level and contain basin-shaped valleys and depressions, and the content of stone is less. The roads also are straighter and smoother. Erosion on virgin areas is not very rapid, owing to the forest protection, but under cultivation provision must be made to control it, or the results may be serious. Surface drainage is good to excessive, but the subdrainage is slow, owing to the heavy subsoil.

The vegetation on this type consists of yellow pine, scattered cedar, white and black oak, and underbrush consisting mainly of manzanita and various species of ceanothus.

Very little of this soil is under cultivation, though it is fairly productive and some very good orchards are located on it. Apples, pears, peaches, and prunes all do well. In the main the soil is not as deep as the better areas of the Aiken clay loam, but selected spots in this soil undoubtedly would make good orchard sites. Grain, potatoes, hay, and garden truck are grown with low to moderate yields. The soil responds very well to irrigation, which is advisable where water is available. Settlements are usually far apart, with roads sufficient only to serve them. Uncleared land can probably be bought for $20 to $50 an acre.

Sierra clay loam, shallow light-textured phase.—The shallow light-textured phase of the Sierra clay loam is similar in color and other essential characteristics of the surface soil to the typical soil, but a distinct subsoil layer is in places lacking and the bedrock is much nearer the surface, within usually 2 to 4 feet. In texture the material is on the average somewhat lighter, being less completely weathered. In addition, there are numerous outcrops of the bedrock, these occurring as rounded bosses from 2 to 10 feet or more in diameter.

One large irregular shaped body of this soil extends from Indian Springs south and southeast for several miles. Another area covering 2 or 3 square miles lies north and northeast of Spenceville. The largest area extends from a point just north of Penn Valley to Anthony House and north to Bridgeport and east nearly to Newtown. There are other small bodies in the northern part of the area near North San Juan, Tyler, and north of Nevada City, and areas of small extent lie south of Grass Valley and at the east of Nevada City.

The topography is more hilly and rolling than that of the typical soil, but the hills are all rounded, and the slopes are not precipitous. Where it is not too densely wooded, land of this phase is used largely for pasture. A few orchards have been established, some of which are irrigated and well cared for and giving good returns. Fine peaches are grown, as well as apples, pears, and other tree fruits. One orchard of prunes and plums grown without irrigation is giving

very fair returns. Grain is grown in numerous small selected fields Only a very small part of the soil is under cultivation, possibly 2 per cent, but much more of it could be tilled, especially if irrigation water were available. Some of the steeper parts have a very low agricultural value, owing to the steep slopes and the shallow nature of the soil. Fields in the less elevated part of the area are all in pasture, which seems to be their most profitable use. With irrigation some selected spots where the soil is deepest and the surface of more gentle slope could be profitably farmed.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Sierra clay loam:

Mechanical analyses of Sierra clay 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.*
574817	Soil	7.3	13.4	4.2	10.0	7.9	33.5	23.9
574818	Subsoil	13.0	11.8	3.6	7.6	5.8	30.7	27.6

HOLLAND FINE SANDY LOAM.

The surface soil of the Holland fine sandy loam consists of 12 to 24 inches of brown fine sandy loam, in places approaching in texture a light loam, and containing considerable coarse gritty material. It is loose and friable and easy to cultivate. It contains a small to moderate percentage of organic matter and little lime. The soil retains moisture only fairly well. Some small fragments of stone occur, but they are not very abundant. The subsoil, which extends to a depth of 4 to 6 feet, is a brown fine sandy loam or loam, slightly compacted and carrying, like the soil, coarse gritty material and some larger stone fragments, and passing gradually into the disintegrated parent rock.

Where this type occurs in basinlike depressions, which is commonly the case, the surface soil may be modified by deposits of alluvial material a few inches to a foot thick. Such deposits occupy the lower parts of the type and areas near the shallow drainage channels, but are too small to be shown on a map of the scale used in this survey. The type also includes small bodies of a shallow phase, with bedrock lying not more than a foot or two below the surface and outcropping in places. Some material occupying old alluvial terraces is likewise included. If more extensive, this would have been separated as types of the Corning series. Small, poorly defined areas of grayish or reddish color approach in character the soils of the Siskiyou and the Sierra series.

