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EDWARD HYATT, State Engineer

Bulletin 23

SACRAMENTO-SAN JOAQUIN

WATER SUPERVISOR'S REPORT

FOR YEAR

1931

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CHAPTER VII

SALINITY

Purpose

As outlined in previous reports, the purpose of the salinity investigation has been to record the occurrence and extent of the encroachment of salinity from San Francisco Bay and to establish the relation between movement of salinity, stream flow to the Delta and tidal action. With the recent completion of the special salinity investigation begun in 1929 as a part of the State Water Resources Investigation, this relation has been established for the conditions which obtained during the period of the investigation, and the results of this study and analysis are presented in Bulletin No. 27, "Variation and Control of Salinity in Sacramento-San Joaquin Delta and Upper San Francisco Bay". Although the relation sought has thus been established there are certain considerations pointing to the desirability and importance of a continuation of the salinity, tidal and stream flow records. The utilization of the established relation lies chiefly in the present determination of the amount of stored water needed for salinity control and, when that storage shall have been provided, in the determination of its proper release to effect the desired control. Obviously when control by means of storage releases becomes operative, records showing the variation of the salinity will be essential. But most essential also appears to be the requirement that in the meantime there shall have been maintained an unbroken record of the salinity, tidal and stream flow variations. Such a record will be required not only in the corroboration of the relation

as at present established, but as the basis for a check of possible modifications of the relation due to changes in channel and tidal conditions which may or will have taken place.

In view of these considerations then, and an additional one of especial significance in 1931, - the necessity of keeping the Delta water users advised as to salinity conditions - the salinity investigation has continued in 1931 to the extent of maintaining complete records at all salinity and tide gage stations, and it is contemplated that this program will be continued in the future.

1931 Scope

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 Upper Bay region that the advance and retreat of the salinity from early Summer to late Fall would be completely recorded. In 1931 the Summer stream flow to the Delta was the lowest of record and correspondingly this year witnessed the highest salinity encroachment of record. This is indicated on Plate 6 which shows the limit of encroachment into the Delta of salinity of 100 parts of chlorine per 100,000 parts of water in the years 1920 to 1931, inclusive. Sixty-five stations were established and maintained in order to completely record the 1931 salinity, and samples were received from an average of sixty stations throughout the period from July to November. Nineteen stations are maintained permanently throughout the year as are also seven stations at which drainage water is sampled. The work in 1931 included also the regular maintenance of tide gagos, the edition of salinity bulletins,

and many special investigations of the salinity in local areas.

Station Maintenance and Records

As in the past, the salinity sampling at all regular stations was done by local observers. Each observer was provided with a schedule showing the exact time for taking the samples so that, throughout the Delta at four-day intervals, all samples would be taken at approximately one and one-half hours after the same high tide. The observers were furnished with stamped containers for the sample bottles so that the latter could be mailed as filled to the laboratory at Sacramento. All testing was done at the chemical laboratory of the Division of Highways. The record of the tests of all samples taken at the regular stations in 1931 is given in Table 90, and Table 89 gives the location and description of each station.

In connection with the investigation of losses in the Delta due to salinity in 1931 (see Chapter VIII) it was necessary to know the salinity on a given date at locations other than the regular sampling stations. To supply this information, a series of Delta maps were prepared showing, for the first of each month May to December inclusive, lines of equal salinity at intervals of 50 parts of chlorine per 100,000 parts of water. These lines were derived from the plotted tests of the samples taken at the first of the month at the regular stations. These maps, when combined as shown on Plate 7, furnish a graphic picturization of the encroachment and retreat of the salinity in the period May to December, 1931.

The maximum salinity as recorded at the stations operated in 1931 is shown in Table 85. For comparative purposes, this table shows

also the maximum salinity recorded at these stations in previous years beginning with 1924. A comparison of the Summer stream flow to the Delta in 1931 and the corresponding salinity at certain of the lower Delta stations is shown on Plate 9.

Salinity Bulletins

With the unusually early encroachment of salinity in the 1931 season, water users throughout the Delta were anxious to obtain the results of the tests in order that their irrigation operations might be governed to prevent the use of water of injurious salinity content. In the period from May 1st to November 15th therefore, bulletins reporting the salinity at the various stations were mailed to a large list of Delta water users at weekly or ten-day intervals. This service as well as that in testing many samples taken at points other than the regular stations, was in great demand and was probably instrumental to a considerable extent in reducing or preventing damage from the use of water of too high salinity.

Upper Limits of Sacramento River Salinity

By the middle of July salinity was advancing up the Sacramento River at a very rapid rate and it was desired to obtain a closer definition of its upstream limits and distribution than would have been given by the tests of the samples taken at four-day intervals at the regular stations between Paintersville Bridge and Sacramento. In the period from July 19th to August 15th, therefore, nine sampling "traverses" of the river were made by launch. On each traverse sampling was begun at Paintersville Bridge at one and one-half hours after high tide and, following this phase of the tide upstream as far as Sacramento, samples

were taken at short distance intervals along the entire traverse. The tests for each traverse furnished a "profile" which showed the progressive upstream decrease in salinity and defined the upstream limit of the encroachment. These traverses are shown on Plate 8. It will be noted that the greatest advance of salinity in the lowest three mile section is indicated by the traverse of August 11th but that the greatest advance in the vicinity of Hood Ferry is shown by the traverse of July 28th. The upstream limit of the encroachment is indicated by the traverses to have been about two miles above Hood Ferry. Above this point there was some variation between zero and about ten parts of chlorine but this was apparently the normal salinity content of the river flow passing Sacramento (practically all return water) and was not a result of the encroachment from San Francisco Bay.

Mokelumne Delta Investigation

Through a cooperation between Mokelumne River Delta water users, Woodbridge Irrigation District, East Bay Municipal Utility District, and the Pacific Gas and Electric Company, arrangements were made for the release of stored water in July and August, 1931, in order to retard the encroachment of salinity into the Mokelumne Delta. It was requested by Mokelumne Delta water users that the salinity sampling be planned so as to follow up and check the results of these releases. In addition to furnishing this requested service, it appeared that under the operation of the plan for salinity control by storage releases, the more extended sampling should furnish interesting and valuable data on the relation between stream flow and salinity in this particular area of the Delta. Arrangements were accordingly made for a more

detailed investigation of the salinity in the Mokelumne Delta than would otherwise have been conducted.

The release of stored water was started on July 23d and on the same date daily sampling was begun at the various Mokelumne Delta salinity stations. The releases were continued in varying amounts until August 22d and the daily sampling was maintained until September 15th. Before and after the period of the releases, the sampling was maintained at the regular four-day intervals. The results of the sampling at the Mokelumne Delta stations during the period from July 1st to October 1st are shown in Table 86.

Comparisons of Mokelumne River discharge and the salinity at Mokelumne Delta stations during the months of July, August, and September, are shown on Plates 10, 11, and 12. It was thought that the retardation or repulsion of salinity in the South Fork (East side of Staten Island) might be more efficiently accomplished by an increase in the flow entering this fork through Beaver and Sycamore Sloughs. Accordingly, a small portion of the released storage was diverted via Woodbridge Irrigation District canals to these sloughs and thence to the South Fork. No record was obtained to show the division of the main river discharge to the North and South Forks. The discharge of the North Fork only would have been effective in the control of salinity at stations along this fork, but lacking the segregation of flow to the north and south forks, the river discharge as measured below the Woodbridge dam was plotted on Plate 10 for comparison with the salinity at the North Fork stations. The salinity stations at Staten Island Camps 20 and 25 are located on the South Fork between Beaver and Sycamore Sloughs. To show, then, the influence of the

stream flow on the salinity at these stations the Mokelumne River discharge below Woodbridge Dam plus the inflow to the South Fork from Beaver Slough was plotted on Plate 11. For the South Fork stations below Sycamore Slough, Plate 12 compares the salinity to the combined discharge of the Mokelumne River below Woodbridge Dam and Beaver and Sycamore Sloughs.

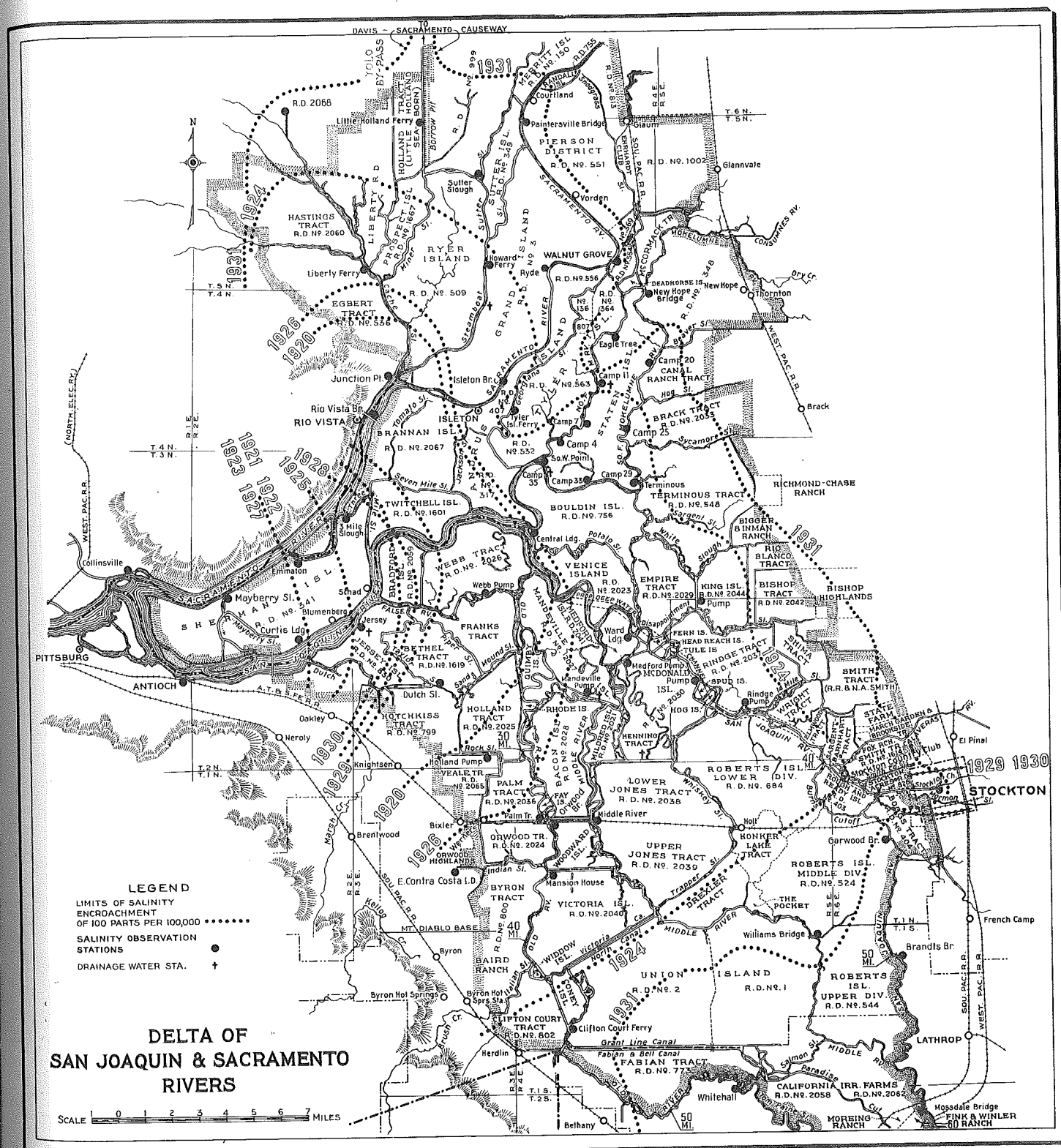
No detailed analysis has been completed to establish the relation between stream flow, salinity and tidal action, that might be derived from these records. Inspection of Plates 10, 11, and 12 would indicate that the increased stream flow was apparently of little benefit below Camp 7 on the North Fork and below Camp 29 on the South Fork. At upper stations, however, the marked increase in the salinity coincident with the stopping of the storage releases indicates that during August the salinity was quite effectively checked and that considerable benefit must undoubtedly have been derived from the release of the stored water.

At the lower stations, with the mean salinity for a tidal cycle at approximately 100 parts of chlorine per 100,000 parts of water, some irrigation could be carried on during low tide periods when the salinity was below 100 parts. As an aid to the water users in determining from the regular high tide salinity tests what the corresponding low tide salinities would be, two sets of observations covering a tidal cycle were made at Staten Island stations, one at Camp 7 August 15-16, and the other at Camp 29 August 20-21st. The variation of salinity with the tide as found by these observations is shown in Table 87. Further special observations were made at Staten Island Camps 7 and 29 to show the variation of salinity with depth

and the results of these tests are shown in Table 88.

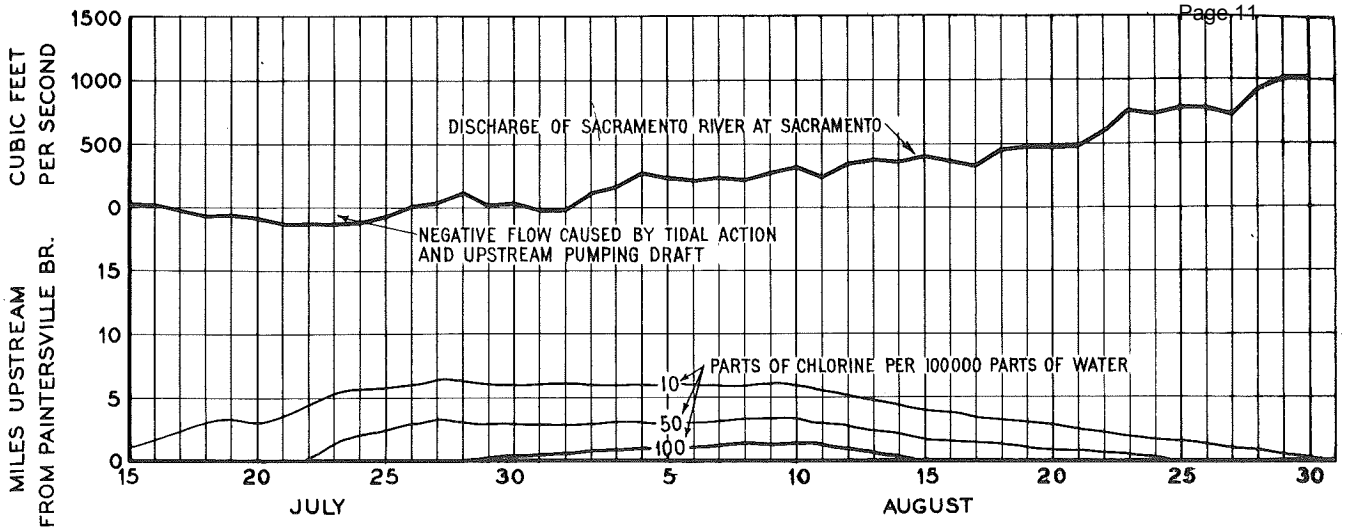
Tide Gages

In the analysis of the relation between salinity, stream flow and tidal action as presented in Bulletin No. 27, the comprehensive information covering the tidal variations throughout the Delta as obtained from the records of the tide gages was important and essential. If, then, a further such analysis under subsequent salinity, stream flow and tidal conditions is to be made, the tide gage records will be indispensible. In conjunction, therefore, with the continued salinity sampling in 1931, the operation of the recording tide gages at upper bay and delta stations has been maintained. Of the stations which supplied data used in the investigation for Bulletin No. 27, four are being maintained by the U. S. Army Engineers, one each by U. S. Coast and Geodetic Survey, U. S. Navy, East Contra Costa Irrigation District and Staten Island Land Company and the remaining stations, eight in number, are being maintained by the Water Supervisor. The latter are located at Sacramento, Walnut Grove, San Joaquin end of Georgiana Slough, Sacramento and San Joaquin ends of Three Mile Slough, Antioch, Collinsville, and Mossdale Bridge (San Joaquin River).



MAXIMUM SEASONAL SALINITY ENCROACHMENT OF 100 PARTS OF CHLORINE PER 100,000 PARTS OF WATER, SACRAMENTO-SAN JOAQUIN DELTA, 1920-1931

PLATE 6


CUBIC FEET PER SECOND
MILES UPSTREAM FROM PAINTERSVILLE BR.
1500
1000
500
0
15
10
5
0
DISCHARGE OF SACRAMENTO RIVER AT SACRAMENTO
NEGATIVE FLOW CAUSED BY TIDAL ACTION AND UPSTREAM PUMPING DRAFT
PARTS OF CHLORINE PER 100000 PARTS OF WATER
10
50
100
15
20
25
30
5
10
15
20
25
30
JULY
AUGUST

