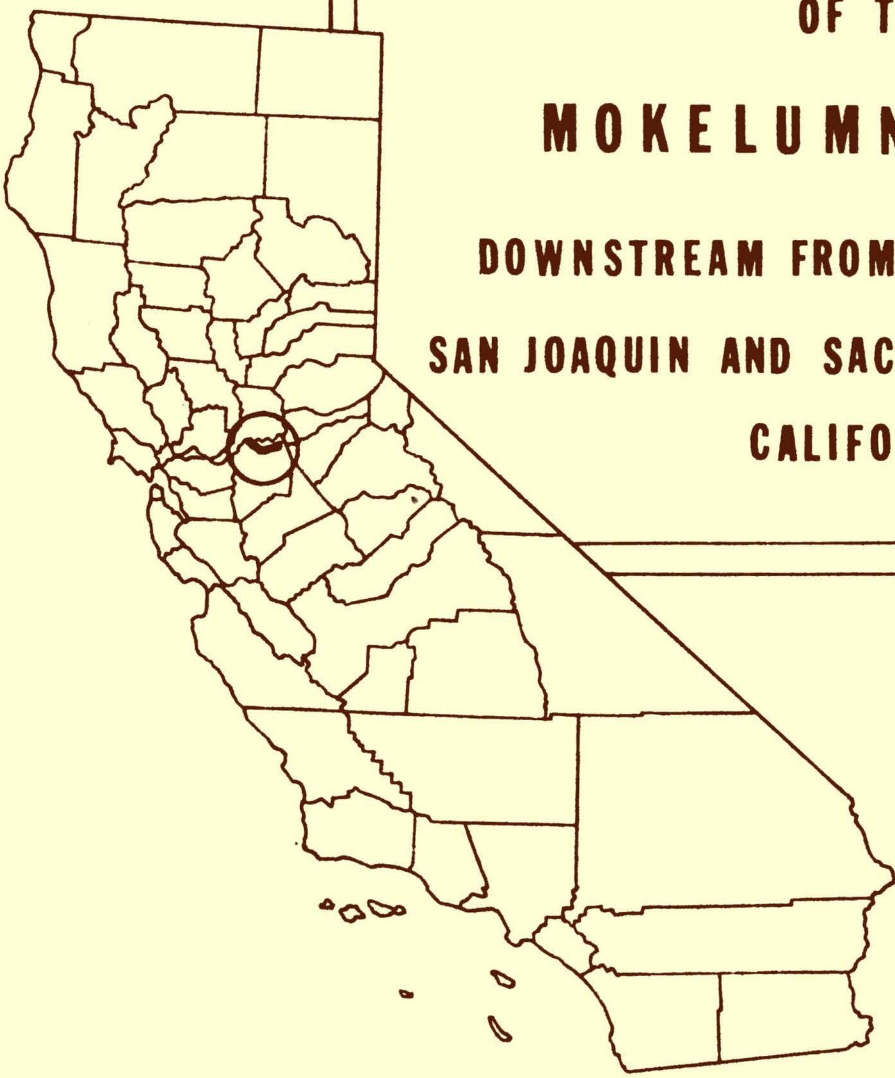
DETERMINATION OF CHANNEL CAPACITY OF THE MOKELUMNE RIVER DOWNSTREAM FROM CAMANCHE DAM SAN JOAQUIN AND SACRAMENTO COUNTIES CALIFORNIA



Prepared in cooperation with
The Reclamation Board
State of California

OPEN-FILE REPORT

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

MENLO PARK, CALIFORNIA
1972

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By

R. G. Simpson

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DETERMINATION OF CHANNEL CAPACITY OF THE MOKELUMNE RIVER DOWNSTREAM FROM CAMANCHE DAM, SAN JOAQUIN AND SACRAMENTO COUNTIES, CALIFORNIA

By R. G. Simpson

SUMMARY AND CONCLUSIONS

This study evaluates the adequacy of a 39-mile reach of the Mokelumne River in San Joaquin and Sacramento Counties, California, to carry planned flood releases between Camanche Reservoir and the Bensons Ferry Bridge near Thornton. The flood releases from Camanche Reservoir are to be restricted, insofar as possible, so that the flows in the Mokelumne River will not exceed 5,000 cfs (cubic feet per second) as measured at the gaging station below Camanche Dam.

Areas of inundation and computed floodwater profiles are based on channel conditions in late 1970 and on observed water-surface profiles during flood releases of about 5,000 cfs in January 1969 and January 1970. The inundated area shown on the maps (appendix A) and the water-surface elevations indicated on the cross sections (appendix G) are for the flood releases of those dates.

The following conclusions are contingent on there being no levee failures during periods of high flow and no significant channel changes since the flood release of January 1970.

1. High tides in San Francisco Bav and, to a greater degree, flood stages on the Cosumnes River, cause backwater in the study reach. Severe backwater conditions occurring simultaneously with a flow of 5,000 cfs in the Mokelumne River can increase the flood stage 4 to 6 feet at Bensons Ferry Bridge (cross section 1). Backwater effects decrease in an upstream direction and are less than 0.5 foot at cross section 35, a river distance of 8.6 miles upstream from cross section 1, and 1.5 miles downstream from the Peltier Road bridge.

2. In the reach between cross sections 1 and 35, a 5,000 cfs release from Camanche Reservoir with maximum backwater effect (measured at cross section 1 at the mouth of the Cosumnes River) is confined within the natural or leveed banks except on the right bank flood plain between cross sections 12 and 19.

3. Upstream from cross section 35, there is overbank flooding at a flow of 5,000 cfs between cross sections 48 and 51, and 62 and 67.5. An increase in flow from 5,000 to 6,000 cfs will cause flooding between cross sections 43 and 47, 52 and 56, and 73 and 85.

4. A discharge of 5,000 cfs will pass through all bridge openings in the study reach except that of the Western Pacific Railroad Co. bridge at cross section 4. If large amounts of debris lodge on the railroad bridge when backwater from the Cosumnes River occurs, the debris could cause higher stages and flooding along the right bank between cross sections 5 and 12.

INTRODUCTION

Purpose and Scope

At the request of The Reclamation Board, State of California, the U.S. Geological Survey made a study in 1970-71 of the channel capacity of a 39-mile reach of the Mokelumne River in San Joaquin and Sacramento Counties, Calif. (fig. 1).

The study was made to determine the water-surface profiles that would result from flood releases between 2,000 and 6,000 cfs from Camanche Reservoir (completed in 1963). Accuracy of the computations was determined by comparing the surveyed high-water profile for the floods of January 1969 and January 1970--about 5,000 cfs--with the computed profile for 5,000 cfs, and by comparing computed stages with measured stages at the gaging stations in the study reach.

The study included the survey of cross sections at selected locations, determination of longitudinal profiles, and identification of areas subject to inundation.

Suggestions and recommendations concerning the structural adequacy of levees or the advisability of channel improvements are beyond the scope of this study.

Base from U.S. Geological Survey
topographic map of California,
North half, 1968, 1:500,000

0 5 10 15 MILES

Contour interval 500 feet
Dotted line represents the 100-foot contour
Datum is mean sea level

FIGURE 1.--Study area

This report was prepared by the U.S. Geological Survey, Water Resources Division, in cooperation with The Reclamation Board, State of California. The work was done under the general supervision of R. Stanley Lord and Lee R. Peterson, successive district chiefs in charge of water-resources investigations in California, and under the immediate supervision of Willard W. Dean, chief of the Sacramento subdistrict office. Most of the illustrations were prepared by F. A. Shelton. The cooperation of the California Department of Water Resources, and the East Bay Municipal Utilities District in furnishing supplementary streamflow data is acknowledged.

Description of the Study Reach

The Mokelumne River originates in the Sierra Nevada at elevations between 8,000 and 9,000 feet and flows westward into the Central Valley to its confluence with the San Joaquin River. The average channel slope in the study reach is 2.7 feet per mile between Camanche Dam and cross section 100, and 1.7 feet per mile from cross section 100 downstream to Thornton.

The Cosumnes River enters the Mokelumne River on the right (north) bank between cross sections 1 and 2. Here, flood stages are largely dependent on flows in the Cosumnes River which is not regulated.

Upstream from the mouth of the Cosumnes River, the Mokelumne River is confined by an extensive levee system to a channel that is generally less than 300 feet wide. The left-bank levee between cross sections 5 and 24 is about 6 feet higher than the right-bank levee. The levees are composed of material that will permit seepage and are subject to scour. Upstream from cross section 24, the river is leveed on both banks to cross section 30 near Tracy Lake. Above Tracy Lake, the left-bank levee is generally continuous past Woodbridge to section 100 northeast of Lockeford. The right-bank levee is not continuous; most of the overflow areas are limited by the elevation of the natural ground surface.

