Douglas B. Sterrett

Water-Supply and Irrigation Paper No. 86 Series J, Water Storage, 8

DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

STORAGE RESERVOIRS

ON

STONY CREEK, CALIFORNIA

BY

BURT COLE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1903

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY.

The publications of the United States Geological Survey consist of (1) Annual Reports; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of the United States, folios and separate sheets thereof; (8) Geologic Atlas of United States, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

The Bulletins, Professional Papers, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports. Complete lists of Seris I to P follow. (WS=Water-Supply Paper, B=Bulletin, PP=Professional Paper.)

SERIES I—IRRIGATION.

WS 2. Irrigation near Phoenix, Ariz., by A. P. Davis. 1897. 98 pp., 31 pls. and maps.
WS 5. Irrigation practice on the Great Plains, by E. B. Cowgill. 1897. 39 pp., 11 pls.
WS 9. Irrigation near Greeley, Colo., by David Boyd. 1897. 90 pp., 21 pls.
WS 10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker. 1898. 51 pp., 11 pls.
WS 13. Irrigation systems in Texas, by W. F. Hutson. 1898. 68 pp., 10 pls.
WS 17. Irrigation near Bakersfield, Cal., by C. E. Grunsky. 1898. 96 pp., 16 pls.
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WS 19. Irrigation near Merced, Cal., by C. E. Grunsky. 1899. 59 pp., 11 pls.
WS 23. Water-right problems of Bighorn Mountains, by Elwood Mead. 1899. 62 pp., 7 pls.
WS 32. Water resources of Porto Rico, by H. M. Wilson. 1899. 48 pp., 17 pls. and maps.
WS 43. Conveyance of water in irrigation canals, flumes, and pipes, by Samuel Fortier. 1901 86 pp., 15 pls.
WS 70. Geology and water resources of the Patrick and Goshen Hole quadrangles, Wyoming, by G. I. Adams. 1902. 50 pp., 11 pls.
WS 71. Irrigation systems of Texas, by T. U. Taylor. 1902. 137 pp., 9 pls.
WS 74. Water resources of the State of Colorado, by A. L. Fellows. 1903. 151 pp., 14 pls.

The following papers also relate especially to irrigation: Irrigation in India, by H. M. Wilson, in Twelfth Annual, Part II; two papers on irrigation engineering, by H. M. Wilson, in Thirteenth Annual, Part III.

SERIES J—WATER STORAGE.

[See last page of this cover.]

SERIES K—PUMPING WATER.

WS 1. Pumping water for irrigation, by Herbert M. Wilson. 1896. 57 pp., 9 pls.
WS 8. Windmills for irrigation, by E. C. Murphy. 1897. 49 pp., 8 pls.
WS 14. New tests of certain pumps and water lifts used in irrigation, by O. P. Hood. 1898. 91 pp., 1 pl.
WS 20. Experiments with windmills, by T. O. Perry. 1899. 97 pp., 12 pls.
WS 29. Wells and windmills in Nebraska, by E. H. Barbour. 1899. 85 pp., 27 pls.
WS 41. The windmill; its efficiency and economic use, Part I, by E. C. Murphy. 1901. 72 pp., 14 pls.
WS 42. The windmill, Part II (continuation of No. 41). 1901. 73-147 pp., 15-16 pls.

SERIES L—QUALITY OF WATER.

WS 3. Sewage irrigation, by G. W. Rafter. 1897. 100 pp., 4 pls.
WS 22. Sewage irrigation, Part II, by G. W. Rafter. 1899. 100 pp., 7 pls.
WS 72. Sewage pollution in metropolitan area near New York City, by M. O. Leighton. 1902. 75 pp., 8 pls.
WS 76. Observations on the flow of rivers in the vicinity of New York City, by H. A. Pressey. 1903. 108 pp., 13 pls.
WS 79. Normal and polluted waters in northeastern United States, by M. O. Leighton. 1903. 192 pp.

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DEPARTMENT OF THE INTERIOR
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STORAGE RESERVOIRS

ON

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CONTENTS.

ILLUSTRATIONS.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, D. C., February 21, 1903.

SIR: I have the honor to transmit herewith manuscript of a paper by Mr. Burt Cole, entitled "Storage Reservoirs of Stony Creek, California," and request that it be published in the series of Water-Supply and Irrigation Papers. The paper treats of the possibilities of reclaiming by irrigation large areas of land in the valley of Stony Creek, a tributary of the Sacramento River, and on the west side of the Sacramento Valley, which have been cultivated by dry farming, but on which irrigation may apparently be introduced with much advantage.

Very respectfully,

F. H. NEWELL,
Chief Engineer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

STORAGE RESERVOIRS ON STONY CREEK, CALIFORNIA.

By BURT COLE.

INTRODUCTION.

By J. B. LIPPINCOTT.

SCOPE AND ORGANIZATION OF WORK.

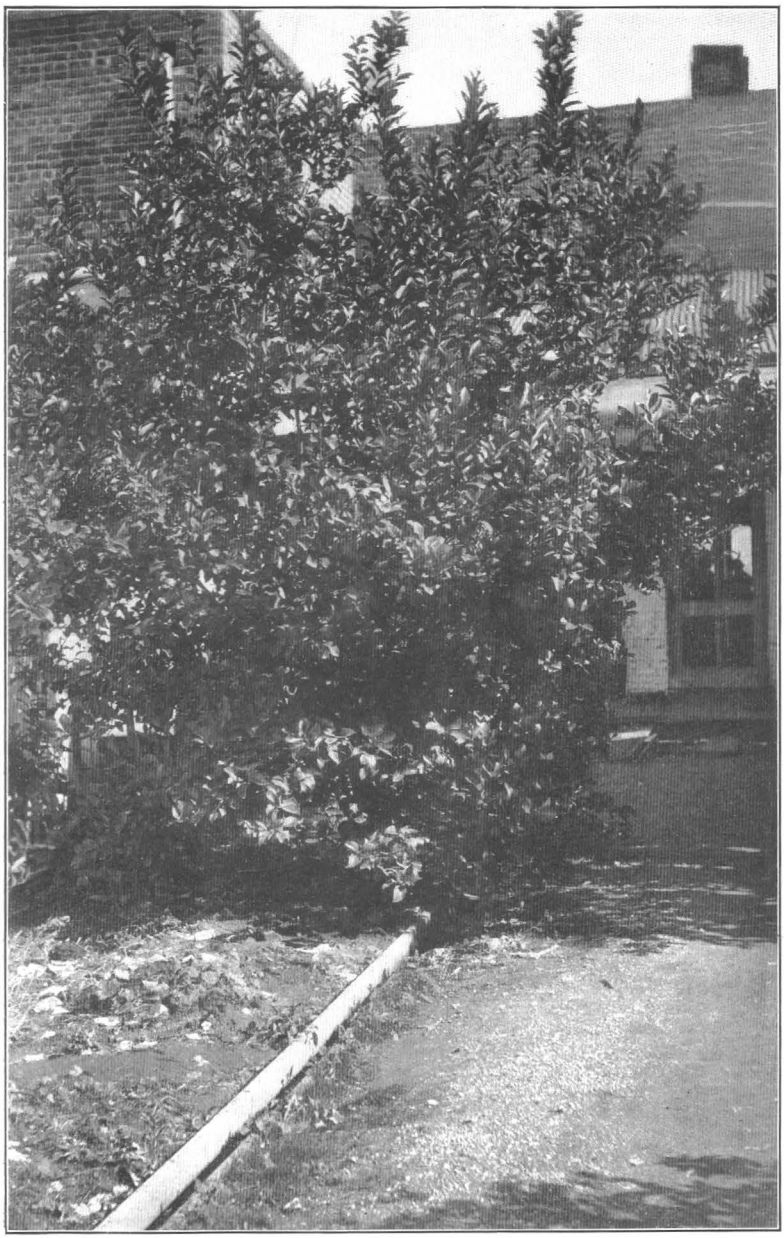
Recognizing the fact that the general and permanent prosperity of California is largely dependent upon successful agricultural development, and furthermore that in the great central valleys of the State farming without irrigation has caused, during the last decade, a decrease in land values, as well as in population, it was deemed desirable to investigate the possibilities of irrigation development in certain typical interior districts of the State. In the above connection the California Water and Forest Association requested the United States Geological Survey to make a study of Glenn County to ascertain if suitable reservoir sites could be found on Stony Creek, so that the waters of that stream could be put upon the higher and warmer marginal lands on the western side of the Sacramento Valley. Willows is the county seat of Glenn County, and the chamber of commerce of this town, through the Water and Forest Association, contributed $250 additional toward defraying the expenses of this study. The field work has been entirely under the direction of the Hydrographic Branch of the Geological Survey, and the greater part of the expense has been borne by that Survey.

The greater portion of this investigation has been devoted to the drainage basin of Stony Creek. However, by far the greatest natural water supply for Glenn and neighboring counties is the Sacramento River, which is the largest navigable river of the State, and forms the eastern boundary of Glenn County. The difficulty of using this river lies in the expense and magnitude of works necessary for its diversion, especially if its waters are to be put upon the higher valley lands. The interference with navigation by the diversion of water from the river during its low stage is a serious question. It is considered pertinent, however, to briefly refer to the Sacramento River and its possible utilization.

WATER SUPPLY OF SACRAMENTO VALLEY.

The seasonal rotation in the Sacramento Valley much resembles that in the southern valleys of the State situated between the Sierra Nevada and the Coast Range. There is more rain in the Sacramento Valley, but it falls in the same months. There is a distinct dry summer extending from April until October. In midsummer the temperature is at times as high as 114°, and the relative humidity is low, ranging from 10 to 20 per cent. In the other half of the year the rainfall ranges from 25.56 inches at Red Bluff, at the head of the Sacramento Valley, to 18.19 inches at Woodland, in Yolo County. The minimum temperature recorded by the United States Weather Bureau at Red Bluff since 1878 is 18°. These temperatures permit the growth of all of the products of the State. A compilation of physical statistics for Red Bluff by Mr. Maurice Connell, observer for the United States Weather Bureau, is given in this report. They show in detail the conditions here referred to.

Surrounding Sacramento Valley on the north, east, and west are high ranges of mountains culminating in Mount Shasta, at the northern apex of the valley, with an elevation of 14,380 feet. Upon the crest of these ranges, the Sierra Nevada on the east and the Coast Range on the west, the precipitation is much greater and occurs usually in the form of snow, which remains at the higher altitudes until melted by the summer sun. As the mountains are higher to the north and east of the valley than to the west, the precipitation is greater there, the temperature is lower, and the snow remains unmelted until later in the summer. The stream conditions resulting from these physical conditions may readily be inferred. From the higher sierras the creeks begin to rise with the fall rains, and the precipitation in the foothills causes them to maintain their flow throughout the winter. Under normal conditions, however, they reach stages of maximum discharge in the spring and early summer, when the snows at the higher levels are melting. They reach their lowest stages in September. On the western side of the valley the streams issuing from the Coast Range, to which class Stony Creek belongs, flow from lower and warmer levels. Consequently the precipitation is more often in the form of rain and the snow is more quickly melted. The resulting stream flow, therefore, is more irregular and the maximum periods of flow are in winter and early spring. These Coast Range streams are reduced to very low discharge throughout the summer months, and their proper utilization is largely dependent upon the construction of reservoirs for the conservation of the winter water. There is therefore a cool, wet winter in the valley, followed by a hot, dry summer. The Sacramento and its eastern tributaries are strong streams during the winter, spring, and early summer, and have relatively low discharges in September and October, while the western tributaries are normally high in winter and early spring and almost dry in the summer. These conditions not only demand the irrigation



ORANGE TREE, WILLOWS, CAL.

of the valley, but furnish the opportunity therefor. Tables of discharge of the Sacramento River and of Stony Creek are made a part of this report and illustrate the above statement.

The higher marginal valley lands are better drained and warmer than the low lands. They are not so well adapted to the growth of grain, as the soil is not so strong, but it is believed that with irrigation they would be among the finest fruit lands of the State, capable of producing the olive, vine, and orange.

The valley of the Po, in northern Italy, is the greatest artificially watered district of Europe. In this region irrigation has been practiced continuously for over one thousand years. The values of water and of irrigated lands have continually increased, and to-day it stands as an example of most intensive cultivation, supporting 391 persons per square mile in the irrigated district.

The following interesting comparison may be made between the climatic conditions of Milan, in the heart of this district, and those in the upper Sacramento Valley. R. Baird Smith, lieutenant of engineers, British service, in a work entitled "Italian Irrigation," is the authority for the statements on Italian irrigation. The record of rainfall and temperature for Milan was obtained from the United States Weather Bureau. It probably extends back into the eighteenth century. For monthly maximum and minimum records at the head of the Sacramento Valley, see the Red Bluff record given later in this report.

Comparison of climatic conditions in Sacramento Valley and in northern Italy.

Month.	Rainfall.		Temperature.			
	Woodlands, Cal.	Milan, Lombardy.	Woodlands, Cal., Mean.	Milan, Lombardy.		
				Max.	Min.	Mean.
	Inches.	*Inches.*	°*F.*	°*F.*	°*F.*	°*F.*
January	3.67	2.28	42.6	55	7	33
February	2.56	2.34	45.5	71	19	38
March	2.72	2.60	48.9	74	21	46
April	1.75	3.59	55.5	82	27	54
May	.85	4.06	62.1	91	39	62
June	.12	3.30	70.1	97	48	70
July	.00	2.92	77.9	99	54	74
August	.02	3.66	76.1	95	53	72
September	.25	3.82	68.6	91	46	65
October	.92	4.93	60.4	78	33	55
November	2.01	4.22	50.4	63	23	43
December	3.42	2.87	43.5	61	10	36
Mean annual	18.25	40.59	58.5	99	7	54

The minimum temperature at Woodlands is not available. The lowest temperature recorded at Red Bluff by the Weather Bureau is 18° above zero.

It will be noted that there is double the rainfall in Lombardy that there is in Glenn County, and a large portion of it occurs in the summer, yet irrigation is accepted as decidedly profitable and water rights are increasing in value. This being true, irrigation certainly should be of marked benefit in the Sacramento Valley.

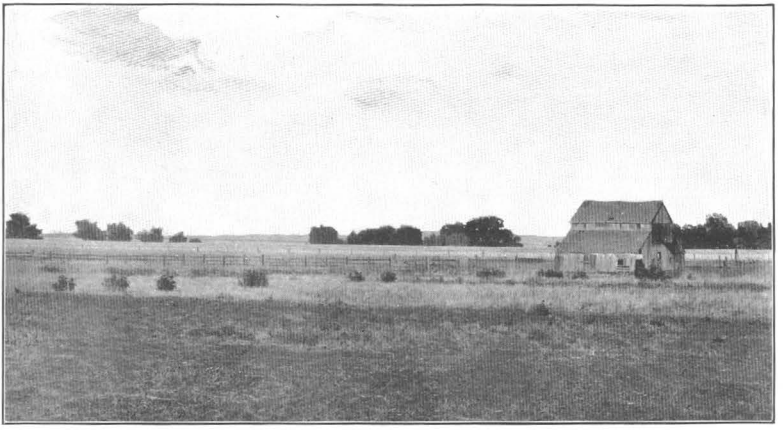
FARMING CONDITIONS.

Glenn County, lying in the upper portion of the Sacramento Valley, and principally upon the western side of the Sacramento River, has so many natural advantages that if its valleys were divided into small farms and irrigated it probably could be made one of the most productive and densely populated agricultural counties in the State of California.

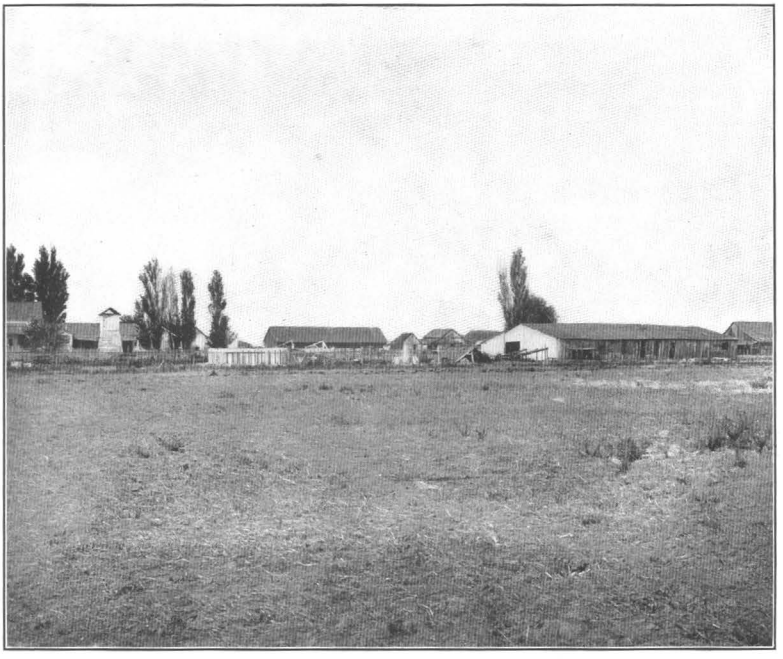
At present the farming land is almost wholly given up to the dry farming of wheat. This practice has been followed for years, until to-day the land, having annually surrendered its nutritive elements, without fertilization, is deteriorating for this crop. This condition, coupled with the low prices obtained for the product during recent years, has resulted in a concentrated landholding, with a resulting decrease of population, large areas of wheat being farmed with greater economy than small ones. This is brought forcibly to the attention of one traveling over the roads in the great valley district. Numerous small bunches of trees mark the points where once stood a house, the home of a small farmer. To-day these families are scattered, and the small ranch is only a small fraction in a great farm of perhaps 10,000 to 20,000 acres, owned by one person and farmed by a drifting population employed only during the planting and harvesting season, and having no interest in the welfare of the county except in obtaining a few weeks' wages, which may or may not be spent in the neighboring towns.

Wheat farming, in spite of the fact that it is carried on by means of modern machinery, with perfect organization, and on a large scale, has not of late been a paying investment in Glenn and adjoining counties.

The climate of this valley is very similar to that of the southern counties of the State. Orange, lemon, and lime trees were seen in various parts of the plains, showing no signs of having been injured by frost. The yield is not large, owing to the fact that the trees have been allowed to grow usually as isolated garden shrubbery, receiving little care except perhaps an occasional watering. With irrigation and scientific care, Glenn County could become the home of numerous small farmers; the population of towns and country would be increased, and a thriving community would exist in the present sparsely settled region.



A. SACRAMENTO VALLEY WHEAT FARM NEAR WILLOWS.



B. TYPICAL RANCH HOUSE ON WHEAT FARM NEAR WILLOWS.

POPULATION.

Intensive farming by irrigation, especially the raising of fruit in California, usually has led to the subdivision of large holdings, both because under these conditions large areas are not successfully handled and because increased land values, resulting from the supply of water, is an inducement for the large landowner to sell.

The census of 1890 gives Colusa County, which at that time included Glenn County, a population of 14,640, while the census of 1900 gives this same territory a population of 12,856 (Colusa 7,346, Glenn 5,510), showing a decrease in the ten years of 12.8 per cent. According to the school census the number of school districts is 38 and the number of school children is 1,280. Of the latter 555 were in the towns, leaving 725 in the country, or only about 1 child to 2 square miles.

In 1891 Mr. William Hammond Hall, in an engineering report on the Central Irrigation District, situated in Glenn County and containing 156,550 acres of valley land, which was then attempting to construct irrigation works, states:

> There are 40 owners of over 1,000 acres each, holding an aggregate of about 89,000 acres, very materially more than half the acreage in this district. There are only about 180 owners of farming lands altogether in it, so that the farm holdings all average very nearly 870 acres in area, and the 140 smaller owners of, say 67,550 acres, have an average of 482 acres apiece. There are but few owners of less than 640 acres in the district, and by reason of the renting and share system still fewer persons who farm as low an acreage. The district has a stable voting population of about 400, of whom about 140 are residents of the towns of Maxwell and Williams. This leaves 260 voters on the farming lands proper, only 1.06 voters, or (taking the usual ratio of voters to population) about 5 persons to the square mile. Each farming landowner of the 180 (supposing all to be residents of the district) gets on with only 0.44 of a resident citizen hired man to help him farm his average holding of 870 acres.

The condition of the Central Irrigation District is practically the condition of the plains district of Glenn and Colusa counties.

Mr. W. H. Markham, deputy assessor of Glenn County, after an examination of the county records in 1900, reports that the average farm-land holding in the plains district, lands which could be irrigated, either from Stony Creek or from the ditches of the Central Irrigation District, is 1,595 acres. There are less than 40 owners of farming lands of 160 acres or less. It is not believed there are any farmers who cultivate less than 320 acres of land, it all being sown to wheat and barley.

For purposes of comparison between areas in California irrigated and those farmed dry, Riverside may be taken as a typical example of development by irrigation. Other similar districts could be referred to. About 13,500 acres are irrigated around Riverside, partly in young trees. It must be remembered that southern California has for seven years been suffering from an intense drought, much more severe than in the central portion of the State. Streams have failed,

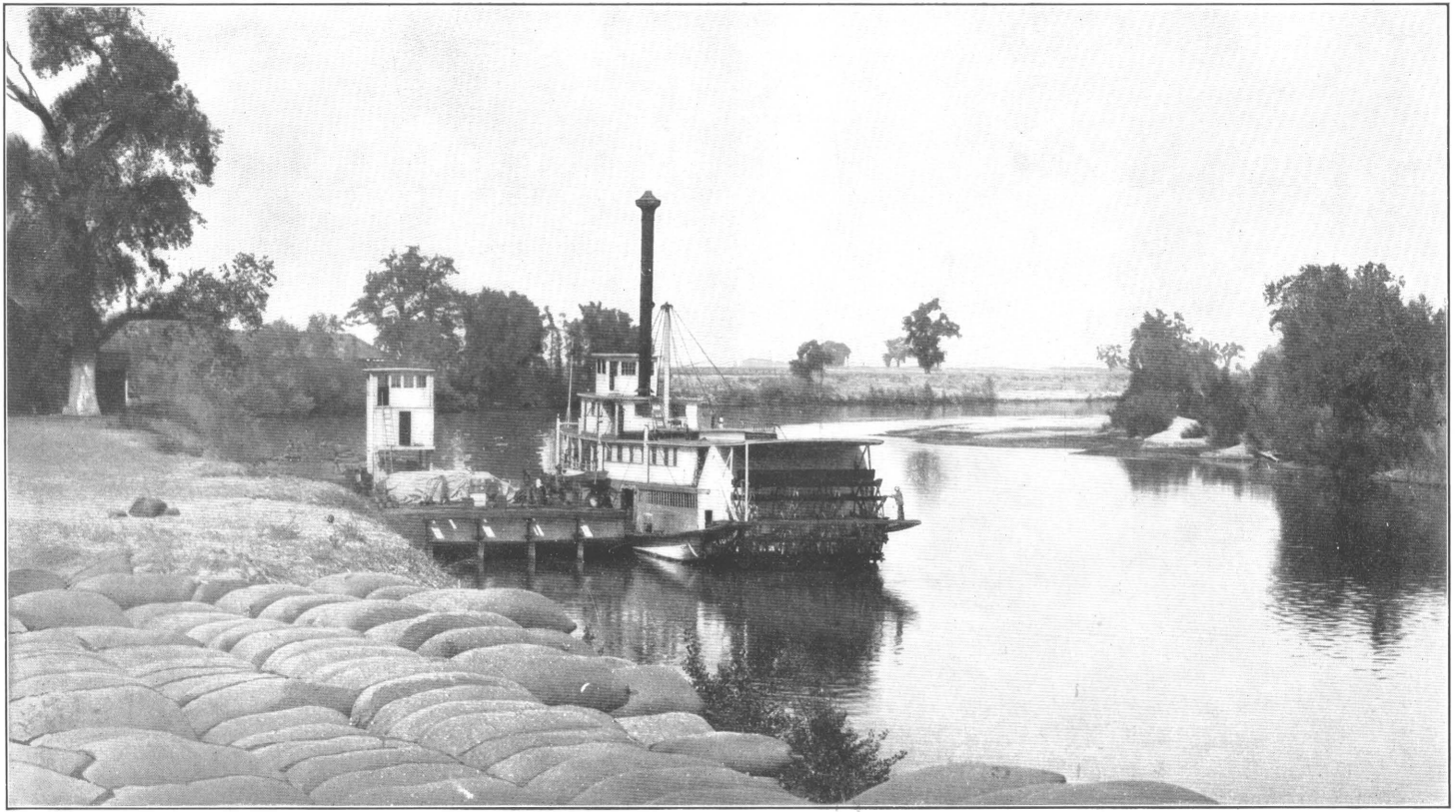
but 500 wells have been sunk to supply these lands, from which the water supply has been maintained in volume as large as during periods of abundant precipitation. These wells probably represent an investment of over half a million dollars, and are producing 75 cubic feet of water per second, or enough to irrigate 20,000 acres of land. Starting with a sheep pasture, assessed under protest at 75 cents per acre in 1870, this district now supports in comfort, if not luxury, about 10,000 inhabitants, or a citizen to every 1.3 acres irrigated (about 100 times as dense a population as the valley portion of Glenn County), and shipped over 4,000 carloads of citrus fruits during the season of 1900. The value of this crop was $150 per acre on the better irrigated area, and the output is rapidly increasing. The city of Riverside has 3 banks, 13 churches, and 8 schoolhouses. The post-office receipts in 1900 were $16,555. The amount of its bank deposits and assessed valuation make it perhaps the first city of its class in the United States.