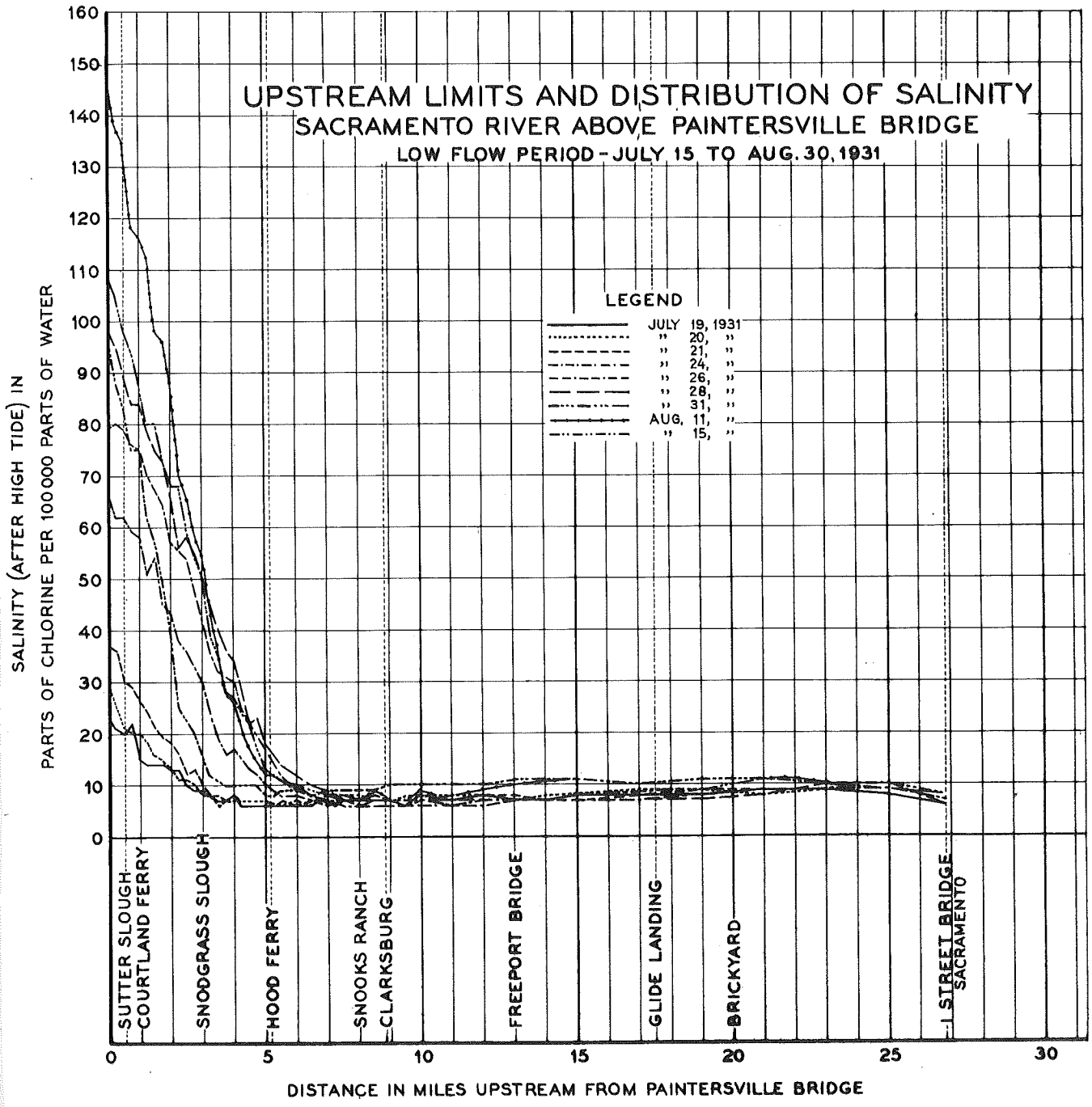
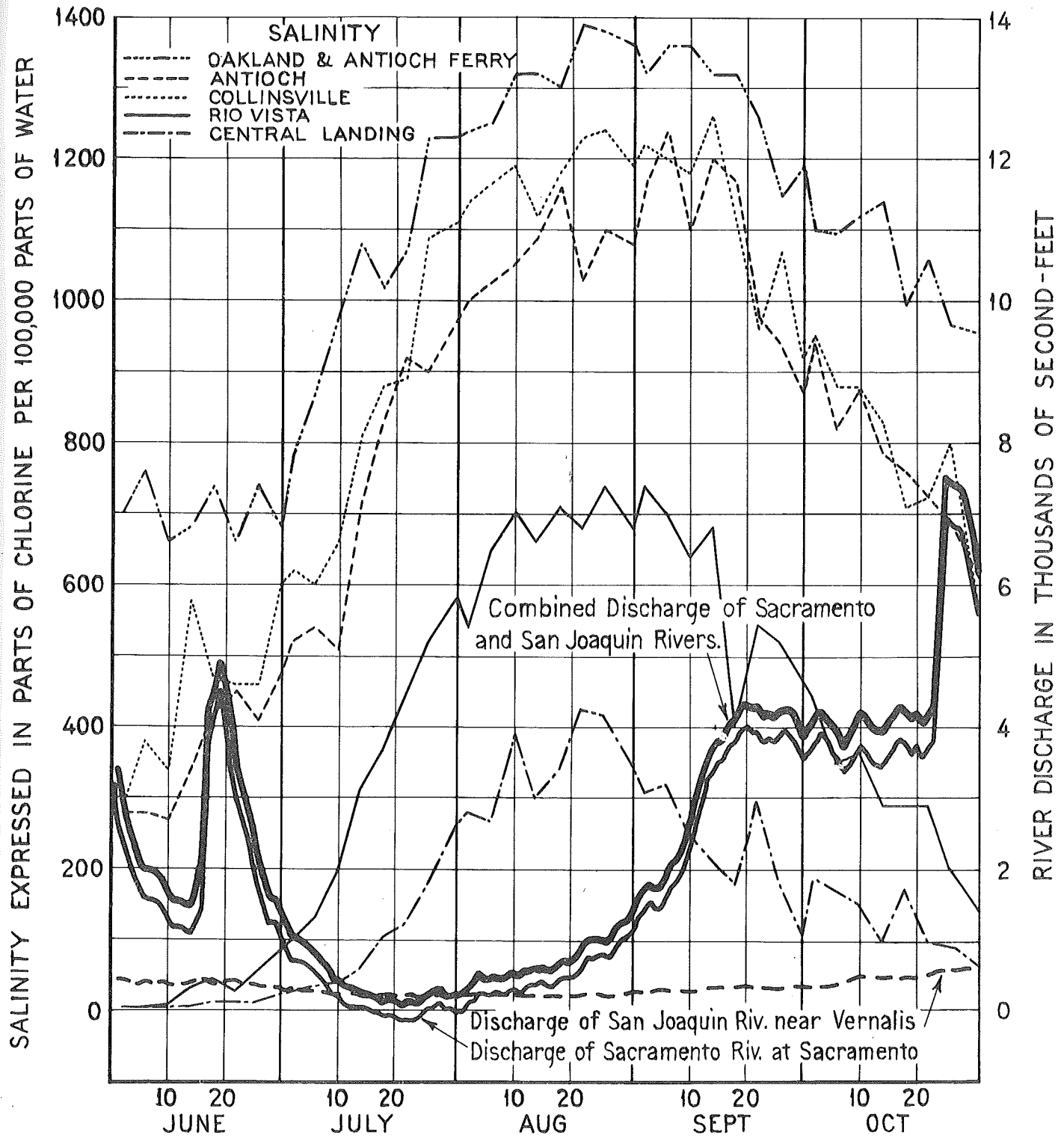

UPSTREAM LIMITS AND DISTRIBUTION OF SALINITY
SACRAMENTO RIVER ABOVE PAINTERSVILLE BRIDGE
LOW FLOW PERIOD - JULY 15 TO AUG. 30, 1931
SALINITY (AFTER HIGH TIDE) IN PARTS OF CHLORINE PER 100000 PARTS OF WATER
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
LEGEND
JULY 19, 1931
" 20, "
" 21, "
" 24, "
" 26, "
" 28, "
" 31, "
AUG. 11, "
" 15, "
SUTTER SLOUGH
COURTLAND FERRY
SNODGRASS SLOUGH
HOOD FERRY
SNOOKS RANCH
CLARKSBURG
FREEPORT BRIDGE
GLIDE LANDING
BRICKYARD
I STREET BRIDGE SACRAMENTO
0
5
10
15
20
25
30
DISTANCE IN MILES UPSTREAM FROM PAINTERSVILLE BRIDGE

PLATE 8



COMPARISON OF RIVER DISCHARGE AND SALINITY AT BAY AND DELTA STATIONS 1931

PLATE 9

TABLE 85

MAXIMUM RECORDED SALINITY AT BAY AND DELTA STATIONS
1924 TO 1931, INCLUSIVE

YEAR	1924		1925		1926		1927		1928		1929		1930		1931	
SEASONAL RUN-OFF TO SAN FRANCISCO BAY IN PER CENT OF NORMAL*	28		83		57		114		80		42		63		29	
STATION (1)	MAXIMUM RECORDED SALINITY IN PARTS OF CHLORINE PER 100,000 AND DATE OF OCCURRENCE															
							SAN FRANCISCO, SAN PABLO AND SUISUN BAYS									
POINT ORIENT					9/30	2020	9/10	1880	7/31	1870	9/26	1830	9/10	1780	8/22	1870
POINT DAVIS					8/26	1850	8/26	1510	8/2	1610	8/30	1660	9/22	1620	8/14	1810
BULLS HEAD POINT					8/30	1690	9/2	1330	8/10	1410	9/6	1370	9/6	1380	8/27	1690
BAY POINT					8/23	1400	9/2	950	8/10	1170	9/6	1050	9/6	1060	8/26	1540
O AND A FERRY	8/28	1345	9/26	762	8/26	1100	8/30	510	8/22	750	8/30	830	8/14	800	8/22	1390
INNISFAIL FERRY											9/18	870	8/30	810	8/22	1400
							NORTH SAN PABLO BAY									
SONOMA CREEK BRIDGE											9/26	1600	9/26	1670	7/10	1660
GRANDVIEW													9/10	1610	8/26	1870
VALLEJO													9/10	1340	9/18	1700
CUTTINGS WHARF													9/18	1320	9/18	1800
							SACRAMENTO RIVER DELTA									
COLLINSVILLE	8/16	1150	9/6	448	9/6	1020	9/10	370	9/2	590	9/2	680	9/2	570	9/14	1260
EMMATON	8/6	802	9/4	136	8/22	540	8/30	65	8/22	156	9/6	310	9/10	250	9/2	1000
THREE MILE SLOUGH BRIDGE	8/30	692	9/6	81	8/26	430	9/10	25	9/2	109	9/6	205	9/10	150	9/2	860
RIO VISTA BRIDGE	8/12	608	9/2	21	8/30	256	9/26	12	8/30	44	9/3	67	8/22	52	8/26	740
JUNCTION POINT											9/6	17	8/10	26	9/2	620
LIBERTY FERRY	8/16	192	9/16	11	8/26	32			9/26	7	7/22	14	7/26	6	9/3	560
ISLETON BRIDGE	8/14	310	9/16	12	8/19	68			8/18	13	9/10	6	8/22	10	8/27	635
HOWARD FERRY	8/16	157			8/6	27					7/14	7			8/18	500
SUTTER SLOUGH	8/8	46									8/10	11			8/14	320
LITTLE HOLLAND FERRY	8/10	48									7/18	11			8/18	300
RYDE											7/18	9			8/3	280
R. D. 2068															9/22	280
WALNUT GROVE	8/10	42			8/19	15					7/18	8			8/14	220
PAINTERSVILLE BRIDGE	8/10	47			9/3	17					7/18	9			8/6	144
HOOD FERRY	8/10	46									7/14	10			7/26	18
FREEPORT BRIDGE	8/16	15									7/10	8			8/22	11
SACRAMENTO											7/2	8	8/2	5	8/26	10

* NORMAL TAKEN AS 40-YEAR MEAN (1889-1929) OF NATURAL RUN-OFF AT FOOTHILL STATIONS OF MAJOR STREAMS TRIBUTARY TO SAN FRANCISCO BAY.
(1) FOR LOCATION AND DESCRIPTION SEE TABLE 89.

TABLE 85 (CONTINUED)

MAXIMUM RECORDED SALINITY AT BAY AND DELTA STATIONS
1924 TO 1931, INCLUSIVE

YEAR	1924		1925		1926		1927		1928		1929		1930		1931	
SEASONAL RUN-OFF TO SAN FRANCISCO BAY IN PER CENT OF NORMAL *	28		83		57		114		80		42		63		29	
STATION (1)	MAXIMUM RECORDED 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	7/30	9	8/14	390
CAMP 4															8/14	265
CAMP 33					9/6	32			7/30	25	7/18	8	7/30	7	8/26	245
CAMP 7	8/30	113													9/10	230
TYLER ISLAND FERRY					8/2	19					7/22	9	7/30	9	8/14	200
CAMP 11	8/8	44			9/6	23					7/6	7			9/14	134
CAMP 29	9/26	96			9/2	25			8/30	16	7/6	11			9/10	182
EAGLE TREE															10/18	57
CAMP 25					9/14	24					7/30	7			9/14	164
NEW HOPE BRIDGE	9/24	110			9/10	17					7/18	6	7/10	2	10/26	64
CAMP 20					10/10	22					7/18	8			9/27	124
									SAN JOAQUIN RIVER DELTA							
ANTIOCH	8/20	1080	9/4	356	8/26	920	9/18	179	9/2	450	8/30	500	9/14	470	9/6	1240
CURTIS LANDING											9/10	450			8/27	1060
JERSEY	8/30	708	9/6	81	8/26	470	9/14	53	9/6	192	9/3	365	8/26	220	9/14	910
WEBB PUMP	9/6	414	9/4	24	8/14	147	9/10	16	8/30	46	8/31	80	8/30	61	9/2	680
CENTRAL LANDING	9/24	288	9/2	10	9/2	98			8/2	19	8/31	20	9/6	15	8/22	425
DUTCH SLOUGH															9/14	510
WARD LANDING											9/26	23	9/14	16	9/14	350
HOLLAND DAM															9/12	330
HOLLAND PUMP	10/4	308	9/22	18	9/2	148			10/10	34	9/22	42	8/26	23	9/26	325
MC DONALD PUMP											10/14	58			9/14	305
MANDEVILLE PUMP					9/30	84			8/2	25	9/26	25	9/14	17	9/10	350
KING ISLAND PUMP	10/2	164			9/28	48			10/12	19	9/26	16			9/22	261
RINDGE PUMP	9/16	126	9/2	35	9/14	50			9/30	28	8/26	28	8/2	16	9/18	198
ORWOOD BRIDGE					9/18	86			9/22	21	9/18	18	9/18	12	10/2	277
EAST CONTRA COSTA I. D.											9/18	16	11/26	17	10/22	200
MIDDLE RIVER P.O.	9/30	186	9/13	13	10/8	69			8/2	21	9/18	17	9/14	13	9/27	270
MANSION HOUSE	10/12	148	9/16	11	9/26	69			9/2	16	9/18	16	9/14	11	10/6	240
STOCKTON COUNTRY CLUB	9/16	108			8/30	48					8/14	36	8/6	18	9/14	122
CLIFTON COURT FERRY	10/2	80			8/30	24					8/18	23			9/18	130
STOCKTON											8/18	200	5/2	120	9/14	132
GARWOOD BRIDGE															9/10	92
BRANDT BRIDGE															8/14	43
WILLIAMS BRIDGE	9/4	42			9/2	18					7/14	12			9/2	118
WHITEHALL											7/14	15			9/2	31
MOSSDALE BRIDGE	9/3	14									7/22	16	7/30	10	7/6	12
DURHAM FERRY BRIDGE															7/10	10

* NORMAL TAKEN AS 40-YEAR MEAN (1889-1929) OF NATURAL RUN-OFF AT FOOTHILL STATIONS OF MAJOR STREAMS TRIBUTARY TO SAN FRANCISCO BAY.
(1) FOR LOCATION AND DESCRIPTION, SEE TABLE 89.

COMPARISON OF
RELEASED DISCHARGE AND SALINITY
MOKELUMNE DELTA 1931

DISCHARGE BELOW WOODBRIDGE
SALINITY AT NEW HOPE BRIDGE AND STATEN ISLAND NORTH FORK STATIONS, EAGLE TREE, CAMPS 11 AND 7 AND SOUTH WEST POINT

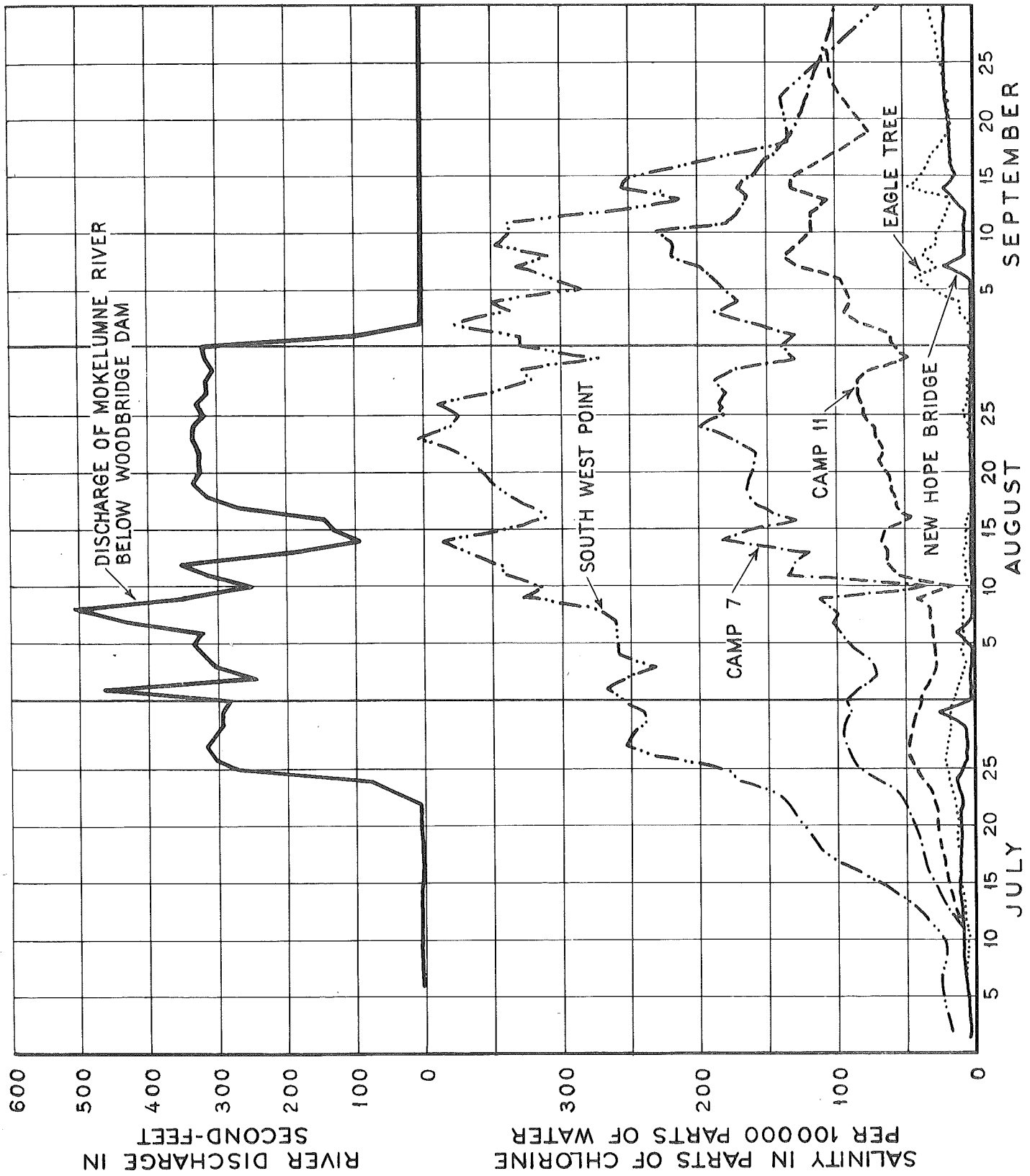


PLATE 10

COMPARISON OF
RELEASED DISCHARGE AND SALINITY
MOKELUMNE DELTA 1931

DISCHARGE BELOW WOODBRIDGE PLUS BEAVER SLOUGH
SALINITY AT STATEN ISLAND SOUTH FORK CAMPS 20 AND 25

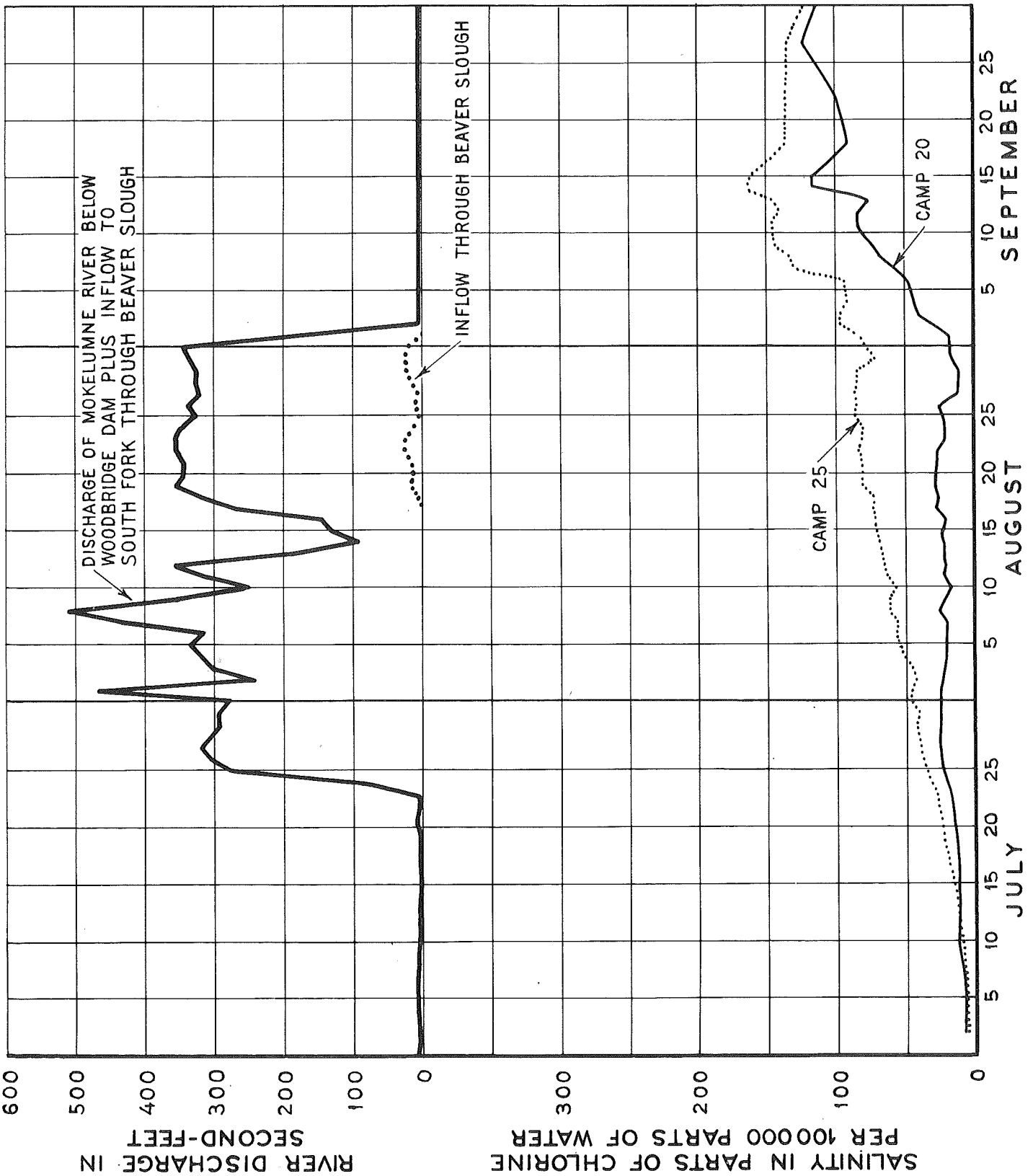


PLATE 11

COMPARISON OF

RELEASED DISCHARGE AND SALINITY

MOKELUMNE DELTA 1931

DISCHARGE BELOW WOODBRIDGE PLUS BEAVER AND SYCAMORE SLOUGHS
SALINITY AT CENTRAL LANDING AND
STATEN ISLAND SOUTH FORK CAMPS 33 AND 29