During low flows Dry Creek enters the Mokelumne River from the north, downstream from cross section 15, through two culverts under the right-bank levee. Floodflows are diverted to the Cosumnes River via Grizzley Slough, and for this study, Dry Creek is considered to be a tributary of the Cosumnes River. Dry Creek floodflows inundate the flood plain on the right bank of the Mokelumne River between cross sections 15 and 18 (shown in app. A as subject to flooding by Dry Creek). The Mokelumne River contributes to this inundation only during periods of maximum backwater effect at the mouth of the Cosumnes River.

Woodbridge Reservoir, which includes Lodi Lake Municipal Park, occupies the channel between Woodbridge and Lodi. This reservoir has no significant effect on floodflows. Upstream from Lodi, some waste treatment ponds are in the flood plain between cross sections 56 and 67.5. Several gravel plants are on the flood plain between cross sections 102 and 120; gravel mining has left pits that serve as holding ponds in this reach.

Characteristics of Floodflow in the Study Reach

Flows in the Mokelumne River have not exceeded the design release of 5,000 cfs since the completion of Camanche Dam in December 1963. During the floods of January 1969 and January 1970, the peak flow decreased from about 5,000 cfs at the gaging station below Camanche Dam to 4,700 cfs at the station at Woodbridge.

Peak discharges in excess of 3,000 cfs have not been measured downstream from the Woodbridge gage (cross section 51), and therefore variations in floodflow in the downstream part of the study reach are of unknown magnitude.

Annual peak elevations and discharges at the gaging stations on the Mokelumne River below Camanche Dam and at Woodbridge are given in tables 1 and 2 for water years 1905-70.

Table 1.--*Maximum annual peak stages and discharges of the Mokelumne River below Camanche Dam, California*

Water year	Date	Stage, in feet, above mean sea level	Discharge (cfs)
a1905-25	3-19-07	90.8	25,500
b1926	4-30-26	76.14	3,740
b1927	5-17-27	81.08	7,870
b1928	3-25-28	89.25	25,600
b1929	6-16-29	78.49	6,220
b1930	5-21-30	76.15	4,060
c1931-40	3-31-40	79.93	6,760
c1941	5-15-41	77.71	5,140
c1942	1-27-42	80.35	7,440
c1943	3-10-43	82.03	9,360
c1944	2-29-44	73.23	1,990
c1945	2- 2-45	79.44	5,930
c1946-50	6-12-43	77.28	4,240
	6- 1-50	78.38	4,500
c1951	11-21-50	90.21	28,800
c1952	6- 8-52	78.76	4,770
c1953	6-22-53	75.94	3,630
c1954	5-22-54	73.48	2,000
c1955	12- 9-54	72.86	1,810
c1956	12-24-55	90.66	27,300
c1957	6- 3-57	78.56	5,120
c1958	4- 3-58	81.69	8,220
c1959	2-18-59	71.52	1,160
c1960	6- 6-60	72.37	1,550
c1961	6-28-61	70.32	641
d1962	6-12-62	90.73	3,100
	6-13-62		
d1963	2- 2-63	93.58	5,920
d1964	1-31-64	88.18	822
d1965	12-31-64	90.56	2,900
d1966	10- 7-65	89.62	2,120
d1967	5-24-67, 5-25-67, 5-26-67	90.53	3,140
d1968	10-10-67, 10-11-67, 10-12-67, 10-13-67, 10-14-67, 10-16-67, 10-17-67, 10-19-67	89.01	1,580
d1969	1-28-69	92.72	4,940
d1970	1-24-70	92.67	5,130

a. 1905-25, nonrecording gages 3.6 miles downstream at Old Clements bridge (cross section 108).
b. 1926-30, recording gage 75 feet upstream from Old Clements bridge.
c. 1931-61, recording gage 1,100 feet upstream from Old Clements bridge (cross section 109).
d. 1962-70, recording gage 1 mile below Camanche Dam (cross section 122).

Table 2.--*Maximum annual peak stages and discharges of the Mokelumne River at Woodbridge, California*

Water year	Date	Stage, in feet, above mean sea level	Discharge (cfs)
a1926	5- 1-26	33.62	3,200
a1927	5-18-27	39.8	5,470
a1928	3-26-28	44.87	24,000
b1929	6-18-29	34.13	3,290
b1930	5-22-30	31.92	2,710
c1931-40	4- 4-40	36.61	5,100
c1941	5-22-41	35.21	4,470
c1942	1-28-42	36.75	4,950
c1943	3-11-43	37.37	5,190
c1944	11-22-43	27.21	1,650
c1945	2- 6-45	36.64	5,140
c1946-50	6-12-48	33.86	4,030
	6- 3-50	33.57	3,780
c1951	11-22-50	43.87	27,000
c1952	6- 6-52	35.70	4,590
c1953	6-23-53	29.73	2,440
c1954	5-18-54	26.97	1,460
c1955	11-16-54	27.92	1,940
c1956	12-24-55	43.29	23,000
c1957	6- 4-57	33.88	4,350
c1958	4- 3-58	37.19	4,960
c1959	12-31-58	26.43	1,580
c1960	1- 4-60	26.66	1,640
c1961	11-10-60	26.75	1,670
c1962	6-13-62	30.95	2,340
c1963	2- 4-63	36.85	5,340
c1964	11-16-63	27.63	1,710
c1965	6-25-65	32.49	3,300
c1966	11-12-65	30.45	2,510
c1967	5- 3-67	32.01	2,970
c1968	10-31-67	29.34	2,170
d1969	1-31-69	37.01	4,660
d1970	1-29-70	36.97	4,720
	1-30-70		

a. 1926 to July 1928, recording gage about 100 feet downstream from highway bridge.
b. July 1928 to March 1931, recording gage 400 feet downstream from highway bridge.
c. March 1931 to July 25, 1968, recording gage on left bank about 2,200 feet downstream from highway bridge.
d. July 25, 1968 to present, recording gage on right bank about 2,000 feet downstream from highway bridge (cross section 51).

COMPUTATION OF WATER-SURFACE PROFILES

The step-backwater method is used to determine water-surface profiles for given discharges in natural channels. Data necessary for the computations include the geometry of the stream channel, channel-roughness coefficients, and a measured or theoretical stage-discharge relation at the downstream end of the reach. The water-surface profile corresponding to any discharge may be computed from this information.

Theory

The basic theory for the computation of water-surface elevations, as discussed by Bailey and Ray (1966), is the principle of the conservation of energy between two cross sections of a stream. The equation is expressed as follows:

$$h_d + h_{v_d} + h_f + h_e = h_u + h_{v_u}$$

where subscripts d and u refer to the downstream and upstream cross sections, respectively; h is elevation of the water surface, in feet, above a datum plane; h_v is velocity head, in feet, at a cross section; h_f is the friction loss, in feet, between cross sections; and h_e is the energy loss, in feet, resulting from deceleration of flow in an expanding subreach between cross sections.

The step-backwater analysis consists of solving the basic equation by trial-and-error computations within specified tolerances. This method is one of several used in the computation of gradually varied flow profiles (Chow, 1959, chap. 10). It is applicable to subcritical or supercritical flow provided that subcritical flow computations progress in the upstream direction and supercritical flow computations progress downstream. All flows in this study were subcritical. The theory underlying the basic equations assumes that uniform-flow formulas are applicable to gradually varied flow conditions. The following conditions are assumed to be in effect:

1. Flow is steady between cross sections.

2. Slope is small so that depths perpendicular to the water surface can be considered equal to vertical depths.

3. Water-surface elevation is level across a cross section.

4. Effects of sediment and air entrainment are negligible.

5. All energy losses are included in the h_f and h_e terms.

The individual terms in the basic equation are computed as follows:

$$h_v = \alpha V^2/2g \tag{1}$$

where V is average velocity, in feet per second, α is the velocity distribution factor, and g is the acceleration of gravity (32.2 ft/sec^2).

$$h_f = \frac{LQ^2}{K_d K_u} \tag{2}$$

where L is the distance, in feet, between cross sections; Q is discharge, in cubic feet per second; and K is the conveyance, at a cross section. The equation to compute K is

$$K = \frac{1.486AR^{2/3}}{n} \tag{3}$$

where A is the area, in square feet, of a cross section; R is the hydraulic radius, in feet, of a cross section; and n is the Manning roughness coefficient.

$$h_e = K(\Delta h_v) \tag{4}$$

where k = 0 for a contracting subreach between cross sections and k = 0.5 for an expanding subreach and $\Delta h_v = h_{v_u} - h_{v_d}$.

This method has two advantages: (1) The maximum possible use of channel geometry is permitted, and (2) knowledge of the water-surface elevation anywhere within the study reach is not a prerequisite. Elevation of the water surface is not required because several water-surface profiles of the same discharge, starting with different water-surface elevations at the initial section, will tend to converge to a single profile if the reach is of adequate length. Where these profiles converge, the computed elevation will be theoretically correct. Consequently, an approximate stage-discharge relation can be used for the computations at the initial cross section provided that the initial cross section is far enough downstream from the study reach to insure convergence prior to entering the lower end of the study reach.