From an agricultural standpoint the difference between northern and southern California is irrigation.

CENTRAL IRRIGATION DISTRICT.

In the course of the present work the constructed portion of the Central Irrigation canal was visited and inquiries were made as to its status. This canal was designed to take water from the Sacramento River near the northern boundary of Glenn County and irrigate 156,550 acres of fertile land in Glenn and Colusa counties. After expending $574,000 for construction and right of way, the district became involved in legal and financial difficulties growing out of the Wright act, under which it was organized, and work was discontinued. Both the constitutionality of the organic law and the organization under that law were contested by certain dissatisfied holders of large land areas in the proposed district. These parties objected to an organization based upon and controlled by a majority vote of all electors in the district, irrespective of their property holdings therein, the acceptance of water at uniform rates for all lands in the district being compulsory under the law. These objections have been brought forward in all the districts that have been organized under this statute.

No successful attempt has ever been made to collect either principal or interest on these bonds. The interest is increasing and the principal is becoming due. Much money has been spent by both "anti-irrigationists" and "irrigationists" in legal battles, but so far no definite result, except the stoppage of work for lack of funds, has been accomplished. The headworks of the canal were never built and no water has ever been delivered. The bonds are discredited in the financial market, and if the district should now be declared to be legal and the bonds properly issued it will force nearly every farmer in the district into bankruptcy, as it has been twelve years since the



SACRAMENTO RIVER OPPOSITE WILLOWS.

bonds were issued. The bondholders are getting no interest on their investment and the landholders are going on year after year summer fallowing their land for wheat, and barely making interest on a low valuation of the land and property, while right at hand flows the Sacramento River, capable of turning this valley into as productive and densely populated a county as the irrigated portions of southern California counties.

The Sacramento River has an unfailing supply of water sufficient for all the needs of this section and of the lower valley lands, as is shown by the following table of flow, taken from the various reports of the United States Geological Survey.

Estimated monthly discharge of Sacramento River at Red Bluff.

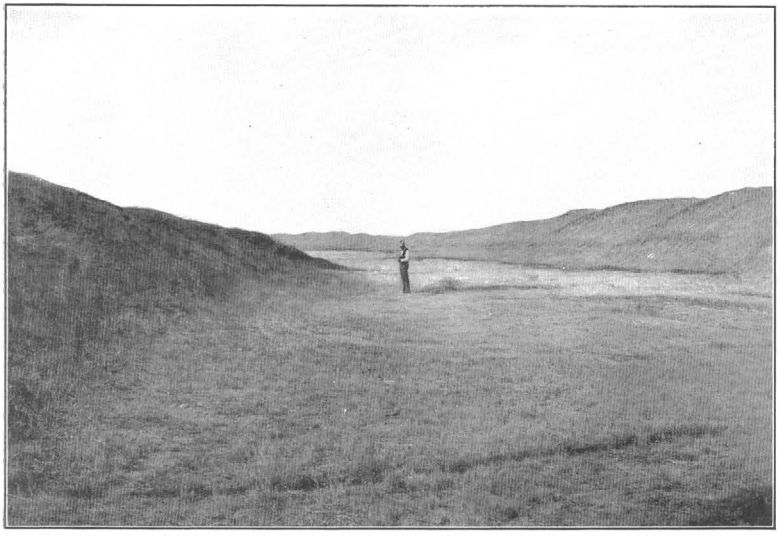
[Drainage area, 9,356 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1895.						
January	123,000	15,220	47,267	2,906,320	5.05	5.82
February	65,600	13,860	26,792	1,487,940	2.86	2.98
March	85,360	15,220	32,517	1,999,418	3.48	4.01
April	33,880	26,670	29,566	1,759,300	3.16	3.53
May	48,600	16,840	30,238	1,859,250	3.23	3.73
June	18,600	9,040	12,764	759,510	1.36	1.52
July	9,040	6,150	7,235	444,863	.77	.89
August	6,150	5,990	6,057	372,436	.65	.75
September	10,820	5,830	6,321	376,106	.68	.75
October	6,285	5,910	5,989	368,261	.64	.74
November	6,690	5,910	6,046	359,792	.65	.71
December	36,880	6,150	10,095	620,760	1.08	1.24
The year	123,000	5,830	18,390	13,313,956	1.97	26.67

Estimated monthly discharge of Sacramento River at Jellys Ferry, Tehama County.

[Drainage area, 9,134 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1896.						
January	130,050	6,360	46,152	2,837,813	5.05	5.86
February	34,460	10,070	15,468	889,764	1.69	1.82
March	62,870	11,310	24,099	1,481,801	2.64	3.05
April	59,500	16,920	25,793	1,534,819	2.82	3.14
May	75,120	19,300	30,941	1,902,543	3.39	3.91
June	20,515	9,200	14,217	846,018	1.56	1.74
July	8,960	6,720	7,591	466,789	.83	.95
August	6,720	6,180	6,394	393,201	.70	.81
September	6,360	6,000	6,204	369,163	.68	.75
October	8,000	6,000	6,163	378,960	.67	.77
November	43,000	6,360	11,965	712,014	1.31	1.46
December	93,000	8,480	22,318	1,372,304	2.44	2.82
The year	130,050	6,000	18,109	13,185,189	1.98	27.08
1897.						
January	49,765	8,320	14,280	878,050	1.56	1.80
February	89,100	17,420	36,108	2,005,335	3.95	4.11
March	44,340	13,100	21,790	1,339,825	2.39	2.76
April	28,710	18,830	22,807	1,357,108	2.50	2.79
May	18,520	9,200	13,737	844,660	1.50	1.73
June	9,200	6,680	7,620	453,420	.83	.92
July	6,550	5,120	5,699	350,420	.62	.71
August	5,120	4,600	4,776	293,667	.52	.60
September	4,600	4,600	4,600	273,718	.50	.56
October	6,680	4,600	4,955	304,673	.54	.62
November	8,600	5,120	5,590	332,627	.61	.68
December	16,940	5,380	7,792	479,114	.85	.98
The year	89,100	4,600	12,480	8,912,617	1.36	18.26
1898.						
January	6,525	5,835	6,120	376,307	.67	.77
February	33,600	5,835	12,479	693,049	1.37	1.43
March	22,500	6,525	9,745	599,201	1.07	1.23
April	7,260	6,525	6,872	408,911	.75	.83
May	10,800	5,375	6,632	407,789	.73	.84
June	10,500	5,150	6,674	397,130	.73	.81
July	5,150	4,475	4,700	288,994	.52	.60



A. CENTRAL IRRIGATION DISTRICT CANAL OPPOSITE JACINTO.

B. CENTRAL IRRIGATION DISTRICT CANAL NEAR ST. JOHNS.

Estimated monthly discharge of Sacramento River at Jellys Ferry, Tehama County—Continued.

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1898.						
August	4,475	4,250	4,276	262,923	0.47	0.54
September	4,475	4,250	4,280	254,677	.47	.53
October	4,925	4,475	4,631	284,751	.51	.59
November	6,892	4,475	4,785	284,727	.52	.58
December	5,950	4,700	4,991	306,887	.55	.63
The year	33,600	4,250	6,349	4,565,346	.70	9.38
1899.						
January	42,600	5,065	13,498	829,965	1.48	1.71
February	8,644	5,810	6,646	369,100	.73	.76
March	83,400	6,750	20,915	1,286,022	2.29	2.64
April	16,100	7,800	10,837	344,845	1.19	1.33
May	7,530	6,030	6,908	424,759	.76	.87
June	15,200	4,965	6,199	365,865	.68	.75
July	4,760	4,170	4,531	278,592	.50	.58
August	4,170	3,980	3,986	245,061	.44	.51
September	3,980	3,980	3,980	236,826	.44	.49
October	10,550	3,980	5,063	311,314	.55	.63
November	53,480	4,760	14,532	864,712	1.59	1.77
December	45,600	8,915	14,519	892,744	1.59	1.83
The year	83,400	3,980	9,301	6,752,805	1.02	13.87
1900.						
January	119,700	10,400	30,661	1,885,271	3.36	3.88
February	24,800	7,800	11,687	649,063	1.28	1.33
March	123,000	10,700	23,288	1,431,923	2.55	2.94
April	16,700	8,630	12,082	718,929	1.32	1.47
May	19,780	6,265	9,572	588,559	1.05	1.21
June	6,265	4,760	5,477	325,904	.60	.67
July	4,760	3,805	4,212	258,986	.46	.53
August	3,805	3,805	3,805	233,960	.42	.48
September	5,170	3,630	3,981	236,886	.44	.49
October	21,520	3,805	6,381	392,352	.70	.81
November	28,800	4,560	8,205	488,231	.90	1.00
December	80,100	6,030	15,553	956,317	1.70	1.96
The year	123,000	3,630	11,242	8,166,381	1.23	16.77

Estimated monthly discharge of Sacramento River at Jellys Ferry, Tehama County—Continued.

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1901.						
January	74,240	8,915	20,982	1,290,194	2.30	2.66
February	101,880	9,800	34,138	1,895,928	3.74	3.89
March	46,100	12,200	20,628	1,268,366	2.26	2.61
April	16,700	9,200	10,870	646,810	1.19	1.33
May	13,700	7,530	9,804	602,824	1.07	1.23
June	7,265	4,965	5,596	332,985	.61	.68
July	4,760	3,980	4,365	268,393	.48	.55
August	3,980	3,805	3,850	236,727	.42	.48
September	5,380	3,630	3,922	233,375	.43	.48
October	5,380	3,980	4,194	257,879	.46	.53
November	44,100	4,360	7,745	460,859	.85	.94
December	61,800	5,380	12,149	747,013	1.33	1.53
The year	101,880	3,630	11,521	8,241,353	1.26	16.91

Estimated monthly discharge of Sacramento River at Iron Canyon, Tehama County, Cal.

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1902.						
January [a]	6,750	4,760	5,376	330,557	0.59	0.68
February	151,320	5,660	69,153	3,840,563	7.44	7.75
March	61,700	14,150	27,371	1,682,977	2.94	3.39
April	53,800	14,150	21,992	1,308,615	2.37	2.64
May	24,460	10,150	17,803	1,094,663	1.92	2.21
June	13,450	7,060	9,998	594,922	1.08	1.20
July	7,060	5,880	6,192	380,731	.67	.77
August	5,880	5,440	5,674	348,881	.61	.70
September	5,220	5,000	5,007	297,938	.54	.60
October	11,750	5,000	5,931	364,683	.64	.74
November	118,200	5,660	19,834	1,180,204	2.13	2.38
December	39,100	8,110	17,506	1,076,402	1.88	2.17
The year	151,320	4,760	17,653	12,501,136	1.90	25.23

[a] Record of Sacramento at Jellys Ferry for January, 1902.

POSSIBLE REORGANIZATION OF CENTRAL IRRIGATION DISTRICT.

It is believed that the present time is auspicious for the carrying out of a reorganization plan. The question of the legality or illegality of the district's organization and bond issues has not yet been finally determined, and neither party seems willing to push the matter to a final issue.

If it is desirable to complete the works under private management, it is believed that the following plan might be carried out: The district to acquire what rights of way are necessary for the completion of the work. This probably can be done for about $30,000. The district should then deed to the bondholders its interest in the canal and rights of way and then disorganize, the bondholders canceling all indebtedness against the land and furnishing the money to complete the works. The bondholders could then form an irrigation company and sell water at the low annual charge of $2 per acre, and thereby both secure themselves and benefit the landowners. The land is fertile and suited to irrigation, and, owing to its closeness to market, should be high priced and productive of handsome returns.[a]

TOPOGRAPHY.

The purpose of the present work was primarily to determine what could be done toward increasing the area of lands irrigated from the basin of Stony Creek. Stony Creek has a drainage area of about 760 square miles, as obtained from the best available Land-Office maps. While the crest of the watershed does not exceed about 6,700 feet in elevation, its proximity to the coast assures to it a substantial amount of rainfall. In the valleys the precipitation is 20 inches annually, while in the higher portions of the basin it probably reaches 40 inches. The summits are heavily covered with timber, much of it being commercial pine, spruce, and cedar. Several sawmills are located in the heart of this timbered area. Sheep, goats, and cattle are permitted freely to graze over the public lands, and numerous forest fires were observed, apparently coincident with the location of the grazing camps. It is currently stated that it is the common practice for sheep men to set fires upon leaving the ranges in the fall so that the underbrush and grasses can grow up young and tender for the next season. Cattlemen, finding heavily brushed areas over which it is difficult for the cattle to graze, are reported to set fires so as to make the country more open. The resulting damage does not apply alone to the brush-covered territory, as the fires, once started, keep on burning, unrestrained, into the timber belts, until a continued wind from the contrary direction causes the flames to back fire and extinguish

[a] Since the above was written (1901) a strong movement has been initiated to disorganize the district and to have a corporation complete the canal and distribute the water, the bonded debt to be assumed by the corporation.

themselves. If this forest destruction continues, it will cause the run-off to be more spasmodic, floods will closely follow each rain, and the amount of silt carried by the water will become so great that it would lead to the impairment of any reservoirs which might be constructed in this basin. It is strongly urged that the main portion of this drainage basin be set aside as a forest reserve, and that sheep and goat grazing be restricted or prohibited, and strong steps taken to prevent forest fires.

PROPOSED STONY CREEK FOREST RESERVE.

In respect to this matter the Sacramento Valley Development Association, on November 17, 1900, passed the following resolution as a result of the investigations on the stream:

Whereas the experts of the United States Geological Survey now conducting investigations along Stony Creek report the existence of many excellent storage-reservoir sites thereon; and

Whereas the waters of said creek are now used for irrigation, and by their conservation and proper regulation a vast area may be brought to a much higher state of cultivation; and

Whereas the preservation of the forests along the headwaters of said creek is necessary to insure a permanent water supply and also to moderate the flow of flood waters, thereby preventing the rapid filling with silt and detritus of any reservoirs that may hereafter be constructed along said Stony Creek or any of its tributaries: Therefore be it

Resolved, That we, the Sacramento Valley Development Association, earnestly petition the President of the United States to set aside as a forest reserve such of the public lands about the head of said Stony Creek and its tributaries as the experts of the Geological Survey shall recommend as necessary for the protection of the water supply of said creek.

Adopted at a meeting of the Sacramento Valley Development Association held in Oroville, Cal., November 17, 1900.

Practically the same resolutions were also passed by the Water and Forest Association.

In response to the above requests the following area has been temporarily withdrawn from entry, August 14, 1900, pending investigation by the Bureau of Forestry:

Beginning at the northwest corner of T. 23 N., R. 6 W., Mount Diablo meridian; thence south to the northwest corner of T. 20 N., R. 6 W., Mount Diablo meridian; thence west on township line to northwest corner of sec. 2, T. 20 N., R. 7 W.; thence south to southwest corner of sec. 26, township and range aforesaid; thence east to northwest corner of sec. 36, township and range last aforesaid; thence south 1 mile; thence east to northeast corner of T. 19 N., R. 7 W., Mount Diablo meridian; thence south on range line 3 miles to southwest corner of sec. 18, T. 19 N., R. 6 W.; thence east to northeast corner of sec. 19, T. 19 N., R. 6 W. thence south to southeast corner of sec. 31, said township and range aforesaid; thence west to northwest corner of T. 18 N., R. 6 W.; thence south on range line between

Rs. 6 and 7 W., to southwest corner of sec. 6, T. 17 N., R. 6 W.; thence east to northeast corner of sec. 8, township and range last aforesaid; thence south to southeast corner of sec. 32, T. 16 N., R. 6 W.; thence west on township line between Ts. 15 and 16 N., to southwest corner of T. 16 N., R. 10 W.; thence north on range line between Rs. 10 and 11 W., to northwest corner of T. 23 N., R. 10 W.; thence easterly to northwest corner of T. 23 N., R. 6 W., the place of beginning.

Local stock and lumbermen are now (1903) violently opposing the creation of this and other proposed reserves in the basin of the Sacramento River. It is believed that this is largely done because the true purpose of forestry is not understood.

A forest reserve is created for the permanent benefit and ultimate improvement of the district wherein it exists. These benefits may be divided into two classes: First, forestry; second, irrigation. There are some good timbered lands on the headwaters of Stony Creek and the crest of the range immediately to the west. Under the ordinary methods of procedure a lumber company entering into business in a timbered district will cut off the entire forest cover as rapidly as possible, sell the product, clean up its business, and get out of the country, leaving the district in a denuded and wrecked condition. This is so abundantly evident in so many different localities in California that it is scarcely necessary to enter into an extended argument as to its impropriety. The county is a permanent loser, because when these lands are once cut off they are usually abandoned to the State because of delinquent taxes. There is no permanent employment offered for citizens of the community, and the result is a rapid wrecking of the forest.

The effect on the State of reckless deforestation is the destruction of a permanent source of lumber supply. This method of procedure has led to the marked deterioration of many of the older countries. The policy advocated for the Federal Government is that looking toward a continuous use of the forest as a permanent source of lumber supply along lines of development now practiced by England in India, by France, Germany, Sweden, and other European countries. With this method only the matured or ripened tree is cut off. The younger trees are protected and saved. The policy is distinctly one for the continued utilization of the forest and not for its destruction. Again, by far the greatest enemy of forests is fire, and with the creation of a forest reserve there will be provided guards to prevent these fires and fight them when they are once started. The general effect on the nation and State is to furnish a permanent lumber crop for the development of towns and cities.

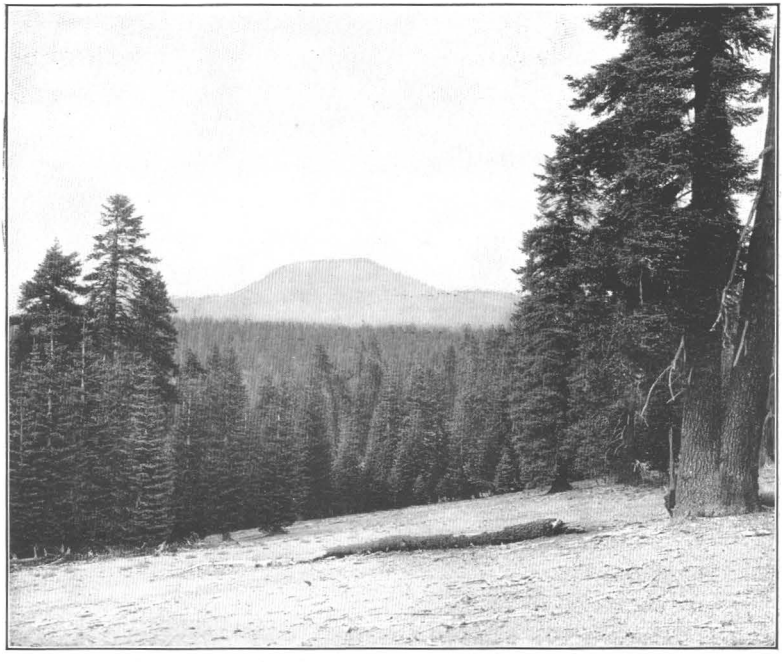
The forest is a great natural regulator of the waters used in irrigation. A stream proceeding out of a denuded area becomes a violent torrent immediately following a storm, washing great gullies in the

sides of the hills, carrying down débris and stones, and depositing them on the valleys and lowlands. The stream in the summer time dries up, and a condition of desolation is an almost inevitable result. If storage reservoirs are built upon such a stream the tendency is to rapidly fill them with débris. An engineer could scarcely recommend the construction of a reservoir on any of the branches of Stony Creek if the drainage basin above it were denuded.

Stony Creek presents great natural opportunities for the regulation of storm waters. Surveys made for sites by the Geological Survey show that the construction of reservoirs is commercially feasible. The climatic conditions along the foothills are such as to permit, with irrigation, the raising of any crop that is grown in the State of California. It is believed that the day is not distant when these reservoirs will be built, when the foothill land will be under cultivation, when the products therefrom will be as valuable as from any portion of the State, and when the population on these lands will approach an inhabitant to each 2 acres.

Glenn County is confronted to-day with a decreasing population and a decreasing assessed valuation, as a result of efforts at dry farming. With natural opportunities greater than any that exist in southern California it has not reached 1 per cent of the development which is possible. It is believed that the day will come when this development will occur, and when the conservation of the stream will be the basis of its successful maturing. It would, therefore, seem to be ill-advised for the county to oppose the creation of a forest reserve which looks toward the development of such a condition as that suggested, particularly as the only compensation which would be received therefrom would consist in furnishing pasture for a few thousand sheep and goats, which would range over the hills of the back country.

The forest-reserve policy is not hostile to stockmen. It would oppose such unrestricted overstocking and burning off of mountain sides as is now being practiced in the drainage basin of Stony Creek. In the forest reserves of other portions of the United States where the trees are mature, and where, after careful study, the conclusion has been reached that stock will not injure the reserve, they have been permitted to range therein under proper regulations and restrictions, and particularly with safeguards against fires. Cattle range throughout the forest reserves of the Sierra Nevada. In selecting the persons who may range stock in these districts, preference is always given to local residents. It is absurd to claim that this forest reserve is being presented and promoted by large corporate interests for their selfish advantage. On the other hand, it is recommended and indorsed by many of the most intelligent and far-seeing men of California and of the United States.



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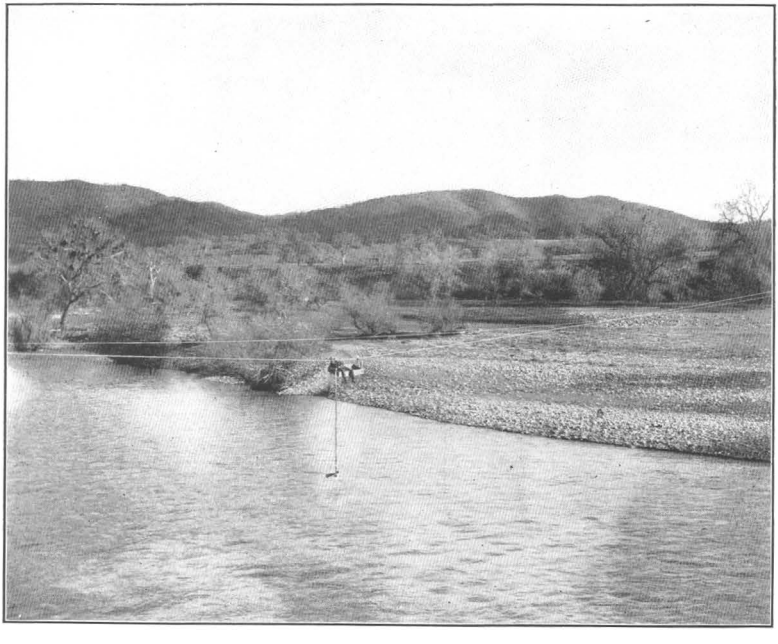


B. STONY CREEK GAGING STATION.

PRECIPITATION AND CLIMATE.