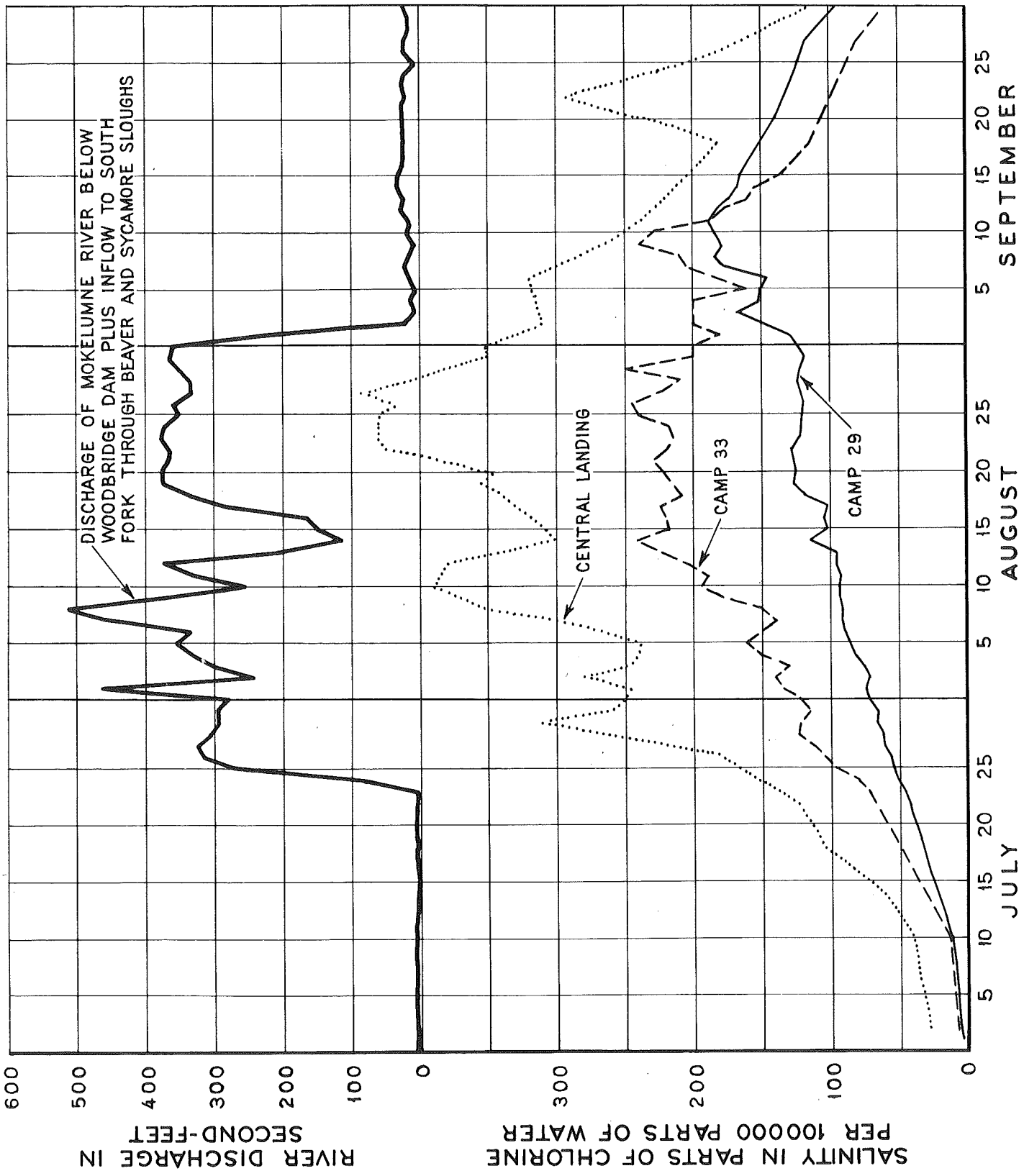


PLATE 12

TABLE 86

DAILY SALINITY OBSERVATIONS, MOKELUMNE RIVER DELTA, 1931
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.

Date	Station														
	Central Landing	Southwest Point	Camp 4 Staten Island	Camp 33 Staten Island	Camp 7 Staten Island	Tyler Island Ferry	Camp 11 Staten Island	Camp 29 Staten Island	Eagle Tree	Camp 25 Staten Island	New Hope Bridge	Camp 20 Staten Island
Jul.												
1					7	8	9		8		7	
2	28*	18		9				8		7		9
3					7		8		9		7	
4												
5												
6	35*	26*		9*		5*		9*		8*		9*
7					8*		8*		8*			
8												
9												
10	40*	22*		13*		5*		11*		11*	8*	14*
11					10*		10*		7*			
12												
13												
14	60*	73*		33*		6*		19*		14*		12*
15											11	
16					35		23		11			
17												
18	104	114		47			25	31	11	21	11	14
19					40							
20												
21												
22	122*										9*	
23		145		72	56	24	31	45	15	29	11	19
24		172		80	71		39	52	18	33	13	22
25		180		96	84		44	54	20	37	12	24
26	180*	230		105	91	31*	49	55	22	38	13	26
27		255		111		37*		60		40		26
28	265	250		123	96	58*	47	62	19	41	9	27
28		121ø		69ø	33ø		18ø	39ø	10ø	17ø	9ø	17ø
29	315	240		122	95	80*	45	66	18	44	6	26
30	260	240		115	90	92	42	65	16	43	25	
31	250	255		122	93	110	40	72		47	4	26

* Low High Tide. ø Low Low Tide.

TABLE 86 - CONTINUED

DAILY SALINITY OBSERVATIONS, MOKELUMNE RIVER DELTA, 1931
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.

Date	Station														
	Central Landing	Southwest Point	Camp 4 Staten Island	Camp 33 Staten Island	Camp 7 Staten Island	Tyler Island Ferry	Camp 11 Staten Island	Camp 29 Staten Island	Eagle Tree	Camp 25 Staten Island	New Hope Bridge	Camp 20 Staten Island
Aug.												
1	245	270		135	88	100	37	75	14	47	3	26
2	280	250		140	72		30	72	10	44	3	23
3	245	230		130	72	130	28	74	7	46	3	
4	240	260	145	150	78	130	29	82	9	52	2	22
5	240	260	148	160	92	175						
6	270					155	31	88	7	56	3	22
7	300	260	154	140	104	175*	34	90	8	56	2	22
8	350	275	160	150	100	160*	34	90	8	62	1	26
9	370	330	185	180	115		44	92	9	61	2	21
10	390	315	90	195	35	175*	16	93	3	56	1	17
11	385	345	201	190	135	195*	58	92	7	64	2	21
12	380	345	235	205	131	235*	63	96	6	65	3	21
13		370	235	225	170	190	64	96	7	67	2	23
14	300*	390	265	240	185		68	115	6	68	2	23
15		345	230	220	165	200	65	102	7	72	3	24
15					20ø							
16		310	205	220	130		46	104	3	72	2	22
17		320	215	225	155	190	56	102	3	74	1	28
18	340*	340	220	210	165	200	58	122	2	73	1	26
19	355	350	230	215	165	170*	62	128	3	82	2	28
20	345							58ø				
21		365	240	230	160	135*	70	127	3	82	1	28
22	425	380	215	220	160	155*	66	128	3	84	1	26
23	430	405	240	215	180	155	71	121	4	82	1	21
24	430	380	250	220	200	135	73	120	4	81	1	22
25	430	375	260	240	180	145	81	119	6	86	1	24
26	415	390	255	245	185	135*	82	119	4	85	1	26
27	445	350	255	225	180		85	121	4	87	1	12
28		320	260	210	190		85	124	4	85	1	12
29		330	260	250	175		74	122	3	85	1	10
30	350	270	200	200	130	62*	48	118	3	72	1	17
30		170ø	100ø	120ø	60ø		2ø	94ø	2ø	32ø	1ø	1ø
31	350	330	200	200	140	64	58	124	3	78	1	18

* Low High Tide. ø Low Low Tide.

TABLE 86 - CONTINUED

DAILY SALINITY OBSERVATIONS, MOKELUMNE RIVER DELTA, 1931
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.

Date	Station															
	Central Landing	Southwest Point	Camp 4 Staten Island	Camp 33 Staten Island	Camp 7 Staten Island	Tyler Island Ferry	Camp 11 Staten Island	Camp 29 Staten Island	Eagle Tree	Camp 25 Staten Island	New Hope Bridge	Camp 20 Staten Island
Sep.												
1		330	190	180	130		58	128	2	82	1	17
2	310*	380	210	200	160	36	82	152	4	96	1	31
3		330	200	200	190		94	168	10	96	1	41
4		350	210	200	170		90	152	10	92	1	44
5		285		160								
6	320*		200		190		96	146	41	94	1	49
7		335	250	205	200		126	180	26	128	23	58
8		310	260	210	220		138	184	37	134	5	68
9		350	250	240	220		128	178	26	144	7	75
10	250*	340	230	230	230		118	182	26	146	6	79
11		340	190	190	180		118	186	22	146	7	85
12		270	180	180	170		116	184	19	140	6	83
13		214	160	162	166		106	172	14	146	11	76
14	212	256	166	156	172	8	134	166	48	164	23	117
15		250	132	136	160		130	164	36	160	14	118
16												
17												
18	180*	134*		116*				148*		136*		91*
19					130*		76*		15*			
20												
21												
22	295*	142*		98*				132*		130*	20*	98*
23					116*		100*		20*			
24												
25												
26	178					3						
27		105*		80*				116*		133*	21*	124*
28					104*		107*		29*			
29												
30	110*	70*		60*		3*		94*		123*	21	114
Oct. 1					99*		91*		33*			

* Low High Tide.

TABLE 87

TIDAL VARIATION OF SURFACE ZONE SALINITY
AT STATEN ISLANDS, CAMPS 7 AND 29, MOKELUMNE RIVER DELTA, 1931
Samples taken at one-foot depth.
Salinity expressed in parts of chlorine per 100,000 parts of water.

Camp 7, Staten Island (Complete Tidal Cycle)				Camp 29, Staten Island (Partial Tidal Cycle)			
Date	Time	Tide Gage Feet	Salinity	Date	Time	Tide Gage Feet	Salinity
August 15th	5 A.M.	4.19	160	August 20th	9 P.M.	3.92	109
	6 A.M.	4.12	180		9:30 PM	4.17	113
	7 A.M.	3.42	150		10 P.M.	4.42	126
	8 A.M.	2.88	130		10:30PM	4.54	130
	9 A.M.	2.39	108		11 P.M.	4.54	133
	10 A.M.	1.79	86		12 M	4.17	123
	11 A.M.	1.21	70	August 21st	1 A.M.	3.50	119
	12 M	0.65	50		2 A.M.	2.83	107
	1 P.M.	0.17	32		3 A.M.	2.25	97
	2 P.M.	0.08	20		4 A.M.	1.71	86
	3 P.M.	0.92	20		5 A.M.	1.08	80
	4 P.M.	1.62	32		6 A.M.	0.67	72
	5 P.M.	2.33	52		7 A.M.	0.00	63
	6 P.M.	2.92	76		8 A.M.	0.00	58
	7 P.M.	3.21	106		9 A.M.	0.71	59
	8 P.M.	3.17	126		10 A.M.	1.42	73
	9 P.M.	2.58	98		11 A.M.	2.08	83
	10 P.M.	1.96	90		11:30AM	2.29	89
	11 P.M.	1.42	72		12 M	2.50	92
	12 P.M.	1.00	56		12:30PM	2.69	97
August 16th	1 A.M.	0.75	42		1 P.M.	2.83	100
	2 A.M.	1.21	34				
	3 A.M.	1.94	48				
	4 A.M.	2.62	78				
	5 A.M.	3.19	100				
	6 A.M.	3.67	130				
	7 A.M.	3.79	154				
	8 A.M.	3.21	144				

TABLE 88

VARIATION OF SALINITY WITH DEPTH AT STATEN ISLAND,
CAMPS 7 AND 29, MOKELUMNE RIVER DELTA, 1931
August 30, 1931

Total Depth in Feet	Time	Tide Gage Feet	Salinity in Parts of Chlorine Per 100,000 parts of Water for Depths in Feet Below Surface of					
			1	5	10	15	20	(1)
Camp 7, Staten Island								
25	6:00 A	6.0	150	150	150	152	154	156
	7:15A(2)	6.0	140	146	152	156	160	162
	8:15 A	5.4	112	140	142	150	150	158
22	12:20 P	2.85	46	54	62	74		88
	1:25P(3)	2.70	26	32	44	56		74
	2:25 P	3.30	20	26	40	56		70
Camp 29, Staten Island								
20	9:45 A		112	112	110	112		114

(1) Two feet from bottom.
(2) High High Tide.
(3) Low Low Tide.

TABLE 89

SALINITY STATIONS AT WHICH OBSERVATIONS WERE TAKEN DURING 1931

Station	Miles from Golden Gate	Time Interval between high tide at Golden Gate and time for taking samples at station		Location
		Hours	Minutes	
				SAN FRANCISCO, SAN PABLO AND SUISUN BAYS
Point Orient*	12.3	2	20	North end San Francisco Bay, east shore, ½ mile south of Pt.San Pablo. Wharf of Standard Oil Company.
Point Davis*	25.2	3	15	East end San Pablo Bay, south shore. Oleum wharf of Union Oil Company.
Bulls Head Point*	34.0	3	50	West end Suisun Bay, south shore. Wharf of Mountain Copper Company.
Bay Point*	39.9	4	15	Suisun Bay, south shore. Bay Point wharf of Coos Bay Lumber Company.
O and A Ferry*	46.5	4	40	Upper end Suisun Bay between Mallard Station and Chipps Island at Sacramento Northern Railroad ferry crossing.
Innisfail Ferry*	47.3	4	50	Montezuma Slough, about 1 mile east of junction with Cutoff Slough, near north end of Grizzly Island.
				NORTH SAN PABLO BAY
Sonoma Creek Bridge*	26.4	3	10	Sonoma Creek entrance at Drawbridge.
Grand View *	27.0	3	10	Petaluma Creek, State Highway Drawbridge near town of Grandview.
Vallejo *	29.1	3	35	Napa River at Sears Point Toll Road Bridge, about one mile from Mare Island Navy Yard Causeway.
Lakeville	33.8	3	40	Petaluma Creek, at town of Lakeville about 7½ miles from mouth of creek.
Cuttings Wharf*	36.7	4	00	Napa River, right bank, opposite north end of Bull Island, near Carneros Station on Southern Pacific Railroad.
Napa	43.7	4	20	Napa River at Third Street Bridge in Napa.
Petaluma	45.7	4	30	Petaluma Creek, at Washington Street Bridge in Petaluma.

* Permanent stations maintained throughout the year.

TABLE 89 - CONTINUED

SALINITY STATIONS AT WHICH OBSERVATIONS WERE TAKEN DURING 1931

Station	Miles from Golden Gate	Time Interval between high tide at Golden Gate and time for taking samples at station: Hours	Minutes	Location
				SACRAMENTO RIVER DELTA
Collinsville*	50.8	5	25	Sacramento River, north bank, at junction with San Joaquin River.
Mayberry	54.9	5	40	Sacramento River, south bank, just above Mayberry Slough.
Emmaton *	57.7	5	45	Sacramento River, south bank, lower end of Horseshoe Bend.
Three Mile Slough Br.	60.0	5	55	At junction of slough and Sacramento River.
Rio Vista Bridge	63.5	6	05	At Highway Bridge near northerly limits of Rio Vista.
Junction Point	65.2	6	10	Sacramento River, right bank, just below the junction with Steamboat Slough.
Liberty Ferry	67.6	6	25	Cache Slough at junction with Prospect Slough.
Isleton Bridge	68.7	6	30	Sacramento River, one mile upstream from Isleton.
Howard Ferry	71.4	6	55	Steamboat Slough, 1½ miles below junction with Sutter Slough.
Sutter Slough	72.8	7	00	At junction with Miner Slough.
Little Holland Ferry	73.2	7	05	Back borrow pit of Reclamation District 999, 2 miles above junction with Miner Slough.
Ryde	74.4	7	15	Sacramento River, right bank, at town of Ryde.
Reclamation Dist.2068	74.6	7	15	Haas Slough, at Reclamation District 2068 pumping plant.
Walnut Grove	77.4	7	25	Sacramento River, Highway Bridge, at Walnut Grove.
Paintersville Bridge	77.6	7	25	Sacramento River, 1 mile below Courtland.
Hood Ferry	82.5	7	50	Sacramento River, ½ mile above Hood.
Freeport Bridge	90.2	8	25	Sacramento River below Freeport.
Sacramento *	103.5	9	30	Sacramento River at Southern Pacific Railroad Bridge.

* Permanent stations maintained throughout the year.

TABLE 89 - CONTINUED

SALINITY STATIONS AT WHICH OBSERVATIONS WERE TAKEN DURING 1931

Station	Miles from Golden Gate	Time Interval; between high tide at Golden Gate and time for taking samples at station		Location
		Hours	Minutes	
				MOKELUMNE RIVER DELTA
Southwest Point	73.3	7	25	Staten Island, North Fork Mokelumne River, south bank, just above junction with South Fork.
Camp 4, Staten Island	80.0	7	30	North Fork, Mokelumne River; 2 miles from junction with South Fork.
Camp 33, Staten Is.	80.2	7	30	South Fork, Mokelumne River, north bank, 2 miles above North Fork junction.
Camp 7, Staten Island	81.8	7	40	North Fork, Mokelumne River, south bank, approximately 3 miles above South Fork junction.
Tyler Island Ferry	81.9	7	40	On Georgiana Slough, about due east of Isleton.
Camp 11, Staten Is.	83.1	7	45	North Fork Mokelumne River, east bank, 4 miles above South Fork junction.
Camp 29, Staten Is.	83.4	7	50	South Fork, Mokelumne River, north bank, opposite Terminous.
Eagle Tree	85.8	8	05	Staten Island, North Fork, Mokelumne River, south bank, 1¾ miles below Millers Ferry Bridge.
Camp 25, Staten Is.	86.4	8	05	South Fork, Mokelumne River, west bank, 1 mile above Sycamore Sl. junction.
New Hope Bridge	87.0	8	10	North end Staten Island near upper junction of North and South Forks Mokelumne River.
Camp 20, Staten Is.	88.9	8	30	South Fork, Mokelumne River, west bank, ½ mile below Beaver Slough junction.
				SAN JOAQUIN RIVER DELTA
Antioch *	54.9	5	55	San Joaquin River, at City Water Works pumping plant.
Curtis Landing	58.9	6	10	San Joaquin River, right bank, about 3/4 mile above Antioch Toll Bridge.
Jersey *	61.4	6	20	San Joaquin River, left bank, 1 mile below mouth of False River.
Webb Pump	72.0	7	00	False River, 2 miles below Old River junction.

* Permanent stations maintained throughout the year.