The approximate stage-discharge relation at the initial cross section may be developed by the slope-conveyance method for which the Manning equation is written in the form:

$$Q = KS^{\frac{1}{2}}$$

The energy slope, S, is assumed to be parallel to the channel slope and can be measured in the field or interpolated from topographic maps. From the approximate stage-discharge relation thus developed, starting water-surface elevations are selected for the discharges to be routed upstream by the step-backwater technique.

Collection of Field Data

Field Surveys

The pertinent geometry of the stream channel was determined by transit-stadia survey. Vertical control was established at several locations throughout the study reach from U.S. Coast and Geodetic Survey bench marks. All elevations given in this report are referenced to mean sea-level datum (1929 datum, 1960 adjustment). Locations of cross sections were selected and horizontal control established using U.S. Geological Survey topographic maps (7.5-minute series) and aerial photographs of the study reach. In places, cross sections were extended across wide flood plains using data from the topographic maps.

Channel cross sections were surveyed at selected intervals throughout the study reach and related to the longitudinal water-surface profiles. For leveed areas, ground elevations were obtained near the shoreward toe of each levee.

Roughness Coefficients

The channel-roughness coefficient, n, as used in the Manning discharge equation and in backwater computations, is affected primarily by the following factors: Bed roughness (bed material composition), channel irregularities and alinement, size and shape of channel, vegetation, obstructions, stage, and suspended material. Roughness coefficients for the flood plain may be different from those for the main channel for natural reasons or because farming practices have altered vegetation density and ground-surface irregularity in the flood plain. Roughness coefficients for the flood plain and main channel are evaluated independently.

The basic roughness coefficients used in this study were determined in the field. Adjustments were made when necessary, using roughness coefficients determined at selected locations on the basis of the high-water profile and discharge measurements obtained during and after the floods of January 1969 and January 1970 and a water-surface profile surveyed in December 1970.

Stage-Discharge Relations

The starting point for step-backwater computation is a downstream site where water-surface elevations corresponding to selected discharges are known or can be derived. This stage-discharge relation was developed for cross section 1 at Bensons Ferry Bridge by using the stage data for the gaging station on the Mokelumne River at Thornton (operated by California Department of Water Resources) with the discharge record for the Woodbridge gage. Relations were developed for maximum and minimum measured backwater conditions. Maximum water-surface elevations were based on a surveyed high-water mark at elevation 16.7 ft for the flood of November 1950, and the recorded maximum stage of 15.5 ft for the flood of December 1964.

During the flood of December 1964, releases were not made from Camanche Reservoir until after flood peaks on the Cosumnes River and Dry Creek had receded. With a flow of only 350 cfs at the Woodbridge gage on December 24, the peak stage at the Thornton gage was 15.5 feet. This peak stage is more than 10 feet above the minimum measured stage for 350 cfs.

The rating for the recording gage on the Mokelumne River at Victor (cross section 80) operated by East Bay Municipal Utility District, was extended from 3,000 cfs to 5,000 cfs using surveyed high-water marks and corresponding discharges determined at the Woodbridge gage (cross section 52). This rating was used as the starting point to compute water-surface elevations upstream to the gage below Camanche Dam (cross section 122).

RESULTS OF THE STUDY

Reduction in channel size causes flood stages to be higher for a particular discharge. The analyses that follow, therefore, are applicable for conditions surveyed in 1970 and are contingent on there being (1) no levee failures, (2) no additional encroachment in the channel by land reclamation and levee construction, and (3) no additional encroachment by trees and brush.

Water-surface elevations at cross sections 1-122 in the study reach were determined by the step-backwater technique for discharges between 3,000 and 6,000 cfs. Water-surface elevations tabulated in appendix B for cross sections 1-35 are based on minimum observed backwater conditions at cross section 1. Water-surface elevations for maximum observed backwater conditions measured at cross section 1 for flows of 2,000 to 5,000 cfs are tabulated for cross sections 1-35 in appendix C.

For a given discharge, the profile for maximum backwater conditions tends to converge with the profile for minimum backwater conditions in an upstream direction. At cross section 35, the maximum backwater effect is less than 0.5 feet at a discharge of 5,000 cfs.

Left and right-bank profiles that denote effective stages before overbank flow will occur are shown on profiles (app. A) as bankfull stage. The bankfull stage is the elevation where flow will overtop the levee or natural ground, at each cross section. Levee or natural ground elevations at all of the cross sections in the study reach are listed in appendix D.

Surveyed water-surface elevations for the floods of January 1969 and January 1970 were within ±0.5 feet of the elevations computed using the step-backwater analysis. In addition, computed elevations were compared with measured stage at gaging stations at cross section 24.8 (for minimum backwater conditions), 51, 80, and 122 (table 3).

Table 3.--*Comparison of measured and computed stage-discharge relations*

Gaging station	Discharge (cfs)	Stage, in feet, above mean sea level	
		Measured	Computed
Mokelumne River at Frandy (cross section 24.8)	2,000	13.6	a14.2
	4,000	19.8	a20.2
	5,000	22.0	a22.2
	6,000	23.1	a23.9
Mokelumne River at Woodbridge (cross section 51)	2,000	29.1	29.4
	4,000	35.5	35.3
	5,000	37.5	37.8
	6,000	38.4	39.9
Mokelumne River at Victor (cross section 80)	2,000	53.8	54.1
	4,000	59.3	59.6
	5,000	61.2	61.4
	6,000	62.1	62.8
Mokelumne River below Camanche Dam (cross section 122)	2,000	89.4	89.4
	4,000	91.4	91.6
	5,000	92.5	92.6
	6,000	93.6	93.4

a. For minimum measured backwater conditions.

Computed elevations for discharges greater than 5,000 cfs are for bounded conditions where all flow is assumed to be confined to the main channel. The assumed lateral boundaries for each cross section are given in table 4.

Mean velocities with minimum backwater conditions at cross sections 1-122 for discharges of 1,500, 3,000, and 5,000 cfs are given in appendix E. Mean velocities at cross sections 1-35 for flows with maximum measured backwater conditions are given in appendix F.

Areas subject to inundation by a release of 5,000 cfs are indicated on the maps in appendix A. With channel conditions as determined in 1970, most of the study reach will carry 5,000 cfs within the natural or leveed banks. Overbank flow will occur between cross sections 12 and 19 during periods of maximum backwater. Flooding of industrial waste ponds at cross sections 48-51 and 62-67 will also occur whenever flows reach 5,000 cfs. During the flood of January 1970, levee breaks caused overbank flooding between cross sections 74 and 84.

Table 4.--*Lateral boundaries for cross sections 1-122 on the Mokelumne River*

Cross section number	Distance, in feet, from initial point on left bank flood plain		Cross section number	Distance, in feet, from initial point on left bank flood plain	
	Left boundary	Right boundary		Left boundary	Right boundary
1	0	584	61	416	742
2	123	306	61.1	397	742
3	152	356	62	0	240
4	0	264	63	0	353
5	95	316	64	510	715
6	107	244	65	1,146	1,326
7	118	259	66	0	450
8	93	286	67	0	451
9	29	169	67.5	479	708
10	62	303	68	97	398
11	48	223	69	0	254
12	0	220	70	0	314
13	46	202	71	0	464
14	78	259	72	753	944
15	63	280	73	429	600
16	103	242	74	750	972
17	43	203	75	262	472
18	44	210	76	145	316
19	66	282	77	1,125	1,336
20	369	507	78	1,086	1,274
21	395	567	79	0	401
22	612	824	80	0	279
23	65	224	81	248	379
24	60	200	82	265	444
24.5	245	406	83	1,271	1,436
24.8	73	380	84	55	273
25	104	297	85	44	256
26	36	250	86	91	344
27	490	710	87	46	239
28	77	305	88	45	440
29	527	712	89	76	274
30	392	588	90	57	296
31	71	211	91	0	400
32	54	270	92	0	349
33	84	240	93	70	306
34	400	607	94	424	758
35	71	298	95	61	289
36	51	260	96	113	397
37	101	354	97	98	384
38	494	837	98	151	372
39	183	435	99	55	358
40	98	777	100	84	450
41	68	603	101	53	325
42	0	1,079	102	57	385
43	86	278	103	48	228
44	52	261	104	68	307
44.5	342	771	105	60	414
45	52	248	106	130	470
46	50	290	107	0	652
47	91	232	108	0	432
48.5	220	366	109	0	490
48.7	228	348	110	1,261	1,521
49	610	774	111	0	1,734
50	540	740	112	0	474
51	412	572	113	0	499
52	750	962	114	0	403
52.4	673	904	115	748	1,086
53	160	461	116	0	466
54	0	217	117	0	541
55	640	808	118	0	478
56	383	614	119	214	532
57	0	500	120	0	342
58	0	408	121	0	873
59	337	602	122	0	714
60	0	303			