Only a small area of the Holland fine sandy loam is developed in the present area. It is found in Penn Valley, where it occupies smooth gently rolling areas and shallow saucer-shaped depressions. The drainage is adequate. The soil supports a native growth

consisting of large scattered valley oaks and a few small groves of other trees, with a cover of grass over most of the land.

Penn Valley, where this type is found, is relatively of considerable importance in this area of very scant agricultural development. Probably about one-fifth of the type is under cultivation, grain being the main crop, which during favorable years yields well. Some alfalfa is grown, and under irrigation the returns are satisfactory. A young pear orchard that has not had very good care is doing fairly well. This is a dairy section and the pasturage is all utilized by dairy cows. Small fields of corn or kafir are grown for silage. The agricultural practice seems well suited to the soil, the use of which is more or less restricted by its relatively shallow depth. Irrigation has been found profitable but so far only alfalfa has been irrigated. Irrigation could probably be advantageously extended also to fruit and the native pastures. The principal need of this soil is organic matter and probably it would be improved by the application of lime.

Holland fine sandy loam, shallow phase.—The surface soil and subsoil of the shallow phase of the Holland fine sandy loam have the same characteristics as the typical soil, except in depth of the soil material and in area of rock outcrop. In the phase a distinctive subsoil is often lacking, and the depth of soil and subsoil combined is ordinarily from 1 to 2 feet, and rarely 3 feet. The bedrock, however, normally has a weathered zone from 1 to 2 feet thick, which is permeable by water. No field is entirely free from rock outcrops, characteristically rounded masses protruding from 1 to 5 or 10 feet or more above the surface.

A number of variations and small areas of other types of soil are included with the shallow phase. There is a small area about 3 miles northwest of Nevada City that differs considerably from the typical. It is derived from aplite and is quite variable in texture. Some of it is a loam, nearly free from stone, much of it is a stony loam and some of it has so much stone in it that it is nearly non-agricultural. The soil is brown in color from 12 to 30 inches deep, and granular. There is no distinct subsoil. The land is of quite low agricultural value. Another variation occurs on the slopes of the high ridge just north of Nevada City. It is derived from the rhyolite tuff which overlies the auriferous gravels at this place and which in turn is overlain by the andesite which caps these hills where it has not been removed by erosion. The tuff is a light-gray or ashen colored rock, in places soft but in others more or less cemented. The soil varies from grayish brown to brown or to brownish red. It contains no stones, except some fragments of andesite that have rolled down from the slopes above. It lacks a distinct subsoil, and passes directly into the underlying soft tuffaceous rock.. The surface of this area is so steep that the land has little agricultural value. There are quite a number of miner's houses on it and some small gardens and fields are cultivated. The yields are at best moderate.

There are a few spots in this phase, notably in the northern part of the area that are gray in color, and if more extensive would be mapped as soils of the Siskiyou series.

A fair-sized area of this phase lies a few miles south of Indian Springs and another one south of North San Juan. There is a small body just north of North San Juan, one about 4 miles west of Newtown, and one at Smartville. The total extent is small.

The topography of the shallow phase of the Holland fine sandy loam is gently rolling to hilly, with small included saucer-shaped valleys and a few rather steep-sided valleys. The surface in the northern part of the area near North San Juan is in general steeper and more rugged than south of Indian Springs. Erosion is active in places. Drainage is good to excessive.

The type of vegetation varies with the topography and location. In the southern bodies it consists largely of oaks and digger pine, and at higher elevations of yellow pine, with an undergrowth of ceanothus and manzanita.

The shallow phase of the Holland fine sandy loam is a soil of low agricultural value, owing mainly to its shallowness and the protrusions of bedrock. Very little of it is under cultivation and the crops grown, mainly grain, give only light yields in average years. Where the forest cover is open, the land is used for pasture, and areas suited to this purpose bring a rental of 50 cents to $1 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Holland fine sandy loam:

Mechanical analyses of Holland 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.*
574813	Soil	1.8	6.4	4.1	25.6	26.1	24.8	11.1
574814	Subsoil	1.4	6.6	5.0	29.2	25.1	21.0	11.4

SITES STONY LOAM.