TABLE 89 - CONTINUED

SALINITY STATIONS AT WHICH OBSERVATIONS WERE TAKEN DURING 1931

Station	Miles from Golden Gate	Time Interval between high tide at Golden Gate and time for taking samples at station: Hours	Minutes	Location
				SAN JOAQUIN RIVER DELTA - CONTINUED
Central Landing *	72.0	7	00	Mokelumne River at Central Landing, Bouldin Island.
Dutch Slough	73.0	7	05	At Bethel Island Bridge.
Ward Landing	79.6	7	35	San Joaquin River near junction with Little Connection Slough on the Southwest side of Empire Tract.
Holland Dam	80.1	7	40	Rock Slough. Below Dam at southeast corner Holland Tract. Dam completed about June 1, 1931.
Holland Pump	80.6	7	40	Rock Slough, north bank, 1½ miles west of Old River junction.
McDonald Pump	82.7	7	50	San Joaquin River, northeast corner of McDonald Island about 1½ miles below Hog Island.
Mandeville Pump	83.0	7	50	Connection Slough, north bank, 1 mile west of Middle River, on south end of Mandeville Island.
King Island Pump	84.2	8	00	Honker Cut at Empire Tract - King Island Ferry.
Rindge Pump*	86.1	8	10	San Joaquin River, north bank, 1 mile below Fourteen Mile Slough junction.
Orwood Bridge	86.3	8	10	Old River, at Santa Fe Railroad Crossing, Orwood.
East Contra Costa I.D.	86.7	8	20	Indian Slough, at East Contra Costa Irrigation District pumping plant.
Middle River, P. O.*	87.7	8	20	Middle River, east bank, at Santa Fe railroad crossing.
Mansion House	88.4	8	30	Victoria Island, Old River, east bank, at junction with North Victoria Canal
Stockton Country Club	90.8	8	45	On Lindley Cut-off (San Joaquin River), north bank, about ⅝ mile above Burns Cut-off junction.
Clifton Court Ferry	94.2	9	10	Old River just below junction with Grant Line Canal.

* Permanent stations maintained throughout the year.

TABLE 89 - CONTINUED

SALINITY STATIONS AT WHICH OBSERVATIONS WERE TAKEN DURING 1931

Station	Miles from Golden Gate	Time Interval between high tide at Golden Gate and time for taking samples at station: Hours	Minutes	Location
				SAN JOAQUIN RIVER DELTA - CONTINUED
Stockton	94.3	9	15	Near head of Stockton Channel at wharf of California Transportation Co.
Garwood Bridge	95.3	9	15	San Joaquin River. At Drawbridge 1 mile above Santa Fe Railroad Crossing.
Brandt Bridge	100.6	9	50	San Joaquin River. At Drawbridge 6 miles above Santa Fe Railroad Crossing.
Williams Bridge	101.6	9	55	Middle River, about 4 miles below Salmon Slough junction.
Whitehall	104.8	10	20	Old River, west of junction of Salmon Slough and Paradise Cut. Due north of Tracy.
Mossdale Bridge*	108.5	10	50	San Joaquin River at Lincoln Highway Crossing, about 3 miles southwest of Lathrop.
Durham Ferry Bridge	125.8	No Tide		San Joaquin River, ½ mile below San Joaquin City.
				DRAINAGE WATER STATIONS
Jersey Drain *	61.4	--	--	Jersey Island drainage pump on San Joaquin River, about 1 mile below False River.
Grand Island Drain Steamboat Slough *	68.2	--	--	Grand Island drainage pump on Steamboat Slough, about 3 miles from Junction Point.
Camp 35, Staten Island Drain *	78.7	--	--	Staten Island, drainage pump on South Fork Mokelumne River, 1 mile from junction with North Fork Mokelumne River.
McDonald Drain *	82.7	--	--	McDonald Island drainage pump on Empire Slough about ¾ mile west of Whiskey Slough junction.
Bacon Island Drain *	82.9	--	--	Bacon Is. drainage pump on Old River near junction with Rock Slough.
Mandeville Drain *	83.0	--	--	Mandeville Is. drainage pump on Connection Sl., about 1 mi. from Middle R.
Camp 11, Staten Island Drain *	83.1	--	--	Staten Island drainage pump on North Fork Mokelumne River, 4 miles above junction with South Fork Mokelumne River.

* Permanent stations maintained throughout the year.

TABLE 90

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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	ab1540	1640	1520	1540	1420	1400	1380	1410
Point Davis	1250	1150	1080	940	1100	1020:a	810	1020
Bulls Head Point	1150	910	790	900	680	660	700	850
Bay Point	920	650:a	320	540	:ab	435	325	
O and A Ferry	162	185:a	95	118	116	97	87	61
Innisfail Ferry	440:b	390	345	270	180:b	300	275	155
North San Pablo Bay								
Sonoma Creek Bridge	1040:a	920:ab	760:ab	850:a	770:b	640	500	830
Grandview	1230	1250	1200	1170	1160	1080	1050	960
Vallejo	980	930:a	820			800	750	800
Lakeville	1380	1330	1190	1160	:a	1130	870	960
Cuttings Wharf	900	720	580	680	730:a	720	260	390
Napa	150	:a	15	74		2		
Petaluma	1080	910	520	590	690:a	640	80	230
Sacramento River Delta								
Collinsville	215	126	30	33	34:a	29	8	9
Emmaton				1	2	3	2	2
Sacramento	:ab 1:a	1	2:ab	2:a	5:a	2	1	2
San Joaquin River Delta								
Antioch	135	68:a	21:ab	13	20	14	9	6
Jersey	19	6	6	7	8	6	7	6
Webb Pump	6	6	5	6	6	7	6	5
Central Landing	3	3:a	4	2:a	4:a	2	2	
Holland Pump	7	9	10	11	10	10	11	8
Mandeville Pump	7:a	7	8	8	9:a	9	10	10
Rindge Pump	9	11	13	13	12:a	14	11	12
East Contra Costa I.D.	:a	10	12	12:a	13:a	13:a	15	
Middle River P.O.	7:a	5	9	9:a	8:a	10	12	11
Mansion House	:ab 5	:d	8:ab	8	:a	9	10	
Stockton	34	76	66	75		101	63	55
Mossdale Bridge	7:a	7	9	8:a	7:a	7	6	6
Drainage Water Stations								
Jersey Drain	24	26	30	31	48	33	32	34
Grand Is.Dr.(Steamboat)	:c 4:c	6:c	5:c	4:c	8:c	5:c	6	
Camp 35 Drain (Staten Is)	7	15	19	19	13	18	23	30
McDonald Drain							:b	15
Bacon Island Drain	:b 11		11	9	10	9	17:b	10
Mandeville Drain	14	13	14	15	14	15	15	14
Camp 11 Drain (Staten Is)			21	27	46	54	38	38

a,b, c, d, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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	FEBRUARY						
	2	6	10	14	18	22	26
San Francisco, San Pablo & Suisun Bays							
Point Orient	1550	1470	1540		1330	1320	1360
Point Davis	1080	1020	940:ab	990:ab	760	810	780
Bulls Head Point	700	680	780	840	600:a	280	500
Bay Point	465						300
O and A Ferry	92	66	58	81	31	9	10
Innisfail Ferry	170	190:d	175	190	220	190:d	140
North San Pablo Bay							
Sonoma Creek Bridge	650:a	770:a	660:ab	760:a	680:a	680	820
Grandview	950:a	930:a	940	910	930	900	980
Vallejo	790	690	730		700	620	680
Lakeville		960	900:a	1020:ad	900		910
Cuttings Wharf	615	460	490	510:a	635	380	400
Napa				93	63		50
Petaluma	460	520	580	:a	600	520	500
Sacramento River Delta							
Collinsville		20	22	25	7	3	7
Emmaton	:a 2	2					3
Sacramento	:ab 2	2	1:ab	1:a	1	1	1
San Joaquin River Delta							
Antioch	12	12	11	19	9	6	6
Jersey	6	4	5	7	7	3	5
Webb Pump	6	5	6	7	6	6	8
Central Landing	4	4	2	2		2	4
Dutch Slough					11	10	12
Holland Pump	10	10	10	10	10	12	12
Mandeville Pump	10	10	10	10:a	11	10	10
Rindge Pump	10	11	12	12	14	9	12
East Contra Costa I.D.	12	12	13	:a	13		21
Middle River P.O.	11:a	15	9	:a	9	8	9
Mansion House		9		:a	9		
Stockton	56		61	75		64	66
Mossdale Bridge	6	7:ab	7:ab	7:a	8	7	7
Drainage Water Stations							
Jersey Drain	34	47	34	35	38	53	37
Grand Is. Drain (Steamboat Slu.)	e 7:e	7:e	5:e	6:e	6:e	5:f	6
Camp 35 Drain (Staten Is.)	41	28	29	28	23	23	30
McDonald Drain	:b 16	17:e	17:c	17:b	15:b	14	17
Bacon Island Drain	10	12	10	10	10	12	9
Mandeville Drain	14	15	11	13	12	13	14
Camp 11 Drain (Staten Is.)	31	57	53	45	38	47	33

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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	1490:	1460:	1420:	1340:	1440:	1230:	1240:	1210:
Point Davis	960:	960:	860:	920:	910:	:	580:b	920:
Bulls Head Point	710:	640:	660:	450:	490:	370:	200:	:
Bay Point	:a	260:a	235:	265:	240:	:	75:	163:
O and A Ferry	12:	72:	35:	48:	24:	5:	3:ab	4:
Innisfail Ferry	75:a	85:	103:	112:	:a	106:	106:	79:
North San Pablo Bay								
Sonoma Creek Bridge	760:	:	:	:	:	:	:	:
Grandview	950:a	980:a	980:	990:	1020:	1060:	1050:	1020:
Vallejo	660:	:	:	:	:	:	:	570:
Lakeville	:	:	:	:	910:f	940:	880:	:
Cuttings Wharf	600:a	480:	590:	540:	460:a	410:a	260:	300:
Napa	67:a	90:	:	3:	:	:a	8:	:
Petaluma	570:a	660:	700:	520:	500:a	520:	600:	630:
Sacramento River Delta								
Collinsville	6:a	4:	11:	8:	3:	1:	2:	3:
Emmaton	1:	1:a	1:	2:	1:	1:	:	:
Sacramento	:	:	:	1:ab	1:	1:	1:	1:
San Joaquin River Delta								
Antioch	4:	6:	11:	9:	7:	3:	5:	5:
Jersey	7:	4:	5:	5:	6:	4:	4:	5:
Webb Pump	7:	6:	7:	6:	5:	4:	6:	4:
Central Landing	4:	4:	4:c	3:	1:	1:	3:	4:
Dutch Slough	:a	9:	9:	9:	9:	:	8:	11:
Holland Pump	10:	9:	11:	10:	10:	9:	11:	10:
Mandeville Pump	:b 10:	11:	11:	10:d	10:	10:	8:	10:
Rindge Pump	12:	12:	12:	14:	15:	17:	17:	13:
East Contra Costa I.D.	14:	16:	12:	9:	9:	9:	9:	11:
Middle River P.O.	12:	9:	11:	11:	14:	10:	12:	13:
Mansion House	:	:	9:	8:	:	7:	:a	11:
Stockton	:	64:	64:	71:	83:	86:	:	67:
Mossdale Bridge	:ab 9:	10:	12:	15:ab	15:	13:	:ab	13:
Drainage Water Stations								
Jersey Drain	34:	48:	41:	44:	34:	42:	34:	40:
Grand Island Dr.(Steamboat)	e 7:b	4:e	5:e	6:e	5:e	5:e	4:e	7:
Camp 35 Drain (Staten Is.)	20:	17:	20:	21:	18:	18:	20:	19:
McDonald Drain	16:e	15:c	17:b	17:	15:e	17:b	17:	18:
Bacon Island Drain	11:	11:	10:	10:	9:	9:	10:	9:
Mandeville Drain	15:	13:	14:	14:	15:	14:	14:	15:
Camp 11 Drain (Staten Is.)	34:	37:	15:	25:	14:	24:	17:	28:

a, b, c, d, e, f, See footnotes last page of this table.

SACRAMENTO-SAN JOAQUIN WATER SUPERVISOR'S REPORT 1931

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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	APRIL							
	2	6	10	14	18	22	26	30
San Francisco, San Pablo & Suisun Bays								
Point Orient	a 1520	1580	1420 b	1480 b	1560	1600	1550 b	1620
Point Davis	b 1020	970	920 b	940 b	1120	1340	1250 a	1270
Bulls Head Point	b 550	580	500 b	630 b	730	1000	830 b	970
Bay Point	159 a	218	315 a	370 a	455 a	550	a	600
O and A Ferry	b 39	74	45 b	162 b	275	250 ab	210 a	270
Innisfail Ferry	a 59	70	74	a	98	200	240 a	270
North San Pablo Bay								
Grandview	a	1050	1110 b	1100 b	1120 a	1180	1190 a	1160
Vallejo	b 590	640	680 b	760 b	840	850	850 b	970
Lakeville	a 870		990 a	950 a	990 d	1020		
Cuttings Wharf	b 320	390	440	410 b	400	440	580 b	770
Napa	a 16		15 a	20				
Petaluma	a 630	660	720 a	760 a	760 d	820	750 a	830
Sacramento River Delta								
Collinsville	4	37	20 a	16 a	40	92	107 a	81
Mayberry							a	34
Emmaton		3	13 b	1 a	12	4		
Sacramento	b 1	1	1 b	1 b	1	1	1 b	1
San Joaquin River Delta								
Antioch	a 4	9	9 a	10 a	17	70	78 a	60
Curtis Landing								38
Jersey	3	3	5 a	4 a	4	18	17 ab	20
Webb Pump	d 3	2	4 d	5	3	14	4	5
Central Landing	a 4	3 d	3 a	3 a	1	2	2	
Dutch Slough	a 7	8	9 b	8 b	7		7 b	9
Holland Pump	b 9	7	9 b	7 b	7	7	10 b	9
Mandeville Pump	b 9 d	9	b	12 b	7	6	7 b	6
Rindge Pump	a 22	19	20 b	21 b	16	15	16 a	17
East Contra Costa I.D.			12 a	13 b	10	13	11	
Middle River P.O.	12	12	13 b	12 b	11	12	11 a	11
Mansion House	b 11	11	11 b	10 b	10		b	14
Stockton	a 80	80	b	102 b	98		92	
Mossdale Bridge	b 13 d	12 ab	13 b	12 b	10	11 ab	10 a	10
Durham Ferry Bridge								7
Drainage Water Stations								
Jersey Drain	b 45	41	32	43	19	28	21	42
Grand Is.Dr.(Steamboat Sl)	e 7	6	6	5	4	4	5	5
Camp 35 Drain (Staten Is.)	18	16	12					
McDonald Drain	18 e	15 b	17	16 e	15 b	14		
Bacon Island Drain	9	8	11 b	11	10	12	10	
Mandeville Drain	b 14	15		b	13	15	5 b	14
Camp 11 Drain (Staten Is.)	21	36	36	33	32	47	43	34

TABLE 90 (CONTINUED

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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	a 1540	1610	1600	a 1520	b 1700	1640	1670	b 1690
Point Davis	b 1320	1320	1280	a 1250	a 1280	1330	1410	b 1490
Bulls Head Point	b 1030	1050	900	b 870	b 870	1200	1110	b 1210
Bay Point	a 530	a 600	a 640	a 630	540	a 760	a 700	a 810
O and A Ferry	a 350	360	b 355	b 405	b 420	a 430	b 560	b 600
Innisfail Ferry	a 290	350	a 345	a 350	a 390	a 440	a 450	a 505
	North San Pablo Bay							
Sonoma Creek Bridge					a 1240	1340	b 1380	
Grandview	a 1260	a 1200		a 1270	a 1365	a 1450	1460	b 1420
Vallejo	b 930	950	940		a 1020	1020		
Lakeville	a 1070	d 1090	a 1100		ad1180	a 1200	a 1230	
Cuttings Wharf	a 770	a 530	a 780	a 750	a 920	920	a 890	a 900
Petaluma	a 830	a 890	ad 860	a 960	a 970	1040	a 970	a 1070
	Sacramento River Delta							
Collinsville		229	166	a 150	bd 290	280	a 255	a 285
Mayberry	a 41	134	b 95		b 78	200	a 132	a 165
Emmaton	b 4	5	b 4	a 6				
Three Mile Slough Bridge	a	7	a 3	a 6	b 5	14	b 26	a 30
Rio Vista Bridge	a	4	b 1	b 4	b 3	3	b 3	a 5
Junction Point						a	5	a 5
Isleton Bridge						b	3	b 5
Sacramento		a	1	b 1	b 2	2	a 1	b 2
	Mokelumne River Delta							
Southwest Point	b 5	a 11	a 2	a 4		4		
Camp 33, Staten Island	b 2	a	4	ab	3	2		
Camp 7, Staten Island		4	a	4		a	7	
Tyler Island Ferry						b	4	b 4
Camp 11, Staten Island	b 4	4	a	7		a	7	
Camp 29, Staten Island	b 2	a	1	b	4	4		
Eagle Tree		8	a	6		a	7	
Camp 25, Staten Island	b 5	a	4	b	5	4		
New Hope Bridge			ab	3	b 9	b 2	a 9	b 7
Camp 20, Staten Island	b 5	a	6	b	8	5		

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 (CONTINUED)							
	2	6	10	14	18	22	26	30
				San Joaquin River Delta				
Antioch	a 62	144 a	88 a	90 a	70	260 a	150 a	204
Curtis Landing	a 34	78 b	64	b	100	124 a	92 a	137
Jersey	a 9	38 a	6 a	12 a	15	95 a	44 a	43
Webb Pump	4	8 b	6 b	6 d	7	10	11	15
Central Landing	a 4	3	3 a	3 a	4	5 a	5 a	6
Dutch Slough	b 7		a	8 b	10 a	8 a	8	
Holland Pump	b 7	b 7 a	7 b	8 b	10	10 a	9 b	8
Mandeville Pump	b 8	8	a	7 b	7	6 a	7 b	8
Rindge Pump	b 16	19 a	14 b	18	17	22 a	22 b	21
East Contra Costa I.D.		10 a	11 a	10 b	10	9	a	11
Middle River P.O.	a 11	11 a	9 b	10 b	8	7 a	8 a	11
Mansion House		11 a	7 b	9		11	b	11
Stockton		106 b	94 b	96 b	85	85 b	85	
Mossdale Bridge	b 9	8 a	7 b	10 b	10	10 a	10 b	12
Durham Ferry Bridge	6	8	6 c	11		9	10	11
				Drainage Water Stations				
Jersey Drain	31	43	40	19	14	28	16	26
Grand Is.Dr. (Steamboat Sl)	c 6	c 13 c	5 b	8 c	6 c	5 c	8	
Camp 35 Drain, (Staten Is.)	b 5	16 c	4	7 b	7	4	6	
McDonald Drain		12	15	11	13	9		
Bacon Island Drain	9	7	10 b	10	10	9	10	9
Mandeville Drain	b 15	15	14	14 b	12	11	9 b	9
Camp 11 Drain (Staten Is.)	19	25 c	33	8 b	9	14	9	

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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	JUNE							
	2	6	10	14	18	22	26	30
				San Francisco, San Pablo & Suisun Bays				
Point Orient	b 1730	1680	1640	b 1680	b 1710	1720	1740	b 1740
Point Davis	b 1440		a 1380	b 1530	b 1520	1460	1510	a 1540
Bulls Head Point	b 1210	1080	1080	b 1280	b 1300	1200	b 1360	b 1360
Bay Point	a 830	800	a 780	a 920	a 980	a 920	b 1160	a 1000
O and A Ferry	b 700	760	b 660	b 680	b 740	a 660	b 740	a 680
Innisfail Ferry	a 560	600	a 560	a 640	bd 740	a 700	a 710	a 780
				North San Pablo Bay				
Sonoma Creek Bridge			1440	b 1420			1560	
Grandview	a 1440		a 1440		a 1540		1580	
Vallejo			a 1100		ad 1220			d 1380
Lakeville	d 1340	1340						
Cuttings Wharf	b 1050		960		a 980		a 980	
Petaluma	ad 1140	1080						
				Sacramento River Delta				
Collinsville	a 285	380	a 340	a 580	470	a 460	ad 460	a 600
Mayberry		230						
Emmaton	b 87	a 88	b 170	b 148	b 280	a 192	b 225	b 275
Three Mile Slough Bridge	a 31	45	b 70	a 76	a 100	a 90	a 100	a 155
Rio Vista Bridge	b 6	5	b 10	b 34	b 46	29	b	85
Junction Point	a 5	3	a 5	a 7	a 6	a 8	a 9	a 14
Liberty Ferry					ac 5		a	6
Isleton Bridge	b 4	4	b 4	b 10	b 7	a 5	b 12	b 21
Sacramento	b 1	4	a 4	b 7	b 2	a 1	a 5	b 6
				Mokelumne River Delta				
Southwest Point	b 6	3	a 5	a 8	14	a 10	a 7	20
Camp 33, Staten Island	b 5	a	4		5	a 7	a 6	10
Camp 7, Staten Island		4	a	6	b 5	ab 5	ab 6	b 7
Tyler Island Ferry	b 4	3	b 3	b 3	b 5	b 3	b 6	a 8
Camp 11, Staten Island			ab	7	b 6	b 5	ab 8	b 9
Camp 29, Staten Island	b 4	a	4		5	a 6	a 8	8
Eagle Tree		8	a	8	b 8	ab 8	ab 9	b 8
Camp 25, Staten Island	b 6	a	5		6	a 6	a 9	9
New Hope Bridge	b 6	5	b 9	b 6	b 7	a 6	b 9	b 7
Camp 20, Staten Island	b 8	a	7		6	a 7	a 8	b 10