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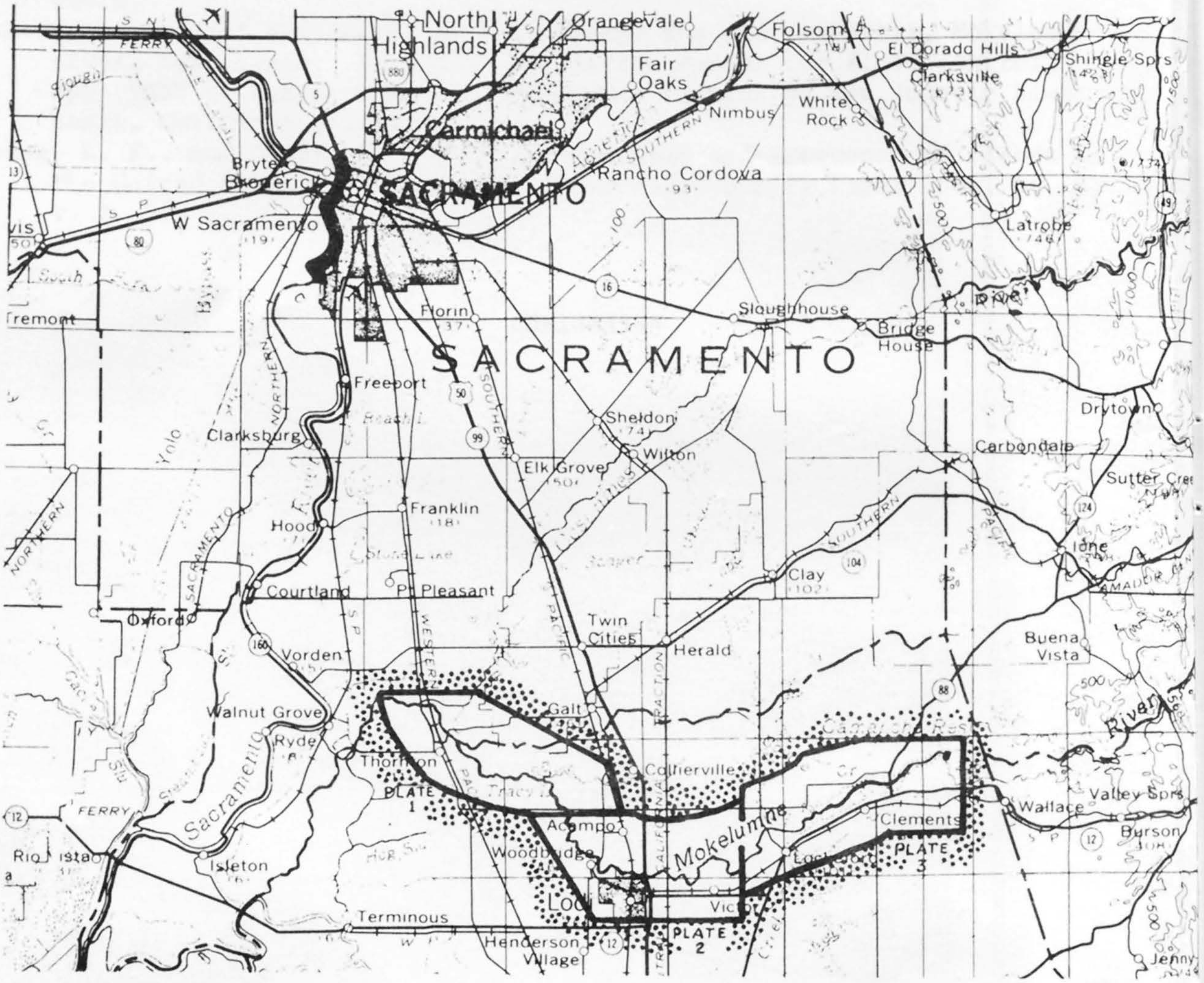
APPENDIXES

Composites of the page-size maps and profiles in appendix A are available on three plates on request, at the requester's expense, from the district chief, U.S. Geological Survey, Water Resources Division, 855 Oak Grove Ave., Menlo Park, Calif. 94025.

Each composite is 22½ by 35 inches; plate 1 contains the map and the profile showing the location of cross sections 1 through 43, plate 2 contains the map and the profile showing the location of cross sections 44 through 85, and plate 3 contains the map and the profile showing the location of cross sections 86 through 122.



Base from U.S. Geological Survey topographic map of California, North half, 1968, 1:500,000

0 5 10 15 MILES

Contour interval 500 feet
Dotted line represents the 100-foot contour
Datum is mean sea level

APPENDIX A

Strip maps and profiles showing location of cross sections and area of inundation

EXPLANATION OF
PROFILE SYMBOLS

Bankfull stage, right bank

Bankfull stage, left bank

Computed water-surface profile for discharge of 5,000 cfs with maximum measured backwater at cross section 1

Computed water-surface profile for discharge of 5,000 cfs with minimum measured backwater

