Flood Hydrology of Butte Basin 1973 — 77 Water Years Sacramento Valley California

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 78-86

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For readers who may prefer to use metric units (International System of Units) rather than inch-pound units, the conversion factors for the terms used in this report are listed below.

Inch-pound units	*Multiply by:*	*Metric units*
acre-ft (acre-foot)	1.234×10^{-3}	hm^3 (cubic hectometer)
ft (foot)	3.048×10^{-1}	m (meter)
ft^3/s (cubic foot per second)	2.832×10^{-2}	m^3/s (cubic meter per second)
mi (mile)	1.609	km (kilometer)

FLOOD HYDROLOGY OF BUTTE BASIN, 1973-77 WATER YEARS

SACRAMENTO VALLEY, CALIFORNIA

By R. G. Simpson

ABSTRACT

Flooding in Butte Basin is caused primarily by overflow from the Sacramento River, which forms the western boundary of the basin.

Stage and discharge data were collected during the 1973-77 water years at 6 recording and 45 crest-stage gages located within the basin to describe its flood hydrology. These data were combined with discharge records on the main channel of the Sacramento River to determine total flow and flow distribution at the latitudes of Ord Ferry, Butte City, and Gridley Road. Water-surface profiles throughout the basin, inflow/change-in-storage/outflow relations of the Butte Sink, and channel changes of the Sacramento River are shown.

During the 5-year data-collection period, total peak flows decreased between the latitudes of Ord Ferry and Butte City. The reduction varied with each flood and averaged about 7 percent for measured peaks ranging from 100,000 to 200,000 cubic feet per second. The largest floods measured were those in 1974. The total peak flow at the latitude of Ord Ferry was 195,000 cubic feet per second on January 17, 1974. At the latitude of Butte City, the total peak flow was 191,000 cubic feet per second, including 11,000 cubic feet per second from Butte Creek.

For a given flood, overland flow through Butte Basin from the Sacramento River did not change significantly in peak magnitude between measurement locations at Afton Boulevard, Butte City, and Gridley Road. The overland flows of about 45,000 and about 24,000 cubic feet per second on January 18 and April 1, 1974, respectively, measured at the latitude of Butte City, were within 10 percent of those measured at the two other locations.

Spill over Colusa and Moulton Weirs plus overland flow through Butte Basin (represented by flow measured at the latitude of Gridley Road) accounts for practically all inflow to the Butte Sink area of the lower part of Butte Basin. During flood periods, about 70 percent of the inflow occurs at Colusa Weir, 10 percent occurs at Moulton Weir, and 20 percent enters the lower basin at the latitude of Gridley Road.

During the floods of 1974 the Sacramento River, as measured from the left bank of the low-water channel, scoured as much as 300 feet toward Butte Basin at surveyed cross sections in the reach upstream from the end of its east levee. High flows of 1973 and 1975 caused much less channel movement.

INTRODUCTION

Butte Basin is between Chico and Meridian (fig. 1) in Butte, Glenn, Colusa, and Sutter Counties (fig. 2). It is bounded on the west by the Sacramento River, whereas the eastern boundary, for this study, is considered to be the limits of past flooding. The basin is about 35 mi long (north to south), ranges from 2 to 12 mi in width, and consists mainly of sparsely populated agricultural land. The basin serves as a storage area for overflow during floods on the Sacramento River and a conveyance channel for overflow south to Sutter Bypass. It is a major wintering area for migratory waterfowl.

Major flooding caused by overflow from the Sacramento River occurred throughout Butte Basin in the 1940's, in 1958, and in January 1970. The peak flow February 28, 1940, along Ord Ferry Road was estimated to be 370,000 ft^3/s (California Department of Public Works, 1948, p. 54), of which about 180,000 ft^3/s overflowed into Butte Basin at points north of Butte City. Since 1943 the frequency and magnitude of overflow to Butte Basin have been reduced by regulation of the Sacramento River at Shasta Dam, which is about 80 mi north of Ordbend. Peak flows during the floods of February 1958 and January 1970 at the latitude of Ord Ferry were estimated to be 280,000 ft^3/s and 265,000 ft^3/s, respectively; peak overflow north of Butte City to Butte Basin was about 100,000 ft^3/s in both years. The recurrence intervals for the floods of 1958 and 1970, determined at the latitude of Ord Ferry (Simpson, 1976b), are 45 and 35 years, respectively. The peak flow for the flood of 1940, under current conditions, would have a recurrence interval greater than 100 years.

Since the early 1900's, leveling of land and building of levees have changed the distribution of flow and the amount of flood overflow. In 1969 the California Water Commission (California Department of Water Resources, 1970, p. 24), investigating the upper Sacramento River basin, requested that the California Department of Water Resources make hydrologic studies in Butte Basin. The Geological Survey, in cooperation with the California Department of Water Resources and the U.S. Army Corps of Engineers, began a flood-hydrology study of Butte Basin in the autumn of 1972.

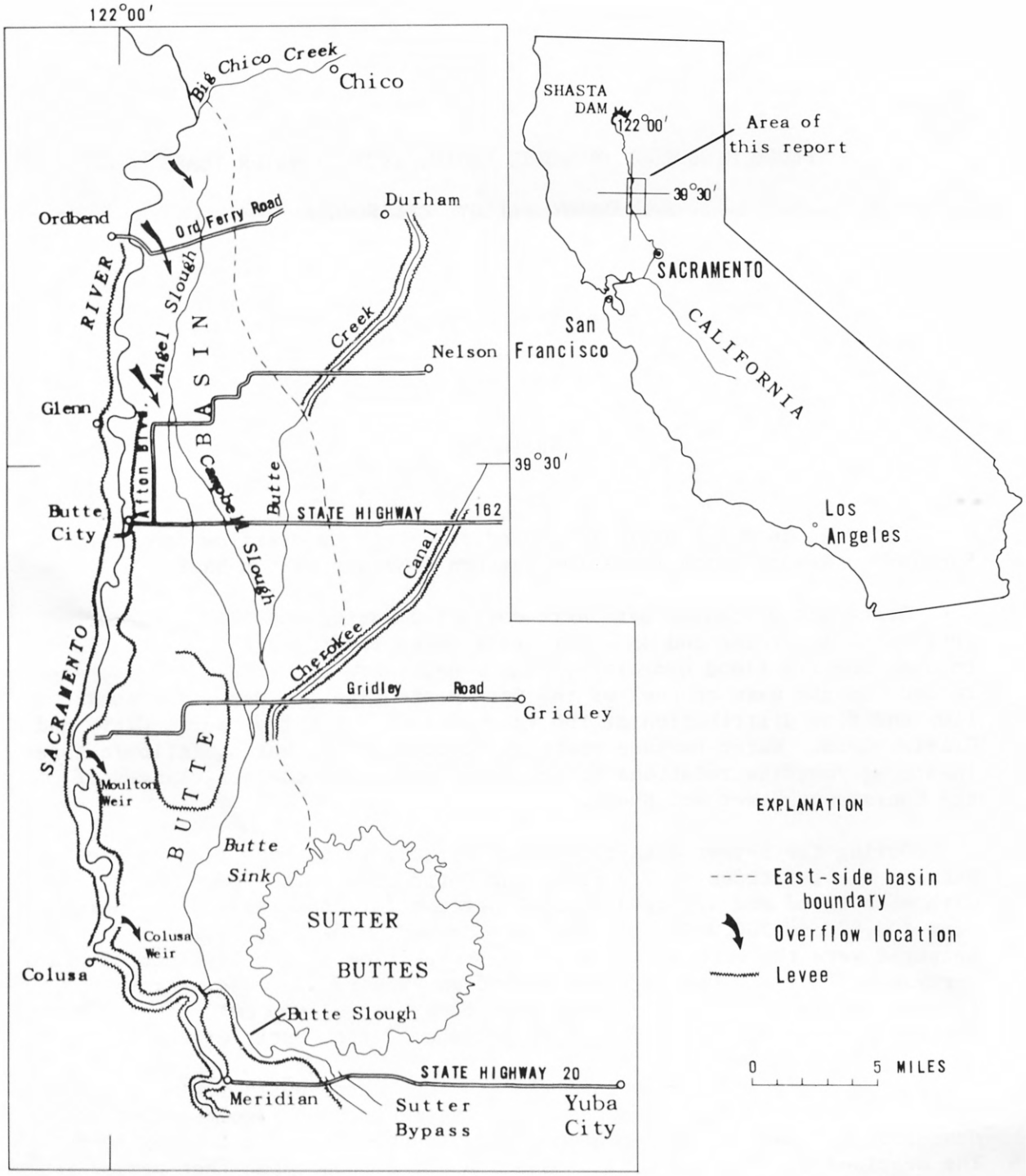


FIGURE 1.—Location of Butte Basin.

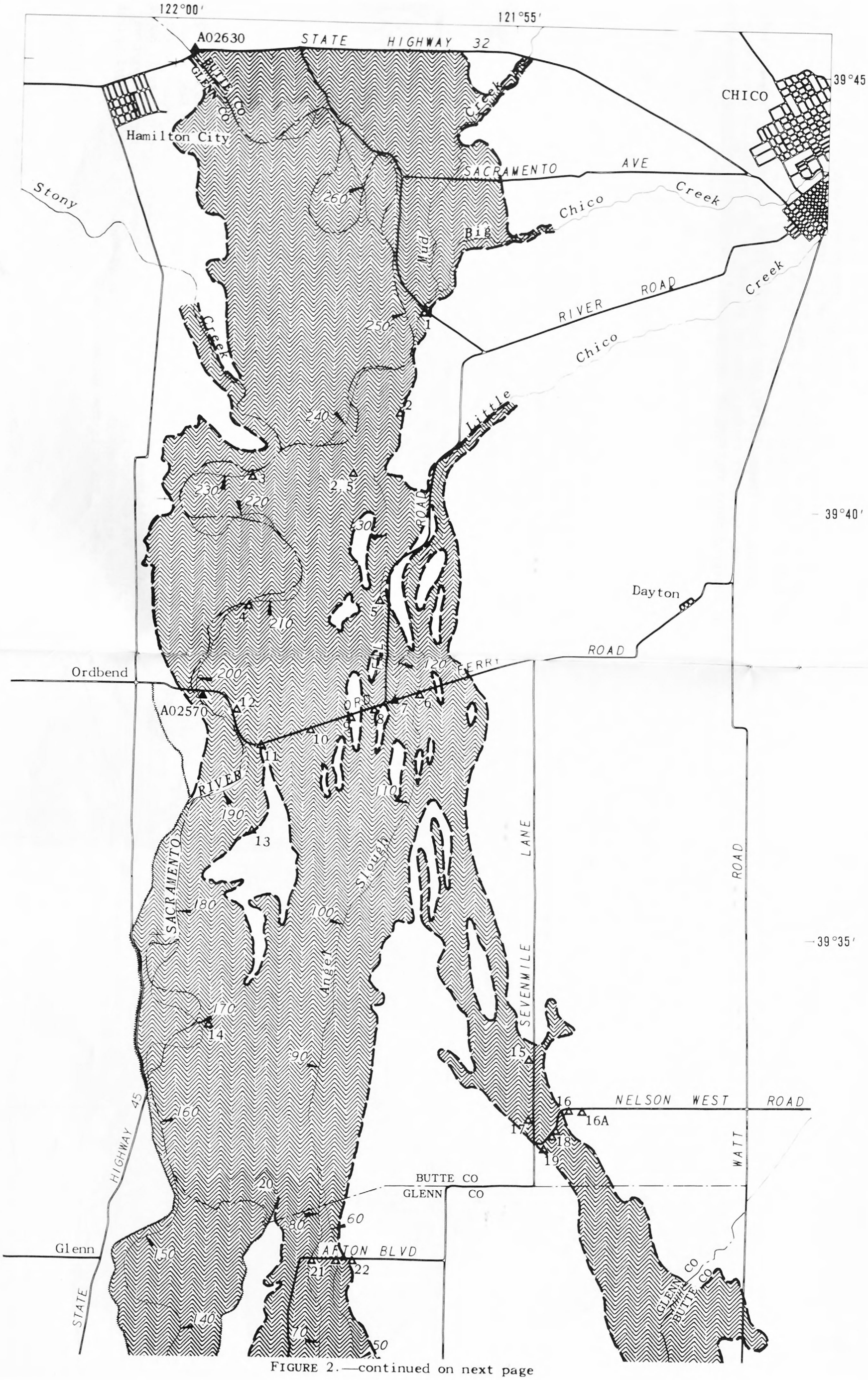
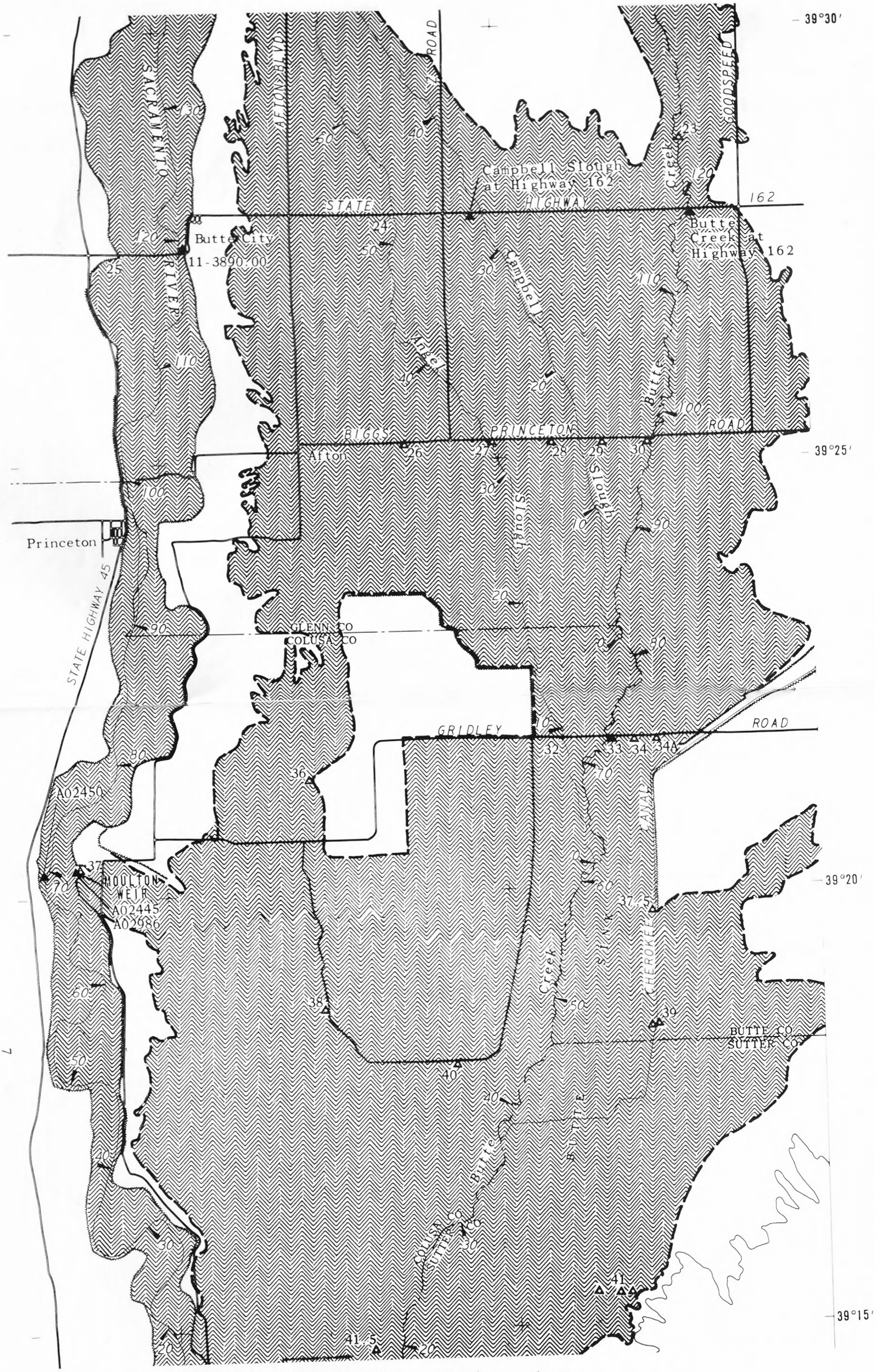


FIGURE 2.—continued on next page



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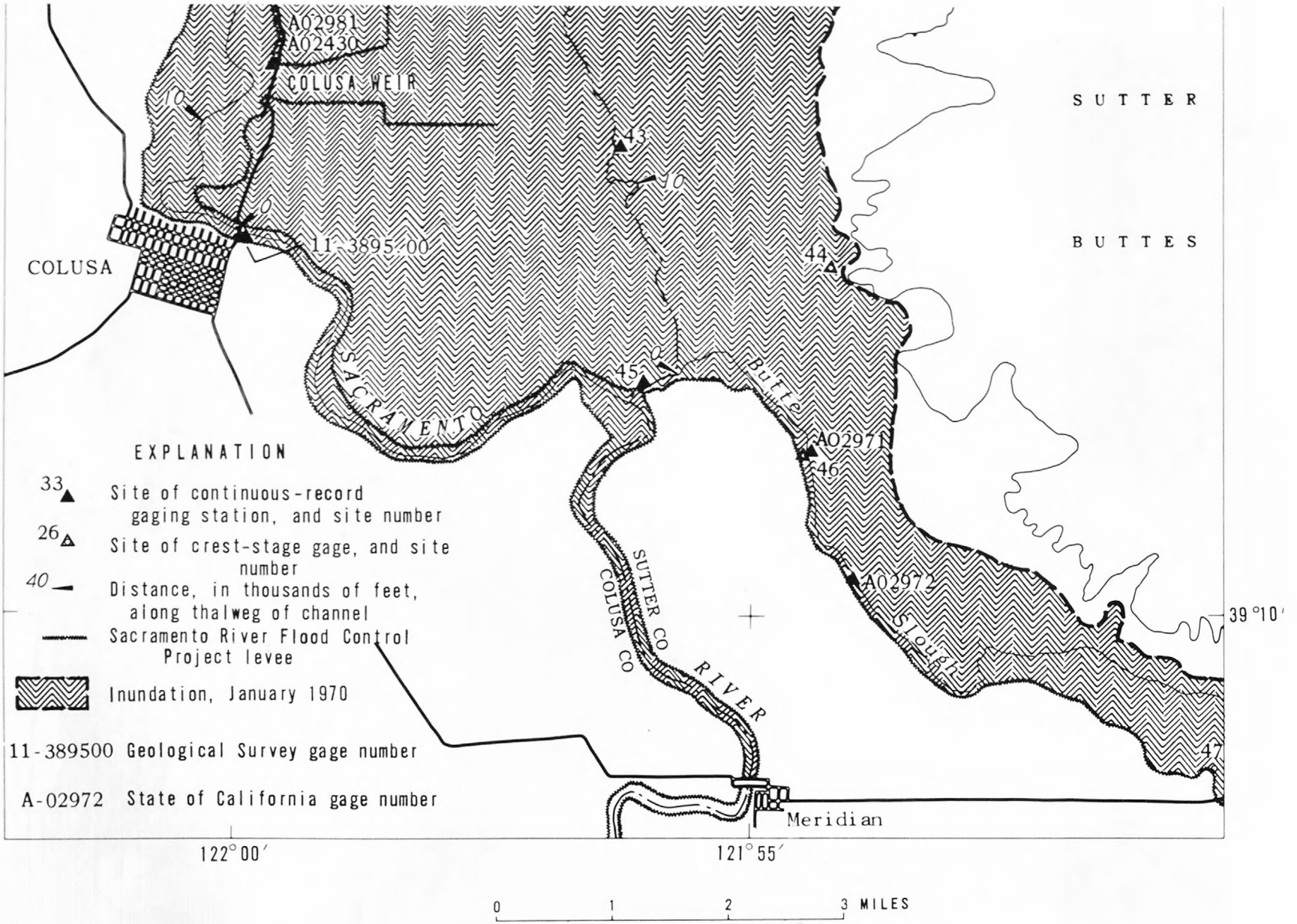


FIGURE 2.—Limits of inundation for the flood of January 1970, gaging-station locations, and distance along thalweg of selected channels.

Purpose and Scope

The purpose of the study was to determine the distribution and sources of water causing flooding in Butte Basin. The scope included (1) collecting and documenting data such as historic stages, inundated areas, discharge, timing and distribution of flow, and flow frequency and duration; (2) describing changes in the main channel of the Sacramento River (meanders, scour, and fill) in the reach from the mouth of Big Chico Creek to Glenn; and (3) discussing the effects of levee, weir, and highway construction in Butte Basin on floodflows that occurred during the study period (water years 1973-77).

A progress report (Simpson, 1976a) described the data-collection network in the basin, stage and discharge data obtained during the 1973 and 1974 water years, and flow distribution and water-surface profiles for peak flows that occurred during January 1973 and during January and the March-April period of 1974. This report, for the water years 1973-77, supplements the information in the progress report and includes data collected during the 1975-77 water years.

Data Collection

Data needed to describe the flood hydrology of Butte Basin are water-surface and ground elevations throughout the basin and discharge measurements at selected latitudes. All elevations in this report are to mean sea-level datum, supplementary adjustment of 1956.

Records of water-surface elevations (stages) were obtained from continuous-record gages and crest-stage gages and by surveying high-water marks following a flood. Continuous-record gages and crest-stage gages were installed during the autumn of 1972 in Butte Basin (fig. 2) to augment existing gages.

The continuous-record gages on Angel Slough at Ord Ferry Road (site 7) and on Butte Creek at Gridley Road (site 33) are at sites where flow measurements are made. The gages on Butte Creek opposite Colusa Bypass (site 43) and on Butte Slough at Outfall Gates (site 45) were installed to collect stage records for the flood storage area in the lower basin commonly referred to as Butte Sink. The gage on Butte Creek opposite Colusa Bypass (site 43) was removed August 19, 1975, as the record of flood stages obtained here was found to correlate well with the record obtained at site 45.

Crest-stage gages were concentrated along roads where flow measurements are made and where stages are needed to define flow profiles. Three additional gages (sites 2.5, 37.5, 41.5) were installed during the autumn of 1973. One gage, site 14, was destroyed by high water in December 1973.

