STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

REPORTS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, STATE ENGINEER

SACRAMENTO-SAN JOAQUIN

WATER SUPERVISOR'S REPORT

FOR YEAR 1929

HARLOWE M. STAFFORD
WATER SUPERVISOR

SACRAMENTO, CALIFORNIA
JUNE 1, 1930

77926 7-30 350 CALIFORNIA STATE PRINTING OFFICE, SACRAMENTO

DEPARTMENT OF PUBLIC WORKS
STATE OF CALIFORNIA

REPORTS OF THE
DIVISION OF WATER RESOURCES
EDWARD HYATT, State Engineer

S A C R A M E N T O S A N J O A Q U I N

W A T E R S U P E R V I S O R ' S

R E P O R T

FOR YEAR

1 9 2 9

HARLOWE M. STAFFORD
Water Supervisor

Sacramento, California
June 1, 1930

TABLE OF CONTENTS

Page

SUPPLEMENTARY REPORT

(This comprises a report of about 400 pages giving the 1929 daily diversion records in acre-feet for those diversions for which the monthly data only is tabulated in Chapter III. This supplementary report is not published but is on file and available for reference in the office of the Division of Water Resources.)

LIST OF TABLES

LIST OF PLATES

ACKNOWLEDGMENTS

It is desired to acknowledge and express appreciations for:

The cooperation and contributions to this work, of various state and federal agencies. These have included the Water Resources Branch of the U.S. Geological Survey, through H. D. McGlashan, District Engineer; the U. S. Department of Agriculture, Division of Agricultural Engineering, through W. W. McLaughlin, Associate Chief; and the University of California, Division of Irrigation Investigations and Practice, through Professor Frank Adams.

The splendid cooperation given by the various engineers, water superintendents, and the water users themselves throughout the territory covered by this work.

The loyal and efficient assistance of the engineers as listed under the organization statement who have been employed on this work during the past year.

ADVISORY COMMITTEE

PERMANENT COMMITTEE OF THE SACRAMENTO-SAN JOAQUIN RIVER PROBLEMS CONFERENCE

The successful prosecution of the Water Supervisor's work both in stream administration and collection of records may be attributed in no small measure to the backing, advice, and continued interest and cooperation of the Permanent Committee of the Sacramento-San Joaquin River Problems Conference.

This Committee, directly representative of the water users and other interests involved, was appointed by the First Sacramento-San Joaquin River Problems Conference in January, 1924. Its present personnel is as follows:

Herbert E. White, Acting Chairman, Sacramento

E. L. Adams, Chico,
A. E. Anderson, San Francisco,
Alden Anderson, Sacramento,
G. A. Atherton, Stockton,
P. M. Downing, San Francisco,
William Durbrow, Willows,
Manly S. Harris, San Francisco,
W. I. Hechtman, Sherman Island,
Warren H. McBryde, San Francisco,
R. V. Meikle, Turlock,
Jesse Poundstone, Grimes,
F. T. Robson, Vina.

ORGANIZATION

B. B. Meek - - - - - - - - - - - - - - - - - - Director of Public Works
Edward Hyatt - State Engineer

- - 0 - -

Harold Conkling - - - - - - - - - - Deputy in Charge of Water Rights

Harlowe M. Stafford
Sacramento-San Joaquin Water Supervisor

Martin H. Blote - - - - - - - - - - - - - Assistant Water Supervisor
James M. Brockway - - - - - - - - - - - - - - - - Assistant Engineer
Frederick E. Anderson - - - - - - - - - - - - - - Assistant Engineer
Ralph S. Rose - - - - - - - - - - - - - - - - - - Assistant Engineer

DELTA COOPERATIVE INVESTIGATION

W. W. McLaughlin - - - - - - - - - - - - - - - - - - Associate Chief,
Division of Agricultural Engineering, U. S. Department of Agriculture.
O. V. P. Stout - - - - - - - - - - - - - - - - - - Hydraulic Engineer
Lloyd N. Brown - - - - - - - - - - - - - Assistant Hydraulic Engineer

CHAPTER I

INTRODUCTION

Purpose

The purpose of this report is to make of record the measurements made and data collected through the office of the Sacramento-San Joaquin Water Supervisor during the 1929 irrigation season.

Origin and History of Work

This work was inaugurated in 1924 through the efforts of the first Sacramento-San Joaquin River Problems Conference and its Permanent Committee working with the Division of Water Rights. The funds for the work in the first year were largely subscribed by the water users but subsequently it has been conducted under legislative appropriations included in the regular biennial budget of the Division. The origin and history of this work have been described in detail in the 1924 and 1926 Biennial Reports of the Division of Water Rights, in Bulletin Number 4 of the same Division, and in Bulletin Number 23 of the Division of Water Resources*. The latter bulletin brings together all data and measurements obtained by the Water Supervisor in the five year period, 1924 to 1928, inclusive.

Scope

As outlined in previous reports this work is divided into (1) engineering investigations, measurements and collection of records, and (2) conservation, waste prevention and such administration of the stream flow as shall fall within the jurisdiction of the Division of Water Resources or be mutually agreed upon by the water users. This report presents chiefly, for permanent record, the results of the engineering investigations. These

* Under the reorganization effected August, 1929, the Division of Water Rights as a Division was abolished and became a part of the Division of Water Resources

comprise measurements and records of all diversions of water from the Sacramento, Feather, Yuba, American and lower San Joaquin rivers within the valley floor and above the Delta; stream flow measurements throughout the territory, largely in cooperation with the Water Resources Branch, U. S. Geological Survey; measurements and records of waters returned to the Sacramento and San Joaquin Rivers; studies of the consumptive use of water in the Sacramento-San Joaquin Delta in cooperation with the U. S. Department of Agriculture Division of Agricultural Engineering and the University of California, Division of Irrigation Investigations and Practice; an annual census of irrigated areas and crops under all diversions recorded and throughout the Delta; and investigation and study of the advance and retreat of salinity in the Delta channels and upper Bays.

Organization

The regular organization has included the Water Supervisor, two assistant hydraulic engineers working on the Sacramento River and one assistant hydraulic engineer covering the Feather and American Rivers, Delta Uplands and the irrigation census in the Delta. In the 1929 season an intensive salinity investigation was conducted under the direction of the Water Supervisor as a part of the special investigation and report on the salinity in connection with the Water Resources Investigation of the Division of Water Resources. The organization on this special work included an assistant hydraulic engineer and from three to as high as twenty-four assistants, junior hydraulic engineers and engineering aids, depending upon the nature and requirements of the work. The organization for the cooperative Delta duty of water investigations under the direction of Mr. W. W. McLaughlin, Associate Chief, Division of Agricultural Engineering, U. S. Department of

Agriculture, has included an hydraulic engineer and one assistant giving full time to the field work.

Above Sacramento the work was handled by Engineers James M. Brockway and Ralph S. Rose, the former working from Meridian to Redding and the latter from Sacramento to Meridian. The census of irrigated acreages and crops in the Delta, the work in the Delta uplands and that on the Feather, American and Yuba Rivers was covered by Engineer Fred E. Anderson. The return water measurements on the San Joaquin River and its tributaries were made by Engineers Brockway and Rose. The field work of the special salinity investigation was in charge of Engineer Martin H. Blote. Major O. V. P. Stout has been in charge of the Delta Cooperative work with Engineer Lloyd N. Brown in resident charge at King Island.

Conservation Features

A comparison of the run-off and water supply conditions in the 1929 season with those of the previous seasons in which the work of the Water Supervisor has been conducted is indicated in the following tabulation:

Year	Entire Run-off to San Francisco Bay in Per Cent of Normal	Minimum Flow in Second-feet		
		At Colusa	At Sacramento	San Joaquin Near Vernalis
1924	27	1470	705	391
1925	78	1870	2760	660
1926	55	1030	1330	565
1927	108	1960	3420	1290
1928	75	1960	2510	840
1929	41	1550	2300	565

It will be noted that although the entire seasonal run-off to San Francisco Bay in per cent of normal for 1929 was only forty-one per cent and placed the run-off of that year about half way between that of 1924 and 1926, the minimum discharge in the river at Sacramento approached more nearly that of 1928, in which year the run-off was seventy-five per cent normal. This condition was doubtless due to the fact that the 1929 rice acreage under Sacramento River diversions was smaller than the acreage in any of the other seasons, 1924 to 1928, inclusive, although the 1929 general crop acreage under Sacramento River diversions exceeded that of any of these years.

If, with a forty-one per cent run-off year, the rice acreage had equalled that of 1926 or 1927, the requirements for strict conservation measures and regulation of diversions upon the part of the Water Supervisor would in all probability have been similar to those of 1924 and 1926 which were twenty-seven and fifty-five per cent years, respectively. As it turned out, there were apparently no serious navigation difficulties or shortages of water for irrigation purposes in 1929 and salinity to the extent of 100 parts of chlorine per 100,000 encroached very little higher in the Delta region than it did in 1928. In 1929, therefore, the Water Supervisor's work was confined largely to the engineering investigation dealing with the collection of required hydrographic data and records.

CHAPTER II

MEASUREMENTS OF STREAM FLOW

During the irrigation season of 1929 stream flow measurements and records have been obtained through the cooperation of the Water Resources Branch of the U. S. Geological Survey for stations on the Sacramento River at Kennett, Red Bluff, Butte City, Colusa, Knights Landing, and Verona; on the Feather River at Nicolaus; on the American River at Fair Oaks; on the Mokelumne River at Woodbridge and Thornton and on the San Joaquin River near Vernalis. Supplementing these, the Water Supervisor has maintained additional stations on upper Butte Creek one mile west of the East Side Highway, on lower Butte Creek and Butte Slough, on the American River at "H" Street Bridge, and in connection with the San Joaquin return water measurements (See Chapter IV) stations as follows: Stanislaus River at Orange Blossom Bridge and at Elliot Ranch, Tuolumne River at Roberts Ferry Bridge and at Tuolumne City, Merced River at Yosemite Valley Railroad Crossing and at the bridge on Hills Ferry Road, Dry Creek at Old Waterford Bridge and at Basso Ranch, and San Joaquin River at San Luis Island and at Grayson (Laird Slough).

TABLE 1

DISCHARGE OF SACRAMENTO RIVER AT KENNETT

Day	Daily Discharge in Second-feet						
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	4750	7960	3850	3330	2990	2820	2880
2	4750	7160	3850	3210	2990	2820	2880
3	4590	6760	3850	3100	2940	2820	2880
4	4920	6370	3850	3100	2940	2820	2880
5	4920	6180	3850	3210	2880	2820	2880
6	4920	5990	4430	3210	2880	2820	2880
7	4430	5800	3990	3100	2880	2820	2940
8	4590	5800	3990	3100	2880	2820	3210
9	4590	5800	3850	3100	2880	2820	3100
10	4590	5620	3850	3100	2820	2820	2990
11	4430	5440	3850	3100	2880	2820	2990
12	4430	5440	3850	3100	2880	2820	2940
13	4590	5260	3710	3100	2880	2820	2940
14	5260	5260	3710	3100	2880	2820	2940
15	7560	5260	4280	3100	2880	2880	2880
16	6760	5260	5090	2990	2820	2880	2880
17	6370	5090	4750	2990	2820	2880	2880
18	6370	5090	4280	2990	2820	2880	2940
19	9220	4920	3990	2990	2820	2880	2880
20	9880	4750	3850	2990	2880	2880	2880
21	9000	4750	3710	2940	2820	2880	2880
22	11800	4590	3710	2940	2820	2820	2880
23	11100	4590	3580	2940	2820	2820	2880
24	10300	4430	3580	2990	2820	2820	2880
25	9220	4280	3450	2940	2820	2820	2880
26	9000	4130	3450	2940	2820	2880	2940
27	8560	3990	3450	2940	2820	2820	2990
28	7960	3990	3450	2940	2820	2820	2990
29	7760	3990	3450	2990	2820	2880	2990
30	7560	3850	3330	2990	2820	2880	2990
31		3850		2990	2820		2990
Mean	6810	5210	3860	3050	2860	2840	2930
Acre-feet for Month	405000	320000	230000	188000	176000	169000	180000

NOTE: This is a permanent station of the Water Resources Branch of the U. S. Geological Survey established at Kennett in 1925. This station is maintained throughout the year, but the record is given here for the period of the irrigation season only.

TABLE 2

DISCHARGE OF SACRAMENTO RIVER NEAR RED BLUFF

Day	Daily Discharge in Second-feet						
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	5880	10000	4590	3830	3150	3150	3320
2	5650	8900	4490	3740	3150	3150	3320
3	5650	8400	4390	3580	3150	3150	3320
4	5880	7800	4390	3490	3150	3150	3320
5	6370	7400	4390	3490	3150	3060	3320
6	6120	7160	4690	3490	3060	3060	3580
7	5880	6890	5000	3400	3060	3060	3660
8	5650	6630	4790	3400	3060	3060	3660
9	5880	6630	4590	3400	3060	3060	3580
10	5650	6630	4590	3400	3060	3060	3490
11	5650	6370	4590	3400	3060	3060	3490
12	5430	6120	4390	3400	3060	3060	3400
13	5650	6120	4300	3320	3060	3060	3400
14	5880	6120	4200	3320	3060	3060	3400
15	7430	6120	4390	3320	3060	3060	3490
16	8000	5880	10500	3240	3060	3150	3490
17	7430	5880	7160	3240	3060	3150	3490
18	7160	5880	5880	3320	3060	3150	3490
19	7710	5650	5210	3240	3060	3150	3490
20	12900	5650	4900	3240	3060	3150	3400
21	10900	5650	4690	3240	3060	3150	3490
22	17400	5430	4490	3240	3060	3150	3400
23	15100	5320	4390	3240	3060	3150	3490
24	13300	5210	4300	3240	3060	3150	3490
25	11900	5000	4200	3240	3060	3150	3490
26	10900	4790	4200	3240	3150	3150	3490
27	10200	4690	4010	3240	3150	3150	3400
28	9700	4590	3830	3240	3150	3240	3400
29	9400	4490	3830	3150	3150	3240	3400
30	9200	4390	3830	3150	3150	3400	3400
31		4390		3150	3150		3320
Mean	8330	6130	4770	3340	3090	3130	3450
Ac.Ft. for Month	496000	377000	284000	205000	190000	186000	212000

NOTE: This is a permanent station of the Water Resources Branch of the U. S. Geological Survey located near the site of the proposed Iron Canyon Dam: Mile 198.6 above Sacramento. This station is maintained throughout the year, but the record is given here for the period of the irrigation season only.

TABLE 3

DISCHARGE OF SACRAMENTO RIVER AT BUTTE CITY

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	8300	3480	2630	1850	1780	2700
2	8100	3560	2560	1920	1780	2860
3	7660	3560	2410	1920	1780	2780
4	7440	3480	2340	1850	1780	2780
5	7000	3400	2270	1850	1780	2860
6	6780	3400	2200	1850	1780	2780
7	6340	3640	2200	1780	1850	2860
8	6120	3960	2200	1780	1920	2930
9	5990	3880	2130	1850	1920	3160
10	5850	3800	2060	1720	1990	3240
11	5720	3800	2060	1720	2060	3240
12	5590	3800	2060	1720	2130	3160
13	5450	3640	2060	1720	2130	3160
14	5320	3480	2060	1720	2130	3080
15	5190	3480	2060	1720	2130	3080
16	5190	3770	2060	1720	2200	3080
17	5020	6900	1990	1650	2270	3080
18	5020	5830	1920	1650	2270	3080
19	4850	5020	1920	1650	2340	3000
20	4850	4520	1920	1650	2410	3080
21	4680	4200	1920	1650	2410	3080
22	4680	3880	1920	1720	2480	3080
23	4520	3720	1990	1650	2560	3000
24	4520	3560	1920	1720	2480	3000
25	4360	3400	1920	1720	2630	3000
26	4120	3240	1920	1780	2630	2930
27	3960	3080	1850	1780	2630	2930
28	3800	2860	1850	1780	2630	2860
29	3720	2700	1850	1780	2780	2860
30	3640	2700	1850	1780	2700	2860
31	3480		1850	1780		3000
Mean	5400	3790	2060	1760	2210	2990
Ac.Ft. for Month	332000	226000	127000	108000	132000	184000

NOTE: Gagings taken near Butte City Bridge, Mile 116 above Sacramento. Station maintained by Water Resources Branch of the U. S. Geological Survey under cooperative agreement.

TABLE 4

DISCHARGE OF SACRAMENTO RIVER AT COLUSA

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	7880	3300	2470	1640	1700	2790
2	7640	3390	2310	1700	1700	2870
3	7640	3390	2240	1700	1700	2870
4	7280	3300	2240	1700	1640	2870
5	6920	3210	2240	1700	1700	2870
6	6580	3210	2100	1700	1700	2870
7	6250	3210	2100	1700	1700	2790
8	5920	3660	2030	1640	1820	2870
9	5700	3660	1960	1640	1890	3120
10	5600	3570	1890	1640	1890	3210
11	5500	3570	1820	1580	1960	3210
12	5400	3570	1820	1580	2030	3210
13	5300	3480	1820	1580	2100	3210
14	5300	3300	1820	1580	2100	3210
15	5100	3210	1820	1550	2170	3120
16	5100	3300	1760	1580	2240	3120
17	4900	5790	1820	1580	2310	3030
18	4800	6710	1700	1580	2310	3030
19	4800	5540	1700	1580	2390	3030
20	4600	4800	1700	1580	2390	3030
21	4500	4300	1700	1550	2470	3030
22	4400	3930	1700	1580	2550	3030
23	4400	3750	1700	1550	2550	2950
24	4300	3480	1700	1550	2550	2950
25	4200	3210	1700	1610	2550	3030
26	4110	3030	1640	1640	2630	3030
27	3930	2950	1640	1700	2630	3030
28	3750	2790	1640	1700	2710	3030
29	3570	2550	1640	1700	2790	3030
30	3480	2550	1640	1700	2790	2950
31	3390		1640	1700		3030
Mean	5230	3660	1860	1630	2190	3010
Ac.Ft. for Month	322000	218000	114000	100000	130000	185000

NOTE: Gagings taken near Colusa Bridge, Mile 89.4 above Sacramento. Station maintained by Water Resources Branch of the U. S. Geological Survey under cooperative agreement.

TABLE 5

DISCHARGE OF SACRAMENTO RIVER AT KNIGHTS LANDING

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	8500	3520	2470	1580	1760	2820
2	8200	3520	2330	1580	1760	2820
3	8200	3660	2120	1580	1700	2890
4	8000	3660	2120	1640	1640	2960
5	7800	3590	2120	1640	1640	2960
6	7500	3590	2000	1520	1760	2960
7	7200	3590	1940	1520	1820	2960
8	6900	3660	1820	1520	1940	2960
9	6500	4080	1700	1520	2000	3100
10	6200	4220	1640	1520	2000	3170
11	6000	4400	1580	1520	2120	3240
12	5700	4400	1580	1460	2260	3240
13	5500	4220	1580	1460	2400	3240
14	5340	4080	1580	1430	2470	3240
15	5340	3870	1640	1430	2540	3170
16	5340	3830	1580	1400	2610	3170
17	5420	5060	1520	1400	2680	3170
18	5340	6240	1520	1400	2750	3170
19	5340	6180	1430	1430	2750	3100
20	5200	5520	1370	1400	2820	3100
21	4970	4890	1370	1370	2960	3100
22	5040	4350	1430	1400	2960	3100
23	5040	4080	1460	1400	2960	3170
24	4970	3870	1460	1400	2960	3170
25	4900	3660	1460	1460	2890	3170
26	4600	3380	1460	1460	2890	3170
27	4440	3170	1460	1460	2890	3170
28	4080	3030	1460	1520	2890	3380
29	3870	2750	1520	1640	2890	3240
30	3660	2610	1520	1700	2890	3100
31	3590		1580	1700		3170
Mean	5760	4020	1670	1500	2420	3110
Ac.Ft. for Month	354000	239000	103000	92200	144000	191000

NOTE: Gagings are taken at the Railroad Bridge at Knights Landing at Mile 34.0 above Sacramento and therefore include the water entering the river from the Back Borrow Pit of Reclamation District 787. Station maintained by Water Resources Branch of the U. S. Geological Survey under cooperative agreement.

TABLE 6

DISCHARGE OF SACRAMENTO RIVER AT VERONA

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	14700	6060	3880	2970	3300	5020
2	14700	5930	3640	2970	3300	5020
3	14900	6060	3410	2970	3300	5020
4	15500	5930	3410	2970	3300	5150
5	15700	5930	3410	2970	3300	5280
6	15500	5930	3190	2750	3520	5410
7	14700	5930	2970	2860	3640	5410
8	14100	5930	2860	2860	3880	5410
9	13500	6590	2750	2860	4000	5670
10	13300	6870	2640	2860	3880	5800
11	13000	6870	2640	2860	4000	5670
12	12800	6870	2530	2970	4120	5670
13	12400	6730	2530	2860	4370	5670
14	12400	6320	2530	2860	4500	5540
15	12400	6190	2530	2860	4630	5540
16	12600	6850	2420	2750	4630	5540
17	12800	11200	2420	2860	4630	5540
18	13000	12600	2420	2860	4890	5540
19	12800	12100	2420	2860	4890	5410
20	12200	10400	2320	2750	5020	5410
21	11900	8700	2320	2860	5150	5410
22	11700	7600	2530	2860	5150	5410
23	11500	7010	2640	2860	5280	5410
24	11200	6450	2640	2860	5150	5410
25	10600	5800	2750	2860	5150	5410
26	9550	5410	2750	2860	5150	5410
27	8870	5150	2750	2750	5150	5410
28	7900	4890	2860	2860	5150	5540
29	7440	4500	2970	3080	5150	5280
30	6980	4120	2750	3190	5150	5280
31	6520		2860	3190		5410
Mean	12200	6900	2800	2900	4420	5420
Ac. Ft. for Month	750000	411000	172000	178000	263000	333000

NOTE: This station is located at Mile 19.6 above Sacramento below the junction of the Feather with Sacramento River. It is just above the mouth of "Cross Canal", main drain of Reclamation District 1001, and is only a short distance above the upstream limit of the tide effect. Station maintained by Water Resources Branch of the U. S. Geological Survey under cooperative agreement.

TABLE 7

DISCHARGE OF SACRAMENTO RIVER AT SACRAMENTO

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	19700	7960	4500	2930	3230	5020
2	20100	7820	4210	2860	3200	5050
3	20700	7670	3940	2960	3130	5070
4	21800	7360	3940	2940	3090	5150
5	21500	7400	3790	2880	3130	5320
6	21000	7260	3480	2740	3410	5450
7	20100	7200	3260	2770	3560	5480
8	19700	7250	3150	2780	3840	5450
9	19500	8180	2890	2790	3960	5730
10	18900	8850	2830	2760	3850	5920
11	18400	8990	2780	2880	3980	5770
12	18100	8550	2730	2910	4180	5850
13	18000	8330	2660	2750	4470	5770
14	18300	7800	2600	2740	4620	5610
15	18000	7790	2550	2740	4730	5640
16	18300	13500	2400	2570	4660	5610
17	18700	17000	2500	2730	4640	5640
18	18800	17500	2400	2710	4900	5610
19	18000	16100	2400	2700	4960	5460
20	17100	13500	2350	2620	5090	5480
21	16900	11300	2300	2680	5220	5470
22	16800	9870	2480	2720	5280	5420
23	16300	9100	2640	2760	5360	5500
24	15900	8000	2570	2760	5160	5460
25	14800	7330	2700	2820	5150	5550
26	13200	7690	2690	2740	5150	5470
27	11700	6260	2690	2570	5140	5560
28	10100	5910	2760	2690	5190	5600
29	9360	5360	2890	2900	5180	5330
30	8740	4940	2680	3130	5210	5310
31	8270		2830	3070		5420
Mean	17000	9060	2920	2790	4420	5490
Ac. Ft. for Month	1045000	539000	180000	172000	263000	338000

NOTE: This represents the flow past Sacramento (below the City of Sacramento ihtake) to the Delta. The discharges of this table have been computed by adding to the measured Verona discharges the measured inflow of return water and American River and subtracting therefrom the measured diversions between Verona and Sacramento. A gaging station is not maintained at Sacramento because of tidal action.

TABLE 8

DISCHARGE OF BUTTE CREEK NEAR EAST SIDE HIGHWAY

Day	Daily Discharge in Second-feet						
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	141	113	15	3	0	2	6
2	141	113	13	3	0	2	6
3	140	112	11	3	0	2	7
4	139	112	10	3	0	2	7
5	138	112	10	3	0	2	8
6	137	106	9	3	1	2	8
7	136	100	9	3	1	2	8
8	135	97	8	3	1	2	9
9	134	93	8	3	1	2	9
10	133	90	8	2	1	2	10
11	132	87	7	2	1	2	10
12	131	84	7	2	1	2	11
13	130	80	7	2	2	2	12
14	129	76	6	2	2	2	13
15	128	72	6	2	2	2	14
16	127	68	5	2	2	3	15
17	126	64	5	1	2	3	16
18	125	60	5	1	2	3	17
19	124	54	5	1	2	3	18
20	123	50	4	1	2	3	17
21	122	46	4	1	2	3	18
22	121	42	4	0	2	4	17
23	120	38	4	0	2	4	15
24	119	34	4	0	2	4	13
25	118	32	4	0	2	4	11
26	117	30	3	0	2	4	9
27	116	28	3	0	2	4	8
28	115	26	3	0	2	5	.6
29	114	24	3	0	2	5	4
30	113	21	3	0	2	5	2
31		18		0	2		2
Mean	127	67.2	6.4	1.5	1.5	2.9	10.5
Ac.Ft. for Month	7580	4130	383	91	89	172	647

NOTE: This record is estimated from current meter measurements and occasional staff gage readings. Station is located at bridge one mile west of the East Side Highway.

TABLE 9

DISCHARGE OF FEATHER RIVER AT NICOLAUS

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	6170	2190	1340	1100	1410	1830
2	6430	2360	1100	1100	1340	1910
3	6960	2230	1060	1100	1240	1990
4	7800	2150	1100	1130	1270	2070
5	8080	2150	1000	1060	1440	2190
6	7660	2110	745	880	1520	2230
7	7240	2110	745	1030	1590	2190
8	6960	2150	770	1100	1670	2230
9	6960	2270	648	1100	1590	2360
10	6960	2270	648	1130	1480	2360
11	6820	2450	670	1160	1520	2270
12	6690	2360	670	1130	1750	2270
13	6430	2150	670	1000	1830	2230
14	6430	2030	648	1130	1870	2150
15	6690	1950	602	1060	1790	2070
16	6820	3220	540	1100	1750	2150
17	7100	7360	560	1100	1670	2270
18	7240	6080	520	1130	1750	2270
19	6960	5000	520	1060	1830	2150
20	6170	4050	520	970	1910	2230
21	6300	3420	580	1160	1990	2150
22	6170	2920	795	1160	2070	2110
23	5910	2630	795	1130	2030	2190
24	5650	2360	820	1200	1990	2150
25	5260	1950	850	1270	2110	2150
26	4630	1910	940	1240	2110	2190
27	3940	1910	1030	1100	2070	2070
28	3220	1830	1100	1270	2030	1990
29	2820	1670	1060	1340	2030	1950
30	2540	1480	940	1380	1910	2030
31	2360		1100	1380		1990
Mean	6040	2690	809	1140	1750	2140
Acre-feet for Month	371000	160000	49700	70100	104000	132000
Monthly Diversions below Nicolaus	1294	1247	371	1933	655	36
Discharge to Sacramento R. Acre-feet	370000	159000	49300	68200	103000	132000

NOTE: Gagings at Nicolaus Bridge, Mile 9.6 above mouth of River. Station maintained by Water Resources Branch of the U. S. Geological Survey under cooperative agreement.

TABLE 10

DISCHARGE OF AMERICAN RIVER AT SACRAMENTO

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	5200	2180	950	256	235	54
2	5640	2000	893	200	221	86
3	6080	1880	860	235	110	66
4	6540	1700	795	221	100	70
5	6010	1720	721	207	130	82
6	5790	1610	615	242	152	82
7	5710	1550	596	182	152	62
8	5860	1560	551	207	152	66
9	6240	1820	506	214	164	114
10	5860	2180	533	235	130	152
11	5640	2320	472	228	135	130
12	5640	1940	472	242	200	170
13	5930	1800	481	164	188	140
14	6240	1710	406	140	221	115
15	6010	1770	382	152	176	130
16	6080	6790	358	152	120	100
17	6240	5910	374	140	90	95
18	6080	5030	310	152	74	100
19	5480	4160	326	164	110	90
20	5200	3320	342	140	100	100
21	5340	2740	318	115	86	110
22	5410	2480	302	135	140	100
23	5130	2240	256	176	120	82
24	4990	1980	270	176	90	82
25	4500	1820	270	152	70	74
26	3940	1560	270	120	70	90
27	3120	1420	270	100	50	82
28	2540	1340	221	110	58	90
29	2240	1220	228	146	90	86
30	2080	1110	200	200	74	70
31	2060		228	182		50
Mean	5120	2360	444	177	127	94
Ac.Ft. for Month	315000	140000	27300	10900	7550	5790
Monthly Diversions below gaging station	77	129	149	142	101	13
Discharge to Sacto. River Ac.Feet	315000	140000	27200	10800	7450	5780

NOTE: Gaging station located at "H" Street Bridge, Sacramento.

TABLE 11

DISCHARGE OF MOKELUMNE RIVER AT WOODBRIDGE

Day	Daily Discharge in Second-feet						
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	170	742	106	74	3.9	4.6	5.5
2	103	822	100	70	4.2	4.4	5.5
3	284	1510	168	46	4.3	4.6	5.5
4	568	1710	236	26	4.4	4.9	5
5	346	1770	196	10	4.4	5	5
6	282	1860	158	8	4.6	5	5
7	282	1530	122	7.5	4.9	5.5	5
8	298	1150	147	7	5	5.5	4.9
9	228	1530	207	6	5	5.5	4.8
10	250	1950	249	4.2	4.4	5.5	4.8
11	211	2210	887	3.6	3.9	5.5	4.8
12	234	2380	694	3.5	3.8	6	4.8
13	234	2320	379	3.5	3.0	6.5	4.6
14	274	2320	256	3.5	3.3	6.5	4.8
15	362	2350	418	3.5	3.5	7	5
16	346	2280	1370	3.5	3.8	7	5
17	338	2280	2490	3.3	4.3	7.5	5
18	596	2280	2770	2.8	4.3	7.5	5
19	896	2460	1650	2.8	4.3	7	5
20	990	2420	1440	3.2	4.3	7	5
21	157	2140	886	3.4	4.0	7	5
22	144	1650	751	3.5	3.3	6	5
23	190	1770	713	3.5	3.3	6	5
24	87	1830	341	3.6	3.6	5.5	5
25	159	1920	224	3.6	3.9	5.5	5
26	322	1830	168	3.6	4.4	5.5	5.5
27	682	1300	158	3.6	4.8	5.5	5.5
28	764	675	142	3.8	4.6	5.5	4.6
29	764	427	123	3.8	4.4	5.5	3.9
30	720	350	90	3.8	4.6	5.5	3.9
31		196		3.6	4.6		3.9
Mean	376	1680	588	10.7	4.16	5.85	4.91
Ac.Ft. for Month	22400	103000	35000	658	256	348	302

NOTE: Gaging station located just below Woodbridge Irrigation District's Dam at Woodbridge. Station maintained by Water Resources Branch of the U. S. Geological Survey throughout the year, but the record is given here for the period of the irrigation season only.

TABLE 12

DISCHARGE OF MOKELUMNE RIVER AT THORNTON

Day	Daily Discharge in Second-feet				
	Jun.	Jul.	Aug.	Sep.	Oct.
1		117	9.5	7.5	9
2		105	9.5	7.5	7.5
3		94	9.5	7.5	9
4		65	9.5	7	9
5		48	9.5	7	9
6		35	10	7.5	9
7		30	10	7.5	9
8		27	10	7.5	8.5
9		24	9.5	8	8.5
10		23	11	8	8
11		20	9	8.5	8
12		20	9	8.5	8
13		20	8.5	7	8
14		19	8.5	8	8
15		15	8	9.5	8
16		12	8	11	8
17		12	8	11	8.5
18		12	8	11	8.5
19		12	7	11	8.5
20		11	7.5	11	8.5
21		11	7.5	11	8.5
22		11	7	11	8.5
23		10	7	8.5	8.5
24		10	7	9.5	7
25		10	7	10	7.5
26		10	7	10	8.5
27	*227	10	7	9	8.5
28	201	10	7	9.5	8.5
29	185	10	7.5	9.5	8
30	146	10	7.5	9	7.5
31		10	7.5		7.5
Mean	**190	26.9	8.34	8.95	8.29
Ac.Ft. for Month	**1510	1650	513	533	510

* Beginning of record for season.
** Four days.

NOTE: This station is located near Thornton at the lowest point on the River which is above tidal effect. Station maintained by Water Resources Branch of the U. S. Geological Survey.

TABLE 13

DISCHARGE OF SAN JOAQUIN RIVER NEAR VERNALIS

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	1140	2020	1160	682	648	1390
2	1090	2020	1090	648	682	1490
3	1060	1900	1140	682	682	1540
4	1000	1780	1160	665	682	1490
5	980	1660	1090	665	822	1540
6	1000	1490	940	665	1000	1540
7	1000	1390	880	630	1040	1540
8	980	2570	805	595	1060	1490
9	940	2090	788	580	1090	1440
10	960	1720	770	595	1190	1440
11	940	1720	735	612	1190	1340
12	980	1600	718	612	1190	1290
13	1160	1540	700	595	1190	1290
14	1290	1540	752	595	1190	1340
15	1340	1440	770	580	1240	1440
16	1390	1440	700	580	1240	1490
17	1440	1540	665	565	1240	1540
18	1540	1960	630	595	1240	1540
19	1660	3150	580	595	1240	1490
20	2270	2970	580	612	1240	1440
21	2830	2760	595	612	1290	1440
22	2270	2270	612	612	1340	1340
23	2270	2080	612	612	1340	1340
24	2340	1840	580	612	1340	1340
25	2970	1600	580	612	1340	1340
26	3250	1440	580	630	1290	1340
27	3670	1390	612	648	1290	1390
28	3460	1290	612	612	1340	1290
29	2410	1240	665	580	1340	1240
30	2200	1190	665	565	1390	1240
31	2080		665	580		1240
Mean	1740	1820	756	614	1150	1410
Ac. Ft. for Month	107000	108000	46500	37800	68400	86700

NOTE: Gaging station located at Durham Ferry Bridge below the junction of Stanislaus and San Joaquin Rivers. Station maintained by Water Resources Branch of the U. S. Geological Survey under cooperative agreement.