Rainfall records in Stony Creek Basin above the proposed points of impounding the flood waters are very meager and fragmentary.

A record at Fouts Springs, in the watershed of Little Stony Creek, has been furnished by John F. Fouts and S. E. Sites for three seasons, and partial records for two other years. There is also a short record at Little Stony, in the same basin. A rain gage was placed at Julian's ranch house on main stream, February, 1901, at the time the gaging station was established. These records are the only ones available directly in the watersheds tributary to the proposed reservoirs. Records for several points outside of the basin are given as being typical of the rainfall at the higher elevations of the watershed. These are Bartlett Springs, on the North Fork of Cache Creek, which adjoins the watershed of Little Stony on the south; Camp Wright, which is situated a few miles west of the crest of Stony Creek watershed; and Weaverville, which is several miles north of the basin.

The records of precipitation at Red Bluff, at the head of Sacramento Valley; at Jacinto, which is situated on the Sacramento River 14 miles southeast of Orland; and at Woodlands, have been selected as typical of the rainfall in the valley lands to be irrigated from the stored waters of Stony Creek.

Precipitation, in inches, at Bartlett Springs, Lake County.

[Latitude, 39° 10′; longitude, 122° 45′; elevation, 2,375 feet; authority, J. E. McMahon.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1897	------	------	------	------	3.50	6.78	5.36	0.75	0	0	0	0	16.39
1897–98	0	1.70	2.31	3.72	1.53	8.36	.19	.63	2.39	1.10	0	0	21.93
1898–99	0	0	1.87	1.23	13.14	0	8.49	.85	2.47	0	0	0	28.05
1899–1900	0	4.79	10.06	7.87	7.51	1.27	6.42	3.23	.88	0	0	0	42.03
1900–1901	------	------	------	------	------	------	------	------	------	------	------	------	------
1901–2	1.17	1.80	5.86	4.02	1.71	22.38	5.98	5.20	3.40	0	0	0	51.52
1902–3	0	5.97	11.07	------	------	------	------	------	------	------	------	------	------

Precipitation, in inches, at Fouts Springs, Colusa County.

[Latitude, 39° 20′; longitude, 122° 40′; elevation, 1,650 feet; authority, John F. Fouts and S. E. Sites.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1885–86	(0)	0.20	19.43	4.85	9.29	2.00	1.65	5.01	0.50	T.	0	0	42.93
1886–87	0	.70	.20	2.83	2.00	7.88	2.12	1.66	T.	T.	T.	0	17.39
1887–88	T.	0	1.25	4.35	10.83	.70	5.00	3.34	2.14	0.65	(0)	(0)	28.25
Mean	0	.30	6.96	4.01	7.37	3.53	2.92	3.34	.88	.22	0	0	29.52
1892–93	------	------	------	------	2.08	7.11	5.17	1.95	------	------	------	------	[a]16.31
1900–1901	------	------	------	5.41	12.57	4.06	------	.79	------	------	------	------	[a]22.83

[a] Year incomplete.

Precipitation, in inches, at Little Stony, Colusa County.

[Latitude, 39° 25′; longitude, 122° 30′; authority, C. M. Polley.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1884–85	.....	.....	.....	8.40	1.29	1.04	0	1.38	0	1.19	0	0	[a]13.30
1885–86	0	0.27	13.29	3.51	3.44	0	1.10	3.89	.....	.....	.....	.....	[a]25.50

[a] Year incomplete.

Precipitation, in inches, at Julian's ranch, on Stony Creek, Glenn County.

[Latitude, 39° 35′; longitude, 122° 30′; elevation, 750 feet; authority, Mrs. Lee Julian.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1900–1901	.....	.....	.....	.....	.....	4.26	0.12	1.24	0.50	0	0	0	[a]6.12
1901–2	1.07	0.60	3.18	0.82	0.85	9.27	3.24	2.37	2.06	0	0	0	23.46

[a] Year incomplete.

Precipitation, in inches, at Camp Wright, Mendocino County.

[Latitude, 39° 45′; longitude, 123°; elevation, 1,800 feet; authority, U. S. War Department.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1864–65	0.03	0.85	6.19	12.20	3.64	4.88	3.57	0.36	0.43	0	0	0	32.15
1865–66	.81	.87	16.67	2.05	15.83	4.30	11.80	1.05	.....	.....	.....	.....	[a]53.38
1866–67	0	0	5.92	24.67	8.92	7.85	2.38	3.10	.01	0	0	0	52.85
1867–68	1.56	3.75	6.38	29.03	8.61	5.89	9.11	3.25	.71	1.58	0	0	69.87
1868–69	.05	.25	2.79	6.63	13.57	4.13	3.80	4.51	.55	0	0	0	36.28
1869–70	1.42	.84	5.38	8.06	7.03	6.61	2.40	2.02	.39	0	0	0	34.15
1870–71	0	0	1.28	1.19	2.66	4.60	7.10	1.07	1.96	0	0	0	19.86
1871–72	.50	.31	4.03	16.64	11.52	19.78	5.34	.66	.12	.04	0	0.20	59.14
1872–73	0	.36	5.20	7.24	3.55	6.92	2.91	1.13	.04	.30	0.10	0	27.75
1873–74	.05	.34	4.98	15.50	12.94	5.46	7.26	3.72	1.16	.26	.01	0	51.68
1874–75	0	5.61	12.99	2.27	9.83	1.06	1.76	.59	2.32	0	0	0	36.43
Mean	.40	1.20	6.53	11.41	8.92	6.50	5.22	1.95	.77	.20	.01	.02	43.13

[a] Year incomplete.

Precipitation, in inches, at Weaverville, Trinity County.

[Latitude, 40° 46′; longitude, 123° 25′; elevation, 2,162 feet; authority, George E. Noonan.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1869–70	1.06	1.03	8.01	6.15	10.11	9.64	2.05	1.06	0.22	0	0	0	39.33
1870–71	.64	1.39	6.41	9.43	8.16	11.19	3.02	1.73	1.03	0.14	0	0	43.14
1871–72	.29	.40	11.50	3.52	19.62	15.09	3.11	2.43	.84	.17	0	0.25	57.22
1872–73	.35	.78	3.01	6.32	6.51	4.29	2.78	.50	.27	0	0	0	24.81
1873–74	1.80	4.39	4.02	9.57	15.40	4.41	3.12	3.58	2.67	.70	0	0	49.66
1874–75	0	1.57	10.30	1.32	6.59	.46	2.14	.19	1.22	.93	0	0	24.72
1875–76	0	2.82	15.39	11.94	9.69	9.49	8.23	2.79	1.63	.15	0.47	0	62.60
1876–77	.67	7.38	1.50	.29	6.27	6.24	4.52	2.26	1.62	1.72	.02	0.21	32.70
1877–78	0	1.83	8.72	6.50	19.83	16.20	8.53	2.42	1.07	.07	.02	.03	65.22
1878–79	1.28	1.80	3.58	4.91	2.02	6.48	12.84	4.05	4.02	.68	.02	.03	41.71
1879–80	.03	2.08	8.09	13.20	6.64	2.59	4.72	10.78	1.46	.23	.38	.36	50.56
1880–81	0	.55	1.49	14.14	18.61	11.05	1.21	3.13	1.15	.99	0	0	52.32
1881–82	.93	3.77	2.58	8.00	4.19	6.90	3.62	2.44	1.29	0	0	0	33.72
1882–83	1.38	8.36	.78	5.05	4.46	1.50	3.24	5.00	3.72	0	0	0	33.49
1883–84	.88	2.45	1.50	4.97	8.81	3.56	5.10	6.29	1.60	2.93	.13	0	38.22
1884–85	.44	.11	16.56	6.78	3.68	3.70	.15	2.78	.51	1.41	0	0	36.12
Mean	.61	2.54	6.47	7.15	9.41	7.05	4.27	3.21	1.52	.63	.07	.05	42.84

Precipitation, in inches, at Jacinto, Glenn County.

[Latitude, 39° 35′; longitude, 122°; elevation, 110 feet.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1892–93	------	------	6.32	8.13	4.20	2.99	3.71	0.87	1.44	0	0	0	29.49
1893–94	0.47	0.06	2.67	1.61	4.50	1.47	.89	.51	1.24	0	0	0	13.42
1894–95	1.20	1.33	.35	8.69	8.73	1.86	1.74	2.49	.22	0	.36	0	26.97
1895–96	2.33	0	1.10	.94	9.37	.24	2.92	4.03	.69	0	0	.52	22.14
1896–97	.63	.68	3.06	5.28	3.78	3.54	1.72	.77	.60	.44	0	0	20.50
1897–98	0	2.12	1.16	1.40	.76	3.42	.31	2.07	0	0	0	0	11.24
1898–99	.35	.41	.49	1.39	6.36	0	4.29	.36	1.21	.53	0	0	15.39
1899–1900	0	2.68	4.40	3.40	3.06	.17	1.27	1.68	.72	0	0	0	17.38
1900–1901	0	2.42	5.00	------	------	------	------	------	------	------	------	------	[a]7.42
Mean	.62	1.21	2.72	3.85	5.09	1.71	2.11	1.59	.76	.12	.04	.06	18.22

[a] Year incomplete.

Precipitation, in inches, at Woodlands, Yolo County.

[Latitude, 38° 42′; longitude, 121° 47′; elevation, 63 feet; authority, O. P. Co., 1878–1899, and Elston drug store, 1894–1899.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Total.
1878	.....	.....	.....	.....	8.17	8.36	3.83	1.47	0.65	0	0	0	22.48
1878–79	0.17	0.22	0.89	0.42	3.03	3.20	4.74	1.91	1.68	0.24	0	0	16.50
1879–80	0	.21	2.09	3.69	1.04	1.60	.93	6.96	.35	0	0	0	16.87
1880–81	0	0	.06	8.77	4.94	1.86	1.05	1.53	0	.33	0	0	18.54
1881–82	0	.37	2.08	2.25	.89	1.88	1.89	1.37	0	0	0	0	10.73
1882–83	.59	1.38	2.40	.51	1.98	.45	3.13	1.23	4.12	0	0	0	15.79
1883–84	.44	1.03	.29	.29	3.47	3.24	4.69	3.83	0	0	0	0	17.28
1884–85	0	1.00	0	4.63	1.43	.12	.10	1.44	0	0	0	0	8.72
1885–86	0	.20	8.70	3.75	4.78	0	1.31	4.10	0	0	0	0	22.84
1886–87	0	0	0	1.29	.80	5.58	.65	1.53	0	0	0	0	9.85
1887–88	0	0	.40	3.30	4.20	1.27	2.38	.10	1.10	0	0	0	12.75
1888–89	.56	0	5.57	4.97	0	.55	6.21	.62	1.46	.35	0	0	20.29
1889–90	0	5.32	3.75	8.48	5.10	2.40	3.35	1.00	1.60	0	0	0	31.00
1890–91	.60	0	0	2.35	.82	8.08	.35	1.17	.43	0	0	0	13.80
1891–92	0	0	.40	3.10	2.05	2.73	2.14	1.28	2.22	0	0	0	13.90
1892–93	0	.57	5.47	6.10	2.88	2.78	2.00	.62	.61	0	0	0	21.03
1893–94	0	.08	1.71	1.92	4.12	2.15	.88	.42	1.49	.77	0	0	13.54
1894–95	.85	1.12	.85	10.82	9.83	1.28	.91	.52	.45	0	0	0	26.63
1895–96	1.37	.19	1.69	.90	11.87	.11	2.08	6.73	.76	0	0	0.35	26.05
1896–97	.50	1.27	3.76	2.03	3.32	5.21	2.75	.25	.29	.09	0	0	19.47
1897–98	.02	1.81	.56	.72	.43	3.35	.12	.21	1.38	.18	0	0	8.78
1898–99	.35	.98	.47	1.53	5.67	.14	14.46	.13	.08	.78	0	0	24.59
1899–1900	0	3.55	3.01	3.53	2.14	.40	1.20	.96	.54	0	0	0	15.33
1900–1901	0	1.46	5.17	1.22	3.26	5.39	.51	1.91	.71	0	T.	0	19.63
1901–2	0	.90	4.21	.92	.34	6.52	2.01	1.25	.57	.40	0	0	17.12
Mean	.23	.90	2.23	2.81	3.46	2.74	2.54	1.70	.82	.13	0	.01	17.74

NOTE.—The figures for the years 1894 to 1899, inclusive, are the mean of two records.

Mean monthly and annual temperature, in degrees Fahrenheit, at Fruto, Glenn County.

[Elevation, 295 feet.]

Year.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Mean annual.
1888–89	83.3	70.9	57.4	49.7	47.3	52.0	58.6	64.0	70.3	84.7	84.5	84.5	.....
1889–90	82.9	63.5	58.2	48.9	41.6	48.3	52.9	62.3	71.2	.....	.....	.....	.....

Mean monthly and annual temperature, in degrees Fahrenheit, at Willows, Glenn County.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean annual.
1878											54.0	45.5	
1879	42.9	52.3	56.9	62.5	66.1	82.2	84.1	84.6	77.5	63.1	50.3	43.3	63.8
1880	42.7	45.2	48.9	57.4	67.5	77.2	86.4	80.3	75.5	66.6	50.5	50.1	62.2
1881	49.2	52.3	55.1	66.1	74.7	[77.4]	86.4	77.2	75.7	58.2	51.4	46.5	[64.2]
1882	43.6	41.8	53.6	57.8	72.4	82.7	88.3	84.5	78.2	64.9	58.2	43.9	64.2
1883	37.3	46.5	62.0	63.8	70.1	[77.4]	85.8	81.9	81.1	63.8	55.2	45.4	[64.2]
1884	47.4	46.0	58.9	53.2	64.7	76.6	78.2	79.6	68.1	62.4	57.2	45.2	61.5
1885	45.2	47.2	65.8	65.0	71.6	73.1	79.2	81.9	76.9	69.0	51.0	50.5	64.7
1886	44.1	53.1	52.3	55.6	67.5	81.1	82.7	83.1	80.0	64.2	52.9	51.0	64.0
1887	50.0	45.7	60.2	64.7	73.1	80.0	86.3	87.0	78.4	71.7	56.0	46.3	66.6
1888	40.3	51.1	51.6	64.1	67.2	70.9	79.8	78.8	84.2	67.8	52.5	47.6	63.0
1889	42.9	47.6	51.8	59.7	67.9	80.3	82.2	79.7	74.7	60.7	53.0	46.6	62.3
1890	42.2	47.4	49.9	57.7	69.3	69.6							
Mean	44.0	48.0	55.6	60.6	69.3	77.4	83.6	81.7	77.3	64.8	53.5	46.8	63.6

Mean monthly and annual temperature, in degrees Fahrenheit, at Woodlands, Yolo County.

[Elevation, 63 feet.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean annual.
1876											53.9	46.6	
1877	49.7	54.6	60.9	61.7	65.7	77.1	80.1	76.1	74.7	59.9	54.9	48.6	63.7
1878	48.7	50.7	56.4	61.6	67.4	75.4	76.0	75.7	68.4	63.2	54.5	45.3	61.9
1879	44.4	54.3	57.7	61.7	64.3	76.0	78.4	79.6	74.6	64.6	53.3	45.0	62.8
1880	44.9	47.2	50.0	56.3	65.2	73.3	78.7	76.2	72.9	65.9	52.7	51.6	61.2
1881	50.4	55.3	53.4	64.1	70.8	75.0	88.8	77.0	74.3	64.1	51.0	49.2	64.4
1882	46.1	45.4	52.7	61.0	72.3	74.7	79.9	76.4	72.5	60.8	50.9	48.9	61.8
1883	42.3	47.0	56.4	58.1	65.9	79.4	78.8	75.5	75.5	63.2	54.7	42.0	61.6
1884	46.5	45.6	54.2	56.1	66.5	69.3	79.2	80.1	72.1	68.6	59.0	51.1	62.4
1885	47.7	55.4	63.6	65.5	72.9	68.5	74.7	77.5	73.8	67.6	[55.2]	53.0	[64.6]
1886	48.1	55.3	57.1	61.5	70.8	78.4	80.2	78.6	71.7	55.5	53.3	51.1	63.5
1887	49.2	47.6	60.8	62.0	70.0	81.6	82.8	78.6	77.1	78.1	68.1	51.9	67.3
1888	43.2	46.1	48.1	51.7	62.5	67.3	73.4	76.1	74.6	68.8	58.3	50.1	60.0
1889	44.0	46.5	54.0	59.9	65.9	72.1	75.8	71.8	70.9	58.9	53.3	49.0	60.2
1890	41.2	45.6	50.9	59.4	63.8	70.7							
Mean	46.2	49.8	55.4	60.0	67.4	74.2	79.0	76.9	73.3	64.6	55.2	48.8	62.6

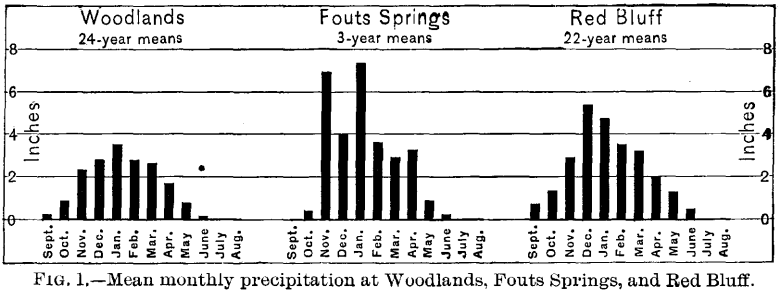


FIG. 1.—Mean monthly precipitation at Woodlands, Fouts Springs, and Red Bluff.

Climatological data for Corning, Orland, and Willows, three points within or close to the land that would be irrigated from the water stored in the Stony Creek Basin, are given for the years 1897 to 1901, inclusive:

Climatological data for Corning, Orland, and Willows.

Stations.	Counties.	Elevation.	Year.	Temperature (degrees Fahrenheit).					Precipitation (inches).				Rainy days.	Sky.			Prevailing direction of wind.
				Annual mean.	Highest.		Lowest.		Total for year.	Greatest monthly.	Month.	Total snowfall.		Clear days.	Partly cloudy days.	Cloudy days.	
					Degrees.	Date.	Degrees.	Date.									
Corning	Tehama	277	1897	61.2	110	Aug. 19	27	Dec. 22	16.54	5.69	Feb.	0	...	...	...	...	...
			1898	59.7	112	June 25	23	Dec. 11	.....	....	.....	5	...	260	0	105	S.
			1899	62.2	110	July 18	25	Feb. 4	27.72	8.13	Jan.	0	44	228	0	137	N.
			1900	63.1	110	July 19	32	Dec. 31	21.55	4.61	Jan.	0	51	213	8	144	N.
			1901	63.8	108	June 28	26	Jan. 1	20.66	6.09	Jan.	3.5	41	227	0	138	N.
Orland	Glenn	254	1897	64.9	110	Aug. 19	27	Dec. 22	14.14	4.01	Feb.	0	...	...	...	...	...
			1898	65.6	118	Aug. 12	26	Jan. 12	7.93	3.64	Feb.	0	25	229	4	132	N.
			1899	64.4	115	July 19	26	Feb. 4	22.41	6.98	Jan.	0	65	195	3	167	N.
			1900	62.0	112	...do	29	Dec. 31	18.40	4.61	Nov.	0	60	200	1	164	N.
			1901	65.0	116	Aug. 3	24	Jan. 1	17.86	5.14	Feb.	1	40	....	....	....	N.
Willows	...do	132	1897	....	105	June 30	32	Dec. 20	10.85	4.26	Feb.	0	...	...	...	...	...
			1898	64.8	112	Aug. 12	30	Dec. 30	6.94	2.46	Feb.	0	20	273	4	88	N.
			1899	63.0	115	July 24	32	Feb. 2	19.15	6.56	Jan.	0	46	250	0	115	N.
			1900	66.3	105	July 7	35	Dec. 31	14.28	4.37	Nov.	0	42	233	9	123	N.
			1901	67.2	109	Aug. 3	30	Jan. 1	16.54	3.88	Feb.	0	39	255	0	110	N.

On page 4 of the California section of the Climate and Crop Bulletin of the Weather Bureau for November, 1900, is an excellent and more complete collection of data, compiled by Maurice Connell, observer, which are given in full as fairly representing the climatic conditions of the territory on the west side of the Sacramento Valley in the vicinity of Willows, Orland, and Corning.

Red Bluff is the county seat of Tehama County, at the northern end of the Sacramento Valley. The city is situated on the western bank of the Sacramento River, in latitude 40° 10′ north, longitude 122° 14′ west, the average elevation above sea level being 309 feet. The land slopes gently to the river, and within a radius of 5 miles the country is comparatively flat. The general movement of the air is from the north and northeast into the valley from the mountains on the north and east. During the summer months, however, there is a well-marked northerly movement of the air, which is in part due to the strong westerly indraft through the Golden Gate and its subsequent deflection northward through the valley. The highest temperature recorded is 114° and the lowest 18°. The average annual precipitation is 25.56 inches.

Monthly and annual mean temperature at Red Bluff, Cal., in degrees Fahrenheit, with departures from normal.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.	Departure from normal.
1878	47.3	50.2	55.5	60.4	67.4	81.0	81.6	83.2	72.9	65.4	55.6	47.4	64.0	+1.6
1879	44.6	53.6	57.0	61.3	62.5	78.7	81.6	83.4	77.2	64.0	51.0	44.6	63.3	+ .9
1880	44.5	46.5	49.7	55.8	64.1	73.9	83.4	77.4	74.7	65.3	50.0	49.4	61.2	−1.2
1881	50.0	53.0	55.6	63.6	69.3	72.8	78.7	76.4	71.5	57.5	51.0	45.9	62.1	− .3
1882	44.1	44.4	52.5	56.6	67.4	75.6	84.3	81.2	60.3	58.3	51.3	47.5	60.2	−2.2
1883	41.2	45.1	58.3	56.3	64.3	80.3	84.9	79.9	75.4	57.7	50.6	44.4	61.5	− .9
1884	46.2	45.9	51.6	56.8	68.0	69.6	78.4	81.5	67.3	62.1	54.7	47.5	60.8	−1.6
1885	47.5	53.5	61.0	62.1	70.4	71.6	80.7	83.8	74.8	65.6	52.7	49.3	64.4	+2.0
1886	46.2	54.5	52.8	57.7	66.9	79.1	82.6	81.5	75.6	60.7	51.3	50.0	63.2	+ .8
1887	48.7	43.4	58.9	60.2	68.8	77.1	85.9	81.3	76.4	71.1	55.2	48.2	64.4	+2.0
1888	40.9	53.9	54.5	67.0	68.1	70.7	80.9	83.7	81.2	68.2	54.8	48.3	64.5	+2.1
1889	45.8	51.6	56.8	61.0	66.8	80.0	81.3	80.0	76.0	61.4	54.4	44.8	63.3	+ .9
1890	39.2	45.2	50.8	60.3	67.6	72.6	80.4	79.5	74.4	65.0	57.9	45.0	61.5	− .9
1891	48.5	44.4	55.0	57.8	66.3	72.2	82.6	83.1	72.9	66.0	56.8	42.5	62.4	0.
1892	47.1	53.0	56.0	54.1	65.6	71.8	78.7	80.4	72.0	63.5	56.1	47.6	62.2	− .2
1893	43.2	46.8	49.8	54.6	65.8	73.4	80.4	81.0	67.5	61.4	53.5	50.2	60.6	−1.8
1894	42.4	45.3	51.5	61.4	66.8	69.1	83.0	82.0	74.8	63.9	59.0	45.0	62.0	− .4
1895	43.8	52.8	52.8	59.1	66.2	78.2	80.0	81.2	68.5	67.0	53.6	43.4	62.2	− .2
1896	48.8	53.2	53.8	52.2	61.0	77.4	85.3	78.8	72.8	67.2	50.8	49.0	62.5	+ .1
1897	45.8	47.0	54.4	63.2	72.6	74.0	82.1	80.2	72.6	62.9	49.7	46.0	62.0	− .4
1898	42.4	51.0	59.2	64.4	63.6	75.4	83.1	81.3	72.6	64.3	53.6	45.7	62.5	+ .1
1899	48.8	51.6	52.2	60.8	63.2	77.9	82.0	73.8	78.0	61.0	54.4	45.5	62.4	0.
Means (22 years)	45.2	49.3	54.6	59.3	66.6	75.0	81.9	81.1	72.9	63.7	53.5	46.7	62.4	

Temperature summaries, Red Bluff, Cal.