The surface soil of the Sites stony loam consists of 12 to 24 inches of red, dull-red, or brownish-red loam, in places approaching a fine sandy loam, carrying much fragmental rock. The interstitial soil is loose and friable, but the content of organic matter and lime is low and the material unretentive of moisture. The stones consist of fragments of the parent rocks, which are hard shale or slate, fine-grained sandstone, and chert. A distinctive subsoil is lacking over much of the type, the surface soil resting directly on the bedrock, but where developed it is of red, reddish brown, or brown color, of stony sandy loam, or stony clay loam texture, and from 1 to 2 feet thick. The upper part of the bedrock is weathered, a layer of partly disintegrated rock, 1 or 2 feet thick, overlying the solid beds. Small areas of the gravelly

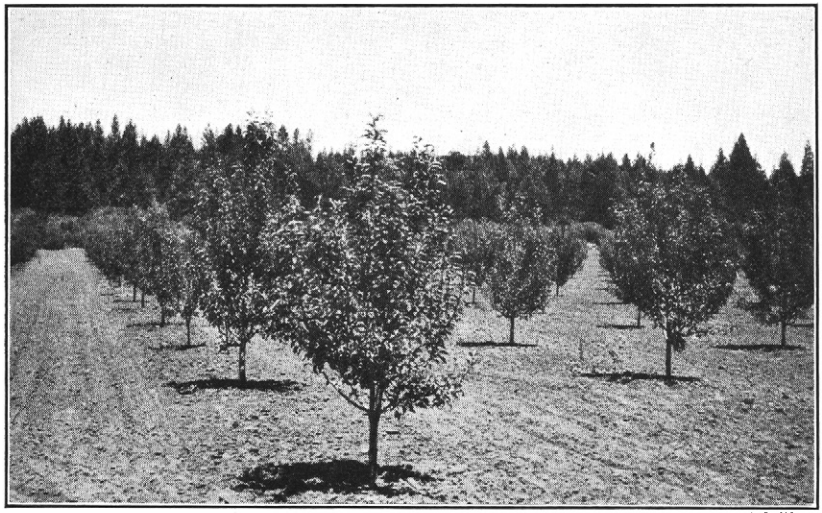


Photo from Univ. of Calif.

FIG. 1.—YOUNG PEAR ORCHARD ON AIKEN CLAY LOAM NEAR GRASS VALLEY.

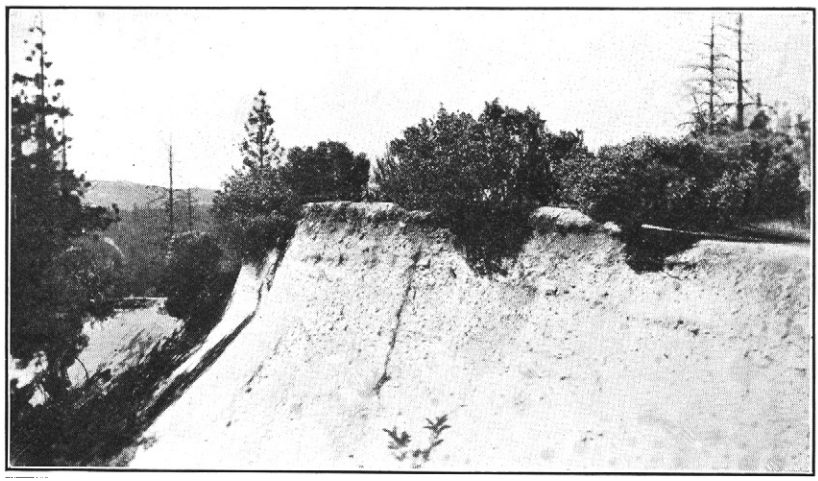


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FIG. 2.—SECTION IN MATERIAL OF THE CORNING GRAVELLY CLAY LOAM NEAR YOU BET.