CHAPTER III

MEASUREMENT OF DIVERSIONS

Measurements and records of diversions in 1929 have included those from the Sacramento River and its tributaries within the valley floor, those to the Delta Uplands from San Joaquin River, Old San Joaquin River and Tom Paine Slough and those on the Stanislaus, Tuolumne, Merced, and San Joaquin Rivers and Dry Creek in the period July to September, inclusive, as obtained in connection with the return water measurements (See Chapter IV). This report records a total of 396 diversions, segregated to the various sources as follows: Sacramento River 237, Colusa Trough 12, Back Borrow Pit (carrying drainage water from Colusa Basin along the back levees of Reclamation Districts 108 and 787) 5, Lower Butte Creek and Butte Slough 15, By-pass and Drainage Channels 13, Feather River 35, Yuba River 6, American River 29, Old San Joaquin River to Delta Uplands 11, Tom Paine Slough to Uplands 7, and San Joaquin River to Uplands (below junction with Stanislaus River) 26. In addition, the San Joaquin Valley diversions (recorded in the return water measurements) totaled 59, as follows: San Joaquin River 12, Merced River 29, Tuolumne River 5, Stanislaus River 8, and Dry Creek 5.

Under the system for obtaining the diversion records, pump operators have kept daily records on blanks furnished by the Water Supervisor. These records are collected monthly by the field engineers at the same time that the readings of the electric meters are recorded. In order to establish the relation between power input and water pumped, as many as possible current meter measurements of discharge are made throughout the season. With the daily operation reocrds available it has been possible to compile from the monthly diversions as computed from the power record, a daily

diversion record for each plant. In this report and the tables of this chapter it is only possible to publish the record of monthly diversions for each plant. However, the daily diversion records have been compiled as a supplemental report and this is on file and available for reference in the office of the Division of Water Resources.

TABLE 14

SUMMARY OF SACRAMENTO RIVER DIVERSIONS (ACRE-FEET)

River Section	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Totals
Redding to Red Bluff	11150	19131	11858	21677	21539	20435	13729	119519
Red Bluff to Butte City	59591	92248	79596	91016	84878	48378	20724	476431
Butte City to Colusa	12333	14693	12028	15192	11034	3834	1123	70237
Colusa to Knights Landing	43136	54587	45527	55586	52642	23188	5515	280181
Knights Landing to Verona	3185	4291	3116	3578	2702	1170	108	18150
Verona to Sacramento	8888	19410	15253	20736	18551	10098	2755	95691
Totals	138283	204360	167378	207785	191346	107103	43954	1060209

TABLE 15

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
City of Sacramento	0.8 L	3-20" 1-18"	2114	2660	2615	3089	3015	2534	2182	18209	Municipal	
E. Fourness	1.45 R	1-8"	19	28	13	49	10	11	1	131	81	
C. W. Jones	2.05 L	1-8"	19	52	9	52	17	37		186	100	
Frank Christophel	2.40 L	1-5"	6	15		23	7	11		62	34	
H. M. Swalley	2.45 L	1-5"		2.9	3.0	18.2		15.0	2.4	41.5	40	
Albert Elkus	2.9 L	1-5"	2.0	14.5	13.7	13.5		6.0		49.7	23	
Hayward Reed	3.55 R	1-16"	280	428	248	330	74	261	66	1687	325	
W. E. M. Beardslee	3.75 R	1-5"		10.5	5.9	3.2				19.6	18	
W. I. Elliot	4.00 R	1-8"		45	51	78	52	96	16	338	170	
Reese and Greer	4.65 R	1-7"	11	125	109	110	12			(1) 367	265	
Harbinson Bros.	5.05 R	1-14"		265	204	249	23	28	16	(2) 785	90	
R. S. Seydel	5.25 R	1-8"		118	101	99	94			412	132	
C. H. Merkeley Estate (Merkeley Bros.)	5.3 R	1-8"		0.8	22.1	4.8				27.7	55	
A. Casselman	5.5 R	1-5"		2.2	9.4					11.6	20	
K. L. Lovdal	5.70 R	1-10"		23	37	14	9	11	15	109	100	
J. E. Bandy	6.0 R	1-6"				35				35	70	
Riverside Mutual Water Co.	6.10 L	2-18"		802	709	1161	876	610		4158	1150	
O. A. White	6.40 R	1-6"		NO DIVERSION								
A. Marty (3)	7.0 R	1-4"		16	16	16				48	15	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) Additional water estimated at 440 Acre-feet received from Harbinson Plant at Mile 5.05 R during May, June and July. Includes 12 acre-feet used for stock water in August.

(2) Approximately 440 acre-feet of diversions here shown were, during the months of May, June and July, used on Reese and Greer lands to the south (See Mile 4.65 R). 67 Acre-feet used for stock in August, September and October.

(3) New installation 1929.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
California Bank & Trust Co.	7.50 L	1-8"	NO DIVERSION									
F. L. Martin and A. B. Carter (F. J. Stahl)	7.80 L	1-10"	62	92		1	131	5		291	100	
A. Marty	7.90 R	1-8"	2	135	103	113	35	46	45	479	(1)385	
M. E. and R. F. Bennett	7.90 L	1-10"		4	81	90	93	14		282	120	
M. Marty	8.30 R	1-10"	5	348	244	266				863	(2)	
Julius Blauth	8.5 R	1-5"	NO DIVERSION									
H. Waldeck (H. Melvin)	8.70 R	1-6"		40	18	27	10	7	7	109	41	
T. T. C. Gregory (Spreckles Sugar Company)	8.95 R	1-18"	259	249						508	700	
Kate Merkeley	9.15 R	1-2"	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.4	Domestic	
Kate Merkeley	9.20 R	1-6"	NO DIVERSION									
A. A. Sousa	9.35 R	1-14"	31	193	164	223	374	166	149	1300	340	
R. G. Pearson and P.S. Driver (F. C. Jones and C. M. Owen)	9.80 L	1-14"		129	95	94	105	76		499	374	
Carl Casselman	9.90 R	1-12"		55	62	66	96	30	10	319	120	
F. W. Kiesel	10.25 L	1-14"	341	353	119	562	258	518	39	2190	566	
Reese Estate (Louis Ashwandan)	10.75 R	1-12"		97		158	65	51	31	402	88	
R.F. Fiddyment & E. J. Cahill	10.75 L	1-12"		31	33	116	64	27	3	274	155	
H. L. Hill, Jr. (W. R. Taylor)	11.10 R	1-14"	NO DIVERSION									
Conaway Ranch	12.0 R	4-36"	1762	3478	3252	3702	2922	969	169	16254		1959
Julius Hauser	13.1 R	1-12"	89	65	108	153	69	118		602	80	
California Bank and Trust Co.	13.25 R	1-12"	NO DIVERSION									

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) This is total acreage irrigated by this plant and plant at Mile 8.30 R.

(2) See Plant at Mile 7.90 R.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion: April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Elkhorn Mutual Water Company	14.1 L	1-24": 1-20":	25	1624	1584	1819	2128	1003		8183	2730	
California Lands Inc. (1)	15.15 R	1-8"			18	91	13	58	3	183	125	
M. O. Russ (2)	15.7 L	1-6"	NO DIVERSION									
Central Mutual Water Company	16.0 L	2-38"	989	2728	1544	2816	2665	1358		(3) 12100	1994	656
Frank Fisher and Henry Rich (Hershey Plant)	16.27 R	1-20"	148	574	746	757	730	107		(4) 3062	196	120
Ellis Jones and J. K. Brown	16.3 R	1-10"	NO DIVERSION									
H. T. Silvius	16.4 R	1-6"	NO DIVERSION									
W. B. Beach (5)	16.6 R	1-5"			2	29	16	15		62	70	(6)
Thomas J. Cox Estate (Beach and Cox)	16.7 R	1-16"	NO DIVERSION									(6)

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) Listed previously as M. F. Merkeley.

(2) Formerly Sam White.

(3) This plant pumps water to the irrigation canal both from a drain canal of District 1000 and from the Sacramento River. The diversions listed are those from the river only. The water obtained from the drain canal was as follows: (Acre-feet) May 336, June 600, July 682, August 702, September 112, Total 2432.

(4) During June and July, portions of the diversions shown for these months for the Hershey (Mile 16.27 R), Mull (Mile 17.75 R), and Keller (Mile 22.5 R) plants of Fisher and Rich were by-passed to the east borrow pit (Tule Canal) of the Yolo By-Pass to augment the flow in this channel to the Fisher and Rich plant pumping from it. (See Yolo By-Pass diversions). The total water by-passed from the three plants was approximately 1100 acre-feet in June and 2100 acre-feet in July.

(5) New plant installed in 1929.

(6) See notes for Fisher and Rich, Mull and Keller plants, Mile 17.75 R and 22.5 R.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Frank Fisher and Henry Rich (Mull Plant)	17.75 R	1-20"	779	719	592 (1)	797 (1)	1148	264		4299 (1)	235 (2)	438 (2)
A. Linggi	18.45 L	1-12"		76	54	65	78	77		350	100	
Frank Fisher and Henry Rich (Hoover Plant)	18.95 R	1-18"	NO DIVERSION									
Northern Mutual Water Co.	19.6 L	1-36"	1945	3812	2268	3446	3362	1569		16402 (3)	300 (3)	2101 (3)
J. H. Berghauser	21.7 R	1-15"	NO DIVERSION									

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) During June and July, portions of the diversions shown for these months for the Hershey (Mile 16.27 R), Mull (Mile 17.75 R) and Keller (Mile 22.5 R) plants of Fisher and Rich were by-passed to the east borrow pit (Tule Canal) of the Yolo By-Pass to augment the flow in this channel to the Fisher and Rich plant pumping from it. (See Yolo By-Pass diversions). The total water by-passed from the three plants was approximately 1100 acre-feet in June and 2100 acre-feet in July.

(2) Diversions from Fisher and Rich plants (Mull 17.75 R and Keller 22.5 R) were combined to irrigate the following acreages; Merkeley, Chittenden and Keller, 235 beans; Azevedo 90 rice; California National Bank (formerly Luce), 33 rice; W. B. Beach, 65 rice; Thos. J. Cox Estate, 220 rice; and M. Rose, 30 rice; totals, 438 rice, 235 gen'l.

(3) Cross Canal, the main drain between R.D.1000 and 1001 joins the river at Mile 19.6 L. At the mouth of this drain Natomas Northern Mutual Water Co. maintains, during the irrigation season, a booster pump supplying water from the river to the drain. The water is retained in the drain by a movable dam at its mouth. When the river falls lower than the crest of this dam the gates are closed and the booster pump started. There are pumping plants along the south bank of Cross Canal, but only one, at Mile 4.0 from the mouth, was operated in 1929 and the rice acreage shown was irrigated from this plant. In April and up to May 30th, and from June 17th to 23d (due to June storm) river water was available in Cross Canal without pumping at the booster plant. The diversions here shown are those for the plant at Mile 4.0 on Cross Canal from April 11th to May 29th, inclusive, and for the booster plant at the mouth of the canal for the remainder of the season. The water pumped through the plant at Mile 4.0 on Cross Canal was as follows: (Acre-feet) April 1945, May 3705, June 3530, July 3626, August 3644, September 1697, Total 18147. The excess of water pumped here over that supplied to Cross Canal from the river was probably derived from return water and natural drainage.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Frank Fisher and Henry Rich (Keller Plant)	22.5 R	1-22"	1054	1230	867 (1)	910 (1)	1220	690		(1)5971	(2)	(2)
Hershey Estate (3)	26.95 R	1-18"	NO DIVERSION									
Morse Inglin (4)	28.2 R	1-6"		1	17	19	24			61	18	
Fred Traganza	29.7 R	1-8"	NO DIVERSION									
P. L. Traganza & K. Russell	29.75 R	1-8"		2.5	9.3	2.5				14.3	8	
Laura Freitas	29.9 L	1-12"		25		19				44	30	
Leo Giovanetti	30.2 L	1-3"		4.0	0.4	0.5				(5) 4.9	8	
Charles Ghiselli	30.25 L	1-6"	NO DIVERSION									
Charles Ghiselli	30.45 L	1-2"		1.0	0.5	1.6	1.2		0.1	(5) 4.4	13	
Kendall Ranch (Lower)	30.6 R	1-7"	NO DIVERSION									
J. G. Goulart (6)	30.75 L	1-8" 1-3"		5.0		4.0	2.3	0.3		11.6	7	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) During June and July, portions of the diversions shown for these months for the Hershey (Mile 16.27 R), Mull (Mile 17.75 R), and Keller (Mile 22.5 R) plants of Fisher and Rich were by-passed to the east borrow pit (Tule Canal) of the Yolo By-Pass to augment the flow in this channel to the Fisher and Rich plant pumping from it. (See Yolo By-Pass diversions). The total water by-passed from the three plants was approximately 1100 acre-feet in June and 2100 acre-feet in July.

(2) Diversions from Fisher and Rich Plants (Mull 17.75 R and Keller 22.5 R) were combined to irrigate the following acreages: Merkeley, Chittenden, and Keller, 235 beans; Azevedo, 90 rice; California National Bank (formerly Luce), 33 rice; W. B. Beach, 65 rice; Thos. J. Cox Estate, 220 rice; and M. Rose, 30 rice; totals, 438 rice, 235 general.

(3) This plant does not divert directly from the Sacramento River but is on Grays Bend which is now cut off. The old bend channel fills in the Winter and retains the water for later use. If the irrigation demand exceeds the storage, a booster plant is installed at the upper end to divert from the river to the bend.

(4) New installation 1929.

(5) The water diverted at the Giovanetti (mile 30.2 L) and Ghiselli (Mile 30.45 L) plants was combined for the irrigation of the acreage under these plants.

(6) Formerly William Dreher.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
A. C. Huston (A. Simmons)	31.5 R	1-12"	6	9	12	15	13	16	11	82	40	
M. Alonso (1)	31.8 L	1-4"		3	4	4	3			14	13	
Kendall Ranch	32.0 R	1-10"										
		1-18"		159	18	31	57	42	4	311	105	
Sutter Mutual Water Company (Portuguese Bend)	32.0 L	2-24"	2090	2802	2098	2503	1297	360	60	(3)11210	(2)	(2)
Collier Bros.	32.5 R	1-10"	8	5	12	10	11	16	3	65	45	
J. G. Knox and Fred Leiser	33.75 L	1-12"	27	70	69	79	60	22	30	357	177	
Meek Estate	34.2 R	2-16"										
		1-10"	45	695	338	574	169	308		2129	390	
River Farms Company (Townsite Plant)	34.25 R	1-24"										
		1-26"	2070	1516	1369	1326	718	835	532	8366	2472	
		1-20"										
Commercial Investment Co. (R. B. Bailey)	34.85 L	1-12"		25	64	107	88			284	120	
Fred Van Lew	35.2 L	1-12"		8	46	9	9	11		83	25	
J. H. Scott	35.6 L	1-7"		19		15	10			44	20	
J. H. Donnelly (A. Morconi)	35.8 L	1-10"	41	43	6	8	17	7		122	72	
Amedeo Moroni	36.7 L	1-5"		NO DIVERSION:								
River Farms Co. (Garden Pump)	36.95 R	1-2"	4.4	5.8	4.8	6.2	5.1	1.4	0.4	28.1	4	
W. W. Bottimore	37.2 L	1-14"		NO DIVERSION:								
L. W. Bundock	37.75 L	1-8"				16	10			26	87	
Bank of Italy (H.A.Kramer)(1)	38.8 L	1-10"				59				59	85	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) New installation 1929.

(2) See Sutter Mutual Water Company plant at Mile 63.75 left.

(3) Sixty acre-feet diverted in August, and all diverted in September and October was for stock water.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Sutter Mutual Water Company (McCutcheon Ranch-A. Colli)	39.4 L	1-12"		39	12	6	26			83	65	
Commercial Investment Co. (Otto Bushaw)	39.8 L	1-10"		63		27	39	59		188	85	
Sutter Mutual Water Company (State Ranch Bend)	40.6 L	1-24"	1165	1805	517	2386	1969	277	314	8433	(1)	(1)
Buell Ranch (M. K. Dean)	41.8 L	1-4"	NO DIVERSION									
Sutter Mutual Water Company (Bozzi and Pressenda)	42.3 L	1-8"		68	78	15				161	81	
A. Kramer (2)	42.6 L	1-12"				13	63	4		80	70	
El Dorado Ranch	43.1 R	1-18"	99	324	306	600	461	270	53	2113	555	
River Farms Company (Recl.Dist. #2047 Plant)	43.1 R	2-50"	6085	6906	5781	8581	8436			35789	3522	3554
John Clauss	47.3 L	1-14"		431	469	493	90			1483	288	
P. J. Hiatt	48.7 L	1-20"	755	556	886	980	1081	395		4653	(3) 60	250
Reclamation District 108 (Tyndall Mound Plant)	51.1 R	1-36" 2-24"	NO DIVERSION									
G. J. Stam	51.2 L	1-24"	807	890	1271	1480	1520	547	17	6532	100	600
J. F. White (2)	51.5 L	1-8"					3.0	1.5		4.5	25	
J. R. Gailbraith (J. A. Campbell)	55.1 L	1-20"		448	483	233	123			1287	1400 (4)	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) See plant at Mile 63.75 Left.

(2) New Installation 1929.

(3) Sixty acres frrigated for Morrow and Mundell to the south. An additional 320 acres of general crops of Hiatt's were irrigated from a lake at the lower end of his property. The lake source is Winter flood water.

(4) This acreage irrigated both from this plant and that at Mile 56.95 Left.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Reclamation District 108 (Boyer Bend Plant)	56.4 R	1-18" 1-30"			244	466	195	52		957	950 (1)	
J. M. Miller (2)	56.65 R	1-12"	25	240	162	41	84	98	3	653	50	
J. R. Gailbraith (J. A. Campbell)	56.95 L	1-20"		672	619	378	5			1674	(3)	
R. A. Lamb (Lamb Bros.)	59.8 L	1-12"		28	80	12	35			155	140	
Reclamation District 108 (Steiner Bend Plant)	59.85 R	1-14" 1-16"		NO	DIVERSION							
Thomas J. Coulter	60.5 L	1-12"		35	80	113	45	8		281	130	
Hines Ranch	62.3 R	1-10"		8	6	62	4	10		90	40	
William Baker	62.6 R	1-8"			26					26	23	
Reclamation District 108 (Wilkins Slough Plant)	63.2 R	5-42"	4815	1450	255	510	5596	1611		14237	7623	
Sutter Mutual Water Company (Tisdale) and Improvement Mutual Water Company	63.75 L	6-42"	21328	29966	23005	25366	21458	13518	4204	138845	26313 (4)	6224 (4)

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) In the 1926, 1927 and 1928 seasons, 12, 20, and 55 acres, respectively, were irrigated from this plant for J. M. Miller (See Mile 56.65 R). These acreages were not included in the acreage data for Boyer Bend Plant as reported for these years.

(2) This plant operated in the 1924 and 1925 seasons but did not operate in the 1926, 1927 and 1928 seasons. In the latter seasons, 12, 20, and 55 acres respectively, were irrigated from the Boyer Bend Plant of Reclamation District 108 (See Mile 56.4 R.).

(3) See Plant at Mile 55.1 Left.

(4) These figures give the total acreages irrigated from the Portuguese Bend, State Ranch Bend, and Tisdale plants at Miles 32.0 L, 40.6 L, and 63.75 L, respectively. They include 564 acres of rice irrigated by the Improvement Mutual Water Company (in Reclamation District 1660) entirely from the Tisdale Plant.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Cloman Land and Sheep Co.	64.3 R	1-12"		20	13	21	22			76	30	
Tisdale Irrigation and Drainage Company	64.4 L	1-12"	245	713	555	665	613	362		3153	1192 (1)	582 (1)
Otto Wackerman	65.1 R	1-10"	6	26	29	19	16	17	2	115	44	
D. L. W. Hoffman	65.7 L	1-12"				78	62	21		161	72	
J. L. Browning (2)	66.4 R	1-20"			122	146	122	34		424	120	
Tisdale Irrigation & Drainage Company (Winship Plant)	67.1 L	1-20"	1190	1573	1127	1434	1388	752		7464	(3)	(3)
Eliza Smith	67.2 L	1-10"		N O D I V E R S I O N:							(4)	
Meridian Farms Water Company Number 6	67.4 L	1-14"	70	111	61	277	177	56	6	758	277	
Meridain Farms Water Company Number 5	68.81 L	1-12"	240	256	353	300	280	270	25	1724	257	
J. L. Browning	69.0 R	1-24"		80	750	122	222	313		1487	520	
Faxon Ranch	69.2 R	1-18"	100	248	116	200	264	16	8	952	520	
Wilbur Jensen and Mary Cecil, et. al.	70.35 R	1-24"		N O D I V E R S I O N:								
Houchins-Hoffman-Beckley and Ritchie (J. M. Ritchie)	70.4 R	1-20"		190	30	119	20			359	108	
Meridian Farms Water Company Number 4 (Grimes)	71.1 L	1-24"	1193	671	1118	1777	1585	740	23	7107	1859	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) These figures give the total acreage irrigated from this plant and the other company plant (Winship) at Mile 67.1 Left. The general crop figure includes 138 acres of the Eliza Smith lands also irrigated from the Winship Plant.

(2) New installation 1929.

(3) See plant at Mile 64.4 Left.

(4) See note for Tisdale Irrigation and Drainage Plant at Mile 64.4 Left.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Anton Steidelmeyer	71.9 R	1-12"				181	46			227	75	
E. E. Vann (Coffman Bros.)	73.6 R	1-12"		29	192	169	131	31		552	160	
Meridian Farms Water Company Number 3 (Headquarters)	74.5 L (1)	1-20"	258	119	518	504	401	158	24	1982	545	
J. H. Yates	76.1 L	1-12"		10	88	47	35			180	(2)68	
E. V. Jacobs	77.9 L	1-12"	NO DIVERSION									
Sebia Davis	78.8 R	1-24"	733	1172	1399	1567	1420	277		6568	942	1173
C. E. Reische	79.0 L	1-10"	71	76	71	100	45	28		391	(3)142	
G. W. Woods	79.7 L	1-10"	5	67	14	46	20	6		158	(4)137	
Meridian Farms Water Company Nos. 1 and 2 (Meridian)	80.0 L	1-24" 1-18"	1286	1459	1427	2439	2453	1592	56	10712	2445	
Geo. P. Ahlf	80.3 R	1-8"	NO DIVERSION									
Steidelmeyer Bros. (5)	81.9 R(5)	(5)1-16"		347	363	157	328	254		1449	(6)165	
Geo. W. Kirkpatrick	83.3 L	1-14"	14	39	15	24				92	75	
P. E. Garmire	83.6 L	1-10"	NO DIVERSION									
Oakland Prune Company	86.1 R	1-12"	35	44	36	78	12			205	75	
J. F. Peck	86.6 L	1-18"		162	8	49	124			343	(7)100	
Lloyd Scoggins	86.8 L	1-10"	71	46	13	65				195	50	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) This plant was moved from 74.5 L to 74.8 L in May, 1928, but change in location was not noted in 1928 report.

(2) Includes 8 acres irrigated for neighbor (Coffman).

(3) Includes adjacent lands irrigated from this plant as follows: Reische 62, Stacs 30, Kilgore 30, Rockholt 20.

(4) Includes adjacent lands irrigated from this plant as follows: Woods 52, Summy 60, Craig 25.

(5) Formerly F. J. Steidelmeyer and Sons, Mile 80.9 R, 12" pump. In 1929 the 12" plant was dismantled and a new 16" plant installed upstream at Mile 81.9 R.

(6) Includes 45 acres irrigated on adjacent Tubbs land.

(7) Includes 30 acres irrigated on adjacent lands of Max Reichel.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Campbell-Dwyer (Lower)	86.9 R	1-16"	166	39	54	185	169	54	108	775	(2)400	
Campbell-Dwyer (Upper)	87.4 R	1-15"	77	37	32	170	22		8	346	(1)	
Jacobsen and O'Rourke	87.6 L	1-10"		19						19	(3)10	
Swinford Tract Irrigation Co.	87.7 R	1-12"	81	39	85	56		1	53	315	140	
J. B. DeJarnett (Nagle and Locovitch)	88.2 L	1-10"	11	10	87	92				200	60	
J. B. DeJarnett	88.7 L	1-14"	6	43	278	187				514	300	
Colusa Irrigation Company	89.2 R	1-20"	39	622	303	430	406	193	40	2033	852	
Phil B. Arnold (4)	89.25 L	1-8"		79					39	118	80	
P. V. Berkey (5)	89.3 L	1-12"			162					162	70	
Colusa Delta Farms (Reclamation District 1004)	89.3 L		PLANT DISMANTLED									
T. H. Boggs and Sisters	89.8 L	1-12"	NO DIVERSION									
T. H. Boggs and Sisters (6)	90.4 L	1-6"		7.5	6.3	5.3	10.0			29.1	40	
Roberts Ditch Company	90.7 R	2-20"	350	403	432	536	438	195	40	2394	800	
Geo. P. Ahlf	92.5 L	1-14"		129	27	76	38	26		296	155	
U. W. Brown (7)	93.0 R	1-12"		35	41				43	119	(8) 90	
I. G. Zumwalt	93.2 R	1-36" 1-18"	NO DIVERSION									

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) See plant at Mile 86.9 Right.
(2) This acreage irrigated jointly by this plant and the one at Mile 87.4 Right.
(3) All on Jacobsen's land.
(4) New installation 1929.
(5) New installation 1929, at same location as former Colusa Delta Farms Company (plant dismantled).
(6) Portable plant, temporary installation, 1929.
(7) Plant re-installed 1929.
(8) Includes 40 acres for Ella H. Arnold Estate.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion: April to: October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Tuttle Land Company	94.3 R	1-15" 1-20"	129	96	133	148	244	102	55	(1)907	475 (2)	
W. E. Pinney	94.8 R	1-12"		108	83	8	3			202	(3) 90	
F. W. Farnsworth	95.2 L	1-20" 1-14"		NO DIVERSION								
A. N. Lewis (California Farming Company)	95.6 L	1-16"			370	312	210	66		(4)958	425 (5)	
I. G. Zumwalt	95.7 R	1-12"	48	118	131	140	3		96	536	250	
Bridget Graham Estate	95.8 L	1-16" 1-20"	43	89	2	410	42	5	19	(6)610	329	
I. G. Zumwalt	96.8 R	1-12"		NO DIVERSION								
Bolla Bros.	97.7 R	1-20"	5	49	21	50	20	16		161	59	
Frank Beckley	98.0 L	1-6"		16	9	22	30			77	17	
J. L. Erisey	98.3 R	1-10"				22	19			41	10	
Sperry and Colusa Development Company (Joe Boggs) (7)	98.6 L	1-15"		34	54	40			14	142	(8)50	
Wm. and D. Boggs	98.8 L	1-18"	10	26	61	48	29	14		188	96	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) 86 Acre-feet of this diversion used for stock watering during September and October.

(2) Includes 25 acres on E.T. Niebling property.

(3) Includes 40 acres on Marsh property.

(4) A portion of this diversion was used on the Bridget Graham Estate (See Mile 95.8 L) as follows: (Acre-feet) July, 100; August, 66; September, 66; Total 232.

(5) Includes 100 acres of Colusa Development Company.

(6) Additional water to the amount of 232 acre-feet was received from the A. N. Lewis plant (See Mile 95.6 L).

(7) Formerly Poirier and Sperry.

(8) 140 acres additional were irrigated from Terrill and Sartain plant (See Mile 99.2 L).

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Cheney Slough Irrigation Company	99.0 R	1-36" 2-26"	855	206		68	25	13	13	1180	342	
Terrill and Sartain	99.2 L	1-20"	92	231	432	561	548	112	18	1994	(1)1010	
Dave George	99.8 L	1-12"		NO DIVERSION							(2)	
W. F. Klewe	100.8 L	1-20"		NO DIVERSION								
A. F. & R. C. Wohlfrom	101.1 R	1-20"	15	16	101	141	9	25		307	147	
Byron D. Beckwith	101.9 L	1-12"		NO DIVERSION								
Maxwell Irrigation District	102.8 R	2-30"										240
		1-36" 2-18"	379	735	640	682	715	57		3208		(3)
American Trust Company	103.7 R	1-16"	123	359	342	431	327	259	85	1926	355	
Compton-Delevan Irrigation District (4)	103.8 R	2-24" 1-36"		NO DIVERSION				(4)			(4)	(4)
E. M. Gordon	103.9 R	1-20" 1-16"			16					16	7	
B. F. Gould	104.8 L	1-26"	203	450	96	489	196	74	108	1616	570	
Thousand Acre Ranch (H. W. Keller)	106.0 R	1-14"	35	102	57	24	79	24		321	235	
St. Johns Park Company (W. A. Yerxa and Sons)	110.0 R	1-12"	86	75	110	99	100	9	68	547	166	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) Includes 140 acres irrigated for J. Boggs (See Mile 98.6 L); 80 acres for J. W. Browning and 170 acres for D. W. George.

(2) 170 acres irrigated from Terrill & Sartain Plant (See Mile 99.2 L).

(3) Additional Maxwell Irrigation District areas (rice and gun clubs) irrigated from Colusa Trough. See Colusa Trough Diversions.

(4) See plant at Mile 154.8 Right.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Anna Kern	126.5 R	1-1½"		0.2	0.1					0.3	1	
J. E. Scharsch	130.8 R	1-1½"		NO DIVERSION								
Parrott-Phelan Estate	141.5 L	5-24"	433			2352	2058	2591	740	(1)8174	(2)280	(2)1550
Merrill Knight	146.7 L	1-3"		0.4	0.4		0.4			1.2	1	
P. M. Rooney	146.9 L	1-5"			27	34				61	25	
Henry Gianella	150.0 L	1-10"	17	99	55	109	80	94		454	156	
Joseph Gianella	150.0 L(3)	1-10"		NO DIVERSION								
Sacramento Valley Sugar Company	151.0 R	1-12"		NO DIVERSION								
		1-18"										
A. Holecek	152.2 R	1-6"		7	9	11	8	6	1	42	30	
Maas Bros.	154.6 R	1-5"		5	1	8	5	1	1	21	13	
Glenn-Colusa Irrigation District	154.8 R	2-30"										
		1-42"										
		2-50"	40394	62851	52617	58934	55949	30285	14912	315942	31667	14811
		4-72"								(4)	(5)	(6)
		1-100"										

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) Additional water estimated at 11000 acre-feet was obtained for acreage here shown and other areas, from Butte Cr.

(2) Segregation of irrigated areas as follows; Phelan Estate, 950 rice; Parrott Investment Company, 280 general and 600 rice. Between 2000 and 3000 acres of pasture were also reported watered on the Parrott Ranch from Butte Creek water.

(3) Pump on Nord Slough or Pine Creek Lagoon which joins Sacramento River at Mile 147.0 Left. Plant is located three miles up slough on right bank or opposite Mile 150.0 Left, Sacramento River.

(4) There were additional early and late diversions as follows: (Acre-feet) March 902, November 19310, December 3171. There were no gravity or Stony Creek diversions in 1929.

(5) Includes 2029 acres served for filling or freshening duck ponds and 150 acres of pasture served through Provident Irrigation District canals.

(6) Includes 203 acres abandoned in mid-season and 169 acres served through Provident Irrigation District canals.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Jacinto Irrigation Dist. (1)	154.8 R	(1)	1530	2434	1710	3500	2448	1679	1108	14409	(2)4055	
Compton-Delevan Irr. Dist.(1)	154.8 R	(1)	1140	1679	1545	1599	1312	120		7395	5	985
Provident Irr. Dist. (1)	154.8 R	(1)	9700	18473	17498	17962	17103	9051	1190	(3) 90977	(3)652	(3)4334
C. L. Leonard (1)	154.8 R	(1)	36	68	47	39	77		10	277	153	
Geo. Butler (A. F. Landis)	166.7 R	1-3"				5	5	5	3	18	9	
Wm. H. Hall	166.8 R	1-2"			1.2	1.0	1.5	1.0	1.0	5.7	4	
R.A. Foster	168.7 R	1-5"	NO DIVERSION									
R. A. Foster	169.1 R	1-8"	NO DIVERSION									
Hammon Stock Ranches	169.8 R	1-8"	NO DIVERSION									
Hammon Stock Ranches	170.7 R	1-6"	NO DIVERSION									
Hammon Stock Ranches	171.2 R	1-8"					20			20	20	
Hammon Stock Ranches	174.2 R	1-8"	NO DIVERSION									
E. B. Noble (C. E. Flournouy)	184.5 R	1-14"		63	23	244	128	22	44	524	100	
J. J. Silva (4)	185.3 R	1-10"										
R. R. Howell	193.5 L	1-1½"		11	9	18	20	6	5	69	20	
		1-4"										
S. E. Ayer	193.6 R	1-3"	NO DIVERSION									

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) Same plant as that of Glenn-Colusa Irrigation District.

(2) In addition to acreage here shown this water served 50 acres general crops for Provident Irrigation District. There were additional diversions in November and December of 955 and 62 acre-feet respectively.

(3) In addition to acreage here shown this water served 401 acres rice for Princeton-Codora-Glenn Irrigation District (See Mile 112.4 R) and 169 acres rice and 150 acres pasture for Glenn Colusa Irrigation District. The general crop figure includes 2434 acres pasture and 150 acres duck ponds. It includes also 50 acres served from Jacinto Irrigation District canals. There was an additional diversion of 75 acre-feet in November.

(4) In 1929 the river channel shifted and left this plant on a slough without a direct low water connection with the river.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
S. E. Ayer	194.1 R	1-6"	NO DIVERSION									
G. E. Sutton	196.2 R	1-6"		5.1	3.5	6.2	7.6	1.0	0.5	23.9	15	
J. A. Edwards	196.2 L	1-6"	NO DIVERSION									
A. W. Gibson (T. A. Crook)	196.4 L	1-8"		35	5	28	29	14	10	121	17	
W. E. Johnson	196.5 L	1-4"			5	13	5			23	27	
J. Erickson	196.6 L	1-3"										
		1-5"		7	12	12		6	1	38	26	
H. P. Stice	197.0 L	1-8"		41	17	74	64			196	65	
Freemeyer Bros.	197.65L	1-3"			0.9	6.9				7.8	25	
Pearl Edwards	197.73L	1-6"	NO DIVERSION									
Griffen Bros.	206.0 L	1-6"	PLANT REMOVED									
Geo. J. Ernest (1)	209.0 L	1-2½"			2.2					2.2	9	
J. F. Nunas	215.5 R	1-7"	NO DIVERSION									
J. F. Nunas	216.0 R	1-3"		1	5	10	9	2		27	15	
W. A. Hunaeus	216.4 L	1-3"				2.7	1.1	1.9		5.7	4	
Haskins Bros.	218.0 L	1-4"		1	21	6	1			29	39	
Johnson and Coates	221.0 R	1-10"		37	39	167	100	15		358	420	
L. C. Smith (Fowler) (2)	233.0 L	1-6"										
		1-4"			4	3	3	3		13	8	
Wm. Menzel Meat Company	240.2 L	1-12"		50	78	337	108	40		(3) 613	(3)100	

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) Formerly Jesse Alford.

(2) Previously listed as W. Northrup.

(3) Additional water for 25 acres of the acreage shown was received from plant at Mile 240.5 Left.