Current-meter measurements of discharge along previously surveyed cross sections of the flood plain are used to relate the stage data obtained at the gages to flow magnitudes. Most of the discharge measurements of overflow were made along Ord Ferry Road and Gridley Road. Discharge measurements were also made along Afton Boulevard at crest-stage gage sites 21 and 22 on Angel and Campbell Sloughs.

Stage and discharge data were collected in Butte Basin at the latitude of Butte City in cooperation with the California Department of Transportation. Two recording gages, one on Butte Creek and one on Campbell Slough, have been operated at this latitude since December 1969. Flow measurements were made at all bridges and road overflows between Goodspeed-Watt Road and Butte City.

DESCRIPTION OF FLOODING

The extent of flooding in Butte Basin is mainly dependent on the location, magnitude, and duration of overflow from the Sacramento River. Flows from Butte Creek and local sloughs in most years cause only minor flooding in the basin. As flow in the Sacramento River increases, overflow begins at Colusa Weir, then at Moulton Weir, and finally along unleveed reaches of the Sacramento River 5 to 15 mi north of Butte City (table 1 and fig. 2). All overflows are uncontrolled as there are no floodgates on the weirs.

A peak flow in the Sacramento River (table 2) of about 100,000 ft^3/s, measured at Butte City, will cause overflow of about 10,000 ft^3/s to upper Butte Basin (the part of Butte Basin north of Gridley Road). Overflow of this magnitude can be carried through the basin within existing channels, principally Angel and Campbell Sloughs, and the extent of flooding is minor. Durations of these overflows are usually one or two days at a given latitude, which generally corresponds to the number of days that mean daily flow exceeds 90,000 ft^3/s in the main channel at Butte City.

Table 1.--*Stage and discharge of the Sacramento River when overflow to Butte Basin begins*

[Location of overflow is shown in figure 1]

Location of overflow	Stage (feet)[1]		Discharge,[2] in cubic feet per second
	Mean sea level datum	U.S. Army Corps of Engineers datum	
Colusa Weir	58.9	61.8	30,000
Moulton Weir	73.9	76.8	60,000
Unleveed reaches north of Butte City	--	--	90,000

[1] Stage recorded at location of overflow.
[2] Discharge determined from gaging stations at Colusa and Butte City.

Table 2.--*Annual peak discharge, excluding overland flow through Butte Basin, of the Sacramento River at Butte City since completion of Shasta Dam*

Water year	Date	Instantaneous peak discharge (ft^3/s)	Maximum mean daily discharge (ft^3/s)
1944	2- 4-44	42,400	38,500
1945	2- 2-45	62,700	58,100
1946	12-29-45	114,000	112,000
1947	2-13-47	49,300	47,200
1948	3-24-48	58,000	57,500
1949	3-12-49	82,200	80,100
1950	2- 7-50	59,400	57,200
1951	1-23-51	74,300	70,800
1952	12-29-51	111,000	102,000
1953	1-14-53	106,000	104,000
1954	2-19-54	80,700	78,900
1955	12-10-54	33,500	32,100
1956	1-16-56	149,000	145,000
1957	3- 6-57	59,500	59,200
1958	2-20-58	160,000	158,000
1959	2-17-59	94,100	70,700
1960	2- 9-60	89,300	82,700
1961	12- 2-60	65,300	57,500
1962	2-16-62	87,800	81,500
1963	4-15-63	105,000	94,800
1964	1-21-64	50,800	39,100
1965	12-24-64	126,000	122,000
1966	1- 6-66	72,700	68,600
1967	2- 1-67	98,400	97,000
1968	2-26-68	69,500	68,500
1969	1-14-69	120,000	114,000
1970	1-25-70	152,000	146,000
1971	1-18-71	95,800	87,600
1972	3- 1-72	27,500	26,300
1973	1-19-73	98,500	94,200
1974	1-18-74	136,000	130,000
1975	2-14-75	91,000	84,700
1976	3- 1-76	27,300	24,700
1977	1- 3-77	13,700	11,000

Flows in the Sacramento River that exceed 120,000 ft^3/s at Butte City will cause significant overflow through the upper basin. This overflow, combined with Butte Creek and local drainage, will inundate an area about 7 mi wide at the latitude of Butte City (State Highway 162). At this latitude the Geological Survey collected peak-flow data during the flood of January 1970, which included, for the first time, overflow through Butte Basin. Blodgett and Pearce (1971, p. 25) reported a peak flow of 225,000 ft^3/s on January 24, 1970. This discharge included 74,000 ft^3/s flowing through Butte Basin. About 10,000 ft^3/s of the 74,000 ft^3/s was from Butte Creek. A map showing inundation in January 1970 was obtained from the State of California, Department of Water Resources and was used as a basis for determining areas of inundation (fig. 2) throughout the basin. Small areas of dry land are not shown because of map scale.

Downstream from State Highway 162, the levees of Reclamation District 1004 and those along Cherokee Canal gradually narrow the area subject to flooding to about 2 mi at Gridley Road. This flooded area receives a mixture of overland flow from the Sacramento River, flow from Butte Creek, and local runoff. The resultant floodflow is referred to as the flow in Butte Creek at Gridley Road.

Flooding of the lower basin is largely dependent on the duration and magnitude of overflow at Colusa Weir and at Moulton Weir. Inflow to the lower basin from Cherokee Canal is minor. Floodwater leaves the lower basin by way of Butte Slough, which empties into Sutter Bypass. Outflow is measured by the California Department of Water Resources at the gage on Butte Slough near Meridian. Since the beginning of regulation by Shasta Dam, spill over Colusa Weir accounts for about 70 percent of the inflow, by volume, to the lower basin during a flood period. This percentage is based on measured outflow volume through Butte Slough which is representative of total inflow. Spill over Moulton Weir accounts for about 10 percent of inflow. Most of the remaining 20 percent enters the lower basin in Butte Creek either as runoff from Butte Creek drainage or as Sacramento River overland flow that enters the upper basin north of Butte City. The percentage of total inflow at each location varies with the magnitude and duration of each flood period. Table 3 lists volumes of inflow to and outflow from the lower basin for selected flood periods. Outflow, at times, may exceed inflow because of inaccuracy of flow measurement; also minor inflow from the drainage area along Sutter Buttes has not been included in total inflow.

Table 3.--*Volume of outflow and distribution of inflow for lower Butte Basin for selected periods*

Period of outflow	Volume of outflow from lower Butte Basin[1] (thousands of acre-ft)	Volume of inflow to lower Butte Basin, in thousands of acre-feet									
		Colusa Weir		Moulton Weir		Cherokee Canal		Butte Creek[2]		Total	
		Volume	Percent of outflow	Volume	Percent of outflow	Volume	Percent of outflow	Volume	Percent of outflow	Volume	Percent of outflow
Jan. 9 to Feb. 2, 1953	1,750	1,326	76	268	15	--	--	--	--	--	--
Dec. 20, 1955, to Feb. 15, 1956	3,650	2,803	77	378	10	--	--	--	--	--	--
Jan. 27 to Mar. 10, 1958	4,240	3,009	71	859	20	--	--	--	--	--	--
Dec. 23, 1964, to Jan. 24, 1965	2,550	1,649	65	285	11	45	2	--	--	--	--
Jan. 11 to Feb. 22, 1970	4,550	2,650	58	663	15	68	1	890	20	4,271	94
Jan. 11-29, 1973	987	696	71	63	6	44	4	167	17	970	98
Jan. 14 to Feb. 8, 1974	2,020	1,356	67	269	13	28	1	373	18	2,026	100
Mar. 31 to Apr. 20, 1974	1,457	927	64	191	13	13	1	270	19	1,401	96
Feb. 9-22, 1975	333	187	56	11	3	26	8	112	34	336	101

[1]Outflow measured by California Department of Water Resources at Butte Slough gaging station.

[2]Inflow measured by U.S. Geological Survey at latitude of Butte City, 1970; at latitude of Gridley Road, 1973-75.

Flooding, 1973 and 1974 Water Years

Flooding in Butte Basin during the 1973 and 1974 water years was described in a progress report by Simpson, (1976a). Stage and discharge hydrographs, flow distribution, water-surface profiles, and tabulations of stage and discharge data were given for flows through Butte Basin and for the Sacramento River. Many of these data are not repeated; additional data for 1973 and 1974--such as a detailed description of flows at the latitude of Butte City and surveyed cross sections of the Sacramento River showing channel changes--are included in this report. Summaries of stage and discharge, including data collected during 1973 and 1974, are given in Data A and Data B. Staff-gage readings made at Princeton during January and the March-April period of 1974 are given in Data C. A description of the flood of January 1974 follows.

The flood of January 1974, the largest in Butte Basin since the flood of January 1970, has a recurrence interval of about 10 years (Simpson, 1976b). Aerial photographs of Butte Basin (fig. 3) taken January 21, 1974, show inundation following a peak flow, measured at Butte City, of 136,000 ft^3/s that occurred on January 18. The peak overland flow through the upper basin from the Sacramento River occurred on January 17 and was about 45,000 ft^3/s. Flows shown for January 21 are about 100,000 ft^3/s within the levees at Butte City, and about 10,000 ft^3/s overland flow through the upper basin. The area inundated south of Gridley Road was considered ponded and was slightly less inundated than it was at the peak water-surface elevation of 61.3 ft on January 19. Peak water-surface elevations in Butte Basin during the flood of January 1974 are compared to those for the floods of January 1970 and February 1940 in table 4.

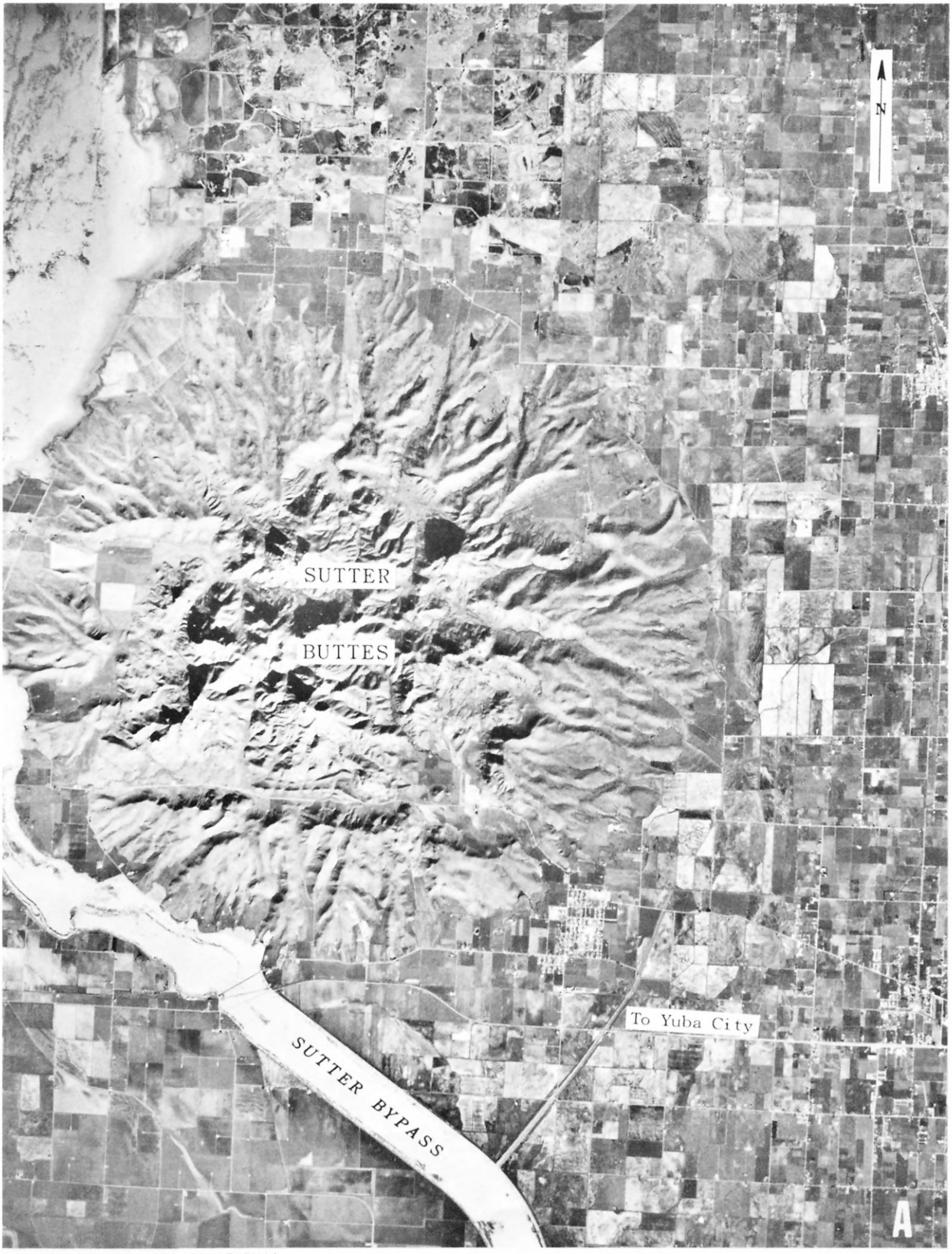
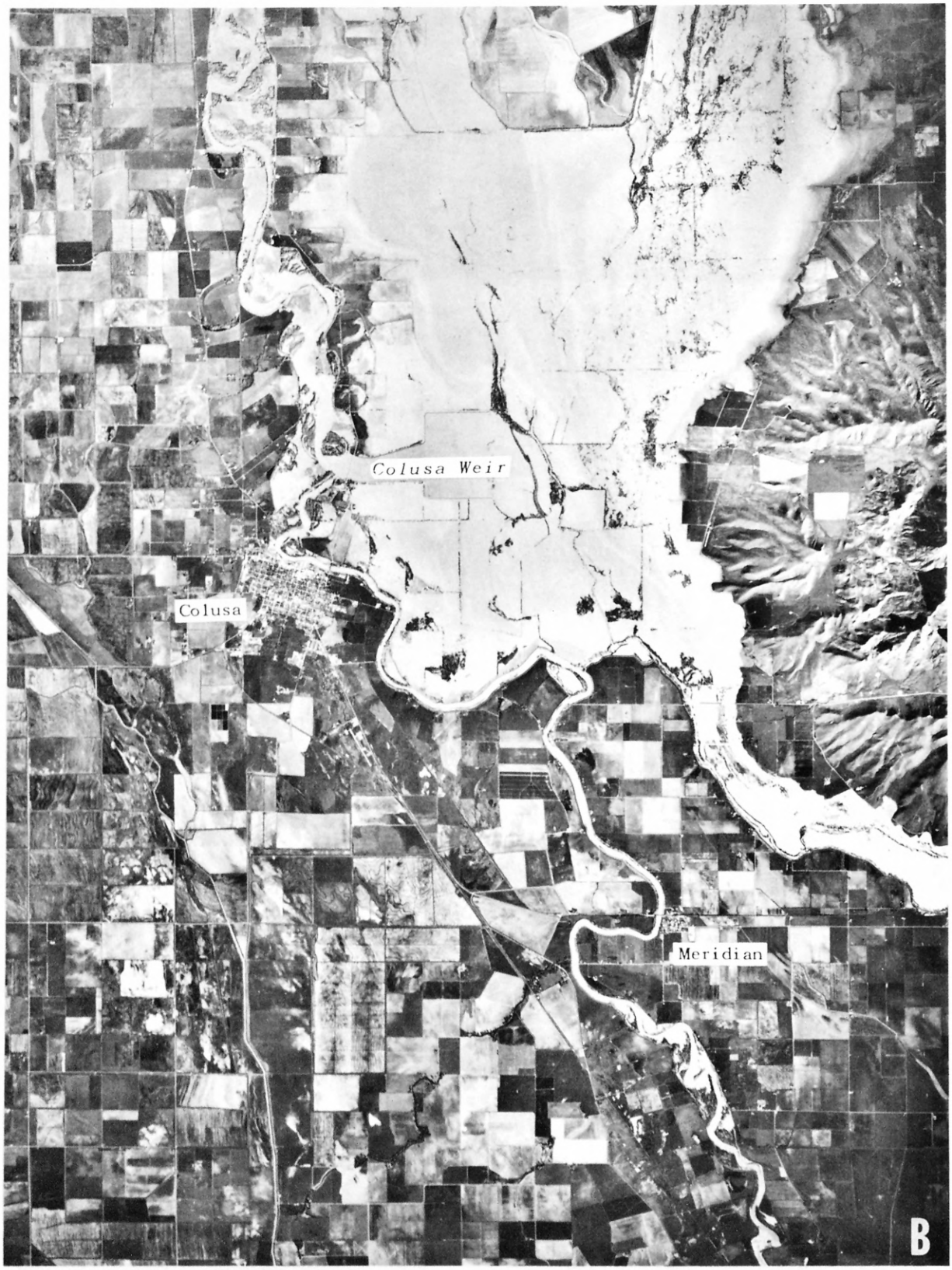
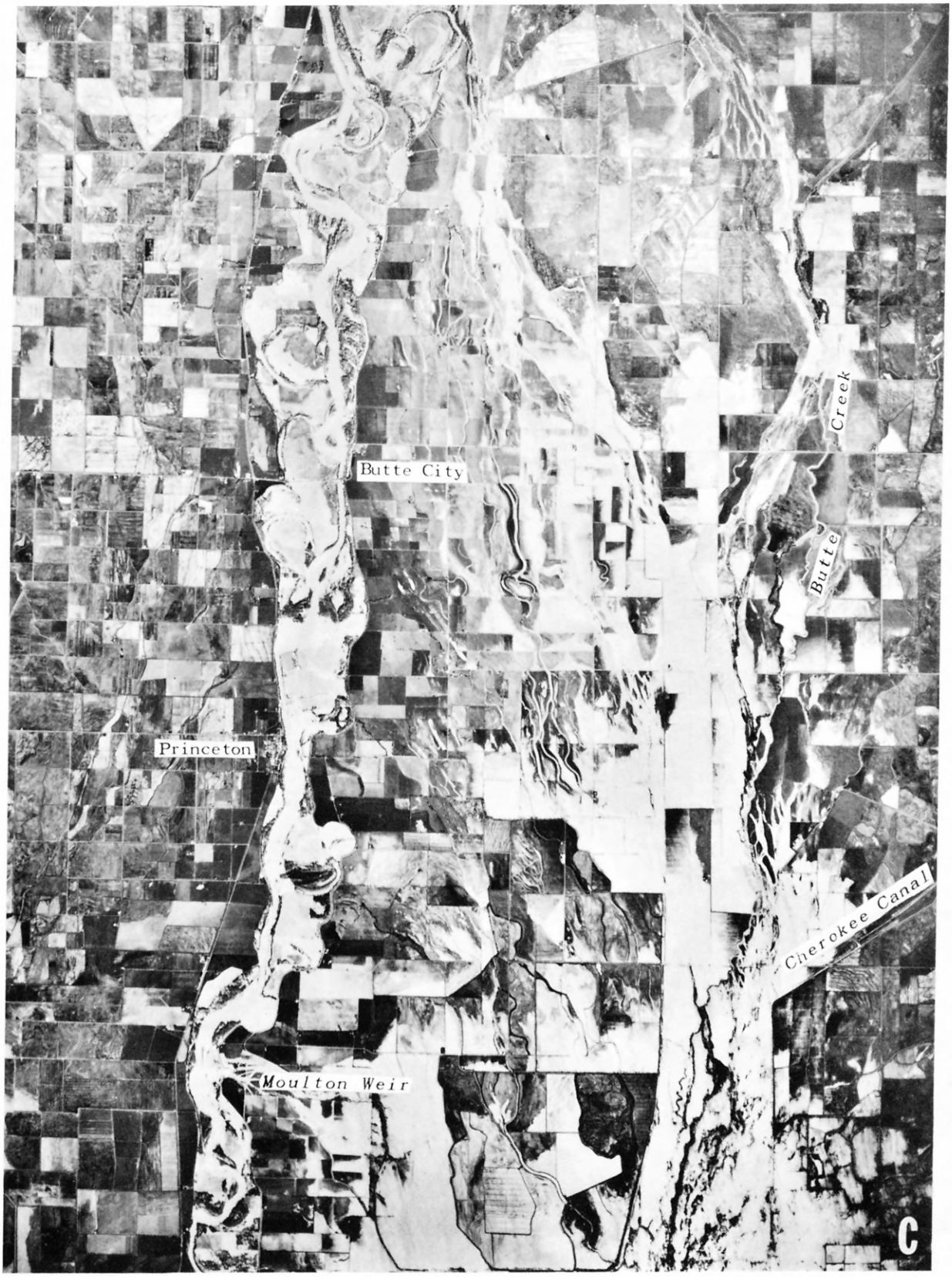


FIGURE 3.—Inundation in Butte Basin on January 21, 1974



PHOTOGRAPH FROM THE CALIFORNIA
DEPARTMENT OF WATER RESOURCES

FIGURE 3.— continued



PHOTOGRAPH FROM THE CALIFORNIA
DEPARTMENT OF WATER RESOURCES

FIGURE 3.— continued

PHOTOGRAPH FROM THE CALIFORNIA
DEPARTMENT OF WATER RESOURCES

FIGURE 3.— continued

Table 4.--*Peak stages, 1940, 1970, and 1974, at gages in Butte Basin*

Gaging station number or name	Stage, in feet, above mean sea level		
	Feb.-Mar.[1] 1940	Jan. 1970	Jan. 1974
1	--	134.31	133.54
2.5	--	128.5	128.43
4	--	118.99	118.62
7 Angel Slough at Ord Ferry Road	114.2	114.2	112.85
11	--	115.26	114.71
Sacramento River at Ord Ferry	119.22	117.27	115.91
13	--	113.23	112.47
18	--	99.6	97.90
20	--	101.54	100.76
22	97.3	96.46	95.0
24	--	82.7	82.13
Sacramento River at Butte City	93.29	93.00	91.62
Campbell Slough at State Highway 162	--	81.2	81.30
Butte Creek at State Highway 162	--	82.0	81.65
27	74.5	74.3	72.79
Sacramento River at Moulton Weir	80.5	80.86	79.72
37.5	--	64.8	62.01
39	--	63.8	61.80
41	67.6	63.8	61.40
41.5	67.9	64.7	61.52
Sacramento River at Colusa Weir	67.72	65.52	65.72
Sacramento River at Colusa	66.86	64.66	64.73
45 Butte Slough at Outfall Gates	67.6	63.8	61.21
46	66.1	--	60.05
Butte Slough near Meridian	--	58.49	56.99
47	54.5	52.87	50.93

[1]A break occurred in the levee on west side of Butte Slough about 3.3 miles above site 47 at 0130 hours on March 1, 1940.