Month.	Highest monthly mean.		Lowest monthly mean.		Absolute maximum.			Absolute minimum.			Mean daily range.	Mean daily variability of mean temperature.	Mean relative humidity.	
	Year.	° F.	Year.	° F.	Day.	Year.	° F.	Day.	Year.	° F.			5 a.m.	5 p.m.
													P. ct.	*P. ct.*
January	1881	50.0	1890	39.2	27	1899	77	14	1888	18	15.6	3.6	87	68
February	1886	54.5	1887	43.4	25	1888	82	14	1884	22	18.9	3.1	82	56
March	1885	61.0	1880	49.7	9	1892	86	16	1880	28	19.2	3.0	82	53
April	1888	67.0	1892	54.1	24	1898	96	18	1885	34	22.2	3.3	76	43
May	1897	72.6	1896	61.0	29	1887	110	11	1892	38	24.1	3.9	71	38
June	1878	81.0	1884	69.6	30	1891	110	1	1898	44	27.1	3.5	59	26
July	1887	85.9	1884	78.4	8	1887	112	1	1881	53	30.5	3.2	49	18
August	1885	83.8	1889	73.8	22	1891	114	22	1881	52	30.6	3.0	49	20
September	1888	81.2	1882	60.3	1	1891	107	9	1884	46	26.7	3.2	57	28
October	1887	71.1	1881	57.5	5	1892	97	14	1881	32	24.6	3.3	67	38
November	1894	59.0	1897	49.7	3	1890	88	30	1880	26	21.4	3.5	75	55
December	1893	50.2	1891	42.5	5	1885	79	13	1884	25	13.4	3.5	87	70
Annual	.....	85.9	.....	39.2	.....	.....	114	.....	.....	18	22.8	3.3	70	43

Precipitation exceeding 2.50 inches in any consecutive twenty-four hours.

	Inches.
January 16, 1878	5.11
December 5, 1879	5.04
January 29, 1881	3.25
December 14, 1881	2.89
November 3, 1882	2.88
November 10, 1885	4.73
December 15, 1896	2.64
January 10, 1899	4.04

Monthly and annual precipitation, in inches, at Red Bluff, Cal., with annual departures from normal.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.	Departure from normal.
1878	20.71	16.66	4.16	2.26	0.89	0	0	0	0.42	1.56	1.66	0.69	49.01	+23.45
1879	3.18	3.67	5.39	2.12	2.18	.30	.04	.28	T.	.48	6.05	9.95	33.64	+ 8.08
1880	2.01	1.66	1.70	7.05	1.04	0	0	0	0	.08	.14	12.85	26.53	+ .97
1881	9.40	2.79	.51	1.83	.79	.51	T.	0	1.07	1.61	.73	5.69	24.93	− .59
1882	2.81	3.94	2.67	2.12	.33	.15	0	0	.49	2.80	5.07	1.44	21.82	− 3.40
1883	.87	.39	2.60	1.96	2.96	T.	0	T.	1.04	2.68	.74	.52	13.76	−11.05
1884	3.55	2.21	7.81	4.31	.18	.97	0	T.	.36	.90	.04	7.73	28.06	+ 2.67
1885	1.84	1.19	T.	.62	.64	1.37	.05	0	2.91	.10	17.05	3.86	29.63	+ 4.24
1886	4.85	.18	1.31	4.12	.73	T.	T.	T.	0	1.76	.34	3.92	17.21	− 8.18
1887	.57	5.21	1.13	1.76	.77	.26	T.	T.	.06	0	1.52	2.32	13.60	−11.79
1888	4.08	2.17	3.47	.53	.51	2.61	.07	0	.33	T.	4.32	6.85	24.94	− .45
1889	.51	.71	6.83	1.11	2.04	.64	0	0	0	8.41	3.37	9.25	32.87	+ 7.48
1890	6.55	3.67	6.14	1.70	2.67	.11	0	0	1.55	.01	0	3.20	25.60	+ .21
1891	1.36	10.68	1.42	2.27	1.50	.55	.17	0	.19	.64	.46	3.80	23.04	− 2.35
1892	4.30	3.11	2.69	2.92	3.02	.27	T.	T.	.29	1.42	7.25	8.21	33.48	+ 8.09
1893	3.82	3.22	6.08	1.42	.61	0	.03	0	1.23	1.09	4.22	2.64	24.36	− 1.03
1894	5.29	2.30	2.40	.55	1.46	1.00	.02	T.	1.11	.89	.95	11.01	26.98	+ .59
1895	8.29	2.86	2.59	.34	1.65	0	.16	0	1.76	T.	1.93	2.99	22.57	− 2.82
1896	7.30	.27	3.06	3.67	2.42	T.	0	.54	.63	.66	3.41	6.20	28.46	+ 3.07
1897	3.22	6.26	1.99	1.22	.06	1.25	0	T.	.03	2.70	1.49	1.86	20.08	− 5.31
1898	.59	5.45	.01	.63	2.28	.14	0	T.	.45	.46	1.21	1.69	12.91	−12.48
1899	9.29	.01	6.22	.72	.69	.94	0	.02	0	3.02	4.08	3.08	28.07	+ 2.51
Average (22 yrs.)	4.74	3.57	3.19	2.06	1.34	.50	.02	.04	.63	1.30	2.95	5.40	25.56	

Greatest amount of precipitation, in inches, in twenty-four hours.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	The year.
1878	5.11	2.41	0.96	0.76	0.40	0	0	0	0.22	1.38	1.20	0.45	5.11
1879	1.54	1.36	1.55	.43	.58	.30	.03	.28	0	.23	1.68	5.04	5.04
1880	.94	.41	.78	2.03	.50	0	0	0	0	.08	.10	1.84	2.03
1881	3.25	.45	.27	.56	.70	.44	0	0	.74	.68	.33	2.89	3.25
1882	.91	1.38	.99	1.03	.26	.13	0	0	.37	1.05	2.88	.62	2.88
1883	.76	.39	1.14	1.72	1.10	0	0	0	1.04	1.03	.43	.40	1.72
1884	1.12	1.06	2.17	1.47	.14	.56	0	T.	.17	.68	.04	2.00	2.17
1885	.63	.45	T.	.22	.58	.71	.05	0	2.91	.06	4.73	1.83	4.73
1886	1.89	.18	.43	1.01	.22	T.	T.	T.	0	1.35	.21	1.81	1.89
1887	.30	1.59	.62	.82	.39	.14	T.	T.	.06	0	.77	.83	1.59
1888	.66	.96	1.25	.53	.15	.84	.04	T.	.33	T.	1.61	1.43	1.61
1889	.16	.45	1.95	.31	.85	.58	0	0	0	1.70	1.70	1.83	1.95
1890	2.02	1.16	1.71	1.51	1.67	.06	0	0	1.40	.01	0	1.48	2.02
1891	.92	3.80	.56	.82	.48	.32	.16	0	.10	.44	.19	.81	3.80
1892	1.44	1.36	.91	1.12	1.56	.22	T.	T.	.29	.72	2.30	1.79	2.30
1893	1.89	1.40	1.20	.65	.26	0	.03	0	.81	.96	1.85	.85	1.89
1894	2.00	.86	.85	.41	.55	.45	.02	T.	1.11	.38	.91	1.70	2.00
1895	2.36	1.70	1.05	.16	1.06	T.	.10	T.	.96	T.	.75	1.26	2.36
1896	1.38	.17	.58	1.80	.77	T.	0	.54	.58	.61	1.36	2.64	2.64
1897	1.04	1.12	.90	.83	.04	.70	0	T.	.02	1.08	1.00	.93	1.04
1898	.25	1.54	.01	.41	1.09	.12	0	T.	.20	.23	.58	.92	1.54
1899	4.04	.01	1.56	.48	.34	.79	0	.02	0	1.02	1.00	1.54	4.04
Greatest monthly	5.11	3.80	2.17	2.03	1.67	.84	.10	.54	2.91	1.70	4.73	5.04	

Summary of weather conditions at Red Bluff, Cal.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Average number of—													
Clear days	11	12	13	13	17	23	28	28	24	21	17	11	218
Partly cloudy days	10	9	10	11	9	6	3	2	5	7	7	9	88
Cloudy days	10	7	8	6	5	1	0	1	1	3	6	11	59
Rainy days	11	9	11	8	6	4	1	0	3	4	6	12	75
Mean cloudiness	5	4.4	4.6	4.1	3.5	2.1	0.5	0.9	1.7	2.6	4	5.5	3.3

Number of thunderstorms, Red Bluff, Cal.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1884					2		1	1	2	1			7
1885		1		1	1	1	2		1				7
1886		1			1					1			3
1887				1	1		1					2	5
1888	1				2	2		1	4				10
1889			2	1	2								5
1890					1	2		1					4
1891			1		1								2
1892			1	1		2	1				1	1	7
1893				1			1		1				3
1894					2	1							3
1895		1	1										2
1896			2	1	2								5
1897						2				1			3
1898		2			1	2			1				6
1899			1							1			2
1900		2	1			1		1	1				

Dates of first and last killing frosts from 1882 to 1899, inclusive.

Year.	Last in spring.	First in autumn.	Year.	Last in spring.	First in autumn.
1882	Mar. 20	Nov. 12	1891	Feb. 25	Dec. 5
1883	Feb. 17	Nov. 25	1892	Feb. 9	Nov. 24
1884	Mar. 11	Dec. 11	1893	Mar. 13	Nov. 19
1885	Feb. 9	Dec. 21	1894	Mar. 4	Nov. 23
1886	Mar. 1	Nov. 21	1895	Mar. 14	Nov. 25
1887	Feb. 27	Nov. 24	1896	Apr. 19	Nov. 28
1888	Mar. 3	Dec. 6	1897	Mar. 30	Nov. 7
1889	Feb. 17	Dec. 27	1898	Mar. 24	Nov. 20
1890	Feb. 27	Dec. 10	1899	Feb. 7	Dec. 19

RUN-OFF.

A gaging station was established January 30, 1901, on Stony Creek at Julian's ranch, 6 miles northwest of Fruto and $1\frac{3}{4}$ miles above the proposed Mill Site dam. Daily gage heights have been kept and numerous meter measurements have been made, from which rating curves have been constructed for estimating the daily flow and total annual run-off from the basin. The total run-off from February 1 to

December 31, 1901, was estimated as 298,578 acre-feet or 0.57 second-feet per square mile, which amounts to 7.39 inches in depth over the entire watershed when taken as 760 square miles.

Table of daily flow from February 1, 1901, to December 31, 1902, is given on page 35; also the estimated monthly discharge for 1901 and 1902.

Daily mean discharge in second-feet of Stony Creek at Julian's ranch for 1901.

[Drainage area, 760 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1,225	2,215	435	555	195	2	10	5	300	47	340
2	.....	1,125	1,785	435	555	195	2	10	5	260	35	1,325
3	.....	1,025	1,540	490	490	165	2	10	5	260	35	630
4	.....	1,025	1,325	490	490	165	2	10	5	225	35	3,875
5	.....	1,225	1,225	435	490	165	.....	5	5	225	35	1,325
6	.....	1,025	1,125	490	435	140	.....	5	5	225	35	1,125
7	.....	925	1,025	435	385	140	.....	5	5	195	35	435
8	.....	925	925	435	385	117	.....	5	5	165	35	435
9	.....	825	925	385	385	97	.....	5	5	140	35	385
10	.....	825	1,025	340	340	97	.....	5	5	140	47	340
11	.....	725	1,125	340	340	77	.....	5	5	117	47	340
12	.....	725	1,025	300	340	62	.....	5	5	97	47	260
13	.....	1,125	925	300	340	62	.....	5	5	77	47	225
14	.....	1,920	825	340	340	47	15	5	5	77	47	195
15	.....	1,325	825	385	340	47	15	5	10	62	77	165
16	.....	3,875	825	385	300	35	15	5	10	47	97	165
17	.....	2,790	825	340	300	35	15	5	10	35	62	140
18	.....	2,215	825	340	300	25	15	2	10	25	77	140
19	.....	10,385	725	300	260	25	15	2	10	15	77	140
20	.....	8,215	630	300	260	15	15	2	10	15	165	117
21	.....	5,611	630	300	300	15	15	2	10	10	165	117
22	.....	3,875	630	260	300	15	10	2	15	5	340	97
23	.....	6,479	555	260	300	10	10	2	15	5	340	77
24	.....	4,526	555	225	300	10	10	2	15	2	300	77
25	.....	3,441	555	225	340	10	10	2	25	.....	225	97
26	.....	3,224	555	225	300	5	10	2	25	.....	195	97
27	.....	2,790	555	225	300	5	10	2	25	260	195	117
28	.....	2,390	555	225	300	5	10	2	25	300	195	117
29	.....	.....	.....	490	630	260	5	10	2	25	340	1,125	97
30	.....	1,325	.....	490	555	260	5	10	2	725	340	630	97
31	.....	1,325	.....	435	.....	225	.....	10	2	.....	62	.....	97

Daily discharge, in second-feet, of Stony Creek at Julian's ranch, for 1902.

[Drainage area, 760 square miles.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	125	109	5,860	920	690	370	9	2	5	55	109	1,340
2	150	125	7,000	1,000	620	320	9	2	5	55	109	1,340
3	125	125	4,360	1,080	550	270	9	2	5	55	109	1,250
4	125	109	3,750	1,165	550	270	9	2	5	55	109	1,165
5	125	125	2,900	1,250	490	270	9	2	5	55	109	2,765
6	109	430	3,315	2,510	490	225	5	2	5	55	125	1,165
7	109	2,390	3,315	4,680	840	225	2	2	5	55	125	1,080
8	109	3,175	5,170	3,315	1,000	225	2	2	5	67	490	1,000
9	109	3,175	4,520	2,900	920	185	2	2	5	67	5,005	1,080
10	109	3,750	3,175	2,510	840	185	2	2	9	67	3,605	1,165
11	109	5,170	2,900	2,275	765	150	2	2	9	67	2,160	1,165
12	109	3,175	2,510	1,940	840	150	2	2	9	67	1,525	1,080
13	109	2,510	2,510	1,430	840	150	2	2	9	67	1,430	1,080
14	109	2,765	2,510	1,525	840	125	2	2	9	80	1,340	1,080
15	109	4,360	2,510	1,525	690	125	2	2	9	80	1,340	1,000
16	109	3,175	2,510	1,430	620	109	2	2	9	80	1,340	1,000
17	109	3,035	2,390	1,340	620	94	2	2	9	80	1,430	1,000
18	109	2,160	2,275	1,250	620	94	2	2	9	80	2,765	1,000
19	109	2,160	2,050	1,165	550	80	2	2	9	80	3,605	920
20	109	2,390	2,050	1,080	490	67	2	2	9	80	2,635	920
21	109	3,315	1,940	1,165	490	55	2	2	9	80	2,160	840
22	125	4,360	1,940	1,000	430	44	2	2	9	94	2,050	765
23	125	7,600	1,080	1,080	430	44	2	2	9	94	1,940	765
24	125	14,650	1,080	1,000	370	35	2	2	14	185	1,940	690
25	109	13,150	1,000	1,080	370	35	2	2	14	225	1,835	920
26	109	9,890	1,000	920	370	37	2	5	14	185	1,835	1,525
27	109	12,660	920	840	320	5	2	5	14	150	1,730	1,250
28	109	7,600	920	840	320	5	2	5	14	125	1,625	1,250
29	109	-------	920	765	270	5	2	5	14	125	1,525	1,250
30	109	-------	920	690	320	5	2	5	14	125	1,430	1,165
31	109	-------	920	-------	370	-------	2	5	-------	109	-------	1,080
Total	3,532	117,638	80,220	45,670	17,925	3,949	100	80	269	2,844	47,535	35,095
Mean	114	4,201	2,588	1,522	578	132	3	3	9	92	1,584	1,132
Run-off, per square mile	.15	5.53	3.41	2.00	.76	.17	0	0	.01	.12	2.08	1.49
Run-off, in inches	.17	5.76	3.93	2.23	.88	.19	0	0	.01	.14	2.32	1.72

Estimated monthly discharge of Stony Creek at Julian's ranch.

[Drainage area, 760 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1901.						
February [a]	10,385	725	2,707	150,339	3.56	3.71
March	2,215	435	893	54,908	1.18	1.36
April	630	225	361	21,481	.48	.54
May	555	225	349	21,459	.46	.53
June	195	5	66	3,927	.09	.10
July	10	0	7	430	.01	.01
August	10	2	4	246	.01	.01
September	725	5	35	2,083	.05	.06
October	340	0	130	7,993	.17	.20
November	1,125	35	161	9,580	.21	.23
December	3,875	77	425	26,132	.56	.64
11 months	10,385	0	428	298,578	.57	7.39
1902.						
January	150	109	114	7,010	.15	.17
February	14,650	109	4,201	233,312	5.53	5.76
March	7,000	920	2,588	159,130	3.41	3.93
April	4,680	690	1,522	90,565	2.00	2.23
May	1,000	270	578	35,540	.76	.88
June	370	5	132	7,855	.17	.19
July	9	2	3	184	0	0
August	5	2	3	184	0	0
September	14	5	9	536	.01	.01
October	225	55	92	5,657	.12	.14
November	5,005	109	1,584	94,255	2.08	2.32
December	2,765	690	1,132	69,604	1.49	1.72
The year	14,650	2	997	703,832	1.31	17.35

[a] Maximum flood discharge of Stony Creek February 19, 1901, 8 p. m., estimated, 18,000 second-feet.

SILT.

The vegetable covering, geologic character, and grades of the watershed of Stony Creek and tributaries are such that the streams, even in flood, carry a comparatively small quantity of silt.

The setting aside of the principal part of the watershed as a forest reserve would assure the preservation of the forest at the headwaters and the regulation of the run-off, and hence the continuation of the

present favorable condition for the long life of storage reservoirs that may be built to impound the flood waters of these streams.

STORAGE POSSIBILITIES.

For the investigation of the storage possibilities of Stony Creek nearly the entire drainage basin was visited. Stony Creek has a very peculiar topographic catchment area. The main stream, flowing northerly and parallel with the Coast Range, lies wholly in the sedimentary rock, and is fed by several tributaries coming into it from the west from the granitic crest of the range. These tributaries, until they enter the sedimentary rock, have a very heavy grade, and reservoir sites are therefore not found thereon. At various points in the basin a conglomerate of more or less hardness is upturned in lines parallel with the axis of the main range, and has resisted erosion to a very large extent. Wherever this ridge has been crosscut by the various streams, dam and reservoir sites of more or less merit are found.

No exploration for bed rock was made at any of the following dam sites, and consequently the estimates in this particular are merely preliminary and should be confirmed before construction is undertaken.

GRINDSTONE CREEK.

Grindstone Creek joins Stony Creek in sec. 15, T. 21 N., R. 6 W., Mount Diablo meridian, draining a large part of the most productive portion of the basin. At a point about 4 miles above its mouth the stream intersects and passes through one of the conglomerate ridges above referred to, but as its canyon above is narrow it was not considered of enough importance to make surveys to determine the reservoir capacity of this site.

SALT CREEK.

On Salt Creek the same conglomerate is upturned, and the reservoir conditions are practically the same, except that the water supply is much less.

NORTH FORK OF STONY CREEK.

On the North Fork of Stony Creek, at the town of Newville, a reservoir site was found and surveyed by means of a plane table up to the 60-foot contour. The capacity was found to be 25,400 acre-feet at that level, distributed over an area of 1,350 acres. The foundations and abutments for this dam are not good, however, and the land to be covered would be some of the most valuable in the county. The drainage area tributary to this reservoir site is insufficient to supply this amount of water except in years of excessive rainfall, therefore no estimates of cost of building a dam at this point were made. Owing to this insufficient drainage area, a reconnaissance by means of hand level and barometer was made to determine the possibility of diverting Thomas Creek, the next creek to the west, into this reservoir site. From the cursory examination made it appears that

there are no engineering difficulties to be encountered which could not be overcome, except that of a heavy cost for the work. It would probably not be public policy, however, to divert this stream, as a reservoir site exists, and was surveyed by others several years ago, about 3 miles south of the town of Paskenta, Tehama County, on Thomas Creek. No information as to the capacity or cost of this reservoir could be obtained, and surveys were not considered justified. The dam site appears fair, and the basin above it is extensive. As this was outside of the Stony Creek investigation no surveys were made. The locality upon which this water should logically be diverted is the land naturally tributary thereto, either in the basin of Thomas Creek or at the point where it debouches into the Sacramento Valley.

BRISCOE CREEK.

This creek has a catchment area of 50 square miles of good mountain drainage. The crest of the drainage is a high mountain, locally

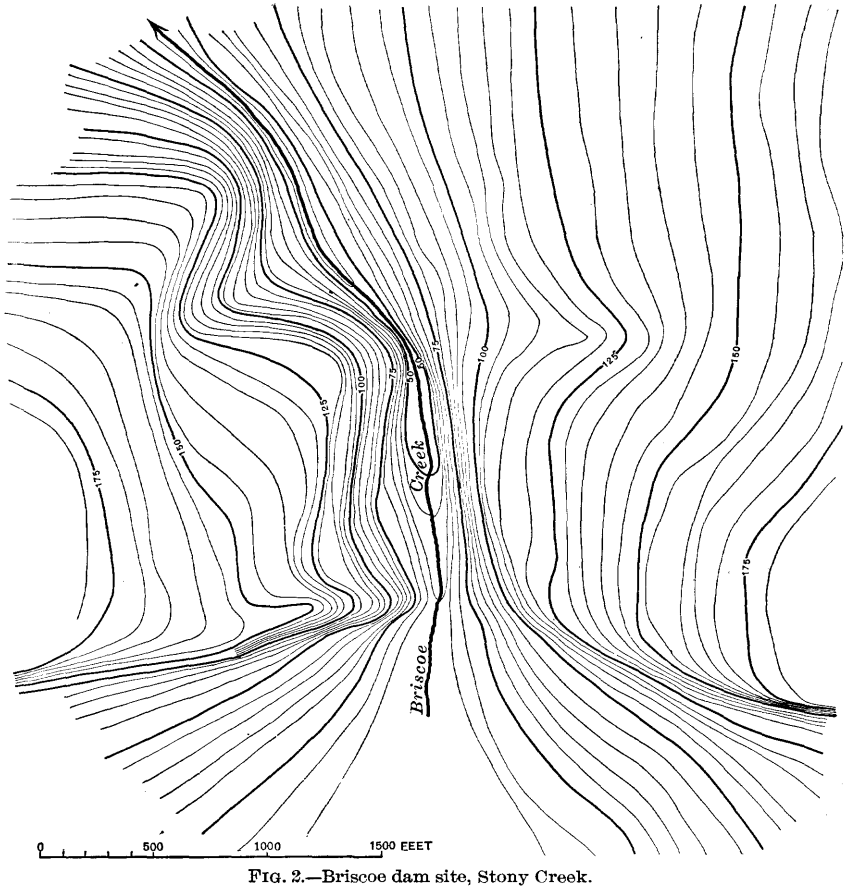


FIG. 2.—Briscoe dam site, Stony Creek.

known as Sheetiron Mountain, and inhabitants of this locality report that it lies in what may be termed a "rainy belt," having a width of

about 6 miles and extending northeast from this mountain about 8 miles. Briscoe Creek, in sec. 30, T. 20 N., R. 6 W., M. D.M., intersects a conglomerate bed in a narrow rocky gorge that in places is only 3 feet

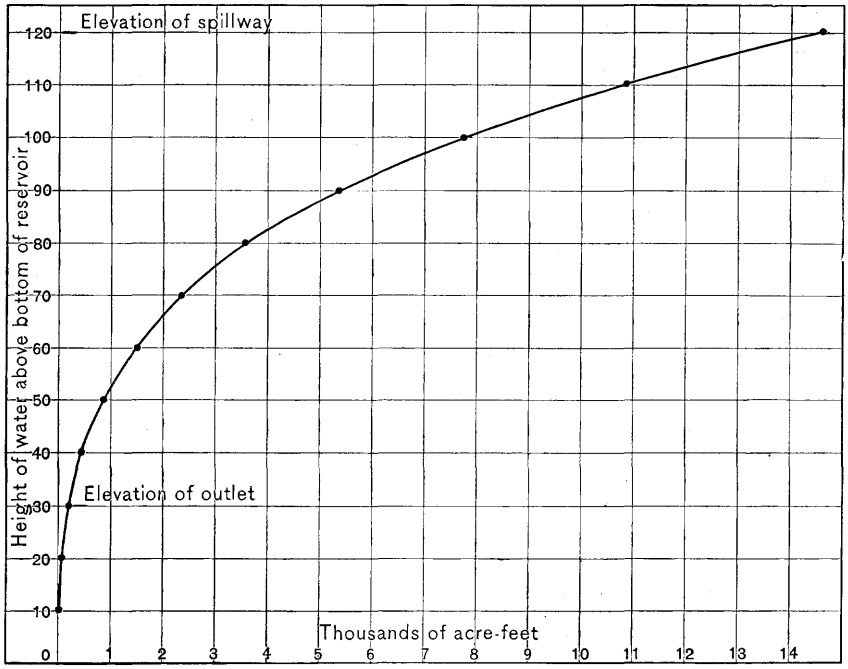


FIG. 3.—Capacity curve, Briscoe reservoir.