TABLE 15 (CONTINUED)

SACRAMENTO RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Fitzpatrick and Dempster and J. L. Henderson (1)	240.5 L	1-10"		38	63	330	185	16	5	(2) 637	115 (3)	
M. Leonardini Estate (Graf and Graf)	242.0 L	1-8"		44	10	70	73	37		234	55	
Adams Bros.	242.5 R	1-6"		12	1	34	53	37		137	67	
John Diestelhorst	243.0 R	1-5"	22	23	19	22	20	22	22	(4) 150	30	
Anderson Cottonwood Irrigation District	243.0 R	Gravity	11128	18925	11616	20695	20986	20261	13702	117313 (5)	(6)	
TOTALS			13828	204360	167378	207785	191346	107103	43954	1060209	13694	13894

* Mileage along river above Southern Pacific Bridge, Sacramento.

(1) Formerly Harris and Dempster and J. L. Henderson.

(2) In addition to acreage shown this water served 25 acres for Menzel Meat Company (See Mile 240.2 Left).

(3) Fitzpatrick 90 acres, Henderson 25 acres.

(4) This pump runs practically continuously throughout the irrigation season but excess water runs right back to river through gardens. Actual seasonal diversion by the pump was 667 acre-feet but the use for the 30 acres is estimated at 5 acre-feet per acre or 150 acre-feet as shown.

(5) There is a considerable amount of water from this diversion which is returned to the Sacramento River through the Creek channels between Redding and south of Cottonwood. An estimate (from observation of these channels at various times during the season) of this return water (including seepage to the channels) for the 1929 season gives the following: (Acre-feet) April 2400, May 3400, June 1800, July 4000, August 4000, September 3900, October 3100, total 22600.

(6) Of this amount, 8243 acres only were cropped lands reported as irrigated. The remaining 10000 acres is pasture and grazing land estimated to have received some water, mostly through sub-irrigation. (21,679 acres of pasture and grazing land are reported with estimates from 10 to 50 per cent as the portion thereof receiving benefit by direct or sub-irrigation).

TABLE 16

*COLUSA TROUGH DIVERSIONS

Water User	**Location	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Henry Jameson	SW¼SE¼ Sec.23 T19N R2W Right Bank	1-16"	153	696	701	715	743	363		3371		200
Compton-Delevan Irrigation District	SW¼NE¼ Sec. 9 T17N R2W Right Bank(1)	1-30"	NO DIVERSION									
Bearrup & Fessigm & Mary E. Rouke (Babu) (2)	NE¼SE¼ Sec. 9 T17N R2W Left Bank (3)	2-32" Box	459	801	785	806	746	246		3843		390
Maxwell Irrigation Dist.(Plant #2A)	SW¼SE¼ Sec.33 T17N R2W Right Bank	1-26" 1-15"	593	1082	420	1961	2570	2305	1334	10265	3350 (4)	400
Pete Larie	NE¼NW¼ Sec.16 T16N R2W Right Bank	1-32" Box	NO DIVERSION									
Maxwell Irrigation Dist. (Plant #6)	SW¼NW¼ Sec.20 T16N R2W Left Bank	1-20" 1-12"			864	964	806			2534	(5)	

* Main Drain of Reclamation District 2047.
** Pumps tabulated in downstream order.
(1) Corrected description. Previously given as SE¼ NE¼ Sec. 19, T 17 N, R 2 W, Right Bank.
(2) Formerly American Trust Company (C. J. Whiting).
(3) Corrected description. Previously given as NE¼ NE¼ Sec. 17, T 17 N, R 2 W, Left Bank.
(4) All duck club acreage. This is the total served from both Colusa Trough plants of the District.
(5) See Maxwell Irrigation District, Plant #2A.

TABLE 16 (CONTINUED)

*COLUSA TROUGH DIVERSIONS

Water User	**Location	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Sacramento Shooting Club (1)	SW¼NW¼ Sec.20 T16N R2W Right Bank	1-36" Box				140	285	104	192	721	Duck Club	
Sacramento Shooting Club	SE¼NW¼ Sec.21 T16N R2W Right Bank	1-36" Box			63	59	122	69	37	350	Duck Club	
A.D.J. Land Company	SE¼NW¼ Sec.21 T16N R2W Left Bank	1-28" Box(2)		40	29	110	223	131		533	Duck Club	
I. G. Zumwalt	NE¼NW¼ Sec.28 T16N R2W Right Bank	1-36"		NO DIVERSION								
Hattie O'Hair	NE¼NE¼ Sec. 2 T15N R2W Left Bank(3)	1-10" Box		NO DIVERSION								
Tuttle Land Company	NE¼NE¼ Sec. 2 T15N R2W Left Bank(3)	1-10" Box		NO DIVERSION								
Totals			1205	2619	2862	4655	5495	3218	1563	21617	3350	990

* Main Drain of Reclamation District 2047.
** Pumps tabulated in downstream order.
(1) New installation in 1929.
(2) 6" Pump replaced by 28" box pump in 1929.
(3) On Powell Slough tributary to main canal of District 2047 (Trough) in SW¼SW¼ Sec. 1, T 15 N, R 2 W.

TABLE 17

**BACK BORROW PIT DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated Rice Only
			Apr.	May	June	July	Aug.	Sep.	Oct.		
River Farms Company (1)	1.8 R	1-14"	310	600	583	620	620	315		3048	538
Hershey Estate	11.15 R	1-14"	282	392	535	514	510	110		2343	350
B. F. Mumma	14.75 R	1-10"		121	123	140	117	67		568	120
County Line Gun Club	15.75 R	1-15"		124	32	34	167	225	78	660	Duck Club
T. H. Mumma	20.0 R	2-15" (2)	1162	1243	1646	1557	1488	57		7153	850
G. Gregory, J. W. Browning, M. Kindery, M. Brindenburg	22.15 R	1-16" 1-12"	PLANT REMOVED								
Totals			1754	2480	2919	2865	2902	774	78	13772	1858

* Mileage along Borrow Pit from Horseshoe outfall gate just above junction of Borrow Pit with Sacramento River at Knights Landing.

** Carries return water from Colusa Basin along west border of Reclamation Districts 108 and 787 and thence to discharge to Sacramento River at Knights Landing.

(1) Previously operated in 1924 and 1925. Listed as W. C. Eldridge in 1924.

(2) Additional 15" pump installed in 1929.

TABLE 18

LOWER BUTTE CREEK AND BUTTE SLOUGH DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	(1) Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
LOWER BUTTE CREEK											
Reclamation District 833 (Ingram) (2)	2.9 L	36" Box		56	111	282	357			806	577
El Anzar Gun Club	(3) 3.9 L	1-10"	**NO DIVERSION PRIOR TO SEPTEMBER 1ST								Duck Club
Reclamation District 1004 (Colusa Delta Farms Co.)	3.9 R	1-15" 1-12"		152	526	761	194	501		2134(4)	2346(4)
Butte Lodge Gun Club	4.0 R	1-22"	**NO DIVERSION PRIOR TO SEPTEMBER 1ST								Duck Club
South Butte Gun Club	(5) Opp. 5.5 L	1-10"	**NO DIVERSION PRIOR TO SEPTEMBER 1ST								Duck Club
Winchester Gun Club	(5) Opp. 5.5 L	1-12"	**NO DIVERSION PRIOR TO SEPTEMBER 1ST								Duck Club
Reclamation District 1004 John Hannah	9.3 R	Gravity 20" Box	1280	891	350	651	(7)	(7)		3172(7)	(6) (7)
John Hannah	20.2 R		NO DIVERSION								
John Hannah	21.2 R	3' x 3' Box	NO DIVERSION								

* Approximate mileage along creek from junction with Sacramento River.

** With the duck club diversions the purpose is to show only such diversions as may occur prior to September 1st, when there would be a possibility of interference with other water uses.

(1) All general crops or gun clubs.

(2) New installation 1929.

(3) On a barge.

(4) This acreage served also by waste from upper rice irrigation of the district, by 1800 acre-feet direct diversion from Sacramento River "Princeton" Plant in July, (see Mile 112.1 L., Sacramento R. diversions) and by gravity diversion from Butte Creek (See mile 9.3 R). An additional 1100 acres of gun club lands were served from these sources during the latter part of the season.

(5) On dredger cut extending to east side of Butte Basin.

(6) 2346 acres of general crops served from this and other sources (see mile 3.9 R).

(7) Diversions after September 1st are not included as they were entirely for gun club lands. (1100 acres served from this and other sources - see mile 3.9 R).

TABLE 18 (CONTINUED)

LOWER BUTTE CREEK AND BUTTE SLOUGH DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	(1) Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
BUTTE SLOUGH											
M. Marty	0.3 West	1-12"		25	69	27	20			141	60
I. E. Nall	3.5 West	1-10"	43	48	34	67	55	36		283	115
W. H. Ross (C. E. Ray)	3.7 West	1-10"	5	57	14	28	29	10	9	(2)152	46
P. A. Reische	4.1 West	1-12"	22	31	47	118	127	23	4	372	(3)194
E. V. Jacobs (G. M. Gomez)	4.8 West	1-10"		16	107	109	124	79		435	113
A. Armstrong & Colusa County Bank (4)	5.1 West	1-10"			97	168	42	22		329	218
W. G. Thompson	7.6 West	1-2"	PLANT REMOVED								
TOTALS (Lower Butte Creek and Butte Slough)			70	1513	1522	1675	2166	364	514	7824	3669

* Approximate mileage along Slough from junction with Sacramento River.
(1) All general crops.
(2) 10 acre-feet diverted in September were for stock.
(3) Includes adjoining lands which were served by this plant as follows: (Acres) - Feith 3, Grannerman 5, Messick 14.
(4) Formerly L. F. Putman.

TABLE 19

BY-PASS AND DRAINAGE CHANNEL DIVERSIONS

Water User	Location	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion: April to October Acre-feet	(1) Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
TISDALE BY-PASS											
Sutter Basin Company	No.1 - 6" NE¼ NW¼ Sec.32 T14N, R2E, South Bank (2)	1-6"	NO DIVERSION								
Sutter Basin Company	No.2 -12" NE¼ NW¼ Sec.33 T14N, R2E, South Bank (3)	1-12"	NO DIVERSION								
SUTTER BY-PASS											
D.C.Smith, E.I.McGrath and S. A. McKeehan	NE¼NW¼ Sec.25 T15N, R1E, West Borrow Pit	1-10"		1005	685	898	1067	512		4167	2145
R. L. Moorehead	SW¼NE¼ Sec.24 T15N, R1E, East Borrow Pit	1-10"				134	23	21	13	191	90
Sutter Basin Company (E. H. Christensen)	NW¼ NW¼ Sec.20, T13N, R3E, East Borrow Pit	1-16"	483	500	575	608	750	74		2990	200 Rice
A. C. Middleton and L. M. Dessez (R.L.Young) (4)	NW¼SE¼ Sec. 3 T13N, R2E, West Borrow Pit	1-15"	135	327	493	819	837	775		3386	300 Rice
Sutter Basin Company (W. W. Thornton)	SW¼SE¼ Sec. 3 T12N, R3E, Willow Slough	1-8"	NO DIVERSION								
J.F.Holmes & R.E.Hughes (4)	NW¼NE¼ Sec.10 T12N, R3E, East Borrow Pit	1-8"		51	23					74	200
Sutter Basin Company (Musser and Seydel)	NW¼SW¼ Sec.21 T11N, R3E, Sacramento Slough Sou.Bk	1-12"	PLANT NOT INSTALLED IN 1929								

(1) All general crops except as noted.
(2) Corrected description - Previously given as SW¼ SW¼ Sec. 29, T 14 N, R 1 E.
(3) Corrected description - Previously given as SE¼ SW¼ Sec. 28, T 14 N, R 1 E.
(4) New plant 1929.

TABLE 19 (CONTINUED)

BY-PASS AND DRAINAGE CHANNEL DIVERSIONS

Water User	Location	Number and size of pump	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Total Diversion: April to October Acre-feet	(1) Acreage Irrigated
YOLO BY-PASS (TULE CANAL)											
Frank Fisher & Henry Rich (2)	SE¼SE¼ Sec. 4, T10N, R3E	1-24"		1469	1887	2337	2279	976		8948	660
		1-16"			(3)	(3)				(3)	Rice
Basil Beach	SE¼NE¼ Sec. 9, T10N, R3E	1-10"		NO DIVERSION							
Robert Swanston	East Borrow Pit, 1/2 Mile North of North Levee Sacramento By-Pass	1-15"		NO DIVERSION							
BACK BORROW PIT RECLAMATION DISTRICT 1000											
W. F. Sandercock (LeClare and Sons)	SE¼NE¼ Sec.26, T9N, R4E	1-10"		44		73	7	15		139	79
KNIGHTS LANDING RIDGE CUT											
Russell Brothers	NE¼SW¼ Sec.25, T11N, R2E North Bank	1-12"		23	30		51	38	28	170	75

(1) All general crops except as noted.
(2) New plant 1929.
(3) Some of this water was derived from the Sacramento River through the Hershey, Mull, and Keller plants of Fisher and Rich (See Sacramento River diversions) which diverted the water direct to the By-pass. These river diversions to the By-Pass amounted to approximately 1100 acre-feet in June and 2100 acre-feet in July.

TABLE 20

FEATHER RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion: April to: October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		Gen-eral	Rice
Meyer and Rutz	1.55 L	1-6"	1	34	37	63	37	23	35	230	70	
Sutter Basin Company	2.60 R	1-20"; 1-26"		1218	1128	212	1809	556		4923	1514	
R. B. Cattlett	3.13 L	1-8"	P L A N T R E M O V E D									
S. A. McKeehan	5.44 L	1-6"	2	7	3	6	6	5	1	30	35	
M. Scheiber	7.70 L	1-8"		34	79	90	81	71		355	75	
Geo. Pollock Company (Spreckles Sugar Company)	9.75 R	1-12"; 1-16"	127	687	517	730		164	89	2314	921	
Garden Highway Mutual Water Company	13.1 R	1-20"; 1-24"	229	658	558	836	859	428		3568	2553: (1)	
Feather River Water Company	16.35 R	1-14"		181	52	109	198	9		549	236	
Plumas Mutual Water Company	17.5 L(2)	1-22"	584	1500	1321	1406	2062	949	88	7910	(3)1200	300
G. C. Shannon	18.75 R	1-6"		49	45	22				116	84	
Alicia Mutual Water Company	24.0 L	1-20"; 1-16"	276	1152	1250	1388	1358	107	57	5588	1000	400
J. L. Sullivan	33.9 R	1-10"	88	116	24	143	166	16		553	175	

* Mileage along river above mouth.

(1) Includes 339 acres of Brown and Purington.

(2) Heretofore listed erroneously as 16.0 L.

(3) Additional water diverted from Plumas Lake in early part of season for some of this acreage.

TABLE 20 (CONTINUED)

FEATHER RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Sutter Butte Canal Company (Sunset Plant) (1)	38.1 R	2-42" 1-26"	NO DIVERSION									
Pacific Highway Orchards Tract (Charles Cottrell)	(2)43.7 L H.S1.0.4L	1-18"	NO DIVERSION									
Moznett-Wetmore Subdivision #1 (Charles St. Claire)	(2)43.7 L H.S1.1.2L	1-10"	8	156	158	103	222	37	12	696	209	
Manuel A. Barba (J.E.Davis)	(2)43.7 L H.S1.1.25L	1-8"		20	19	42	27	25		133	30	
A. P. Barba (John Bettencourt)	47.9 L	1-12"		81	24	80	25	43		253	75	
E. F. Biggs (Wm. Luiz)	48.3 L	1-10"		123	75	111	160	3		472	345	
J. F. Harriger	51.1 L	1-7"		28	4	23	47	8	10	120	(3)74	
Donald Steadman	51.4 R	1-10"			46	17	1			64	100	
Silva-Bergtholdt	51.6 R	1-5"				4	9			13	25	
Blower Brothers	52.1 L	1-9"		30	40	25	33	17		145	140	
C. O. Kister	52.5 L	1-6"		13	37	40	25	2	3	120	30	

* Mileage along river above mouth.

(1) See Mile 58.1 R.

(2) Plant diverts Feather River water backed into Honcut Slough. Slough is tributary to Feather River at Mile 43.7 Left. Mileage of plant above mouth of Honcut Slough is indicated.

(3) Includes 30 acres irrigated for E. J. Robinson.

TABLE 20 (CONTINUED)

FEATHER RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion: April to October Acre-Feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
F. L. Morris	52.7 L	1-8"		14	17	24	12			67	75	
Frank Dutra	52.9 R	1-6"		27	8	6	22			63	30	
G. H. Bogue	53.1 R	1-6"		17	15	23	22	12	2	91	40	
Budh Singh	54.7 R	1-8"		32	11	5	53			101	55	
Hearst Estate (Sunical Packing Company)	55.1 L	1-14"	17	221	97	236	172	36		779	400	
L. A. Kister	55.5 L	1-8"	7	12	21	1	39	18		98	48	
Rio Bonito Ranch	56.6 R	1-14"		125	50	183	73	34		465	77	
J. E. Carrico	57.0 R	1-8"		NO DIVERSION:								
Henry Haselbusch	57.9 R	(1)1-10"		12	7	25	35			79	53	
Emma C. Eakle (E.A.Switzer)	58.1 R	1-8"				13	11			24	10	
Sutter Butte Canal Company	58.1 R	Gravity	43205	76545	65177	65638	61104	32513	12380	356562	16534	16355
Western Canal Company	59.7 R	Gravity	3906	14203	12750	15457	13509	2635	34	(2) 62494	2798	6862
Ralph Butler	63.7 R	1-5"		NO DIVERSION:								
TOTALS			48450	97295	83570	87061	82177	37711	12711	448975	29011	23917

* Mileage along river above mouth.

(1) Listed previously as 8".

(2) In addition to diversions here listed there were diversions by Western Canal for flooding ponds of duck clubs in Butte Basin as follows: (Acre-feet), September 5272, October 12620, November 12482, December 3257, Total 33631.

TABLE 21

YUBA RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated	
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		General	Rice
Marysville River Farms Co. (Unit #10 Plant)	2.8 L	1-12"	NO DIVERSION:									
Dantoni Orchards	4.2 L	1-10"	NO DIVERSION:									
Wm. W. Dinsmore	4.5 L	1-6"	NO DIVERSION:								(1)	
Dantoni Orchards	5.2 L	1-8"	28	11	18	20	70			147	(2)120	
Marysville River Farms Co. (Unit #8 Plant)	6.6 L	1-12"		204	125	218	102	40		689	110	
Hallwood Irrigation Company and Cordua Irrigation Dist.	11.0 R	Gravity	3944	10593	8700	9138	8538	7268	4237	52418	4950 (3)	2450 (3)
TOTALS			3972	10808	8843	9376	8710	7308	4237	53254	5180	2450

* Approximate mileage along river above Highway Crossing at Marysville.

(1) See Plant at Mile 5.2 Left.

(2) Includes 40 acres irrigated for Wm. W. Dinsmore (See Mile 4.5 Left).

(3) Hallwood Irrigation Company and Cordua Irrigation District have a common point of diversion and common canal for about one-half mile; diversion and acreage figures are for combined projects. Irrigated acreage is segregated as follows: Hallwood, Rice 850, General 4550; Cordua, Rice 1600, General 400.

TABLE 22

AMERICAN RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversion in Acre-feet							Total Diversion April to October Acre-feet	** Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
G. A. Meister	3.2 L	1-10"		47	88	98	100	81	3	417	152
G. A. Meister	3.6 L	1-6"(1)		14	25	40	28	14	6	127	50
G. A. Meister	3.8 L	1-6"(2)		16	16	11	14	6	4	67	38
E. Clemens Horst Company	6.0 R	1-8"	PLANT REMOVED								
Cutter Brothers	6.8 L	1-5"	13	22	32	19	19	16		121	90
S. H. Cowell	7.1 L	1-7"		69	6	45	49			169	60
E. Clemens Horst Company	7.5 R	1-8"		7	18	83				108	75
Kiyoshi Okomoto	7.9 R	1-8"		10	2	21	15	21	4	73	40
P. M. Rooney	8.6 L	1-8"	NO DIVERSION								
M. T. Harding	9.0 L	1-8"(3)		11	6	13	7			37	45
Edward Morinini	9.2 R(4)	1-8"		22	60	60	109	44		295	75
A. F. Counsman (Nelson)	9.2 L	1-8"				21	11			32	35

* Mileage along river above mouth.
** All general crops. No rice.
(1) New pump installed to replace 4".
(2) New pump installed to replace 10".
(3) Previously listed as 7"
(4) Heretofore listed erroneously as Mile 8.7 R.

TABLE 22 (CONTINUED)

AMERICAN RIVER DIVERSIONS

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	** Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
C. E. Wells	9.45 L	1-5"			12	15				27	(1) 85
C. E. Wells	9.5 L	1-8"			24	7				31	(2)
C. E. Wells (3)	9.55 L	1-5"			10	23	4			37	(2)
Henry Cowell (Quong Ham)	9.9 L	1-5"		6	17	52	28			103	40
Gibbens and Richardson	10.2 R	1-8"			0.9	15.2	3.7	5.3		25.1	40
H. W. Bartell	10.3 L	1-20"	142		40	121				303	(4)200
E. H. Gerber (Gold Nugget Orchard Co.)(5)	10.4 R	1-5"			3.2					3.2	15
Del Paso Hop Company	10.5 R	1-10"	NO DIVERSION								
Annie Hoey	11.2 L	1-6"(6)	3	14	26	10		4		57	24

* Mileage along river above mouth.
** All general crops. No rice.
(1) Combined acreage irrigated from plants at Miles 9.45 L, 9.5 L, and 9.55 L.
(2) See Plant at Mile 9.45 L.
(3) New installation 1929.
(4) Some additional water for this acreage was derived from wells. However, river pump will serve about 240 acres.
(5) Plant reinstalled 1929.
(6) Former 8" pump replaced by 6".

TABLE 22 (CONTINUED)

AMERICAN RIVER DIVERSIONS

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion: April to October Acre-feet	** Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
J. T. Gore Estate (C.E.Wells)	11.5 L	1-6"	NO DIVERSION								
Wm. A. Meyer	11.7 L	1-4"		12	1	11	4			28	29
Harry Nakatomi	11.7 L	1-5"				22	2	5		29	20
P. Osterle	13.2 R	1-4"	NO DIVERSION								
Mary Deterding	13.9 R	1-6"			2					2	3
Mary Deterding	14.7 R	1-3"	NO DIVERSION								
Mary Deterding	15.1 R	1-4"	NO DIVERSION								
Carmichael Irrigation Dist.	16.0 R	1-6"									
		1-8"	324	561	545	850	886	666	343	4175	1961
		1-12"									
Wm. H. Devlin	17.1 R	1-6"									
		1-1¼"		1.5	2.1	2.2	0.6	1.7	0.8	8.9	(1)
TOTALS			482	812	936	1539	1280	864	361	6275	3077

* Mileage along river above mouth.
** All general crops. No rice.
(1) Gardens and domestic.

TABLE 23

DELTA UPLANDS DIVERSIONS FROM OLD SAN JOAQUIN RIVER

Water User	*Mile and Bank	Number and Size of Pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
East Contra Costa Irrigation District	36.5 L (1)	2-30": 1-24": 1-18":	4493	5417	4203	5351	4888	3522	1665	29539	14939
Byron-Bethany Irrigation District	40.9 L (2)	1-26": 1-30":	2867	3131	1619	3094	2662	2188	409	15970	9181
Joe F. Costa	45.2 L	(3) 1-7":	15	12	12	54	48	4		145	30
E. H. Stevenson (Ray Bros.)	45.8 L	1-12":	43	8		12	48			111	110
H. Lindeman	47.2 L	1-12":	35	20	59	16	42	31	5	208	75
Kooyman Bros. (4)	47.2 L	1-10":	5	96	71	192	139	116	32	651	100
West Side Irrigation District	47.65 L (5)	7-15":	4566	2868	2047	4054	3985	2493	839	20852	10107
N. E. and John Welty (T. B. Silva)	48.7 L	1-8"	17	23	34	30	17			121	80
Naglee-Burke Irrigation District	50.4 L	1-16": 1-18":	596	1160	543	1470	1014	961	439	6183	2127
Freemont Irrigation Ass'n.	50.9 L	1-14":	318	423	243	410	269	150		1813	500
Labrucherie, Platti and Smallpage	52.4 L	1-10":	22	12	63	52	31			180	110
Totals			12977	13170	8894	14735	13143	9465	3389	75773	37359

* Distance along the river from its mouth 4½ miles below Antioch. Mileage as established by War Department Survey of 1913-15.

(1) To junction of Old River and Indian Slough. Pumping plant is located 2½ miles west along Indian Slough.

(2) To junction of Old River and Italian Slough. Pumping plant is located 2 3/4 miles southwest along Italian Slough and extension cut.

(3) Formerly listed as 8".

(4) New installation 1929.

(5) To junction of Old River with intake cut. Pumping plant is located one mile south along intake cut.

TABLE 24

DELTA UPLANDS DIVERSIONS FROM TOM PAINE SLOUGH

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
Stinson Estate Company	0.7 S	1-20"	411	431	232	637	310	241		2262	(1) 1945
Holly Western Sugar Company	(2)2.1 S	1-12"				30	310	300	310	(3) 950	Industrial
Tracy Clover Irrigation Dist.	(2)2.1 S	1-16"	66	258	206	319	404	238	7	1498	720
California Irrigated Farms Co.											
Plant Number 1	2.9 S	1-12"	76	134	26	122	87	91	48	584	(4) 2530
Plant Number 3	6.3 S	(6)1-20"	824	1166	916	1473	1405	895	682	7361	(5)
Plant Number 5	8.3 S	1-12"	109	270	93	345	201	180	75	1273	(5)
Plant Number 5A	9.0 S	1-12"	68	117	169	102	97	155	32	740	(5)
Totals			1554	2376	1642	3028	2814	2100	1154	14668	5195

* Distance along Tom Paine Slough from its mouth which is at Mile 54.3 on Old San Joaquin River (War Department Survey of 1913-15).

(1) Additional acreage irrigated by waste water from Holly-Western Sugar Factory in previous years is now irrigated from wells.

(2) To junction of Tom Paine Slough and Dredger Cut. Pumping plant is located 1½ miles south along Dredger Cut.

(3) Waste water from the sugar factory which in previous years has been used on lands of the Stinson Estate (Mile 0.7 S) is now returned directly to the dredger cut.

(4) This is the total uplands area (south of Tom Paine Slough) irrigated from all California Irrigated Farms Company plants on Tom Paine Slough.

(5) See Plant at Mile 2.9 South.

(6) Formerly listed as 18" pump.

TABLE 25

DELTA UPLANDS DIVERSIONS FROM SAN JOAQUIN RIVER

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
Paul Weston	46.3 R	1-4" 1-6"	10	31	24	22	18	4	1	110	40
August Eisele	47.2 R	1-5"	2.3	1.8	3.3	1.8	2.5	0.6		12.3	7
Wolfinger Bros.	47.3 R	1-10"	26	19	24	30	30			129	55
John Haack	47.7 R	1-4"	NO DIVERSION								
John Haack	48.0 R	1-12"		2	53	61	149			265	105
Joe Calcagno	48.5 R	1-6"	21	27	25	26	46	58	13	216	60
I. Yoshito (1)	48.5 R	1-3½"	7.6	6.0	2.6	3.4	9.3	5.6	5.1	39.6	7
Frank Piccardo	48.6 R	1-6"	8	22	6	9	14	8	2	69	55
G. Accinielli	48.7 R	1-6"	6	37	19	40	34	34	23	193	60
M. O. Couper (M. Matsumoto)	49.0 R	1-5"		0.7	2.5	1.9	3.5	0.7	0.4	9.7	2
A. A. Rodgers	50.1 R	1-8"		67	55	48	48	4		222	75
N. Lagler and Joe Reichmuth	50.4 R	1-8"	33	35	76	36	30	43		253	102
John Brandt	50.5 R	1-6"		4.2	13.0	0.9				18.1	3
F. Delima	53.4 R	1-8"	8	8	11	19	5	7	5	63	33
M. Dos Reis (Cordoza, Sousa and Avellar)	53.7 R	1-12" (2)		164	76	222	172	108	61	803	550

* Distance along San Joaquin River from its mouth four and one-half miles below Antioch. (Mileage as established by War Department Survey of 1913-15.)

(1) New plant in 1929.

(2) Formerly listed as 10" pump.

TABLE 25 (CONTINUED)

DELTA UPLANDS DIVERSIONS FROM SAN JOAQUIN RIVER

Water User	*Mile and Bank	Number and size of pump	Monthly Diversions in Acre-feet							Total Diversion April to October Acre-feet	Acreage Irrigated
			Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.		
W. C. Frank (M. Martin Co.)	54.9 R	1-10"	24	22	29	40	20	26	9	170	45
Oakwood Stock Farm	57.0 R	1-14"	129	252	199	194	237	116	16	1143	420
S. Mauro (1)	57.2 R	1-5"		2	13	12				27	25
A. J. Thompson	57.3 R	1-5"		0.8	3.6	3.0				7.4	5
P. Colori Company	57.5 R	1-4"	24	19	8	27	3	3	1	85	36
V. Sanguenetti	58.4 R	1-2½"	3.4	2.7	2.3	4.3	5.2	1.6		19.5	15
G. B. Figari (G. Alfieri)	58.6 R	1-3"	2.4	0.6	1.5	2.2	2.8	0.6		10.1	4
R. Mauro	58.7 R	1-3"	6.3	1.6	2.5	2.0	4.5	1.0	0.1	18.0	14
H. A. Niestrath (Joseph Egger)	59.3 R	1-14"	27	106	10	316	6	82	114	661	185
Banta Carbona Irrigation District	67.5 L	1-36" 2-20" 3-24"	6295	8685	4786	9375	6696	3912	2316	42065	14678(2)
River Junction Farms Company	73.2 R	1-12"	114	84	52	97	88	83	19	537	360
Totals			6747	9600	5497	10594	7624	4498	2586	47146	16941

* Distance along San Joaquin River from its mouth four and one-half miles below Antioch. (Mileage as established by War Department Survey of 1913-15).

(1) New Plant 1929.

(2) Includes 2000 acres in the Kasson District formerly served by the old River View Land and Water Company. This area is not in the Banta Carbona District but the latter is under obligation to serve it.

CHAPTER IV

MEASUREMENTS OF RETURN WATER

San Joaquin Return Waters

In the San Joaquin Valley return water measurements of 1929, the gaging stations were located at the same points as in 1928 and the same methods were followed. That is, a continuous record of the discharge from June to September, inclusive, was secured at an upper and lower station on each stream: San Joaquin, Stanislaus, Tuolumne, and Merced Rivers, and Dry Creek. On the San Joaquin River, continuous records of discharge were also obtained for intermediate stations, one near Grayson (Laird Slough) and the other just below the junction with Merced River. The latter is a station maintained by the U. S. Geological Survey and referred to as "San Joaquin River near Newman". Measurements and records of all pumping diversions between the upper and lower stations on each stream were also obtained, thereby completing the necessary data for the computation of the return water. Tables 26 to 31, inclusive, give the results of the San Joaquin return water measurements and Table 32 presents a comparison of the return water and the irrigation draft for the 1929 season.

Sacramento Return Waters

In the Sacramento Valley the flow was measured and recorded for all of the well defined channels discharging return water from irrigation back to the Sacramento River. Table 33 lists these channels in downstream order and gives the total flow computed from measurements thereon.

Between Colusa and Red Bluff there are no large well defined return channels. Records or estimates of all natural inflow from streams

in this stretch of the river were, however, obtained. Above Red Bluff, on the upper end of the river between Redding and a point below Cottonwood, there is a considerable return from the irrigation of the Anderson-Cottonwood Irrigation District. An estimate of this return water is given in the footnote at the end of Table 15, Chapter III.

Return Flow from other than Sacramento River Sources

In the water returned to the Sacramento River as included in Table 33, it should be noted that practically all of that entering the river through Butte Slough is derived from Feather River diversions through the Western and Sutter Butte canals. Of the discharge entering through Sacramento Slough, that portion flowing down the East Borrow Pit of Sutter By-Pass is, also, practically all from Feather River irrigation.

Relation of Sacramento Return Water to Irrigation Draft

Tables 34 and 35 record the Sacramento River return water, June to September, inclusive, 1929, and indicate the relation between the return and the diversions from which it is derived. Since, in these tables, it is the purpose to show the return water from Sacramento River diversions only, the inflow from Butte Slough, East Borrow Pit of Sutter By-Pass, Back Borrow Pit of Reclamation District 1000 and the Feather and American Rivers has been excluded. In Table 34 is shown the relation to the diversions of that return water only which was actually measured at the well defined channels. With the records available for the discharge of the Sacramento River at Red Bluff, Butte City, Colusa, Knights Landing, Verona and Sacramento, and all diversions between these points recorded, as well as the inflow from the Feather and American Rivers, it is possible to compute what should represent the total

water returned to the river between each of these points, including not only the flow in the definite channels which were measured, but all seepage, groundwater return, etc., which cannot be directly measured. The figures for the return water as computed in this manner and the relation of this return to the draft are shown in Table 35. A comparison of Tables 34 and 35 shows that seepage, groundwater return, etc., which cannot be directly measured, amounted to 11 per cent of the irrigation draft in the period June to September, inclusive, while the direct return as measured in definite channels totaled 31 per cent of the draft. The total return amounted to 42 per cent of the draft. Plate 2 is a diagram showing the accumulated irrigation draft and return water in downstream order, Red Bluff to Sacramento, for the four months' period, June to September, 1929.

Draft-Return Water Relation for Particular Sacramento Valley Areas

In the Sacramento Valley there are certain units or districts which are so set apart physically by levees or otherwise that the return water in each district may be readily segregated. In each case the records of all diversions to and discharges from the unit are available. Such units are, the area above the Colusa Trough at the Colusa-Williams Highway, Reclamation District 108, and Reclamation District 1500. The relation between the 1929 draft and return water for the Colusa Trough area is shown in Table 36 and for Reclamation Districts 108 and 1500, in Tables 36-A and 36-B, respectively.

Tables 37 to 44, inclusive, present in detail the discharge measurements for the Sacramento Valley return water channels.