Flooding at the Latitude of Butte City, 1974 Water Year

Total peak flow at the latitude of Butte City is made up of flow in the main channel and west-bank overflow (this flow is between flood-control levees) and flow on the east-bank flood plain. Peak flow between the flood-control levees is shown in table 2. During large floods, flow on the east-bank flood plain consists of overland flow from the Sacramento River and flow from the Butte Creek drainage area. Flows on the east-bank flood plain in 1970 and 1973 were described by Blodgett and Stiehr (1974) using numbered overflow areas with flow in these areas divided into bridge and road overflow quantities. These same overflow areas (table 5 and shown in fig. 4) are used in this report to describe flooding in 1974.

January 1974.--Peak overflow at the latitude of Butte City (excluding Butte Creek) of 44,500 ft^3/s (revised from 43,000 ft^3/s used by Simpson, 1976a) occurred on January 18. Corresponding peak flow for Butte Creek was 11,000 ft^3/s. Distribution of peak flow, including the percentage of total discharge through bridges and over sections of State Highway 162, is given in table 5. Most percentages of total discharge are similar to those for the flood of January 1970 (Blodgett and Stiehr, 1974, table 6). Road overflow at area 8, in percent, was larger in January 1974 than in January 1970, possibly because of removal of trees in 1973 from high ground along the downstream road embankment.

A total overflow hydrograph (fig. 5 and Data D) for the period January 16-21 was developed for the east-bank overflow, based on discharge and stage measurements and stage relations among the various overflow areas. The recession part of the hydrograph was estimated from the corresponding hydrograph developed for the latitude of Gridley Road. Volume of overflow determined for the January flood period agrees closely with that determined at the latitude of Gridley Road and is about 18 percent of the total inflow to the lower Butte Basin.

March-April 1974.--Significant flood overflow from the Sacramento River occurred March 31-April 5. Peak overflow was 23,900 ft^3/s on April 1. Butte Creek floodflow peaked at 14,900 ft^3/s on March 30; at the time of the river peak overflow, Butte Creek flow was 5,710 ft^3/s. Distribution of flow is given in table 6. A hydrograph for the flood period was not made because only peak road overflow was measured.

Future Distribution of Flow.--During the summer of 1976, improvements were made to State Highway 162 in the reach inundated by overflows from the Sacramento River and Butte Creek. Several bridges were rebuilt, and the roadway was resurfaced. The effects of these changes, if any, on the distribution of flow and the effects of agricultural changes and vegetal growth subsequent to the flooding in 1974 have not been determined.

Table 5.--*Distribution of Sacramento River east-bank overflow and of Butte Creek during peak of January 18, 1974 (0400 hours), at the latitude of Butte City*

[Modified from Blodgett and Stiehr, 1974, table 6]

Overflow area[1]	Bridge			Road overflow		Total discharge (ft^3/s)	Percentage of total discharge
	Number	Peak stage[2] (ft)	Discharge (ft^3/s)	Peak stage[3] (ft)	Discharge (ft^3/s)		
			Overland flow[4] from Sacramento River				
10	11-18	82.2	1,700	82.6	500	2,200	5.0
9	11-19	82.6	2,100	82.8	5,000	7,100	16.0
8	11-20	83.0	2,000	82.8	7,450	9,450	21.2
7	11-21	82.9	820	83.2	1,590	2,410	5.4
6	11-22	83.1	1,280	83.1	5,800	7,080	15.9
5	--			82.1	4,650	4,650	10.4
4	11-23	81.3	2,600	81.7	4,000	6.600	14.8
3	11-31	80.8	2,060			2,060	4.6
	11-24	80.3	3,000		0	3,000	6.7
2	--				0	0	0
	Total		15,560		28,990	44,550	100.0
			Floodflow from Butte Creek				
1	11-32	81.5	1,350		130	1,480	13.5
	11-33	81.8	1,320		80	1,400	12.8
	11-34	81.7	660		110	770	7.1
	11-26	81.3	1,800		10	1,810	16.5
	11-27	81.52	4,000		0	4,000	36.5
1A	12-57	81.8	1,100		300	1,400	12.8
	12-56	81.5	90		0	90	.8
	Total		10,320		630	10,950	100.0

[1]Divisions of flow (see fig. 4) are identical to those used by Blodgett and Stiehr, 1974, p. 24.
[2]Water-surface elevation at downstream side of bridge.
[3]Average water-surface elevation on roadway.
[4]Peak flow in main and west-bank channels of Sacramento River was 136,000 ft^3/s.

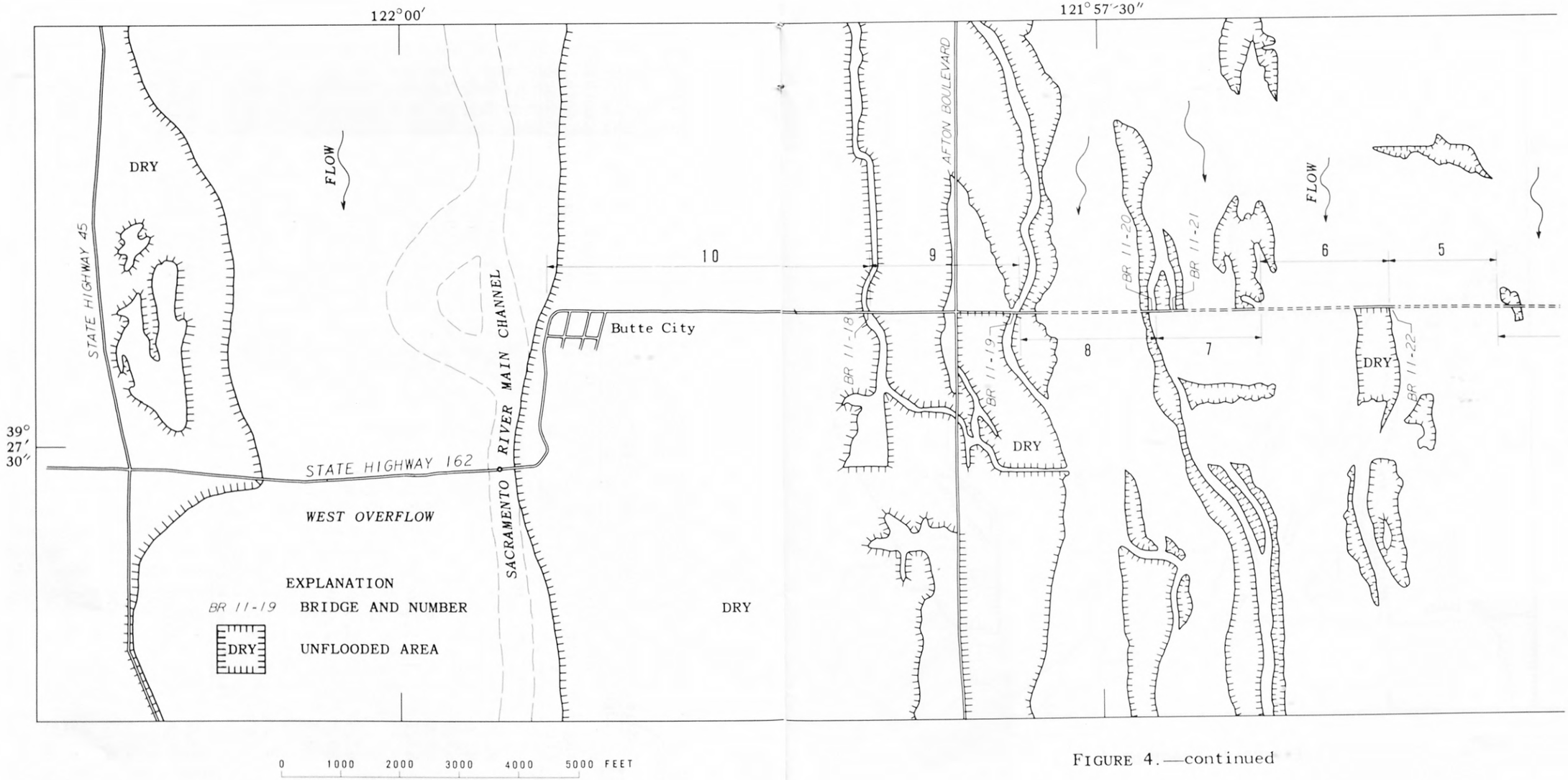


FIGURE 4.—Area inundated at latitude of Butte City on January 19, 1974, at 1300 hours, and location of overflow areas 1A through 10.

FIGURE 4.—continued

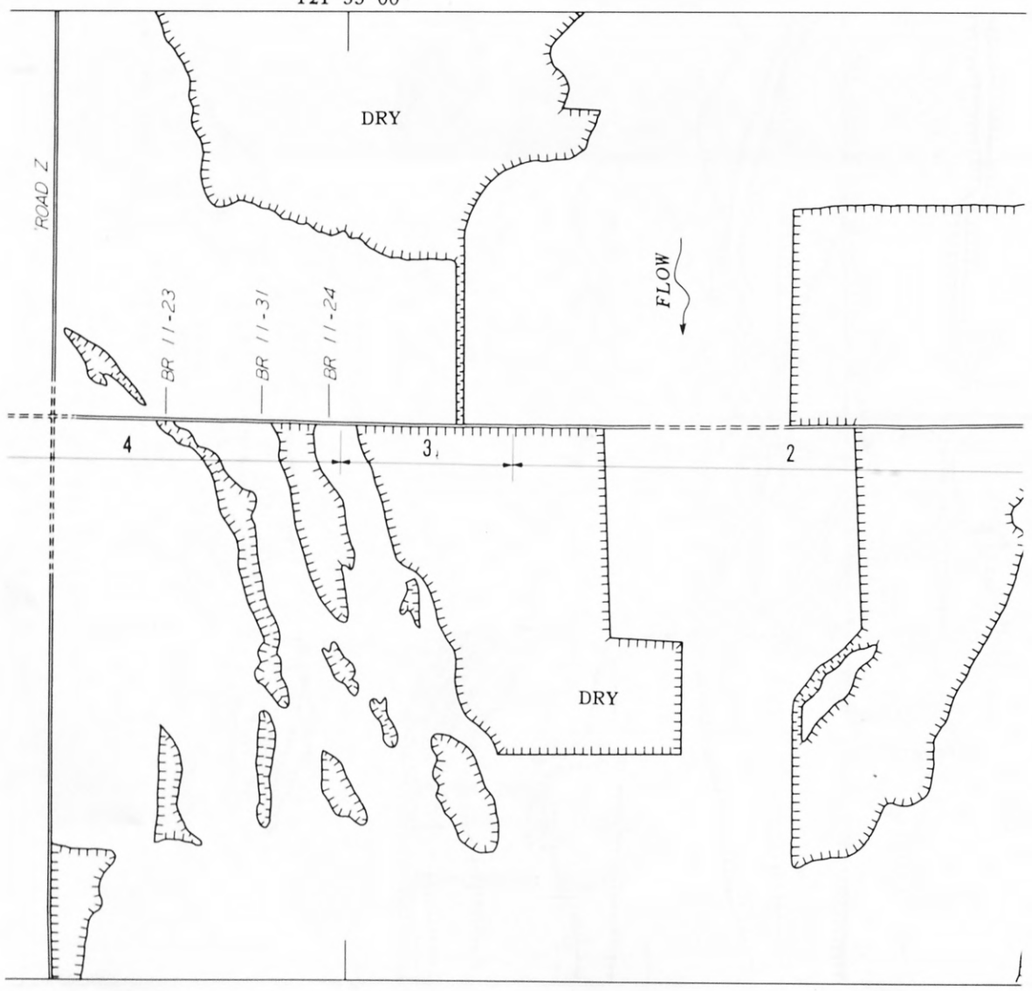


FIGURE 4.—continued

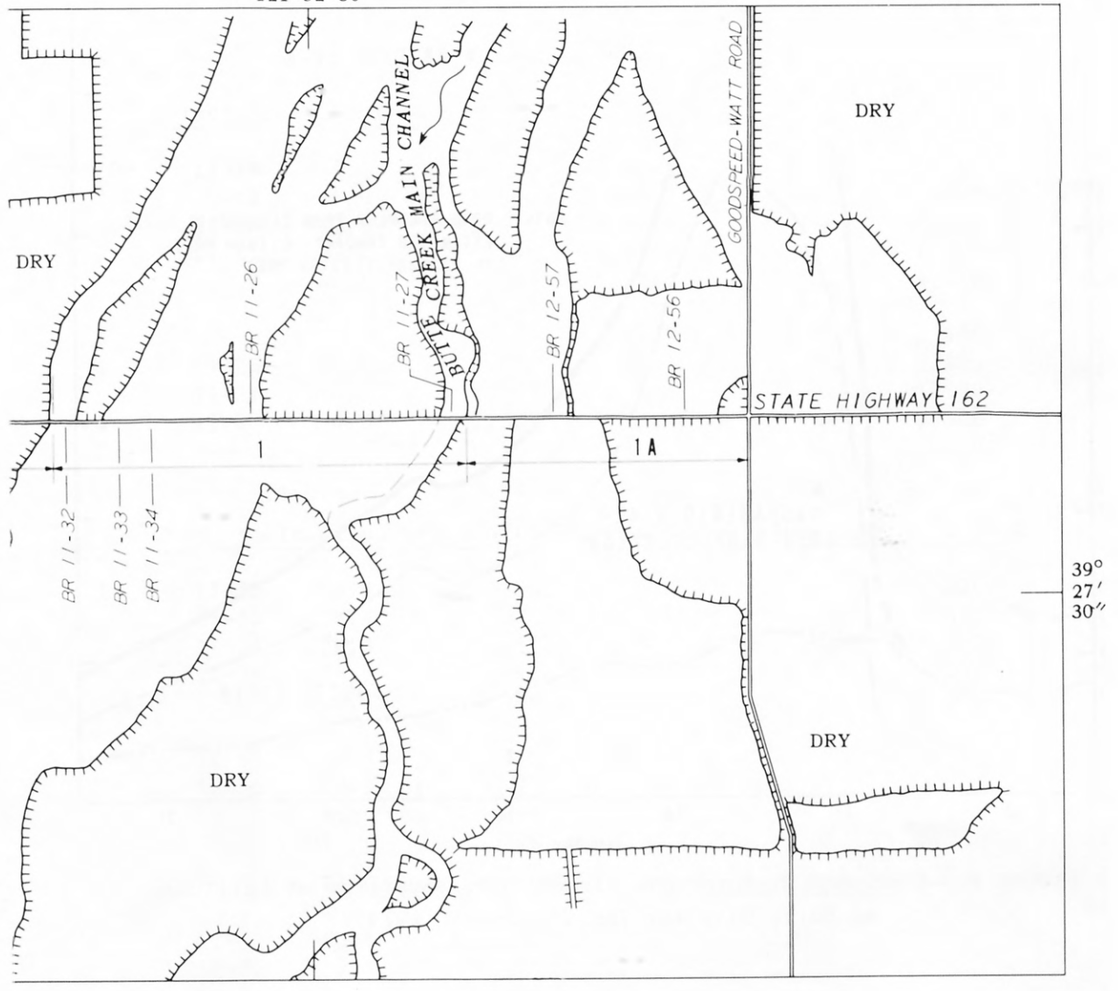


FIGURE 4.—continued

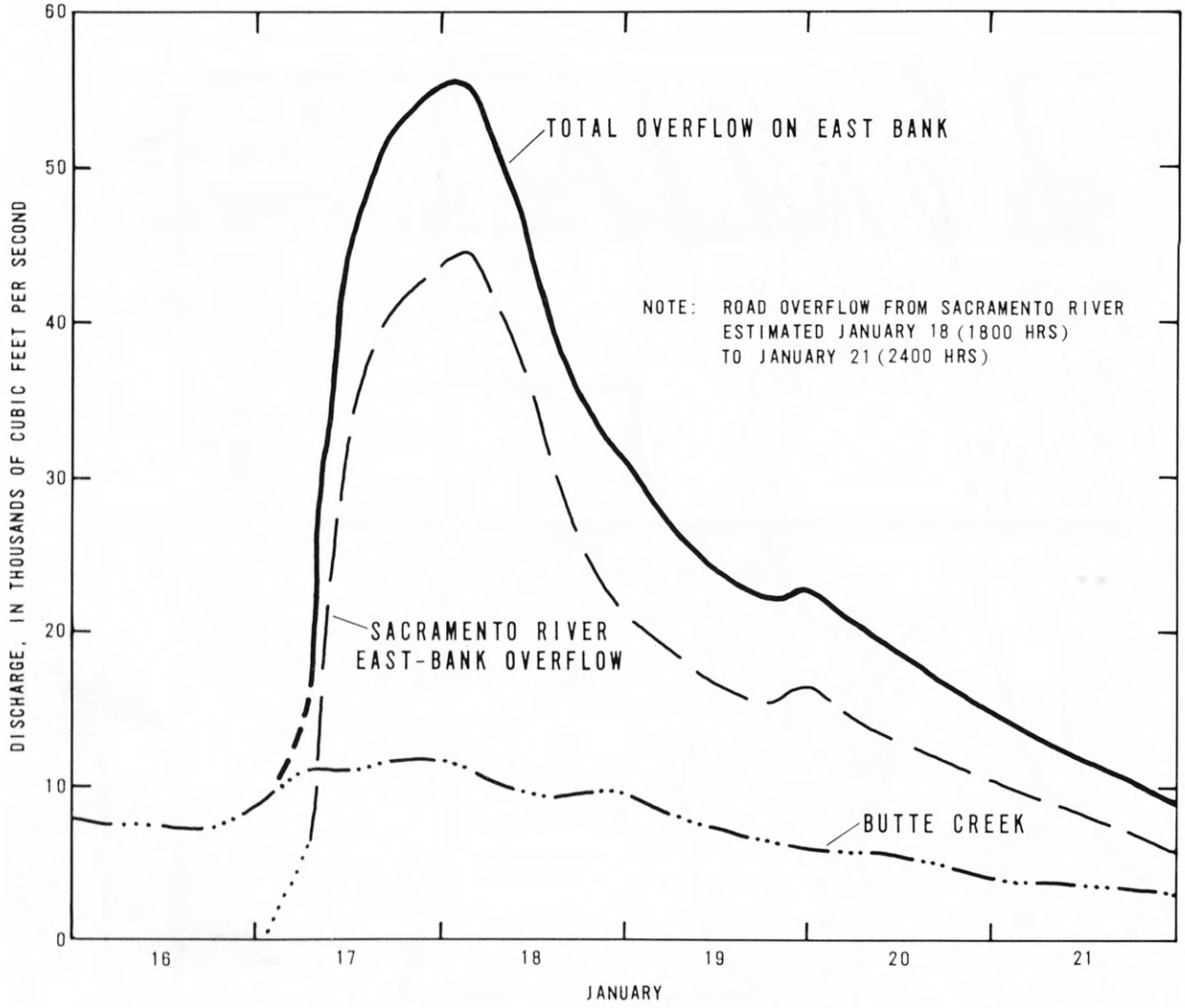


FIGURE 5.—Discharge hydrographs of east-bank overflow at latitude of Butte City for January 16-21, 1974.

Table 6.--*Distribution of Sacramento River east-bank overflow and of Butte Creek during peak of April 1, 1974 (0630 hours), and distribution of flow in Butte Creek on March 30, 1974, at the latitude of Butte City*

Overflow area[1]	Bridge			Road overflow		Total discharge (ft^3/s)	Percentage of total discharge
	Number	Peak stage[2] (ft)	Discharge (ft^3/s)	Peak stage[3] (ft)	Discharge (ft^3/s)		
	Overland flow[4] from Sacramento River at 0630 hours April 1, 1974						
10	11-18	81.6	1,000	82.4	355	1,360	5.7
9	11-19	81.9	1,560	82.2	1,330	2,890	12.1
8	11-20	82.3	1,220	81.8	1,260	2,480	10.4
7	11-21	82.4	540	81.4	505	1,040	4.3
6	11-22	82.1	1,700	82.4	4,030	5,730	24.0
5	--			81.9	2,630	2,630	11.0
4	11-23	80.9	2,500	81.3	1,220	3.720	15.6
	11-31	80.5	1,750			1,750	7.3
3	11-24	79.9	2,300		0	2,300	9.6
2	--				0	0	0
	Total		12,570		11,330	23,900	100.0
	Floodflow from Butte Creek at 0630 hours, April 1, 1974						
1	11-32	79.4	620			620	10.9
	11-33	79.4	620			620	10.9
	11-34	79.4	210			210	3.7
	11-26	78.9	640			640	11.2
	11-27	80.1	3,300			3,300	57.8
1A	12-57	79.4	300			300	5.2
	12-56	79.1	20			20	.3
	Total		5,710		0	5,710	100.0
	Floodflow from Butte Creek on March 30, 1974						
1	11-32	82.1	1,200	--	[5]2,000		
	11-33	82.1	1,500	--			
	11-34	82.0	800	--			
	11-26	81.6	1,900	--			
	11-27	81.95	4,200	--			
1A	12-57	82.5	1,600	82.5	1,000		
	12-56	82.5	200				
	Total		11,900		3,000	14,900	100.0

[1]Divisions of flow (see fig. 4) are identical to those used by Blodgett and Stiehr, 1974, p. 24.

[2]Water-surface elevation at downstream side of bridge.

[3]Average water-surface elevation on roadway.

[4]Peak flow in main and west bank channels of Sacramento River was 122,000 ft^3/s.

[5]Road overflow estimated for overflow area 1.

Flooding, 1975 Water Year

Two peaks of almost equal magnitude occurred on the Sacramento River during this water year. The first, in February, caused slight overflow at the latitude of Ord Ferry. The second, in March, caused no overflow to the upper basin. Total peak flow at the latitude of Ord Ferry was estimated to be 106,000 ft^3/s on February 14. Of this flow, 1,020 ft^3/s was contained in the Angel Slough channel and about 3,900 ft^3/s was contained by the numerous channels between the Ord Ferry bridge and Angel Slough.