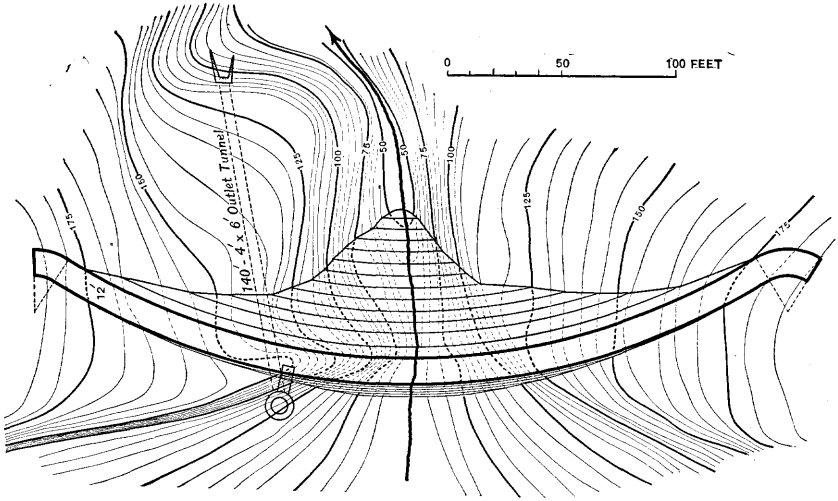
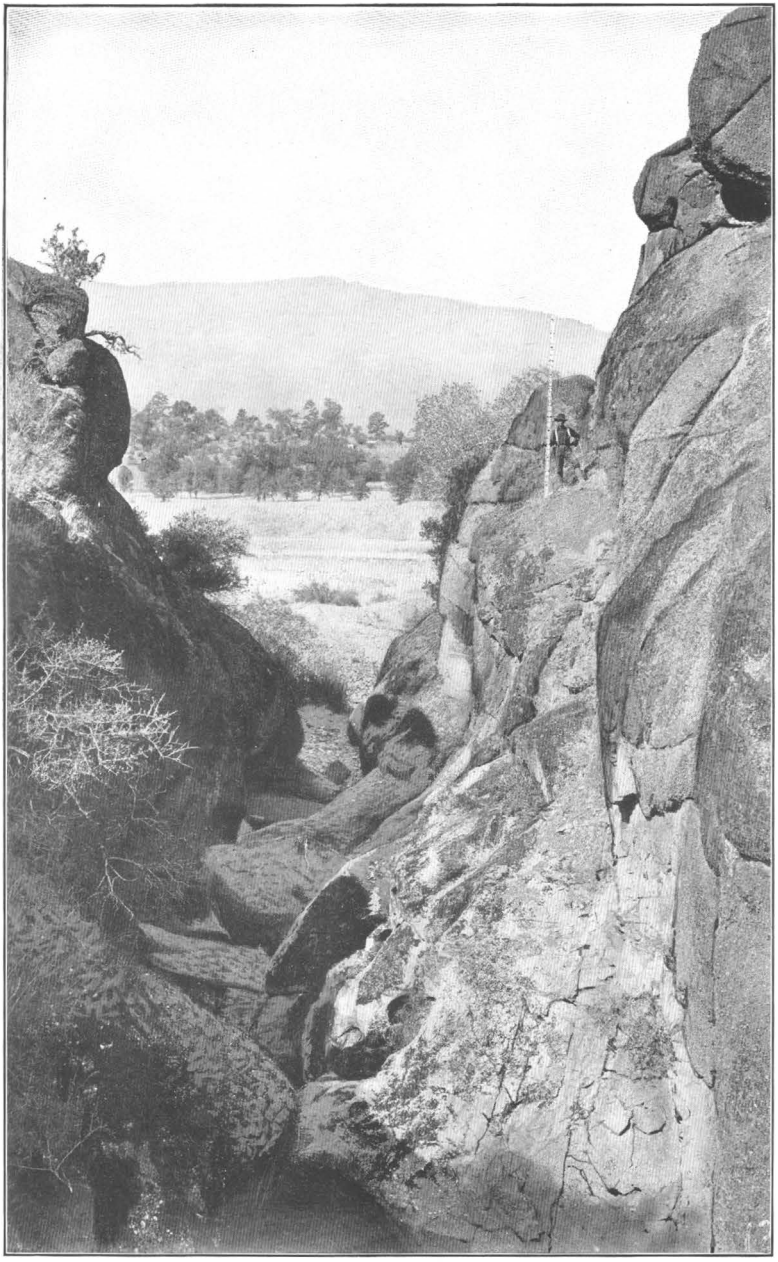


FIG. 4.—Plan of concrete dam, Briscoe reservoir.

wide. The site was surveyed and found to have a capacity of 14,385 acre-feet with a dam 125 feet high. A subsidiary dam at the divide, 1,700 feet north of dam site, will also be necessary, with a maximum



BRISCOE CREEK DAM SITE.

height of 30 feet. The conglomerate at the dam site is very hard and compact, a sample taken weighing 143 pounds per cubic foot. Bed rock is at the surface in the canyon at the dam site, and the walls of the canyon are good.

It is considered that the best type of dam for this place will be a rock and concrete gravity dam with a concrete spillway at the subsidiary dam.

The following estimates with regard to the concrete are based on the assumption that 25 per cent of the conglomerate rock will quarry

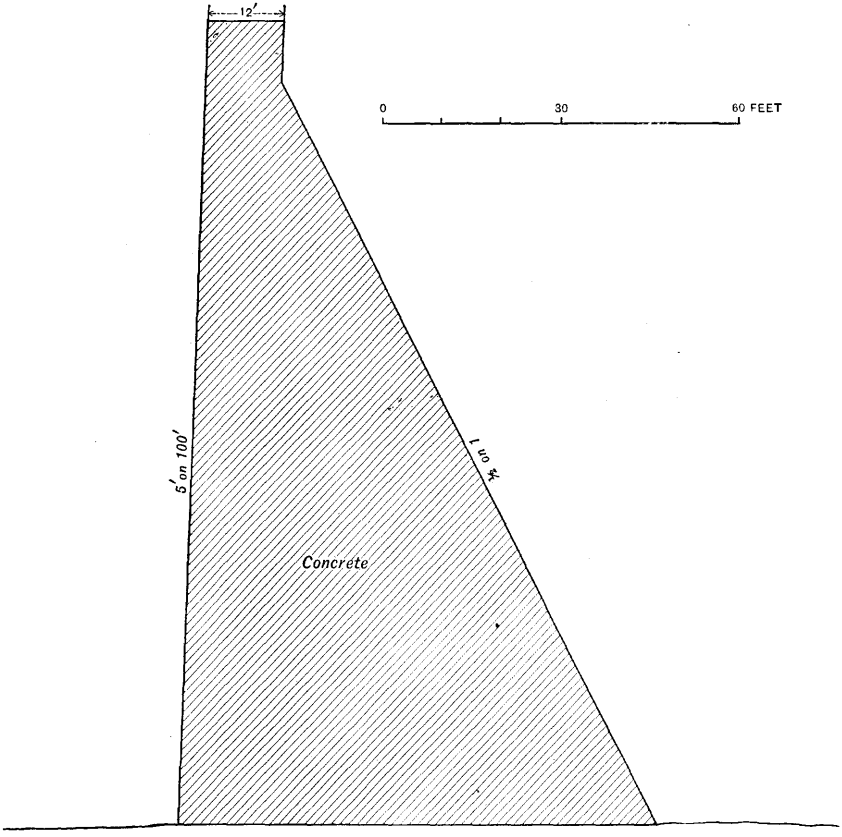


FIG. 5.—Section of concrete dam, Briscoe reservoir.

out in large blocks and that these, after having their surfaces thoroughly cleaned, can be embedded in concrete and will occupy at least one-fifth of the cubic contents of the dam. For purposes of comparison of cost, three types of dam have been estimated upon. First, the above-mentioned concrete gravity dam of light cross section and having a curve upstream on a radius of 300 feet, with a small return curve at each end, to fit the ground. With this design the overflow would be through the spillway. Second, a concrete overflow dam curved with a 300-foot radius and with a cross section the same as

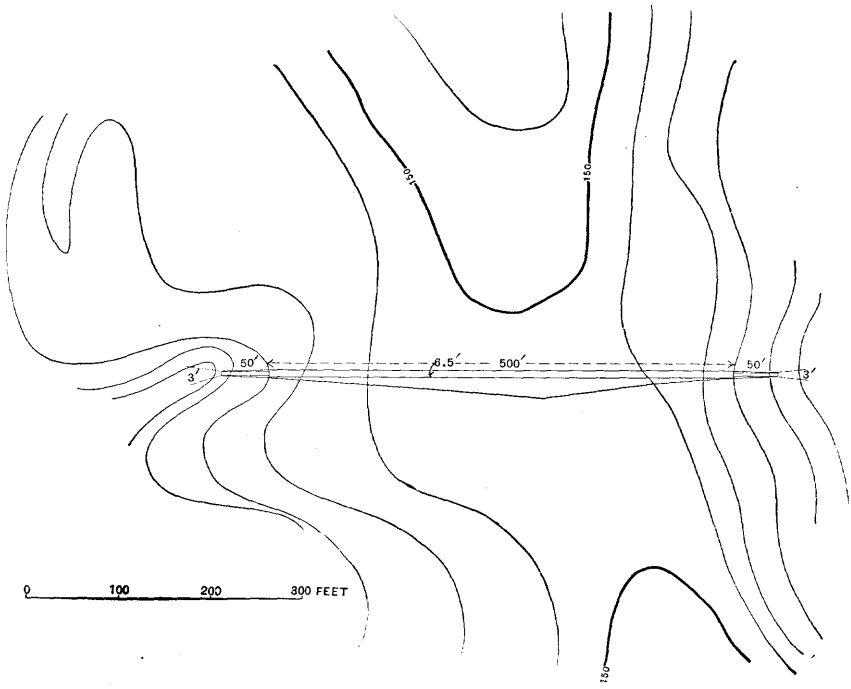


FIG. 6.—Plan of spillway, Briscoe reservoir.

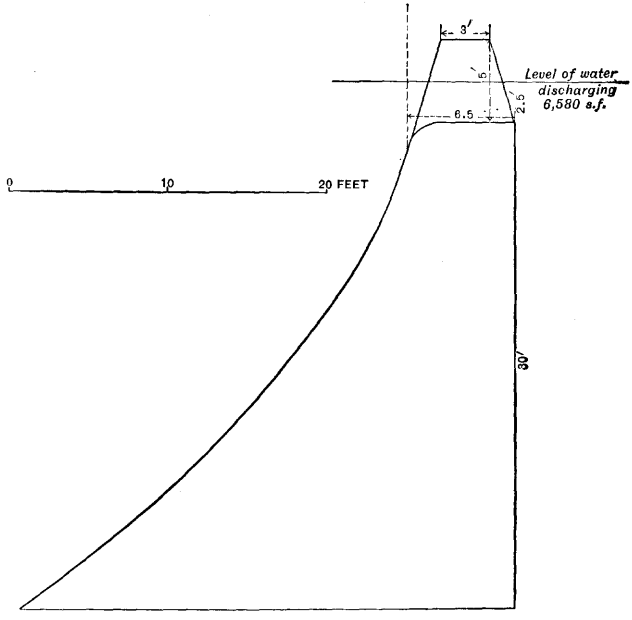
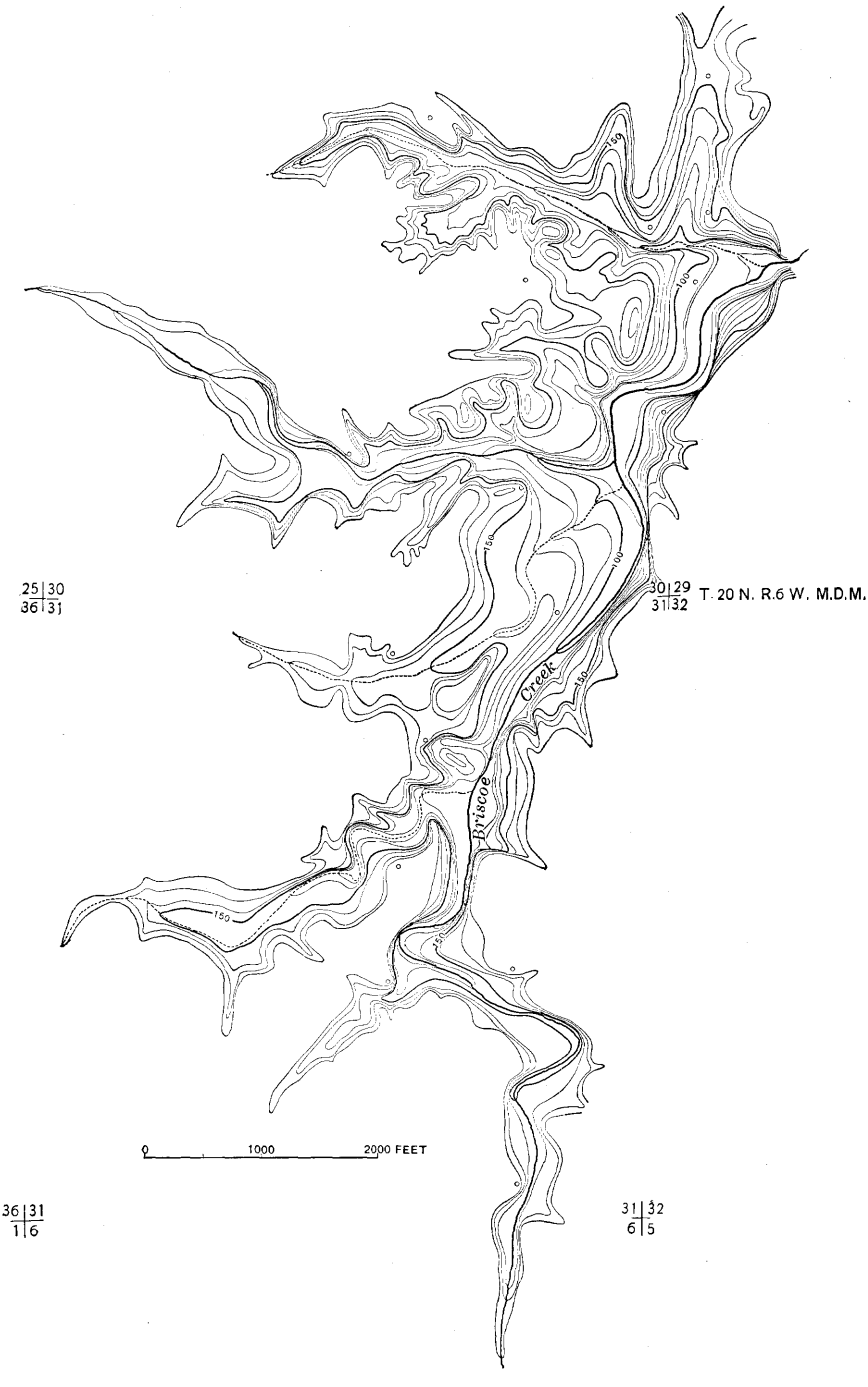


FIG. 7.—Section of spillway, Briscoe reservoir.



BRISCOE CREEK RESERVOIR SITE.

designed for the San Carlos dam on the Gila River, Arizona. In this plan the surplus water would pass over the dam. And third, a dry rubble or loose rock dam with straight crest and a plank water face.

In connection with the first and third type a concrete weir dam has been designed for a spillway at the location for the subsidiary dam.

For the second type, or overflow dam, an earth subsidiary dam is designed with concrete cut-off wall riprapped on water face. A concrete tower and tunnel outlet has been designed for each of the types; that for the loose rock type requiring a longer outlet tunnel and longer bridge, connecting tower with crest of dam.

The following data have been used in connection with designing an overflow concrete dam for the spillway:

The area of watershed is 50 square miles. Assuming the highest probable flood discharge at 100 second-feet per square mile, we have 5,000 second-feet flood discharge. It is desirable to have the surface level of the reservoir at the 180-foot contour (based upon an assumed datum), which, therefore, will be the level of lip of spillway weir. This will give a depth of 120 feet of water in the reservoir. The lowest point in the divide where the spillway is to be is at 154 feet elevation. Maximum height to crest of weir, 26 feet; length on top at 185-foot contour, 550 feet; length of weir opening at 180-foot contour, 500 feet. With a depth of water over weir of $2\frac{1}{2}$ feet the discharge capacity will be 6,580 second-feet, and with a depth over weir of 4 feet the capacity will be 13,320 second-feet, and the water level will be within 1 foot of the crest of main dam, the latter case being a most extreme assumption.

Capacity of Briscoe reservoir.

Contour.	Height of dam.	Area.	Capacity between contours.	Total capacity.
Feet.	*Feet.*	*Acres.*	*Acre-feet.*	*Acre-feet.*
70	10	1.7	8.5	8.5
80	20	10.7	62	70.5
90	30	17.2	139.5	210
100	40	30.6	239	449
110	50	53.0	418	867
120	60	71.9	624	1,491
130	70	99.1	855	2,344
140	80	144.8	1,219	3,565
150	90	211.1	1,779	5,344
160	100	271.0	2,410	7,754
170	110	347.8	3,094	10,848
180	120	401.5	3,747	14,595

Elevation of outlet 30 feet above bottom of reservoir.
Elevation of spillway 120 feet above bottom of reservoir.
Capacity, 14,595−210=14,385 acre-feet.

Estimate for dam on Briscoe Creek of type No. 1, concrete dam with wasteway to the north.

SPECIFICATIONS.

	Feet.
Length of dam on crest	360
Width of crest	12
Maximum height	125
Radius of crest	300
Elevation at base of dam	60
Elevation at outlet	90
Elevation at crest of spillway	180
Elevation at crest of dam	185
Front slope	¼ to 1
Back slope	5 to 100

Capacity of reservoir, 14,385 acre-feet.
Specific gravity of conglomerate, 143 pounds per cubic foot.

COST.

3,186 cubic yards rock, at $1	$3,186.00
12,744 cubic yards concrete, at $10	127,440.00
Spillway, 4,787.8 cubic yards concrete, at $10	47,878.00
Tower and outlet tunnel, complete	8,884.00
Bridge, 15-foot span	50.00
Plant and material	10,000.00
Right of way	1,000.00
	198,438.00
Engineering and contingencies, 10 per cent	19,843.80
Total	218,281.80

Cost per acre-foot stored, $15.17.

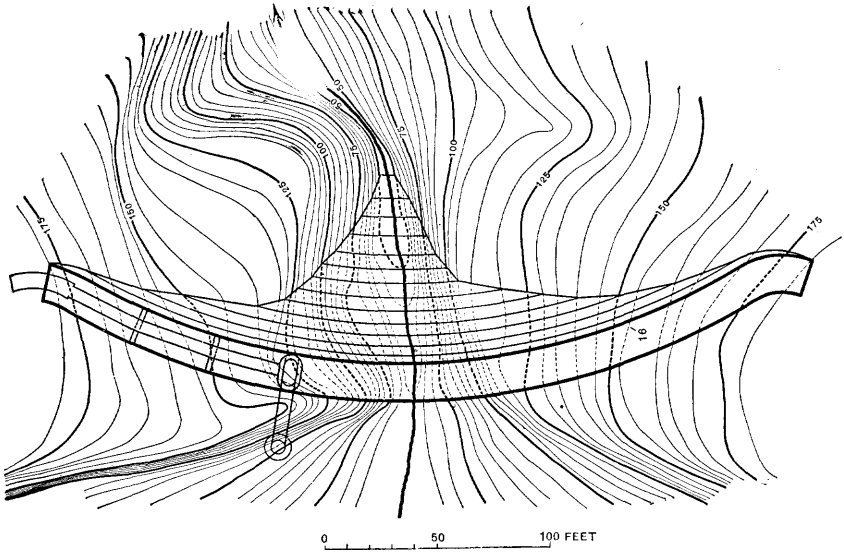


FIG. 8.—Plan of concrete overflow dam, Briscoe reservoir.

BRISCOE CREEK DAM SITE ABUTMENT.

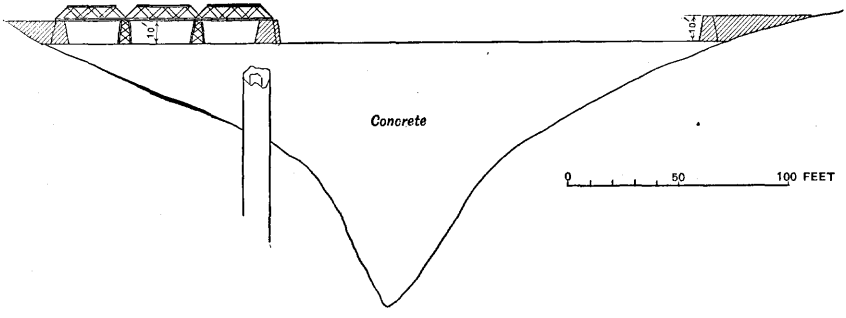


FIG. 9.—Elevation of concrete overflow dam, Briscoe reservoir.

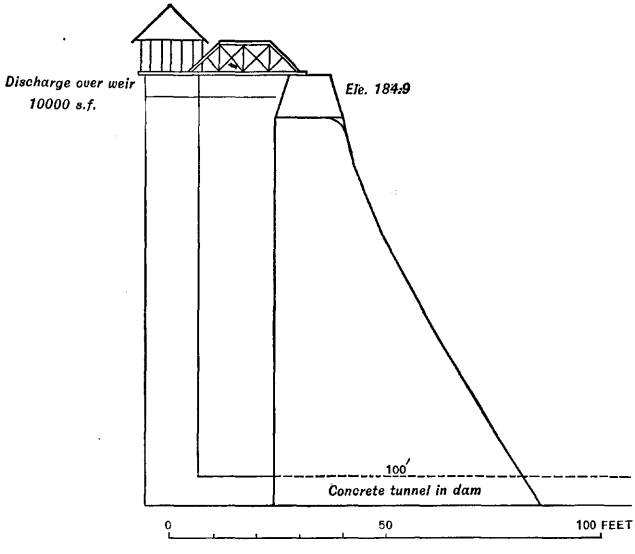


FIG. 10.—Cross section of concrete overflow dam, Briscoe reservoir.