This shows the destruction caused by hydraulic mining.

member of this series are included with the stony loam. Two such areas lie about 2 miles southwest of Grass Valley and several small bodies south and southeast of Nevada City. Minor variations of yellowish or of brownish color are also included locally.

The largest area of the Sites stony loam is situated in the eastern part of the survey on both sides of the Greenhorn River. A small area lies just south of Newtown and others southwest of Grass Valley, between Grass Valley and Nevada City, and on Banner Hill. The topography is rolling to hilly and steep. Erosion is active and drainage good to excessive. The larger vegetation consists of a forest of yellow pine, cedar, oak, fir, with an undergrowth of ceanothus, manzanita, cascara, poison oak, and other brushy plants.

This is one of the poorer soils in the area, its low productiveness being due mainly to its shallowness. A few of the areas of deeper soil have been cultivated in the past but are now abandoned. Grain is the only crop grown on the soil at present, and this in small fields. Yields are low to moderate. Under present conditions the greater part of this soil should be kept in forest or pasture, and only the deeper parts farmed. Where irrigation water is available, leguminous crops may be grown and if used to increase the supply of organic matter considerable improvement in the soil would result.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Sites stony loam:

Mechanical analyses of Sites stony loam.

[Fine earth.]

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.*
574821	Soil	4.2	8.1	3.5	12.3	12.8	44.0	15.4
574822	Subsoil	7.9	13.7	5.1	16.0	12.3	34.4	10.5

SITES CLAY LOAM.

The surface soil of the Sites clay loam is a red, brownish-red, or dull-red clay loam of comparatively friable structure and from 12 to 24 inches deep. The soil contains little organic matter, but retains moisture fairly well. Angular rock fragments are present, but nowhere in quantities large enough to affect cultivation. The subsoil, to a depth of 6 feet or more, is a red or brownish-red clay loam or clay, fairly compact, low in lime, and containing some gravel and larger rock fragments. Bedrock is encountered at various depths, but normally below 6 feet. The upper foot or two of this rock is weathered and partly disintegrated.

This type is of little importance. Most of it occurs in the neighborhood of Newtown, one area lying west and another south of this place. Two very small areas are situated southwest of You Bet.

The type occupies gently rolling to hilly areas, and though the slopes are in places steep, the topographic forms are in general smooth and rounded. Erosion is active and must be guarded against in cultivated areas. Surface drainage is good to excessive, but subdrainage is comparatively slow and imperfect. The native vegetation consists mostly of second-growth yellow pine, with lesser amounts of oak, cedar, and fir, and an undergrowth of ceanothus, manzanita, and cascara.

Only a small proportion of this soil is cultivated. The crops consist mainly of small grains. One young pear orchard was noted. This is a soil of only moderate productiveness, but with good culture fair crops are raised. The original supply of organic matter soon becomes depleted under continual cropping and the yields then decline. To keep the soil in a productive condition it is necessary that erosion be prevented and the supply of organic matter be increased. Irrigation is advisable where water can be obtained, especially where fruits and vegetables are to be grown.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Sites clay loam:

Mechanical analyses of Sites clay 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.*
574819	Soil	2.0	5.2	2.6	7.3	6.8	53.1	22.8
574820	Subsoil	1.0	3.8	2.5	8.4	8.8	46.5	29.4

CORNING GRAVELLY CLAY LOAM.

The surface soil of the Corning gravelly clay loam, to a depth of 12 to 30 inches, is typically a dull-red or brownish-red clay loam, relatively high in coarse sand and containing much gravel. The soil is low in organic matter and lime. It retains moisture fairly well. In this survey the type has no distinct subsoil, the surface soil grading into the substratum, a deep gravel bed, compacted and partly weathered, especially in its upper part. (Pl. III, fig. 2.) All classes of rocks are represented in this bed, but those of igneous origin predominate.