Peak flow through the basin was not measured at the latitude of Afton Boulevard. Based on stage-discharge relations developed at this latitude during the 1974 water year, the peak discharge was about 1,000 ft^3/s in the combined channels of Angel and Campbell Sloughs.

At the latitude of Butte City, the peak flow of the Sacramento River within the Flood Control Project levees was 91,000 ft^3/s on February 14 and 88,900 ft^3/s on March 23. Peak overflow on the east-bank flood plain was determined to be about 1,800 ft^3/s on February 15, excluding Butte Creek. The peak flow in Butte Creek, at the time of the Sacramento River overflow peak on February 15, was 3,820 ft^3/s.

At Gridley Road the peak flow was a result, mainly, of flows originating in the Butte Creek drainage. The peak at this latitude was 7,300 ft^3/s on February 14.

Overflow to Butte Basin at Colusa and Moulton Weirs peaked at 38,600 ft^3/s and 6,350 ft^3/s, respectively, on February 14. Peak outflows from the basin, measured in Butte Slough at Meridian, were 32,400 ft^3/s on February 15 and 36,900 ft^3/s on March 24.

Peak stages in the lower basin, measured at the gaging station opposite Colusa Bypass, were 55.20 ft on February 15 and 55.54 ft on March 23.

Peak flows in the study area for the 1975 water year were, in general, similar to those measured during January 1973. The indicated increase in peak overland flow in February 1975 from the latitude of Afton Boulevard to the latitude of Butte City was probably due to lack of definition of the low flow stage-discharge relations at both latitudes.

Stage and discharge hydrographs at selected locations for the February high-flow period are shown in figures 6 and 7. Selected flood stages and discharges for the 1975 water year are listed in Data E.

Water-surface profiles for the Sacramento River between Butte City and Ord Ferry (fig. 8) for the February 1975 high water are 3-4 ft below those shown for January 1974 and 4-5 ft below the profile for the January 1970 flood.

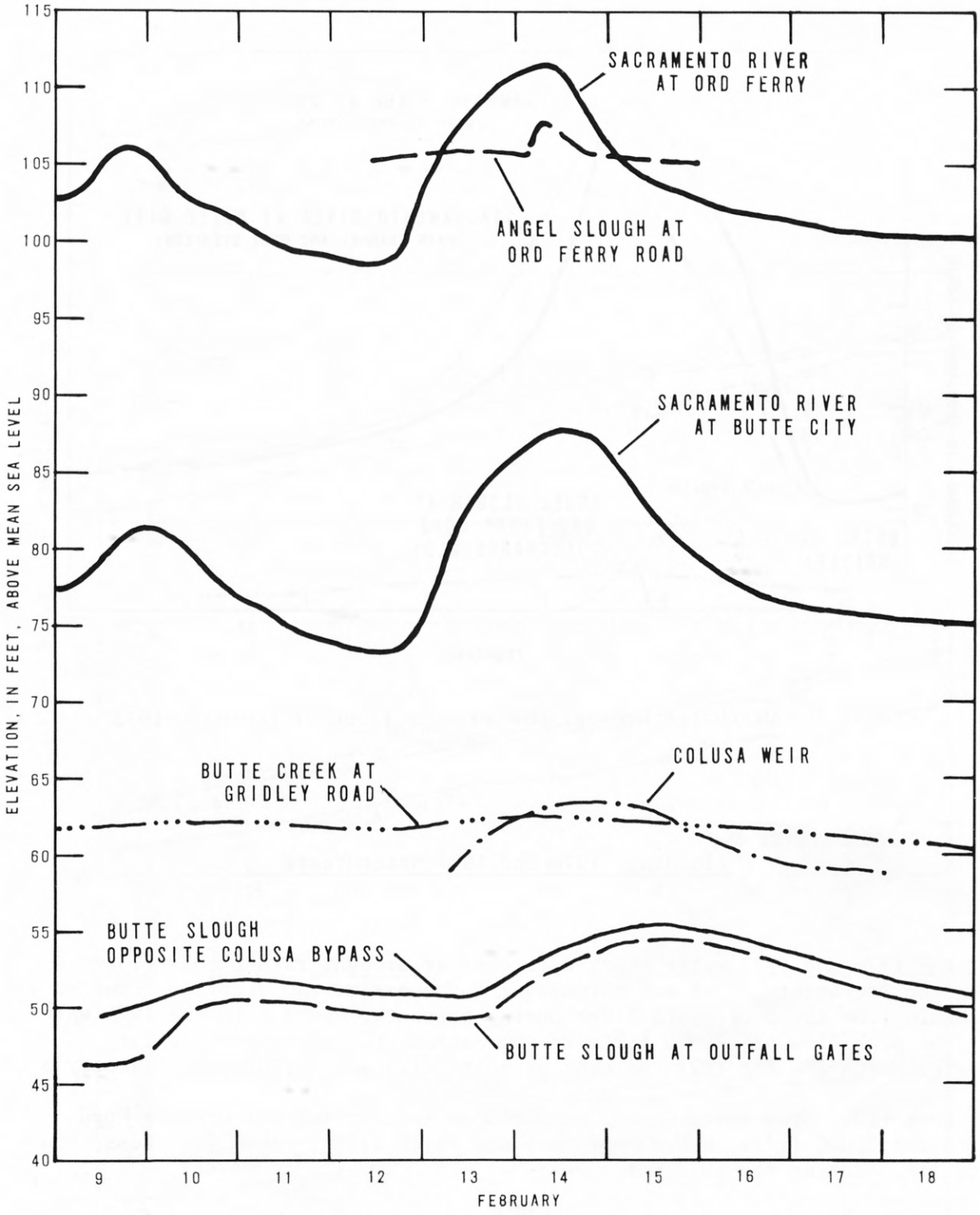


FIGURE 6.—Stage hydrographs for the flood of February 1975.

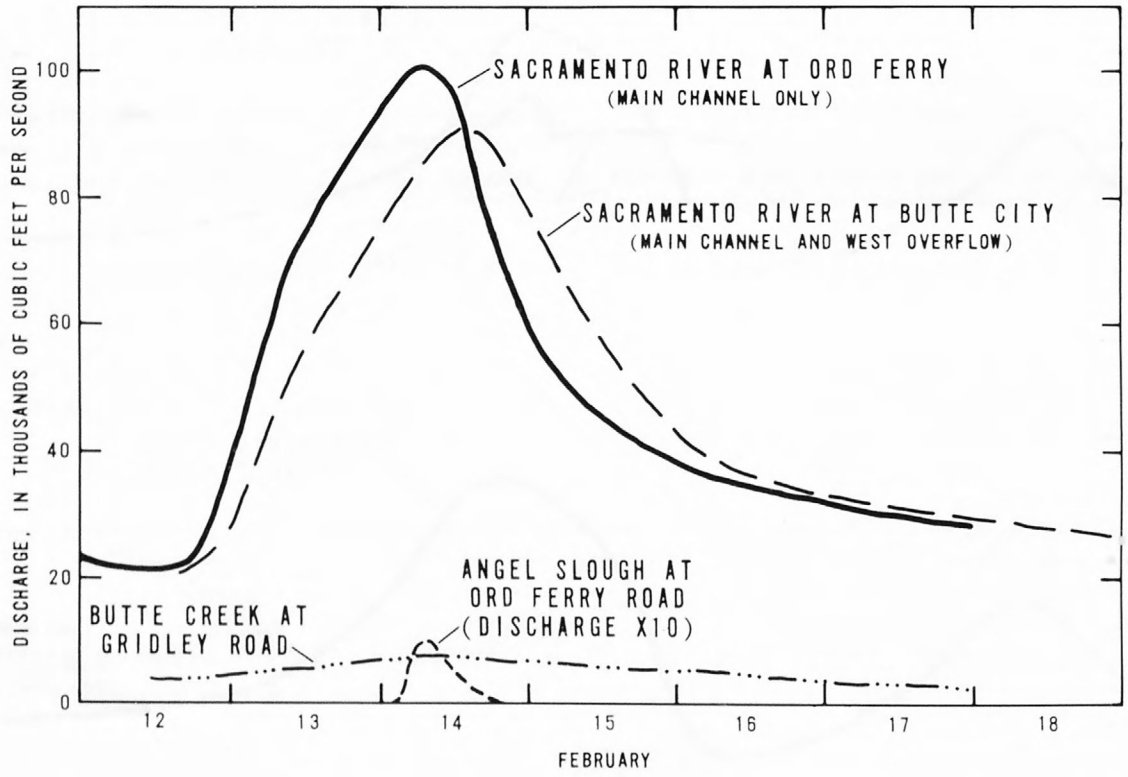


FIGURE 7.—Discharge hydrographs for the flood of February 1975.

Flooding, 1976 and 1977 Water Years

The 1976 and 1977 water years were ones of drought rather than flooding along the Sacramento River and throughout Butte Basin. No overflow occurred to the basin from the Sacramento River during these two years. In the 1976 water year the peak flow of 27,300 ft^3/s in the Sacramento River at Butte City occurred March 1. For 1977 the peak at Butte City was 13,700 ft^3/s January 3.

Peak flows from Butte Creek, measured at the latitude of Gridley Road, were about 2,000 ft^3/s in December 1975 and March 1976. Flows were less than 1,000 ft^3/s during the 1977 water year.

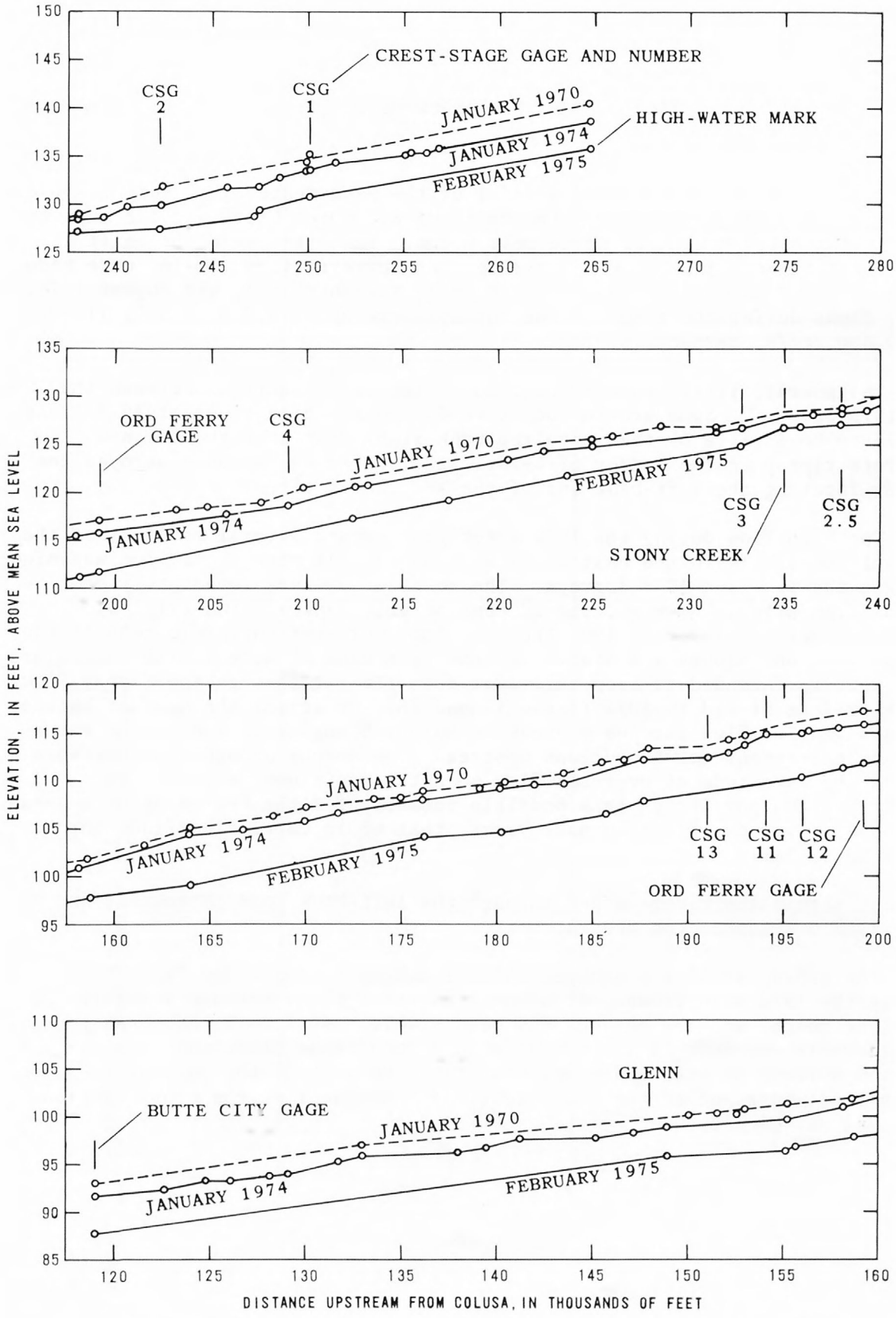


FIGURE 8.—Water-surface profiles for the Sacramento River for the floods of January 1970, January 1974, and February 1975.

CHANNEL CHANGES, SACRAMENTO RIVER

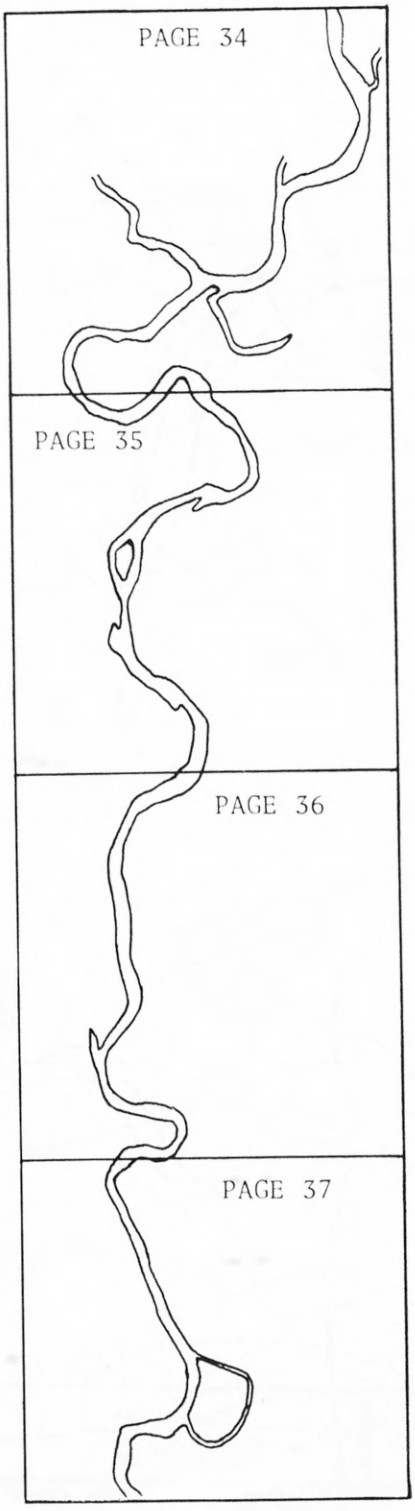
Cross sections of the main channel of the Sacramento River were surveyed at eight sites (fig. 9) between the mouth of Big Chico Creek and the end of the east-bank flood control levee near Glenn. The sites were chosen at locations of left-bank scour. Cross-section surveys (figs. 10-16) were made at these sites in October 1972, August 1973, November 1974, and August 1976. Daily flows during the times of the surveys were about 8,900, 8,500, 11,600, and 9,400 ft^3/s, respectively.

In general, little change occurred in the cross sections between the 1972 and 1973 surveys. Some erosion occurred during the high flows of 1973 along Ord Ferry Road (site 6) that required bank stabilization with rock and concrete riprap in the summer of 1973. Also, lateral erosion destroyed the marker locating the left-bank end of the section at site 8.

The high flow during the 1974 water year caused lateral movement of the channel 200-300 ft to the east at sites 2 and 3. At site 4, erosion was minor between the 1973 and 1974 surveys. The reach of channel immediately downstream from site 4, however, showed considerable bank erosion (fig. 9). In the summers of 1974 and 1975 the U.S. Army Corps of Engineers rebuilt the levee at Murphy Slough and stabilized the left bank at site 4 with rock riprap. This work is intended to keep the river from flowing through the Murphy Slough break area as it did in 1974 (figs. 17 and 18), or across the meander between sites 4 and 5. Flow through a break at Murphy Slough will reduce the water-surface elevations for floodflows upstream from Murphy Slough and therefore reduce the magnitude of overbank flow to Butte Basin near site 3. The vicinity of Murphy Slough is a possible location for the beginning of a bypass proposed at various times in past years, that would carry floodflows through upper Butte Basin.

At site 5 the river washed through the left-bank road embankment and at high flow overtopped the present bank.

The riprap at site 6 stopped lateral movement toward Ord Ferry Road during the 1974 high flows. At site 7 the river flows through a relatively straight reach, and the channel has been stable. At site 8 there has been considerable movement of the meanders in a downstream direction. Cross-section surveys at site 8 are not comparable because of the varying location of the left-bank end of the cross section; consequently, the cross-section plot has not been shown.



INDEX TO FIGURE 9

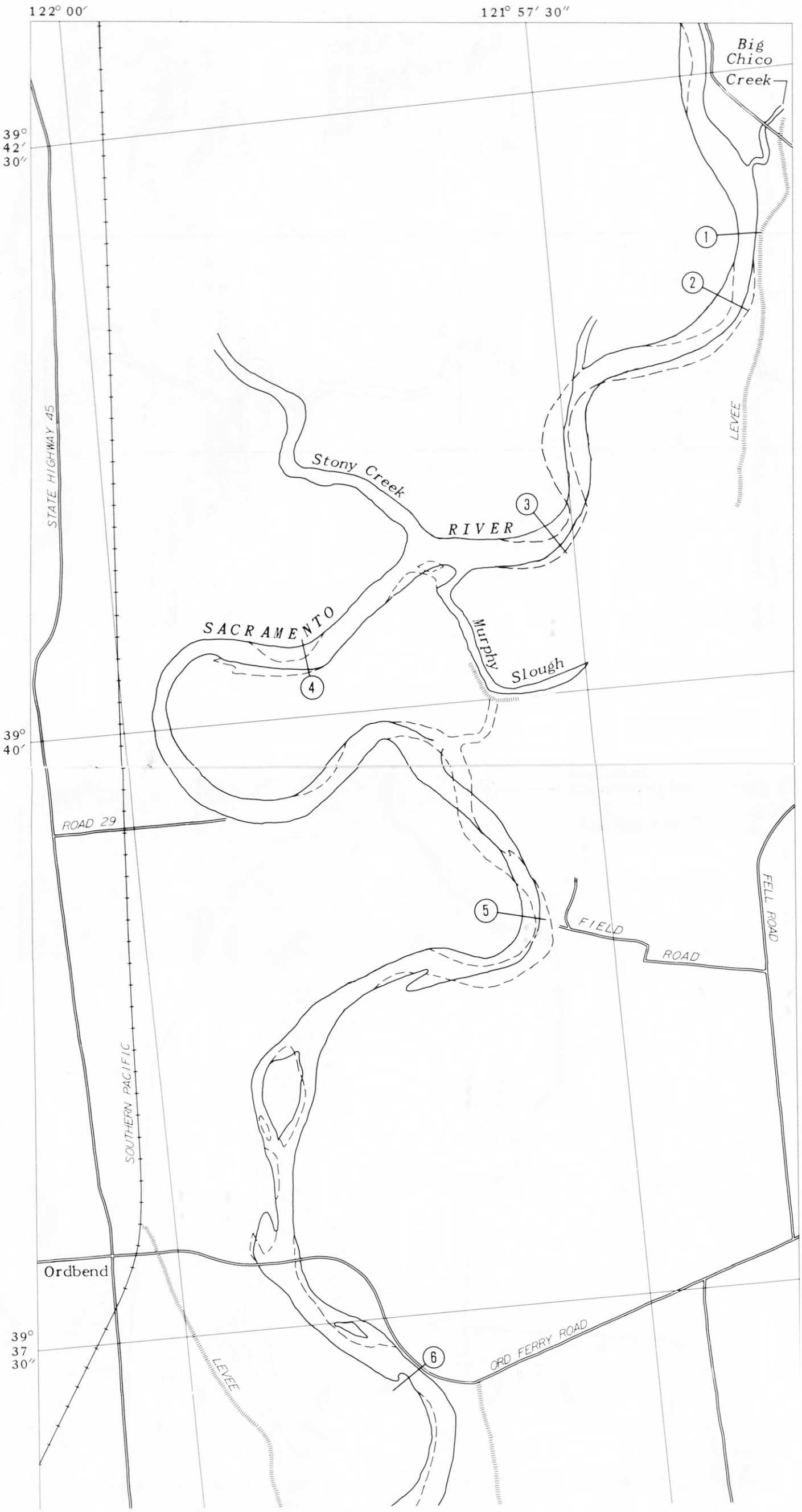


FIGURE 9.—continued on next page

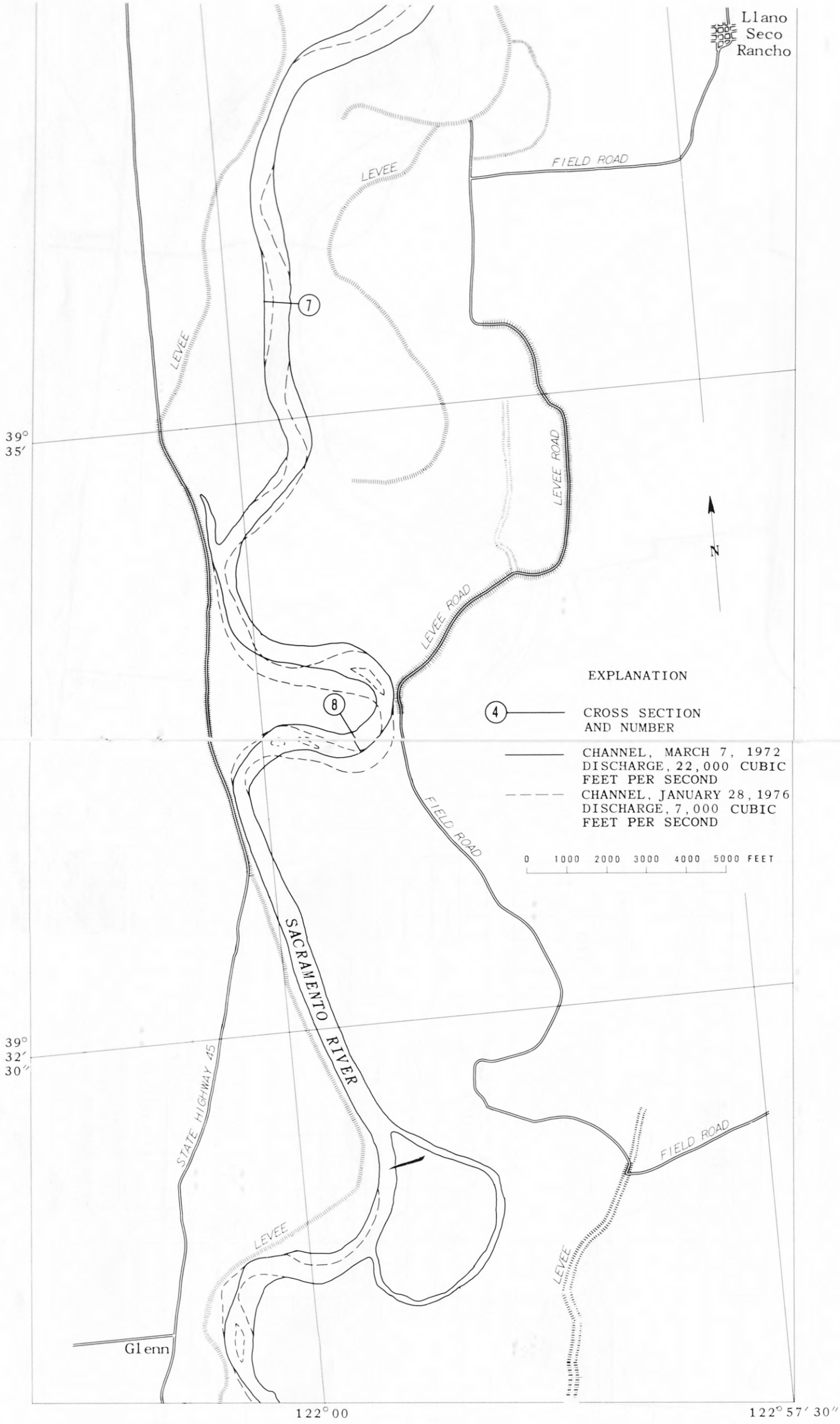


FIGURE 9.—Sacramento River low-water channel in March 1972 and January 1976, with location of cross sections.