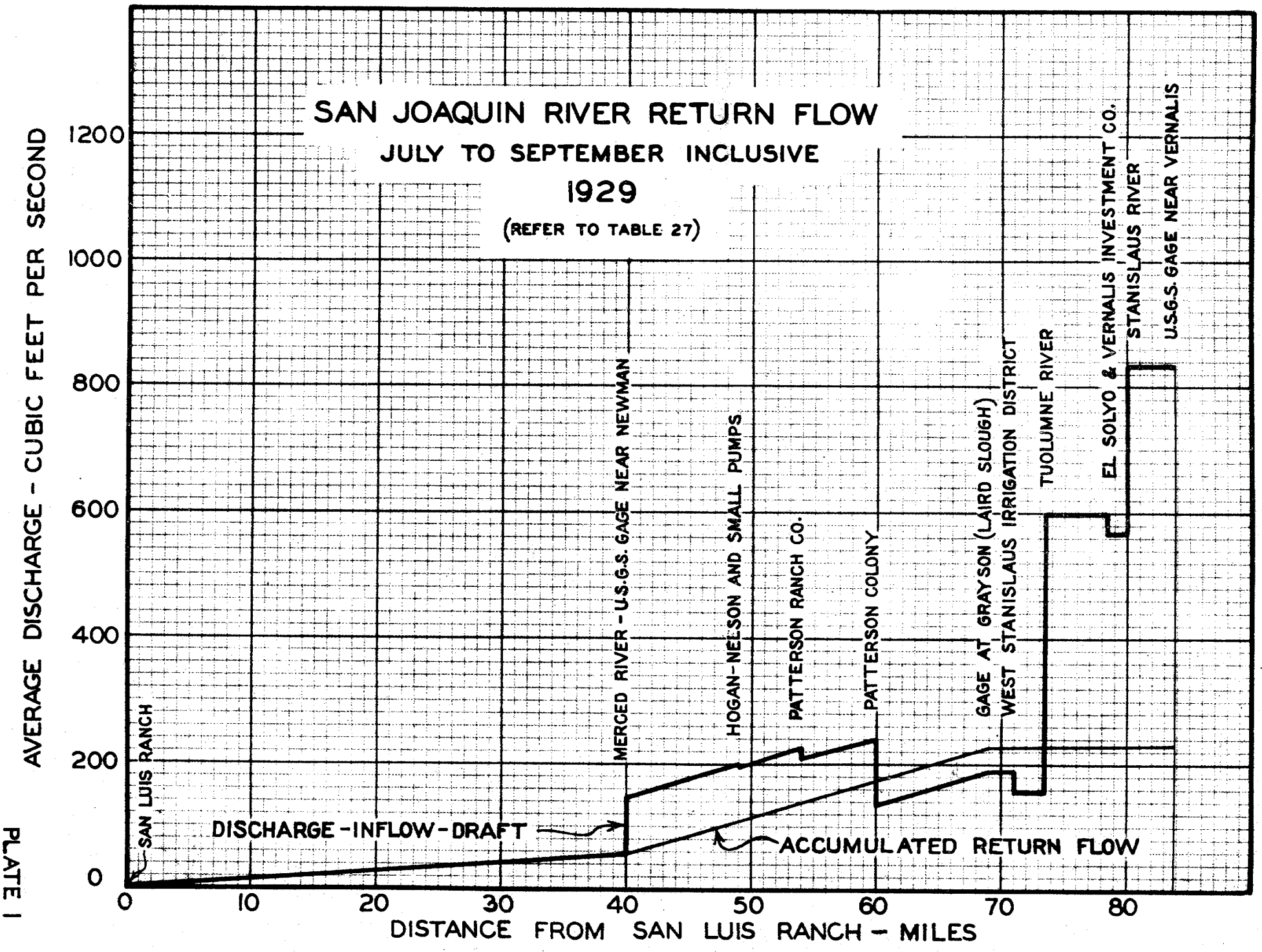

SAN JOAQUIN RIVER RETURN FLOW
JULY TO SEPTEMBER INCLUSIVE
1929
(REFER TO TABLE 27)
AVERAGE DISCHARGE - CUBIC FEET PER SECOND
1200
1000
800
600
400
200
0
0
10
20
30
40
50
60
70
80
DISTANCE FROM SAN LUIS RANCH - MILES
SAN LUIS RANCH
MERCED RIVER - U.S.G.S. GAGE NEAR NEWMAN
HOGAN-NEESON AND SMALL PUMPS
PATTERSON RANCH CO.
PATTERSON COLONY
GAGE AT GRAYSON (LAIRD SLOUGH)
WEST STANISLAUS IRRIGATION DISTRICT
TUOLUMNE RIVER
EL SOLYO & VERNALIS INVESTMENT CO.
STANISLAUS RIVER
U.S.G.S. GAGE NEAR VERNALIS
DISCHARGE - INFLOW - DRAFT
ACCUMULATED RETURN FLOW

PLATE I

TABLE 26

RETURN FLOW IN SAN JOAQUIN VALLEY STREAMS DURING THE IRRIGATION SEASON

	July		August		September		Jul. to Sep. Incl.	
	Ac.Ft.	Av.SecFt.	Ac.Ft.	Av.SecFt.	Ac.Ft.	Av.SecFt.	Ac.Ft.	Av.SecFt.
SAN JOAQUIN RIVER								
Discharge at San Luis Ranch	0		0		0		0	
Discharge near Vernalis (U.S.G.S.Station at Durham Ferry Bridge	(1) 46500	(1) 756	37800	615	(2) 68400	(2) 1148	(1) (2) 152700	(1) (2) 837
Inflow of Merced, Tuolumne and Stanislaus Rivers	(1) 44855	(1) 729	35907	584	(2) 65009	(2) 1091	(1) (2) 145771	(1) (2) 799
Accretion-Exc.of Trib. Streams) San Luis	1645	27	1893	31	3391	57	6929	38
Total Diversions) Ranch to	12814	208	11021	179	10790	182	34625	190
Total Return Flow-Exc.of Trib.) Durham Fy.	14459	235	12914	210	14181	239	41554	228
Streams) Bridge								
STANISLAUS RIVER								
Discharge at Orange Blossom Bridge	3174	52	3316	54	2747	46	9237	51
Discharge at Elliot Ranch	(3)14586	237	13091	213	13330	224	41007	225
Accretion) Orange Blossom Bridge	11412	185	9775	159	10583	178	31770	174
Total Diversions) to	1059	17	807	13	605	10	2471	14
Total Return Flow) Elliot Ranch	12471	202	10582	172	11188	188	34241	188
TUOLUMNE RIVER								
Discharge at Roberts Ferry Bridge	2259	37	2630	43	(2) 32102	(2) 540	(2) 36991	(2) 203
Discharge at Tuolumne City Bridge	17956	292	17992	293	(2) 45302	(2) 762	(2) 81250	(2) 445
Inflow of Dry Creek	2303	37	2311	38	3049	51	7663	42
Accretion-Exc. Dry Creek)Roberts Fy.	13394	218	13051	212	10151	171	36596	200
Total Diversions)Bridge to	477	8	338	6	189	3	1004	6
Total Return Flow-Exc. Dry Cr.)Tuolumne Cy.	13871	226	13389	218	10340	174	37600	206
)Bridge								

(See Dry Creek and Merced River next page)

(1) Includes 7600 acre-feet estimated as power releases and spill in Stanislaus River in July (See footnote (3)).

(2) Includes 28240 acre-feet released in September to Tuolumne River from Don Pedro Reservoir through La Grange power plant.

(3) The measured discharge at this station was 22186 acre-feet but a deduction of 7600 acre-feet has been made as the estimate of power water releases and spill which was flowing out subsequent to rapid drop in discharge at Orange Blossom Bridge from 876 second-feet on June 23d to 86 second-feet on July 1st.

TABLE 26 (CONTINUED)

RETURN FLOW IN SAN JOAQUIN VALLEY STREAMS DURING THE IRRIGATION SEASON

	July		August		September		July to Sep. Inc.	
	Ac.Ft.	Av.SecFt	Ac.Ft.	Av.SecFt	Ac.Ft.	Av.SecFt	Ac.Ft.	Av.SecFt
DRY CREEK								
Discharge near Old Waterford Bridge	434	7	371	6	640	10	1445	8
Discharge at Basso Ranch	2303	37	2311	38	3049	51	7663	42
Accretion) Old Waterford Bridge	1869	30	1940	32	2409	41	6218	34
Total Diversions) to	27	--	14	--	12	--	53	--
Total Return Flow) Basso Ranch	1896	31	1954	32	2421	41	6271	34
MERCED RIVER								
Discharge at Yosemite Valley RR. Crossing	777	13	724	12	633	10	2134	12
Discharge at Bridge on Hills Ferry Road	4713	77	4824	79	6377	107	15914	87
Accretion) Yosemite Val. RR. Xing	3936	64	4100	67	5744	97	13780	75
Total Diversions) to	3420	56	2965	48	1942	32	8327	46
Total Return Flow) Br. on Hills Fy. Road	7356	120	7065	115	7686	129	22107	121

TABLE 27

SAN JOAQUIN RIVER RETURN WATER AND DIVERSIONS
(Acre-feet except as noted)

Location of Measurements (1)	July		August		September		July to Sept. Incl.	
	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions
At San Luis Ranch	0		0		0		0	
Merced River near Mouth (Hills Ferry Road Bridge)	4713		4824		6377		15914	
At Hills Ferry Bridge (U.S.G.S. Station "Near Newman")	8670		7560		9340		25570	
Hogan		96		96		96		288
Nelson Bros.		40		0		0		40
Silviera		35		24		16		75
Johnson		0		10		0		10
Ustick		104		87		124		315
Patterson Ranch Company		1273		1230		805		3308
Patterson Colony		7301		5937		5564		18802
Charles Moreing		131		120		73		324
At Grayson (Laird Slough Bridge)	10998		9806		12958		33762	
Burkhart		93		62		70		225
West Stanislaus Irrigation Dist.		1593		1544		2700		5837
Tuolumne River above mouth (Tuolumne City Bridge)	17956		17992		(3)45302		(3)81250	
El Solyo Ranch		1455		1150		720		3325
Vernalis Investment Company (2)		693		761		622		2076
Stanislaus River above Mouth (Elliot Ranch)	(4)22186		13091		13330		(4)48607	
Near Vernalis (U.S.G.S. Station at Durham Ferry Bridge)	(4)46500		37800		(3)68400		(3) (4) 152700	
Accretion (San Luis Rch. to Durham Ferry Br.(5)	1645		1893		3391		6929	
Total Diversions		12814		11021		10790		34625
Total Return Flow - (San Luis Ranch to Durham Ferry Bridge (5)	14459		12914		14181		41554	
Total Return Flow (Av.Sec.Ft.) (5)	235		210		239		228	

(1) Listed in downstream order.
(2) Previously listed as Kincaid.
(3) Includes 28240 acre-feet released in September to Tuolumne River from Don Pedro reservoir through La Grange power plant.
(4) Includes 7600 acre-feet estimated as power releases and spill in Stanislaus R. in July (See **footnote Table 31).
(5) Exclusive of Merced, Tuolumne and Stanislaus inflow.

TABLE 28

MERCED RIVER RETURN WATER AND DIVERSIONS
(Acre-feet except as noted)

*Location of Measurements	July		August		September		July to Sept. Incl.	
	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions
At Yosemite Valley RR. Crossing	777		724		633		2134	
L. Rusconi		157		176		111		444
Harter and Perrigo		19		25		10		54
Harter and Perrigo		20		20		19		59
J. G. Strong		33		20		11		64
C. L. Mehrton		9		12		10		31
R. K. Kynaston		34		42		23		99
G. H. Lovely		16		10		9		35
Wells		0		0		0		0
McCormick		8		8		8		24
C. E. Drew		49		46		28		123
C. A. Laughlin		32		23		19		74
State Land Settlement (Delhi)		38		16		9		63
McConnel (Veiera and Santos)		3		2		0		5
Linehers Company		188		151		106		445
Wm. Collier (Cabrall)		194		140		118		452
Wm. Collier (Cabrall)		58		58		26		142
Scott Hughes		36		34		26		96

* Listed in downstream order.

TABLE 28 (CONTINUED)

MERCED RIVER RETURN WATER AND DIVERSIONS
(Acre-feet except as noted)

*Location of Measurements	July		August		September		July to Sept. Incl.	
	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions
California Lands Incorporated (1)		89		74		42		205
McCormack (Neves-Bettencourt)		185		177		163		525
H. F. Milliken		332		298		254		884
W. D. Adams		245		234		211		690
Robert Adams		270		250		200		720
Grace McCullagh		189		196		140		525
Mary Collier		0		0		0		0
Francis Hartman		42		31		0		73
Stevinson Corporation		36		24		33		93
J. F. Peck		47		62		69		178
Floyd Stevinson		15		9		0		24
J. J. Stevinson		1076		827		297		2200
At Bridge on Hills Ferry Road	4713		4824		6377		15914	
Accretion - Yosemite Valley RR. Cr. to Bridge on Hills Ferry Road	3936		4100		5744		13780	
Total Diversions		3420		2965		1942		8327
Total Return Flow-Yosemite Valley RR. Cr. to Br. on Hills Ferry Rd.	7356		7065		7686		22107	
Total Return Flow-(Av.Second-feet)	120		115		129		121	

* Listed in downstream order.
(1) Formerly French American Corporation.

TABLE 29

DRY CREEK RETURN WATER AND DIVERSIONS
(Acre-feet except as noted)

*Location of Measurements	July		August		September		July to Sept. Incl.	
	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions
Near Old Waterford Bridge	434		371		640		1445	
J. S. Tully		15		7		4		26
J. R. Mills		5		1		0		6
W. H. Howell		2		3		2		7
C. Ayer		2		1		5		8
Young		3		2		1		6
Dry Creek Two Miles above Modesto at Basso Ranch **	2303		2311		3049		7663	
Accretion-Old Waterford Bridge to Basso Ranch	1869		1940		2409		6218	
Total Diversions		27		14		12		53
Total Return Flow-Old Waterford Bridge to Basso Ranch	1896		1954		2421		6271	
Total Return Flow-(Av. Second-feet)	31		32		41		34	

* Listed in downstream order.

** New location for lower Dry Creek station. Former station at Modesto Bridge is affected by back water from Tuolumne River.

TABLE 30

TUOLUMNE RIVER RETURN WATER AND DIVERSIONS
(Acre-feet except as noted)

(1) Location of Measurements	July		August		September		July to Sept. Incl.	
	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions
Tuolumne R.at Roberts Ferry Bridge	2259		2630		(2)32102		(2)36991	
G. H. Sawyer		33		25		17		75
R. L. Benson		0		0		0		0
Dry Creek at Basso Ranch	2303		2311		3049		7663	
W. F. Duffie		88		69		74		231
Bancroft Fruit Farm		166		136		61		363
Bancroft Fruit Farm		190		108		37		335
Tuolumne River at Tuolumne City Br.	17956		17992		(2)45302		(2)81250	
Accretion-Roberts Ferry Bridge to Tuolumne City Bridge (3)	13394		13051		10151		36596	
Total Diversions		477		338		189		1004
Total Return Flow - Roberts Ferry Bridge to Tuolumne City Bridge (3)	13871		13389		10340		37600	
Total Return Flow-(Av. Sec.Ft.) (3)	226		218		174		206	

(1) Listed in downstream order.
(2) Includes 28,240 acre-feet released in September from Don Pedro Reservoir through La Grange power plant.
(3) Exclusive of Dry Creek inflow.

TABLE 31

STANISLAUS RIVER RETURN WATER AND DIVERSIONS
(Acre-feet except as noted)

*Location of Measurements	July		August		September		July to Sept. Incl.	
	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions	Discharge	Diversions
At Orange Blossom Bridge	3174		3316		2747		9237	
Stoddard		12		11		1		24
Allen Ranch		1		0		0		1
D. F. Kcetitz		97		40		66		203
Updike		30		30		15		75
Henry Pelucca		46		30		0		76
River Junction Farms (W. H. Beale)		721		565		450		1736
River Junction Farms (W. H. Beale)		14		14		15		43
Elliot		138		117		58		313
At Elliot Ranch (below pumps)	**14586		13091		13330		41007	
Accretion-Orange Blossom Bridge to Elliot Ranch	11412		9775		10583		31770	
Total Diversions		1059		807		605		2471
Total Return Flow - Orange Blossom Bridge to Elliot Ranch	12471		10582		11188		34241	
Total Return Flow-(Av.Second-Feet)	202		172		188		188	

* Listed in downstream order.

** The measured discharge at this station was 22186 acre-feet but a deduction of 7600 acre-feet has been made as the estimate of power water releases and spill which was flowing out subsequent to rapid drop in discharge at Orange Blossom Bridge from 876 second-feet on June 23d to 86 second-feet on July 1st.

TABLE 32

COMPARISON OF DIVERSIONS AND RETURN WATER, SAN JOAQUIN VALLEY, 1929
(Quantities in Acre-feet Except as Noted)

		Jul.	Aug.	Sep.	Jul. Sep. Incl.
DIVERSIONS					
San Joaquin River near Friant (1) (2)					
(Miller and Lux Canals)		95300	77500	42600	215400
Merced River at Exchequer (1) (2)					
(Merced Irrigation District Canal)		96500	83000	16800	196300
Turlock Irrigation District Canal (1)		49100	71900	45600	166600
Modesto Irrigation District Canal (1)		30900	34700	23700	89300
South San Joaquin Irrigation District Canal (1)		42800	35200	24600	102600
Oakdale Irrigation District Canal (1)		15000	14600	11600	41200
Pumping Diversions--San Joaquin, Stanislaus, Tuolumne, Merced Rivers and Dry Creek (3)		17800	15100	13500	46400
Total Diversions		347400	332000	178400	857800
Total Diversions (Average Second-feet)		5650	5400	3000	4700
RETURN					
San Joaquin River near Vernalis (1)		(4) 38900	37800	(5) 40160	116860
Pumping Diversions-San Joaquin, Stanislaus, Tuolumne, Merced Rivers and Dry Creek (3)		17800	15100	13500	46400
Total Return		56700	52900	53660	163260
Total Return (Average Second-feet)		923	861	903	897
Return in per cent of Diversions		16	16	30	19

(1) U. S. G. S. Station.
(2) This flow all diverted below the gaging station after July 1st.
(3) From Table 26. This is return water diverted by pumping.
(4) Excludes from recorded flow 7600 acre-feet power releases and spill on Stanislaus River.
(5) Excludes from recorded flow 28,240 acre-feet released to Tuolumne River from Don Pedro reservoir through La Grange power plant.

TABLE 33

WATER DISCHARGED TO THE SACRAMENTO RIVER ABOVE SACRAMENTO AS MEASURED AT DEFINITE RETURN CHANNELS

*From records for Butte Slough, District 70 Drain, District 108 Drain, Colusa Basin Drainage at Knights Landing, Sacramento Slough, District 1000 Drain (2d Bannon Slough) and Back Borrow Pit of District 1000.

Month	Acre-feet	Average Second-feet
June	82400	1390
July	50700	825
Aug.	55300	899
Sep.	57700	971
Oct.	23500	382
Totals	269600	886

* See Tables 38 to 44, inclusive.

TABLE 34

RELATION BETWEEN RETURN WATER AND DRAFT, SACRAMENTO RIVER, RED BLUFF TO SACRAMENTO, JUNE TO SEPTEMBER,
(USING ONLY RETURN WATER WHICH ENTERED THROUGH DEFINITE MEASURED CHANNELS*)

	June		July		August		September		June to September Inclusive	
	Ac.Ft.	c.f.s.	Ac.Ft.	c.f.s.	Ac.Ft.	c.f.s.	Ac.Ft.	c.f.s.	Ac.Ft.	c.f.s.
RETURN										
Reclamation District 70 Drain	631	11	1660	27	1940	32	1360	23	5591	23
Reclamation District 108 Drain	2460	41	1250	20	3240	53	2990	50	9940	41
Colusa Basin Drainage at Knights Landing	33600	565	18300	297	21700	353	23300	392	96900	400
Sacramento Slough (Less flow down East Borrow Pit of Sutter By-Pass)	18300	307	17900	291	17100	278	16000	269	69300	286
Reclamation District 1000 Drain (2d Bannon Slough)	931	16	430	7	1360	22	2180	37	4901	20
Total Return	55922	940	39540	642	45340	738	45830	771	186632	770
Total Diversions-Red Bluff to Sacramento	155520	2617	186108	3027	169807	2762	86668	1458	598103	2472
Return in per cent of Diversions	36%		21%		27%		53%		31%	

NOTE: In order to show return water from Sacramento River irrigation only, the discharge to the river of Butte Slough is excluded, as is also a portion of the return through Sacramento Slough derived from Feather River diversions and the return through the Back Borrow Pit of Reclamation District 1000.

* As distinguished from use of all accretions as indicated in Table 35.

TABLE 35

*RELATION BETWEEN RETURN WATER AND DRAFT, SACRAMENTO RIVER, RED BLUFF TO SACRAMENTO, JUNE TO SEPTEMBER
(INCLUDING ALL ACCRETIONS)

River Section	June		July		August		September		Total Return Jun-Sep. Incl.		Red Bluff to Lower End of Section				
											Return		Draft		Return in
	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Per Cent of Draft
	- - RETURN - -														
Red Bluff-Butte Cy.	17300	291	12600	205	2760	45	-7340	-124	25320	105	25320	105	303868	1256	8%
Butte City-Colusa	4030	68	2190	36	3030	49	1830	31	11080	46	36400	151	345956	1430	11%
Colusa-Knights Ldg.	46200	777	34400	559	35100	571	28600	481	144300	596	180700	747	522899	2161	35%
Knights Ldg.-Verona	10300	173	22300	363	20000	325	14100	237	66700	276	247400	1023	533465	2205	46%
Verona-Sacramento	931	16	430	7	1360	22	2180	37	4901	20	252301	1043	598103	2472	42%
Total Return	78761	1325	71920	1170	62250	1012	39370	662	252301	1043					
Total Draft - Red Bluff to Sacto.	155520	2618	186108	3027	169807	2762	86668	1458	598103	2472					
Return in per cent of Draft	51%		39%		37%		45%		42%						

* As the return water in this table between any two stations is computed as the difference in discharge between the upper and lower station, making due allowance for the intervening diversions, the results include both those accretions entering from definite return channels which have been measured and accretions due to seepage, groundwater return, etc., which cannot be directly measured.

NOTE: Computed from record of river discharge at Red Bluff, Butte City, Colusa, Knights Landing, Verona and Sacramento and measured diversions between these points. In the return water here shown the discharge to the Sacramento River of the Feather and American Rivers is excluded as is also return through Butte Slough, a portion of the return through Sacramento Slough derived from Feather River diversions and the return through the Back Borrow Pit of Reclamation District 1000. Also, inflow from Mill, Antelope, Deer and other Creeks between Red Bluff and Butte City has been excluded.

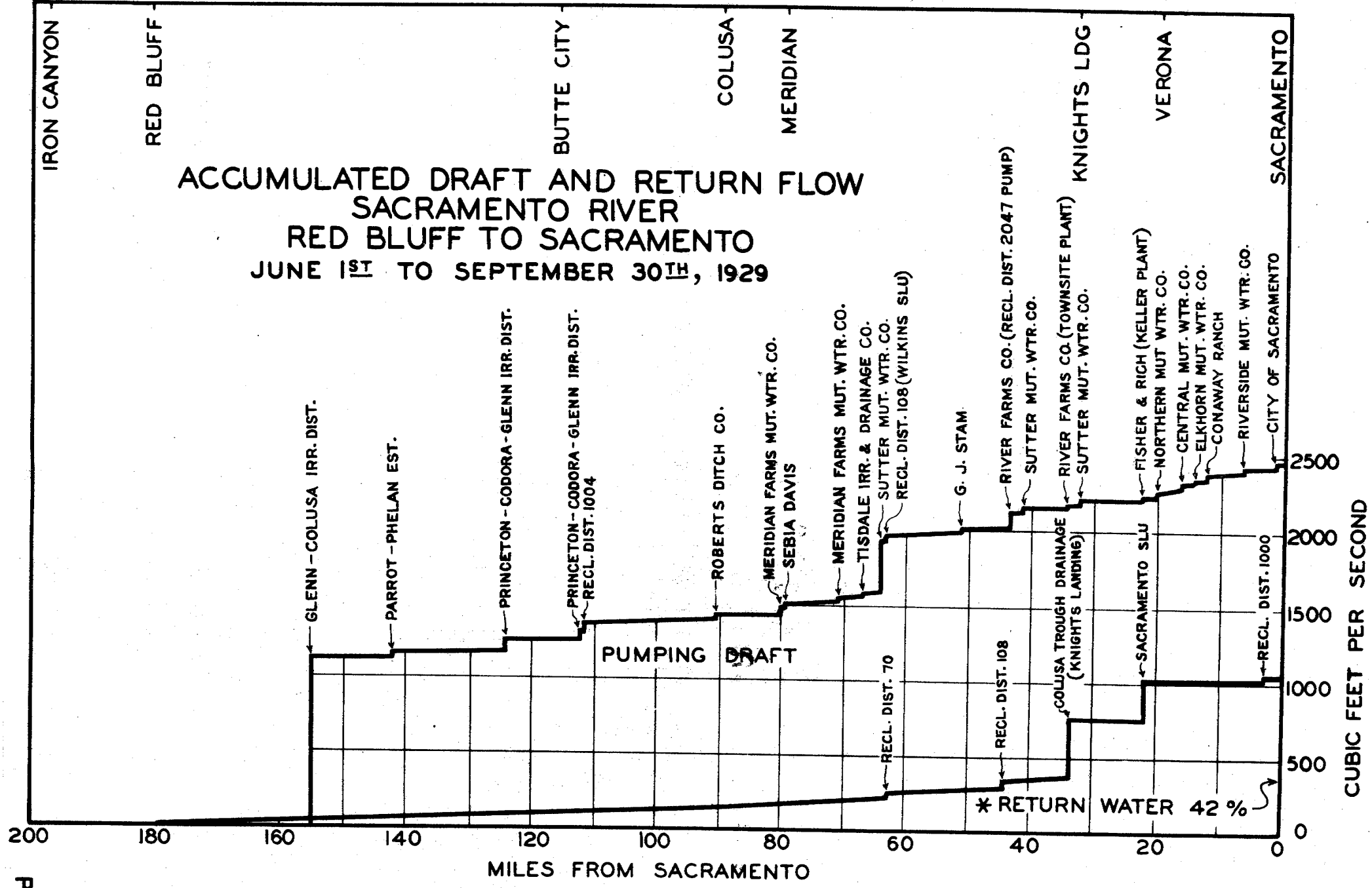


PLATE 2

* THIS RETURN WATER DIAGRAM SHOWS ALL ACCRETIONS AS TAKEN FROM TABLE 35.

NOTE: IN ORDER TO SHOW RETURN WATER FROM SACRAMENTO RIVER IRRIGATION ONLY, THE DISCHARGE TO THE SACRAMENTO RIVER OF THE FEATHER AND AMERICAN RIVERS IS EXCLUDED AS IS ALSO RETURN THROUGH BUTTE SLOUGH, A PORTION OF THE RETURN THROUGH SACRAMENTO SLOUGH DERIVED FROM FEATHER RIVER DIVERSIONS AND THE RETURN THROUGH THE BACK BORROW PIT OF RECL. DIST. 1000.

TABLE 36

RELATION BETWEEN THE RETURN WATER IN COLUSA TROUGH AT COLUSA-WILLIAMS HIGHWAY AND THE DIVERSIONS FROM WHICH THE RETURN WATER WAS DERIVED

	June		July		August		September		June to Sept. Incl.		Acreage Irrigated	
	Ac.Ft.	cfs	Ac.Ft.	cfs	Ac.Ft.	cfs	Ac.Ft.	cfs	Ac.Ft.	cfs	Rice	Gen'l
DIVERSIONS												
Glenn-Colusa, Jacinto, Provident and Compton-Delevan Irrigation Districts	73417	1234	82034	1334	76889	1250	41135	692	273475	1130	20130	38532
California Joint Stock Land Bank	145	2	300	5	216	4	191	3	852	4		370
Princeton-Codora-Glenn Irrigation District	8390	141	9906	161	8660	141	4675	79	31631	131	2096	3228
American Trust Company	342	6	431	7	327	5	259	4	1359	6		355
Maxwell Irrigation District (River Plant)	640	11	682	11	743	12	73	1	2138	9	240	
Henry Jameson (Trough)	701	12	715	12	743	12	363	6	2522	10	200	
Bearrup and Fessigm and Mary E. Rourke(Trough)	785	13	806	13	746	12	246	4	2583	11	390	
Maxwell Irrigation District (Trough)	1284	22	2825	46	3376	55	2305	39	9790	40	400	*3350
Sacramento Shooting Club (Trough)	63	1	199	3	407	7	173	3	842	3	Duck Club	
A. D. J. Land Company (Trough)	29		110	2	223	4	131	2	493	2	Duck Club	
Total Diversions	85796	1442	98008	1594	92330	1502	49551	833	325685	1346	23456	42485
RETURN												
Colusa Trough Measured at Colusa-Williams Hy.	31700	533	21000	341	23400	381	22100	371	98200	406		
Trough Diversions	2862	48	4655	76	5495	89	3218	54	16230	67		
Total Return	34562	581	25655	417	28895	470	25318	425	114430	473		
Return in per cent of Diversions	40%		26%		31%		51%		35%			

* All duck club acreage.

TABLE 36-A

RELATION BETWEEN RETURN WATER AND DIVERSIONS - RECLAMATION DISTRICT NUMBER 108 - 1929

	June		July		August		September		June - Sept. Inclusive		Acreage Irrigated	
	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Rice	Gen'l.
Diversions*	6474	109	9660	157	14315	233	1771	30	32220	133	3554	12208
Return Water**	2460	41	1250	20	3240	53	2990	50	9940	41		
Return in Per Cent of Diversions	38%		13%		23%		168%		31%			

* The diversions comprise all those from Sacramento River, right bank, from Mile 43.1 to Mile 63.2. The principal ones are the plants of Reclamation District 108 at Wilkins Slough, Eldorado (Recl.Dist.2047 Plant), Steiner Bend, Tyndall Mound and Boyer Bend.

** The return water is the discharge to the Sacramento River of Reclamation District 108 drain at Rough & Ready Bend.

- - - oOo - - -

TABLE 36-B

RELATION BETWEEN RETURN WATER AND DIVERSIONS - RECLAMATION DISTRICT 1500 - 1929

	June		July		August		September		June - Sept. Inclusive		Acreage Irrigated	
	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Acre-feet	Aver. c.f.s.	Rice	Gen'l.
Diversions*	27477	462	31526	513	25082	408	14277	240	98362	406	6510	29414
Return Water**	15900	268	15500	252	14800	241	13400	225	59600	247		
Return in Per Cent of Diversions	58%		49%		59%		94%		61%			

* The diversions comprise all those from the Sacramento River, left bank, from Mile 29.9 to Mile 63.75. The principal ones are Sutter Mutual Water Company's plants at Tisdale, State Ranch Bend, and Portuguese Bend.

**The return water is the discharge through the drainage plant of Reclamation District 1500 (See Table 42-A), on the west borrow pit of Sutter By-Pass. This water reaches the Sacramento River via Sacramento Slough.

TABLE 37

DISCHARGE OF COLUSA TROUGH AT COLUSA-WILLIAMS HIGHWAY

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	480	499	343	390	408	125
2	497	527	356	390	445	123
3	508	550	345	385	424	123
4	529	567	343	354	413	145
5	629	578	345	350	430	120
6	656	590	254	366	447	173
7	598	616	295	354	464	183
8	524	624	318	360	481	120
9	563	641	333	356	498	132
10	663	752	333	350	516	125
11	558	787	341	348	521	121
12	540	746	366	348	483	120
13	584	685	224	364	480	120
14	632	641	328	375	474	120
15	573	586	343	379	499	119
16	670	580	369	367	497	123
17	622	561	369	364	486	112
18	588	556	337	360	347	98
19	559	535	341	375	434	120
20	559	499	328	394	407	109
21	584	438	331	394	303	97
22	603	443	347	402	314	103
23	599	400	350	386	301	120
24	578	404	337	386	227	102
25	556	398	337	417	163	120
26	533	383	337	416	156	110
27	512	356	347	415	138	105
28	472	343	369	413	131	133
29	449	337	394	412	131	101
30	462	352	404	411	128	100
31	483		426	410		100
Mean	560	532	342	380	372	120
Ac.Ft. for Month	34400	31700	21000	23400	22100	7380

NOTE: This is return water flowing in the main drain of Reclamation District 2047; it is drainage chiefly from lands irrigated by Glenn-Colusa, Provident, Princeton-Codora-Glenn, Compton-Delevan, and Maxwell Irrigation Districts.

TABLE 38

DISCHARGE OF BUTTE SLOUGH

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	430	338	233	183	165	98
2	378	328	219	184	141	74
3	365	318	211	179	122	80
4	369	311	198	189	114	76
5	372	308	193	177	113	95
6	347	306	179	175	115	108
7	336	316	174	169	126	140
8	342	329	172	169	128	114
9	350	340	167	172	131	71
10	345	349	168	167	143	72
11	346	360	169	162	143	72
12	350	377	165	166	165	70
13	355	382	169	164	181	70
14	364	384	174	166	181	69
15	372	389	170	178	169	68
16	376	403	173	167	167	67
17	376	416	175	168	169	65
18	380	428	169	167	157	66
19	384	427	165	163	164	64
20	393	427	161	158	173	62
21	408	424	162	153	187	66
22	404	413	168	149	177	64
23	397	402	168	148	167	62
24	394	381	175	148	172	63
25	380	359	173	153	164	64
26	372	334	161	162	150	65
27	381	309	162	164	149	66
28	378	281	166	161	139	67
29	372	262	164	149	121	88
30	359	250	164	153	112	102
31	345		169	168		110
Mean	372	355	175	166	150	78
Acre-feet for Month	22800	21100	10800	10200	8940	4800
Monthly Diversions below Gaging Stations	177	368	517	397	170	13
Discharge to Sacramento R.	22600	20700	10300	9800	8770	4790
Natural flow in Butte Cr. (See Table 8)	4130	383	91	89	172	647
Net Return Water Sacramento River Acre-feet	18500	20300	10200	9700	8600	4140

NOTE: To determine the amount of this discharge that is strictly return water the discharge for the station measuring natural flow in Butte Cr. one mile west of the East Side Highway (See Table 8) is subtracted as shown above.

This return water is practically all from lands irrigated by Feather River diversions, and is measured in a dredger cut which carries the water from Butte Creek to Butte Slough and joins the latter at Mile 0.7 West. Butte Slough joins the Sacramento River at Mile 84 Left.

TABLE 39

DISCHARGE OF RECLAMATION DISTRICT 70 DRAIN

Day	Daily Discharge in Second-feet						
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	*0	17	0	19	23	28	14
2	0	40	0	19	23	28	10
3	8	*37	0	15	23	28	8
4	0	27	0	22	24	28	12
5	0	23	0	23	24	28	0
6	0	23	0	25	25	28	
7	0	45	0	26	26	28	
8	12	22	0	27	27	28	"
9	12	15	0	28	28	28	"
10	10	15	0	30	30	28	"
11	0	15	0	26	30	27	
12	*13	12	19	29	30	27	"
13	16	15	22	31	30	26	"
14	16	15	21	31	30	24	"
15	16	15	20	31	30	24	"
16	16	15	17	31	30	22	NO FLOW
17	16	15	18	31	30	22	
18	16	0	4	27	30	20	
19	16	0	8	27	30	20	
20	16	0	13	26	30	20	
21	16	16	15	26	41	20	
22	0	16	18	29	41	18	
23	0	16	18	31	41	18	
24	0	16	17	32	41	18	
25	0	16	17	31	41	18	
26	*9	16	17	30	41	16	"
27	15	16	16	25	40	16	"
28	20	16	18	26	38	16	
29	20	16	20	27	36	16	0
30	15	16	20	29	33	16	15
31		16		26	30		15
Mean	9.3	18	11	27	32	23	2.4
Ac.Ft. for Month	551	1080	631	1660	1940	1360	147

* Pumping April 1st to 12th and April 26th to May 3d. Gravity flow remainder of season.