Small areas of the Corning gravelly clay loam lie in the mining sections of the area. Some lie north of Nevada City on both slopes of Sugar Loaf Mountain and on the south slope of Harmony Ridge. There is one small body about 3 miles southeast of Nevada City and several near Tyler, North San Juan, Sweetland, Birchville, French Corral, You Bet, and Scotts Flat. Two areas entirely disassociated from the others occur in the southwest corner of the survey. In topography this type is level to gently sloping, the surface being in general smooth or marked by numerous small mounds. The soil erodes easily. The drainage is good to excessive. The two small

bodies in the southwestern part of the area are treeless, the vegetation consisting of grass. The others support a forest of second-growth yellow pine, with an undergrowth of manzanita and ceanothus. On some areas the covering of brush is very dense.

On account of its small extent, this is a type of little importance, but as most of the old hydraulic mines were located on it, many miners cleared small areas for gardens and orchards. Remains of the old orchards exist at the present day, and although they have been entirely neglected, many of the trees are still bearing, notably the cherry trees. A few cherry trees in North San Juan which have been well cared for have attained great size and bear heavy crops. The success of these cherry trees is evidence of the possibilities of fruit culture on this soil; but little extension of the orchard area is taking place, owing to the poor roads, the distance to market, and the very small extent of the soil.

HONCUT SILTY CLAY LOAM.

All the recent alluvial soils in the area have been grouped under the name of Honcut silty clay loam, although there are several well-defined types represented here. This has been done for two reasons: First, the very small extent of each of the individual types and even of all of them combined, the total area being less than 2 square miles; and second, the fact that all these alluvial soils have been modified or produced by mining operations within the last 70 years, and therefore differ from soils as they occur under natural conditions. The original alluvial deposits in many of the small valleys have been dug over, some of the material several times, in the search for gold, and this has intimately mixed all horizons of the normal soil. The washings from local hydraulic and placer mining operations have been caught and deposited in these small valleys and have either produced an alluvial soil where none existed before or have left a superficial layer over the materials deposited under natural conditions. Finally, the later washings from the stamp mills, the finely crushed rock flour, have spread out over several of the small valleys, where it now exists in various stages of weathering.

The typical surface soil of the Honcut silty clay loam, to a depth of 12 to 36 inches, is a brown silty clay loam of friable structure with a fair content of organic matter and varying proportions of gravel and stone. Normally the soil is low in lime. The color of the included material in this area is extremely variable, ranging from gray or grayish brown to brown and reddish brown, and in a few cases to red. The texture also varies from a fine sandy loam to a silty clay loam, the latter texture occurring only in a few places. Most of the soil is acid.

The subsoil is quite variable, both in texture and color, and in its burden of gravel and stone. Much of it shows by its mottled color

poor internal drainage and lack of aeration. In several small areas the soil contains enough stone and gravel to constitute a gravelly or stony type, and such areas have been shown on the map by symbols. The material in Penn Valley is lighter in texture than typical, most of it being a fine sandy loam. In the northern part of the area where the recent alluvial material is derived largely from grano-diorite, much of the soil material has mica in it, and in places the proportion of this mineral is relatively large.

South of Grass Valley, where the washings from the stamp mills connected with the larger mines are discharged, there are accumulations of what might best be called "made land." This when freshly laid down consists of gray or light-gray material of sand, fine sand, or silty texture. In a year or two this begins to show signs of weathering. Iron stains occur, the color becomes darker, grasses and other plants begin to grow, and it is reported that within 5 or 6 years crops may be grown, especially if the washings are mixed with the underlying soil in plowing.

The Honcut silty clay loam is found in small scattered bodies occupying depressions in all parts of the area, as recent alluvial deposits along streams, or as small alluvial fans or areas of the washings from the mines. The surface is level or gently sloping and for the most part smooth.

Drainage is good in most places, though poorly drained spots exist. The low position makes the land easy to irrigate.

This soil, though of small extent, has considerable agricultural importance in the area. Most of it is under cultivation—vegetables, potatoes, grain, and feed for cattle all being grown. The yields are ordinarily very good. The soil is improved by applications of lime. The addition of organic matter and deeper and more careful cultivation should also give good results.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Honcut silty clay loam:

Mechanical analyses of Honcut silty clay 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.*
574815	Soil	1.6	3.2	1.4	6.0	10.0	53.1	25.0
574816	Subsoil	1.0	4.1	3.0	12.1	10.9	38.7	30.3

RIVERWASH.