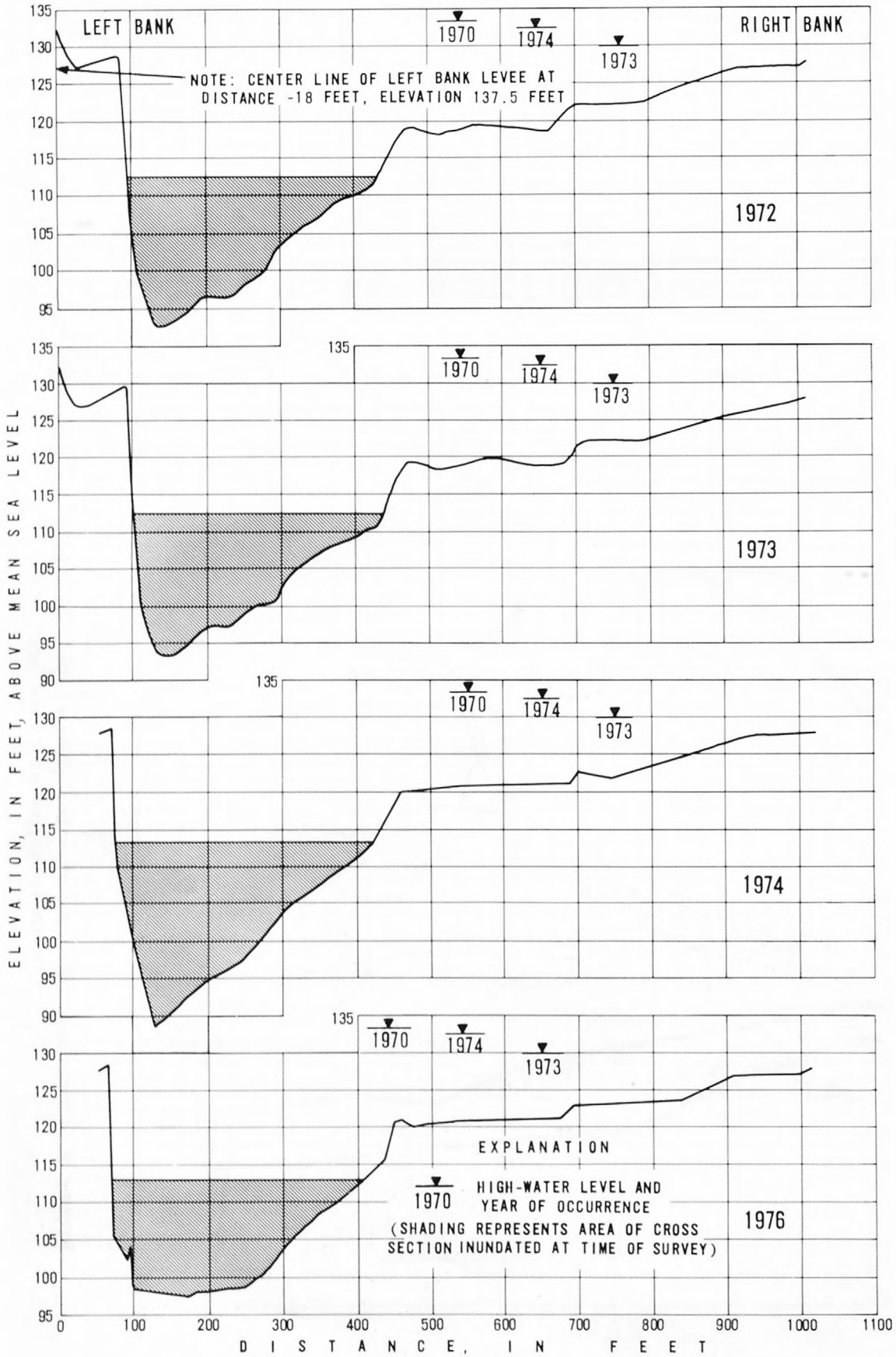


FIGURE 10.—Sequential cross sections and water levels of the Sacramento River at site 1.

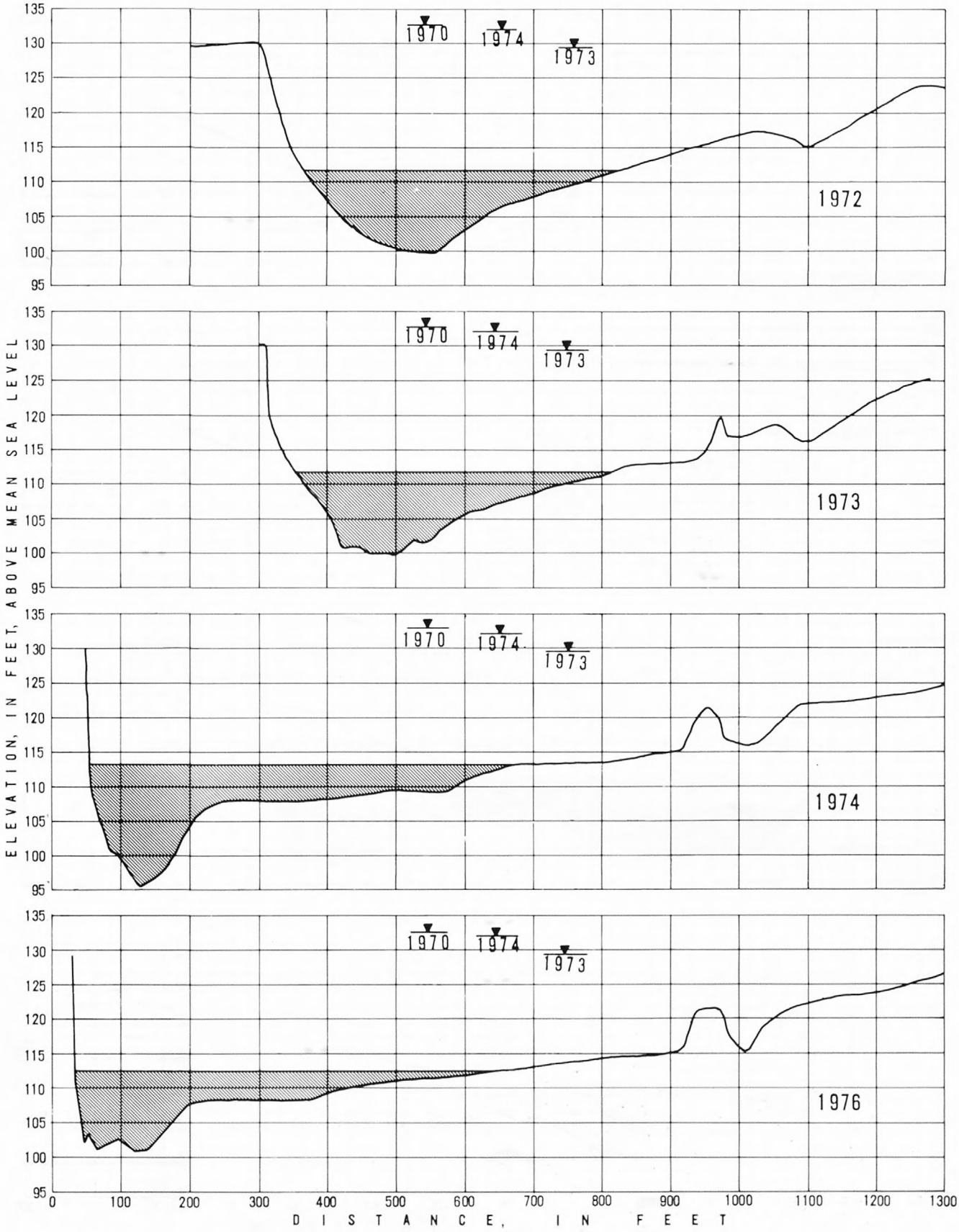


FIGURE 11.—Sequential cross sections and water levels of the Sacramento River at site 2.

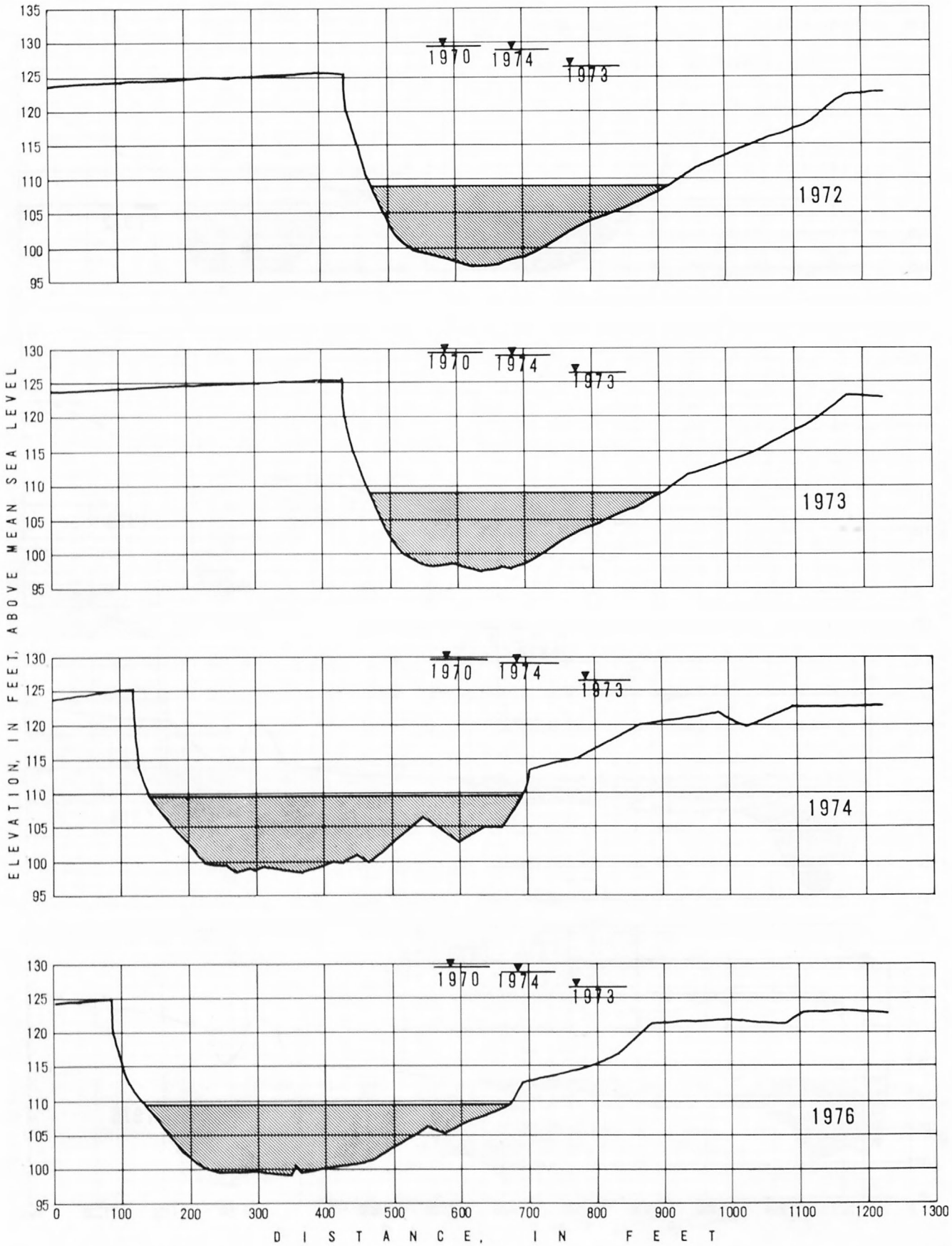


FIGURE 12.—Sequential cross sections and water levels of the Sacramento River at site 3.

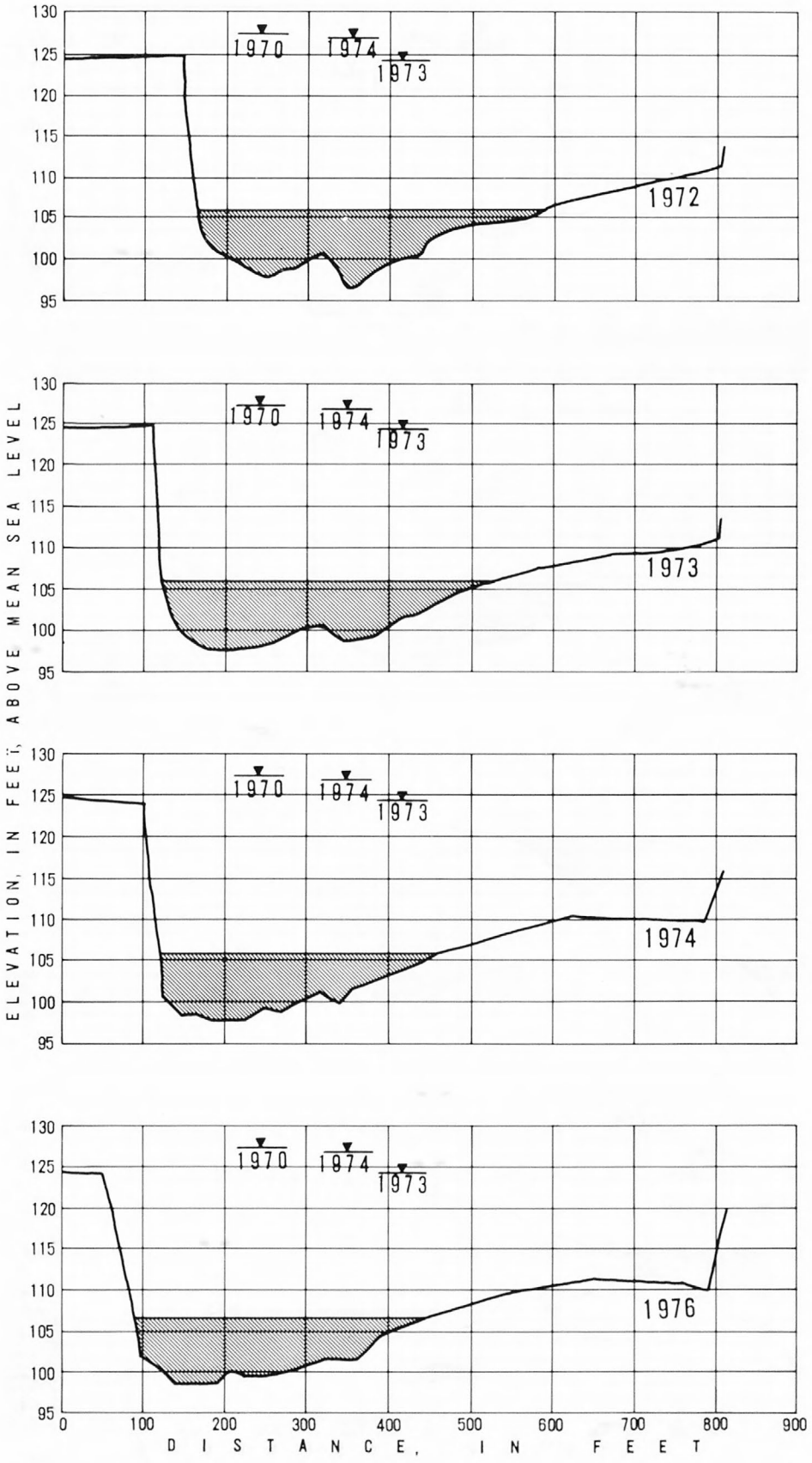


FIGURE 13.—Sequential cross sections and water levels of the Sacramento River at site 4.

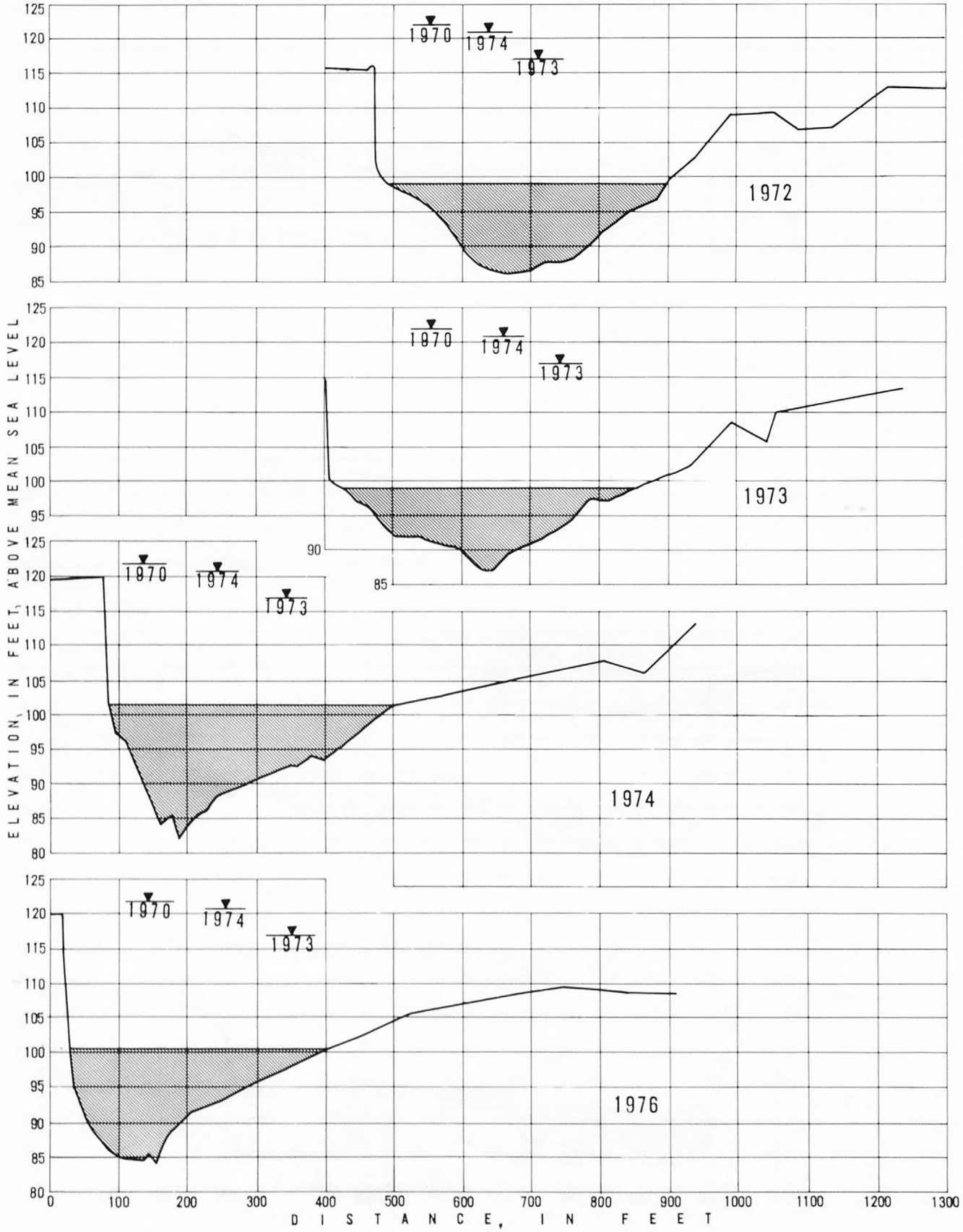


FIGURE 14.—Sequential cross sections and water levels of the Sacramento River at site 5.