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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	JUNE (CONTINUED)							
	2	6	10	14	18	22	26	30
San Joaquin River Delta								
Antioch	a 280	280 a	270 a	340 a	420	450 a	410 a	475
Curtis Landing		155		b	234 a	280 a	310	
Jersey	b 118	60 a	42 a	90 b	248 a	160 a	155 a	260
Webb Pump	20	15	26	36 b	49 a	40	76	95
Central Landing		7 a	7 a	8 a	12 a	acd 13 ad	13 a	24
Dutch Slough					acd	29 a	42 b	56
Holland Dam	e	12 ab	8	c	14 b	16 a	15 b	18
Holland Pump	b 7	8 ab	8 b	10 c	10 b	14 a	12 b	17
Mandeville Pump	b 9	9 a	9 b	9 b	11 a	12 a	15 b	19
King Island Pump				b	12 b	11	b	14
Rindge Pump	b 20	19 a	17 b	23 b	17 a	20 a	19 a	19
East Contra Costa I.D.	b 12	10 a	10 b	13 b	12 a	12	a	12
Middle River P.O.	b 11	9 a	9 a	10 b	10 a	10 a	11	13
Mansion House	b 8	a	8	b	12	b	11 b	12
Stockton Country Club		a	28 b	26	a	30		
Stockton	e 76	b	62	b	80 b	80 b	76 b	76
Mossdale Bridge	b 11	11 a	13 b	9 b	9 a	8 a	11	
Durham Ferry Bridge	9	8	10 b	11	9	9	10	8
Drainage Water Stations								
Jersey Drain	b 27	17	30	29 b	57	56	63	77
Grand Is.Dr.(Steamboat Sl.)	7	6	7	13 ab	4	8	8	9
Camp 35 Dr. (Staten Is.)	b 7	9	8	9	6 b	8 b	10 b	9
McDonald Drain					12	12	13	14
Bacon Island Drain	11	8	10	11	11	11	13	14
Mandeville Drain	b 9	10	9 b	8 b	11	12	17 b	17
Camp 11 Dr. (Staten Is.)	b 8	7	4	7	7 b	7 b	9 b	10

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 and Suisun Bays								
Point Orient		1770	1780:b	1780	1770	1820	1830:b	1840
Point Davis	:b 1480	1640	1660:b	1670	1680:a	1680:a	1700:b	1740
Bulls Head Point - Benicia	:b 1340	1370	1390:b	1500	1380	1480:b	1610:b	1570
O and A Ferry	:a 780	870	980:b	1080	1020	1070:b	1230:b	1230
Innisfail Ferry		840:a	780:a	910:a	1030	1080:a	1140:b	1230
North San Pablo Bay								
Sonoma Creek Bridge	:a 1590		1660					
Grandview	:a 1570		1660		:a 1670		:a 1760	
Vallejo	:a 1320		:d 1420		:b 1560			
Cuttings Wharf	:a 1050		1200				:ad1340	
Sacramento River Delta								
Collinsville	:d 620	:a 600	:a 660	:a 810	880	:a 890	:a 1090	:a 1110
Mayberry				:a 660		:a 770		
Emmaton	:a 280	:a 365	:a 470	:b 540	560	630		
Three Mile Slough Bridge	:b 210	250	:a 290	:a 430	:a 430	500	:a 560	:a 655
Rio Vista Bridge	:b 98	132	:b 196	:b 315	370	450	:b 520	:b 580
Junction Point					260	280	:a 370	:a 390
Liberty Ferry		:a 24	:ae 22	:a 58		:a 116		
Isleton Bridge		68	:b 83	:b 146	230	250	:b 360	:b 380
Howard Ferry				:a 98	170	:a 190	:a 245	:b 342
Sutter Slough					58	:a 83	:a 135	:b 220
Little Holland Ferry							:ab 110	:a 142
Ryde			:d 6	:a 29	:a 48	:a 71	:a 109	:a 190
R. D. 2068				:a 4	5	:a 10	:a 35	:a 74
Walnut Grove				:b 21	27	:f 76	81	:b 130
Paintersville Bridge				:b 25	20	:b 48	:b 92	:b 112
Hood Ferry					6	8	18	15
Freeport Bridge				:b 7	7	:b 8	:b 8	:b 7
Sacramento		:b 6		6:b 7	5	:a 5	:b 7	:b 6
Mokelumne River Delta								
Southwest Point		18:a	26:a	22:a	73	114:b	145	230	240
Camp 33, Staten Island		9:a	9:a	13:a	33	47:b	72	105	115
Camp 7, Staten Island	:b	7:ab	8:ab	10:c	35:b	40:b	56	91	90
Tyler Island Ferry		:a	5:a	5:a	6	:b	24:a	31	92
Camp 11, Staten Island	:b	8:ab	8:ab	10:c	23	25:b	31	49	42
Camp 29, Staten Island		8:a	9:a	11:a	19	31:b	45	55	65

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 (CONTINUED)							
	2	6	10	14	18	22	26	30
Mokelumne River Delta (Continued)								
Eagle Tree	:b 9:ab	8:ab	7:c	11:	11:b	15:	22:	16:
Camp 25, Staten Island	: 7:a	8:a	11:a	14:	21:b	29:	38:	43:
New Hope Bridge	:b 7:	:a	8:b	11:	11:b	11:	13:	25:
Camp 20, Staten Island	: 9:a	9:a	14:a	12:	14:b	19:	26:e	26:
San Joaquin River Delta								
Antioch	:a 520:	540:a	510:a	710:	830:	920:a	900:	:
Curtis Landing	:b 440:a	440:a	425:	:a	640:a	660:ab	830:a	850:
Jersey	:b 365:a	325:a	270:a	430:	600:a	500:b	790:b	780:
Webb Pump	: 102:	146:	168:	245:	310:b	380:	460:	480:
Central Landing	:a 28:a	35:a	40:a	60:	104:a	122:a	180:	260:
Dutch Slough	:b 78:a	82:a	79:a	116:	:	:	:	:
Ward Landing	: :	:	:	:	:	:ac	140:	167:
Holland Dam	: :ab	20:a	23:b	53:	60:	61:b	100:b	140:
Holland Pump	:b 19:ab	22:a	24:b	38:	46:	51:b	80:b	105:
Mandeville Pump	: :ab	19:a	29:b	43:	55:a	65:a	111:b	140:
King Island Pump	:b 16:b	17:	:d	24:	:b	47:	:bd	74:
Rindge Pump	:b 18:a	22:a	22:b	23:	25:a	28:a	35:b	49:
Orwood Bridge	: :	:	:b	25:	31:	:b	61:b	74:
East Contra Costa I.D.	:b 12:a	12:a	14:a	15:	19:b	21:a	31:b	39:
Middle River P.O.	:bd 13:a	15:b	18:a	22:a	27:a	34:b	57:b	79:
Mansion House	:b 10:a	15:a	15:b	24:	26:	:a	25:b	66:
Stockton Country Club	:b 22:a	24:	:b	25:e	26:a	29:a	9:b	44:
Clifton Court Ferry	: :	:	:b	16:	18:a	19:b	27:b	34:
Stockton	:b 76:b	82:	:ab	80:	:b	88:	:	:
Garwood Bridge	: :	:	:	:	:	:	:	39:
Brandt Bridge	: :	:	:	:	:	:	:	33:
Williams Bridge	: :	:	:b	15:	15:b	16:b	20:b	30:
Whitehall	: :	:	:	:	:	:	:	16:
Mossdale Bridge	:b 8:a	12:a	11:b	10:	9:a	9:	:b	11:
Durham Ferry Bridge	: 8:	7:	10:	8:	:	8:	8:	8:
Drainage Water Stations								
Jersey Drain	:b 79:	141:	162:	130:	120:	92:b	177:b	180:
Grand Is.Dr.(Steamboat Sl.)	c 8:	:c	11:c	32:c	52:	:c	116:	:
Camp 35 Dr. (Staten Is.)	:b 8:b	11:b	14:b	23:	28:	:c	55:	:
McDonald Drain	: 13:	15:	20:	23:	24:	30:	46:	55:
Bacon Island Drain	: 15:	18:	21:	29:	:	47:	75:	83:
Mandeville Drain	:b 18:	19:	27:b	36:	44:	63:	83:b	115:
Camp 11,Dr. (Staten Is.)	:b 8:b	8:b	12:b	19:b	24:	:c	42:	:

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 and Suisun Bays								
Point Orient	1820:	1810:	1860:b	1860:	1840:	1870:b	1840:	1820:
Point Davis	:a 1760:a	1770:	1770:b	1810:a	1690:a	1780:b	1810:a	1740:
Bulls Head Point	:e 1660:	1610:b	1610:b	1570:	1600:	1640:b	1690:	1560:
Bay Point	:	:	:	:	:a	1440:a	1540:a	1450:
O and A Ferry	1240:	1250:b	1320:b	1320:	1300:	1390:b	1380:	1360:
Innisfail Ferry	1180:a	1140:a	1260:	:	1340:	1400:a	1380:	
North San Pablo Bay								
Grandview	1820:	:	1820:	:	1800:	:a	1870:	
Vallejo	1620:	:a	1660:	:	:	:	:	
Cuttings Wharf	1680:	:a	1700:	:	1570:	:a	1750:	
Sacramento River Delta								
Collinsville	1140:	:a	1190:a	1120:a	1180:a	1230:a	1240:	1190:
Mayberry	:	:a	1010:	:	:	:	:	:
Emmaton	870:	860:a	870:b	880:	930:a	780:a	840:a	930:
Three Mile Slough Bridge	:a 680:a	760:b	760:b	790:	790:b	670:a	840:	780:
Rio Vista Bridge	540:	650:b	700:b	660:	710:b	680:b	740:	680:
Junction Point	:a 440:a	470:a	520:a	570:a	550:a	590:a	615:a	600:
Liberty Ferry	:	:	:b	390:	:ac	490:ab	520:ab	540:
Isleton Bridge	420:	440:b	510:b	545:	:b	595:b	635:	460:
Howard Ferry	:	380:	:b	480:	500:a	485:	:	460:
Sutter Slough	:de	260:a	235:b	320:	:a	225:b	155:	120:
Little Holland Ferry	198:	230:a	235:a	220:	300:a	225:b	250:	120:
Ryde	:ab 280:ab	220:ab	230:ab	220:ab	160:	:a	150:a	80:
R. D. 2068	86:a	122:a	137:a	190:	:	:a	175:	100:
Walnut Grove	160:b	180:b	200:b	220:	120:b	126:b	120:c	38:
Paintersville Bridge	122:b	144:b	139:b	110:	63:b	59:b	28:	11:
Hood Ferry	13:	12:a	8:a	8:	10:a	11:a	10:	10:
Freeport Bridge	7:b	8:b	10:b	9:	10:a	11:b	10:	9:
Sacramento	8:a	8:b	8:c	8:a	9:a	9:b	10:	7:
Mokelumne River Delta								
Southwest Point	250:b	260:	315:	390:	340:	380:	390:	270:
Camp 4, Staten Island	:e	148:	90:	265:	220:	215:	255:	200:
Camp 33, Staten Island	:: 140:e	160:	195:	240:	210:	220:	245:	200:
Camp 7, Staten Island	72:e	92	35:	185:	165:	160:	185:	130:

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 (CONTINUED)							
	2	6	10	14	18	22	26	30
Mokelumne River Delta (Continued)								
Tyler Island Ferry	e 100:	155:a	175:ab	200:	200:a	155:e	145:b	64:
Camp 11, Staten Island	30:	31:	16:	68:	58:	66:	82:	48:
Camp 29, Staten Island	72:	88:	93:	115:	122:	128:	119:	118:
Eagle Tree	10:	7:	3:	6:	2:	3:	4:	3:
Camp 25, Staten Island	44:	56:	56:	68:	73:	84:	85:	72:
New Hope Bridge	3:	3:	1:	2:	1:	1:	1:	1:
Camp 20, Staten Island	23:	22:	17:	23:	26:	26:	26:	17:
San Joaquin River Delta								
Antioch	1000:	:a	1050:a	1090:	1160:a	1030:a	1100:	1080:
Curtis Landing	:d	770:a	920:ab	1020:	990:a	920:b	1060:	:
Jersey	720:	:a	700:	:	:	:	:	:
Webb Pump	d 460:	505:a	520:	600:	540:	600:	670:	560:
Central Landing	280:	270:	390:a	300:a	340:	425:	415:	350:
Dutch Slough	:ab	295:ade	300:	:ac	380:	:	:	:
Ward Landing	165:	:a	225:a	238:	275:a	250:a	310:	290:
Holland Dam	b 132:	143:a	165:b	220:a	220:a	240:b	315:	270:
Holland Pump	bd 116:a	74:b	180:b	180:a	200:a	240:b	250:	230:
McDonald Pump	155:	140:ad	170:	240:	:a	201:	280:	260:
Mandeville Pump	d 158:a	190:a	220:b	265:a	230:a	280:b	320:	300:
King Island Pump	:b	89:	102:	:	150:	:b	175:	200:
Rindge Pump	70:a	72:a	86:b	120:	112:a	160:b	146:	170:
Orwood Bridge	82:b	100:b	123:b	144:	154:b	182:b	215:	200:
East Contra Costa I.D.	45:a	54:a	71:b	105:a	102:a	116:b	129:	134:
Middle River P.O.	92:a	86:a	130:b	180:	:a	200:a	230:	220:
Mansion House	77:a	76:b	118:	130:	:a	140:b	170:	170:
Stockton Country Club	45:	53:a	60:	:	:a	84:a	97:	102:
Clifton Court Ferry	39:a	39:	56:b	68:a	37:a	81:b	94:	80:
Stockton	89:b	97:	:	:	:b	106:	:a	104:
Garwood Bridge	:a	45:b	55:b	65:a	58:a	66:b	82:	80:
Brandt Bridge	38:a	35:a	39:a	43:	37:a	38:a	34:	40:
Williams Bridge	31:b	43:b	52:b	58:	68:b	84:b	94:	100:
Whitehall	18:af	16:b	19:b	21:a	24:a	29:b	28:	28:
Mossdale Bridge	9:a	10:b	10:b	9:a	9:a	10:b	9:b	6:
Durham Ferry Bridge	7:	8:	8:	8:	9:	9:	7:	6:
Drainage Water Stations								
Jersey Drain	325:	:	125:	:	:	:	:	:
Grand Is.Dr.(Steamboat Sl.)	e 154:e	160:e	155:e	180:e	260:e	240:e	150:e	130:
Camp 35 Dr.(Staten Is.)	43:	:	:e	66:	:	:	85:	80:
McDonald Drain	64:	87:	78:	:	:	:	:	:
Bacon Island Drain	92:	48:	75:	126:	180:	180:	158:	170:
Mandeville Drain	130:	171:	180:b	210:	240:	215:b	220:	180:
Camp 11 Dr. (Staten Is.)	30:	:	:e	54:	:	:	58:	10:

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 and Suisun Bays								
Point Orient	1800:	1820:b	1780:	1800:	1760:	1800:	:b 1790:	
Point Davis	:	:	:	:	:	1750:	:a 1730:	
Bulls Head Point	1620:	1660:b	1580:	1620:	1640:b	1600:	1500:	1550:
Bay Point	1520:	1500:a	1460:	1520:ab	1440:a	1440:	1420:	1440:
O and A Ferry	1320:	1360:b	1360:	1320:	1320:b	1260:	1150:b	1190:
Innisfail Ferry	1360:	1360:a	1340:	1380:a	1380:a	1390:	1390:b	1390:
North San Pablo Bay								
Grandview	1820:	:a	1740:	:	1820:	:	1835:	:
Vallejo	:	:a	1680:	:a	1700:	:	1640:	:
Cuttings Wharf	1600:	:a	1780:	:	1800:	:	1740:	:
Sacramento River Delta								
Collinsville	:a 1220	:a 1200	:a 1180:	1260	:a 1120	:a 960:	1070	:a 920:
Emmaton	1000:	955:	:	970:	:a	660:	680	:a 540:
Three Mile Slough Bridge	:a 860:	820	:a 840:	740	:a 680	:b 600:	585	:a 410:
Rio Vista Bridge	740:	700	:b 640:	680:	400	:b 545:	520:	:
Junction Point	:a 620	:a 600	:a 430:	600	:a 310	:a 440:	435:	:
Liberty Ferry	:b 560	:ab 460	:ab 400	:a 540:	280	:a 350:	315	:a 200:
Isleton Bridge	560:	480	:b 440:	460:	230:	:	42	:b 198:
Howard Ferry	:a 480	:a 210	:a 37:	50:	18	:a 4:	:	:
Sutter Slough	:a 48:	:b	12	:a 7	:a 5:	:ab	4	:a 4:
Little Holland Ferry	:a 90	:b 88:	:	27	:a 11	:a 8:	4	:a 5:
Ryde	:a 42:	19:	12:	8	:a 5	:a 3	:a 4	:a 3:
R. D. 2068	160	:a 150	:a 128:	:	:a	280:	238	:a 270:
Walnut Grove	28:	:b	10:	8:	:	:	3:	:
Paintersville Bridge	:e 10	:b 10	:b 7:	8	:ab 4	:b 3:	4:	:
Hood Ferry	:a 9	:a 9	:a 7:	:a	4	:a 4:	3	:a 3:
Freeport Bridge	:	:b	7:	6	:b 4	:b 3:	3:	:
Sacramento	:a 8	:a 5	:a 5	:a 5	:a 4	:b 2	:ab 3	:a 3:
Mokelumne River Delta								
Southwest Point	380	:e 285:	340:	256	:a 134	:a 142	:ab 105	:a 70:
Camp 4, Staten Island	210:	200:	230:	166:	:	:	:	:
Camp 33, Staten Island	200	:e 160:	230:	156	:a 116	:a 98	:ab 80	:a 60:
Camp 7, Staten Island	160:	190:	230:	172	:ab 130	:ab 116	:ac 104	:ab 99:
Tyler Island Ferry	36:	:	:	8:	:	:	3	:a 3:
Camp 11, Staten Island	82:	96:	118:	134	:ab 76	:ab 100	:ac 107	:ab 91:
Camp 29, Staten Island	152:	146:	182:	166	:a 148	:a 132	:ab 116	:a 94:

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 (CONTINUED)							
	2	6	10	14	18	22	26	30
Mokelumne River Delta (Continued)								
Eagle Tree	4:	41:	26:	48:ab	15:ab	20:ac	29:ab	33:
Camp 25, Staten Island	96:	94:	146:	164:a	136:a	130:ab	133:a	123:
New Hope Bridge	1:	1:	6:	23:	:a	20:ab	21:a	21:
Camp 20, Staten Island	31:	49:	79:	117:a	91:a	98:ab	124:a	114:
San Joaquin River Delta								
Antioch	1160:a	1240:a	1100:	1200:	1170:a	980:	940:a	870:
Curtis Landing	1060:	:a	910:	1040:	1060:a	930:	860:a	760:
Jersey	800:	:a	800:	910:	:	:	690:	:
Webb Pump	680:b	640:b	620:	660:	600:	545:	490:	470:
Central Landing	:a 310:a	320:a	250:	212:a	180:a	295:	178:a	110:
Dutch Slough	:	:	:	510:a	440:a	485:	450:b	408:
Ward Landing	320:a	330:a	330:a	350:a	320:a	320:	310:a	325:
Holland Dum	:a	300:	:f	330:ab	315:b	310:b	315:b	326:
Holland Pump	:a	250:	:f	270:ab	280:b	290:b	325:b	282:
McDonald Pump	:ab 270:ab	280:ab	246:ab	305:ab	270:ab	290:b	290:b	263:
Mandeville Pump	:a 325:a	330:a	350:a	350:a	340:a	345:	340:a	315:
King Island Pump	:	:	:	:	:b	261:	230:	235:
Rindge Pump	:a 160:a	170:b	180:a	174:a	198:a	188:	196:a	187:
Orwood Bridge	230:c	230:b	230:	246:b	250:b	255:	260:b	253:
East Contra Costa I.D.	:a 140:a	156:b	150:a	160:a	174:a	180:ab	174:	:
Middle River P.O.	:e 210:a	240:a	250:a	240:a	262:a	255:ab	270:a	265:
Mansion House	190:a	190:b	220:a	210:a	200:a	220:	220:a	235:
Stockton Country Club	:a 98:a	120:	:a	122:a	110:a	118:	:a	89:
Clifton Court Ferry	94:a	110:b	100:a	128:a	130:a	130:	130:	:
Stockton	:	:	:a	132:	:	:	114:	:
Garwood Bridge	:a 80:ab	80:b	92:	:a	46:b	70:	69:a	10:
Brandt Bridge	:a 27:a	14:a	10:a	8:a	7:a	7:	8:a	8:
Williams Bridge	118:b	80:	:	96:a	60:b	50:	42:	:
Whitehall	:a 31:a	24:b	23:a	24:a	16:b	16:	:a	12:
Mossdale Bridge	:a 8:a	7:b	8:a	9:a	8:b	7:b	9:a	8:
Durham Ferry Bridge	7:	6:	7:	7:	6:	6:	6:	6:
Drainage Water Stations								
Jersey Drain	70:	:	70:	72:	:	:	74:	:
Grand Is.Dr.(Steamboat Sl.)	124:	130:	140:	130:	86:	98:	58:	61:
Camp 35 Dr. (Staten Is.)	30:	9:	17:	16:	13:	13:c	91:	109:
Bacon Island Drain	110:f	110:	160:	180:	150:	118:	124:	125:
Mandeville Drain	190:	190:	200:	210:	190:	210:	200:	194:
Camp 11 Dr. (Staten Is.)	8:	6:	:6:	8:	9:	18:c	23:	75:

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 and Suisun Bays								
Point Orient	1800:	1800:	1800:b	1795:	1780:	1770:	1765:	1760:
Point Davis	:	1760:	1790:a	1690:	1705:	1700:ab	1655:a	1550:
Bulls Head Point	1615:	1600:	1550:	1510:	1485:	1475:	1390:	1455:
Bay Point	:a 1380:a	1300:	1365:	1410:	1320:	1315:	1275:	1190:
O and A Ferry	1100:	1095:	1120:b	1140:a	995:	1060:	965:	855:
Innisfail Ferry	1380:a	1335:	1300:a	1290:	1230:	1210:	1240:	1010:
North San Pablo Bay								
Grandview	1800:	:	1835:	:	1765:	:	1750:	:
Vallejo	1620:	:	:	:	:	:	:	:
Cuttings Wharf	:a 1790:	:	1800:	:a	1745:	:ad	1760:	:
Sacramento River Delta								
Collinsville	950:a	880:	880:a	830:a	710:	725:	800:	560:
Emmaton	:e 450:	:	:b	475:	385:	517:	310:a	272:
Three Mile Slough Bridge	545:a	417:	457:a	375:a	425:	435:	225:a	227:
Rio Vista Bridge	440:b	350:	365:b	292:	:	291:	200:	142:
Junction Point	360:a	200:	265:b	145:	85:	188:	125:	133:
Liberty Ferry	:acd190:c	212:	151:b	156:	111:	120:	75:	68:
Isleton Bridge	238:b	116:	114:	177:	5:	118:	3:	4:
Howard Ferry	:a 9:	:	:	:a	2:	:	2:	2:
Sutter Slough	:a 4:a	3:	2:	:	:	:	:	:
Little Holland Ferry	6:a	4:	:a	3:a	3:	:	2:	:
Ryde	:a 3:	:	:	:	:	:	:	:
R. D. 2068	:a 180:a	188:	158:a	148:a	108:	154:	192:a	134:
Walnut Grove	3:	:	:	:	:	:	:	:
Paintersville Bridge	3:	:	:	:	:	:	:	:
Hood Ferry	:a 4:	:	:	:	:	:	:	:
Freeport Bridge	3:	:	:	:	:	:	:	:
Sacramento	:e 4:b	2:ab	1:a	2:a	2:ab	1:ab	1:a	1:
Mokelumne River Delta								
Southwest Point	:a 76:a	111:	90:b	76:a	76:	62:a	24:a	20:
Camp 33, Staten Island	:a 61:a	70:	66:b	43:a	38:	37:a	22:a	16:
Camp 7, Staten Island	:ab 87:ab	91:b	78:a	71:a	63:b	59:ab	54:a	42:
Tyler Island Ferry	3:a	3:	2:b	1:a	2:	1:	2:	2:
Camp 11, Staten Island	:ab 94:ab	86:b	82:a	77:a	72:b	69:ab	64:a	60:
Camp 29, Staten Island	:a 87:a	74:	75:b	65:a	56:	55:a	44:a	37:
Eagle Tree	:ab 36:ab	39:b	50:a	53:a	57:b	56:ab	55:a	57:

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 (CONTINUED)							
	2	6	10	14	18	22	26	30
Mokelumne River Delta (Continued)								
Camp 25, Staten Island	a 116	a 100	92	b 89	a 83	78	a 68	a 67
New Hope Bridge	a 22	a 30	50	37		b	64	a 45
Camp 20, Staten Island	a 116	a 114	110	b 104	a 102	96	a 91	a 89
San Joaquin River Delta								
Antioch	945	a 820	875	a 785	760	725	690	610
Curtis Landing	a	695	705	b 635	660	660	ab 475	a 465
Jersey	a	600		a	430	532	435	a 390
Webb Pump	390	b 430	405	400	332	327	292	a 260
Central Landing	188		151	a 99	a 172	98	93	a 62
Dutch Slough	a 410	a 384	ab 387			348	337	323
Ward Landing	278	a 225	270	a 216	a 246	185	212	132
Holland Dam	a	328	305	bd 310	a 303	302	292	282
Holland Pump	a	292	290	bd 283	a 279	270	263	256
McDonald Pump	e	266	ad 269	e 219	e 197	e 215	e 201	e 187
Mandeville Pump	a 320	a 311	304	a	283	276	287	a 255
King Island Pump	220	a 216	224	a 230	b 223	200	199	191
Rindge Pump	e 172	a 187	183	b 155	a 141	130	133	a 106
Orwood Bridge	277	b 268	272	cd 254	b 259	244	235	d 232
East Contra Costa I.D.	a 180	a 187	199	b 189		200	197	
Middle River P.O.	a 260	a 268	ab 268	a 229	a 257	253	ab 215	a 232
Mansion House	a 236	a 240	237	b 220		234	ab 195	
Stockton Country Club	a 87	ac 91	ab 89	a 80		49		
Clifton Court Ferry	109	a 112	125	b 66	a 103	69	61	21
Stockton	130	b 76	74	b	84	89	73	51
Garwood Bridge	a	46	43	a 13	a 19	25	17	a 13
Brandt Bridge	a 9	a 8	8	a 8	a 8	8	8	a 8
Williams Bridge	a 21	b 19	24	b 11	c 11	8	8	11
Whitehall	a 11	a 12	8	b 8	b 8	8	8	a 9
Mossdale Bridge	a 8	a 8	8	b 8	a 7	8	ab 8	a 9
Durham Ferry Bridge	7	c 5	c 6	c 6	c 6	7	8	9
Drainage Water Stations								
Jersey Drain		78			63	60	60	83
Grand Is.Dr.(Steamboat Sl.)	e	62	e 63	e 52	e 19	e 25	e	13
Camp 35 Dr. (Staten Is.)	b 119	b 112	b 99	93	80	91	b 59	59
Bacon Is.Drain	133	191	190	204	255	247	206	182
Mandeville Drain	195		196	187	188	186	191	187
Camp 11 Dr. (Staten Is.)	b 100	b 102	b 95	79	48	34	b 58	45

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 and Suisun Bays								
Point Orient	1755:		1785:	1761:	1735:	1780:	1720:	1770:
Point Davis		1490:	1590:	1510:	1515:	1455:	1470:	1370:
Bulls Head Point	1345:	1300:	1360:	1385:a	1040:	1010:	1230:	1080:
Bay Point		:ab1095:b	1155:	1070:a	930:	850:	970:	840:
O and A Ferry	825:	740:	780:	815:	595:	655:	640:	610:
Innisfail Ferry		1030:	945:	935:	985:	1015:a	870:	720:
North San Pablo Bay								
Grandview	:a 1775:		1740:		1650:		1690:	
Cuttings Wharf	1640:		1585:		1500:		:a 1470:	
Sacramento River Delta								
Collinsville	:a 520:	510:	590:a	525:	455:	380:a	255:a	282:
Emmaton		253:	289:a	253:	163:	85:	153:	100:
Three Mile Slough Bridge	270:ab	202:	231:	246:	113:	84:a	44:	75:
Rio Vista Bridge	153:	128:	132:	128:	28:	32:	19:	11:
Junction Point	:a 68:		76:a	30:	13:	7:	4:	4:
Liberty Ferry	66:	57:	39:a	29:	21:	10:	10:	10:
Isleton Bridge	3:	18:	37:	4:	2:	1:	4:	1:
R. D. 2068	:a 167:	145:	127:		76:	82:		80:
Sacramento	:a 2:	1:ab	2:a	1:	1:ab	2:a	2:a	2:
Mokelumne River Delta								
Southwest Point	:a 41:	42:a	24:a	28:	19:	6:a	13:a	5:
Camp 33, Staten Island	:a 14:	14:a	9:a	10:	11:	9:a	6:a	6:
Camp 7, Staten Island	:ab 38:ab	31:ab	30:ae	32:b	27:b	24:ab	23:ab	31:
Camp 11, Staten Island	:ab 59:ab	52:ab	49:ae	52:b	45:b	38:ab	41:ab	46:
Camp 29, Staten Island	:a 28:	21:a	19:a	20:	17:	17:a	12:a	21:
Eagle Tree	:ab 60:ab	57:ab	57:ae	59:b	56:b	53:ab	53:ab	51:
Camp 25, Staten Island	:a 52:	55:a	44:a	42:	37:	40:a	33:a	40:
New Hope Bridge	:a 48:	48:ab	48:a	48:	47:	52:	:a	32:
Camp 20, Staten Island	:a 85:	78:a	75:a	72:	62:	62:a	53:a	57:

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 (CONTINUED)							
	2	6	10	14	18	22	26	30
San Joaquin River Delta								
Antioch	560	485	560	535	430	333	375	
Curtis Landing	a 430	465	390 a	430	365 ab	215	305 a	215
Jersey	a 360				ab	245		
Webb Pump	221	216	235	185	169	132	128	109
Central Landing	a 76	71	45 a	73	15	72	74 a	18
Dutch Slough	a 290	282	280 a	247			a	185
Ward Landing	201	146	163 a	139	154	148	136	132
Holland Dam	a 267	261	253 a	241				
Holland Pump	a 253	241	229 a	217				
McDonald Pump	190 d	171 d	175 d	149	152	b	170	
Mandeville Pump	a 237	234	225 a	203	201	201	a	168
King Island Pump	172	151 ab	167	140	130 ab	143	123	114
Rindge Pump	a 76	106 a	107 a	84	82	88	74 a	57
Orwood Bridge	223	210	209	199	181 c	171	163	150
East Contra Costa I.D.	a 172	159	154 a	133		126 a	99 a	100
Middle River P.O.	a 221 ab	205	212 a	198	181 ab	172 a	168 a	153
Mansion House	a 170	185	184 a	188		114	a	120
Stockton Country Club					ab	25 a	26	
Clifton Court Ferry	a 12		a	15	28	18	13 a	11
Stockton		71	55	58	58		45	
Garwood Bridge	a 12	16	12 a	15	17	14 a	11 a	9
Brandt Bridge	a 9	10	12 a	9				
Williams Bridge	20	11	14	11	11	9	11	7
Whitehall	a 9	9	10		8		8 a	10
Mossdale Bridge	a 11	10 d	10 a	9				
Drainage Water Stations								
Jersey Drain	68				b	94		
Grand Is.Dr.(Steamboat Sl.)	21	21	22	17	51	21	16	17
Camp 35 Dr. (Staten Is.)	b 54 b	61 b	53 e	54 b	111	50 b	62	46
Bacon Island Drain	175	168	160	96	176	96	68	63
Mandeville Drain	184	180	180	176	176	172		165
Camp 11 Dr. (Staten Is.)	b 74 b	62 b	64 e	59 b	73	60 b	51	48

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 and Suisun Bays								
Point Orient	bd1750	1660	1820	1680	1660	1650	1680	1350
Point Davis	1390	1400a	1500	1320	1310	1415	a	385
Bulls Head Point	a 1020	1220	1235	975a	965	1235	1020	95
Bay Point	880	960		730a	690	950		45
O and A Ferry	500	480	460			635	20b	20
Innisfail Ferry	820b	700	750	775	690	665	480	290
North San Pablo Bay								
Sonoma Creek Bridge				a 1385				
Grandview	1740		1660		1640		1300b	400
Vallejo	b 1270		1210			c 432		
Cuttings Wharf	a 1320		d 1400		1275		440	
Sacramento River Delta								
Collinsville	290	320	370a	245	222	293	96	21
Emmaton	110		164	68	49d	88a	10a	4
Three Mile Slough Bridge	a 64	60						
Rio Vista Bridge	22	18	19	5	3	3	1	2
Junction Point	5							
Liberty Ferry		8						
Isleton Bridge	1	1						
R. D. 2068	54	72a	58					
Sacramento	1ab	1a	1a	2	3ab	1a	1	1
Mokelumne River Delta								
Southwest Point	21	28e	63ae	11	16			
Camp 33, Staten Island	6	4						
Camp 7, Staten Island	b 16	b 10						
Camp 11, Staten Island	b 30	b 26	21a	42e	8			
Camp 29, Staten Island	11	7e	6ae	12	11	7		
Eagle Tree	b 48	b 44						
Camp 25, Staten Island	38	24						
New Hope Bridge	30		44a	30	32	a	2	
Camp 20, Staten Island	51	43e	39ae	44	44	40		

a, b, c, d, e, f, See footnotes last page of this table.

TABLE 90 (CONTINUED)

SALINITY OBSERVATIONS, SACRAMENTO-SAN JOAQUIN DELTA AND UPPER BAYS, 1931
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 (CONTINUED)							
	2	6	10	14	18	22	26	30
				San Joaquin River Delta				
Antioch	268:	300:	390:	250:	220:	273:	113:	34:
Curtis Landing	:	237:	239:	173:	164:	161:	104:	:
Jersey	150:	:	:a	98:	:	134:	82:	:
Webb Pump	:b 102:	94:	92:a	91:	76:	66:	57:	:
Central Landing	20:	34:a	34:	31:	56:	26:a	11:	13:
Dutch Slough	:	154:a	138:	:	122:	79:	:	:
Ward Landing	122:	116:	80:a	72:	71:	:	52:	32:
Holland Dam	160:	167:a	155:a	147:ab	131:	121:a	89:	92:
Holland Pump	177:	150:a	137:a	123:	99:	96:	86:	58:
McDonald Pump	:e 84:e	146:de	140:e	117:e	104:e	97:	:	:
Mandeville Pump	165:	150:a	144:a	134:	129:	116:a	97:	61:
King Island Pump	:	108:	130:	:	93:	84:	73:	63:
Rindge Pump	64:	56:	56:a	48:	28:	33:a	7:	3:
Orwood Bridge	130:	128:	119:b	82:	72:	72:	63:a	29:
East Contra Costa I.D.	86:	82:	70:a	62:	54:	51:a	43:	31:
Middle River P.O.	145:b	124:	110:a	100:	88:	91:	72:	51:
Mansion House	:e 94:ab	98:	99:a	98:	128:a	53:	13:	16:
Stockton Country Club	:	22:a	22:a	19:	:	18:a	12:	:
Clifton Court Ferry	9:	10:	12:a	9:	10:	9:	8:	9:
Stockton	:	:	:	:ab	47:a	38:	40:	:
Garwood Bridge	10:	10:	:	:	:	:	:	:
Mossdale Bridge	11:	6:a	8:	:	7:	8:a	8:	2:
				Drainage Water Stations				
Jersey Drain	77:	:	:	96:	:	90:	83:	:
Grand Is.Dr.(Steamboat Sl.)	c 24:c	18:	:c	14:	:	10:c	15:	:
Camp 35 Dr. (Staten Is.)	:b 43:	38:	46:	24:	48:	:	:	:
Bacon Island Drain	:	42:	33:	53:	60:	45:	50:	49:
Mandeville Drain	162:	160:	162:	155:	149:	143:	128:	114:
Camp 11 Dr. (Staten Is.)	:b 55:	56:	50:	29:	63:	:	:	:

(a) Low high tide.
(b) Taken on following day
(c) Taken two days later.
(d) Over one hour off scheduled time.
(e) Taken on preceding day.
(f) Taken two days earlier.

CHAPTER VIII

LOSSES IN THE SACRAMENTO VALLEY AND DELTA DUE TO 1931 WATER SHORTAGE

At the close of the 1924 season and other past seasons when a water shortage has been experienced in the Sacramento-San Joaquin area, there has always been considerable inquiry as to the extent of losses which may have been sustained due to the water shortage and, in the case of the Delta, the resulting salinity. These questions could not be answered because no investigation had been made in any of those seasons to determine the losses, and approximations were difficult. Early in 1931, therefore, with all indications pointing to a serious water shortage, plans were made for an investigation and determination of the losses which it appeared would be inevitable. This investigation was conducted throughout the season and the results are presented in this chapter. The losses fall naturally under two classifications: those in the territory served by the Sacramento River above Sacramento and those in the Delta due to salinity; and they are so reported.

LOSSES IN THE SACRAMENTO RIVER AREA ABOVE SACRAMENTO

Losses directly chargeable to the water shortage in the area served by the Sacramento River above Sacramento may be classified as follows: (1) Crop Losses - under which fall losses due to (a) abandonment of preliminary work or of plans for planting because of threatened shortage, (b) changes from rice plantings to crops requiring less water (c) abandonment of crops because of water shortage and (d) reduced yields because of insufficient water; (2) Losses represented by expenditures required to rearrange and lower pumping installations, (3) Losses due to the increased cost of pumping under greater lifts.

Crop Losses

In the investigation of these losses, great difficulty was encountered in obtaining definite data. It may have been very evident that a loss under one or more of the classifications outlined had been sustained but the water user was either reluctant or unable to place an estimate upon it. Also, where estimates were obtained, it was found impracticable to segregate them to the definite classifications given. Although a representative of practically every diversion on the river was interviewed, and in the larger districts many of the individual water users were canvassed, the total of the definite figures obtained for crop losses was $6620.

Additional Expenditures for Lowering and Changing Pump Installations

On many sections of the river in 1931 the water receded to record low levels and many pump owners found that such levels had apparently not been anticipated when their pumps were installed. In frequent instances the water fell below the suction pipes or the suction lift was so greatly increased that the pump would not operated. This necessitated expenditures to lengthen the suction pipes and lower the pumps. Various other pumping plant repairs incident to the low river levels were also required. All of the river plants were included in the investigation of these expenditures and the total reported to have been spent was $7425.