Riverwash consists of porous sands and gravels occurring in low-lying, flood-swept areas, along the channels of the Yuba, Bear, and Greenhorn Rivers and Shady and Deer Creeks. For the most part Riverwash is devoid of vegetation, but in places there is a growth of willow and annual weeds. The land is nonagricultural, on account

of its low-lying position and consequent subjection to overflow and its coarse texture and leachy nature.

PLACER DIGGINGS.

Placer diggings, consisting of scarred, eroded lands left as a result of placer and hydraulic mining, have been shown on the soil map. The areas are entirely nonagricultural and require no further discussion here.

ROUGH BROKEN AND STONY LAND.

Rough broken and stony land includes areas which are naturally too rough and stony or steep and broken for cultivation.

The type occurs as stony hills or small mountains in the southern part of the area, where Wolf Creek Mountain, Bushy Mountain, Bald Rock Mountain, and lesser hills rise above the general level of the country and are too steep and rocky for cultivation. Large bodies lie along the canyons of both the Yuba River and its South Fork. Small areas also occur along Bear River, and some of the smaller streams. A few small areas near the center of the survey consist of nearly level land covered with andesitic bowlders. Some of the serpentine hills between Grass Valley and Nevada City also come within this class of material.

Rough broken and stony land is valuable in an agricultural way only for the scanty pasturage it affords.

IRRIGATION.

Soon after the settlement of Nevada County the miners began to construct ditches and develop a water supply for mining operations. By 1857 there were 47 ditches of a total length of 696 miles, the construction of which had cost $1,500,000. The tendency since that time has been to combine the individual organizations controlling the water supply and at the same time to lengthen and enlarge the ditches. By 1880 the number of companies had been reduced to nine and the length of ditches increased to 1,000 miles, with a construction cost of $7,000,000. This was the condition at the maximum expansion of hydraulic mining, which was brought to an end by legislative action in 1886. The water rights and ditches are controlled at the present time by the mining and power companies. The water in all the streams in the area and in the mountains above the area are thus controlled. The water is used at present in power development, for municipal purposes in the cities and towns, in irrigation in the area, in irrigation of lower lying lands outside the boundaries of the survey, and in a small way in mining.

According to the best available information there is less than 4,000 acres of land irrigated in this area. Possibly there is less than 3,000 acres. Some of the ditches once used for irrigation have been abandoned.

The Aiken soils around Chicago Park are quite rolling but not steep. The orchards here are unirrigated, dependence being put on the rainfall, with cultivation to conserve the moisture in the soil. Though in general the cultivation has not been very careful or thorough, most of the orchards have been profitable. Unquestionably greater returns could be obtained by irrigation, but water would have to be brought a long distance at high cost and all available water rights are already appropriated.

It is stated that it would be practicable to build a reservoir on Dry Creek at an elevation sufficient to deliver water to a large body of land around Spenceville. This reservoir could be filled with the run-off which now goes to waste. The soils here are for the most part shallow and are now used mainly for pasture, but it is highly probable that should water be made available, there could be an extension of fruit growing and grain growing in this locality on the areas of deeper soil. Until such irrigation is developed, however, this section will remain much as it is at present.

In addition to gravity water from streams, which source now supplies most of the irrigation water used in this area, the waste water from the stamp mills connected with the large gold mines at Grass Valley is used in irrigating small tracts.

The need of increased water supply for irrigation is felt in many parts of the area. Development of the fruit-growing industry can not be greatly extended without irrigation, but it is stated that in the upper parts of the area, where the soil conditions are favorable, water can not be obtained except by developing new sources of supply in the higher Sierras at great expense, and the water companies do not feel justified in the large expenditure required, as long as there is no demand in sight. Therefore development along this line is at a standstill.