Thalweg

EXPLANATION OF
MAP SYMBOLS

12

Cross section number and location

Location of river channel

Area of inundation at 5,000 cfs

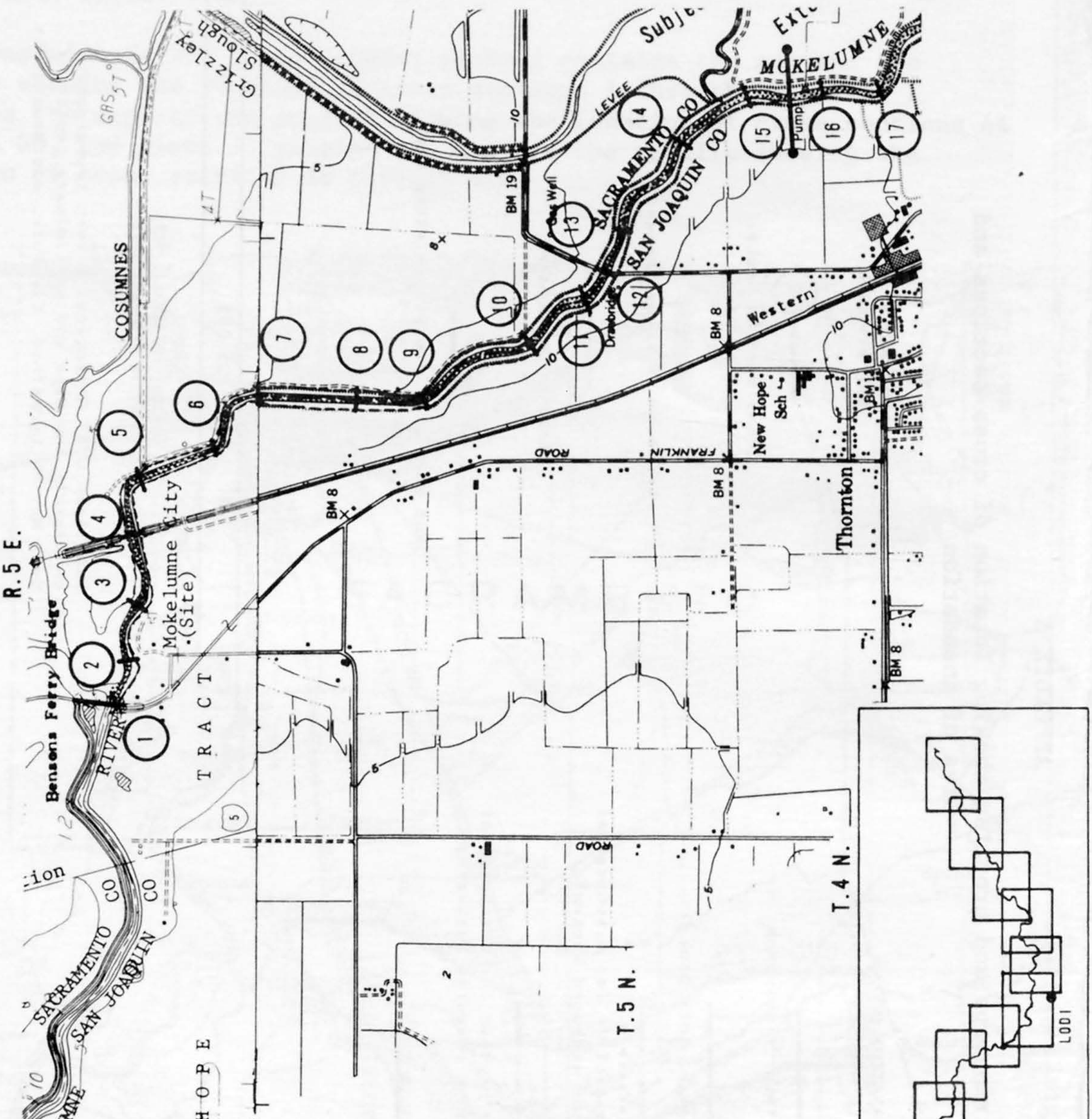
End points of profile on strip maps

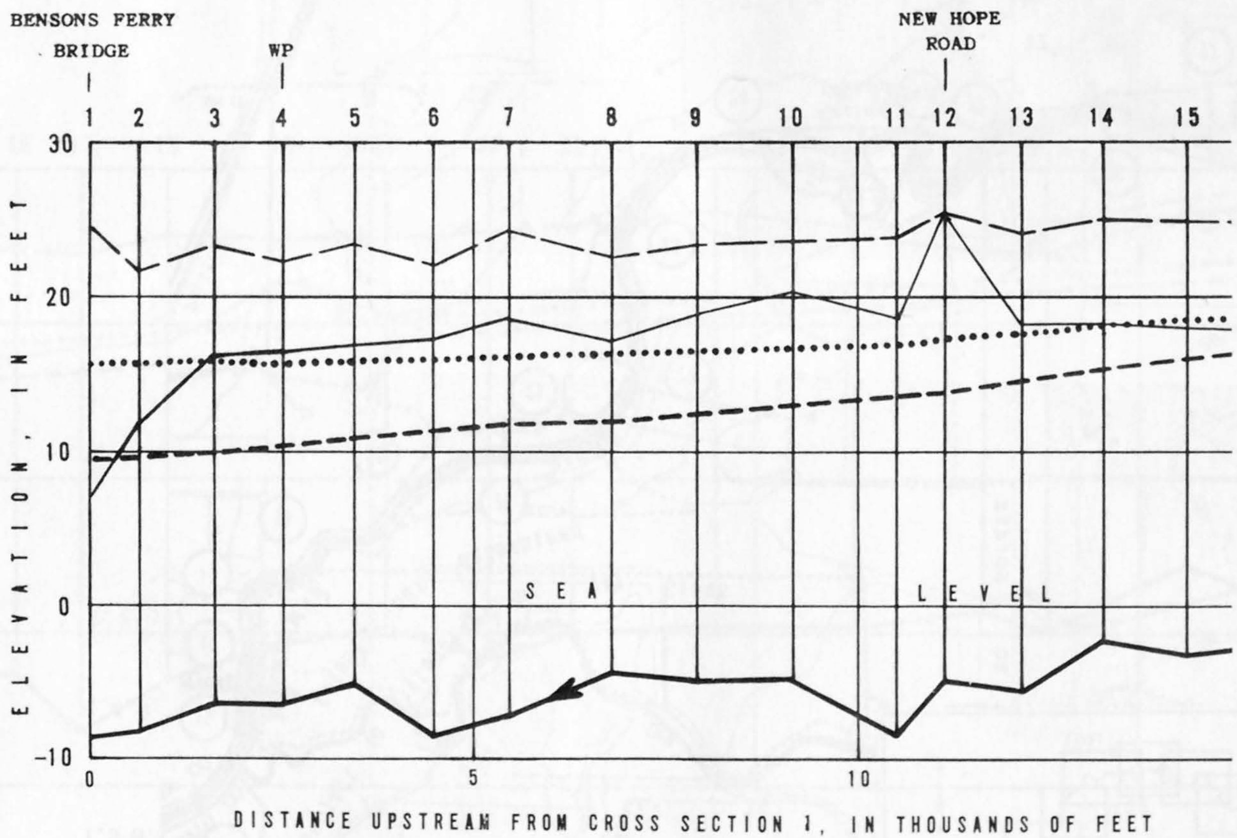
0 1 2 MILES

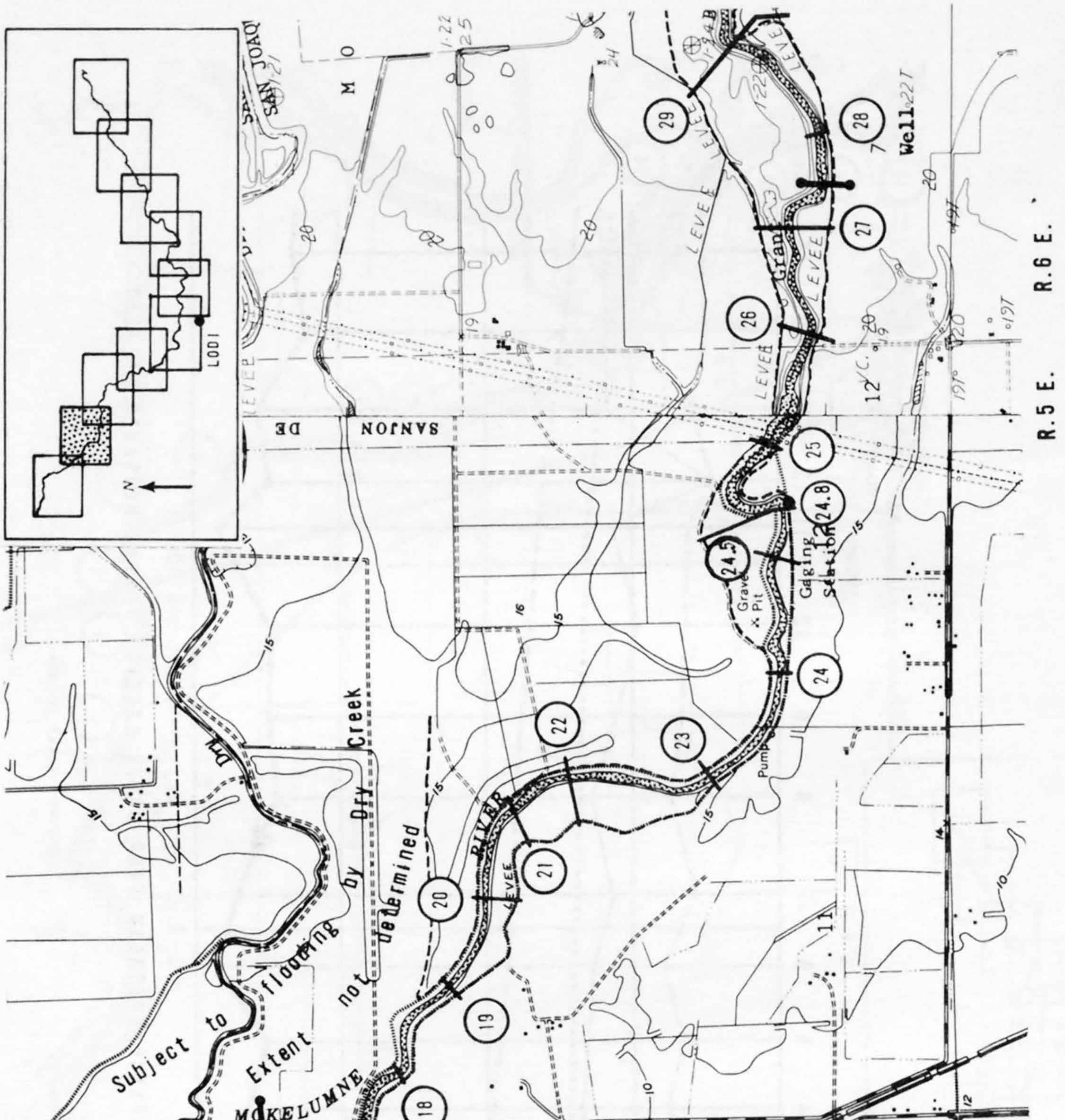
0 5,000 10,000 FEET

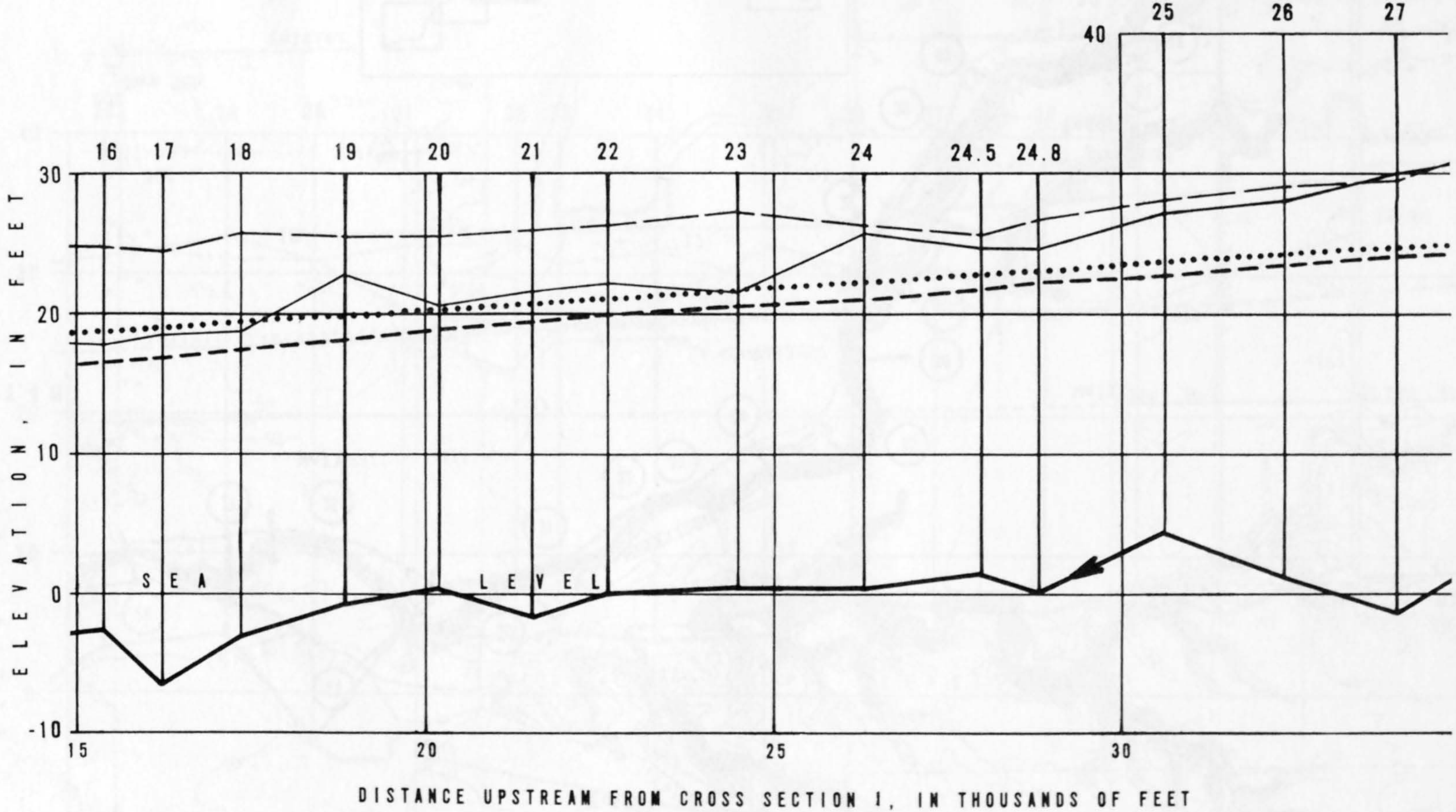
Contour interval 5 feet
Datum is mean sea level