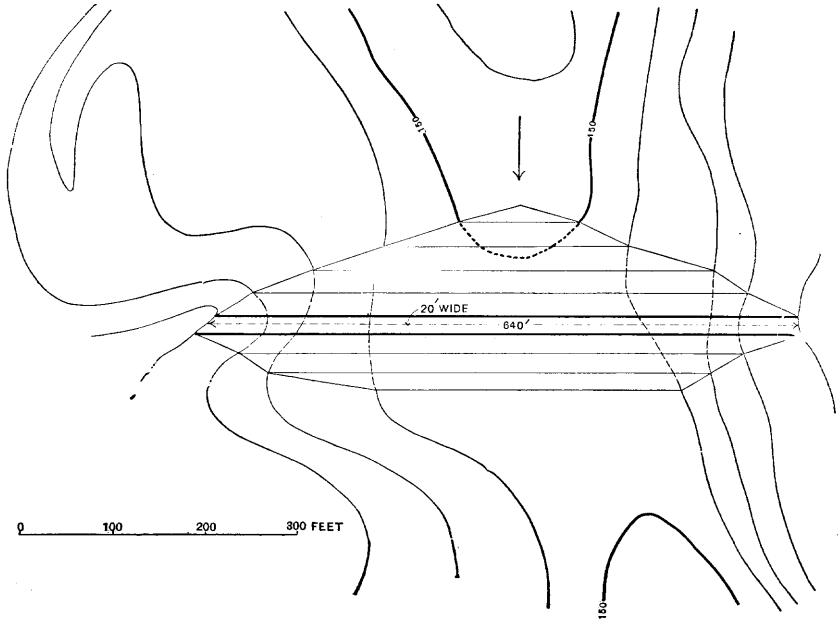


FIG. 11.—Plan of subsidiary earth dam, Briscoe reservoir.

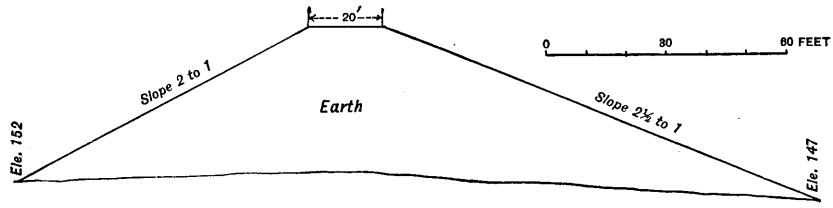


FIG. 12.—Cross section of subsidiary earth dam, Briscoe reservoir.

Estimate of dam on Briscoe Creek, type No. 2, concrete overflow dam, San Carlos cross section.

SPECIFICATIONS.

	Feet.
Length of dam on crest	360
Width of crest	16
Maximum height	120

COST.

3,572 cubic yards rock, at $1	$3,572.00
14,288 cubic yards concrete, at $10	142,880.00
End walls and bridge pier opposite tower, 349 cubic yards, at $10	3,490.00
Protection along toe of slope (concrete)	5,000.00
Subsidiary dam of earth with cut-off wall of concrete and riprapped on water face	15,888.50
Outlet works, tower, tunnel, bridge along axis of dam to tower	10,084.00

Plant and material	$10,000.00
Right of way	1,000.00
	191,914.50
Engineering and contingencies, 10 per cent	19,191.45
Total	211,105.95

Cost per acre-foot stored, $14.67.

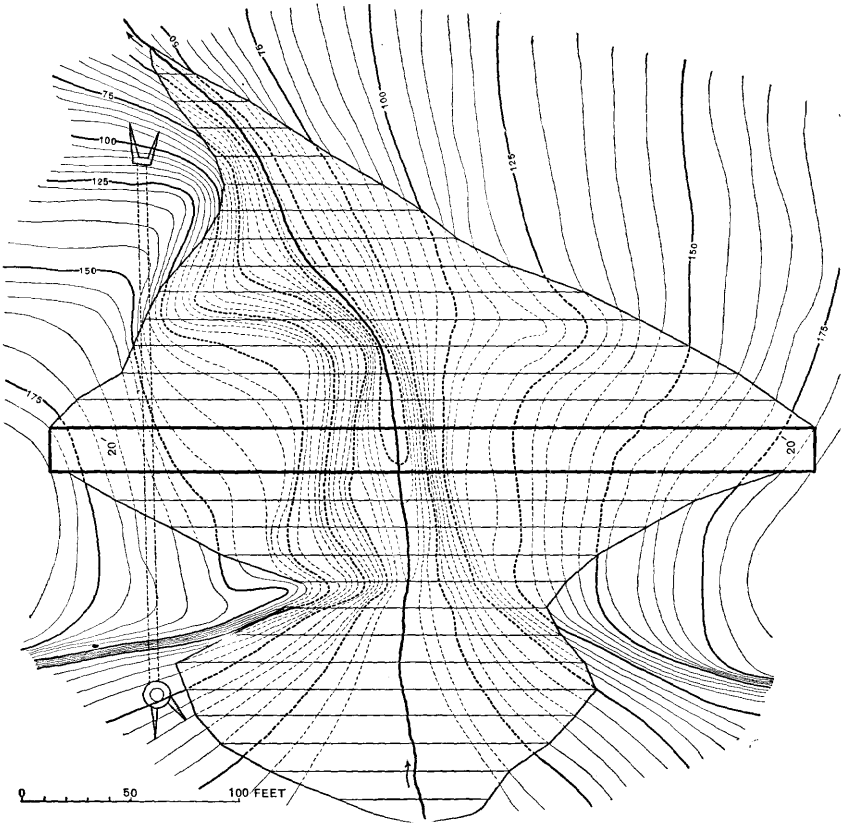


FIG. 13.—Plan of rock-filled dam, Briscoe dam site.

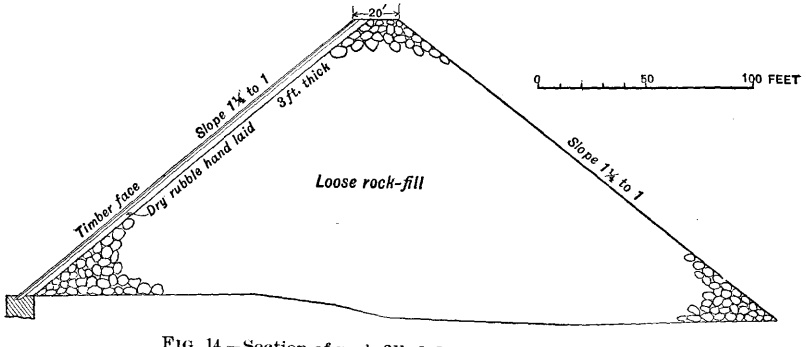


FIG. 14.—Section of rock-filled dam, Briscoe dam site.

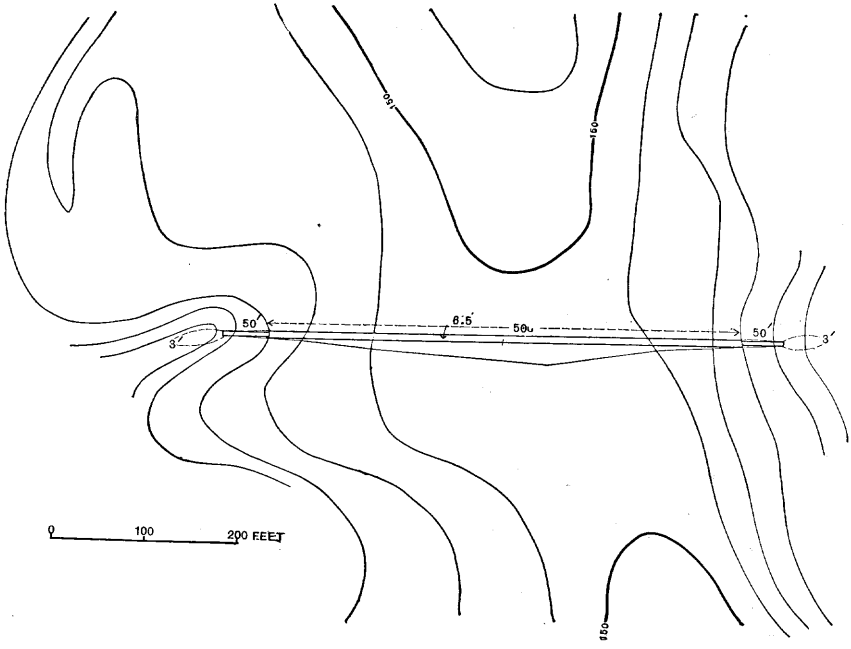


FIG. 15.—Plan of spillway, Briscoe dam site.

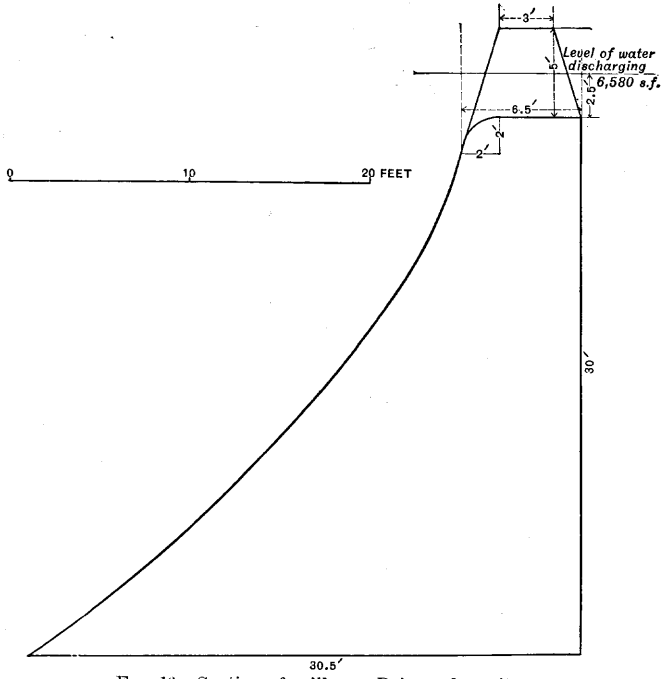
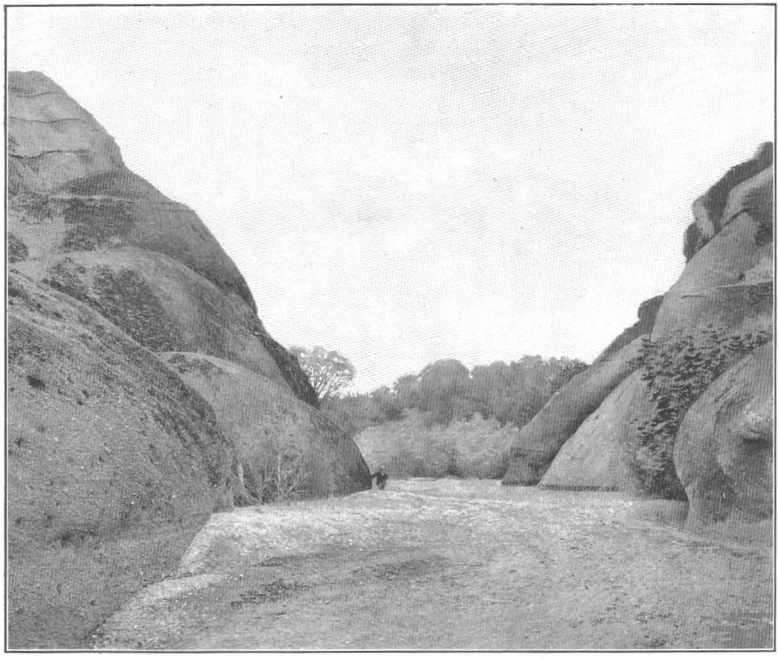
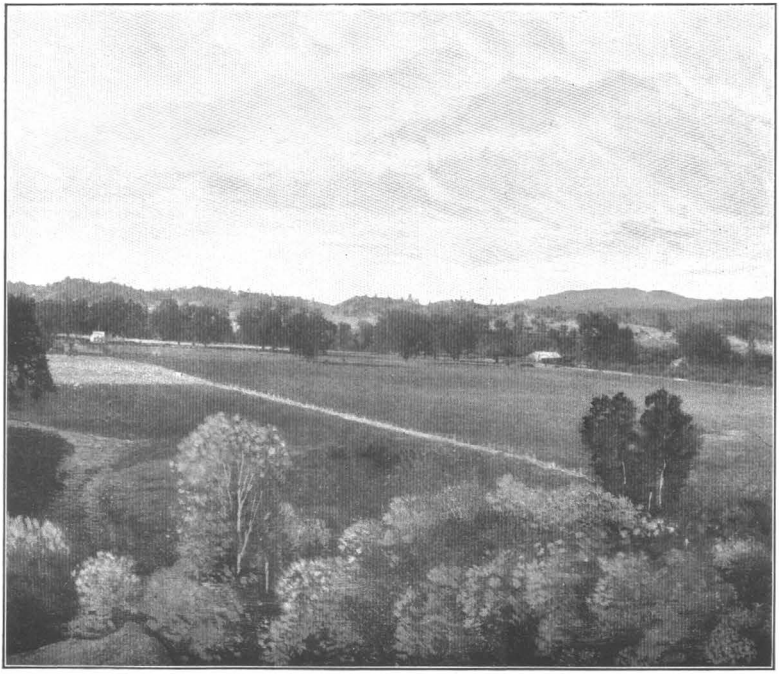


FIG. 16.—Section of spillway, Briscoe dam site.



A. EAST PARK DAM SITE ON LITTLE STONY CREEK.



B. WEST HALF OF EAST PARK RESERVOIR SITE.

Estimate of dam on Briscoe Creek, type No. 3, loose rock dam.

SPECIFICATIONS.

	Feet.
Length of dam on crest	360
Width of crest	20
Maximum height	125
Lower slope	1¼ to 1
Upper slope	1¼ to 1

COST.

78,856 cubic yards loose rock, at $1	$78,856
Timber face, 270,000 feet, at $25 a thousand	6,750
Concrete filling between stringers, 930 cubic yards, at $10	9,300
Dry rubble wall under plank face, 3 feet thick, 3,744 cubic yards, extra cost, at $1.50	5,566
Excavation for concrete cut-off wall: 370 cubic yards, at $2, $740; 1,130 cubic yards, at 75 cents, $848	1,588
Concrete to bed rock under plank face, 1,500 cubic yards, at $10	15,000
Tower and tunnel outlet, 100-foot span Pratt truss bridge, etc	11,000
Spillway same as for type No. 1	47,878
Plant and material	10,000
Right of way	1,000
	186,938
Engineering and contingencies, 10 per cent	18,694
Total	205,632

Cost per acre-foot stored, $14.29 +.

Type No. 1 is recommended for this site as possessing the most features suitable to the locality and conditions.

Type No. 2 is not considered very safe owing to the converging shape of the narrow canyon at the toe of outer slope which would offer immense resistance to the flood water discharging over dam, and the character of the rock is such that it would be liable to give way under the impact.

Type No. 3 is not recommended because of the unstable character of a plank water face and the ultimate necessity of replacing.

It is expected that 14,385 acre-feet of water will be available in the Briscoe reservoir in ordinary years. Below this dam in the Stony Creek Valley lies a body of land which at present is being used almost exclusively for grain farming, but which would with irrigation produce deciduous fruits and alfalfa at a much greater profit.

LITTLE STONY CREEK, EAST PARK RESERVOIR SITE.

At a point on Little Stony Creek about 2 miles southeast of Stony Ford, in Colusa County, a reservoir site was found and surveyed. The result shows that a dam to the 85-foot contour would give an available supply of 26,000 acre-feet of water. The drainage area above the dam is quite extensive but of relatively low elevation. From the meager rainfall records it is estimated that a mean annual draft of

26,000 acre-feet can be obtained from this reservoir. In order to obtain information as to the run-off available from this and other tributaries of Stony Creek the gaging station at Julian's ranch was established and is being maintained. Two types of dams have been designed for this location, corresponding to types Nos. 1 and 3 of Briscoe site.

Capacity of East Park reservoir.

Height of dam.	Area.	Capacity between contours.	Total capacity.
Feet.	*Acres.*	*Acre-feet.*	*Acre-feet.*
0	0	0	
10	2.28	11.4	11.4
20	44.19	232.5	243.9
25			654.3
30	119.97	820.8	1,064.7
40	254.86	1,874.1	2,938.8
50	478.14	3,665.0	6,603.8
60	640.49	5,593.2	12,197.0
70	1,100.36	8,704.3	20,901.3
75	1,240.67	5,852.6	26,753.9

Elevation of outlet, 25 feet.

Elevation of spillway, 75 feet.

Total capacity in acre-feet above outlet at 25-foot contour and up to 75-foot contour, 26,753.9—654.3=26,099.6; 26,000 acre-feet was used as capacity of reservoir.

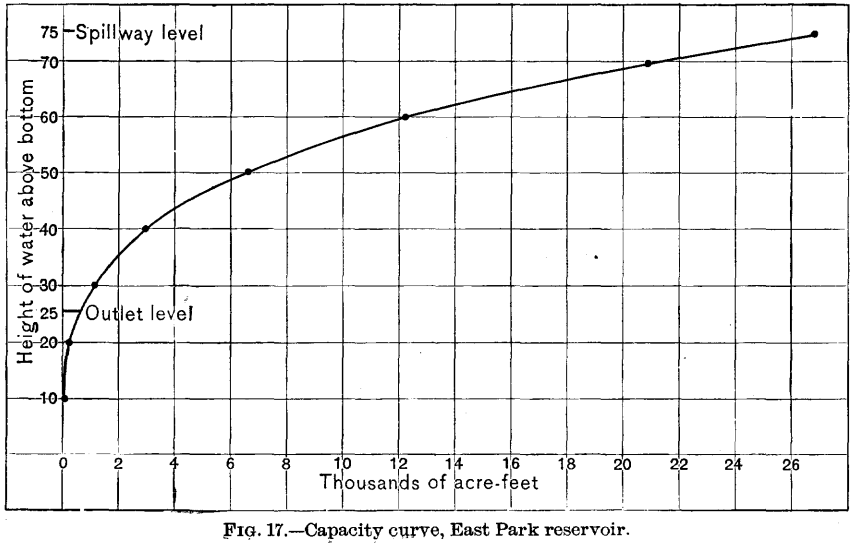
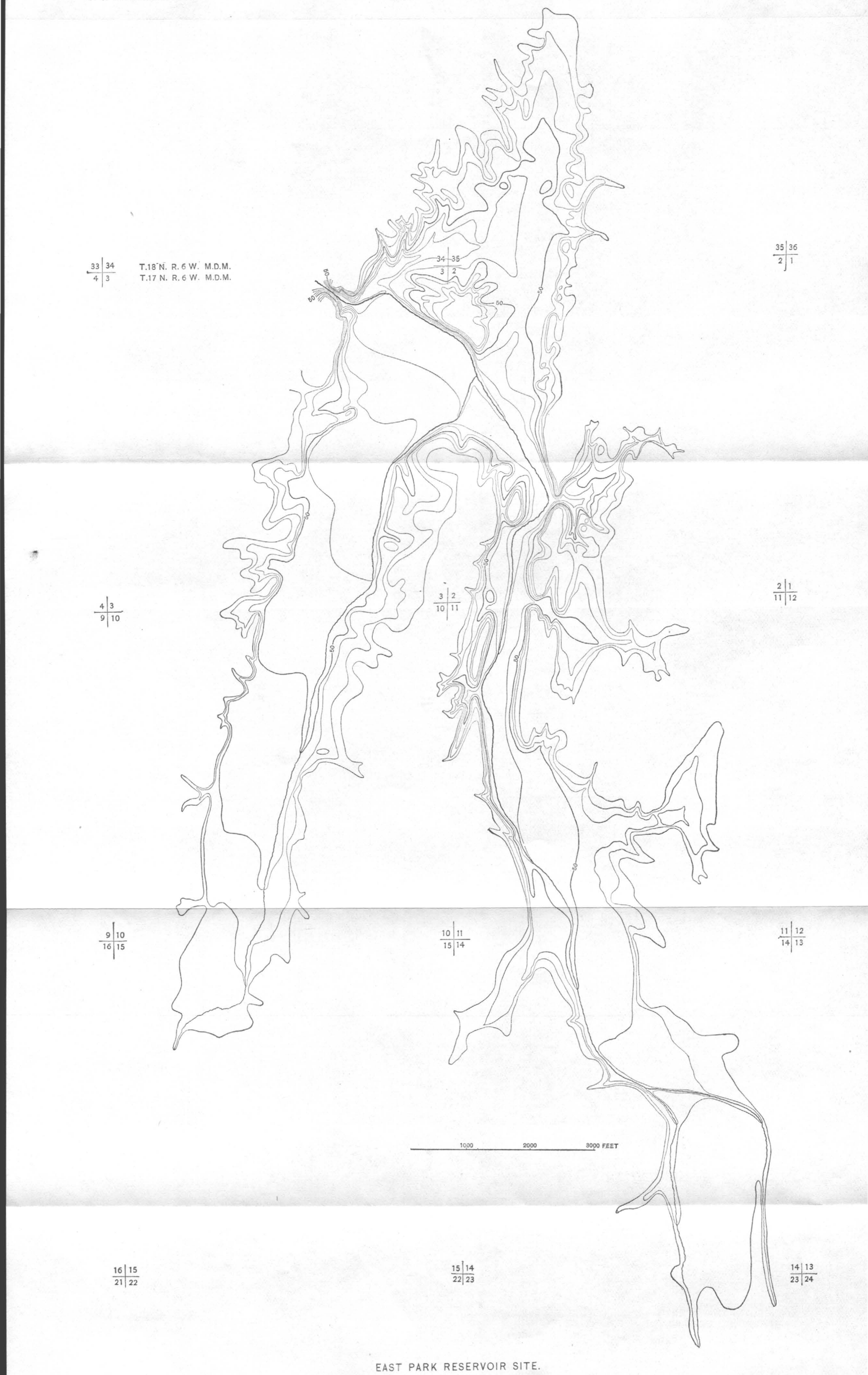


FIG. 17.—Capacity curve, East Park reservoir.



EAST PARK RESERVOIR SITE.

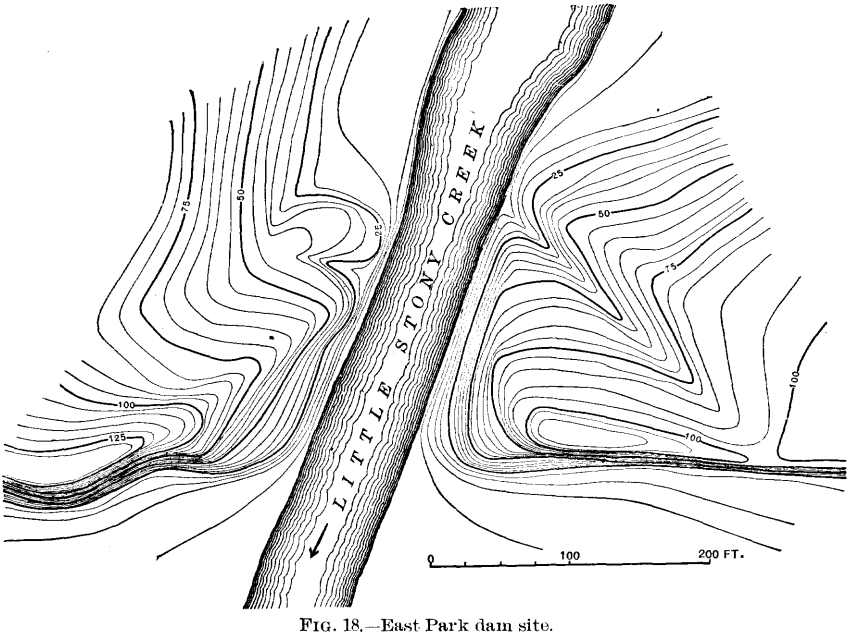


FIG. 18.—East Park dam site.

Estimate for dam on Little Stony Creek, type No. 1, concrete dam.

SPECIFICATIONS.

	Feet.
Batter of water face	5 in 100
Batter of lower face	1 in 2
Elevation of crest of dam	85
Estimated elevation of base of dam	—30
Maximum height of dam	115
Elevation of sill of spillway	75
Elevation of outlet	25

Capacity of reservoir, 26,000 acre-feet.

Capacity of spillway (water 2 feet below crest of dam), 15,070 cubic feet per second.

COST.

13,900 cubic yards concrete, at $10	$139,000.00
Excavation to bed rock	6,000.00
Spillway	3,285.00
Outlet tunnel and works	7,876.00
Bridge	720.00
Cable machinery	10,000.00
Lumber in flumes, etc., 10,000 feet B. M., at $20	200.00
Right of way	20,700.00
	187,781.00
Engineering and contingencies, 10 per cent	18,778.10
Total	206,559.10

Cost per acre-foot stored, $7.94.