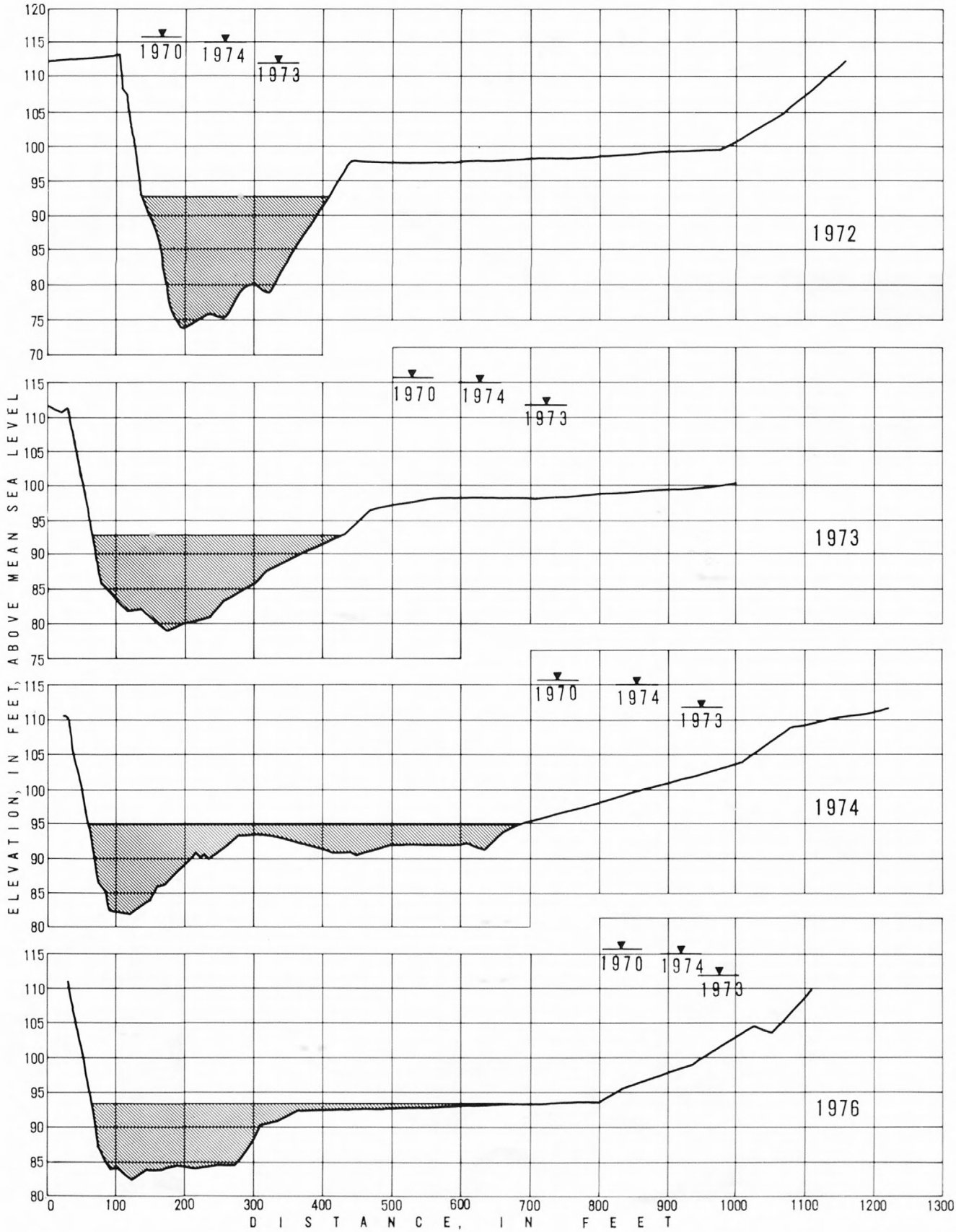


FIGURE 15.—Sequential cross sections and water levels of the Sacramento River at site 6.

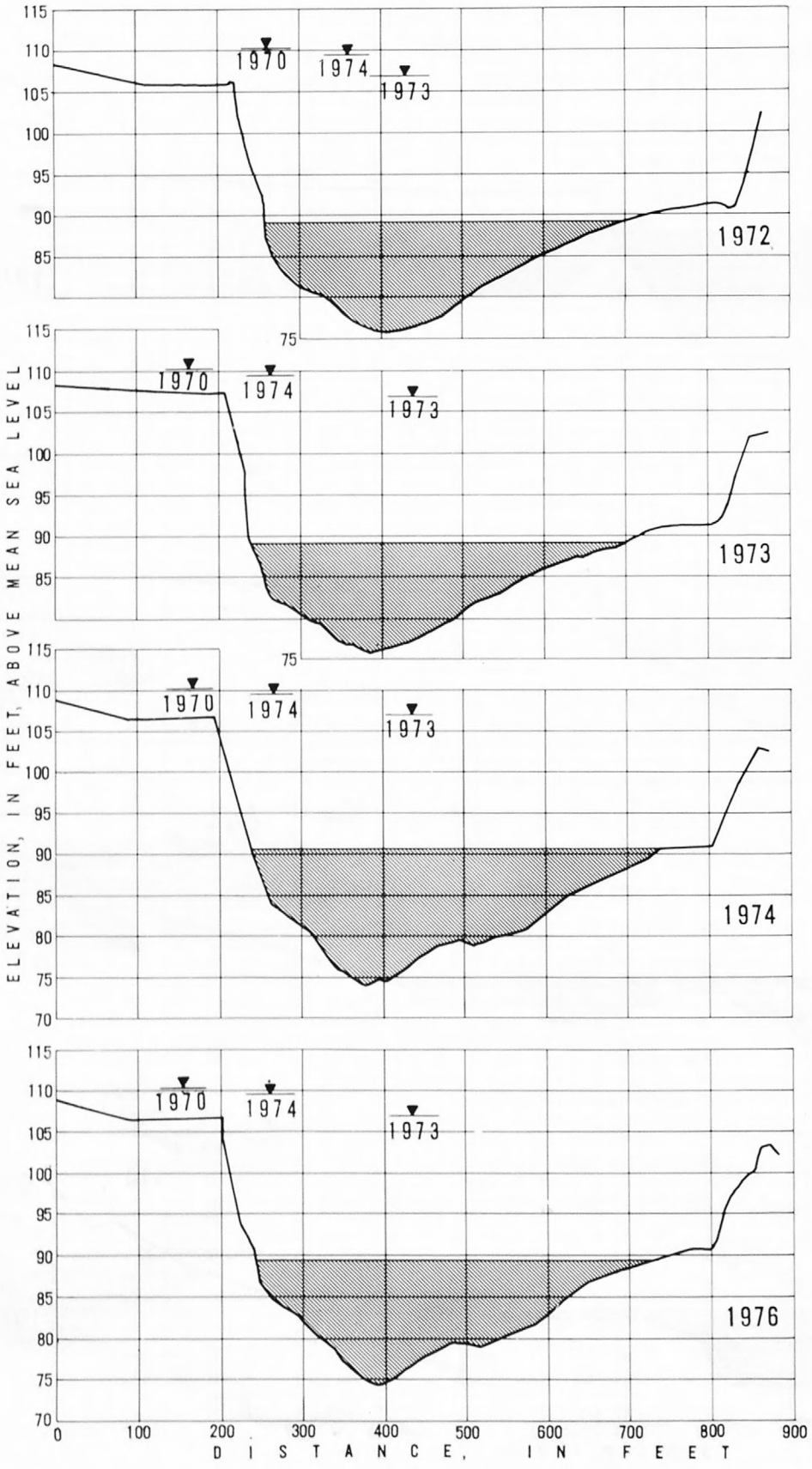


FIGURE 16.—Sequential cross sections and water levels of the Sacramento River at site 7.

FIGURE 17.—Sacramento River at Ord Ferry, and Murphy Slough area of Butte Basin during flood, April 3, 1974. Photograph courtesy of M-H-M, Inc.

FIGURE 18.—Sacramento River north of Ord Ferry, and Murphy Slough area of Butte Basin during flood, April 3, 1974. Photograph courtesy of M-H-M, Inc.

INFLOW, CHANGE IN STORAGE, OUTFLOW OF LOWER BUTTE BASIN

Storage in lower Butte Basin can be related solely to the outflow discharge, and the outflow hydrograph can be calculated from the inflow hydrograph and the relationship between storage and outflow. The relation may be determined by combining elevation-outflow (fig. 19) and elevation-capacity relations (fig. 20).

The water level at site 41 is used to represent the ponding elevation of Butte Sink--the slope in water surface is small and is averaged because this gage is located midway through the area of ponding. The elevation-outflow relation was developed at site 41 from comparison of data obtained at Butte Slough near Meridian, at site 43 opposite Colusa Bypass, and from staff-gage readings made at site 41 (Data F). The elevation-capacity relation was based on topographic maps of the area between Gridley Road and site 46 and was also related to site 41.

Inflow to lower Butte Basin has been measured at Colusa and Moulton Weirs and since 1961 at Cherokee Canal (table 7). Outflow from the basin through Butte Slough was measured at various locations between Mawson Bridge (site 46) and old Long Bridge (site 47). Stage data representing ponding levels in Butte Sink were collected at the Butte Slough outfall gates and at the present site of crest-stage gage 41.5. In the past, measurements were not made of inflow from Butte Creek, including Sacramento River overland flow. Therefore, a hydrograph of total inflow could not be determined for use in the routing of inflow, change in storage, and outflow.

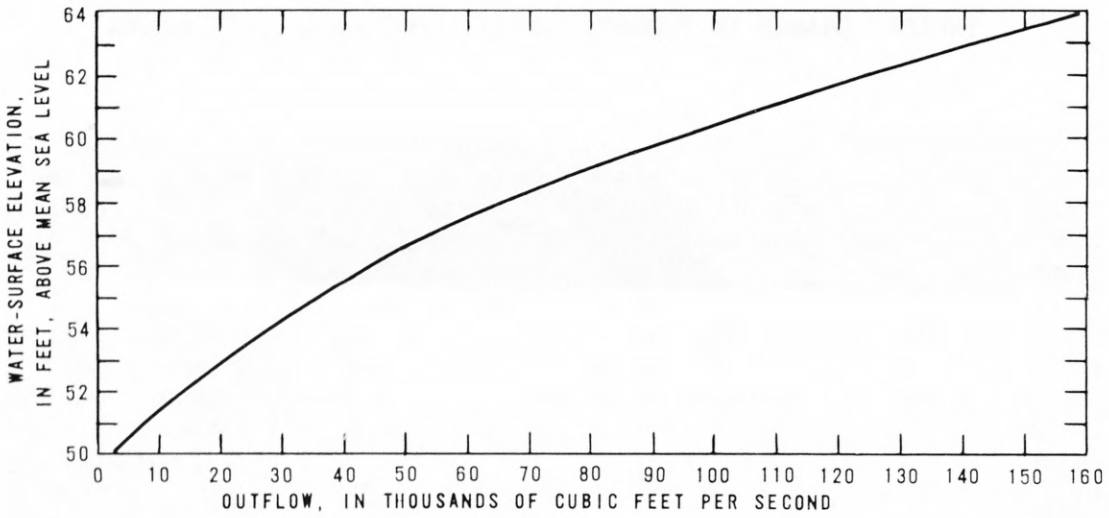


FIGURE 19.--Water-surface elevation and outflow for Butte Sink at crest-stage gage 41.

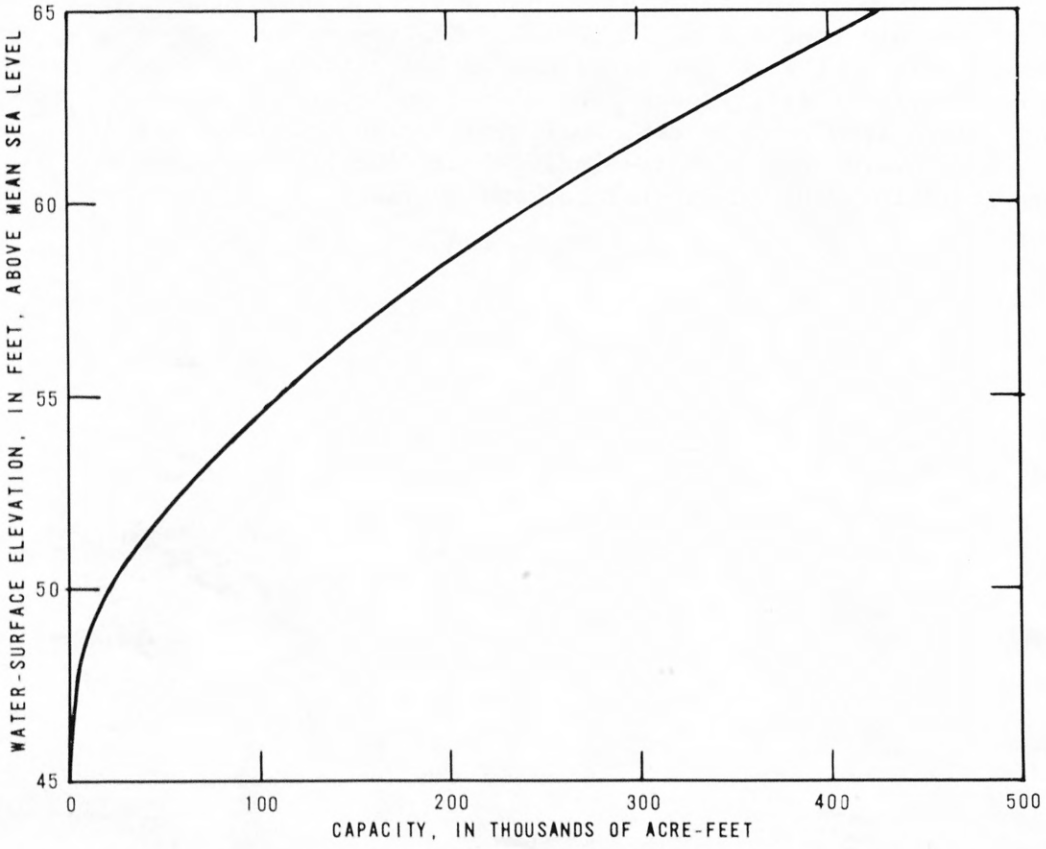


FIGURE 20.—Water-surface elevation and capacity for Butte Sink at crest-stage gage 41.

Table 7.--*Annual peak flows at Colusa and Moulton Weirs, Cherokee Canal, and Butte Slough for water years 1944-75*

Water year	Colusa Weir Spill to Butte Basin			Moulton Weir Spill to Butte Basin			Cherokee Canal			Butte Slough flow to Sutter Bypass		
	Date	Instantaneous discharge (ft^3/s)	Maximum mean daily discharge (ft^3/s)	Date	Instantaneous discharge (ft^3/s)	Maximum mean daily discharge (ft^3/s)	Date	Instantaneous discharge (ft^3/s)	Maximum mean daily discharge (ft^3/s)	Date	Instantaneous discharge (ft^3/s)	Maximum mean daily discharge (ft^3/s)
1944	2-4	--	350		0					2-6	--	5,350
45	2-3	--	17,000		0					2-5	--	15,300
46	12-29	--	65,000	12-29	--	8,500				12-30	--	53,600
47		0			0					2-16	--	3,250
48	4-30	--	17,100							5-2	--	10,100
49	3-12	--	45,800	3-12	--	3,800				3-13	--	24,300
50		0			0					2-8	--	15,800
51	12-16	--	35,100	1-23	--	2,800				12-18	--	20,100
52	2-3	--	32,800	2-3	--	6,500				2-3	--	29,800
53	1-15	--	43,100	1-22	--	11,000				1-16	--	50,200
54	2-19	28,400	27,200	2-19	6,300	5,800				2-20	38,100	36,800
55		0			0					1-22	--	1,560
56	1-16	64,000	60,500	1-16	26,000	24,600				1-17	101,000	96,900
57	3-7	26,200	26,100	3-7	1,580	1,530				3-8	25,400	24,900
58	2-26	77,700	75,300	2-20	36,600	34,700				2-21	127,000	125,000
59	2-18	46,100	38,300	2-17	8,400	4,250				2-19	29,400	27,900
60	2-10	40,800	32,600	2-9	6,780	4,250				2-10	24,800	21,700
61	12-3	22,800	11,900		0					2-4	10,200	9,560
62	2-16	42,000	39,700	2-16	6,230	5,270	2-15	5,570	2,930	2-17	36,200	34,500
63	4-16	45,300	43,900	4-16	10,800	9,530	10-13	15,200	8,030	4-17	44,400	44,000
64	1-22	9,810	6,720		0		1-21	9,750	4,150	1-24	--	3,880
65	1-7	69,600	67,700	12-24	25,900	24,000	1-6	7,260	3,540	12-25	99,300	96,000
66	1-6	29,600	22,700	1-6	2,040	965	1-5	4,610	2,500	1-7	14,300	12,800
67	2-1	51,600	49,100	2-1	14,000	13,100	1-21	7,540	4,510	2-2	66,400	64,500
68	2-26	--	30,100	2-26	--	2,800	2-20	4,210	2,000	2-27	32,100	31,400
69	1-15	56,600	52,700	1-14	18,200	16,200	1-13	11,000	6,820	1-24	83,400	81,300
70	1-25	76,500	73,600	1-25	37,000	34,900	1-14	7,320	4,430	1-26	150,000	150,000
71	12-5	44,200	36,400	12-5	7,720	6,590	11-29	4,520	3,410	12-6	40,900	38,100
72		0			0		1-27	1,100	486	1-25	936	920
73	1-20	45,300	42,100	1-19	11,400	8,590	2-27	4,880	3,250	1-20	59,100	57,500
74	1-18	60,500	59,400	1-18	26,800	25,200	1-15	3,810	2,430	1-19	114,000	111,000
75	2-14	38,600	33,700	2-14	6,350	4,310	2-12	7,130	3,480	3-24	36,900	34,500

Since the 1973 water year, flows at Gridley Road have been measured and discharge hydrographs determined for high-flow periods. These hydrographs, combined with those for spill at Colusa and Moulton Weirs and flow in Cherokee Canal, have been used to produce total inflow hydrographs for floods in January 1973, January 1974, March-April 1974, and February 1975 (figs. 21-24).

Volumes of flow at the latitudes of Butte City and Colusa (table 8) were compared for flood periods since 1970. Total volumes for each flood period at the two latitudes were within 4 percent, with the exception of the 1970 flows which were 7 percent less at Butte City than at Colusa.

Using the data given in figures 19 and 20, outflow was computed and compared to the measured outflow for the flood periods. Comparisons were usually within $\pm$5 percent except during the February 1975 high flow. The larger differences for 1975, computed as much as 25 percent high, are probably the result of cumulative inaccuracies in the inflow and outflow hydrographs.

Inflow to the basin from Butte Creek cannot be computed accurately from outflow and change in storage; these computations have not yielded usable results because small errors in percentage of the outflow and of other inflows cause large fluctuations in computed Butte Creek inflow.

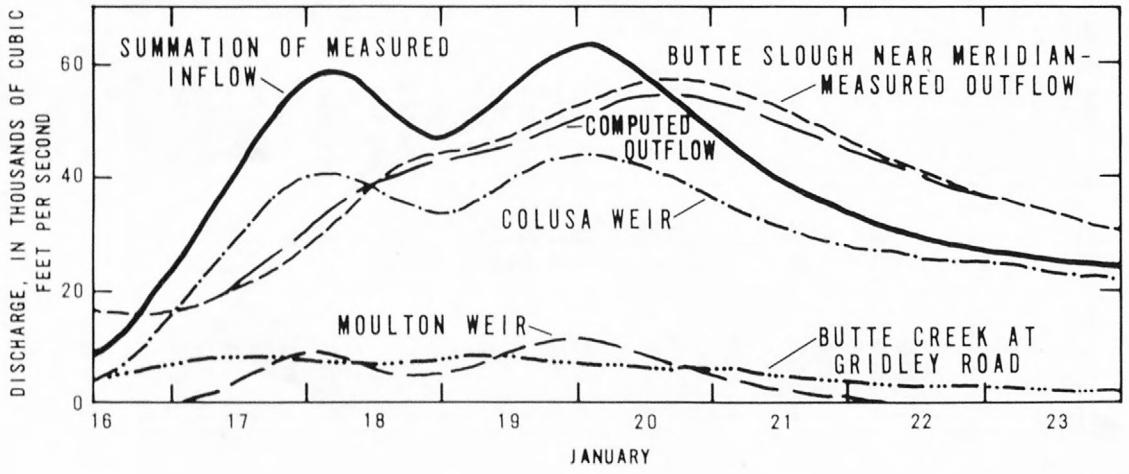


FIGURE 21.—Discharge hydrographs showing measured inflow and outflow and computed outflow for lower Butte Basin for January 16-23, 1973.