NOTE: This is the drainage returned to the Sacramento River at Mile 68.8 left from District 70.

TABLE 40

DISCHARGE OF RECLAMATION DISTRICT 108 DRAIN AT ROUGH AND READY BEND

Day	Daily Discharge in Second-feet						
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	*0	0	52	0	50	99	14
2	209	0	57	0	50	99	13
3	156	152	47	0	50	99	13
4	0	151	52	0	49	97	14
5	0	155	52	9	49	96	13
6	0	158	52	11	49	95	13
7	0	159	52	16	49	94	83
8	0	*105	31	16	49	91	56
9	0	0	15	16	49	88	25
10	0	0	23	19	49	45	0
11	*0	0	52	19	49	44	
12	23	0	57	22	49	45	
13	71	0	52	25	49	45	
14	80	12	57	25	50	45	
15	80	23	61	27	50	44	
16	75	23	52	27	50	42	
17	0	23	0	27	50	41	
18	0	31	0	27	50	39	
19	0	31	0	27	50	38	
20	35	31	0	27	50	36	
21	0	31	65	0	50	33	
22	*164	31	61	0	50	32	
23	98	37	57	0	50	16	
24	93	42	52	0	50	16	
25	95	47	42	0	50	15	
26	0	52	47	17	50	15	
27	0	52	52	17	50	15	
28	0	52	47	26	49	14	
29	0	52	52	26	49	14	
30	156	52	0	105	97	14	
31		52		100	99		0
Mean	44	50	41	20	53	50	7.9
Ac.Ft. for Month	2650	3080	2460	1250	3240	2990	484

* Pumping out April 1st to 11th and April 22d to May 8th. Balance of season gravity outflow.

NOTE: This represents drainage from District 108 discharged to the Sacramento River at Rough and Ready Bend, Mile 44.0 Right.

TABLE 41

DISCHARGE OF COLUSA BASIN DRAINAGE AT KNIGHTS LANDING

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	450	454	303	378	364	149
2	424	461	310	375	395	139
3	376	468	313	368	415	124
4	281	473	316	361	405	114
5	164	485	316	345	402	121
6	555	496	294.	342	392	126
7	970	504	246	342	412	109
8	1060	525	243	329	443	164
9	425	538	252	323	458	151
10	433	589	258	316	477	143
11	373	765	267	316	492	131
12	428	860	261	319	259	117
13	995	809	267	323	383	105
14	1050	722	323	329	485	89
15	1060	636	300	329	527	84
16	1200	605	291	335	569	89
17	0	585	303	329	623	91
18	0	828	313	335	552	100
19	0	1090	307	339	485	82
20	0	1510	300	348	485	73
21	0	458	294	361	457	91
22	0	402	300	371	368	93
23	0	385	307	368	342	91
24	*0	361	310	355	322	**41
25	*906	551	297	355	264	0
26	561	540	294	378	236	0
27	496	326	294	388	207	38
28	465	313	300	402	190	383
29	443	307	316	392	182	198
30	426	300	348	392	174	144
31	447		364	388		**173
Mean	451	565	297	353	392	115
Ac.Ft. for Month	27700	33600	18300	21700	23300	7050

* Where zero flow is shown the River was higher than Borrow Pit. A slight drop in the river below the Borrow Pit level permits an immediate large flow through the outfall gates.

** Earth dam erected across channel on Oct. 24th and washed out October 27th. Sack dam erected across half of outfall gates from Oct. 29th to Oct. 31st, inclusive.

NOTE: This represents the drainage from Colusa Basin passing down the Back Borrow Pit of Reclamation Districts 103 and 787 entering the Sacramento River at Knights Landing.

TABLE 42

DISCHARGE OF SACRAMENTO SLOUGH*

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	275	290	397	253	304	242
2	305	323	347	292	323	252
3	305	282	376	288	326	267
4	306	221	361	280	315	238
5	322	322	333	286	341	237
6	306	357	348	297	358	234
7	322	473	294	297	362	225
8	306	496	288	302	362	222
9	301	553	272	292	356	220
10	303	649	286	273	361	206
11	295	517	267	272	370	203
12	321	484	286	271	374	201
13	308	404	295	288	378	192
14	296	370	286	271	365	189
15	307	477	277	270	323	192
16	319	419	329	294	325	168
17	333	550	314	269	328	109
18	350	567	305	266	347	157
19	358	432	312	263	347	151
20	414	456	295	273	331	143
21	439	398	300	292	335	132
22	391	358	305	263	308	136
23	393	352	291	279	253	129
24	367	336	288	271	291	117
25	367	340	289	283	260	138
26	416	353	281	304	248	120
27	381	373	279	277	276	130
28	395	341	282	280	273	118
29	349	316	285	283	262	144
30	404	330	298	319	227	162
31	281		290	335		157
Mean	340	405	315	283	321	178
Ac.Ft. for Month	20900	24100	18800	17400	19100	11000

* Water discharged through Sacramento Slough to the Sacramento River at a point just above the confluence of the Sacramento and Feather Rivers. This is return water from irrigation and represents the sum of measurements at three points as follows: (1) Discharge of Reclamation District 1500 drainage to West Borrow Pit of Sutter By-Pass, (2) Flow in West Borrow Pit of Sutter By-Pass north of Chandler Station, (3) Flow in East Borrow Pit of Sutter By-Pass at Chandler Station. Practically all of the flow in the East Borrow Pit of the By-Pass at Chandler represents return water from lands irrigated by Feather River diversions. Refer to Table 42-A.

TABLE 42-A

MONTHLY DISCHARGE OF RECLAMATION DISTRICT 1500 DRAIN AND EAST AND WEST BORROW PITS OF SUTTER BY-PASS*

	May		June		July		August		September		October	
	Acre feet	Av. c.f.s.	Acre-feet	Av. c.f.s.	Acre-feet	Av. c.f.s	Acre-feet	Av. c.f.s.	Acre-feet	Av. c.f.s.	Acre-feet	Av. c:f.s.
Reclamation District 1500 Drain	18400	299	15900	268	15500	252	14800	241	13400	225	5520	90
Sutter By-Pass-East Borrow Pit at Chandler (Willow Slough) (1)	1140	19	5780	97	930	15	280	5	3110	52	3930	64
Sutter By-Pass-West Borrow Pit north of Chandler	1310	21	2400	40	2320	38	2350	38	2620	44	1550	25
Totals	20900	340	24100	406	18800	306	17400	283	19100	321	11000	179

* The discharges of these channels combine to make the total flow in Sacramento Slough. (See Table 42).
(1) Practically all of this flow represents return water from lands irrigated by Feather River Diversions.

TABLE 43

DISCHARGE OF RECLAMATION DISTRICT 1000 DRAIN (2d BANNON SLOUGH)

Day	Daily Discharge in Second-feet						
	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.
1		39					
2	38		45			38	
3		39			59	51	45
4				34	52	26	
5						38	
6	44	38			52	39	
7					37	32	45
8				41		32	
9		32			45	32	
10	44		46			38	
11		32	45		52	39	
12				40		38	38
13			46			58	
14					30	58	
15	44				44	51	
16			52			51	
17	38		39	41	59	44	38
18						45	
19			46			45	
20	32	52		41	43	38	
21			46			44	
22						44	
23	38		39			45	46
24		52					
25				20	81	32	
26	44		33		36	51	
27							
28	51				52	44	
29	38						
30			32		44	45	
31							
Mean for Days Pumped	41	40	43	36	49	42	42
Ac. Ft. for Month	815	562	931	430	1360	2180	422

NOTE: This is the drainage pumped back to the Sacramento River at Mile 2.1 Left from District 1000.

TABLE 44

DISCHARGE OF BACK BORROW PIT RECLAMATION DISTRICT 1000

Day	Daily Discharge in Second-feet					
	May	Jun.	Jul.	Aug.	Sep.	Oct.
1	8	5	4	0	0	6
2	9	5	4	-	0	6
3	9	5	3		0	6
4	9	5	3	FLOW	0	6
5	8	6	2		0	6
6	8	5	2	O	0	6
7	8	5	1	N	1	6
8	8	6	1	-	2	5
9	8	6	1	0	3	5
10	8	6	0	1	3	5
11	8	7		0	4	5
12	8	8	"		4	4
13	8	8	"	"	4	3
14	8	8			4	3
15	7	10	"	"	4	3
16	7	10	"	"	4	3
17	7	10	"		4	2
18	7	10	"	"	4	2
19	7	10	W	W	4	2
20	7	10	O	O	4	2
21	7	9	F	F	4	1
22	6	9			4	2
23	6	8	O		4	2
24	6	8	N	O	4	2
25	6	7		N	5	2
26	6	7	"		5	2
27	6	6	"	"	5	2
28	6	6	"	"	6	1
29	6	5			6	2
30	6	5	"	"	6	2
31	5		0	0		2
Mean	7.2	7.2	0.7	--	3.3	3.4
Ac.Ft. for Month	442	426	42	2	194	210

NOTE: This is water flowing down the borrow pit outside the east levee of Reclamation District 1000 and entering the Sacramento River just above the mouth of the American River. It is measured at the Garden Highway crossing. This drainage is probably not derived from Sacramento River sources.

CHAPTER V

USE OF WATER IN THE SACRAMENTO-SAN JOAQUIN DELTA

In Bulletin No. 23, a recent publication by the Division of Water Resources of the Water Supervisor's report for the five-year period 1924 to 1928, the purpose, scope, and outline of the investigation of the use of water in the Sacramento-San Joaquin Delta to the end of the 1928 season has been presented in detail.

As a part of the study to determine the consumptive use of water in the entire Delta Region, there has been obtained each year through the Water Supervisor's organization a complete census of the acreages and crops irrigated, together with information on the period of irrigation for the various crops, general soil classification, etc; and through cooperation with the Division of Agricultural Engineering, U. S. Department of Agriculture, the consumptive use has been determined for various Delta crops grown in tanks, on individual tracts, and for certain entire islands or tracts.

It has been found that the most satisfactory data resulted from the tank work and from the determinations for the large tract comprising the lower unit of Reclamation District 999. The results for the latter indicate that the seasonal consumptive use of water is two acre-feet per acre for the sedimentary lands with a variety of delta crops. The tank work has indicated for each crop a more or less well defined relation between use of water and yield. For a known or estimated average yield per acre of the crop, then, this relation may be used to derive the corresponding specific or average consumptive use of water in acre-feet per acre. With the consumptive use of water determined for a representative delta tract as in the case of Reclamation District 999 and for the various

delta crops as in the tank work, the estimates for use of water by the entire delta area may be derived by using these data in conjunction with the complete census of the irrigated acreages and crops in the delta together with information as to total and average yields for the various crops.

In 1929 the usual crop census data were secured as shown by Tables 45, 46, and 47 and the work done through cooperation with the Division of Agricultural Engineering, U. S. Department of Agriculture is presented in detail in the report by Major O. V. P. Stout and Engineer Lloyd N. Brown which follows in this chapter. The 1929 cooperative work included investigations of the use of water by sugar beets grown in tanks and on a field at King Island, a continuation of the asparagus tank work on the Richmond-Chase tract, and an investigation of the use of water by tules and cattails grown in tanks in Reclamation District 999.

In order to complete the estimate for the consumptive use of water by the entire delta area there remains certain additional tank work with the delta crops not yet tried and with aquatic plants and growths. Also, the necessary information as to crop yields, to be used in conjunction with the established use-yield curves, is to be obtained. It is contemplated that most of these data will be available by the end of the 1930 season and that this project may be brought to a close at that time with the preparation and publication of a summary report presenting the best estimates for the consumptive use of water in the Delta that the results of this investigation afford.

TABLE 45

DETAIL OF ACREAGES IRRIGATED IN THE DELTA

Island or tract	Acreage irrigated															Grain or pasture not irrigated[1]	Total acreage[2]
	Alfalfa	Asparagus	Beans	Beets	Celery	Corn	Fruit	Grain[1]	Hay	Onions	Pasture[1]	Potatoes	Seed	Truck and miscellaneous vegetables	Total acreage irrigated		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Andrus Island—Reclamation Districts Nos. 317, 407, 556	150	2,158	310	15	1,492	773	1,187		30				125	648	6,888		7,570
Bacon Island—Reclamation District No. 2028			243	674	25	1,085	8	135	101	360		2,188	149		4,968	300	5,620
Baird Ranch—Portion of Reclamation District No. 800						240		30					460		730	2,230	3,000
Bethel Tract—Reclamation District No. 1619		305				445		240			170	40		10	1,210	1,470	3,400
Bigger and Inman Ranch						700									700		1,000
Bishop Tract—Reclamation District No. 2042		283		594	30	5				113		40	23	157	1,245	816	2,350
Bishop Highlands											155				155	810	1,000
Boggs Tract—Reclamation District No. 404	1,000					100									1,100	1,050	2,680
Bouldin Island—Reclamation District No. 756	572		464	470	1,571	1,010			196	334		1,097			5,714		6,000
Brack Tract—Reclamation District No. 2033	60	2,320	50		300	260	40					40			3,070	100	4,660
Bradford Island—Reclamation District No. 2059		680				724		160			250		5		1,819		2,060
Brannan Island—Reclamation District No. 2067	405	3,544	369	180	496	662	449	20		50				10	6,185	62	7,260
Byron Tract—Portion of Reclamation District No. 800	160					133		240	60			500			1,093	2,113	3,320
California Irrigated Farms—Portions of Reclamation Districts Nos. 2058 and 2062	4,479		700			100		1,130						75	[3]6,484	2,029	[3]10,290
Canal Ranch	140	2,149						50							2,339	40	2,400
Clifton Court Tract—Reclamation District No. 802	5	225	30			2,050		740			120		100		3,270		3,360
Coney Island						1,000									1,000		1,060
Deadhorse Island						200									200		200
Drexler Tract			760	90		959							380		2,189	500	3,230
Edinger-Johnson Reclamation District[4]	60	50	85			20	175						20	35	445		690
Ehrhardt Club																500	500
Elmwood Tract			16			735						27		13	791		820
Empire Tract—Reclamation District No. 2029															[5]3,443		3,680
Fabian Tract—Reclamation District No. 773			619			1,737		1,043	256						3,655	2,770	6,400
Fay Island										13		83			96		100
Finck and Winler Ranch—Portion of Reclamation District No. 2062	480														480	140	760
Fox Ranch (George R. Fox)	140														140		180
Franks Tract			40			782		730	40	40	50	50			1,732	1,647	3,400
Grand Island—Reclamation District No. 3	294	4,936	844		1,480	700	3,783	1,222	115				305	1,594	15,273	533	17,000
Hastings Tract—Reclamation District No. 2060	45	1,819		1,445		862		300			300				4,771	2,018	7,400
Headreach Island																150	200
Henning Tract—Portion of Reclamation District No. 2030	100							100		200		1,100			1,500		2,700
Hog Island																60	150
Holland Tract (Little Holland—Seaborn)			1,800			800		200							2,800		2,860
Holland Tract—Reclamation District No. 2025	10	50	61			1,077		1,080			43	363			2,684	689	4,280
Honker Lake Tract	120					885									1,005	718	1,890
Hotchkiss Tract—Includes Reclamation District No. 799	150	635				90		150	20					125	1,170	825	3,700
Jersey Island—Reclamation District No. 830	6	1,100		748		221	35	350			700				3,160		3,580
Jones Tract (Upper)—Reclamation District No. 2039						1,646						668	2,389		4,703	1,541	6,290
Jones Tract (Lower)—Reclamation District No. 2038						1,224		[6]1,000				1,032			3,256	2,451	5,740
King Island—Reclamation District No. 2044				2,543		477								114	3,134		3,260
Liberty Reclamation District		1,080	1,188	1,135	300	1,224				638		47			5,612	320	6,750
Mandeville Island—Reclamation District No. 2027			42			186			51	12			40		331	2,117	5,440
March Garden and Brookside Tracts	100						15							35	150	200	600
McCormack Tract			1,500												1,500		1,550
McDonald Island—Portion of Reclamation District No. 2030				901		200		2,123							3,224		3,440
Medford Island—Reclamation District No. 2041			461			160		468							1,089		1,200
Merritt Island—Reclamation District No. 150	1,000	300	435	165			940						1,900	200	4,940		4,980
Mildred Island—Reclamation District No. 2021								200		73		66			339	500	1,250
Moreing Ranch (Lewis Moreing)—Portions of Reclamation Districts Nos. 2058 and 2062	100		550					415							1,065	200	1,470
Orwood Highlands	160							70			100				330	664	1,120
Orwood Tract—Reclamation District No. 2024		112				223		771			84	246	256		1,692	417	2,180
Palm Tract—Reclamation District No. 2036			114			1,100			69	31			617		1,931		2,460
Pierson District—Reclamation District No. 551	349	664	2,568	111	19	450	1,784				52			321	6,318	1,951	8,850
Pocket, The (Roberts Island)	30		130			40									200	300	520
Prospect Island—Reclamation District No. 1667			1,000	275				150							1,425	850	2,480
Quimby Island								500				300			800		820
Randall Island—Reclamation District No. 755							400								400		400
Rhode Island								80							80		100
Rio Blanco Tract															[5]675		675
Rindge Tract—Reclamation District No. 2037				728				[7]3,275	110			2,712			6,825		6,840
Roberts Island (Lower Division)—Reclamation District No. 684	1,200	691	30	22		2,389		1,536			172	818	100		6,958	3,637	10,660
Roberts Island (Middle Division)—Reclamation District No. 524	2,565		1,070			589	30	1,100					125		5,479	4,064	11,000
Roberts Island (Upper Division)—Reclamation District No. 544	550		702				60	2,148				48	213		3,721	3,514	7,480
Rough and Ready Island—Reclamation District No. 403	160		140			20		270			60	90		175	915	210	1,700
Ryer Island—Reclamation District No. 501	293	8,082	318				491	800							9,984	1,300	12,000
Sargeant-Barnhart Tract	230	80				676					90			60	1,136		1,200
Sherman Island—Reclamation District No. 341	190	6,818	150	446		803	40	844	10		40			50	9,391	350	10,300
Shima Tract												200	280		480	267	1,870
Smith Tract (R. R. and N. A. Smith)									60					100	160	1,230	1,520
State Farm	152		30			140	106	230	150					40	848		1,020
Staten Island	10	2,069	11	498		2,394	301		525			475			6,283	2,110	9,260
Stockton Acres—Reclamation District No. 828			5		10		5	165						20	205		700
Sutter Island—Reclamation District No. 349	130	279	79			25	1,234						185	443	2,375		2,550
Terminous Tract—Reclamation District No. 548		2,586		250	2,128	350		500	26		50	1,357		40	7,287	1,911	12,360
Twitchell Island—Reclamation District No. 1601	150	1,312	100	450	380	50		425						9	2,876	300	3,630
Tyler Island—Reclamation Districts Nos. 136, 364, 532, 563, and 807		8,299					230								8,529		9,000
Union Island—Reclamation Districts Nos. 1 and 2	331	1,016	1,955			4,111	179	5,737			310	358			13,997	8,816	23,000
Veale Tract—Reclamation District No. 2065						160		800							960		1,360
Venice Island—Reclamation District No. 2023					160	125		1,472		1,097		325			3,179		3,880
Victoria Island—Reclamation District No. 2040			1,000	300		1,480		1,900	100			1,800	500		7,080		7,310
Webb Tract—Reclamation District No. 2026		400	10	1,971		820		519				396			4,116	1,018	5,520
Widow Island																55	55
Woodward Island			40			200		575	40	90		380			1,325	525	2,245
Wright Tract	454			288	130	200	3					200		15	1,290		1,320
Reclamation District No. 307	440		80	2,110		72	50		100	40			658	515	4,065	1,200	5,940
Reclamation District No. 348	1,869	450	253				551	500						57	3,680	[8]2,700	9,480
Reclamation District No. 369							180								180		550
Reclamation District No. 535			22			4								20	46		4,110
Reclamation District No. 536 (Egbert Tract)	789	2,726		200	200									12	3,927	3,525	8,930
Reclamation District No. 554		110	5				16						395		526		700
Reclamation District No. 673	50		43			10	10							45	158		3,100
Reclamation District No. 744	45		54				256						30	95	480		1,620
Reclamation District No. 746							85								85		140
Reclamation District No. 765	400		350	150				200	100					40	1,240		1,320
Reclamation District No. 813	31					20	121								172		2,550
Reclamation District No. 824	64		4			14								20	102		460
Reclamation District No. 900	3,000	100	600			150	420					200		2,000	6,470		10,240
Reclamation District No. 999	1,150	4,486	10,525	1,594		368	1,481			1,068		800	260	350	22,082	171	[9]23,348
Reclamation District No. 1002		130	110			400	210	260							1,110	200	6,860
Reclamation District No. 1614 (Smith Tract and Tuxedo Country Club Farms)			250				60							235	545	100	1,770
Reclamation District No. 2068[10]	2,680			[11]3,200											5,880	8,160	13,600
Totals	27,048	62,044	32,315	21,553	8,721	40,855	14,935	36,953	2,159	4,159	2,746	18,046	9,515	7,678	292,845	78,444	435,000

[1] In the delta census it has been difficult to get the correct segregation between irrigated and nonirrigated grain and pasture. Included in columns (9) and (12) are the acreages known to have been irrigated directly or those estimated to have received direct benefit through subirrigation. Acreages flooded in the fall either for general improvement or preparatory to next season's grain crop are also included. Grain and pasture acreages considered as nonirrigated are shown in column (17).

[2] Except as noted these figures represent gross area, i.e.: include roads, canals, etc., and entire area within levees.

[3] This is not the total lands of the California Irrigated Farms Company. Approximately 3,400 acres south of Tom Paine Slough is classed in the "Delta Uplands"—see "Delta Uplands Diversion from Tom Paine Slough."

[4] Includes area of Reclamation District No. 745.

[5] No crops planted, but entire island was flooded.

[6] Flooded before or after cropping.

[7] Includes 3,227 acres not planted but flooded.

[8] In 1928 there were 1,200 acres nonirrigated grain not listed in the 1928 report.

[9] Total net acreage for three units as follows: Upper Unit, 386; Middle Unit, 1,038; Lower Unit, 21,924.

[10] There have been irrigated areas in this district in previous years but 1929 is the first year reported.

[11] Planted and irrigated in the fall, on land previously cropped to grain.

CALIFORNIA STATE PRINTING OFFICE
SACRAMENTO, 1930

75587 4-30 400

TABLE 46

SUMMARY OF ACREAGES AND CROPS IRRIGATED IN THE SACRAMENTO AND SAN JOAQUIN-MOKELUMNE DELTAS

Crop	Sacramento Delta	San Joaquin-Mokelumne Deltas	Total
Alfalfa	11715	15333	27048
Asparagus	46893	15151	62044
Beans	22539	9776	33043
Beets	11753	9800	20825
Celery	4090	4631	8721
Corn	7407	33448	40855
Fruit	13542	1393	14935
Grain	4421	32532	36953
Hay	355	1804	2159
Onions	1796	2363	4159
Pasture	392	2354	2746
Potatoes	1047	16999	18046
Seed	3878	5637	9515
Truck and Miscellaneous Vegetables	6407	1271	7678
Flooded - Not Planted	----	4118	4118
Totals	136235	156610	292845

TABLE 47

GENERAL SOIL CLASSIFICATION OF THE DELTA LANDS IRRIGATED IN 1929 AND PERIOD OF IRRIGATION OF THE VARIOUS CROPS

Crop	Peat Soil Acreage Irrigated	Sedimentary Soil. Acreage Irrigated	Average Period of Irrigation		
			Beginning	Ending	Days
Alfalfa	* 3373	23675	Apr. 1	Sep. 15	168
Asparagus	29647	32397	May 15	Oct. 1	138
Beans	5332	26983	May 1	Sep. 15	138
Beets	10778	10775	Apr. 1	Aug. 1	122
Celery	6094	2627	Jun. 1	Oct. 1	122
Corn	25063	15792	Jun. 15	Sep. 1	77
Fruit	373	14562	May 1	Oct. 1	153
Grain	***19083	17870	Sep. 1	Mar. 1	181
Hay	1298	861	Sep. 1	Mar. 1	181
Onions	2413	1746	Feb. 1	Jul. 15	165
Pasture	1869	877	Jul. 1	Nov. 1	**123
Potatoes	16211	1835	May 1	Oct. 1	153
Seed	4346	5169	Mar. 1	Oct. 1	214
Truck and Miscellaneous Vegetables	917	6761	Feb. 1	Nov. 1	273
Flooded - Not Planted	3780	338			
Totals	130577	162268			

* The acreage upon which this alfalfa is grown is classed as peat on the soil maps but is more or less a mixture of sediment and peat along the border of the peat lands.

** There is also a certain amount of winter irrigation for pasture.

*** Includes 4227 acres flooded before or after cropping or flooded without planting.

COOPERATIVE IRRIGATION INVESTIGATIONS IN THE SACRAMENTO-SAN JOAQUIN DELTA IN 1929

By

O. V. P. Stout, Hydraulic Engineer,
Division of Water Resources, State Department of Public Works,
and
Division of Agricultural Engineering,
U. S. Department of Agriculture,

and

Lloyd N. Brown, Assistant Hydraulic Engineer,
Division of Water Resources, State Department of Public Works.

PEAT LAND INVESTIGATIONS

SUMMARY

Tank and field work has been carried on in the usual manner described in the reports of previous years. The field work, however, is receiving less attention than formerly, because it appears that the control which is possible in the tank work makes the latter more definite and therefore more valuable.

All work reported was done on King Island except that on asparagus which was done near Terminous in Reclamation District 548, and some nematode work on the Empire Tract.

A field of sugar beets showed a measured use of 1.53 acre-feet per acre, with a yield of 11.38 tons per acre.

Sugar beet plots did not show that either the height of water table or the length of irrigation season definitely affected either tonnage or sugar content of beets.

Tank work on sugar beets showed fair sugar content when the water table was held at either two or four feet below the ground surface

but a considerably lower percentage when the water was held at three feet below the ground surface.

Asparagus grown in tanks showed little or no correlation between yield of spears and depth to water table. Neither has there developed thus far a serviceable correlation between yield of spears and use of water. There is, however, no occasion to assume that results of future work will fail in this respect.

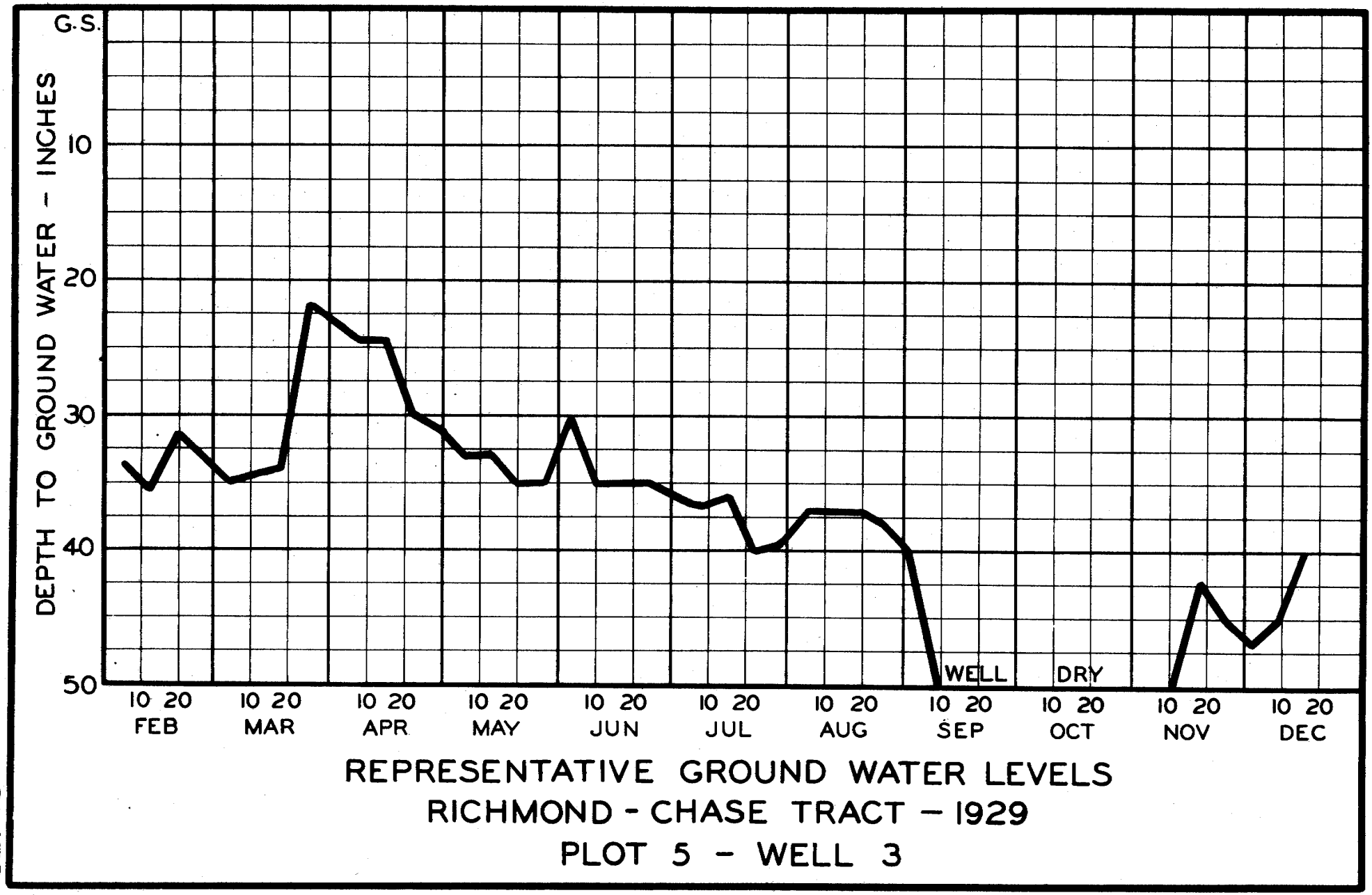
Living nematodes apparently are destroyed by about four months submergence but fertile eggs have survived a year's flooding.

Further experiments were conducted on the movement of underground water.

FIELD IRRIGATION MEASUREMENTS

Sugar Beets

The water admitted to and drained from a 27.94 acre sugar beet field was measured and found to net 1.53 acre-feet applied per acre. The field yielded 318 tons of beets averaging 16 per cent sugar. The figures given above indicate a yield of 11.38 tons of beets per acre, but the actual tonnage on productive ground was somewhat higher than that as the field included a two and one-half or three acre area of alkali where nothing grew. The whole field was overrun with weeds so that, even if seepage into or out of the field were assuredly absent, the use as measured was not determinative of the requirements of beets. It seems that it can be scarcely more than coincidence that the relation of the apparent use of water to yield of beets is about the same as the relation of the actual use of water to yield of beets as shown by the tank work.



REPRESENTATIVE GROUND WATER LEVELS
RICHMOND - CHASE TRACT - 1929
PLOT 5 - WELL 3

PLATE 3

Asparagus

The Richmond-Chase Company, owners of a 900-acre asparagus ranch near Terminous, have not irrigated for several years. They are keeping a record of the ground water by means of test wells. No relation between water table and yield has as yet been developed. On Plate 3 is shown a typical test well record. Asparagus uses very little water during the cutting season, which lasts from the appearance of spears in the Spring until July 1st. As soon as the tops develop, the draft on the water increases very materially and lasts two or three months, until the tops are killed by cold weather.

Irrigation Experiment on Sugar Beets in Plots*

This experiment was designed to determine the effect of various irrigation treatments on the tonnage and sugar percentage of beets. The set-up provided for the following: maintaining a different constant depth to water table in each of four plots; in one plot raising the water table to mature the crop; in each of six plots terminating the irrigation season at a different date. Table 48 sets forth the results of the experiment in terms of weight of tops, weight of roots, per cent of sugar, and yield of beets in tons per acre at the time of harvest.

The seedbed was prepared and the plots, each about 30 by 60 feet in dimension, and twenty-two in number - each alternate one used as a buffer were laid off. Ditches, about two feet deep, were dug around each plot by a ditching machine. The ditches where the water was to be held at three and four feet below the ground surface were deepened by hand and shored

* This experiment was headed by Dr. W. W. Robbins of the University of California Agricultural Experiment Station at Davis, who did all work pertaining to weighing beets and tops, and testing beets for sugar. The writers designed and operated the irrigation system and supervised its installation. All cost and expense was met from funds at the disposal of Dr. Robbins.

to prevent caving.

TABLE 48

IRRIGATION EXPERIMENTS ON SUGAR BEETS IN PEAT PLOTS, KING ISLAND, 1929

Plot	Treatment	Average Weight of Plants in Pounds		Sugar Per Cent	Yield per Acre in Tons
		Tops	Roots		
1	Water table 4 feet below ground surface	2.66	2.63	10.1	40.1
2	Water table 3 ft. below ground surface:	2.48	2.46	11.0	36.7
3	Water table 2 ft. below ground surface:	2.22	2.17	11.1	36.3
4	Water table 1 ft. below ground surface:	2.24	2.31	10.0	36.8
5	Matured by raising water table	1.67	1.49	11.6	29.3
6	Irrigating stopped September 2nd	2.01	1.89	10.7	32.1
7	Irrigating stopped August 19th	1.81	1.60	11.8	31.3
8	Irrigating stopped July 31st	1.42	1.57	14.0	30.6
9	Irrigating stopped July 15th	1.88	2.12	13.3	32.8
10	Irrigating stopped June 30th	1.33	1.93	15.0	31.7
11	Irrigating stopped June 15th	1.90	2.22	13.0	34.0

As appears in Table 48, all plots produced a very satisfactory tonnage. The sugar percentage, however, was very low, although plots 8, 9, 10 and 11 appear to be a little better than the rest. All of the plots produced a tonnage satisfactory from a farming standpoint. In Tables 49, 50, and 51 are given the weights of roots and tops, and sugar percentage for each of the samplings. It will be noted that the roots increased in weight and sugar until harvest. The tops reached their maximum weight about the last of July after which they decreased slightly until harvest.