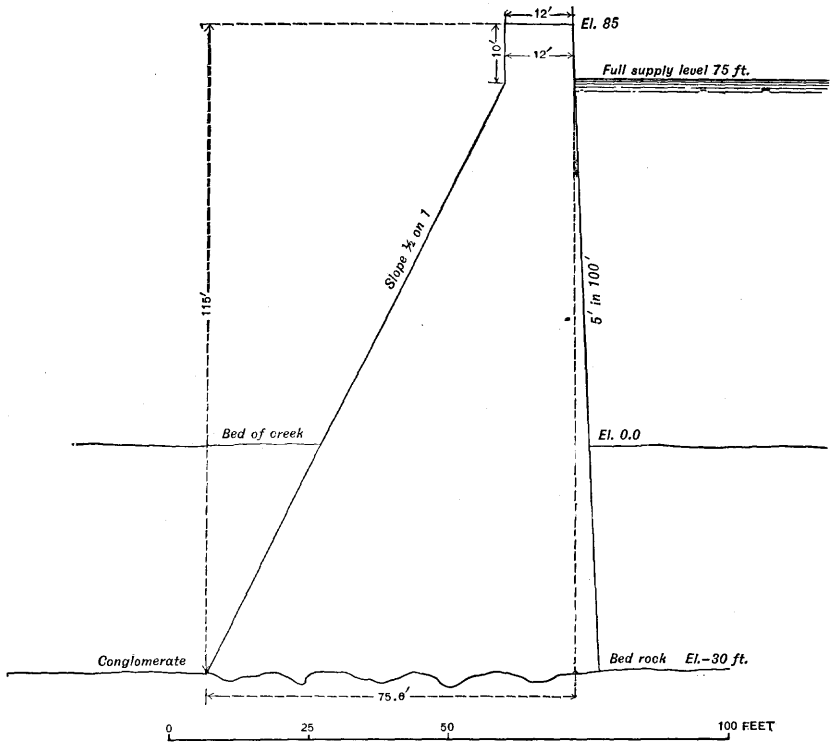


FIG. 19.—Maximum cross section of concrete dam, East Park dam site.

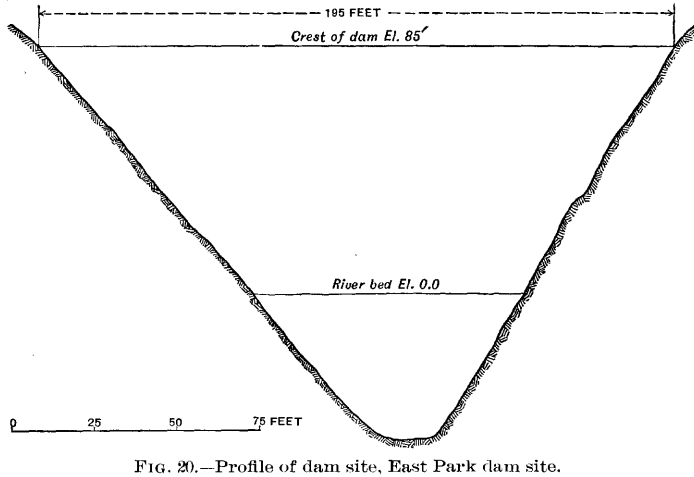
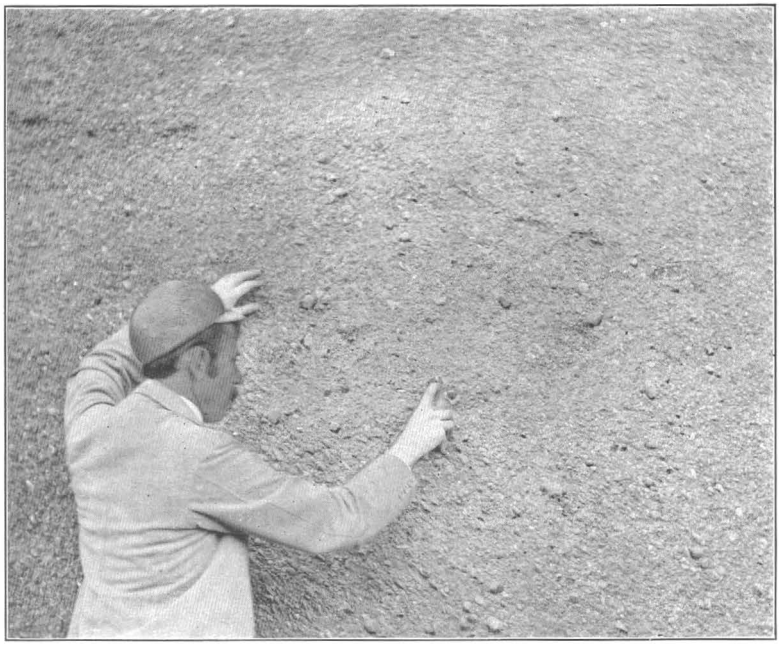
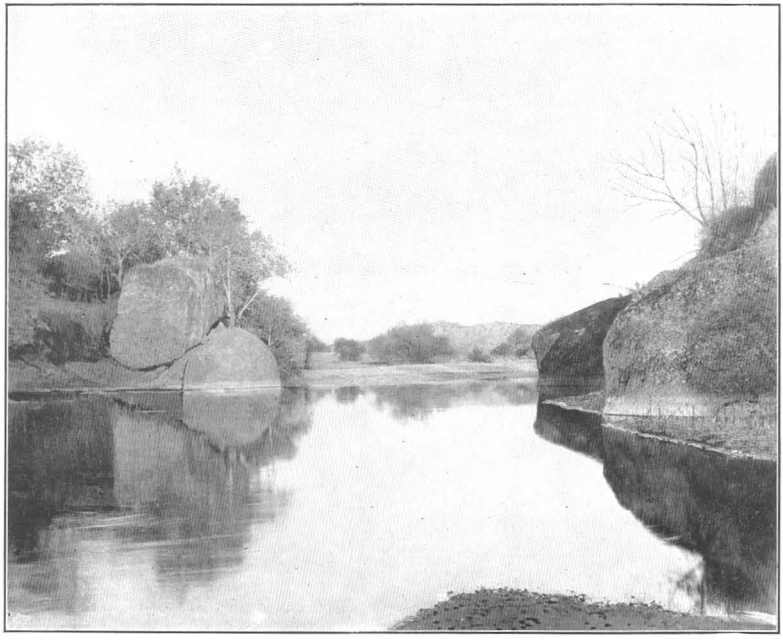


FIG. 20.—Profile of dam site, East Park dam site.



A. CONGLOMERATE AT EAST PARK.



B. MILL SITE DAM SITE ON STONY CREEK.

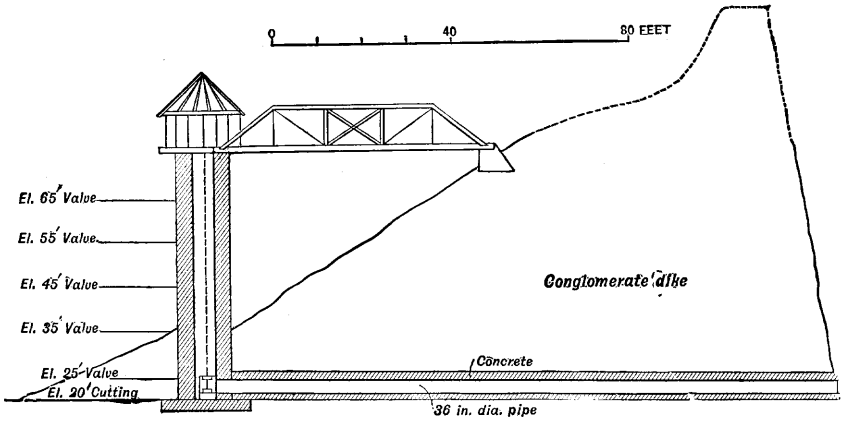


FIG. 21.—Outlet tunnel, East Park dam site.

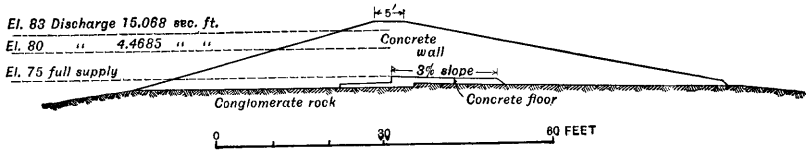


FIG. 22.—Profile of spillway, concrete dam, East Park dam site.

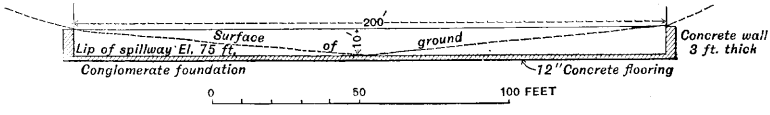


FIG. 23.—Cross section of spillway, concrete dam, East Park dam site.

Estimate of cost of rock-filled dam on Little Stony Creek. Type No. 2.

52,700 cubic yards, at $1.25	$65,875.00
Excavation to bed rock, 2,000 cubic yards, at $2	4,000.00
Concrete to bed rock, 1,500 cubic yards, at $10	15,000.00
Plank face, 170,000 feet B. M., at $25 a thousand	4,250.00
Concrete between stringers under planks, etc., 481 cubic yards, at $10	4,810.00
Concrete valve tower and bridge	7,040.00
Tunnel and concrete filling	1,850.00
Wasteway	18,250.00
Dry rubble foundation under timber, 1,444 cubic yards, at $1.50 (extra cost)	2,166.00
Cable machinery	10,000.00
Right of way	20,700.00
	153,941.00
Engineering and contingencies, 10 per cent	15,394.00
Total	169,335.00

Cost per acre-foot stored, $6.51.

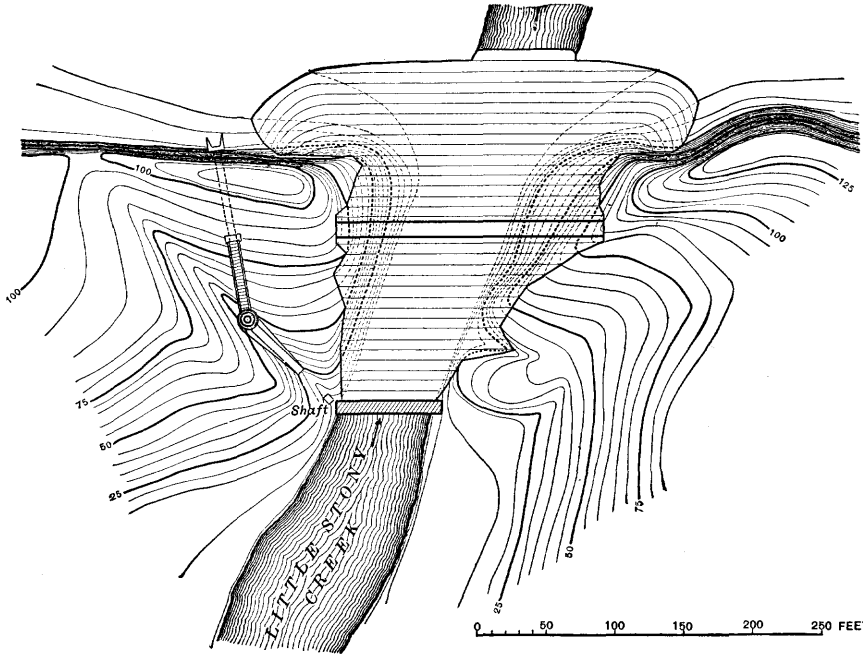


FIG. 24.—Plan of rock-filled dam, East Park dam site.

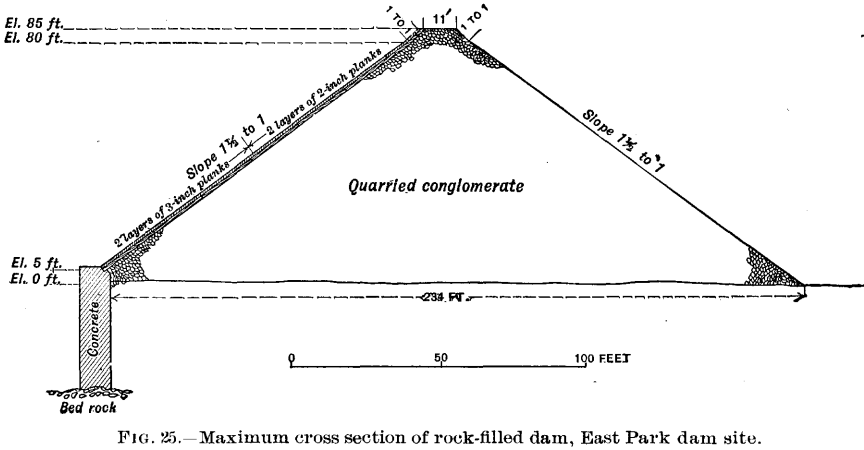


FIG. 25.—Maximum cross section of rock-filled dam, East Park dam site.

Type No. 1 is recommended for this location as being more substantial and serviceable than a rock-fill type.

There is a scarcity of sand at the dam sites on Little Stony Creek, and the cost of concrete has been estimated upon the basis that the conglomerate rock will have to be crushed and washed for use in place of sand. It is thought from inspection that the conglomerate is hard enough to make good sand, which can be ground to a uniform grade and thoroughly washed under pressure in a revolving cylinder.

MILL SITE RESERVOIR SITE.

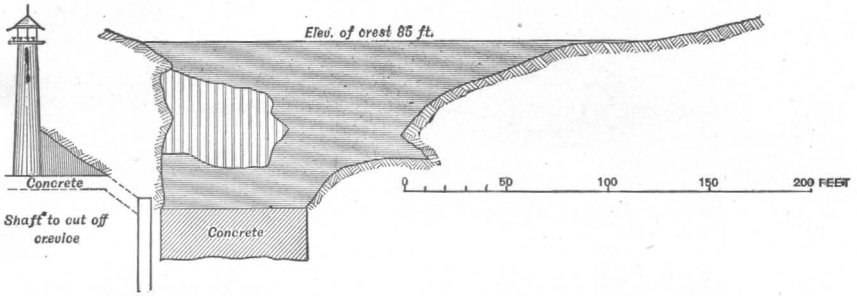


FIG. 26.—Downstream elevation, rock-filled dam, East Park dam site.

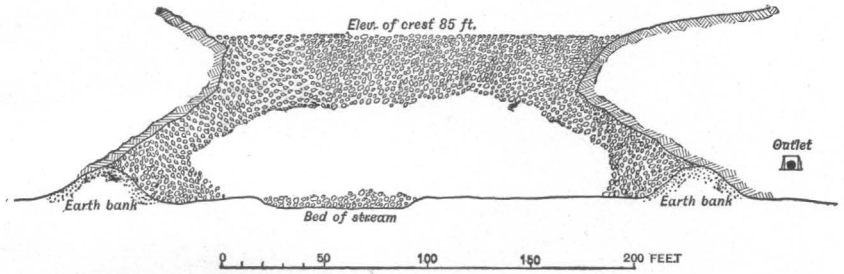
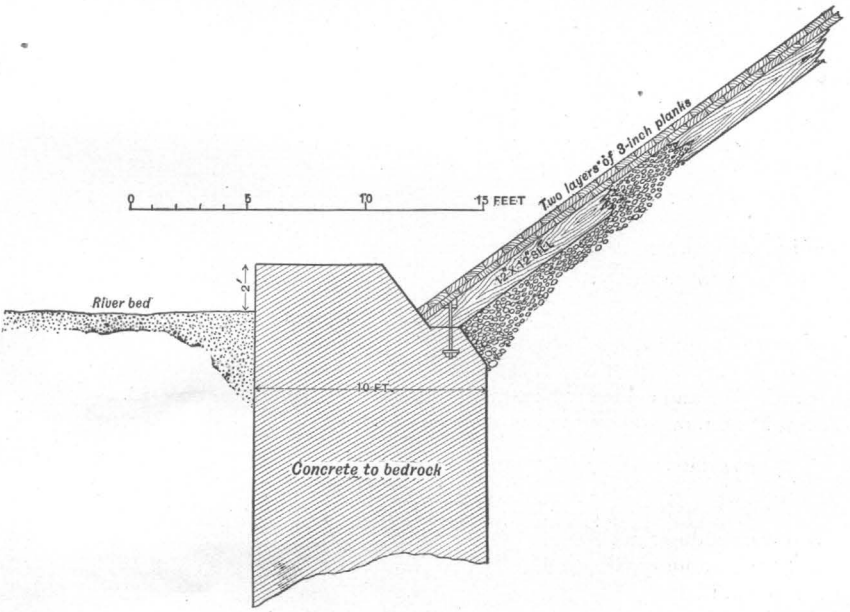


FIG. 27.—Upstream elevation, rock-filled dam, East Park dam site.



G. 28.—Detail of plank face, rock-filled dam, East Park dam site.

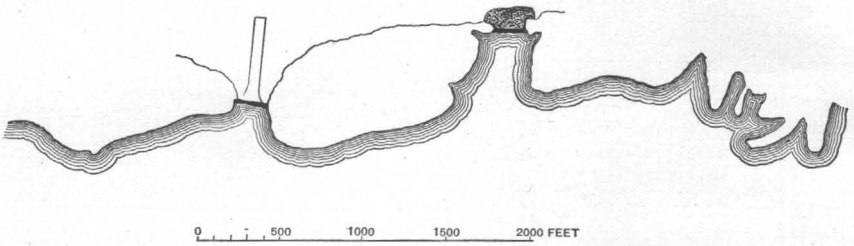


FIG. 29.—Plan showing relative position of wasteway, rock-filled dam, East Park dam site.

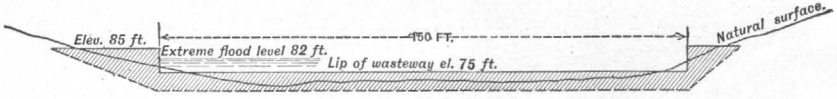


FIG. 30.—Cross section of wasteway, rock-filled dam, East Park dam site.

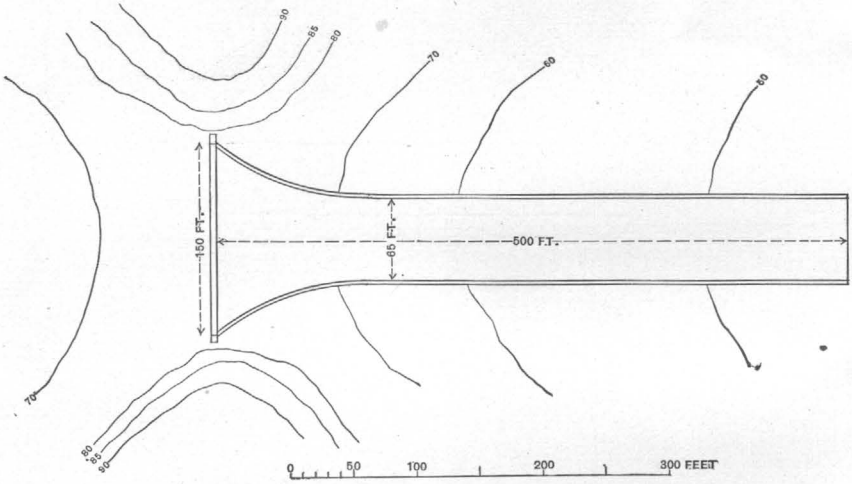


FIG. 31.—Plan of wasteway, rock-filled dam, East Park dam site.

The following figures have been used to estimate the cost of concrete in this locality:

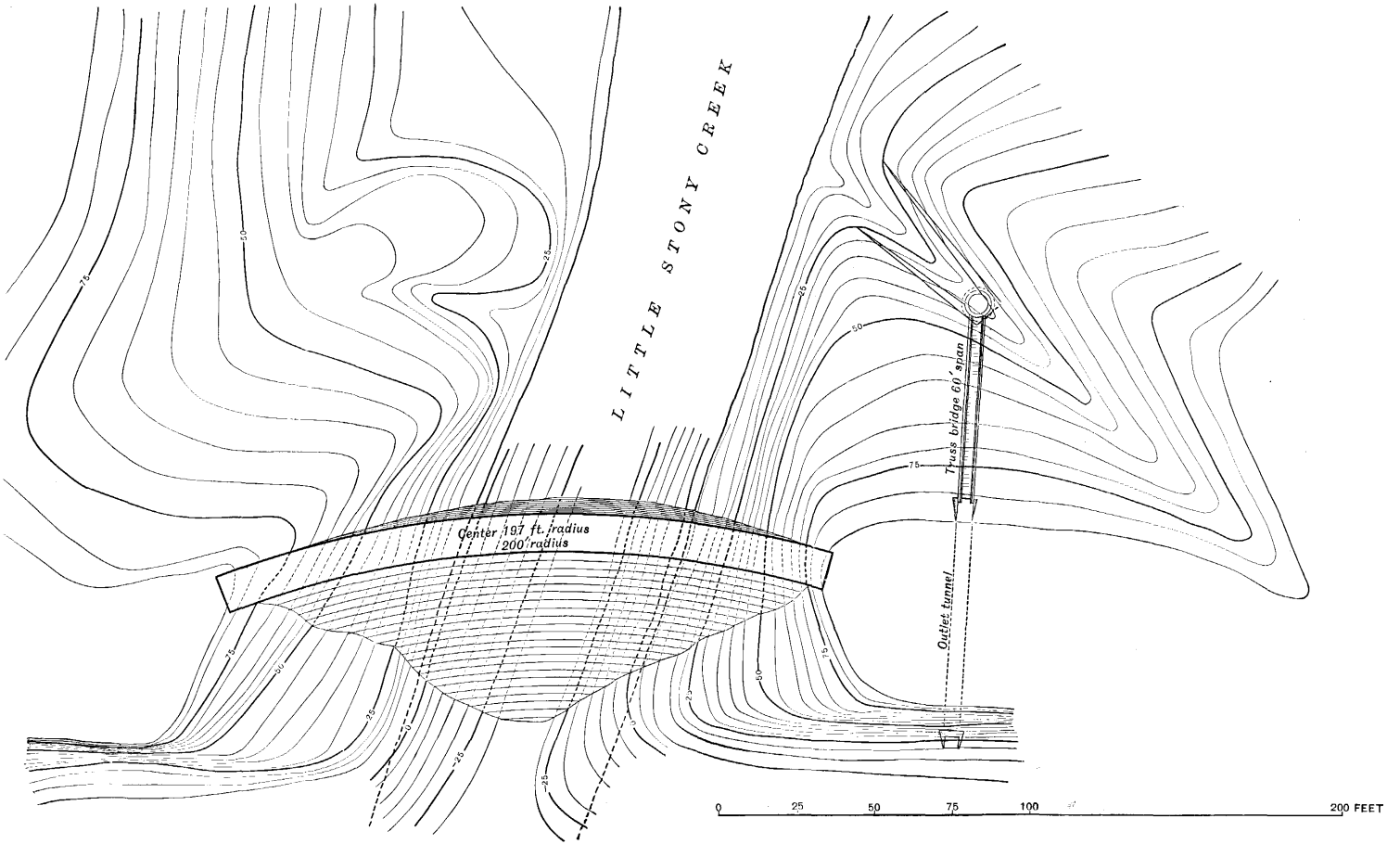
Cost of concrete at Little Stony Creek.

CEMENT.

1 barrel Portland cement, at railroad	$3.75	
Freight to dam, at 20 cents per 100 pounds	.80	
Cost delivered, per 375 pounds		$4.55

PLANT FOR PREPARING CONCRETE.

Mill for crushing rock	1,500.00
Mill for grinding coarse sand	1,500.00
Engine and boiler	1,000.00
Freight and setting up	500.00
Plant for preparing sand and rock for concrete	4,500.00
Machine for washing	1,000.00



PLAN OF CONCRETE DAM, EAST PARK DAM SITE.

PREPARING ROCK AND SAND.