Increased Pumping Costs

In order to determine the increase in 1931 pumping costs due to the low river levels, the pumping lifts of 1931 were compared to those of 1927. The seasonal stream flow of the Sacramento River at

TABLE 91

COSTS OF PUMPING THE DIVERSIONS OF 1931 IN EXCESS OF THE COSTS FOR PUMPING THE SAME DIVERSIONS WITH 1927 RIVER STAGES.
SACRAMENTO RIVER, RED BLUFF TO SACRAMENTO

MONTH	AVERAGE AMOUNT RIVER WAS LOWER IN 1931 THAN IN 1927 — FEET	1931 DIVERSIONS ACRE-FEET	COSTS OF 1931 PUMPING IN EXCESS OF COSTS FOR PUMPING THE 1931 DIVERSIONS WITH 1927 RIVER STAGES — DOLLARS
RED BLUFF TO BUTTE CITY			
APRIL	8	83268	14000
MAY	5	110128	5890
JUNE	2	91596	3010
JULY	2	105271	1920
AUGUST	1	92878	1510
SEPTEMBER	1	43005	40
OCTOBER	1	18015	1110
TOTAL		544161	27480
BUTTE CITY TO COLUSA			
APRIL	18	14700	2150
MAY	10	19836	1100
JUNE	7	17800	1200
JULY	5	19499	830
AUGUST	5	12324	620
SEPTEMBER	3	3790	150
OCTOBER	3	1438	100
TOTAL		89387	6150
COLUSA TO KNIGHTS LANDING			
APRIL	19	80989	20700
MAY	14	74677	11600
JUNE	9	68530	7220
JULY	5	63270	6400
AUGUST	3	53283	2850
SEPTEMBER	2	24494	0
OCTOBER	2	6847	110
TOTAL		372090	48880
KNIGHTS LANDING TO VERONA			
APRIL	18	4371	1060
MAY	16	3978	860
JUNE	10	3964	740
JULY	6	4014	390
AUGUST	3	3020	220
SEPTEMBER	4	1021	90
OCTOBER	3	531	160
TOTAL		20899	3520
VERONA TO SACRAMENTO			
APRIL	17	20326	6910
MAY	14	26938	5700
JUNE	10	24147	2670
JULY	4	28380	810
AUGUST	3	25920	580
SEPTEMBER	3	7946	220
OCTOBER	2	2718	10
TOTAL		136375	16900
TOTAL — RED BLUFF TO SACRAMENTO			
APRIL		203654	44820
MAY		235557	25150
JUNE		206037	14840
JULY		220434	10350
AUGUST		187425	5780
SEPTEMBER		80256	500
OCTOBER		29549	1490
TOTAL		1162912	102930

Red Bluff in 1927 exceeded the mean for the forty-year period 1889-1929 by seventeen per cent. It was considered, therefore, that the departure of the 1931 river levels from those of 1927 would furnish a fair basis for the computation of increased pumping costs in 1931 chargeable to the water shortage and low river levels of that season. A comparison of the minimum river levels of 1927 and 1931, Sacramento to Red Bluff, is shown on Plate 1, Chapter II.

The monthly records of kilowatt hours consumed in 1931 were available for each pumping plant and from these the 1931 pumping costs were derived by application of the appropriate rate schedule. The power that would have been required to pump the 1931 diversions under the pumping heads of 1927 was then computed and the rate schedule applied to derive the comparative 1927 costs. The resulting figures for the difference between the 1927 and 1931 costs are given in Table 91. This shows that from Red Bluff to Sacramento the total increased cost of pumping chargeable to the 1931 water shortage and low river levels was $102,930.

Other Probable Losses

The losses that have been enumerated total $117,000 but this figure probably represents the very minimum of the direct losses and takes no account of other less tangible losses. Instances of the latter were evident throughout the course of the investigation but it was not possible to define them in terms of money. In general, however, such losses were represented by the many and varied additional activities and expenditures required to meet the conditions of curtailed water supplies and to effectively enforce conservation and waste prevention measures.

LOSSES IN THE SACRAMENTO-SAN JOAQUIN DELTA DUE TO ENCROACHMENT OF SALINITY FROM SAN FRANCISCO BAY

Outline of Investigation

Since the beginning of salinity observations in the Sacramento-San Joaquin Delta it has been recognized that in years of deficient Spring and Summer stream flow to the Delta, the resulting extensive encroachment of salinity from San Francisco Bay has caused damage in the Delta. In 1930, 1924, and 1926, but particularly in 1924, the magnitude of the encroachment was such as to leave no doubt that damage must have been sustained. But just what the extent of the damage or the total of crop and other losses might have been, was not determined. In the Spring of 1931 it was plainly evident that the stream flow to the Delta would probably be as low if not lower than it was in 1924 and that a salinity encroachment as great if not greater than in that year could be expected. With this expectation, therefore, the investigation to determine the losses in the Delta due to salinity or to at least derive an approximate definition of the relation between salinity encroachment and losses, was planned as the major activity of the loss investigations.

Procedure and Field Methods

As described in Chapter VI, an engineer is detailed each season to obtain a complete Delta census of the irrigated and non-irrigated crops, and the acreages of aquatic growths, weeds, bare lands, water surfaces, etc., and it was considered that the additional Delta investigation of losses in 1931 could be most advantageously handled as a part of the same detail. Much more time was going to be required,

however, and accordingly beginning in July, an additional assistant was assigned, to devote his entire time to the Delta census and investigation of losses.

At the outset it was recognized that crop losses would represent the greatest item of damage and perhaps the only one possible of definite valuation. Forms, to be used in the field, covering every item with respect to crops which might conceivably be needed in the valuation of crop losses, were, therefore, prepared and used. No fixed forms for reporting items of loss other than those connected with crops were used and such other items were reported only in a general way or by special report. The first field form provided for a detailed report of acreage, irrigation methods, dates of planting and harvest, production, unit value, total value, and record of the dates of irrigation, for each crop. The irrigation record was particularly important for use in conjunction with maps prepared later from which the degree of salinity at a given location for any particular time could be determined. A second form was used in reporting the data with respect to losses. If a loss were reported for any item of the first form, detail data with respect to this item were entered on the second form, such as, the date irrigation was stopped because of high salinity or the dates when water of greater than 100 parts chlorine was used, the effect on growth and yield of use of water of high salinity or of curtailment of irrigation, the loss in production and its value, acreage abandoned or not planted on account of high salinity and the amount of this loss, etc. The investigation required that these two forms be filled in from data obtained by actual contact with the owners, lessees or water users and/or by the engineer's own field observations,

for each individual subdivision of every island or tract in the Delta.

Instructions to Field Men

The field men were instructed, insofar as possible, to obtain all data by direct observation and not from hearsay. Information from landowners although essential was to be considered more or less supplemental, especially in connection with such items as crop growth, damage and yield. Estimates from owners and growers were to be carefully checked and substantiated insofar as possible. Detail observations were to be made of crop growth and all conditions affecting it, with particular attention to be paid to the comparative growth, as between areas of high and low salinity, of like crops under conditions otherwise similar. Especial emphasis was placed upon the necessity for observation and recognition of factors other than salinity such as insects, poor farming, sunburn, etc., likely to affect crop growth and yield.

Segregation of Losses

This report of losses in the Sacramento-San Joaquin Delta due to salinity in the 1931 season falls into two major segregations, "Crop Losses" and "Other Losses". Crop Losses may be further segregated to what might be called "Tangible" and "Intangible" losses. Under tangible losses is classed the actual loss in production of crops in 1931 due to (1) the curtailment of irrigation when the salinity of the irrigation water became too high, (2) the actual application of irrigation water of too high salinity, and (3) the abandonment of a crop, or plans for it, because of high salinity. The classification of intangible losses will be considered subsequently.

Tangible Crop Losses

To arrive at the tangible losses as outlined, all of the data of the field forms were thoroughly reviewed, summarized by islands and crops and compiled as shown in Table 92. Under the three classifications of tangible crop losses, this table shows, segregated by crops, the total losses, in production and money. It is to be noted that the estimates of loss in money represent the market value of the lost production and as such might be termed the gross loss as distinguished from net loss represented by the net profit which the grower might have realized had he been able to market the crops lost. As shown by Table 92, the market value of the Delta crops estimated to have been lost because of salinity in 1931 totals $1,263,716. Of this amount, $890,906, or 70 per cent of the total, is the loss estimated to have resulted from curtailment of irrigation, $357,640 or 29 per cent, the loss due to actual application and use of water of too high salinity and $15,170 or one per cent, the loss due to destruction of permament plantings and to abandonment of crops or plans therefor because of high salinity.

Detail Check of Reported Losses

In the review of the losses reported for each of the individual subdivisions all estimates were carefully checked by comparison with average figures for production and unit prices throughout the Delta, and if it appeared that the estimated loss in production had been based upon a total production expectancy out of proportion to the average or normal figures, the estimates of loss were correspondingly reduced. In addition, the degree of salinity corresponding to the reported

TABLE 92

SUMMARY, BY CROPS, OF 1931 CROP LOSS IN THE SACRAMENTO-SAN JOAQUIN DELTA DUE TO SALINITY.
LOSS EXPRESSED IN PRODUCTION AND DOLLARS

CROP	LOSS EXPRESSED IN PRODUCTION – P: MARKET VALUE $:	ESTIMATED LOSS DUE TO CURTAILMENT OF IRRIGATION	ESTIMATED LOSS DUE TO USE OF WATER OF TOO HIGH SALINITY	ESTIMATED LOSS DUE TO DESTRUCTION OR ABANDONMENT OF PLANTINGS	TOTAL LOSS IN DOLLARS
ALFALFA	P	9135 TONS	400 TONS	347 ACRES	
	$	90460	4000	5400	99860
ASPARAGUS	P	275 TONS		149 ACRES	
	$	16515		3100	19615
BEANS	P	53377 SACKS	620 SACKS		
	$	171078	1508		172586
BEETS	P	22957 TONS	820 TONS		
	$	150920	6150		157070
CELERY	P	325 CARS	618 CARS		
	$	80945	255626		336571
CORN	P	4503 TONS	886 TONS	318 ACRES	
	$	95330	18175	4660	118165
FRUIT	P	315 TONS	8 TONS	2 ACRES	
	$	9300	400	500	10200
GRAIN HAY	P	356 TONS			
	$	3560			3560
ONIONS	P	20720 SACKS			
	$	29710			29710
PASTURE	P	1116 ACRES	205 ACRES	280 ACRES	
	$	2380	100	660	3140
POTATOES	P	306200 SACKS	70800 SACKS		
	$	220500	54821		275321
SEED	P	181 ACRES	*13700 SACKS		
	$	3530	10200		13730
TRUCK	P	**	252 TONS	34 ACRES	
	$	16678	6660	850	24188
TOTAL LOSS IN DOLLARS		890906	357640	15170	1263716

* POTATOES.
** USE OF BOTH TON AND ACREAGE UNITS PRECLUDES TOTAL.

irrigation period was checked to determine whether or not the reported loss might reasonably be assumed to have resulted from salinity or from other causes, and to define where possible, the degree of salinity causing damage to various crops under different conditions. The check of the salinity at the various Delta tracts for different times and periods of the season was accomplished by using maps similar to those shown on Plate 7 (Chapter VII) but to a larger scale. As a result of the detailed check of all figures as outlined, it is considered that the total of the tangible crop losses as shown by Table 92 represents a conservative estimate.

Comparison of Crop Losses and Total Production Value

Table 93 shows the estimated value of the actual 1931 irrigated crop production, segregated by crops, and indicates a total for the Delta of $22,657,663. In the compilation of the actual production and its value, the data on the field forms were not always complete and it was necessary in frequent instances to partially estimate either production, or the unit price to apply to the given production. This was done by comparison with known data for similar crops in adjoining tracts, due consideration being given to any modifying factors noted in the reports or known to exist.

For reasons explained later it was desirable in this compilation to make a segregation with respect to the Delta area within the limits of the maximum encroachment during the season of salinity of 100 parts of chlorine per 100,000 parts of water, and this segre-

TABLE 93

SUMMARY, BY CROPS, OF IRRIGATED ACREAGE, VALUE OF ACTUAL PRODUCTION, AND CROP LOSS DUE TO SALINITY, FOR TOTAL SACRAMENTO-SAN JOAQUIN DELTA AREA AND AREA WITHIN 100 PART SALINITY ENCROACHMENT, 1931

LOSS EXPRESSED IN DOLLARS AND IN PER CENT OF VALUE OF TOTAL PRODUCTION (INCLUDING LOST PRODUCTION) IN (1) TOTAL DELTA AREA AND (2) AREA WITHIN 100 PART SALINITY ENCROACHMENT

CROP	ENTIRE DELTA			AREA WITHIN 100 PART SALINITY ENCROACHMENT		CROP LOSS IN PER CENT OF VALUE OF TOTAL IRRIGATED CROP PRODUCTION**	
	IRRIGATED ACREAGE	VALUE OF ACTUAL PRODUCTION IN DOLLARS	* CROP LOSS DUE TO SALINITY IN DOLLARS	IRRIGATED ACREAGE	VALUE OF ACTUAL PRODUCTION IN DOLLARS	WITHIN AREA OF 100 PRT. SALINITY ENCROACHMENT	ENTIRE DELTA
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ALFALFA	26882	1352621	99860	12651	542711	15.54	6.88
ASPARAGUS	70580	7254899	19615	55549	5695349	0.34	0.27
BEANS	26992	775794	172586	14296	404286	29.92	19.21
BEETS	30915	3128314	157070	17362	1820595	7.94	4.78
CELERY	6303	1640043	336571	6125	1564193	17.71	17.03
CORN	55798	1360921	118165	50081	1224840	8.80	7.99
FRUIT	10775	1364724	10200	7075	1011006	1.00	0.74
GRAIN & HAY	65086	900034	3560	46126	616338	0.57	0.39
ONIONS	3769	982244	29710	2068	512778	5.48	2.94
PASTURE	12748	66284	3140	10254	50614	5.84	4.52
POTATOES	18042	2802585	275321	17747	2788710	8.99	8.94
SEED	8967	499188	13730	3547	150666	8.35	2.68
TRUCK	6498	530012	24188	2110	199316	10.82	4.36
TOTALS	343355	22657663	1263716	244991	16581402	7.08	5.28

* PRACTICALLY ALL WITHIN AREA OF 100 PART SALINITY ENCROACHMENT (SEE PLATE 13).
** INCLUDING VALUE OF LOST PRODUCTION.

gation is shown in Table 93. For each crop, this table shows for the total Delta area and for the area within the 100 part salinity encroachment, the acreage irrigated and the estimated value of the actual production. It shows also, for each crop, the estimated total loss due to salinity, in dollars and in per cent of the total value of production (1) in the area within the 100 part salinity encroachment, and (2) in the total Delta area. It should be noted that the total value or production used in deriving these percentages is the value of the actual production plus the value of the production estimated to have been lost. In the case of the percentage of total production value for the area within the 100 part salinity encroachment, the assumption was made that the total Delta loss in production, as given, occurred entirely within this area, and as shown by Plate 13 and later consideration, this assumption is essentially correct. From Table 93, then, it is seen that the tangible crop losses in 1931 amounted to 5.28 per cent of the total value of the Delta's irrigated crops or 7.08 per cent of the value of the irrigated crops within the area of 100 part salinity encroachment.

Intangible Crop Losses

As to the crop losses termed herein as intangible, it is only possible to outline their character. These are losses which the field evidence and analysis would indicate must surely have been sustained or may yet be suffered but for which the data are insufficient to form any definite estimate. Probably the most important loss of this character is that to be expected due to the effects of 1931 salinity on the crops of 1932 and even subsequent years. Because of high

salinity considerable acreages supporting permanent crops such as fruit, asparagus, etc., were not irrigated when they should have been. As a result it is claimed that buds were not properly formed for next year's crop in the case of fruit and the proper development to produce the desired quantity and quality of next season's spears was retarded in the case of asparagus, etc. Normally, considerable grain land is flooded in the Fall preparatory to planting. This was prevented by high salinity in the Fall of 1931 and may effect the yields of 1932. Perhaps as serious as the effects of non-irrigation in 1931 may be the reduction in future yields of all crops due to impregnation of the soil with water of high salinity and the deposits of salt. Where flooding and drainage facilities are at hand to flush the soil after Winter stream flow has caused the salinity to recede, this may be overcome. In the case of early season crops in the lower Delta, however, and where the flushing cannot readily be accomplished the accumulated salt will remain as a source of considerable damage to future yields. As a minor loss, perhaps, the probable reduction in 1932 yields because certain peat lands could not be burned over in the Fall of 1931, has been noted. It is the practice on some peat areas to burn off two inches or so of the surface to kill nematodes and other pests and this has resulted in greatly increased yields in the following season. To extinguish the fires the island or tract is flooded through the irrigation system or by opening flood gates in the levees. Because of the high salinity of the water in the Fall of 1931 it was not advisable to use the water for this purpose, entailing the danger of depositing salt on the land, and the burning operations were accordingly foregone.

In some of the asparagus and other areas where interplanting

is generally practiced, it was claimed as a loss due to salinity, that it was necessary to refrain from interplanting in 1931. Although the asparagus or the permanent crop might survive successfully the non-irrigation because of high salinity, the grower feared to risk the planting and necessary irrigation of the intercrop.

Other Than Crop Losses

Of the items of 1931 damage from salinity, other than to crops, noted but not defined, may be mentioned: The killing in some areas of the willows which form bank protection along the levees. With this protection gone the banks are subject to damage from wave action, etc. Damage in the nature of extra expenditures required to obtain fresh water supplies by drilling wells, buying water, etc. A great many instances were noted where the growers put down new wells and utilized this source of water for irrigation during the period of high salinity. In some cases the well water was used to dilute the channel supply. Expenditures for new or supplemental domestic and municipal water supplies were required. Dairymen were obliged to obtain fresher water for their stock to drink. In a case noted where the cows had been drinking water from the channel, the dairyman was notified that his percentage of milk solids had dropped below the permissible amount. He was advised by a chemist that the drinking of saline water would cause the milk solids to decrease, and immediately put down wells to supply the dairy with water. Within a week the reports indicated that the milk had returned to standard specifications. Numerous instances were reported of sickness of all kinds of stock due to the drinking of water of too high salinity and in most cases it

was necessary to resort to the use of well water to remedy the conditions.

ESTIMATE OF PAST CROP LOSSES DUE TO SALINITY

It has been stated that no comprehensive investigation of Delta losses due to salinity in years previous to 1931 was ever made. However, with the data of 1931 and the complete salinity and crop data for all years beginning with 1924 available, it appeared that reasonably correct estimates of the losses in these past years might be possible, and the remainder of this chapter gives the results of a study which was made to derive these estimates for the years 1924 to 1930.

Method and Assumptions in Estimating Past Losses

Briefly stated, the method followed to estimate the crop losses due to salinity in past years, was to apply the 1931 relation between losses and total production value within the area of 100 part salinity encroachment to the corresponding total production value in past years. This application involved the assumptions, first, that the area, crop acreage and corresponding production value within the area of 100 part salinity encroachment can be taken as proportionate to, or as close indices of the losses due to salinity, second, that in each past year the loss for each crop in per cent of the total value of its production within the area of 100 part salinity encroachment would have been the same as in 1931 and, third, that the value of production per acre for each crop would have been uniform throughout the Delta had there been no loss due to salinity.

Area Within 100 Part Salinity Encroachment as Crop Loss Index

The facts in support of the first assumption were brought

out when, in comparing the 1931 position of various degrees of salinity at different periods of the season with the Delta area in which salinity losses were reported, it was found that as far as areas are concerned, probably the best index of crop losses due to salinity is the area or irrigated acreage within the maximum seasonal encroachment of 100 parts of salinity. This is well shown by the close approach to coincidence of the two limits shown on Plate 13. The heavy dotted line is the limit of the 100 part salinity encroachment into the Delta in 1931 and the heavy solid line is the limit or boundary of the area in which crop losses due to salinity were reported in 1931. As indicated by this plate, the Delta area within 100 part salinity encroachment may practically be taken as the area within which crop losses due to salinity are confined.