The behavior of the water table in the plots where the water in the ditches was held at one, two, three, and four feet below the ground surface is of interest. A test well was put down in the central portion of each of these plots. An average of the readings of these wells by plots

TABLE 49

AVERAGE WEIGHT OF ROOTS PER BEET IN POUNDS
SUGAR BEET IRRIGATION EXPERIMENT, KING ISLAND, 1929

Plot	Date							
	6-4	6-18	7-3	7-16	7-29	8-12	8-24	9-14
1	0.24	0.65	0.85	1.33	2.30	2.40	2.15	2.63
2	0.18	0.64	0.68	1.68	1.75	2.00	2.10	2.46
3	0.16	0.42	0.87	1.36	2.15	2.60	1.90	2.17
4	0.14	0.54	0.55	0.72	0.90	1.60	1.80	2.31
5	0.18	0.35	0.63	1.10	1.20	1.40	1.63	1.49
6	0.16	0.40	0.53	1.16	1.65	1.30	1.60	1.89
7	0.18	0.45	0.63	1.03	1.20	1.50	1.60	1.60
8	0.16	0.57	0.60	1.04	1.55	2.10	1.43	1.57
9	0.16	0.55	0.74	0.81	1.40	0.95	1.65	2.12
10	0.22	0.65	0.74	0.90	1.60	2.00	2.40	1.93
11	0.18	0.52	0.80	1.33	1.55	2.10	2.10	2.22
Average	0.18	0.52	0.69	1.13	1.57	1.81	1.85	2.04

TABLE 50

AVERAGE WEIGHT OF TOPS PER BEET IN POUNDS
SUGAR BEET IRRIGATION EXPERIMENTS, KING ISLAND, 1929

Plot	Date							
	6-4	6-18	7-3	7-16	7-29	8-12	8-24	9-14
1	0.98	1.90	2.20	1.88	3.00	3.20	2.25	2.66
2	0.78	2.10	1.88	2.66	2.60	2.30	2.00	2.48
3	0.62	1.65	2.33	2.70	2.80	2.65	2.50	2.22
4	0.66	1.90	1.95	2.11	2.05	1.90	2.90	2.24
5	0.62	1.40	2.10	2.85	2.55	2.30	2.45	1.67
6	0.58	1.48	1.95	2.35	2.80	2.20	1.95	2.01
7	0.74	1.75	1.75	2.88	2.25	2.90	2.30	1.81
8	0.76	1.55	1.93	2.50	2.20	1.80	1.55	1.42
9	0.82	1.96	2.40	1.84	2.20	1.65	2.00	1.88
10	0.90	2.34	1.88	1.74	1.65	1.40	1.54	1.33
11	0.70	1.88	1.95	2.13	2.95	2.00	2.75	1.90
Average	0.74	1.81	2.03	2.33	2.46	2.21	2.20	1.97

TABLE 51

PERCENTAGE OF SUGAR IN SAMPLES
SUGAR BEET IRRIGATION EXPERIMENTS, KING ISLAND, 1929

Plot	Date							
	6-4	6-19	7-5	7-17	7-29	8-12	8-24	9-14
1	6.8	6.3	9.6	10.3	10.1	10.9	9.6	10.1
2	7.5	6.4	9.6	9.0	10.4	11.0	11.4	11.0
3	6.7	7.1	9.4	8.2	9.3	11.5	11.5	11.1
4	6.8	6.3	8.2	9.5	10.0	8.5	10.8	10.0
5	7.5	6.8	8.4	7.6	9.3	10.2	9.5	11.6
6	6.7	6.4	8.8	10.0	9.0	9.7	11.0	10.7
7	6.5	6.4	9.3	8.3	9.1	10.8	9.5	11.8
8	6.5	6.0	9.5	10.3	11.6	12.5	15.0	14.0
9	6.7	6.4	8.9	11.3	12.3	14.8	12.2	13.3
10	6.8	6.7	10.9	13.3	11.4	14.8	12.3	15.0
11	6.5	7.4	11.0	10.0	13.1	12.7	13.6	13.0
Average	6.8	6.6	9.4	9.8	10.5	11.6	11.5	12.0

TABLE 52

DEPTH TO WATER IN WELLS IN CENTERS OF PLOTS
SUGAR BEET IRRIGATION EXPERIMENTS, KING ISLAND, 1929

(Quantities in Feet)

Date	Depth of Water Below Surface in Ditches			
	1-foot	2-feet	3-feet	4-feet
7-10	1.30	1.78	2.22	2.67
7-24	1.60	2.05	2.50	2.94
7-27	1.60	2.16	2.52	2.97
8-2	1.27	1.70	2.15	2.61
8-14	1.35	1.85	2.30	2.82
8-23	1.42	1.89	2.35	2.89
8-28	1.70	2.20	2.63	3.04
9-2	1.53	2.08	2.56	3.03
Average	1.47	1.96	2.40	2.87

shows that where the water was held at one foot below the ground surface, the average reading of the well in the center of the plot was 1.47 feet; likewise two feet was 1.96 feet; three feet was 2.45 feet; and four feet was 2.87 feet as shown in Table 52. In other words where the water in the ditch was held at one foot, the water table at the well sagged to 1.47 feet; at two feet it remained near that point, 1.96 feet; but where the water table was held at three and four feet below the surface in the ditches, the water table in the plots bellied up to 2.40 and 2.87 feet, respectively. The inference is that the normal water table at this point is about two feet.

TANK WORK

Sugar Beets

The sugar beet acreage in the delta is increasing rapidly. Present conditions indicate that such a trend may persist for several years. In the tank work in 1928 certain results were regarded more or less skeptically. Consequently it was decided to repeat the work in 1929. The results obtained were practically the same as for 1928. Apparently there is some factor of prime importance affecting sugar percentage, which is, as yet, obscure, and has not been taken into account. The following discussion will explain the procedure and results in detail. The chief difference between the two years' work was that in 1929 the seed used was from a strain of beets that was very constant in sugar percentage. The beets produced in 1928 showed great variation in sugar content between individuals that were treated alike. This was not a desirable condition, as the predominance of either high or low sugar percentage individuals

would affect the average sugar percentage of the group in an erratic way and render a comparison of the groups more or less futile. Consequently a strain of seed was sought which would assure approximate uniformity of sugar content. Dr. W. W. Robbins of Davis furnished seed from a German strain, the individual beets of which are quite constant in sugar percentage.

The seed was planted in the tanks on March 21, 1929. The water table at the time of planting was approximately two feet below the surface of the soil, which is typical of field conditions at that season. The tanks, twenty-eight in number, were divided into four groups - the first and second containing eight tanks each, and the third and fourth containing six tanks each. The treatment was as follows: the first group was treated according to field practice, i.e., the water table was raised two or three times during the first few months of growth, after which it was allowed to drop as the plants used it, to about four feet, where it was maintained for the remainder of the season; the second group was allowed to exhaust the water to the four-foot level where it was maintained; the third to two feet, and the fourth to three feet, where it was maintained for the rest of the season.

Table 53 gives by groups the results of the two years' work on sugar beets in tanks. This table shows no great dissimilarity in the two years' work. The special strain of beets used is the probable cause of the higher sugar content in 1929. The fourth group, where the water is held three feet below the surface, is one that shows peculiar behavior. Each year the sugar is low and the proportion by weight of roots to tops does not agree with the other groups. This group is especially unique

when considered with groups two and three where the water was held at four and two feet respectively, below the ground surface. No satisfactory explanation of this phenomenon is known at the present time.

TABLE 53

USE OF WATER BY SUGAR BEETS GROWN IN TANKS, KING ISLAND, 1928 AND 1929

(Quantities are Averages for Each Group)

Group	Water Used: Acre-feet per Acre	Sugar Percentage	Weight of Beets in Grams	Weight of Tops in Grams
1928				
1*	3.36	15.23	2651	1536
2**	2.58	15.98	2282	1584
3ø	2.53	16.98	2471	1432
4øø	2.69	9.93	2906	3449
1929				
1*	2.45	16.91	1906	989
2**	2.11	17.33	1694	1095
3ø	1.63	18.98	1356	543
4øø	1.75	13.09	1364	1156

* Eight tanks, water manipulated so as to conform to field conditions. In 1929 the figure 2.45 acre-feet per acre represents average of four tanks.

** Eight tanks, beets exhausted water from about two feet to four feet below the soil surface where it was held for the rest of the season.

ø Six tanks, water held at two feet below the soil surface.

øø Six tanks, same as treatment ** except that water was held at three feet below the soil surface.

Table 54 shows the sugar percentage and use of water by tanks for 1928 and 1929. The striking thing about this table is the uniformity in the sugar percentage of the beets grown in 1929 as compared with those grown in 1928. In 1929 the water was raised within slightly less than

TABLE 54

USE OF WATER AND SUGAR PERCENTAGE
BEETS GROWN IN TANKS, KING ISLAND, 1928 AND 1929

Tank	1928 Sugar Percentage	1928 Use of Water Ac.Ft.Per Ac	1929 Sugar Percentage	1929 Use of Water Ac.Ft.Per Ac
		GROUP I		
1	12.2	3.33	17.8	2.47
2	18.8	3.77	15.3	3.37*
3	15.1	3.63	17.1	2.49
4	14.8	3.54	17.0	3.39*
5	10.6	3.00	17.0	2.62
6	14.2	2.90	17.0	3.19*
7	18.0	3.50	17.0	2.22
8	18.1	3.29	17.1	3.22*
Average	15.23	3.36	16.91	2.45**
				3.29***
		GROUP II		
9	13.1	2.41	17.8	2.26
10	12.9	3.09	16.8	1.92
11	14.8	2.74	19.0	2.27
12	17.9	3.02	18.0	1.80
13	18.3	2.61	16.7	2.50
14	14.8	2.41	16.1	1.90
15	14.8	2.04	17.0	1.75
16	21.2	2.29	17.2	2.46
Average	15.96	2.58	17.33	2.11
		GROUP III		
17	16.8	2.55	17.1	1.20
18	19.0	2.63	18.8	1.75
19	16.8	2.66	20.0	1.79
20	14.2	2.10	19.0	1.73
21	18.9	2.87	20.0	1.76
22	16.2	2.34	19.0	1.54
Average	16.98	2.53	18.98	1.63
		GROUP IV		
23	9.3	2.62	17.0	1.80
24	9.2	2.26	16.0	1.98
25	6.9	2.27	14.0	1.88
26	8.7	2.72	14.0	1.41
27	13.9	3.40	10.0	1.62
28	11.6	2.75	7.5	1.79
Average	9.93	2.69	13.09	1.75

* Water raised in these tanks in 1929 fifteen days prior to harvest to about one foot below soil surface with consequent high soil surface evaporation.

** Average of Tanks 1, 3, 5, and 7, only.

*** Average of Tanks 2, 4, 6, and 8, only.

one foot of the surface in four tanks of Group I about three weeks before harvest. The idea has been held by some that such a practice may increase the sugar content of the beets. The sugar percentages, as noted in Table 54, do not show any evidence of having been affected by the above treatment. As shown on the diagram, Plate 4, the points representing use of water and corresponding yield of beets in the respective tanks in 1929 fall into approximate linear relation with the points representing the results of previous years.

Asparagus

Tank work on asparagus began early in 1927 when twelve tanks were installed on the Richmond-Chase ranch near Terminous. The tanks were located in a row running north and south and are numbered from south to north. They are of the same type as used in this work with other delta crops, but are of greater diameter. The inner tank has a soil surface area of 9.28 square feet which represents 4694 crowns per acre, a typical asparagus planting. Crowns of the Mary Washington variety were obtained from the University Farm at Davis and male or staminate plants were set in the odd numbered tanks, female or pistillate plants in the even numbered tanks. It was subsequently found that one of the plants set for staminate was pistillate.

The tanks were arbitrarily divided into three groups for different irrigation treatments. The water was held at two feet below the surface in tanks 1 to 4, inclusive; three feet in tanks 5 to 8, inclusive; and four feet in tanks 9 to 12, inclusive. No asparagus was cut in the first two years - 1927 and 1928 - but was cut regularly in the third year, 1929. The cutting season lasted from the first appearance of spears until

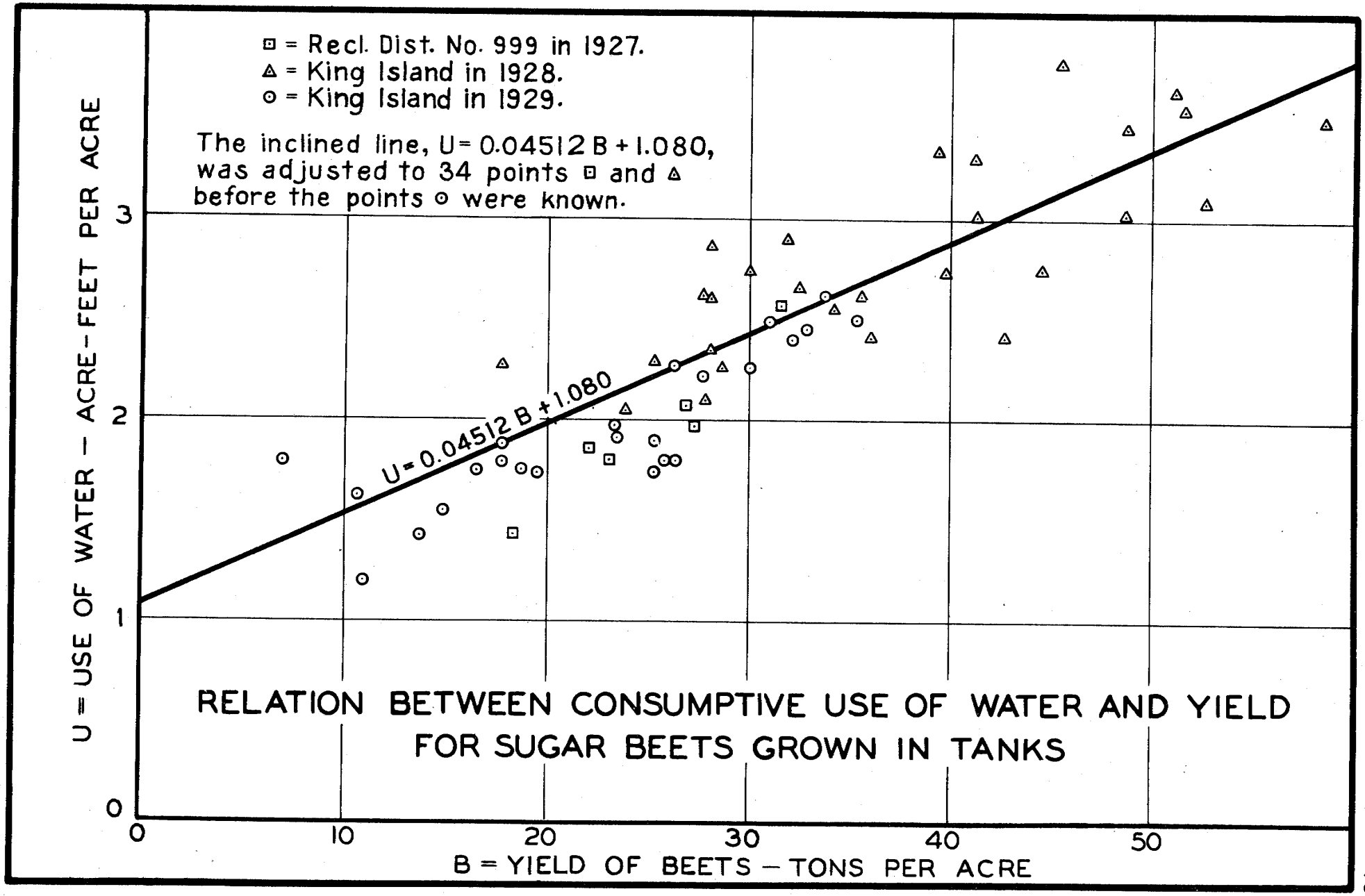

□ = Recl. Dist. No. 999 in 1927.
△ = King Island in 1928.
⊙ = King Island in 1929.
The inclined line, U = 0.04512 B + 1.080, was adjusted to 34 points □ and △ before the points ⊙ were known.
U = 0.04512 B + 1.080
U = USE OF WATER – ACRE-FEET PER ACRE
B = YIELD OF BEETS – TONS PER ACRE
0
1
2
3
10
20
30
40
50
RELATION BETWEEN CONSUMPTIVE USE OF WATER AND YIELD FOR SUGAR BEETS GROWN IN TANKS

PLATE 4

103

July 1st - the commercial cutting season. After the cutting season, the spears were allowed to develop into tops. The weights of the tops and the use of water for 1927, 1928, and 1929 are shown in Table 55, and the yields of spears for 1929 are shown in Table 56. Since these tables are of a general nature, certain matters of interest in them will be set forth later in tables of a more specific nature.

One of the most interesting features of Table 56 is the yield of asparagus in tons per acre. The lowest yield per tank is 2.89 tons per acre; the highest is 11.08 tons per acre; and the average for all twelve tanks is 6.12 tons per acre. The average production of asparagus in California the third year after planting is one-half ton per acre.* The cause of the extreme difference between tank and field yields is not apparent, although it is generally assumed that the ordinary field stand is only sixty or seventy per cent, whereas the tank stand is one hundred per cent. This table also shows that the four-foot water table is much more efficient in the use of water than the two or three-foot water table; i.e., much more asparagus is produced per acre-foot of water with the four-foot water table. Table 57 shows the material from Table 56 in different form. Although grouped according to water table and sex, no interrelation of any significance is established, except that relating to the efficiency of water use, as previously noted. Another grouping somewhat similar to Table 57 is shown in Table 58. In this table are shown the relations between top growth and use of water for 1927, 1928, and 1929. In considering the weight of tops per acre-foot of water used,

---

*"The Asparagus Industry in California" by H. A. Jones and W. W. Robbins, University of California, Bulletin 446, January, 1928.

TABLE 55

USE OF WATER BY ASPARAGUS GROWN IN TANKS, RICHMOND-CHASE TRACT, 1927, 1928 AND 1929

Tank Number	Distance from soil surface to water in feet	Use of Water by Plants: Acre-feet per Acre		Top Growth by Plants In Grams		
		Staminate	Pistillate	Staminate	Pistillate Tops*	Pistillate Berries**
			1927			
1	2		1.72		69.6	146.3
2	2	2.62		107.1		
3	2		2.17		127.6	175.9
4	2		2.62		140.5	307.2
5	3		1.13		59.9	5.6
6	3	1.41		112.8		
7	3		1.35		56.5	93.2
8	3	1.67		109.5		
9	4		1.85		91.0	29.8
10	4	.83		45.4		
11	4		1.40		43.8	56.8
12	4	1.32		152.9		
			1928			
1	2		3.30		291.1	372.7
2	2	6.29		466.4		
3	2		4.98		401.7	84.9
4	2		3.78		399.7	258.2
5	3		2.57		309.0	16.8
6	3	3.20		194.5		
7	3		3.36		309.3	651.3
8	3	3.75		268.0		
9	4		3.87		374.0	2.3
10	4	1.30		128.0		
11	4		1.95		205.3	37.2
12	4	1.55		192.5		
			1929			
1	2		2.44		396.9	112.8
2	2	3.93		609.5		
3	2		3.08		396.9	15.0
4	2		1.94		510.3	64.8
5	3		1.00		113.4	1.3
6	3	2.21		255.2		
7	3		2.04		311.9	78.8
8	3	2.82		425.3		
9	4		1.79		419.6	7.2
10	4	1.04		198.5		
11	4		1.88		482.0	9.6
12	4	1.61		439.4		

* Top dried at room temperature.
** Berries weighed without drying.

TABLE 56

COMPARISON OF 1928 USE OF WATER WITH 1929 YIELD OF SPEARS, ASPARAGUS TANKS, RICHMOND-CHASE TRACT

Tank Number	Distance from soil Surface to Water in Feet	Plants S-Staminate P-Pistillate	Spears in 1929					Use of Water 1928 Ac.Ft. per Ac.	
			Number Cut	Average Weight Grams	Total Weight in Grams	Yield by Tanks Tons per Acre	Yield by Groups	By Tanks	By Groups
1	2	P	17	48.8	830.1	4.30		3.30	
2	2	S	34	63.0	2141.2	11.08		6.29	
3	2	P	22	62.1	1366.6	7.07		4.98	
4	2	P	25	45.9	1148.8	5.94	7.10	3.78	4.59
5	3	P	41	42.7	1751.0	9.06		2.57	
6	3	S	27	39.4	1062.5	5.50		3.20	
7	3	P	22	41.9	920.9	4.76		3.36	
8	3	S	28	20.0	558.3	2.89	5.55	3.75	3.22
9	4	P	43	47.1	2024.1	10.47		3.87	
10	4	S	20	40.1	802.4	4.15		1.30	
11	4	P	15	55.5	832.7	4.31		1.95	
12	4	S	21	35.6	747.2	3.87	5.70	1.55	2.17

TABLE 57

COMPARISON OF USE OF WATER AND YIELD OF SPEARS ACCORDING TO DEPTH OF WATER TABLE AND SEX OF PLANT, ASPARAGUS TANKS, RICHMOND-CHASE TRACT

Tank Number	Discharge from Soil Surface to Water in Feet	Plants S-Staminate P-Pistillate	Spears per Tank - 1929			Average Use of Water in 1928 Acre-feet per Acre
			Average Number	Average Weight in Grams	Average Yield in Grams	
1, 3, 4	2	P	21.3	52.3	1115.1	4.02
2	2	S	34.0	63.0	2141.2	6.29
5, 7	3	P	31.5	42.4	1333.0	2.97
6, 8	3	S	27.5	29.5	810.4	3.48
9, 11	4	P	29.0	49.3	1428.4	2.91
10, 12	4	S	20.5	37.8	774.8	1.43

TABLE 58

COMPARISON OF USE OF WATER AND YIELD OF SPEARS AND TOPS*
ASPARAGUS TANKS, RICHMOND-CHASE TRACT

Group	Distance from Soil Surface to Water in Feet	1927 Use of Water Ac. Ft. per Acre	1927 Average Weight of Tops in Grams	1928 Use of Water Ac. Ft. per Acre	1928 Average Weight of Tops in Grams	1929 Use of Water Ac. Ft. per Acre	1929 Average Weight of Tops in Grams	Yield of Spears** Tons Per Acre
I	2	2.28	111.2	4.59	389.7	2.85	478.4	7.10
II	3	1.39	84.7	3.22	270.2	2.02	276.4	5.55
III	4	1.35	133.3	2.17	225.0	1.58	384.9	5.70

* Berries excluded.
** Spears cut for the first time in 1929

TABLE 59

WEIGHTS OF ASPARAGUS TOPS* AND PERCENTAGES OF INCREASE,
1927, 1928, AND 1929, ASPARAGUS TANKS, RICHMOND-CHASE TRACT

Tank Number	Plant S-Staminate P-Pistillate	Weight of Tops in Grams 1927	1928	1929	Percentage Increase in Weight of Tops 1927 to 1928	1928 to 1929
1	P	69.6	291.1	396.9	318.2	36.3
2	S	107.1	466.4	609.5	335.5	30.7
3	P	127.6	401.7	396.9	214.8	-1.2
4	P	140.5	399.7	510.3	184.5	27.7
5	P	59.9	309.0	113.4	415.9	-63.3
6	S	112.8	194.5	255.2	72.4	31.2
7	P	56.5	309.3	311.9	447.4	.8
8	S	109.5	268.0	425.3	144.7	58.7
9	P	191.0	374.0	419.6	95.8	12.2
10	S	45.4	128.0	198.4	181.9	55.0
11	P	143.8	205.3	482.0	42.8	134.8
12	S	152.9	192.5	439.4	25.9	128.3

*Berries excluded.

the least efficient use is toward the upper left hand corner of the table, and the most efficient is toward the lower right hand corner of the table. This would indicate, at least for the present, that the four-foot water table is the more desirable.

In Table 59, are shown the weights of the asparagus tops, berries omitted, together with the yearly percentages of increase in weight. In comparing 1928 with 1927 the tanks with the higher water table show to advantage, but in a similar comparison of 1929 with 1928 the lowest water table shows greatest relative increase. This may indicate that the four-foot water table is more conducive to steady growth from year to year than the two-foot water table. It must be borne in mind, however, that these relations are affected by the fact that the plants grew throughout the season in 1927 and 1928, but were cut in 1929 until July 1st.

Another feature worthy of mention is the effect of height of water table upon the rate of evaporation from the tank soil surface during the cutting season. Since the ground is kept free of weeds, the only loss of moisture, except that by surface evaporation, is the insignificant amount taken out in the spears. The average evaporation from the soil surface of the three groups from March 14th to July 1st was found to be as follows: two-foot water table ,26 acre-foot per acre; three-foot water table .10 acre-foot per acre; four-foot water table .03 acre-foot per acre.

PESTS

Nematodes

The 1928 report contained a history of experience on this work

with nematodes together with an outline of the proposed method of eradication and description of the plots and water supply. An examination of the soil after six months submergence indicated that all nematodes were dead but eggs that would hatch under field conditions still persisted.

In 1929 the work was continued along the same lines as in 1928. After a year's flooding six of the plots were drained. Samples of the soil were examined microscopically but failed to disclose any nemas.* However, susceptible plants - pumpkins - grown in the drained plots, showed nema infestation. The inference is that the eggs had not been destroyed by the flooding. The shell of the egg is composed of a compound of silicon and due to its inert nature, is very effective in protecting its contents.

The Empire Tract was flooded in the summer of 1929 by the owners, California Delta Farms, Inc., so that an opportunity was afforded to see what flooding under field conditions would do to control nemas. Some soil samples containing nematodes were placed in the central part of the tract before it was flooded. The water covered the samples on May 22nd and was on them until approximately the same date in September - a period of about four months. A microscopic examination of the flooded soil samples failed to disclose any nemas, but when they were placed in a greenhouse some time later, galls developed on plants growing in them. Here again the failure to eradicate the pest is attributed to the survival of the eggs.

The results to date indicate that about four months flooding in the season of the year when the organisms are active will kill all nemas, but that even a full year's flooding will not destroy the eggs.

* This examination was made by Mr. Gerald Thorne of the U.S.D.A. Office of Nematology, at Salt Lake City.

Thus it appears that the details of the method to date have not been such as to insure definite control or complete eradication of the pest. The method of attack may be modified, however, with a chance of making it effective. When, after four months of flooding, the nemas are destroyed, the soil can be drained and the eggs given an opportunity to hatch. Before the resulting nemas have produced any eggs, the land should be reflooded. If all of the eggs have hatched the second flooding should destroy the remaining nemas. An experiment of this nature is contemplated for some of the drained plots in the Summer of 1930.

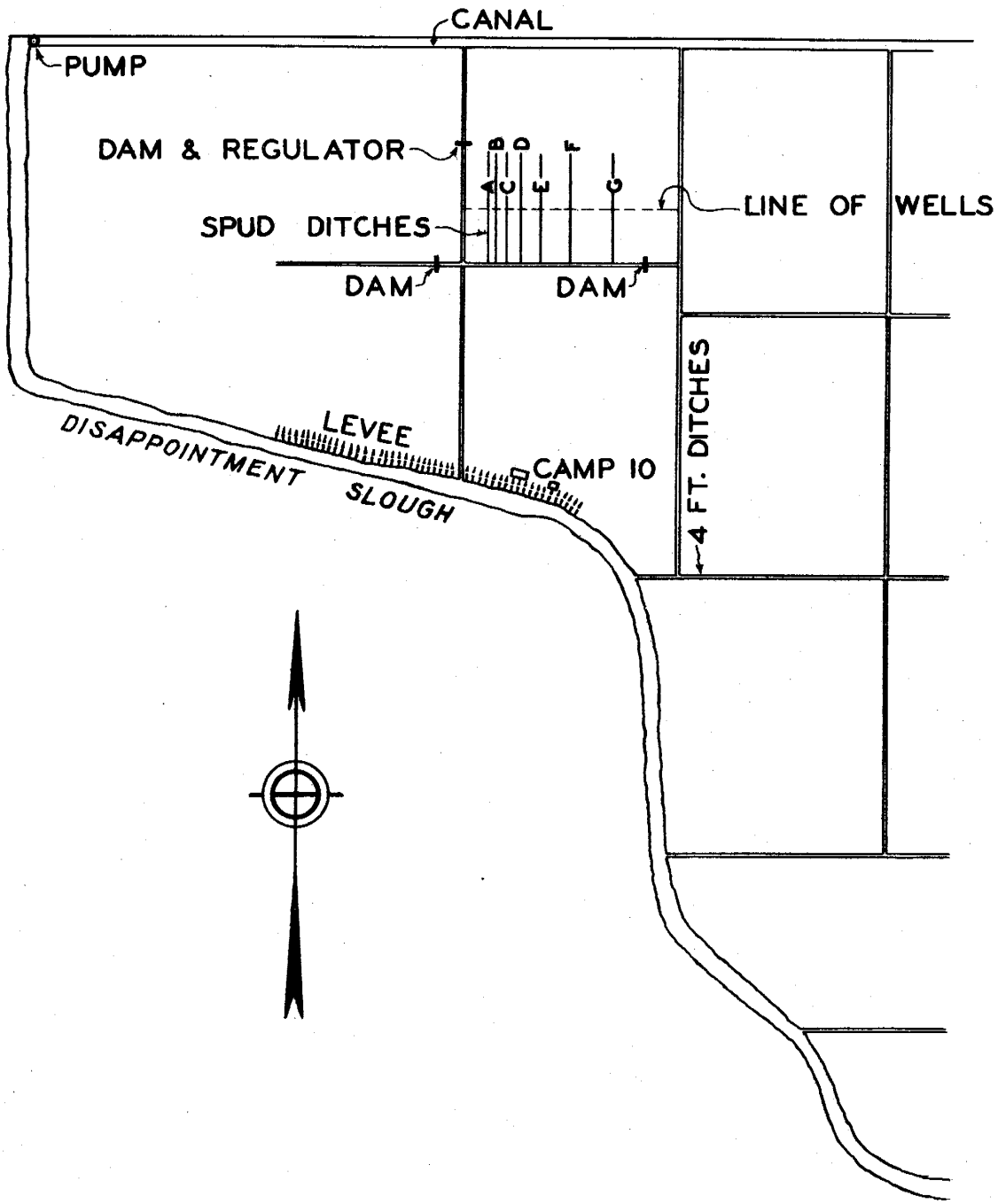
MOVEMENT OF WATER IN THE PEAT SOILS OF THE SACRAMENTO-SAN JOAQUIN DELTA AS RELATED TO IRRIGATION

The Sacramento-San Joaquin Delta contains about 425,000 acres of highly productive peat and sedimentary lands. The area is made up of tracts or islands protected against tide and against surface run-off water, by levees. Since the surface of these islands is lower than low tide in the surrounding channels, the water is made available for irrigation by means of siphons and a system of ditches. These ditches, about three feet wide and four feet deep, partition the land into checks about twelve hundred feet square. The actual irrigating is done by means of "spud" ditches, about ten inches wide and two feet deep, which are dug each year by machines. Spud ditches are usually about fifty feet apart although some crops do not require such close spacing. Thus a check with the ditches installed forms a grid. Irrigating is accomplished by damming up the four-foot ditches which border the checks and raising the water until it flows into the spud ditches. The height to which the water is raised and the length of time it is left in the spud ditches varies greatly

with the different crops. The subirrigation thus accomplished tends to accumulate on the ground surface any alkali that may be present in the soil.

Experiments were carried on with a view to obtaining some facts as to the underground movement of water. The work laid out consisted of two parts: first to see if the interval between spud ditches could not be increased; and second, to determine the route of movement of underground water in an irrigated field. The means employed to investigate the interval between ditches was a line of wells which showed the depth to the water table. Specially designed probes were used to detect upward or downward movement of underground water. More detailed descriptions of the wells and probes will follow later.

The site chosen for the work was a field at Camp 10, King Island, which was approximately one thousand feet square and about one thousand feet from the levee at the nearest point (Plate 5). The spud ditches, each about 450 feet long, were installed in the south half of the field, at right angles to the south side and parallel to the west side. They were dug, starting at a point about 75 feet east of the west side, and thence toward the east side of the field, at intervals of 25, 50, 75, 100, 150, and 200 feet, respectively, seven in all, and designated as ditches A, B, C, D, E, F, and G. Beginning at a point 110 feet west of the westerly border of the field and about 225 feet north of the south boundary of the field, a line of test wells, dug about four feet deep with a six-inch post hole auger, was located, traversing the ditches at right angles. Wells were located five feet from each side of spud ditches with a sufficient number of wells in between the ditches to indicate the character of the water table and also a few near the four-foot ditches



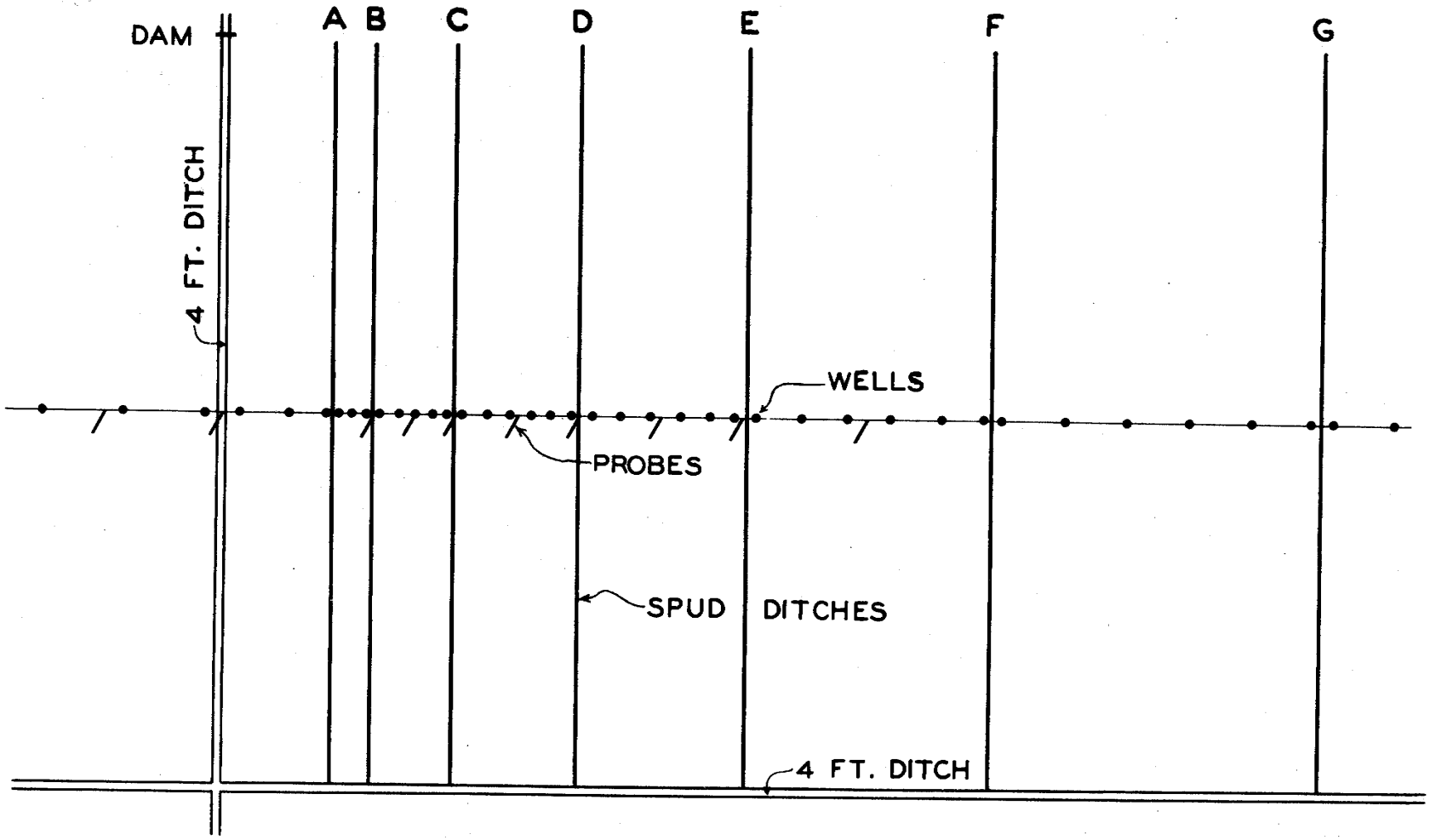
EXPERIMENTAL TRACT
FOR GROUND WATER INVESTIGATIONS
KING ISLAND - 1929

SCALE: 1 IN. = 800 FT. (APPROX.)

on the east and west boundaries of the field. (Plate 6). A hub was set over each well and ditch so that elevations of the water surface could be obtained. Ten probes were installed, one 71 feet west of the west side of the field, one in the four-foot ditch, and one each in ditches B, C, D, and E, and midway between ditches B and C, C and D, D and E, and E and F, as shown on Plate 6.