Rock, crushing, per cubic yard	$1.50	
Rock, washing, per cubic yard	.15	
		$1.65
Sand, grinding, per barrel	.36	
Sand, washing, per barrel	.14	
		.50

TOTAL COST PER YARD OF CONCRETE.

Rock, 1 cubic yard	1.65
Sand, 2 barrels, at 50 cents	1.00
Cement, 1 barrel	4.55
Labor, mixing	.50
Labor, placing in dam	1.00
Allow for machinery	.30
Contingencies	1.00
Estimate total cost, per yard	10.00

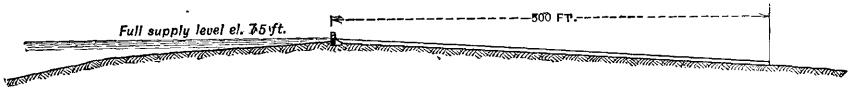


FIG. 32.—Profile of wasteway, rock-filled dam, East Park dam site.

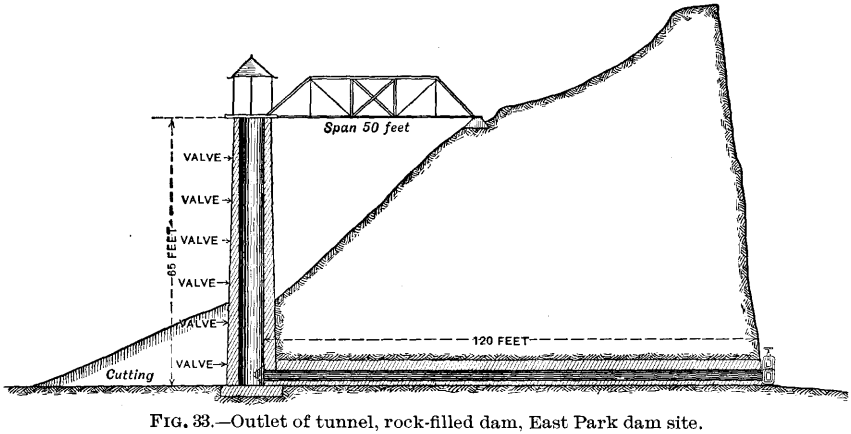


FIG. 33.—Outlet of tunnel, rock-filled dam, East Park dam site.

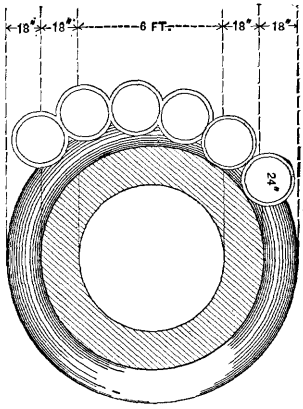


FIG. 34.—Plan of valves, rock-filled dam, East Park dam site.

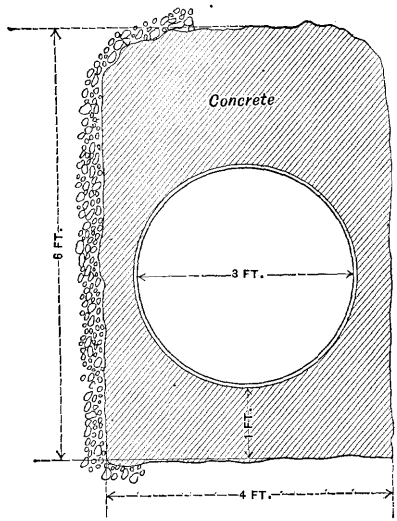


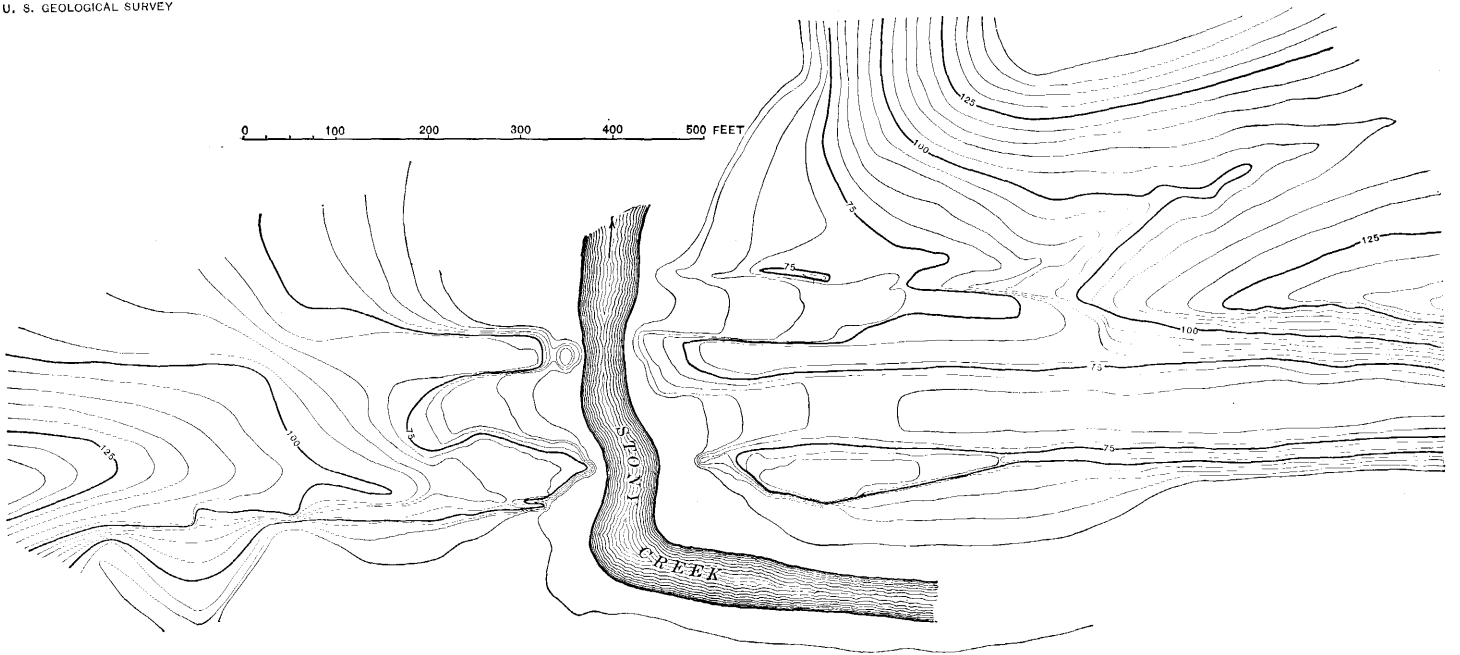
FIG. 35.—Tunnel cross section, rock-filled dam, East Park dam site.

MILL SITE.

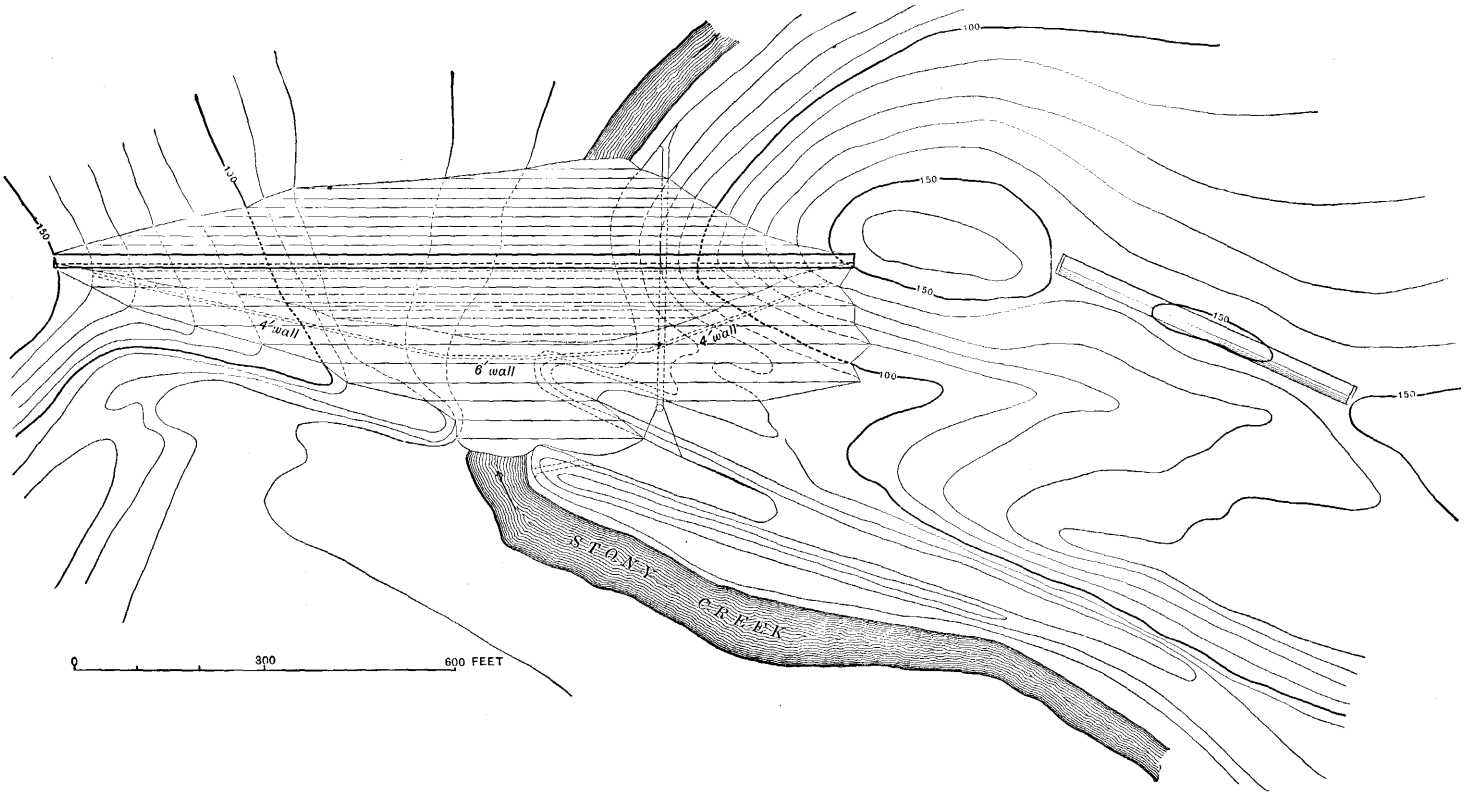
At a point on the main creek in sec. 1, T. 21 N., R. 6 W., Mount Diablo meridian, locally known as the "Mill Site," the main stream intersects a conglomerate bed.

As it is near the Sacramento Valley, and has back of it over 500 square miles of drainage area, exclusive of Briscoe and Little Stony creeks, this site is relatively important. A dam at this point, 95 feet above the stream bed, would impound 43,735 acre-feet of water. The drainage area above the site is such that it is estimated that this amount of water would be available even in dry years. A record of the flow has been kept at Julian's ranch at a point $1\frac{3}{4}$ miles above the dam site; the estimated discharge for 1901 and 1902 is shown by the table on p. 35. The depth to bed rock is assumed to be 35 feet. No soundings were made to determine this.

The wall rock is not very good, and material for concrete would have to be transported 1,600 feet. Owing to these conditions it was decided to estimate on a loose or rock-filled dam with ample spillway. The dam designed has a top length of 1,240 feet, upper slope 1 to $1\frac{1}{4}$; lower slope $1\frac{1}{2}$ to 1; the upper slope is to be faced with an earth embankment built against it with a slope of 3 to 1, the width of the rock on the top to be 15 feet and the earth 5 feet, making the finished crest 20 feet wide. The spillway, calculated to carry 36,250 second-feet of water when flowing 8 feet deep over the sill, is 500 feet wide by 10 feet deep, and would be located to the east of the dam through a low saddle, and discharge several hundred feet below the dam.



MILL SITE DAM SITE, ROCK-FILLED DAM.



PLAN OF MILL SITE DAM.

Estimate of cost of rock-fill dam at Mill Site.

198,400 cubic yards earth and selected material, at 75 cents per cubic yard		$148,800
293,200 cubic yards loose rock to be transported, average 1,600 feet, at $1		293,200
Concrete cut-off wall, 2,836 cubic yards, at $10	$28,360	
Excavation, 1,452 cubic yards, at $2	2,904	
Excavation, 951 cubic yards, at 50 cents	476	
		31,740
Spillway, 500 feet wide 10 feet deep:		
Excavation, 13,160 cubic yards, at 40 cents	5,264	
Concrete wall and apron for weir, 875 cubic yards, at $10	8,750	
		14,014
Outlet tunnel, 400 feet, at $10		4,000
Tower, 90 feet, 1.7 cubic yards per foot, 153 cubic yards, at $10		1,530
Valves and appliances		3,000
Concrete dam in tunnel, 100 feet, 85 cubic yards, at $10		850
100 feet 48-inch pipe and gate attached		2,000
Bridge for tower, 225 feet span, Pratt truss		3,000
18,340 cubic yards riprapping, at $1.50 (additional charge)		27,510
		529,644
10 per cent for contingencies and engineering		52,964
Total		582,808

Cost per acre-foot stored, $13.32.

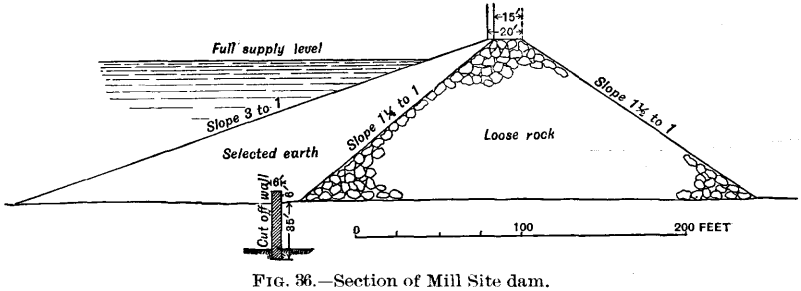


FIG. 36.—Section of Mill Site dam.

Capacity of Mill Site reservoir.

Contour.	Height of dam.	Area.	Capacity between contours.	Total capacity.
Feet.	*Feet.*	*Acres.*	*Acre-feet.*	*Acre-feet.*
55	0	0	0	0
60	5	25.9	130	65
70	15	117.1	715	780
80	25	268.3	1,927	2,707
90	35	398.2	3,333	6,040
100	45	504.6	4,514	10,554
110	55	629.4	5,670	16,224
120	65	798.4	7,139	23,363
130	75	1,029.1	9,137	32,500
140	85	1,231.2	11,300	43,800

Elevation of outlet, 5 feet above bottom of reservoir.
Elevation of spillway, 85 feet above bottom of reservoir.
Capacity, 43,800—65=43,735 acre-feet.

This water would be used to irrigate the rich foothill lands on the west side of the Sacramento Valley between Orland and Willows.

In the judgment of the county assessor, who has an intimate knowledge of the nature of the land in Glenn County, these lands would be easily advanced $30 per acre in value if furnished with ample water supply.

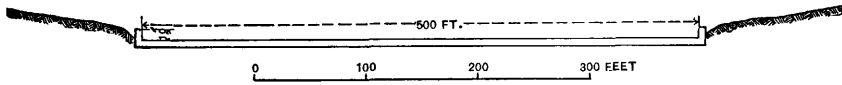
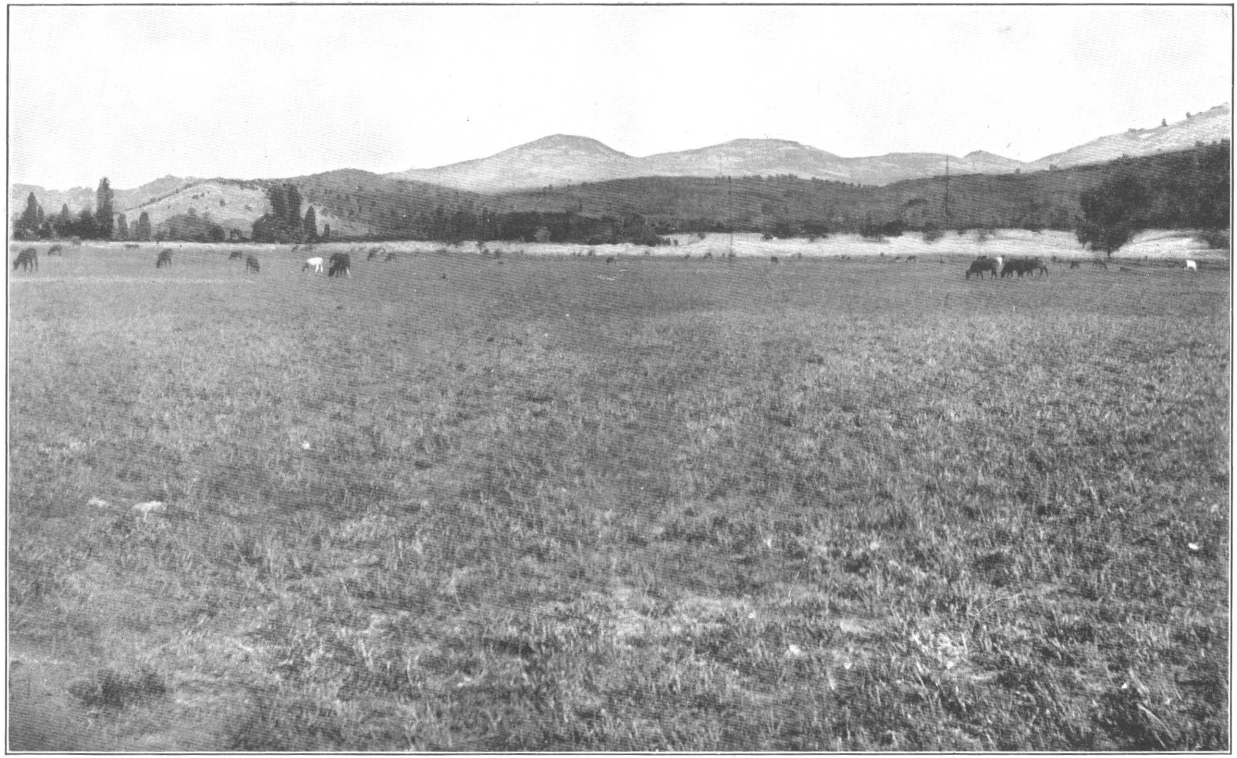


FIG. 37.—Section of spillway, Mill Site dam.

The capacity of the Mill Site reservoir not being sufficient to impound all of the flow of Stony Creek, a further investigation was made in February, 1901, of the feasibility of diverting a portion of this water into Hambright and Eppinger creeks, small streams rising in the foothills and discharging into the Sacramento Valley. Certain reservoir sites exist on those streams too large to be filled from their drainage basins. The result of this investigation indicated that the cost of the diversion-canal line would be too heavy and the reservoir capacity not sufficient to justify the necessary expense incident to this construction.



ALFALFA FIELD, BROWN'S RANCH, STONY CREEK VALLEY.

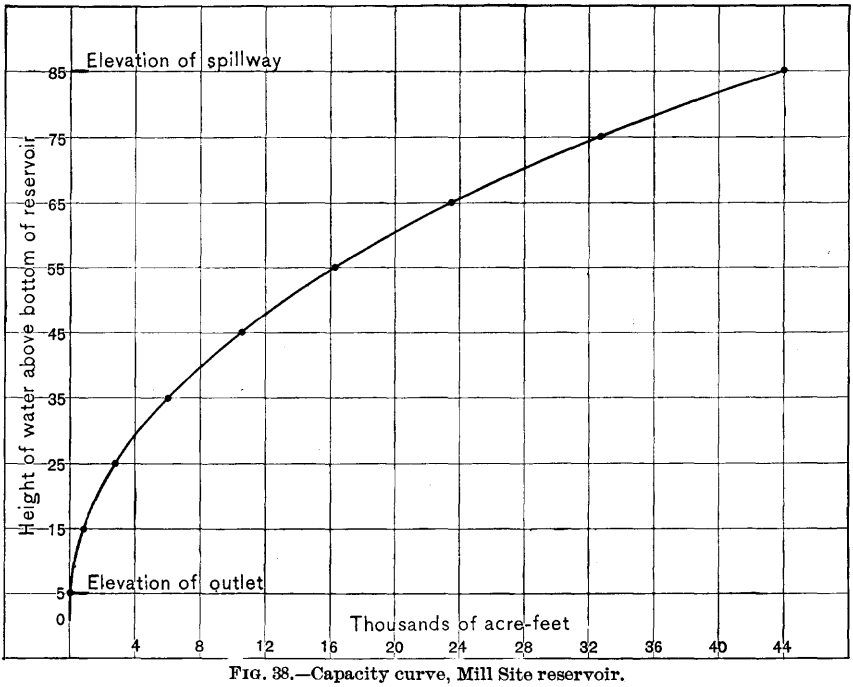


FIG. 38.—Capacity curve, Mill Site reservoir.

SUMMARY.

The annual cost per acre-foot of water stored is the important result to obtain, and this is shown by the accompanying table for each reservoir and for each class of dam estimated upon.

Cost and capacity of reservoirs on Stony Creek.

Improvement.	Description.	Area of watershed.	Length of dam on crest.	Width of crest of dam.	Capacity.	Cost of installation.		Annual cost per acre-foot of water stored for interest and operation.
						Total.	Per acre-foot stored.	
		Square miles.	*Feet.*	*Feet.*	*Acre-feet.*			
Briscoe reservoir.	125-foot concrete gravity dam with wasteway.	50	360	12	14,385	$218,281.80	$15.17+	$1.10
	120-foot concrete overflow dam.	50	360	16	14,385	211,105.95	14.67+	1.07
	125-foot loose rock-fill dam with wasteway.	50	360	20	14,385	205,632.00	14.29+	1.09
East Park reservoir.	115-foot concrete gravity dam with wasteway.	210	197	12	26,000	206,559.10	7.94	.58
	115-foot loose rock-fill dam with wasteway.	210	195	20	26,000	169,335.00	6.51	.50
Mill Site reservoir.	95-foot loose rock-fill dam with wasteway.	500	1,240	20	43,735	582,608.00	13.32	.93

As it is not determined just where the water will be used, loss by seepage and evaporation in the canals can not be estimated. Evaporation from the surface of reservoirs for the months of June, July, August, and September would probably be from 3 to 5 per cent of the capacity of the reservoir, and in these estimates has been neglected.

The life of the plank face in the case of the rock-fill dams has been taken as eight years.

To illustrate particularly the method of arriving at the cost per acre-foot of water delivered, the Mill Site reservoir will be taken as an example. Consider the entire cost, $582,608, to bear 6 per cent interest, and taxes to be at the rate of 0.8 of 1 per cent of cost, and the charge for attendance, etc., to be $1,000 per annum, the annual charges to be provided for would be $40,617.34. The available capacity of the reservoir is 43,735 acre-feet. This, divided into the annual charge of $40,617.38, gives as the annual cost per acre-foot of water delivered from the reservoir 93 cents.

CONCLUSIONS.

The following conclusions may be drawn from the preceding text, tables, and estimates:

(1) The lands of portions of Glenn and Colusa counties have steadily decreased in value, fertility, and population for the last ten years.

(2) The lands on the west side of the Sacramento Valley in the vicinity of Orlando and Willows need irrigation and would be at once increased in value at least $30 per acre if a permanent water supply were assured, and the land values and population would steadily increase under irrigation.

(3) The climatic conditions are favorable for the growth of fruit and nearly all the products of the State in this vicinity.

(4) Several commercially valuable reservoir sites exist in the watershed of Stony Creek and its tributaries.

(5) The annual run-off is sufficient to fill these reservoirs in years of average rainfall. In the case of the Mill Site reservoir the supply is many times greater than the capacity of the reservoir. There would probably not be sufficient run-off to fill the Briscoe Creek and Little Stony Creek reservoirs in years of very low rainfall.

(6) The cost per annum per acre-foot of water stored in the reservoirs ranges from 50 cents to $1.10.

(7) The conditions are favorable for long life of the reservoirs on account of the small amount of silt and débris carried by the streams.

INDEX.

O

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The following paper also should be noted under this heading: Reservoirs for irrigation, by J. D. Schuyler, in Eighteenth Annual, Part IV.

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