In 1917 an investigation was made by J. B. Brown, of the Office of Public Roads and Rural Engineering, in cooperative irrigation work in California, to determine the duty of water supplied by the Excelsior Water and Mining Co. The following notes are taken from the unpublished report of this investigation. Under conditions as they exist in Penn Valley, Pleasant Valley, and at and near Smartville, 1 miner's inch, continuous flow, will irrigate 3.27 acres of pasture, or 4.10 acres of orchard, or 2.72 acres of alfalfa or forage crops. Expressed in another way, this means that the pasture lands show an average net duty of 2.5 acre-feet per annum. The orchards can be well taken care of with less than 2 acre-feet of water, and the alfalfa and forage crops can be taken care of with 3 acre-feet per annum.

As illustrating the value of irrigation, it may be said that on the shallow Aiken soils in the neighborhood of Smartville it is ordinarily estimated that, without irrigation, it takes 20 acres to carry a cow

through the season. One irrigated pasture of 8.27 acres supported 9 cows, 3 horses, and 6 hogs from April 15 to October 15, or at the rate of about two-thirds acre to one cow. The water cost $5.39 per acre and the return in butter fat averaged $47.26 per acre for the season. Alfalfa on Holland fine sandy loam in Penn Valley gave a return of $60 per acre. A mixed orchard consisting mostly of peaches, but containing also apples and cherries, located in Pleasant Valley, on the shallow light-textured phase of the Sierra clay loam, the soil material being 2 to 4 feet deep, gave a gross return of $125 an acre. The cost of water per acre was $3.20. This orchard was well cared for and the water carefully used. Water in all these cases cost 10 cents per miner's inch-day.

As illustrating the necessity of choosing with care the soil that is to be irrigated, the case of one field of clover and oats can be cited. The soil was Sites clay loam from 6 inches to 2 feet deep. The crop was practically a failure. It gave an average value of $7.09 per acre. The water cost $3.58 per acre. Water was available for irrigation once every 10 days, but two of the irrigation periods were missed, and this had some effect on the result. It is felt, however, that the failure was due primarily to the general poverty of the soil. It was very shallow, averaging only a foot in depth. It had very little power to retain moisture and dried out between irrigations, and the crop suffered accordingly.

At the higher elevations the rainfall is greater and the soil is deeper and there is less necessity for irrigation, but even here it has been demonstrated that irrigation is very profitable.

SUMMARY.

The Grass Valley Area covers 439 square miles, lying mostly in Nevada County, which is situated in the foothill belt of the western slope of the Sierra Nevada Mountains. The topography is rolling, hilly, and steep, more gentle in the western part and increasing in ruggedness toward the eastern boundary. The elevation ranges from 200 to 4,000 feet. The drainage is carried by the Yuba and Bear Rivers, and their tributaries.

The area was settled during the gold rush of 1849, and mining has always been the main industry, with agriculture of secondary importance. The population is mainly Anglo-Saxon in origin. The census of 1910 reported 14,955 people in the county.

A short narrow-gauge railroad gives rail connection with outside markets. The wagon roads are rough and many of them have heavy grades.

The climate varies from semiarid in the lower parts adjacent to the Sacramento Valley to a climate considerably cooler and humid in the higher eastern parts.

Disappointed miners started farming at an early date, but tillage has been confined to scattered small bodies of soils and only a small proportion of the area is cultivated. The lower slopes with a thin forest covering and shallow soils are used for pasture. The value of the the pasture, which is dependent upon native grasses, decreases as the elevation increases and timber cover becomes more dense. The more elevated parts of the area have been hindered in agricultural development by the heavy timber growth and the interest in mining. The development taking place now is in fruit culture, especially in the production of pears.

The soils of the Grass Valley Area are nearly all residual. Of the residual soils the Aiken clay loam, a red soil derived from basic igneous rocks, is extensive, and probably the most valuable type in the area. The Aiken stony clay loam also extensive, is of low to medium agricultural value.

The Olympic stony clay loam, a brown soil, has only a small extent and from a farming standpoint, is unimportant.