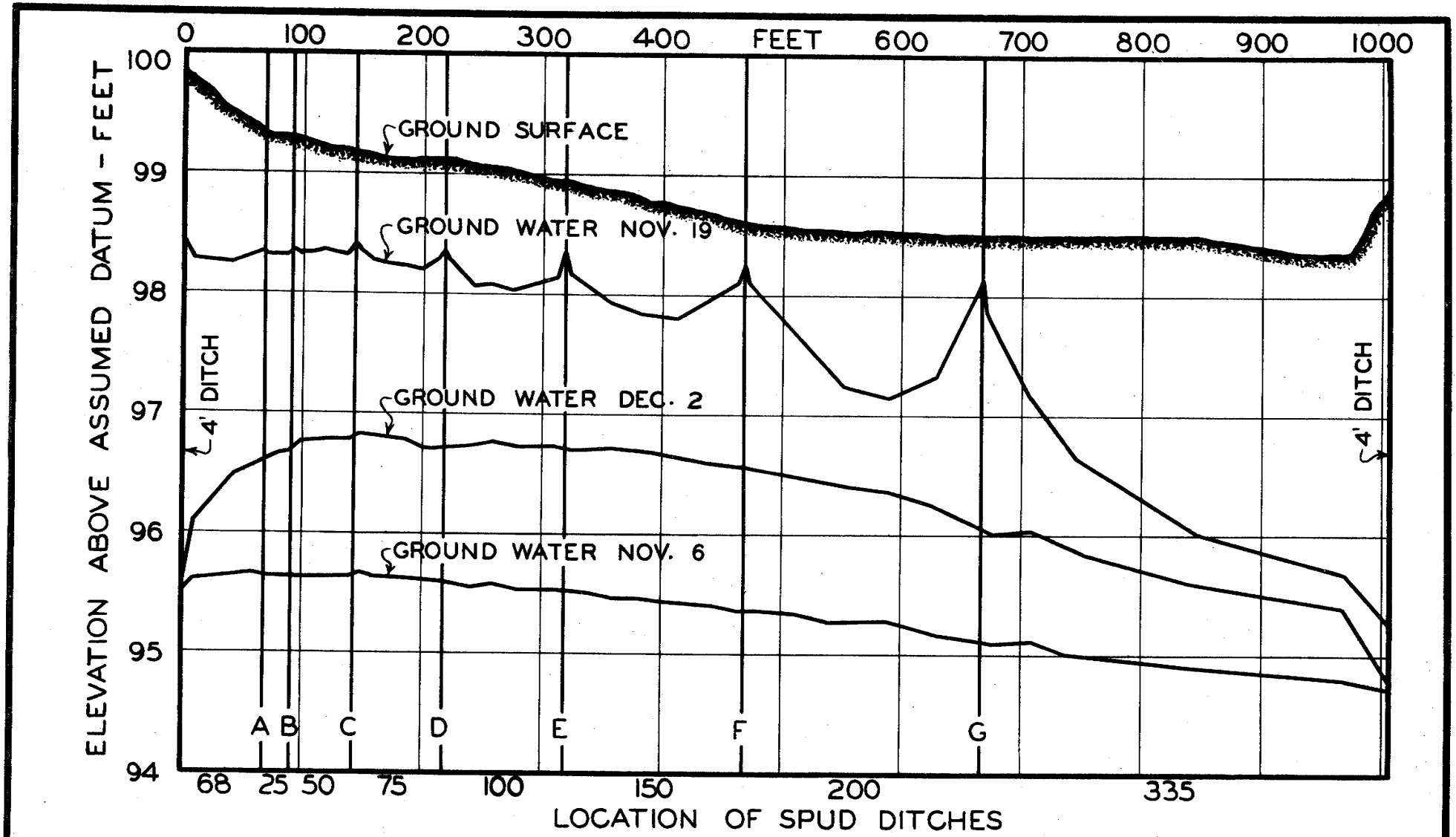
On November 6th, water was turned into the spud ditches and by November 19th it had reached an elevation in the peat comparable to irrigation practice and was then turned off. The plot was allowed to drain until December 2nd, when the water was again turned in and by December 6th attained the same approximate elevation as previously. Thus we have in sequence the records of a filling, a draining, and a second filling.

Profiles taken at transition stages during the above described operations are shown on Plate 7. The drainage ditch on the east side of the field had a noticeable effect on the water table between spud ditches east of Ditch E, as shown on the profile of November 19th. Such a marked effect at this distance was not anticipated. However, the sag which appears shows that the four-foot ditches have a very positive effect on the elevation of the ground water in the checks. The profiles of November 6th and December 2nd (Plate 7) show a condition that is not popularly believed to exist, i.e., when the spud ditches are not in use the water table rises quite abruptly near the four-foot ditches and is then a fairly straight line clear across the field to within a short distance of the next four-foot ditch. This condition is not in accordance with many drainage publications which show an arched water table between drains.



RELATIVE LOCATION OF WELLS, PROBES, AND SPUD DITCHES
EXPERIMENTAL TRACT FOR GROUND WATER INVESTIGATIONS
KING ISLAND - 1929
SCALE: 1 IN. = 100 FT.

PLATE 6



PROFILE OF GROUND SURFACE AND GROUND WATER
EXPERIMENTAL TRACT FOR GROUND WATER INVESTIGATIONS
KING ISLAND-1929

PLATE 7

However, there is at least one recent publication which shows results similar to those described above. (Slope of Water Table in Tile Drained Land, W. W. Weir, Calif. Agr. Expt. Stat. Hilgardia, Vol. 3, No. 5, 1928).

Table 60, shows the average elevation of the water in the wells in each strip between ditches, the wells next to the ditches having been omitted. The reason for this omission is that the tide affected the elevation of the water in the ditches and consequently in the wells near them. Most of the material shown in Table 60 is presented in graphic form on Plate 8. These graphs show that the greater the distance between ditches, the slower the water is in rising - as would be expected. During the drainage period, however, the water moves down at a practically uniform rate in all strips, regardless of width. The profile of December 2nd, Plate 7, also shows the above condition, i.e., the water table sinking fairly uniformly over the whole area. It would appear from the foregoing that the water moves vertically downward through the upper layers of the peat to the more porous and less compacted lower layers, through which it moves horizontally to the drains.

Another comparison of these data is made in Table 61. The figures shown indicate the rates (in feet per day) at which the water rose in each strip of land between spud ditches. During the first filling when the peat was relatively dry the filling took place at a much slower rate than when it was filled the second time. The drainage took place at a fairly uniform rate.

From the profile of November 19th, Plate 7, it appears that such crops as potatoes, onions, and celery, which are very exacting in their water requirements, especially as regards the height of water

TABLE 60

AVERAGE ELEVATION OF WATER IN WELLS BETWEEN DITCHES, GROUND WATER INVESTIGATIONS, KING ISLAND - 1929

(Elevations in feet above assumed datum)

Date	Elapsed time in Days	Number of Wells and Distance between Ditches*: A to B: 1 well: 25 feet	B to C: 3 Wells: 50 feet	C to D: 4 Wells: 75 feet	D to E: 4 Wells: 100 Ft.	E to F: 4 Wells: 150 Ft.	F to G: 4 Wells: 200 Ft.
		RISING WATER TABLE					
11-6		95.66	95.62	95.61	95.54	95.43	95.25
11-7	1.2736	95.85	96.18	95.82	95.80	95.49	95.28
11-8	2.3395	96.95	97.31	96.59	96.16	95.87	95.52
11-9	3.3000	97.76	97.90	97.17	96.61	96.29	95.82
11-11	5.1486	97.66	97.69	97.41	97.05	96.79	96.28
11-12	6.3292	97.81	97.90	97.58	97.22	96.98	96.44
11-13	7.3521	98.45	98.40	97.91	97.44	97.19	96.64
11-15	9.1292	98.37	98.39	98.17	97.81	97.52	96.94
11-19	13.3257	98.32	98.34	98.23	98.07	97.88	97.34
		FALLING WATER TABLE					
11-20	14.2653	97.79	97.76	97.85	97.79	97.67	97.27
11-21	15.0452	97.67	97.67	97.71	97.64	97.54	97.18
11-22	16.0785	97.52	97.60	97.58	97.50	97.40	97.08
11-25	19.0847	97.23	97.32	97.28	97.27	97.10	96.82
12-2	26.0681	96.65	96.77	96.76	96.74	96.65	96.37
		RISING WATER TABLE					
12-3	27.3333	97.63	97.95	97.37	97.11	96.94	96.55
12-4	28.0507	98.33	98.36	97.74	97.39	97.19	96.71
12-5	29.1542	98.24	98.28	97.97	97.66	97.42	96.95
12-6	30.1242	98.11	98.19	97.98	97.75	97.55	97.07

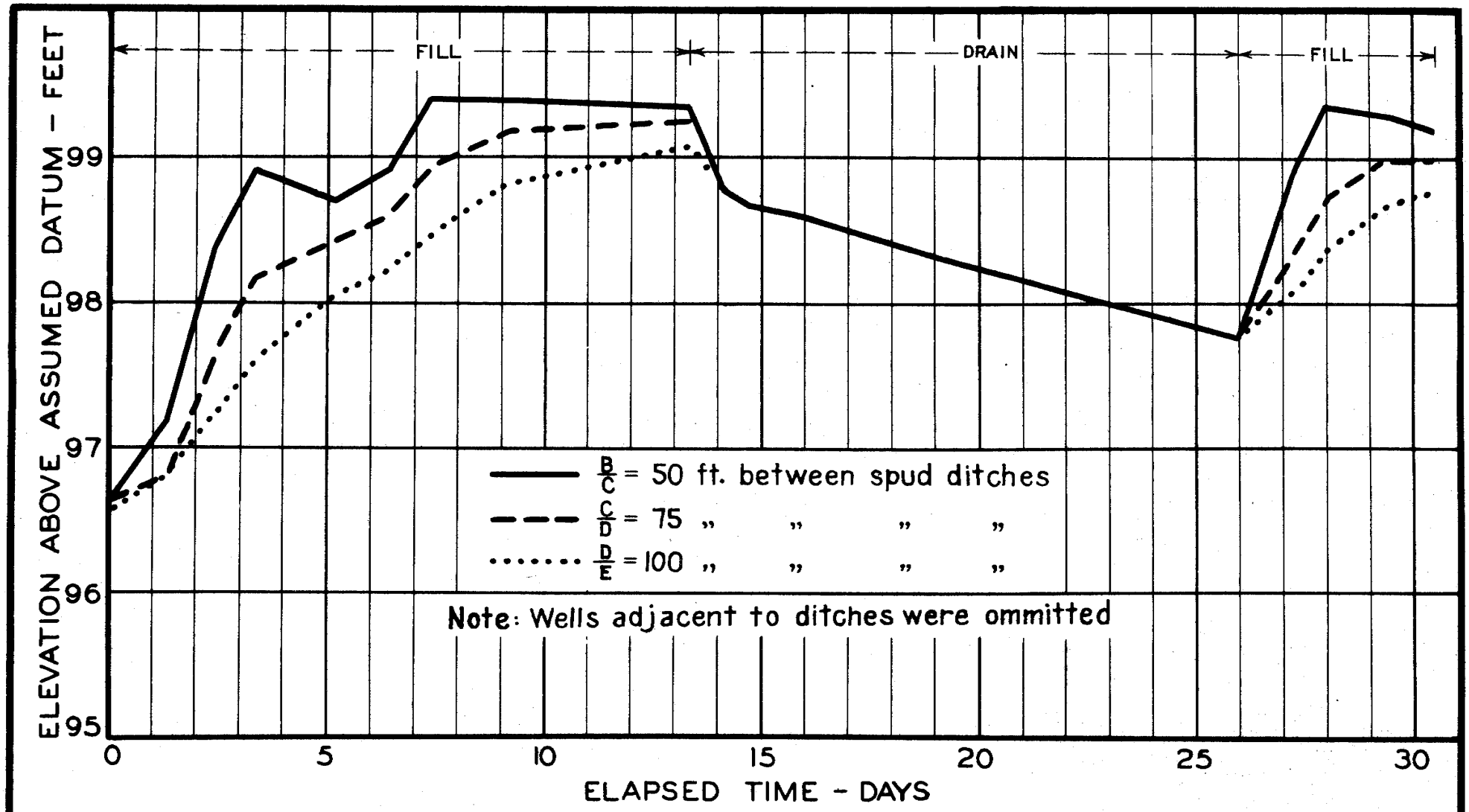
*Data for wells adjacent to ditches are omitted.

TABLE 61

RATES OF RISE AND FALL OF WATER IN WELLS BETWEEN DITCHES, GROUND WATER INVESTIGATIONS, KING ISLAND, 1929

Strip between Ditches	Width in Feet	First Filling: Number of Wells	First Filling: Number of Days	First Filling: Rate of Rise. Ft. per Day	Second Filling: Number of Days	Second Filling: Rate of Rise. Ft. per Day	Draining: Number of Days	Draining: Rate of Rise. Ft. per Day
A to B	25	1	7.35	.379	1.98	.847	12.74	.097
B to C	50	3	7.35	.378	1.98	.802	12.74	.084
C to D	75	4	13.33	.197	3.08	.392	12.74	.092
D to E	100	4	13.33	.190	4.05	.249	12.74	.089
E to F	150	4	13.33	.184	4.05	.222	12.74	.086
F to G	200	4	13.33	.157	4.05	.173	12.74	.076

NOTE: Data for wells adjacent to ditches are omitted.



AVERAGE ELEVATION OF WATER IN WELLS BETWEEN DITCHES
EXPERIMENTAL TRACT FOR GROUND WATER INVESTIGATIONS
KING ISLAND - 1929

PLATE 8

table, can not be irrigated effectively if the spud ditches are at intervals materially more than fifty feet, because there would be too much variation in the depth of soil above the water table when the ditches are farther apart. Sugar beets, while hardly in the above group, would probably be irrigated properly if the space between ditches were 75 feet. With such crops as corn the distance could probably be increased to at least one hundred feet.

The second part of the experiment has to do with some particular feature of the movement of underground water. A probe has been developed designed to detect vertical components in the direction of movement of underground water. As here employed, it consists of a three-quarter-inch pipe with a wooden point on the lower end and a half-inch hole in the pipe just above this point. Probes were installed in pairs, one with an opening five feet below the ground surface and the other ten feet below the ground surface. After being driven down flush with the ground surface and alongside each other so that the holes are outside, they are clamped rigidly together at the top. Following this each probe is "developed" as a well by means of a force pump, so that the water may have free ingress or egress.

When the water stands higher in one well than in the other, a vertical component of direction of flow is indicated. In Table 62 these differences in elevations between the five and ten foot probes are shown - positive quantities signify that the water surface in the ten-foot well was the higher, indicating an upward flow, while negative quantities signify that the water in the five-foot well was the higher, indicating a downward flow. The results for the first pair of probes, as shown in

TABLE 62

DIFFERENCES IN ELEVATIONS OF WATER IN FIVE AND TEN FOOT PROBES
GROUND WATER INVESTIGATIONS, KING ISLAND, 1929

(Differences in Feet)

Date	Elapsed Time in Days	Station and Location of double Probes: 0+39: West of 4 Ft. Ditch	1+10: 4 Ft. Ditch	2+03: Ditch B	2+28: Between Ditches B & C	2+53: Ditch C	2+90.5: Between Ditches C & D	3+28: Ditch D	3+78: Between Ditches D & E	4+28: Ditch E	5+03: Between Ditches E & F
					RISING WATER TABLE						
11-6			-.004	+.027	-.009	-.017	.000	-.014	+.001	+.007	.000	-.014
11-7	1.0902	-.001	-.510	-.032	-.013	+.003	-.012	+.009	+.005	+.004	-.006
11-7	1.3089	-.004	-.199	-.024	+.001	-.306	+.001	-.032	+.008	-.607	+.003
11-9	3.0971	+.007	-.164	-1.163	-.037	-.098	+.012	-.335	+.029	-.275	+.047
11-9	3.3364	+.005	-.092	-1.607	-.057	-.093	+.009	-.268	+.038	-.331	+.064
11-11	5.1871	+.007	-.132	-.598	-.022	-.056	-.002	-.171	+.022	-.281	+.046
11-12	6.3642	-.011	-.029	-.604	-.034	-.047	-.002	-.153	+.020	-.179	+.045
11-13	7.3857	-.002	-.048	-.860	-.028	-.030	.000	-.117	+.034	-.197	+.066
11-15	9.1649	.000	-.023	-.441	-.023	-.011	-.018	+.067	+.030	-.109	+.055
11-19	13.3622	+.013	-.057	-.090	-.029	-.029	-.018	-.046	+.007	-.062	-.002
					FALLING WATER TABLE						
11-20	14.2970	-.004	+.327	+.477	-.016	+.018	-.027	.000	-.009	+.038	-.036
11-21	15.0762	.000	+.371	+.458	-.019	+.009	-.031	-.018	-.009	+.015	-.035
11-25	19.1116	.000	+.338	+.394	-.027	+.008	-.026	-.017	-.010	-.010	-.034
12-2	26.1068	+.001	+.257	+.317	-.024	+.006	-.021	-.004	-.017	-.011	-.031
					RISING WATER TABLE						
12-3	27.3596	-.001	-.391	-1.008	-.055	-.161	+.002	-.297	+.012	-.212	+.016
12-4	28.0763	+.005	-.151	-1.131	-.032	-.037	+.013	-.080	+.011	-.173	+.036
12-5	29.1846	-.009	-.075	-.792	-.021	-.167	-.010	-.035	+.026	-.101	+.042
12-6	30.1561	+.002	-.112	-.600	-.033	-.123	-.013	-.032	+.004	-.087	+.019

NOTE: Plus readings indicate that the water in the ten-foot probe was highest, showing an upward flow. Minus readings indicate that the water in the five-foot probe was highest showing a downward flow.

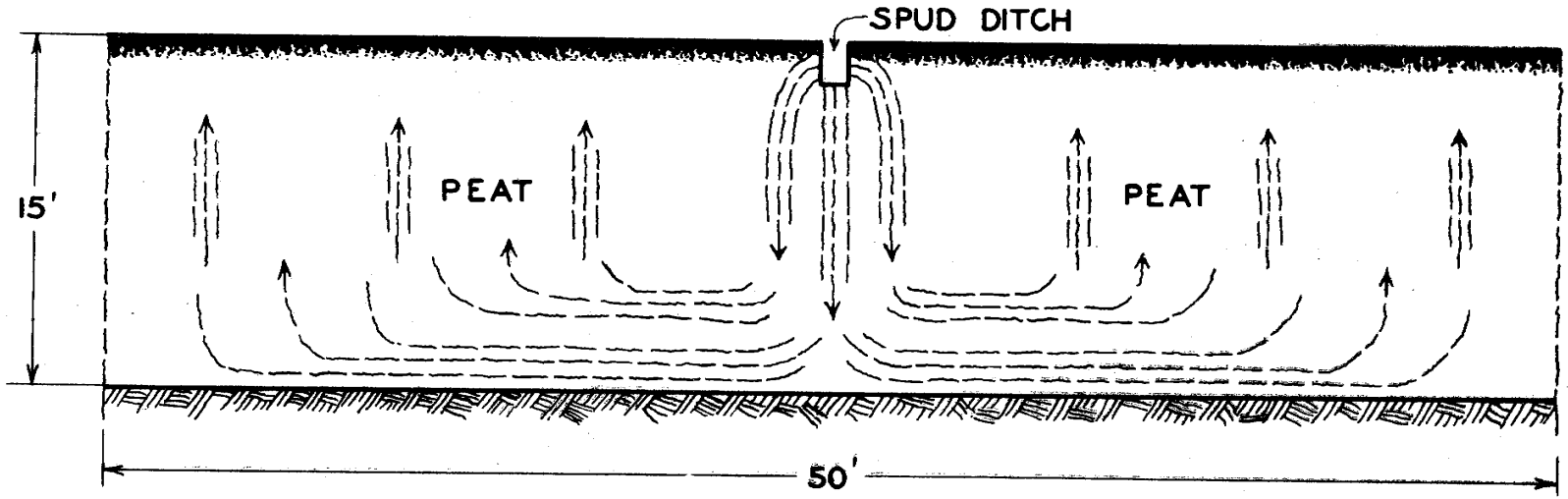
Table 62, do not indicate a material upward or downward flow. Therefore the flow must have been horizontally through the peat because the water in the wells rose 1.67 feet during the first filling, judging by the five-foot well. The probes in the four-foot ditch show in positive fashion, the action of the water when the soil is being filled and also when draining. Starting on November 7th, the downward flow is very marked but becomes less as the ground fills up - then on November 20th drainage started and the action was reversed. In a general way the wells in the spud ditches exhibit this same behavior while irrigation water is in them. When irrigation is stopped and the water table drops below the bottom of the spud ditches, the probes in the ditches indicate the conditions of the field water table, i.e., a uniform downward flow over all but the marginal areas. The action of some of the probes between ditches is not entirely consistent or uniform. During the first filling, for example, the probes between ditches B and C indicate a downward movement of water while the probes between ditches E and F indicate an upward movement and the two probes between show the transition from the former to the latter. As a whole the probes show the conditions that were expected, i.e., when irrigating, water goes down at the ditches and rises in the middle of the strips; and when draining, it goes down fairly uniformly over all but marginal areas near the four-foot ditches.

Since the conditions as described prevail, it might be of interest to consider the amount of fresh or irrigation water supplied to the soil in relation to the water already present. Consider a part of a cropped field where the spud ditches are fifty feet apart and the peat is fifteen feet deep. Each "spud" ditch will be supplying a strip of soil fifty feet

wide, twenty-five feet on each side of the ditch, and fifteen feet deep, with irrigation water. Thus, with the water table two feet from the surface, each lineal foot of ditch will represent six hundred and fifty cubic feet (13 x 50) of soil below the water table. Some earlier experiments indicate the volume of free water in saturated peat amounts to about one-eighth of the volume of the soil. From these figures it is evident that there are about eighty cubic feet of free water in the soil for each lineal foot of ditch. This amount is equivalent to a surface application of 1.6 feet which is probably less than the average use. Therefore if the above amount, 1.6 feet, is applied as irrigation water in the spud ditches, the same water in the soil will tend to be replaced with the fresh water as shown on Plate 9. Consequently since the fresh water replaces the sour water and the latter is used by the plant and surface evaporation, any soluble salt (alkali) will tend to be deposited at or near the surface of the soil.

Due to the conditions just mentioned, several methods of removing the alkali have been employed with more or less success. One system is to use a gopher plow to open up subsurface channels leading to the four-foot ditches and then flood the surface. The water passes down to the channels and is carried by them to the four-foot ditches. This is probably the most effective system in use but is quite costly. Flooding is the system most used. The flooded area varies from one check up to a whole island. The results obtained are not entirely satisfactory. A third method is to run water in every alternate spud ditch allowing the other ditches to act as drains. This system is probably the least successful of the three and is not practiced extensively. About as many combinations

VERTICAL CROSS - SECTION

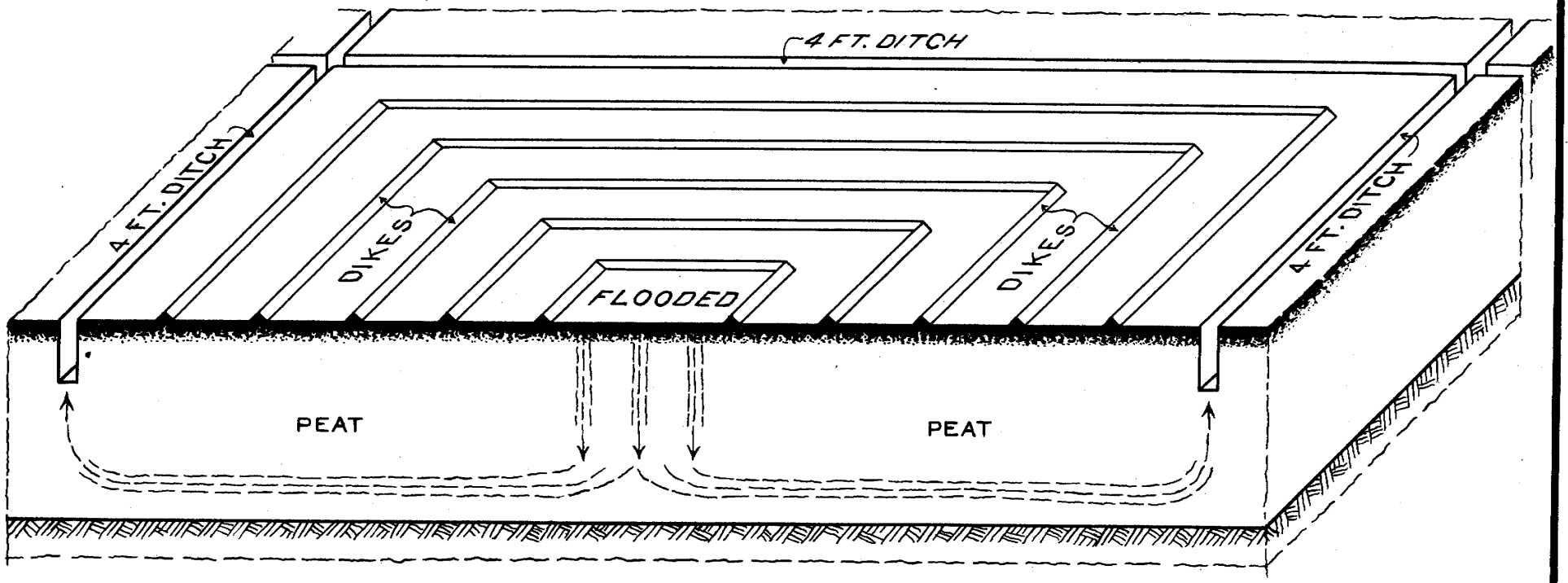


INDICATED MOVEMENT OF GROUND WATER
EXPERIMENTAL TRACT FOR GROUND WATER INVESTIGATIONS
KING ISLAND - 1929

PLATE 9

and modifications of these three systems are used as there are farmers attempting alkali removal by the use of water. Upon one point however, all are fairly well agreed, and that is, that it is desirable to replace the sour water in the soil with fresh water. Theories as to the magnitude, rate, and direction of underground water movement are various. Most of them are based on casual observations and inference rather than on definitely established facts.

From the results of this experiment, a type of alkali removal has suggested itself which may merit trial, as it appears likely to prove both practical and effective. Consider, for instance, a check about twelve hundred feet square from which it is desirable to remove the alkali. Make a basin two hundred feet square in the central portion of this check with levees high enough to permit flooding the whole surface of the basin. Then make a basin one hundred feet wide around this central basin and continue making similar basins successively to the borders of the check. This would mean about four basins around the central basin. A surface ditch would then be constructed to the central basin to carry water to it. Lower the water in all of the ditches adjacent to the check and then turn water into the central basin. Leaching will then take place as shown on Plate 10. After tests have shown that the alkali (practically all sodium chloride in this region) has been leached from the area, flood in addition the adjacent basin and so on until the whole check is flooded. This method gives to each portion of the check in succession from the center outward a channel of escape for the dissolved alkali, whereas flooding the whole field would not facilitate leaching of the central portion.



MOVEMENT OF WATER TO FOUR FOOT DITCHES
EXPERIMENTAL TRACT FOR GROUND WATER INVESTIGATIONS
KING ISLAND - 1929

PLATE 10

Conclusions

A fifty-foot spacing of spud ditches is probably about the maximum desirable distance for crops such as potatoes, celery, and onions, while sugar beets might thrive with the ditches seventy-five feet apart. Corn could likely be grown with ditches a hundred feet apart or even farther.

The water table in a check or field about one thousand feet square rises abruptly near the ditches and then is practically level across the field.

Irrigation water spreads initially but a short distance laterally from spud ditches. It first sinks down to the lower layers of the peat, then moves laterally, and finally rises vertically. This characteristic movement concentrates alkali on the surface of the soil.

A suggested plan for alkali reclamation would be to subdivide the checks to provide a small central basin with other surrounding basins; to keep the four-foot ditches open and successively flood the central and surrounding basins until leaching is accomplished.

SEDIMENTARY LAND INVESTIGATIONS

Consumptive Use of Water by Aquatic Plants

The twelve soil tanks which were received from Medford Island and set in Reclamation District 999 in 1926 are still in place at that location.

In 1929 it was decided to use them to determine the consumptive use of water by aquatic plants. Tules and cattails found growing in the vicinity were therefore dug up and transplanted to the tanks. In digging

up the plants the work was done with some care, so that the roots were imbedded in a cylinder of earth nearly a foot high and of the same diameter as the inner cylinder of the soil tank. The old top soil was taken out of the tank and the excavated cylinder of earth and roots placed in the space thus provided. Cattails were set in tanks numbers 1 to 6, inclusive, and tules in numbers 7 to 12, inclusive, the work of transplanting to tanks numbers 10 and 11 being done on June 20th, and to the other tanks on June 27th. All were watered when set, tanks numbers 10 and 11 on June 25th, and all tanks on July 3d and July 9th. The records of the amount of water added and of elevation of water surface in the annular space in the tanks were begun on July 15th. Observations were made and water added at irregular intervals of less than a week until the end of August; thereafter regularly weekly dates for observations and attendance were established. The soil surface in the tanks was submerged at each watering to a depth of from two to four inches. Usually, by the time of the next watering, the soil surface was uncovered and a water table established some inches beneath.

The transplanted cattails grew to maturity, and in the meantime two additional crops came up about August 1st and October 1st, respectively. The later crops, especially the second, made fair growth but did not mature. A few tules also appeared and grew in the cattail tanks.

It was estimated on August 13th that about ten per cent of the transplanted tule stalks were dead, and by the end of the season probably all of the original transplanting were dead and had been replaced by a younger growth. The tules of the peat region of the Delta grow to a considerably greater height than those in the tanks, and casual obser-

vation indicates that the tank tules were somewhat smaller than the general run of those growing in the vicinity. In September the beet trucks passing on the earth road near the tanks caused the plants to become covered with a thick coating of dust. The inference from the several facts which have just been noted is that the tule areas of the delta may consume water at a rate even higher than that which is submitted below in Table 63, as a result of the tank experiments.

TABLE 63

CONSUMPTIVE USE OF WATER BY CATTAILS AND TULES GROWN IN TANKS, RECLAMATION DISTRICT 999, JULY 15TH TO NOVEMBER 30, 1929

(Quantities in Acre-feet per Acre)

Tank Number	July 15-31	Aug.	Sep.	Oct.	Nov.	Total	
1	1.14	2.76	2.82	*	*	*	
2	1.13	2.59	2.17	1.77	0.98	8.64	Cattails
3	1.23	2.58	2.02	1.71	1.10	8.64	Cattails
4	0.98	1.98	2.49	2.06	1.29	8.80	Cattails
5	0.92	2.44	2.56	2.03	0.92	8.87	Cattails
6	1.04	2.43	2.60	2.23	1.22	9.52	Cattails
7	1.30	2.85	2.50	2.23	1.40	10.38	Tules
8	1.33	3.03	2.56	2.31	1.49	10.72	Tules
9	1.21	2.81	2.39	1.99	1.19	9.59	Tules
10	1.18	2.86	2.32	1.87	0.99	9.22	Tules
11	1.34	2.87	2.26	1.76	1.17	9.40	Tules
12	1.32	2.73	2.09	1.73	1.18	9.05	Tules
Means**	2.34 ***	2.65	2.36	1.97	1.18	9.34	Tules & Cattails

* Tank Number 1 in bad order and abandoned.
** Tank Number 1 not included in the calculation of means.
*** Mean of the July period calculated for a full month of 31 days.

CHAPTER VI

SALINITY

The salinity investigation in 1929 was greatly enlarged and extended beyond that of previous years. This was occasioned by the decision of the State Engineer to make the investigations beginning in June, 1929, the basis for an exhaustive and conclusive report of the salinity situation to be submitted to the 1931 Legislature as a part of the State-wide Water Resources Investigation but with particular reference to the proposed Salt Water Barrier. Under this plan all field work in connection with the extended investigation was conducted under the direction of the Water Supervisor.

As a special report to be published by the Division as a part of the Water Resources Investigation will present in detail both the field and office studies conducted since June, 1929, together with analyses and conclusions, the present chapter of this report is confined to a presentation only of the field data obtained corresponding to a continuation of the previous years' investigations.

As outlined in previous reports the purpose of these investigations has been to establish as clearly as possible the relation which may exist between the discharge of fresh water to the delta through the rivers and the advance and retreat of the salinity. In years of low stream flow it has also had the additional purpose of supplying information to delta water users in order that their irrigation operations might be so regulated as to avoid the use of excessively saline water.

The scope of the investigation each season has been such as to insure that samples of water to be tested for salinity would be taken at

regular intervals at a sufficient number of stations throughout the delta and in the upper bay region, that the advance and retreat of the salinity from early Summer to late Fall would be completely recorded. In 1929, however, the number of stations to fulfill this requirement was considerably exceeded due to the enlargement of the investigation to cover every possible angle. In all, from June to November, samples were received from seventy-six stations and continuous sampling throughout the year has been established at thirty-four stations. Tables 65 and 66 give a description and present the results of all sampling in 1929 for those stations which were also maintained in years previous to 1929 or those newly established in 1929 which will be maintained in the future. The results of the sampling at all of the 1929 stations including those special to the 1929 investigation will be presented in the separate report to be published by the Division in connection with the Water Resources Investigation.

Although the 1928-29 seasonal run-off to San Francisco Bay was only 41 per cent of normal, the minimum flow of the rivers to the delta was more nearly similar to that of the 1927-28 season in which the total run-off to the bay was 75 per cent of normal. Apparently reflecting this condition, the salinity encroachment in 1929 was similar to and very little farther into the delta than the 1928 encroachment. In 1929, the limit in the delta area above which salinity in the channels did not reach 100 parts of chlorine per 100,000, passed through the central portions of Brannan and Twitchell Islands, through the lower portion of Franks Tract and through the central portions of Bethel and Hotchkiss Tracts.

Table 64 presents a comparison of the maximum salinity at bay and delta stations for the years 1924 to 1929, inclusive, and Plate 11 shows a

comparison, for the 1929 season, of the river discharge to the delta and the salinity at certain stations.