Base from U.S. Geological Survey topographic quadrangle New Hope and preliminary copies of Lodi North, Lockeford, Clements, and Bruceville

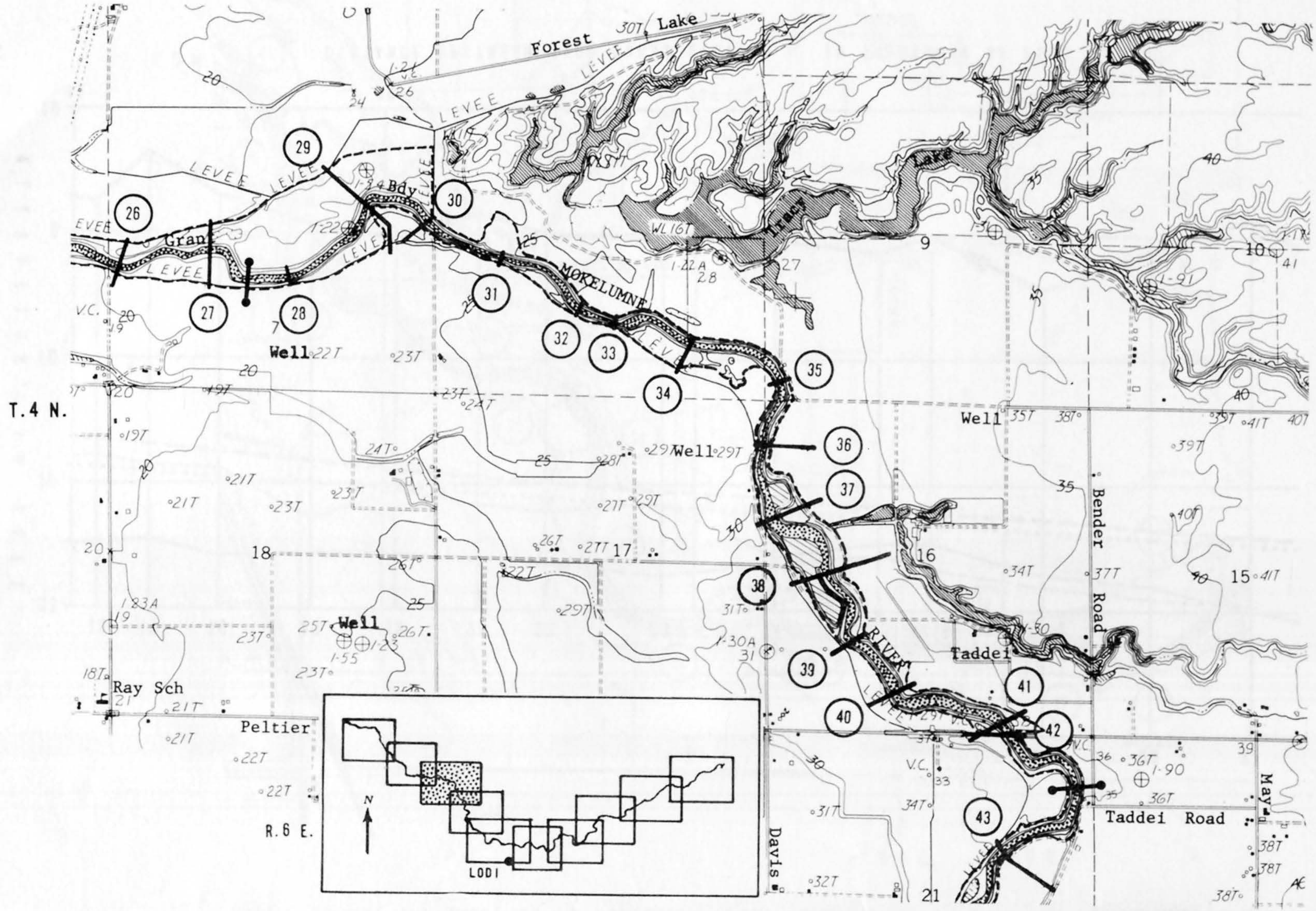

R. 5 E.
Bensons Ferry Bridge
MOKELUMNE
SACRAMENTO CO
SAN JOAQUIN CO
RIVER
COSUMNES
Mokelumne City
(Site)
HOPE
TRACT
38°15'
Grizzley Slough
T. 5 N.
T. 4 N.
BM 8
BM 19
Gas Well
Drawbridge
SACRAMENTO CO
SAN JOAQUIN CO
LEVEE
MOKELUMNE
Pump
FRANKLIN ROAD
ROAD
Western
New Hope Sch
Thornton
LODI
N
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