Equation for Deriving Past Losses

Under the second assumption of the method outlined for the estimate of losses in past years, the percentages of Column 7, Table 93 were to be applied to the production value within the area of 100 part salinity encroachment for each past year to derive the loss for that year by each crop. It was required therefore to obtain for past years the best possible estimates of the value of the actual crop production within the area of 100 part salinity encroachment. Investigation proved that it would be very difficult to obtain these data but, as later outlined, it was found that satisfactory estimates of the value of the actual production in the entire Delta could be derived for the years 1924 to 1930, inclusive. It then became essential to establish the relation between these data and the production values

within the area of 100 part salinity encroachment in order that the percentages of Column 7, Table 93 might still be applied to derive the losses. The ratio, for each crop, of the acreage within the area of 100 part salinity encroachment to the acreage in the entire Delta, was needed. The acreage data for the entire Delta were available from the Water Supervisor reports and it was possible from large scale maps showing, similar to Plate 6 (Chapter VII), the position of the 100 part salinity encroachment each year 1924 to 1931, and from the detail crop data in the Water Supervisor reports for the same period, to tabulate for each irrigated crop and for each year, the acreage within the 100 part line. These data are shown in Table 94. With the ratios thus established and using the third assumption that production value per acre for each crop would be the same throughout the Delta if there were no loss due to salinity, it can be shown that the value of the actual production within the area of 100 part salinity is derived from the following equation:

$$V_S = V\frac{A_S}{A} - L + L\frac{A_S}{A} \qquad (I)$$

where V_S = Value of actual production within area of 100 part salinity

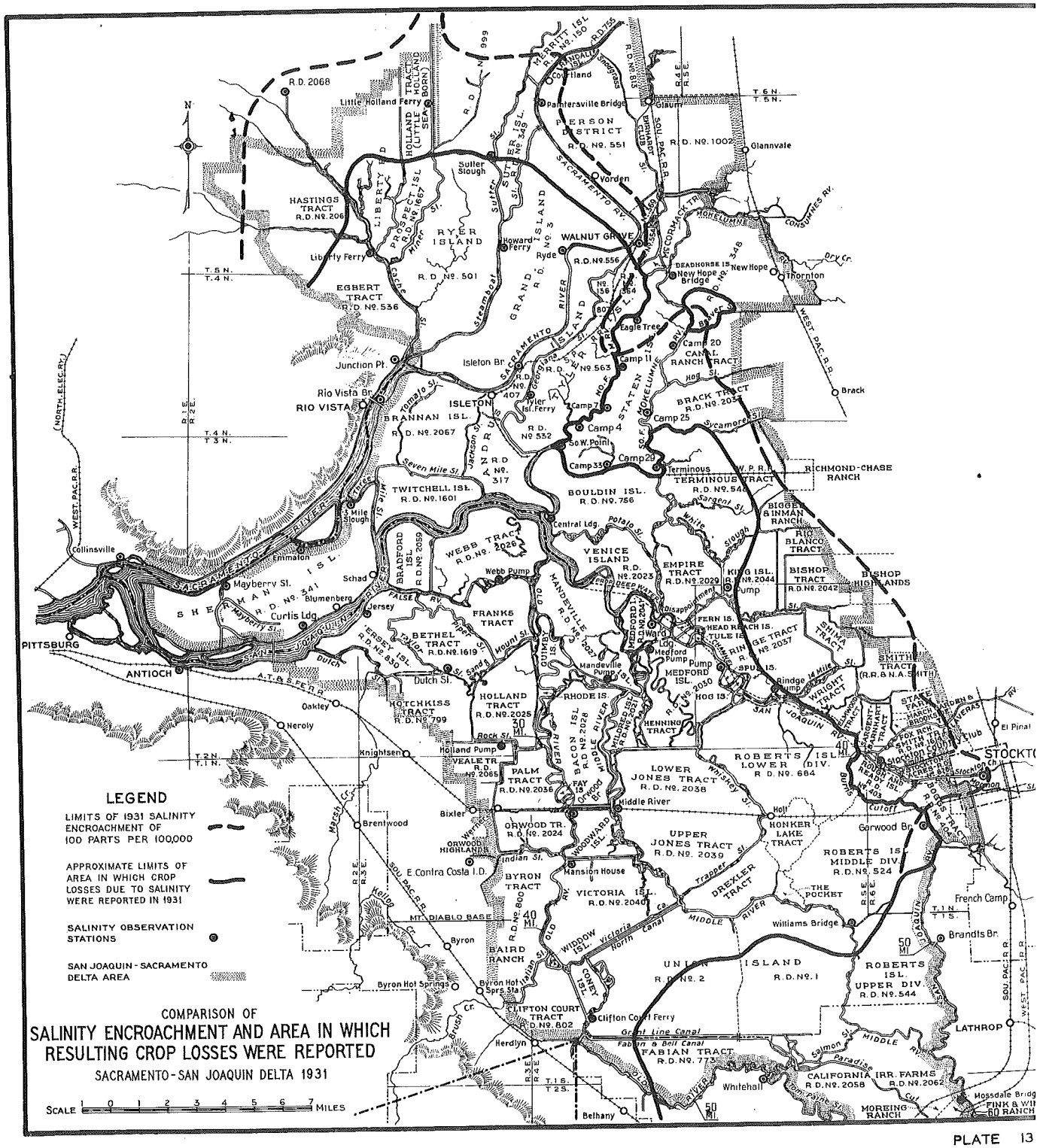
V = Value of actual production in entire Delta

A = Acreage of crop in entire Delta

A_S = Acreage of crop within area of 100 part salinity

L = Crop loss due to salinity - Assumed to be all in area A_S

But according to the loss computation method adopted and the second assumption:


LEGEND
LIMITS OF 1931 SALINITY ENCROACHMENT OF 100 PARTS PER 100,000
APPROXIMATE LIMITS OF AREA IN WHICH CROP LOSSES DUE TO SALINITY WERE REPORTED IN 1931
SALINITY OBSERVATION STATIONS
SAN JOAQUIN - SACRAMENTO DELTA AREA
COMPARISON OF
SALINITY ENCROACHMENT AND AREA IN WHICH RESULTING CROP LOSSES WERE REPORTED
SACRAMENTO - SAN JOAQUIN DELTA 1931
SCALE 0 1 2 3 4 5 6 7 MILES
N
R.D. 2068
Little Holland Ferry
HOLLAND TRACT (LITTLE SEA BORN)
Courtland
Pantersville Bridge
PERSON DISTRICT R.D. Nº. 551
R.D. Nº. 1002
Glannvale
Sutter Slough
Vorden
HASTINGS TRACT R.D. Nº. 206
Liberty Ferry
RYER ISLAND R.D. Nº. 501
Howard Ferry
Ryde
WALNUT GROVE R.D. Nº. 556
New Hope Bridge
Thornton
EGBERT TRACT R.D. Nº. 536
Junction Pt.
Isleton Br.
ISLETON
Eagle Tree
Camp 20 CANAL RANCH TRACT
Brack
Rio Vista Br.
RIO VISTA
BRANNAN ISL. R.D. Nº. 2067
Camp 7
Camp 4
Camp 25
BRACK TRACT R.D. Nº. 2054
Camp 33
Camp 29
Terminous
TERMINOUS TRACT R.D. Nº. 548
RICHMOND-CHASE RANCH
TWITCHELL ISL. R.D. Nº. 1601
BOULDIN ISL. R.D. Nº. 756
BIGGER & INMAN RANCH
Collinsville
Central Ldg.
VENICE ISLAND R.D. Nº. 2023
EMPIRE TRACT R.D. Nº. 2029
KING ISL. R.D. Nº. 2044
BISHOP TRACT R.D. Nº. 2042
BISHOP HIGHLANDS
Mayberry Sl.
Blumenberg
Jersey
Curtis Ldg.
WEBB TRACT R.D. Nº. 2026
FRANKS TRACT
Webb Pump
Ward Ldg.
FERN IS.
HEAD REACH IS.
TULE IS.
PITTSBURG
ANTIOCH
BETHEL TRACT R.D. Nº. 1619
Dutch Sl.
MEDFORD ISL. R.D. Nº. 2030
HOG IS.
SMITH TRACT (R.R. & N.A. SMITH)
HOTCHKISS TRACT R.D. Nº. 799
HOLLAND TRACT R.D. Nº. 2025
RHODE IS.
HENNING TRACT
WRIGHT TRACT
Oakley
Neroly
Rock Sl.
Holland Pump
Knightsen
VEALE TR. R.D. Nº. 2065
PALM TRACT R.D. Nº. 2036
LOWER JONES TRACT R.D. Nº. 2038
ROBERTS ISL. LOWER DIV. R.D. Nº. 684
STOCKTON
Middle River
Bixler
Brentwood
ORWOOD TR. R.D. Nº. 2024
UPPER JONES TRACT R.D. Nº. 2039
HONKER LAKE TRACT
Garwood Br.
ROBERTS ISL. MIDDLE DIV. R.D. Nº. 524
E. Contra Costa I.D.
BYRON TRACT
VICTORIA ISL. R.D. Nº. 2040
Mansion House
THE POCKET
French Camp
Williams Bridge
Byron
Byron Hot Springs
BAIRD RANCH
UNION ISLAND R.D. Nº. 2
ROBERTS ISL. UPPER DIV. R.D. Nº. 544
Brandts Br.
CLIFTON COURT TRACT R.D. Nº. 802
Clifton Court Ferry
Herdlyn
FABIAN TRACT R.D. Nº. 773
LATHROP
CALIFORNIA IRR. FARMS R.D. Nº. 2058
Whitehall
Belhany
MOREING RANCH
Mossdale Bridge
FINK & WI
60 RANCH
PLATE 13

TABLE, 94

DETAIL, BY CROPS, OF IRRIGATED ACREAGE, ESTIMATED VALUE OF ACTUAL PRODUCTION AND ESTIMATED LOSS DUE TO SALINITY, SACRAMENTO-SAN JOAQUIN DELTA, 1924-1931

CROP	IRRIGATED ACREAGE: ENTIRE DELTA	IRRIGATED ACREAGE: WITHIN 100 PART SALINITY ENCROACHMENT	ESTIMATED VALUE OF ACTUAL PRODUCTION IN ENTIRE DELTA	ESTIMATED CROP LOSS DUE TO SALINITY IN DOLLARS
1924				
ALFALFA	31034	3105	2917200	46000
ASPARAGUS	54129	32219	3783800	7700
BEANS	36459	14162	2296000	301200
BEETS	21375	4665	1974200	34800
CELERY	4065	2901	1336500	193500
CORN	27392	18627	1023400	65300
FRUIT	16180	1574	5346000	5200
GRAIN AND HAY	92362	54489	4271300	14400
ONIONS	3886	2568	835800	31400
PASTURE	1035	572	5200	200
POTATOES	27872	21335	5058700	373300
SEED	930	40	129300	500
TRUCK	4021	560	804200	12300
TOTALS	320740	156817	29781600	1085800
1925				
ALFALFA	26011	390	1927900	4500
ASPARAGUS	51974	3560	3944900	900
BEANS	37590	0	2892400	0
BEETS	16685	690	883100	2900
CELERY	5330	40	1879200	2500
CORN	24029	200	944000	700
FRUIT	12772	0	3652800	0
GRAIN AND HAY	84307	3400	2185500	500
ONIONS	5989	0	2050000	0
PASTURE	5273	660	26400	200
POTATOES	22071	0	8475000	0
SEED	3459	0	418500	0
TRUCK	4737	0	829000	0
TOTALS	300227	8940	30108700	12200
1926				
ALFALFA	26108	1910	1631800	18800
ASPARAGUS	55601	16358	4016100	4000
BEANS	51802	5136	2921500	89100
BEETS	7936	1100	841800	9400
CELERY	7392	1585	2835000	112300
CORN	23955	4581	766500	13100
FRUIT	17771	685	3731900	1400
GRAIN AND HAY	77319	14052	1567400	1600
ONIONS	5810	310	1142900	3300
PASTURE	4161	1650	20800	500
POTATOES	21503	2948	5463900	68300
SEED	2883	293	320000	2700
TRUCK	6471	1252	1035400	22200
TOTALS	308712	51860	26295000	346700
1927				
ALFALFA	26348	180	1678400	1800
ASPARAGUS	47897	2100	5182400	800
BEANS	47678	60	1931000	700
BEETS	14527	144	1289900	1000
CELERY	7888	0	3443000	0
CORN	26944	300	972000	1000
FRUIT	17261	0	4660500	0
GRAIN AND HAY	75774	1594	1926900	200
ONIONS	4340	0	1367100	0
PASTURE	2736	0	13700	0
POTATOES	28422	0	6476000	0
SEED	3526	0	416000	0
TRUCK	3590	0	610300	0
TOTALS	306931	4378	29967200	5500

TABLE 94 (CONTINUED)

DETAIL, BY CROPS, OF IRRIGATED ACREAGE, ESTIMATED VALUE OF ACTUAL PRODUCTION AND ESTIMATED LOSS DUE TO SALINITY, SACRAMENTO-SAN JOAQUIN DELTA, 1924-1931

CROP	IRRIGATED ACREAGE: ENTIRE DELTA	IRRIGATED ACREAGE: WITHIN 100 PART SALINITY ENCROACHMENT	ESTIMATED VALUE OF ACTUAL PRODUCTION IN ENTIRE DELTA	ESTIMATED CROP LOSS DUE TO SALINITY IN DOLLARS
1928				
ALFALFA	26783	458	1968600	5300
ASPARAGUS	53971	7618	6773100	3300
BEANS	38429	332	2550100	6600
BEETS	14722	2808	1882400	28900
CELERY	7813	0	1148700	0
CORN	40268	2100	1452700	6700
FRUIT	15763	150	3546700	300
GRAIN AND HAY	72038	1670	1744600	200
ONIONS	3668	0	1371100	0
PASTURE	6284	575	31400	200
POTATOES	24914	316	3014600	3400
SEED	6453	7	671100	100
TRUCK	5909	475	886400	7800
TOTALS	317015	16509	27041500	62800
1929				
ALFALFA	27158	911	2216100	11600
ASPARAGUS	62044	10086	6456600	3600
BEANS	32315	250	1978600	4600
BEETS	21553	1619	2109500	12700
CELERY	8721	190	2043300	7900
CORN	40855	2345	1473800	7500
FRUIT	14935	75	4122100	200
GRAIN AND HAY	76100	3014	1777600	400
ONIONS	4159	0	998200	0
PASTURE	2746	2050	13700	600
POTATOES	18046	170	5887500	5000
SEED	9515	5	1056200	0
TRUCK	7678	60	1228500	1000
TOTALS	325825	20775	31361700	55100
1930				
ALFALFA	26930	480	1504300	4200
ASPARAGUS	70269	9392	7173700	3200
BEANS	29166	270	1249600	3500
BEETS	24058	468	2259000	3500
CELERY	5969	30	975800	900
CORN	54533	1500	1715000	4200
FRUIT	14504	70	2101600	100
GRAIN AND HAY	72932	1272	1789700	200
ONIONS	4341	0	873800	0
PASTURES	7686	0	38400	0
POTATOES	18839	75	4700400	1700
SEED	5352	0	545900	0
TRUCK	15334	0	2223400	0
TOTALS	349913	13557	27230600	21500
1931				
ALFALFA	26882	12651	1352621	99860
ASPARAGUS	70580	55519	7254899	19615
BEANS	26992	14296	775794	172586
BEETS	30915	17362	3128314	157070
CELERY	6303	6125	1640043	336571
CORN	55798	50081	1360921	118165
FRUIT	10775	7075	1364724	10200
GRAIN AND HAY	65086	46126	900034	3560
ONIONS	3769	2068	982244	29710
PASTURE	12748	10254	66284	3140
POTATOES	18042	17747	2802585	275321
SEED	8967	3547	499188	13730
TRUCK	6498	2110	530012	24188
TOTALS	343355	244991	22657663	1263716

$$L = p\ (V_s + L) \qquad (II)$$

where p = the 1931 loss in per cent of the value of the actual 1931 production within the area of 100 part salinity plus the loss. (Column 7, Table 93).

The value of V_s from (I) can therefore be substituted in (II) giving:

$$L = V \left(\frac{\frac{pA_s}{A}}{1 - \frac{pA_s}{A}} \right) \qquad (III)$$

and the loss for each crop, each year, can be derived directly from (III) without making an intermediate computation of the value of the production within the area of 100 part salinity encroachment. Following this procedure it remained only to obtain the estimates of the actual crop production in the Delta in past years.

Crop Production and Value 1924-1930

It was manifestly impossible to obtain complete data of this character for the entire Delta but the endeavor was made to obtain the records for as many years as possible, beginning with 1924, for a number of the larger and representative tracts. Tabulations of statewide price and production figures for all crops in the period 1924 to 1931 were obtained from the office of the Federal-State Cooperative Crop Reporting Service. The data secured by interviews with and questionnaires sent to various Delta organizations and individuals were not entirely complete but were sufficient to account for a considerable Delta acreage and to establish satisfactorily the relation, in the various

years, between Delta production and price figures and the statewide figures obtained from the Federal-State office. A previous reference has stated that the Water Supervisor Reports supplied the necessary data on the acreage of each Delta crop irrigated, 1924 to 1931. As derived, the seasonal totals for the irrigated acreages are greater than those given in the Water Supervisor Reports by the amount of grain, hay and pasture acreages which, although below Elevation 5.0, U.S.G.S., were not classed as irrigated in the Water Supervisor Reports. Later, as explained in Chapter VI, it was determined that, normally, practically all areas below Elevation 5.0 are benefitted from sub-irrigation and should be classified as irrigated.

From all of these assembled data the figures and estimates were derived to show for each year, 1924 to 1930, and for each crop, the acreage irrigated, the total actual production, and the total value of that production. The acreage and value of production figures are shown in Table 94.

Estimated Crop Losses 1924-1931

Having derived the estimates of the value of production as outlined, the crop loss due to salinity each year, 1924 to 1930, inclusive, was computed by solving equation (III) for each crop. The results of these computations are shown in detail in Table 94 and summarized in Table 95. The 1931 data shown in these tables are, of course, the results previously given of the actual survey in that year rather than estimates as derived for the years 1924 to 1930, inclusive. Table 95 gives the estimated losses in per cent of the total value of the Delta's irrigated crop production (including the

TABLE 95

ACREAGE IRRIGATED, ESTIMATED VALUE OF ACTUAL PRODUCTION AND ESTIMATED LOSS DUE TO SALINITY, SACRAMENTO-SAN JOAQUIN DELTA CROPS, 1924-1931

YEAR	ACREAGE IRRIGATED	ESTIMATED VALUE OF ACTUAL PRODUCTION IN DOLLARS	ESTIMATED CROP LOSS DUE TO SALINITY	
			DOLLARS	PER CENT OF TOTAL VALUE OF CROP PRODUCTION*
1924	320740	29781600	1085800	3.52
1925	300227	30108700	12200	0.04
1926	308712	26295000	346700	1.30
1927	306931	29967200	5500	0.02
1928	317015	27041500	62800	0.23
1929	325825	31361700	55100	0.18
1930	349913	27230600	21500	0.08
1931	343355	22657663	1263716	5.28
TOTAL	2572718	224443963	2853316	
AVERAGE	321590	28055500	356700	1.25

* INCLUDING VALUE OF LOST PRODUCTION.

value of the lost production).

As shown by these figures, the estimated tangible crop losses due to salinity in the period 1924 to 1931 varied from a minimum in 1927 of $5500 or 0.02 per cent of the total value of the Delta's irrigated crop in that year to a maximum in 1931 of $1,263,716 or 5.28 per cent of the total crop value. The average annual loss for the period was $356,700 or 1.25 per cent of the average total irrigated crop value.

Future Losses - Conclusion

It is to be noted that the magnitude of the loss in the Delta due to salinity is dependent upon many variables such as stream flow, the period of low flow, production, unit prices, etc., and that the correctness of estimates of the tangible crop loss in past years is only commensurate with the degree to which the variables involved have been correctly evaluated and with the verity of the assumptions required in the computations. If, for example, the Delta's average unit prices of 1924 had prevailed in 1931, the value of the actual production in the latter year would have been forty seven per cent greater, increasing the losses correspondingly to $1,858,000 so that the average annual loss 1924 to 1931 would then have been $431,000. Similarly, if the maximum of the average unit prices 1924 to 1931 had prevailed in 1931 the value of the actual production would have been about seventy per cent greater, the losses $2,136,000 and the average annual loss 1924 to 1931, $466,000 or close to one-half million dollars. The difficulties attendant upon predicting with accuracy what the future losses may be, are, therefore, apparent. However, considering all data as presented, it is believed to be a fair conclusion that if the future Summer stream flow reaching the

Delta is similar in amount and distribution to that of the last decade, a future average annual tangible crop loss due to salinity varying from $350,000 to as much as one-half million dollars is to be anticipated; that if allowance were made for further increase in development and use of water upstream from the Delta, some increase in this estimate would be necessary; and that if, in addition, the crop and other losses previously outlined as intangible were taken into consideration, the estimate would necessarily be further increased.