TABLE 64

MAXIMUM SALINITY AT BAY AND DELTA STATIONS
1924 TO 1929, INCLUSIVE

Year	1924		1925		1926		1927		1928		1929	
Seasonal Run-off to San Francisco Bay in per cent of Normal	27		78		55		108		75		41	
Station(1)	Maximum Salinity in Parts of Chlorine per 100,000 and Date of Occurrence											
SAN FRANCISCO, SAN PABLO & SUISUN BAYS												
Point Orient					9/30	2020	9/10	1880	7/31	1870	9/26	1830
Point Davis					8/26	1850	8/26	1510	8/2	1610	8/30	1660
Bullhead Point					8/30	1690	9/2	1330	8/10	1410	9/6	1370
Bay Point					8/23	1400	9/2	950	8/10	1170	9/6	1050
O and A Ferry	8/28	1345	9/26	762	8/26	1100	8/30	510	8/22	750	8/30	830
Innisfail Ferry											9/18	870
SACRAMENTO RIVER DELTA												
Collinsville	8/16	1150	9/6	448	9/6	1020	9/10	370	9/2	590	9/2	680
Emmaton	8/6	802	9/4	136	8/22	540	8/30	65	8/22	156	9/6	310
Three Mile Slough Bridge	8/30	692	9/6	81	8/26	430	9/10	25	9/2	109	9/6	205
Rio Vista Bridge	8/12	608	9/2	21	8/30	256	9/26	12	8/30	44	9/3	67
Isleton Bridge	8/14	310	9/16	12	8/19	68			8/18	13	9/10	6
Liberty Ferry	8/16	192	9/16	11	8/26	32			9/26	7	7/22	14
Howard Ferry	8/16	157			8/6	27					7/14	7
Sutter Slough	8/8	46									8/10	11
Little Holland Ferry	8/10	*48									7/18	11
Walnut Grove	8/10	42			8/19	*15					7/18	8
Paintersville Bridge	8/10	47			9/3	17					7/18	9
Hood Ferry	8/10	*46									7/14	10
Freeport Ferry	8/16	*15									7/10	8
Sacramento											7/2	8

(1) For location and description see Table 65
* Maximum salinity obtained at start of sampling. Greater salinities may have occurred earlier.

TABLE 64 (CONTINUED)

MAXIMUM SALINITY AT BAY AND DELTA STATIONS
1924 TO 1929, INCLUSIVE

Year	1924		1925		1926		1927		1928		1929	
Seasonal Run-off to San Francisco Bay in per cent of Normal	27		78		55		108		75		41	
Station(1)	Maximum Salinity in Parts of Chlorine per 100,000 and Date of Occurrence											
MOKELUMNE RIVER DELTA												
Southwest Point - - -					8/26	65			8/10	23	9/2	9
Camp 33 - - - - - - -	8/30	113			9/6	32			7/30	25	7/18	8
Tyler Island Ferry -	8/8	44			8/2	19					7/22	9
Camp 11 - - - - - - -	9/26	96			9/6	23					7/6	7
Camp 29 (Terminous) -					9/2	25			8/30	16	7/6	11
Camp 25 - - - - - - -	9/24	110			9/14	24					7/30	7
New Hope Bridge - - -					9/10	17					7/18	6
Camp 20 - - - - - - -					10/10	22					7/18	8
SAN JOAQUIN RIVER DELTA												
Antioch - - - - - - -	8/20	1080	9/4	356	8/26	920	9/18	179	9/2	450	8/30	600
Jersey - - - - - - -	8/30	708	9/6	81	8/26	470	9/14	53	9/6	192	9/3	365
Twitchell Island Pump											9/2	115
Webb Pump - - - - - -	9/6	414	9/4	24	8/14	147	9/10	16	8/30	46	8/31	80
Holland Pump - - - -	10/4	308	9/22	18	9/2	148			10/10	34	9/22	42
Central Landing - - -	9/24	288	9/2	10	9/2	98			8/2	19	8/31	20
East Contra Costa I.D.											9/18	16
Orwood Bridge (2) - -					9/18	86			9/22	21	9/18	18
Middle River P.O. - -	9/30	186	9/13	13	10/8	69			8/2	21	9/18	17
Mansion House - - - -	10/12	148	9/16	11	9/26	69			9/2	16	9/18	16
Ward Landing - - - -											9/26	23
Drexler Bridge - - -											7/18	15
Camp 3⅔ (King Island)	10/2	164			9/28	48			10/12	19	9/26	16
Mandeville Pump - - -					9/30	84			8/2	25	9/26	25
Clifton Court Ferry -	10/2	80			8/30	24					8/18	23
Rindge Pump - - - - -	9/16	126	9/2	35	9/14	50			9/30	28	8/26	28
Williams Bridge - - -	9/4	42			9/2	18					7/14	12
Stockton Country Club	9/16	108.			8/30	48					8/14	36
Stockton - - - - - - -											8/18	200
Mossdale Bridge - - -	9/8	*14									7/22	16

(1) For location and description see Table 65
(2) Prior to 1929 this station was "Palm Tract".
* Maximum salinity obtained at start of sampling.. Greater salinities may have occurred earlier.

TABLE 65

SALINITY STATIONS AT WHICH OBSERVATIONS WERE TAKEN DURING 1929(1)

Stations Arranged in Upstream Order	Description
	SAN FRANCISCO, SAN PABLO & SUISUN BAYS
Point Orient	Upper end S.F.Bay, east shore, ½ mile south of Pt. San Pablo, Wharf of Standard Oil Company.
Point Davis	Upper end San Pablo Bay, south shore, Oleum wharf of Union Oil Company.
Bullhead Point	Lower end Suisun Bay, south shore, Wharf of Mountain Copper Company.
Bay Point	Center Suisun Bay, south shore, Bay Point wharf of Coos Bay Lumber Company.
O and A Ferry	Upper end Suisun Bay between Mallard Station & Chipps Is. on San Francisco-Sacramento RR.
Innisfail Ferry	Montezuma Sl., about 1 mile east of junction with Cutoff Slough. Near most northerly point of Grizzly Island.
	SACRAMENTO RIVER DELTA
Collinsville	North bank Sacramento River at junction with San Joaquin River.
Emmaton	South bank Sacramento River just above Baker Point Cut, on Horseshoe Bend.
Three Mile Slough Bridge	At junction of Slough and Sacramento River.
Rio Vista Bridge	Right bank Sacramento River two miles below junction of Cache and Steamboat Sloughs.
Isleton Bridge	Left bank Sacramento River three miles above junction with Steamboat Slough.
Liberty Ferry	On Cache Slough at junction with Lindsay Slough.
Howard Ferry	On Steamboat Slough, one and one-half miles below junction with Sutter Slough.
Sutter Slough	At junction with Miner Slough.
Little Holland Ferry	Back Borrow Pit of Reclamation District 999, 2 miles above junction with Miner Slough.
Walnut Grove	Left bank Sacramento River at Upper end of Georgiana Slough.
Paintersville Bridge	Sacramento River, 1 mile below Courtland.
Hood Ferry	Sacramento River, ½ mile above Hood.
Freeport Ferry	Sacramento River at Freeport.
Sacramento	Sacramento River, east bank, at Southern Pacific Railroad Bridge.
	MOKELUMNE RIVER DELTA
Southwest Point	Staten Island, north fork Mokelumne River, south bank, just above junction with South Fork.
Camp 33	Staten Island, south fork Mokelumne River, north bank, two miles above north fork junction.
Tyler Island Ferry	On Georgiana Slough, one and one-half miles east of Isleton.
Camp 11	Staten Island, north fork Mokelumne River, east bank, four miles above south fork junction.
Terminous, Camp 29	Staten Island, south fork Mokelumne River, north bank, opposite Terminous.
Camp 25	Staten Island, south fork Mokelumne River, west bank, 1 mile above Sycamore Slough junction.
New Hope Bridge	North end Staten Island at division point for north and south forks Mokelumne River.
Camp 20	Staten Island, south fork Mokelumne River, west bank, ½ mile below Beaver Slough junction.

(1) See next page for note.

TABLE 65 (CONTINUED)

SALINITY STATIONS AT WHICH OBSERVATIONS WERE TAKEN DURING 1929(1)

Stations Arranged in Upstream Order	Description
	SAN JOAQUIN RIVER DELTA
Antioch	San Joaquin River, left bank, three and one-half miles above Sacramento River junction.
Jersey	San Joaquin River, left bank, one mile below mouth of False River.
Twitchell Island Pump	San Joaquin River, Twitchell Island, south side, about midway between Seven Mile and Three Mile Sloughs.
Webb Pump	Washington Slough, two miles below Old River junction.
Holland Pump	Rock Slough, north bank, one and one-half miles west of Old River junction.
Central Landing	Bouldin Island, Mokelumne River, left bank, one-half mile above San Joaquin River junction.
East Contra Costa I.D.	At East Contra Costa Irrigation District pumping plant at head of Indian Slough.
Orwood Bridge	Old River at Santa Fe Railroad crossing.
Middle River P.O.	Middle River, east bank, at Santa Fe Railroad crossing.
Mansion House	Victoria Island, Old River, east bank, at junction with North Victoria Canal.
Ward Landing	San Joaquin River. Near Southwest corner of Empire Tract. Near junction of river and Little Connection Slough.
Drexler Bridge	Middle River, southwest corner of Drexler Tract about one-half mile north of Victoria Canal.
Camp 3½ (King Island)	West side King Island at junction of White Slough and Honkers Cut.
Mandeville Pump	South end Mandeville Island, Connection Slough, north bank, one mile west of Middle River.
Clifton Court Ferry	Old River just below junction with Grant Line canal.
Rindge Pump	San Joaquin River, north bank, one mile below Fourteen Mile Slough junction.
Williams Bridge	Middle River, about four miles below Salmon Slough junction.
Stockton Country Club	On Lindley Cut-off (San Joaquin River) north bank, about three quarters mile above Burns Cut-off junction.
Stockton	Near head of Stockton Channel at wharf of California Transportation Company.
Mossdale Bridge	San Joaquin River at Lincoln Highway Crossing, about three miles southwest of Lathrop.

(1) In connection with the enlarged and special salinity investigation by the Division of Water Resources, initiated in June, 1929, there were maintained, in 1929, many additional stations which are not listed in this table. The list gives only those stations which were also maintained in years previous to 1929 or those newly established in 1929 which will be maintained in the future. The observations at all of the 1929 stations will be presented in a special salinity report to be published by the Division.

TABLE 66

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)
Samples taken by local observers approximately one and one-half hours after high high tide.
Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	JANUARY							
	2	6	10	14	18	22	26	30
	San Francisco, San Pablo & Suisun Bays							
Point Orient	1530	1510	1590	1480	1560	1620	1660	1410
Point Davis	880	940	1040	1210	1050	1160	1040	*1010
Bullhead Point	730	*680	*580	880	960	*660	*620	*870
Bay Point	290	410	430	420	590	500	460	300
O and A Ferry	20	42	54	92	152	75	71	51
	Sacramento River Delta							
Collinsville	17	17	15	*19	16	36	38	15
Emmaton	4	6	*8	*4	4	5	*6	6
	San Joaquin River Delta							
Antioch	8	11	12	15	9	17	14	14
Jersey	5	7	5		6		*6	8
	FEBRUARY							
	San Francisco, San Pablo & Suisun Bays							
Point Orient	1410	1500	1350	1380	1390	1530	1420	
Point Davis	950	820	720	*580	760	850	760	
Bullhead Point	980	*390	400	*300	*370	*420	340	
Bay Point	460	140	60	*152	206		*160	
O and A Ferry	16	9	6	*7	9	12	*10	
	Sacramento River Delta							
Collinsville	17	8	6	8	5	9	*8	
Emmaton	6	5	4	3	3	5	4	
	San Joaquin River Delta							
Antioch	12	8	6		9	8	*10	
Jersey	10	8		10	12	7	7	

(1) See note (1) Table 65.
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929[1]

Samples taken by local observers approximately one and one-half hours after high high tide.

Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	MARCH 2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1420	1530	1540	1350	1390	1450	1440	1460
Point Davis	750	1050	1140	*660		*740	*540	*610
Bullhead Point	670	*750	*620	490	350	*390	420	250
Bay Point	*200	430		*110	190	250	*160	150
O and A Ferry	74	16	7	8	7	8	*6	5
Sacramento River Delta								
Collinsville	9	8	5	6	8	6	*5	3
Emmaton	4	3	5	5	4	8	*5	4
San Joaquin River Delta								
Antioch	7	8	13	6	7	8	*11	5

Station	APRIL 2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1360	1530	1590		1470	1520	1410	1600
Point Davis	810	930	830		820		*810	*650
Bullhead Point	530	500	510	740	600	460	590	300
Bay Point	170	*260	290	290	*310	*180	*170	
O and A Ferry	31	*44	*22	23	*11	*9	*6	*12
Sacramento River Delta								
Collinsville	4	*9	*9	10	*4	*6	*6	2
Emmaton	2	*7	*6	5	*3	*4		
San Joaquin River Delta								
Antioch	4	*6	5	12	*9	7	10	3

(1) See note (1) Table 65.

* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)
Samples taken by local observers approximately one and one-half hours after high high tide.
Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	MAY							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1210	1550	1520	1540	1440	1550	1470	1560
Point Davis	590	*820	*740	800	710	*930	660	*810
Bullhead Point	*240	530	610	650	520	*340	430	710
Bay Point		*140	*108	*158	*104	*110	50	*250
O and A Ferry	*10	*17	*10	7	*6	*8	*10	*12
Sacramento River Delta								
Collinsville	*3	*4	*4	11	*5	*7	7	*5
Emmaton	*4	*3	*4	3		*6	3	*8
Three Mile Sl. Br.							4	*3
Rio Vista Bridge							*5	*3
Isleton Bridge							5	*4
Liberty Ferry							8	*5
Howard Ferry								*4
Walnut Grove								*3
Paintersville Br.							4	*4
Hood Ferry							4	*2
Freeport Ferry								*4
San Joaquin River Delta								
Antioch	5	5	10	6	2	2	2	*4
Jersey								*7
Webb Pump								*5
Holland Pump								*11
Orwood Bridge (2)							10	*12
Middle River P.O.							18	*14
Mansion House								*7
Mandeville Pump								*19
Rindge Pump								*9
Williams Bridge							7	*8

(1) See note (1) Table 65.
(2) Prior to June 14th samples were taken at Palm Tract (Orwood).
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)
Samples taken by local observers apporximately one and one-half hours after high high tide
Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	JUNE							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient		1610	1530	1500	1450	1390	1540	1510
Point Davis	970	*1030	*1140		940	840	780	780
Bullhead Point	520	1020	930	770	750	620	650	570
Bay Point	*138	*440	*400	550	410	350	250	
O and A Ferry	*38	*72	*57	65		*18		*54
Innisfail Ferry			200	180	*150	*140	73	96
Sacramento River Delta								
Collinsville	*4	*26	61	*28	*10	*4	8	*9
Emmaton	*5	*4	2	*6	*4	4	4	*11
Three Mile Sl. Br.	*3	4	2	*6	*8	*4	4	*9
Rio Vista Bridge	3	2	6	3	2	1	1	
Isleton Bridge	2	3	3	*4	5	4	6	9
Liberty Ferry	*2	*15	7	*9	*9	3	5	*5
Howard Ferry	3	*3	2		*4	*2	4	*4
Sutter Slough	*4	*4	*3	*4	*4	*6	3	*6
Little Holland Ferry	*4	*2	7	*3		2		*4
Walnut Grove			3	3	3	2	3	5
Paintersville Br.	4	4	3	4	3	5	6	5
Hood Ferry	*5	*5	3	*2	3	3	4	*3
Freeport Ferry		*2	3	*4		5	4	*4
Sacramento	1	2	3	4	2	3	5	2
Mokelumne River Delta								
S. W. Pt.	*4	*4	4	*4	*8			*5
Camp 33	*9	*3	4	*4	*2	3		*6
Tyler Island Ferry	*3	2	3	*7	*2	*2	3	*5
Camp 11	*3	*7	2	4	2	3		5
Camp 29 (Terminous)	*3	*3	3	*5	*4	3		*4
Camp 25				*7	*2	2		*3
New Hope Bridge	*2	*3	2	*2	*1	1		*4
Camp 20	*7	*4	4	*9	*2	1		*2

(1) See Note (1) Table 65.
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Station	JUNE (CONTINUED)							
	2	6	10	14	18	22	26	30
				San Joaquin River Delta				
Antioch	5	22	33	*16	15	12	11	14
Jersey		*9	12	7	*9	*9	11	*7
Twitchell Is. Pump		4	7	5	5	5	5	6
Webb Pump	*6	4	4	*16	6	5	8	14
Holland Pump	*12	*15	11	*15	*11	11	10	10
Central Landing	6	*5	*2	5	6	6	*6	*5
East Contra Costa I.D			*7	8	7	7	8	7
Orwood Bridge (2)	*12	*11	10	8	8	*9	4	*10
Middle River P.O.	12	*7	5	*9	*13	11	6	*8
Mansion House	5	*7	8	*7	*7	*7	10	*7
Ward Landing			7	11	*10	10	9	11
Drexler Bridge				*7	*7	*15	8	*12
Camp 3½ (King Is.)	*10	*11	*8	8	7	3	7	*10
Mandeville Pump	*12	*11	10	*13	*11	9	9	*12
Clifton Court Ferry	*5	4	5	*6	*7	9	6	*7
Rindge Pump	*11	*14	11	*12	15	15	9	13
Williams Bridge	*6	5	4	*7	8	14	9	*9
Stockton Cy. Cl.	*13	13	10		*16	8	12	*16
Stockton	*106	86	76	*76	64	67	*71	94
Mossdale Bridge	*7	*7	6	5	5	*6	12	11

(1) See note (1) Table 65.
(2) Prior to June 14th samples were taken at Palm Tract (Orwood).
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Samples taken by local observers approximately one and one-half hours after high high tide.

Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	JULY							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1600	1680	*1640	1660	1780	1200	1620	1640
Point Davis	*980		*1380	1160	1360	900	1320	1340
Bullhead Point	990	1030	1040	970	960	840	1180	1260
Bay Point		880	830	770	480	1020	840	1110
O and A Ferry	*74	442	370	350		*450	500	580
Innisfail Ferry	*150	*225	380	370	360	*540	460	580
Sacramento River Delta								
Collinsville	*18	*152	300	*200		*220	360	*280
Emmaton	*4		37	*14	36	*28	*77	*100
Three Mile Sl. Br.	*6	*9	19	*9	*20	36	37	100
Rio Vista Bridge	4	6	2	3	6	3	4	7
Isleton Bridge	6	2	7	2	3	2	3	3
Liberty Ferry	*8	2		*6	*6	14	2	
Howard Ferry	*3	*3	3	*7	*6	4	3	
Sutter Slough	*6	*9	6			6	5	4
Little Holland Fy.	*6	7	7	*9	*11	4	4	*6
Walnut Grove	6	7	3	3	8	2	3	*3
Paintersville Br.	5	7	2	3	9	6	4	4
Hood Ferry	*7	2	10	*10	7	7	4	*3
Freeport Ferry	5		8	*7	6	4	4	3
Sacramento	8	3	3	3	3	2	3	3
Mokelumne River Delta								
S.W.Pt.	*5	*7	4	*8	*6	4	*4	*4
Camp 33	*3	*6	4	*3	*8	4	*3	*4
Tyler Island Ferry	*5	4	6	*6	*6	9	*6	*4
Camp 11	*4	5	2	5	3	4	2	3
Camp 29 (Terminous)	*4	*11	3	4	*8	5	*5	*5
Camp 25	*3	*5	3	*4	6	5	*6	*7
New Hope Bridge	*3	6	2	*1	*6	3	*2	*2
Camp 20	*4	*4	4	*5	*8	5	*5	*7

(1) See note (1) Table 65.

* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Station	JULY (CONTINUED)							
	2	6	10	14	18	22	26	30
				San Joaquin River Delta				
Antioch	36	164	190	*100	240	260	280	370
Jersey	*7	*10	26	*12	89	*40	35	*36
Twitchell Is. Pump	9	9	9	8	18	25	17	11
Webb Pump	14	6	13	8	10			12
Holland Pump	13	15	9	10	14	15	8	12
Central Landing	7	5	6	6	*9	*4	5	*6
East Contra Costa I.D.	9	8	11	13	12	8	8	10
Orwood Bridge (2)	10	11	9	13	12	9	8	7
Middle River P.O.	*12	*11	11	*12	*11	10	*14	*9
Mansion House	*11	*7	10	*10	12	8	*14	
Ward Landing		6	9	*13	*10	8	*7	
Drexler Bridge	*12	8	12	*14	15	13	*11	*8
Camp 3½ (King Is.)	*7	*13	9	*11	10		*9	*10
Mandeville Pump	*11	10	20		13	12	*10	*9
Clifton Court Ferry	6	9	9	*9	12	14	*8	*8
Rindge Pump			15	19	21	16	20	23
Williams Bridge	8	9	8	12	12	11	9	10
Stockton Cy. Club	*20	18	19	*27		21	*26	*31
Stockton	92	80	150	150	220	120	180	100
Mossdale Bridge		10		12		16	11	11

(1) See note (1) Table 65.

* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)
Samples taken by local observers approximately one and one-half hours after high high tide
Salinity expressed in parts of chlorine per 100,000 parts of water

Station	AUGUST							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1700	*1720	1720	1740	1720	1760	1720	1660
Point Davis	1460	*1460	1400	*1520	*1400	1600	*1480	1660
Bullhead Point	1300	1180	1320	1220	1100	1340	1240	1360
Bay Point	1100	1160	1040	*880	1040	1140	1080	1240
O and A Ferry	640	*540	660	800	720	640	820	830
Innisfail Ferry	*610	*720	740	*720	700	760	770	*780
Sacramento River Delta								
Collinsville	*390	*470	600		580		*440	*540
Emmaton	*96	*138	198	*142	*172	*204	232	202
Three Mile Sl. Br.	*84	114	130	*126	*124	142	*88	168
Rio Vista Bridge	10	17	15	23	29	35	40	57
Isleton Bridge	4	*3	5	7	5	6	8	13
Liberty Ferry	*6	*4	*5	*7	*6	7	4	
Howard Ferry		*4	3	*5	*4	*3	4	*4
Sutter Slough	*3	*3	11	*5	*3			
Little Holland Fy.	*4	*4	*4	*4	*4	4	*5	*4
Walnut Grove		*4	*4	4	*3	4	4	4
Paintersville Br.	4	*3	*4	*4	*7	4	4	4
Hood Ferry				*4	*5	3	4	*4
Freeport Ferry	3	6	*4	*4	3	4		3
Sacramento	3	*3	3	3	*3	3	*5	*3
Mokelumne River Delta								
S.W.Pt.	*5	7	*6	*5	7	7	*5	*5
Camp 33	*4	4		*4	4	4		*4
Tyler Island Ferry	*3	*5	*4	*3	*3	4	*4	*4
Camp 11	3	4	4	4	4	4	4	*5
Camp 29 (Terminous)	*5	5	*5	*5	3	5	*5	*5
Camp 25	*6	5	*6	*6	5	5	*6	*6
New Hope Bridge	*2	5	*4	*3	*4	5	*4	*4
Camp 20	*7	8	*7	*5	6	5	*6	*6

(1) See note (1) Table 65.

* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Station	AUGUST (CONTINUED)							
	2	6	10	14	18	22	26	30
				San Joaquin River Delta				
Antioch	380	*350	380	530	500	540	520	580
Jersey	*58	*174		*104	*100	224	240	*175
Twitchell Is. Pump	29	48	40	43	76	77	58	44
Webb Pump	29	*16	43	45	46	56	61	80
Holland Pump	14	17	21	27	26	31	33	39
Central Landing	8	*8	8	8	14	*12	12	20
East Contra Costa I.D.	10	*12	9	10	11	9	9	10
Orwood Bridge	8	*12	9	12	10	11	12	14
Middle River P.O.	*10	*11	*9	*12	*10	14	*11	*12
Mansion House	*15	*9	*12	*14	*9	9	*10	*12
Ward Landing	9	*9	*8	*11	*12	17	*14	*16
Drexler Bridge	9	*10	*11	*10	*11	12	*10	*11
Camp 3½ (King Is.)		*8						
Mandeville Pump	*11	11	*12	11	13	13	*14	*17
Clifton Court Ferry	11	*11	*11	*11	*23	10	*11	10
Rindge Pump	21	*26	20	*25	22	*30	28	*22
Williams Bridge	10	9	12	12	*9	11	*9	
Stockton Cy. Club	*32		*29	*36	*32		*32	*30
Stockton	120	*130	160	90	*200	120	130	115
Mossdale Bridge	*13	10	*8	*11	10	12	12	*10

(1) See note (1) Table 65.
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Samples taken by local observers approximately one and one-half hours after high high tide.

Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	SEPTEMBER							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1770	1760	1740	1730	1810	*1770	1830	*1750
Point Davis	1520	1580	1460	1500	1550	1510	1540	1540
Bullhead Point	1340	1370	1210	1200	1280	1350	1320	1220
Bay Point		1100	1070	1080	1160	1130	1070	1050
O and A Ferry	720	740	750	800	630	690	700	*560
Innisfail Ferry	840	850	850	830	870	860	844	*820
Sacramento River Delta								
Collinsville	680	590	*510	*580	550	530	*440	*420
Emmaton	*255	310	*180	*130	280	*165	*140	
Three Mile Sl. Br.	*160	205	*80		160	130	120	*100
Rio Vista Bridge	67	40	49	47	21	12	15	5
Isleton Bridge	5	6	5	4	3	3	2	*2
Liberty Ferry	5	7	*4	*4	4	4	*3	*2
Howard Ferry	*5	4	4	*3	3		*2	2
Sutter Slough			NO OBSERVATIONS					
Little Holland Ferry	4	4	*3	*3	3	3	*3	*3
Walnut Grove	4	4	3	3	3	2	2	*3
Paintersville Br.	3	4	3	3	3	2	2	
Hood Ferry	3	4	4	3	2	2	*2	*2
Freeport Ferry	3							
Sacramento	3	2	2	2	3	2	1	2
Mokelumne River Delta								
S.W.Pt.	9	*7	*4	*4	5	*5	*2	*3
Camp 33	5	*5	*5	*4	5	*4	*3	*3
Tyler Island Ferry	4	4	*3		3	3	*2	4
Camp 11	5	5	5	6	6	7	6	5
Camp 29 (Terminous)	6	*6	*6	*6	5	*5	*5	*5
Camp 25	6	*5	*6	*7	7	*6	*6	*6
New Hope Bridge	5	*4	*4	*5	5	*6	*6	*5
Camp 20	6	*6	*6	*7	7	*7	*7	*8

(1) See note (1) Table 65.
* Sample taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Station	SEPTEMBER (CONTINUED)							
	2	6	10	14	18	22	26	30
				San Joaquin River Delta				
Antioch	555	550	510	500	480	490	420	440
Jersey	365	*220	*185	285	*185	250	*175	*140
Twitchell Is. Pump	115	98	44	47	82	73	36	*46
Webb Pump	39	54	67	44	43	60	51	
Holland Pump	39	38	37	39	40	42	42	36
Central Landing	19	16	10	20	14	9	10	
East Contra Costa I.D.	11	13	12	13	16	14	15	13
Orwood Bridge	13	15	15	17	18	19	14	17
Middle River P.O.	*13	*13			17	17	*17	*17
Mansion House	15	*12	*12		16	15	*15	*14
Ward Landing	19	*18	*19	21	22	*22	23	*22
Drexler Bridge	12	12	*11	13	13	15	*12	*11
Camp 3½ (King Is.)				*13	14	15	*16	
Mandeville Pump	19	*19	*20	*21	22	*22	*25	*23
Clifton Court Ferry	12	*10	*9	9	8	*7	*7	*7
Rindge Pump		24	27	23	20	18	17	15
Williams Bridge	10	10	*6	6	5	4	*4	4
Stockton Cy. Club.	29	*29	*23		17		*15	
Stockton	105	125	130	90	100	115	105	
Mossdale Bridge	9	*6	*5	5	5	*5	*4	

(1) See note (1) Table 65.
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Samples taken by local observers approximately one and one-half hours after high high tide.

Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	OCTOBER							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1750	1760	1740	1770	1740		1720	
Point Davis	1510	1550	1380	1430	1440	1410	1500	1400
Bullhead Point	1230	1310	1110	1060	1170	1290	1090	1120
Bay Point	970	1050		960	890	890	860	830
O and A Ferry	660	650	470	500	540	540	450	420
Innisfail Ferry	780	810		680	690	660	680	
Sacramento River Delta								
Collinsville	410	*380	*340	320	390	*245	255	210
Emmaton	110	*80	*65	60	50	69	31	21
Three Mile Sl. Br.	41	*55	31	20	20	24	16	15
Rio Vista Bridge	3	3	3	2	2	2	3	2
Isleton Bridge	2	2	2	2	3	2	2	2
Liberty Ferry	3	2	*2	3	3	2	*2	3
Howard Ferry		2	2	2	1	2	*2	2
Sutter Slough						*2		
Little Holland Fy.	3	3	*2	3	3	2	2	2
Walnut Grove	2	2	2	2	2	2	2	3
Paintersville Br.	2	2	2	3	2	2	2	3
Hood Ferry	2	2	*2	2	2	2	2	1
Freeport Ferry						*2		
Sacramento	2	5	2	2	2	2	1	2
Mokelumne River Delta								
S.W.Pt.	*3	*3	*3	2	*3	*3	*3	
Camp 33	*3	*3	*3	3	*3	2	*3	
Tyler Island Ferry	2		*3	3	2	2	*3	2
Camp 11	6	6	6	5	6	4	5	
Camp 29 (Terminous)	*5	*4	*4	4	*4	*5	*5	
Camp 25	*6	*6	*6	6	*8	*7	*7	
New Hope Bridge	5	*5	*6	6	6	*6	*6	
Camp 20	*6	*7	*7	7	*8	7	*8	

(1) See note (1) Table 65.
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINTTY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Station	OCTOBER (CONTINUED)							
	2	6	10	14	18	22	26	30
	San Joaquin River Delta							
Antioch	365	410	280	230	280	290	235	191
Jersey	170	155	95	69	59	*34	*48	60
Twitchell Island Pp.	34	42	22	21	22	19	16	14
Webb Pump	40	37		24	24	21		18
Holland Pump	36	37	28	29	28	27	24	23
Central Landing	9	10	7	7	9	*7	*7	6
East Contra Costa I.D.	15	12	12	11	10	10	10	11
Orwood Bridge	16	16	14	12	13	13	13	12
Middle River P.O.	*17	18	*17	17	16	*14	*13	15
Mansion House	12	11	*12	10	11	*11		
Ward Landing	21	*21	*21		20	18		19
Drexler Bridge	12	11	9	9	9	11	*9	9
Camp 3½ (King Is.)	16			16	16	*15		
Mandeville Pump	25			20	20			19
Clifton Court Ferry	5	*5	*6	6	7	5	6	*7
Rindge Pump		16	16	16	17	16	18	19
Williams Bridge	7	5	*5	*6	6	6	*7	7
Stockton Cy. Club		14	*13	16		17		
Stockton	91	86	90	88	106	86	107	92
Mossdale Bridge	*5	*5	*7	6	6	*6	*7	7

(1) See note (1) Table 65.
* Samples taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)
Samples taken by local observers approximately one and one-half hours after high high tide.
Salinity expressed in parts of chlorine per 100,000 parts of water.

Station	NOVEMBER							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	1770	1740	1620	1690	1730	1730	1760	1730
Point Davis	1330	1430	1350	1380	1510		1350	1390
Bull head Point	1140	1070	1050	1070	1250	1140	1140	1140
Bay Point	860	860		770	950	*800	840	
O and A Ferry	450	480	440	520		450	390	360
Innisfail Ferry	670	640	610	590	550	590	580	570
Sacramento River Delta								
Collinsville	240	280	270	255		285	285	430
Emmaton	54	*15	10		40	*17	23	25
Three Mile Sl. Br.	15	16	10	7	9		15	15
Rio Vista Bridge	2	2	2	2	2	3	2	3
Liberty Ferry	2	3	2	2	3	2	2	
Walnut Grove	3	2	2	2	2	3	2	2
Sacramento	2	2	2	1	2	2	2	1
Mokelumne River Delta								
New Hope Bridge	*6	*2	1	2	*2	*3	2	*2
San Joaquin River Delta								
Antioch	204	200	170	145	240	200	210	255
Jersey	80	46	20	30	63		44	55
Twitchell Island Pp.	16	14	11	11	12	12	12	13
Webb Pump	13	15	13	13	12	14	13	12
Holland Pump	22	20	18	17	18	16	15	15
Central Landing	5		3	4	4	*5	5	5
East Contra Costa I.D.	10	9	12	9	9	9	11	11
Ward Landing	17	17	17	*15	15	*15	16	
Drexler Bridge	11	9	11	8	8	*8	10	12
Rindge Pump	17	18	18	18	18	19	18	18
Stockton Cy. Club	*16	*20					18	
Stockton	105	103	98	105	71		81	90
Mossdale Bridge	*7	*7	7	8	*8	*7	8	7

(1) See note (1) Table 65.
* Sample taken at low high tide.

TABLE 66 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1929(1)

Samples taken by local observers approximately one and one-half hours after high high tide

Salinity expressed in parts of chlorine per 100,000 parts of water

Station	DECEMBER							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient		1700	1660		1420	1430	1220	1330
Point Davis	1360	1280	1290	1220		500	600	830
Bullhead Point	1120	1050	1240	860	250	38	380	560
Bay Point	890	700	920	520	32	8		221
O and A Ferry	400		380	140	11	4	4	21
Innisfail Ferry	610	570	560	400	140	93	64	36
Sacramento River Delta								
Collinsville	320	*195	250	48	2	2		4
Emmaton	33		32	5	1		2	2
Three Mile Sl. Br.	*16	*9	8	2	1	1	3	4
Rio Vista Bridge	2	2	2	1		1	1	1
Liberty Ferry		2	2	3				
Walnut Grove	2		2	1	1	1	1	
Sacramento	2	2	1	1	1	1	1	1
Mokelumne River Delta								
New Hope Bridge	*2	*2	2	*1				
San Joaquin River Delta								
Antioch	230	180	230	60	9	5	4	5
Jersey	65	46	57		7	6		5
Twitchell Is. Pump	12	10	*9	7	3	4	3	5
Webb Pump	11	11	11	10				
Holland Pump	15	14	13	13	12	12	11	11
Central Landing	*4	*4	2	2		2	2	*4
East Contra Costa I.D.	15	12	11	10	10		11	11
Ward Landing					13			
Drexler Bridge	11	10	9	10	9	9	8	9
Rindge Pump	18	17	19	15	20	21	18	18
Stockton Cy. Club		*17	17	15	*23	17	17	*17
Stockton	122	99		59	86			
Mossdale Bridge	7	*8	8	8	10	9	8	9

(1) See note (1) Table 65.

* Sample taken at low high tide.