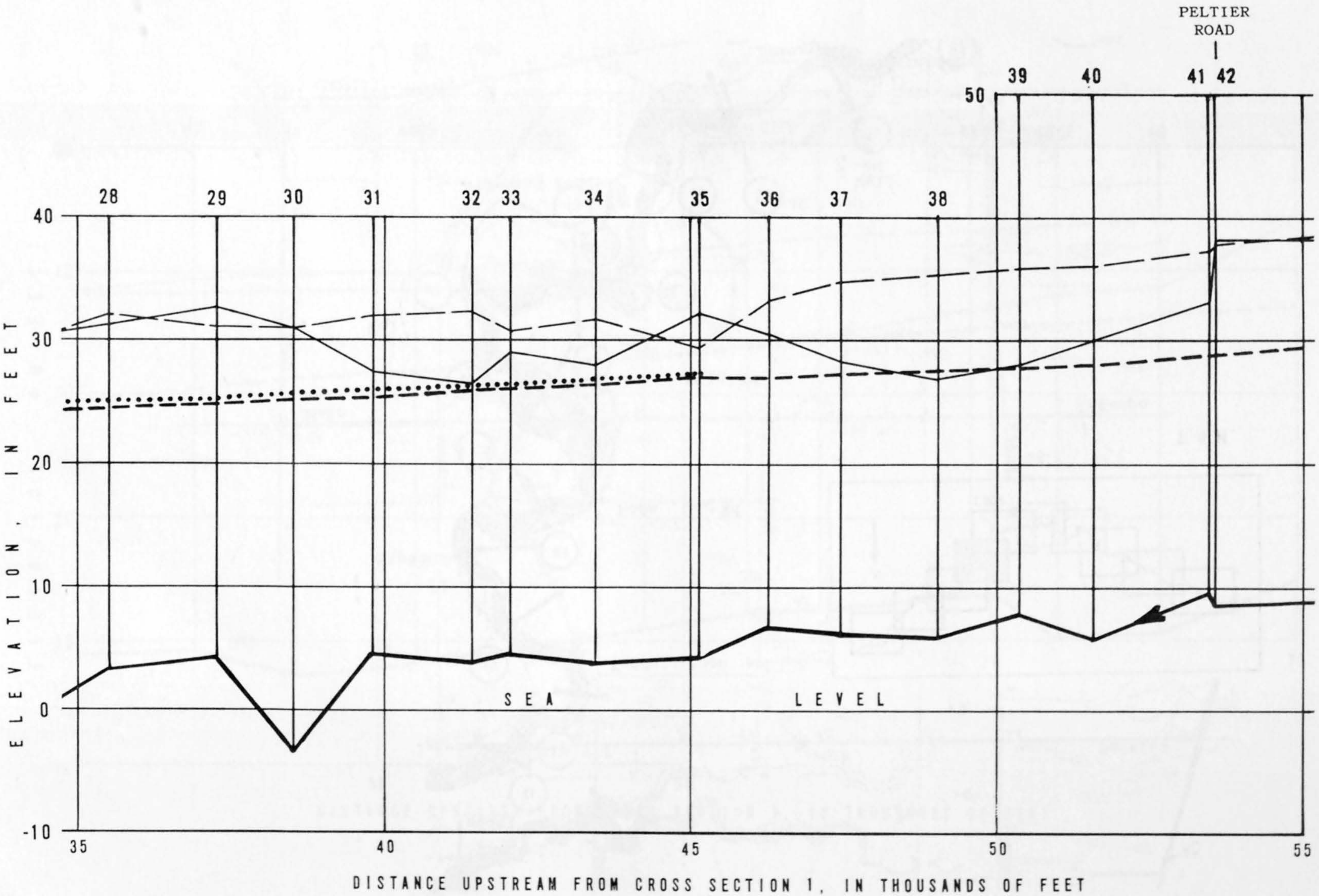

BENSONS FERRY
BRIDGE
WP
NEW HOPE
ROAD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
ELEVATION, IN FEET
30
20
10
0
-10
SEA LEVEL
0
5
10
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET

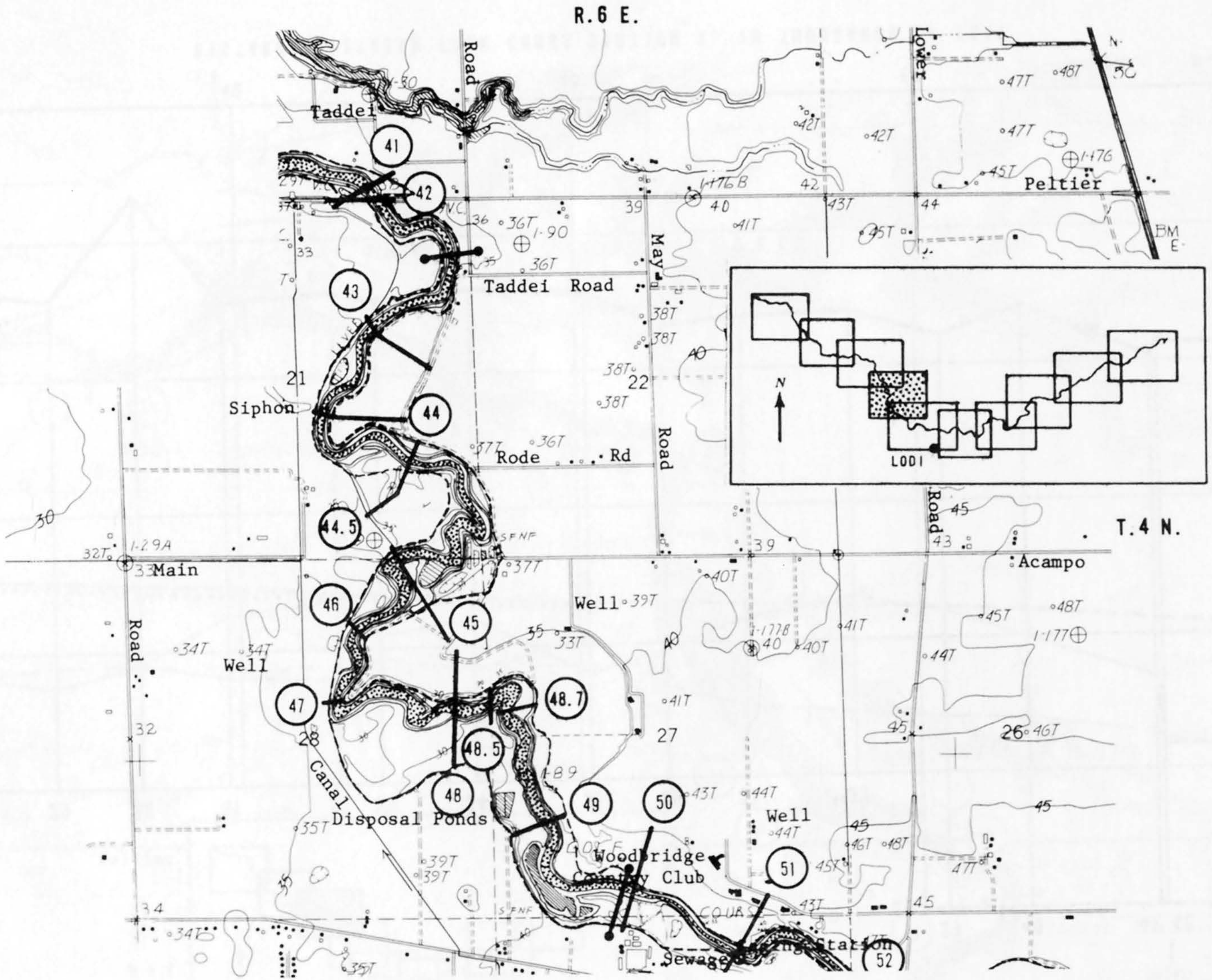

LODI
N
Subject to flooding by Dry Creek
Extent not determined
Dry Creek
MOKELUMNE
RIVER
LEVEE
Pump
Gravel Pit
Gaging Section
Well
Pacific
SANJON DE
14
15
16
17
18
19
20
21
22
23
24
24.5
24.8
25
26
27
28
29
T.5 N.
T.4 N.
R.5 E.
R.6 E.

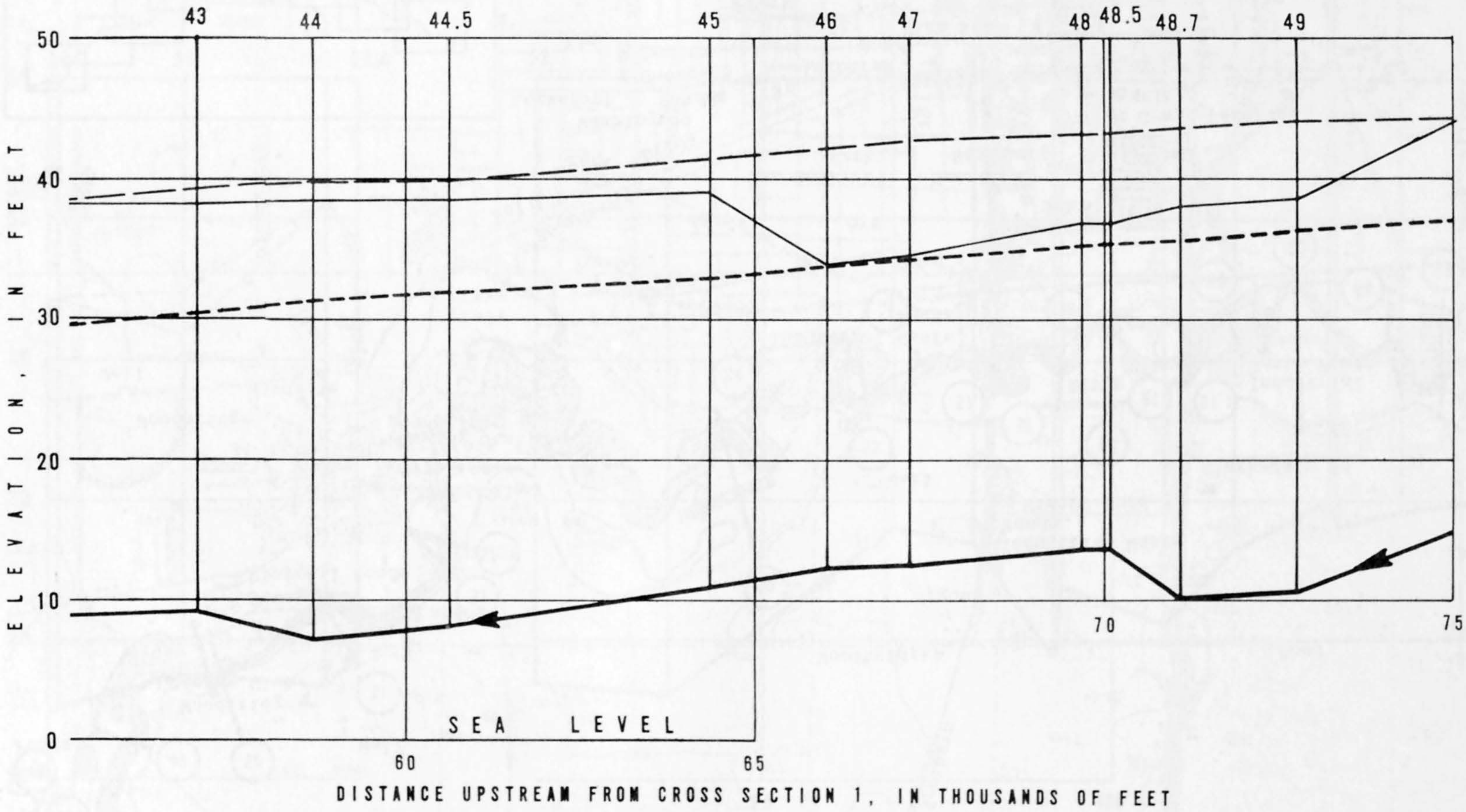

16
17
18
19
20
21
22
23
24
24.5
24.8
25
26
27
40
30
20
10
0
-10
15
20
25
30
SEA
LEVEL
ELEVATION, IN FEET
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET