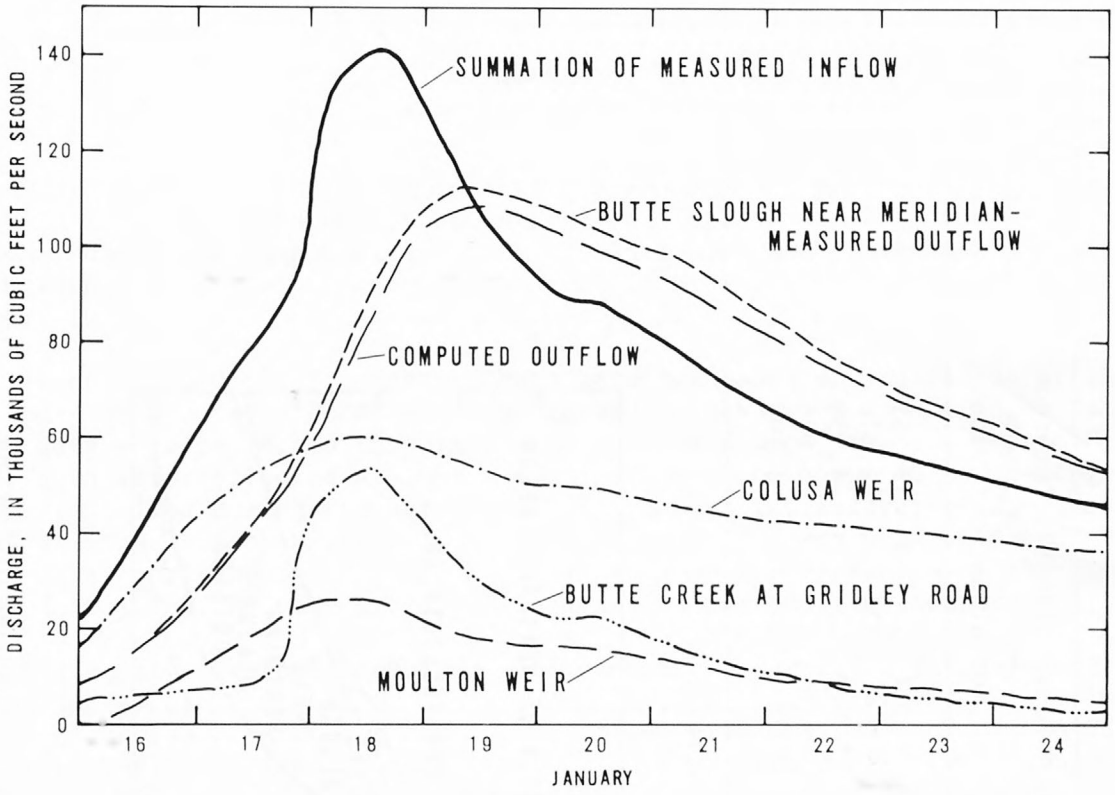


FIGURE 22.—Discharge hydrographs showing measured inflow and outflow and computed outflow for lower Butte Basin for January 16-24, 1974.

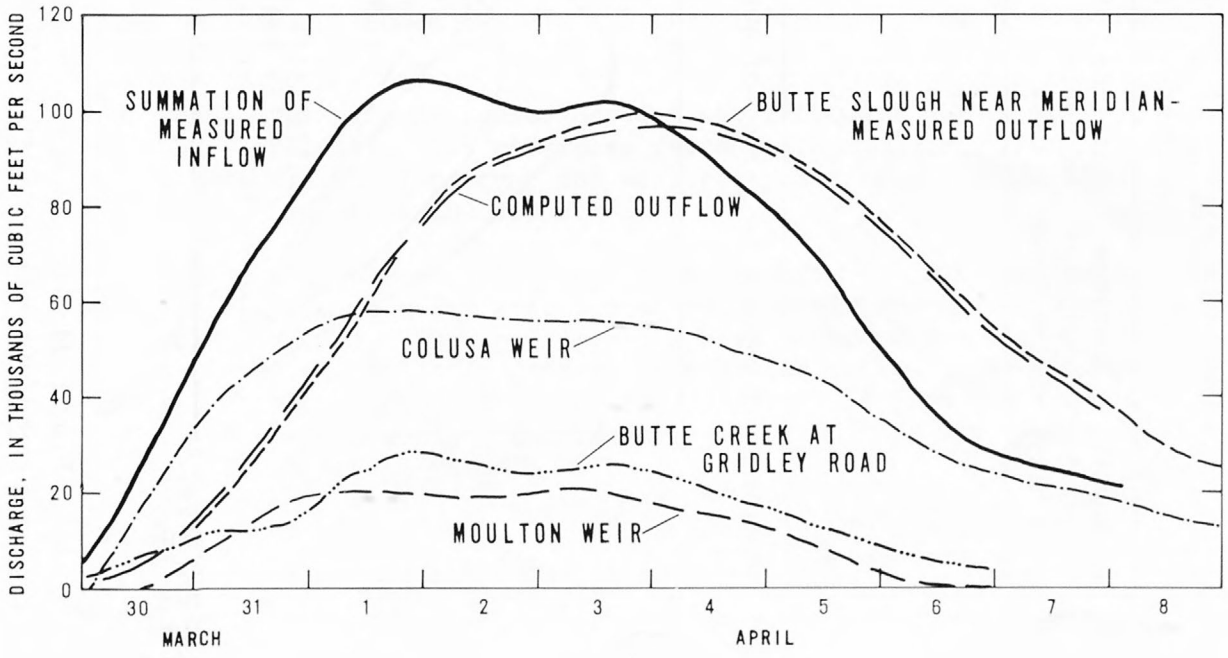


FIGURE 23.—Discharge hydrographs showing measured inflow and outflow and computed outflow for lower Butte Basin for March 30 to April 8, 1974.

Table 8.--*Volume of flow during selected flood periods since 1970 at latitudes of Butte City and Colusa*

Flood period[1]	Volume of flow during flood period (thousands of acre-feet)						Volume of flow at latitude of Butte City as a percentage of volume of flow at latitude of Colusa
	Sacramento River at Butte City	Cherokee Canal plus Butte Creek	Latitude of Butte City	Sacramento River at Colusa	Butte Slough near Meridian	Latitude of Colusa	
Jan.-Feb. 1970	6,303	958	7,261	3,281	4,550	7,831	93
Jan. 1973	2,218	211	2,429	1,359	987	2,346	104
Jan.-Feb. 1974	3,636	401	4,037	2,015	2,020	4,035	100
Mar.-Apr. 1974	2,711	283	2,994	1,566	1,457	3,023	99
Feb. 1975	1,085	138	1,223	865	333	1,198	102

[1]Period of flooding corresponds to period of outflow in table 3.

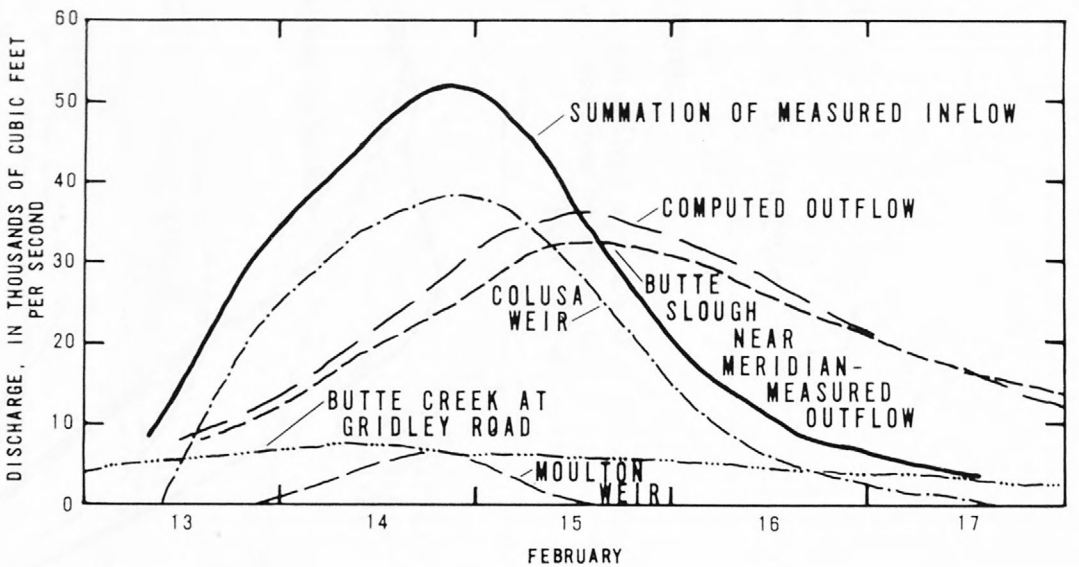


FIGURE 24.—Discharge hydrographs showing measured inflow and outflow and computed outflow for lower Butte Basin for February 13-17, 1975.

SUMMARY

Hydrologic data collected in Butte Basin prior to the beginning of this study in 1972 consisted mainly of water-level data obtained at random locations. The only discharge data available, at the latitudes where present flow measurements are made, were those obtained at Highway 162 during the flood of January 1970.

Since 1973, discharge measurements have been made during floods at the latitudes of Ord Ferry Road, Afton Boulevard, Highway 162, and Gridley Road. Stage data were collected throughout the basin and along the Sacramento River. These data were collected at four recording gages and about 45 crest-stage gages, installed during the autumn of 1972, and at two recording gages located since 1969 at Highway 162. Additional stage data were obtained at many other sites throughout the basin. Cross sections were surveyed of the Sacramento River, as were cross sections at the various flow-measurement sites.

These data have been combined with discharge records on the main channel of the Sacramento River at Ord Ferry and Butte City to determine total flow at the measurement latitudes during peak flow periods in the years 1973-75. The distribution of flow at each latitude, water-surface profiles throughout the basin, and inflow/change-in-storage/outflow relations for the Butte Sink area of Butte Basin have also been determined. Cross-section surveys have been used to show changes in the main channel of the Sacramento River during the study.

Based on data collected in 1970 and from 1972-77, several conclusions may be reached:

1. Total peak flow decreases between the latitudes of Ord Ferry and Butte City. The reduction varied with each peak and averaged about 7 percent for measured peaks ranging from about 100,000 to about 200,000 ft^3/s.

2. Overland flow does not change significantly in peak magnitude between measurement latitudes at Afton Boulevard and Gridley Road (fig. 2). Flow measurements have ranged from no flow to about 54,000 ft^3/s in January 1974 at the latitude of Gridley Road. About 10,000 ft^3/s of the January 1974 flow was from Butte Creek drainage; the remaining 44,000 ft^3/s was overland flow from the Sacramento River.

3. Spills at Colusa and Moulton Weirs and flow in Butte Creek at Gridley Road account for practically all inflow to the lower Butte Basin during flood periods. The inflow hydrograph, adjusted for change in storage in Butte Sink, will generally reproduce the outflow hydrograph at Butte Slough within $\pm$5 percent. Flow over Colusa Weir accounts for about 70 percent of the total inflow, Moulton Weir about 10 percent, and overland flow originating north of Butte City contributes 20 percent.

4. The Sacramento River, as measured at selected sites from the left bank of its low-water channel, scoured as much as 300 feet toward Butte Basin during the high water of 1974. The sites were selected in 1972 in places where bank erosion was evident. Some rock for bank protection was placed at sites 4 and 6 during the project. Flood-flows caused much less scour and fill in 1973 and 1975-76 than in 1974, although the bend at site 8 moved significantly. The overall shape of the main channel at the surveyed cross sections changed very little, and the same magnitude of discharge caused about the same stage each year at those cross sections.

5. Many changes occurred in Butte Basin during the 1973-77 water years. Examples of changes are the break at Murphy Slough in 1974 and subsequent closure owing to levee work and emplacement of channel riprap, highway and bridge changes along Ord Ferry Road and State Highway 162, the clearing of vegetation along the east bank of the Sacramento River south of the Ord Ferry Road, and land leveling and construction of agricultural ditches and embankments throughout Butte Basin. These changes have altered the distribution of flow and stage-discharge relations at most measurement sites, so that in order to describe future flood events accurately new data must be collected.

SELECTED REFERENCES

Blodgett, J. C., and Pearce, V. F., 1971, Determination of floodflow of the Sacramento River at Butte City, California, January 1970: U.S. Geol. Survey open-file rept., 29 p.

Blodgett, J. C., and Stiehr, P. L., 1974, Hydraulic analyses of floodflows in Butte Basin at State Highway 162, Glenn and Butte Counties, California: U.S. Geol. Survey open-file rept., 48 p.

California Department of Public Works, Division of Water Resources, September 1948, Alternative plans for control of floods in Upper Sacramento Valley: State Water Resources Board Inv., 218 p.

California Department of Water Resources, 1960, Surface water flow for 1958: Bull. 23-58, 332 p.

_____1970, Upper Sacramento River Basin investigation: Bull. 150-1, app. E, 30 p.

_____1972, Hydrologic data, 1970, Volume II--Northeastern California: Bull. 130-70, 560 p.

Carter, R. W., and Godfrey, R. G., Manual of hydrology--Part 3, Floodflow techniques, storage and flood routing: U.S. Geol. Survey Water-Supply Paper 1543-B, 1960, 104 p.

Simpson, R. G., 1976a, Flood hydrology of Butte Basin, 1973 and 1974 water years, Sacramento Valley, California--A progress report: Menlo Park, Calif., U.S. Geol. Survey Water-Resources Inv. 36-75, 53 p.

_____1976b, Determination of channel capacity of the Sacramento River between Ordbend and Glenn, Butte and Glenn Counties, California: U.S. Geol. Survey Open-File Report 76-526, 48 p.

U.S. Geological Survey, 1960, Surface water supply of the United States, 1958, Part 11--Pacific slope basins in California: U.S. Geol. Survey Water-Supply Paper 1565, 681 p.

_____1970, Water resources data for California, Part 1. Surface water records, Volume 2--Northern Great Basin and Central Valley: p. 495-1015.

DATA A.--Summary of peak stages, 1973-75 water years

[Elevation of water surface downstream, d, and upstream, u, from road]

Gaging station number or name[1]	Stage, in feet, above mean sea level				
	Jan. 16-20, 1973	Jan. 17-19, 1974	March 30-April 4, 1974	Feb. 14-15, 1975	March 22-24, 1975
1	d 130.93	d 133.54	d 132.60	d 130.77	--
2	127.45	129.84	127.39	127.40	126.17
2.5	--	128.43	124.87	127.02	125.68
3	123.39	126.68	--	124.94	124.01
4	115.51	118.62	117.23	115.03	--
5	u 114.21	u 118.54	u 113.53	u 113.30	u 112.31
6	d 110.30	d 112.80	d 110.22	d 110.71	--
7 Angel Slough at Ord Ferry Road	d 108.45	d 112.85	d 110.97	d 107.73	105.72
8	u 110.82	u 114.64	u 113.37	--	--
9	d 109.15	d 112.49	d 111.20	d 108.62	--
10	d 110.55	d 113.79	d 112.15	d 109.05	d 107.99
11	d 112.16	d 114.71	d 113.00	d 111.44	d 110.73
12	u 112.31	u 115.05	u 113.87	u 111.76	u 110.74
Sacramento River at Ord Ferry[2]	d 112.37	d 115.91	d 114.41	d 111.53	d 110.97
13	--	112.47	--	--	105.97
14	103.71	--	--	--	--
15	--	u 101.40	--	--	--
--	d 100.77	--	--	--	
16	d 95.19	u 98.75	--	--	--
16A	--	u 98.61	--	--	--
--	d 98.49	--	--	--	
17	u 97.29	u 100.67	u 97.29	--	--
	d 99.72	--	--	--	
18	u 95.43	u 97.90	--	--	--
19	d 96.54	d 97.07	--	--	--
20	95.09	100.76	99.5	--	--
21	d 91.24	u 95.57	u 94.47	u 89.60	--
	d 94.96	d 94.06	d 89.35	--	
22	d 90.33	u 95.4	d 93.89	u 88.80	--
	d 95.0	--	d 88.69	--	

See footnotes on page 58.

DATA A.--Summary of peak stages, 1973-75 water years--Continued

Gaging station number or name[1]	Stage, in feet, above mean sea level				
	Jan. 16-20, 1973	Jan. 17-19, 1974	March 30-April 4, 1974	Feb. 14-15, 1975	March 22-24, 1975
23	82.56	--	--	--	--
24	d 79.78	--	d 82.13	--	--
25	--	d 91.08	d 89.87	89.07	--
Sacramento River at Butte City[3]	u 88.49	u 91.62	u 90.45	u 87.70	u 87.52
Campbell Slough at State Hwy. 162	d 79.64	d 81.30	d 81.02	d 78.76	d 75.35
Butte Creek at State Hwy. 162	d 80.95	d 81.65	d 81.95	d 80.41	d 78.98
26	d 69.30	d 74.11	d 73.69	--	--
27	d 69.89	u 72.79	--	--	--
--	d 72.25	--	--	--	
28	d 71.18	u 72.84	d 71.91	--	--
--	d 72.47	--	--	--	
29	d 70.57	u 72.18	d 71.49	d 70.58	d 68.94
--	d 72.11	--	--	--	
30	d 70.80	d 71.99	d 71.63	d 70.67	d 68.89
32	d 60.95	d 64.57	d 63.77	d 60.72	--
--	--	--	u 64.40	--	
33 Butte Creek at Gridley Road	d 62.22	d 64.55	d 63.59	d 62.41	d 61.68
34	d 61.52	u 64.45	u 63.31	d 62.03	d 60.88
34A	u 62.46	u 64.55	--	u 62.62	u 60.95
36	--	64.73	63.24	--	--
Sacramento River at Moulton Weir[4]	77.52	79.72	78.87	76.46	76.43
37	70.87	73.61	72.71	69.7	--
37.5	--	62.01	60.91	59.61	58.87

See footnotes on page 58.

DATA A.--Summary of peak stages, 1973-75 water years--Continued

Gaging station number or name[1]	Stage, in feet, above mean sea level				
	Jan. 16-20, 1973	Jan. 17-19, 1974	March 30-April 4, 1974	Feb. 14-15, 1975	March 22-24, 1975
38	--	61.98	60.89	--	--
39	57.87	61.80	--	56.87	--
40	58.03	61.81	60.75	--	55.99
41	57.53	61.40	60.33	55.22	55.47
41.5	--	61.52	60.52	--	55.66
Sacramento River at Colusa Weir[5]	63.81	65.72	64.80	63.54	63.39
43 Butte Creek opposite Colusa Bypass	57.46	61.29	60.28	55.20	55.54
Sacramento River at Colusa[6]	d 62.56	d 64.73	d 63.82	62.21	62.14
44	57.40	61.24	60.23	55.5	55.6
45 Butte Slough at Outfall Gates	57.14	61.21	60.17	54.46	54.82
46	56.30	60.05	59.09	53.98	54.34
Butte Slough near Meridian[7]	53.75	56.99	56.22	51.63	52.03
47	47.40	50.93	49.69	45.58	45.82

[1]See figure 2 for location of gaging stations.
[2]Add 2.52 feet to stage, in feet above mean sea level, to obtain gage datum.
[3]Add 2.92 feet to stage, in feet above mean sea level, to obtain gage datum.
[4]Add 2.82 feet to stage, in feet above mean sea level, to obtain gage datum.
[5]Add 2.86 feet to stage, in feet above mean sea level, to obtain gage datum.
[6]Add 2.95 feet to stage, in feet above mean sea level, to obtain gage datum.
[7]Add 3.15 feet to stage, in feet above mean sea level, to obtain gage datum.

DATA B.--Summary of peak flows, 1973-76 water years

Location of flow	Discharge, in cubic feet per second				
	January 1973	January 1974	March to April 1974	February 1975	March 1976
Sacramento River at Ord Ferry (main channel)	96,000	125,000	116,000	101,000	28,800
In channel at east end of Ord Ferry bridge[1]	6,000	32,000	19,000	3,000	0
East of site 11 along Ord Ferry Rd (see fig. 2)	4,000	38,000	19,000	1,900	0
Sacramento River main channel and flood plain at Ord Ferry Rd.	106,000	195,000	154,000	106,000	28,800
Angel and Campbell Sloughs at Afton Blvd.	2,900	39,000	21,000	1,000	--
Sacramento River at Butte City (main channel)	98,500	136,000	122,000	91,000	27,300
East-bank flood plain at latitude of Butte City (excluding Butte Creek)	2,800	44,600	23,900	1,790	--
Butte Creek at latitude of Butte City (State Highway 162)	8,200	10,900	5,700	[2]3,820	--
Sacramento River main channel and flood plain at latitude of Butte City (excluding Butte Cr.)	101,000	181,000	146,000	92,800	--
East-bank flood plain (including Butte Cr.) at latitude of Butte City	11,000	55,500	29,600	5,610	--
Butte Creek at Gridley Rd.[3]	8,300	43,000	28,000	7,300	--
Moulton Weir	11,400	27,000	20,000	6,350	0
Colusa Weir	40,000	60,000	59,000	38,600	0
Butte Slough at Meridian[4]	59,100	114,000	100,000	[5]32,400	1,080
Sacramento River at Colusa	42,000	48,000	46,000	41,400	23,900

[1]All or part of flow on flood plain between east end of Ord Ferry bridge and high ground about 1,500 ft east returns to main channel of Sacramento River between crest-stage sites 11 and 12.

[2]Peak flow for year, 7,120 ft^3/s, occurred February 13.

[3]Flood figures for Butte Creek at Gridley Road include a mixture of overland flow from the Sacramento River, flow from the drainage area of Butte Creek, and flow from local sloughs.

[4]Includes all flow from Butte Basin to Sutter Bypass.

[5]Peak flow for year, 36,900 ft^3/s, occurred on March 24.

DATA C.--Staff-gage readings at Princeton Ferry during 1974 water year

STAFF GAGE NAME.--Sacramento River at Princeton Ferry, near Princeton, Calif.

LOCATION.-- Lat 39°24'13", long 122°00'30", in sec. 18, T. 18 N., R. 1 W., Colusa County, on right bank at ferry crossing, 0.5 mi north of Princeton.