The Sierra clay loam, a red soil derived from granitic rocks, is of moderate extent and of low to average agricultural value.

The Holland fine sandy loam, a brown soil derived from granitic rocks, is developed over small areas. It is of moderate productiveness.

The Sites clay loam is a red soil derived from sedimentary rock. It is a soil of very little importance in this area. The Sites stony loam also has a very low agricultural value.

The Corning gravelly clay loam is the only soil derived from unconsolidated old valley-filling material. It is red in color and most of the material has been disturbed by hydraulic mining.

The recent alluvial soils are variable, but have been correlated with the Honcut series. They are small in area, but relatively important, being nearly all under cultivation.

Riverwash, Placer diggings, and Rough broken and stony land are three classes of miscellaneous material of nonagricultural character.

The irrigation ditches now in use were originally built to bring water to the hydraulic mines. Between 3,000 and 4,000 acres are irrigated. Irrigation is necessary for best results in fruit growing, and there is urgent need for development of increased water supplies.

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[PUBLIC RESOLUTION—No. 9.]

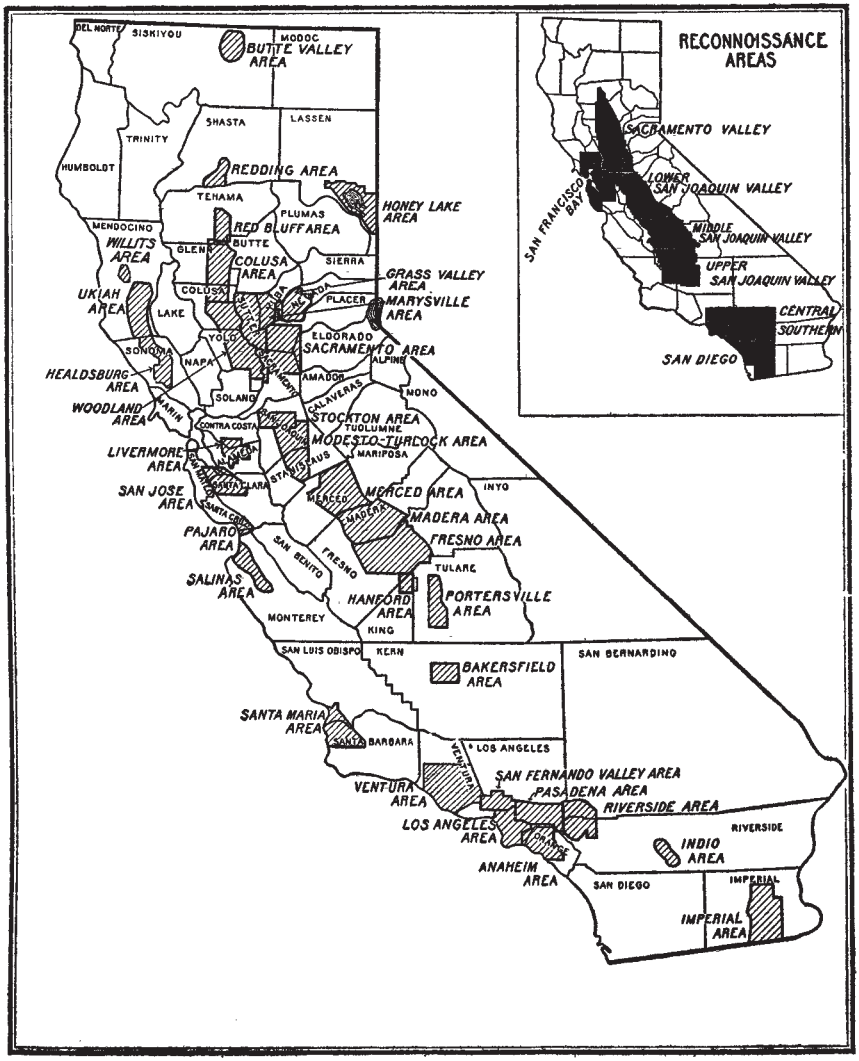
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

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

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

Approved, March 14, 1904.

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



Areas surveyed in California.

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