[Staff-gage readings furnished by Robert Stackhouse, ferryboat operator. Gage height is in feet above mean sea level]

Hour	Gage height
1974	
January 13	
2400	72.6
January 14	
0900	73.1
1500	73.5
2400	73.6
January 15	
0600	74.4
0700	74.6
0800	74.8
0900	75.0
1000	75.2
1100	75.5
1200	75.8
1300	76.0
1400	76.3
1500	76.6
1600	76.9
1700	77.4
1800	77.7
1900	77.9
2100	78.5
2300	79.0
January 16	
0100	79.5
0300	80.0
0400	80.2
0500	80.4
0600	80.9
0700	81.1
0800	81.3
0900	81.6
1030	82.0
1200	82.4
1300	82.6
1430	83.0
1500	83.3
1700	83.7
1800	83.9
2000	84.2
2200	84.4
2300	84.6
January 17	
0100	84.9
0200	85.1
0300	85.2
0400	85.4
0500	85.6
0600	85.7
0700	85.9
0800	86.0
0900	86.2
1000	86.4
1100	86.5
1200	86.6
1300	86.7
1400	86.9
1500	87.0
1600	87.1
1700	87.2
1800	87.3
1900	87.4
2000	87.4
2100	87.5
2200	87.5
2300	87.5
2400	87.6
January 18	
0100	87.6
0700	87.6
0800	87.5
1500	87.3
2300	86.6
January 19	
0100	86.4
0200	86.3
0400	86.1
0600	86.0
0800	85.9
1000	85.8
1200	85.7
1500	85.7
1700	85.6
2300	85.6
January 20	
0300	85.6
0500	85.4
1100	85.4
1300	85.3
1500	85.2
1800	85.2
2100	85.0
2400	84.8
January 21	
0300	84.6
0500	84.6
0700	84.4
0900	84.4
1100	84.2
1300	84.1
1500	84.0
1800	83.8
2100	83.5
2400	83.3
January 22	
1000	83.3
1200	83.2
2400	83.2
January 23	
0600	83.0
0700	82.9
1200	82.9
1500	82.8
1800	82.8
2100	82.7
2400	82.5
January 24	
0600	82.3
1200	82.2
1800	82.1
2400	81.9
January 25	
0600	81.8
1200	81.8
1800	81.7
2400	81.7
January 26	
0600	81.6
1200	81.5
1800	81.5
2400	81.4
January 27	
0600	81.2
1200	80.9
1500	80.7
1800	80.5
2100	80.3
2400	80.2
January 28	
0600	80.1
1200	80.0
1800	79.8
2400	79.6

DATA C.--Staff-gage readings at Princeton Ferry, 1974 water year--Continued

Hour	Gage height
January 29	
0600	79.5
1200	79.3
1800	79.2
January 30	
0600	78.8
1500	78.8
1800	78.7
2400	78.7
January 31	
0700	78.5
0900	78.0
1200	77.9
1500	77.8
1800	77.4
2100	77.3
2400	77.1
February 1	
0600	76.4
0900	76.3
1800	76.3
2100	76.8
2400	76.9
February 2	
0600	77.0
0900	76.9
1200	76.5
1500	76.4
2100	76.3
2400	76.3
February 3	
0600	75.4
0900	75.3
1200	75.1
1500	74.8
1800	74.8
2100	74.7
2400	74.7
February 4	
0600	74.6
1500	74.4
1800	74.3
2100	74.2
March 28	
2400	69.0
March 29	
0600	69.1
1200	69.1
1500	69.1
1800	69.8
1900	70.3
2000	71.1
2100	71.4
2200	72.0
2300	72.7
2400	73.6
March 30	
0100	74.1
0200	74.7
0300	74.9
0400	75.0
0500	75.4
0600	76.0
0700	77.2
0800	77.6
0900	78.2
1000	78.6
1100	78.9
1200	79.2
1300	79.6
1400	79.8
1500	79.9
1800	80.4
2100	81.8
2400	82.8
March 31	
0300	83.3
0600	83.9
0900	84.3
1100	84.9
1400	85.3
1800	85.7
2100	85.9
2400	86.0
April 1	
0300	86.3
0600	86.3
0900	86.1
1200	86.1
1500	86.1
1800	86.0
2100	85.9
2400	85.8
April 2	
0300	85.7
0600	85.7
0700	85.6
1200	85.6
1300	85.7
1500	85.7
1800	85.8
2100	85.8
2400	86.1
April 3	
0300	86.1
0400	86.0
1000	86.0
1200	85.9
1400	85.8
2100	85.8
2400	85.5
April 4	
0300	85.3
0600	85.2
0800	85.0
1000	84.9
1200	84.8
1500	84.6
1800	84.4
2100	84.3
2400	84.1
April 5	
0200	84.0
0400	83.6
0600	83.4
0800	83.1
1000	82.7
1200	82.4
1500	82.1
1800	81.4
2100	80.8
2400	80.3
April 6	
0200	79.9
0400	79.6
0600	79.3
0800	79.0
1200	78.7
1400	78.4
1800	78.2
2400	78.1
April 7	
0600	77.8
1200	77.6
1500	77.4
1800	77.1
2400	76.8

DATA D.--Discharge of Butte Creek, east-bank Sacramento River overflow, and the total discharge of the Sacramento River and Butte Creek at the latitude of Butte City at selected times on January 17-21, 1974

Date	Time	Discharge, in cubic feet per second		
		Butte Creek	East-bank overflow, Sacramento River[1]	Total flow at latitude[2]
January 17	0100	9,200	0	119,000
	0400	10,500	3,000	127,000
	0700	11,000	6,880	137,000
	0800	11,000	13,600	145,000
	0900	11,100	21,200	154,000
	1200	11,100	33,000	170,000
	1500	11,400	37,700	179,000
	1600	11,500	39,000	182,000
	1800	11,700	40,800	185,000
	2100	11,700	42,400	188,000
	2400	11,600	43,500	190,000
January 18	0200	11,400	44,200	191,000
	0400	11,000	44,600	191,000
	0600	10,600	42,900	190,000
	0900	10,000	40,100	185,000
	1100	9,700	37,200	180,000
	1300	9,400	33,700	174,000
	1600	9,500	28,500	167,000
	1800	9,600	26,200	162,000
	2100	9,600	23,200	154,000
	2400	9,550	21,400	151,000
January 19	0300	9,000	19,900	146,000
	0600	8,120	18,700	142,000
	0900	7,800	17,500	139,000
	1200	7,310	16,900	137,000
	1800	6,700	15,400	134,000
	2400	6,230	16,800	135,000
January 20	0600	6,000	14,200	132,000
	1200	5,660	13,100	128,000
	1800	5,000	11,700	124,000
	2400	4,250	10,800	120,000
January 21	0600	3,900	9,200	115,000
	1200	3,700	8,100	110,000
	1800	3,500	7,000	106,000
	2400	3,120	5,900	113,000

[1]Estimated overflow January 17 (0400 hrs), January 18 (1800 hrs) to January 21 (2400 hrs).

[2]Includes Butte Creek, east-bank overflow of Sacramento River, and main channel and west-bank overflow of Sacramento River.

DATA E.--Selected flood stages and discharges for 1975 water year

STATION NAME.--Angel Slough at Ord Ferry Road near Ordbend, Calif.

NUMBER.--7 (see fig. 2 for location).

LOCATION.--Lat 39°37'40", long 121°56'37", in Llano Seco Grant, T. 21 N., R. 1 W., Butte County, on right bank on downstream side of Ord Ferry Road, 3.3 mi east of Ordbend and 4.0 mi southwest of Dayton.

DATE ESTABLISHED.--August 31, 1972.

[Gage height, in feet above mean sea level, and discharge, in cubic feet per second. Add 100 feet to obtain mean sea level datum]

Hour	Gage height	Discharge
	February 11	
2400		No flow
	February 12	
1030	5.14	5.2
1200	5.30	11
1430	5.52	26
1600	5.54	28
1730	5.53	27
2100	5.45	20
2200	5.45	20
2400	5.65	40
	February 13	
0200	5.87	73
0400	5.96	89
0630	5.97	91
0700	5.95	87
1300	5.95	87
2400	5.80	61
	February 14	
0330	5.75	53
0400	6.50	240
0500	7.40	729
0600	7.65	950
0700	7.72	1,010
0800	7.73	1,020
0900	7.63	934
1000	7.45	766
1100	7.24	610
1200	7.06	496
1300	6.89	410
1500	6.54	256
1700	6.09	115
1800	5.92	82
2000	5.75	53
2200	5.65	40
2400	5.52	26
	February 15	
0200	5.43	19
0400	5.38	16
0600	5.35	14
1200	5.26	9.5
1800	5.18	6.6
2400	5.14	5.2

DATA E.--Selected flood stages and discharges for 1975 water year--Continued

STATION NAME.--Butte Creek at Gridley Road, near Princeton, Calif.

NUMBER.--33 (see fig. 2 for location).

LOCATION.--Lat 39°21'44", long 121°53'28", in NE¼NE½, sec. 6, T. 17 N., R. 1 E., Butte County, on left bank on downstream side of bridge on Gridley Road, 6.9 mi southeast of Princeton, and 8.9 mi southeast of Butte City.

DATE ESTABLISHED.--August 30, 1972.

[Gage height, in feet above mean sea level, and discharge, in cubic feet per second.]

Hour	Gage height	Discharge	Hour	Gage height	Discharge	Hour	Gage height	Discharge
	February 12			February 14			February 16	
0600	61.58	3,800	0200	62.40	7,200	0600	61.84	4,650
1100	61.53	3,650	0600	62.41	7,300	1200	61.74	4,300
1400	61.53	3,650	1200	62.38	7,050	1800	61.63	3,950
1800	61.57	3,750	1800	62.34	6,800	2400	61.51	3,600
2400	61.75	4,350	2400	62.27	6,400			
							February 17	
	February 13			February 15		0600	61.37	3,200
0600	61.95	5,050	0600	62.19	6,050	1200	61.23	2,900
0900	62.03	5,400	1200	62.10	5,650	1800	61.10	2,650
1400	62.13	5,800	1800	62.03	5,400	2400	60.96	2,400
1800	62.27	6,400	2400	61.94	5,000			
2100	62.34	6,800						
2400	62.37	7,000						

DATA E.--Selected flood stages and discharges for 1975 water year--Continued

STATION NAME.--Butte Creek opposite Colusa Bypass, near Colusa, Calif.

NUMBER.--43 (see fig. 2 for location).

LOCATION.--Lat 39°13'33", long 121°56'19", in T. 16 N., R. 1 W., Sutter County, on left bank 400 ft downstream from wooden bridge, 1.7 mi downstream from Butte Lodge Outing Club, and 3.5 mi northeast of Colusa.

DATA ESTABLISHED.--Sept. 1, 1972.

[Gage height, in feet above mean sea level]

Hour	Gage height	Hour	Gage height	Hour	Gage height	Hour	Gage height
February 9		February 13		February 17		March 19	
1300	49.49	0800	50.63	1100	52.65	0200	49.13
1600	49.52	1300	50.62	2000	52.09	0230	49.14
1700	49.55	1400	50.66	2300	51.91	0300	49.17
1900	49.71	1500	50.72	2400	51.84	0500	49.64
2000	49.85	2000	51.49			0800	50.10
2400	50.21	2400	52.04	February 18		0900	50.18
February 10		February 14		0700	51.48	1100	50.28
0500	50.59	0300	52.48	1400	51.13	1700	50.52
0800	50.89	1300	53.59	1900	50.91	1900	50.67
1200	51.27	2000	54.25	2400	50.70	2400	51.13
1600	51.48	2400	54.55			March 20	
1700	51.58			February 19		0400	51.48
1900	51.66	February 15		0600	50.50	1000	52.00
2200	51.73	0200	54.70	1500	50.28	1200	52.20
2400	51.74	0300	54.80	1800	50.17	1700	52.60
February 11		0500	54.95	2400	50.04	2100	52.87
0200	51.75	0800	55.11	February 20		2400	53.08
0400	51.74	1100	55.17	0600	49.91	March 21	
1100	51.61	1430	55.20	1200	49.80	0400	53.31
2400	51.20	1700	55.18	1600	49.74	0700	53.53
February 12		1900	55.13	2400	49.66	1100	53.72
0400	51.10	2200	55.03	February 21		1500	53.81
1100	50.97	2400	54.94	0300	49.64	1600	53.96
1200	50.91	February 16		0900	49.57	1730	54.09
1500	50.88	0300	54.82	2400	49.44	1900	54.15
1700	50.89	1200	54.31	March 18		2400	54.23
1800	50.91	1700	53.94	2400	49.13	March 22	
2000	50.84	2100	53.63			0300	54.27
2200	50.85	2400	53.40			0700	54.28
2300	50.81					1100	54.29
2400	50.79					1400	54.35
						1900	54.45
						2400	54.64

DATA E.--Selected flood stages and discharges for 1975 water year--Continued

STATION NAME.--Butte Creek opposite Colusa Bypass, near Colusa, Calif.--Continued

[Gage height, in feet above mean sea level]

Hour	Gage height	Hour	Gage height	Hour	Gage height	Hour	Gage height
March 23		March 25		March 27		March 30	
0400	54.83	0200	54.79	0200	54.93	0600	51.85
0800	55.04	0400	54.76	0700	55.08	1000	51.65
1000	55.14	1000	54.62	1000	55.12	1400	51.41
1400	55.32	1100	54.64	1400	55.14	1900	51.13
1700	55.42	1200	54.63	1730	55.11	2400	50.85
2000	55.50	1300	54.60	2100	54.97		
2200	55.54	1500	54.59	2400	54.90	March 31	
2400	55.52	1700	54.55			0500	50.58
		1900	54.47	March 28		0900	50.36
March 24		2200	54.32			1300	50.20
0330	55.53	2400	54.30	0300	54.78	1700	50.05
0700	55.47			0800	54.59	2000	49.98
0900	55.41	March 26		0830	54.50	2400	49.85
1200	55.34	0530	54.29	0900	54.55		
1400	55.27	0700	54.31	1200	54.37	April 1	
2030	54.98	0900	54.35	1400	54.25	0300	49.78
2100	54.99	1100	54.42	1900	53.90	0700	49.70
2400	54.89	1400	54.50	2400	53.60	1200	49.63
		2000	54.69			1500	49.59
		2400	54.86	March 29		2400	49.49
				0400	53.37		
				0800	53.11	April 2	
				1800	52.57	0300	49.46
				2400	52.22	0630	49.40
						0800	49.40
						1400	49.33
						2400	49.19

DATA E.--Selected flood stages and discharges for 1975 water year--Continued

STATION NAME.--Butte Slough at Outfall Gates near Meridian, Calif.

NUMBER.--45 (see fig. 2 for location).

LOCATION.--Lat 39°11'43", long 121°56'05", in SW¼NE¼, sec. 35, T. 16 N., R. 1 W., Colusa County, on right bank at mouth of Butte Slough, 0.5 mi downstream from Butte Creek, 3.7 mi north of Meridian, and 4.1 mi southeast of Colusa.

DATE ESTABLISHED.--October 13, 1972.

[Gage height, in feet above mean sea level]

Hour	Gage height
February 8	
2400	46.14
February 9	
0800	46.20
1800	46.31
2000	46.39
2200	46.58
2400	46.91
February 10	
0200	47.25
0400	47.65
0600	48.20
0800	48.78
1000	49.28
1200	49.63
1400	49.89
1600	50.10
1800	50.24
2000	50.37
2200	50.45
2400	50.52
February 11	
0200	50.54
0400	50.53
0600	50.51
0800	50.48
1000	50.45
1200	50.42
1400	50.36
1600	50.28
1800	50.20
2000	50.13
2200	50.06
2400	49.99
February 12	
0300	49.87
0700	49.71
1000	49.58
1200	49.53
1400	49.52
1700	49.54
1800	49.50
1900	49.43
2200	49.35
2400	49.28
February 13	
0500	49.11
0900	49.12
1200	49.16
1400	49.17
1500	49.20
1600	49.26
1700	49.37
1900	49.70
2400	50.70
February 14	
0200	51.06
0400	51.40
0700	51.77
1100	52.45
1200	52.57
1700	53.04
2200	53.50
2400	53.66
February 15	
0500	54.12
0800	54.31
1000	54.39
1200	54.44
1500	54.46
1700	54.45
1800	54.42
2300	54.21
2400	54.15
February 16	
0200	54.05
0400	53.99
0800	53.74
1000	53.68
1300	53.53
1600	53.30
2100	52.84
2400	52.62
February 17	
1000	51.80
1700	51.31
2400	50.80
February 18	
0700	50.35
1100	50.12
1400	49.95
2400	49.42
February 19	
0700	49.05
1100	48.80
1300	48.66
1500	48.57
1700	48.46
1900	48.45
2100	48.42
2300	48.41
2400	48.40
February 20	
0500	48.25
0900	48.10
1200	48.02
1800	47.75
2400	47.55
February 21	
0400	47.87
0800	47.23
1100	47.15
1300	47.11
1900	46.93
2200	46.83
2400	46.78
February 22	
0600	46.61
0800	46.58
1600	46.46
1900	46.38
2400	46.28

DATA E.--Selected flood stages and discharges for 1975 water year--Continued

STATION NAME.--Butte Slough at Outfall Gates near Meridian, Calif.--Continued

[Gage height, in feet above mean sea level]

Hour	Gage height
March 18	
2400	45.85
March 19	
0300	45.84
0600	46.38
1200	47.39
1500	48.05
1800	48.75
2100	49.28
2400	49.70
March 20	
0600	50.46
1200	51.25
1800	51.70
2400	52.12
March 21	
0200	52.24
0300	52.27
0700	52.60
1100	52.70
1500	52.65
1800	53.20
2000	53.30
2400	53.38
March 22	
0400	53.45
0700	53.45
0900	53.42
1100	53.45
1300	53.56
2000	53.70
2400	53.85
March 23	
0500	54.05
1200	54.50
1400	54.60
1800	54.74
2100	54.82
2900	54.81
March 24	
0500	54.81
0700	54.75
1200	54.65
1500	54.54
1800	54.34
2100	54.22
2400	54.13
March 25	
0300	54.00
0900	53.90
1200	54.04
1300	54.04
1400	54.00
1500	54.05
1600	54.00
1800	54.00
2300	53.60
2400	53.60
March 26	
0300	53.60
0600	53.54
0900	53.55
1200	53.73
1800	53.90
2100	53.96
2400	54.10
March 27	
0100	54.15
0800	54.34
1100	54.45
1200	54.45
1500	54.51
1700	54.50
1800	54.48
1900	54.42
2400	54.23
March 28	
0600	54.00
0900	53.90
1200	53.77
1500	53.60
1800	53.35
2400	52.90
March 29	
0600	52.50
1200	52.15
1800	51.77
2400	51.33
March 30	
0600	50.93
1200	50.55
1800	50.23
2400	49.80
March 31	
0600	49.45
1200	49.16
1800	48.85
2400	48.39
April 1	
0600	48.02
1200	47.72
1800	47.44
2400	47.16
April 2	
0600	46.93
1200	46.75
1800	46.57
2400	46.41

DATA F.--Staff-gage readings at Sacramento Outing Club

STATION NAME.--Butte Sink at Sacramento Outing Club near Pennington, Calif.

NUMBER.--41 (see fig. 2 for location).

LOCATION.--Lat 39°15'13", long 121°53'25", in SW¼NW¼, sec. 8, T. 16 N., R. 1 E., Sutter County, at Sacramento Outing Club, 6.0 mi southwest of Pennington and 6.6 mi northeast of Colusa.

DATE ESTABLISHED.--October 4, 1972.

[Gage height, in feet above mean sea level. Staff-gage readings furnished by Leroy Pennington of Sacramento Outing Club]

Date	Time	Gage height
1973 Water Year		
Jan. 12	1230	51.53
	1400	51.70
	1700	52.02
13	0700	53.50
	1200	53.90
	1630	54.20
14	0830	54.70
	1700	54.70
15	1000	54.20
16	0900	53.30
	0920	53.32
	1515	53.06
17	0715	53.34
	1030	53.60
18	1200	56.05
19	0700	56.56
	0900	56.60
20	0700	57.40
	1230	57.50
	1630	57.50
22	1430	56.02
23	1630	55.14
25	0830	54.12
26	0930	53.46
	1050	53.42
1973 Water Year--Cont.		
Feb. 8	1250	52.64
10	1030	53.76
	1715	53.68
11	1000	53.98
	1700	54.18
12	1000	54.34
13	0845	54.20
14	1400	53.88
15	0830	53.64
16	0935	53.80
	1445	53.80
17	0930	53.48
	1400	53.34
18	1600	52.28
1974 Water Year		
Nov. 13	0730	51.56
14	0900	53.30
	1505	53.58
	1700	53.42
15	0910	53.28
	1120	53.26
	1645	53.12
1974 Water Year--Cont.		
Nov. 16	0910	52.78
	1700	52.66
17	1330	52.54
	1710	52.60
18	0600	52.96
	0800	52.98
	1130	53.06
	1700	53.26
19	0920	53.76
	1700	53.92
20	0730	54.18
	1110	54.29
	1730	54.34
21	0630	54.02
	1050	53.82
	1700	53.46
22	0615	52.64
	1815	52.00
23	0845	51.68
	1600	51.72
24	0600	51.96
	1325	52.02
	2000	52.06
25	0615	52.08
	1700	52.08
26	1030	52.05
	1700	52.02
27	0900	51.92
	1610	51.86

DATA F.--Staff-gage readings at Sacramento Outing Club--Continued

Date	Time	Gage height
1974 Water Year--Cont.		
Dec. 1	0600	50.46
	1000	50.48
	1630	50.72
2	0600	52.28
	1100	52.86
	1635	53.50
3	0830	54.86
	1130	54.94
	1630	54.98
4	1000	53.70
	1500	54.36
5	1000	53.70
	1800	53.52
6	0920	53.30
	1645	53.16
7	0900	52.92
	1500	52.82
8	0630	52.60
	0945	52.56
9	0630	52.30
	1450	52.18
	1640	52.14
10	1540	51.56
29	0620	51.54
	1145	51.82
	1700	52.04
30	0615	52.60
	1700	53.08
31	0915	53.98
	1200	54.10
Jan. 1	1000	54.20
	1700	54.06
2	0630	53.62
	1720	53.30
3	1000	52.98
	1715	52.72
4	0930	52.30
	1700	52.10
5	0610	51.64
	1700	51.30
16	0600	51.66
	0930	52.00
	1745	53.06
17	0830	55.26
	1700	56.54
18	0840	59.38
	1100	59.70
	2100	60.80
19	1130	61.30
	1800	61.20
20	1115	60.78
	1800	60.60
22	1030	59.06
	1930	58.68
23	1715	57.94
24	1830	57.22
26	0930	56.34
27	0830	55.94
	1730	55.80
28	1145	55.40
Jan. 29	0930	54.90
30	1000	54.38
31	1000	53.96
Feb. 1	0930	53.50
2	1115	52.90
	1515	52.84
3	1000	52.56
5	1000	51.24
	1700	51.08
6	1200	50.70
Mar. 30	2000	50.04
31	0845	52.90
	1545	52.96
April 2	0930	59.54
	1030	59.50
	1400	59.60
	1900	59.80
3	0845	60.10
	1600	60.26
	1930	60.30
4	0800	60.30
	1800	60.10
5	0930	59.60
6	1100	57.90
	1645	57.46
	1900	57.22
7	1445	55.80
8	1800	54.28
9	1000	53.54
11	0900	52.34
13	2000	51.44
14	1100	51.28

GPO 689-035

Simpson--FLOOD HYDROLOGY OF BUTTE BASIN, 1973-77 WATER YEARS, SACRAMENTO VALLEY, CALIFORNIA - WRI 78-86