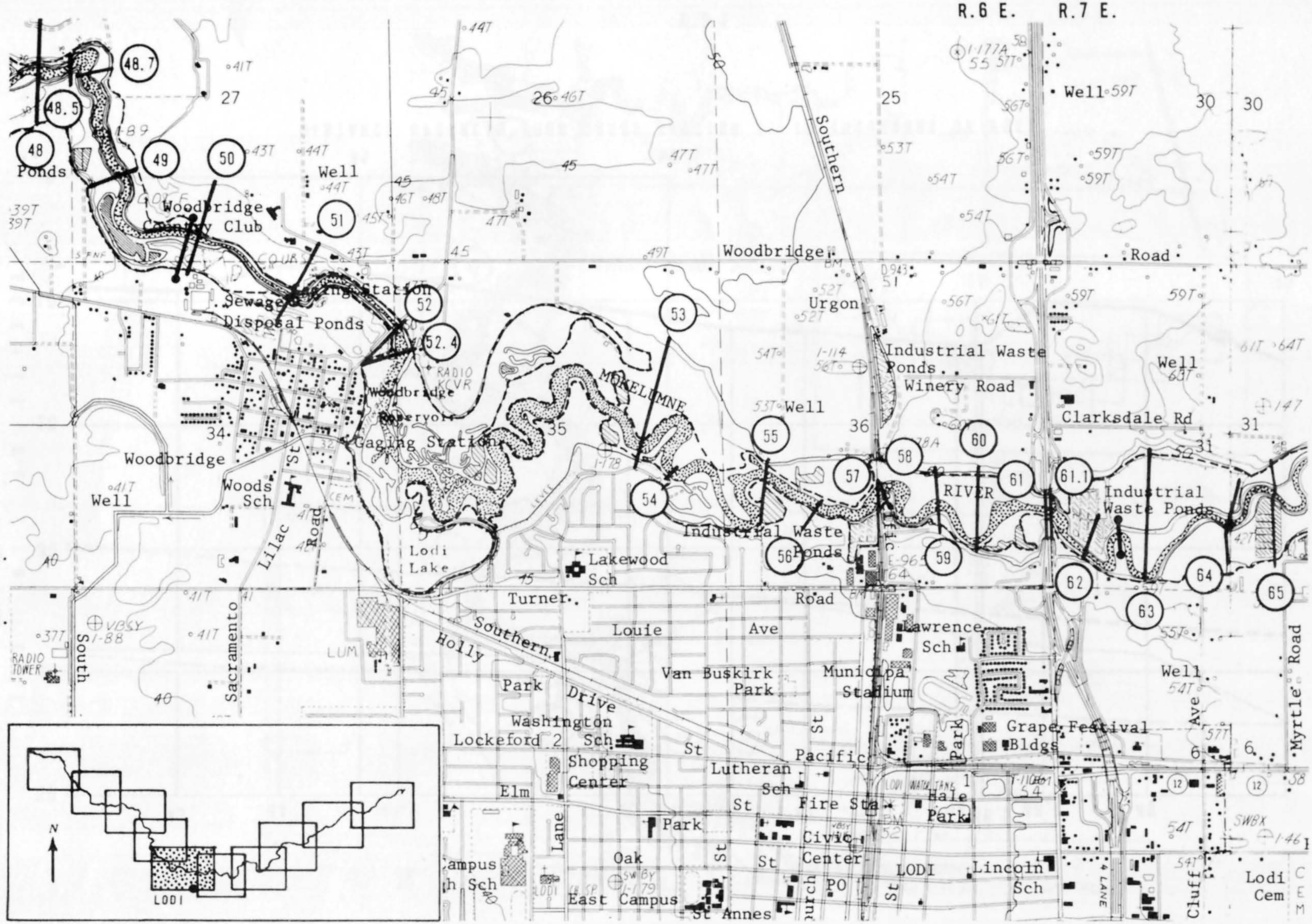
CHANNEL CAPACITY, MOKELUMNE RIVER, CALIFORNIA

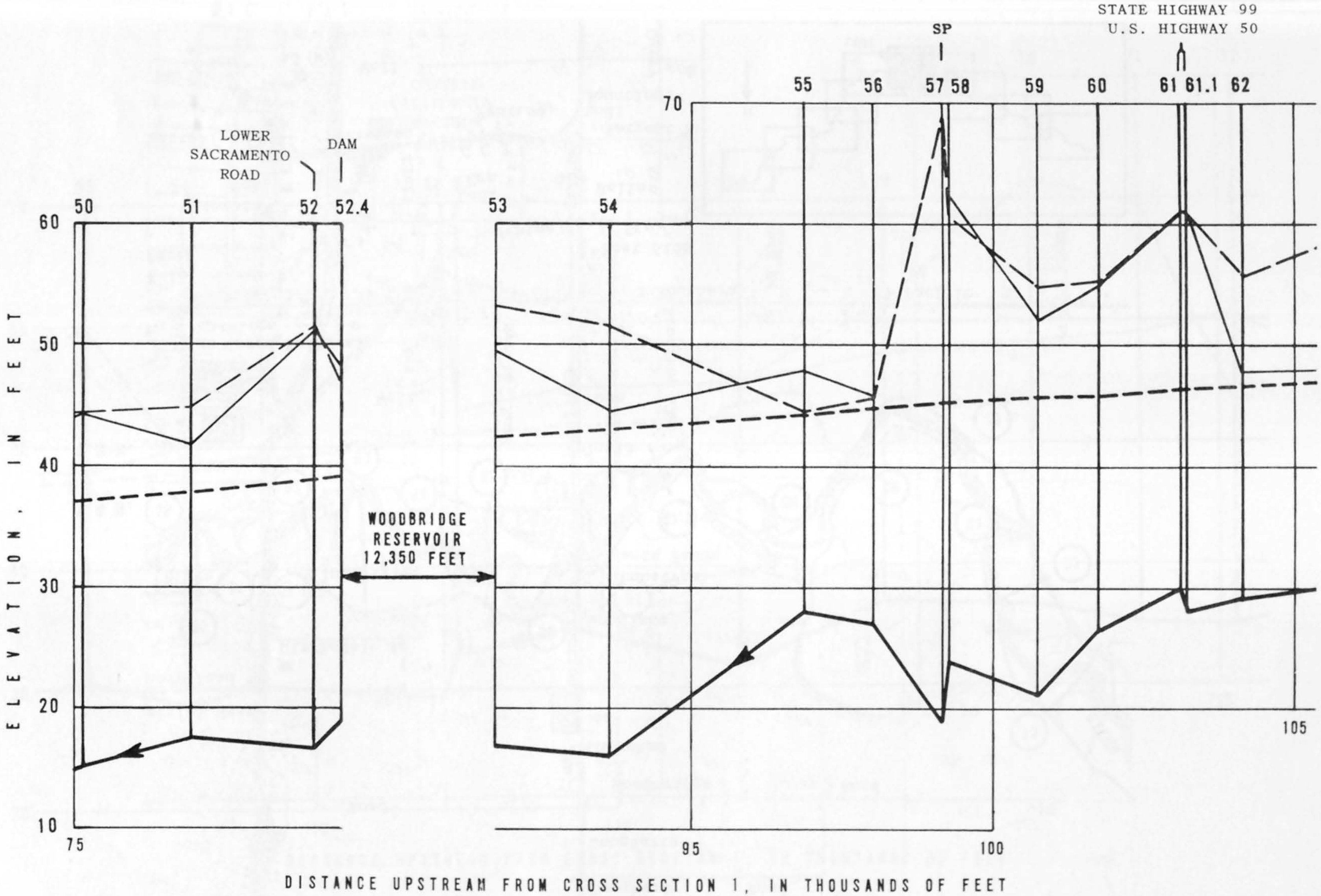


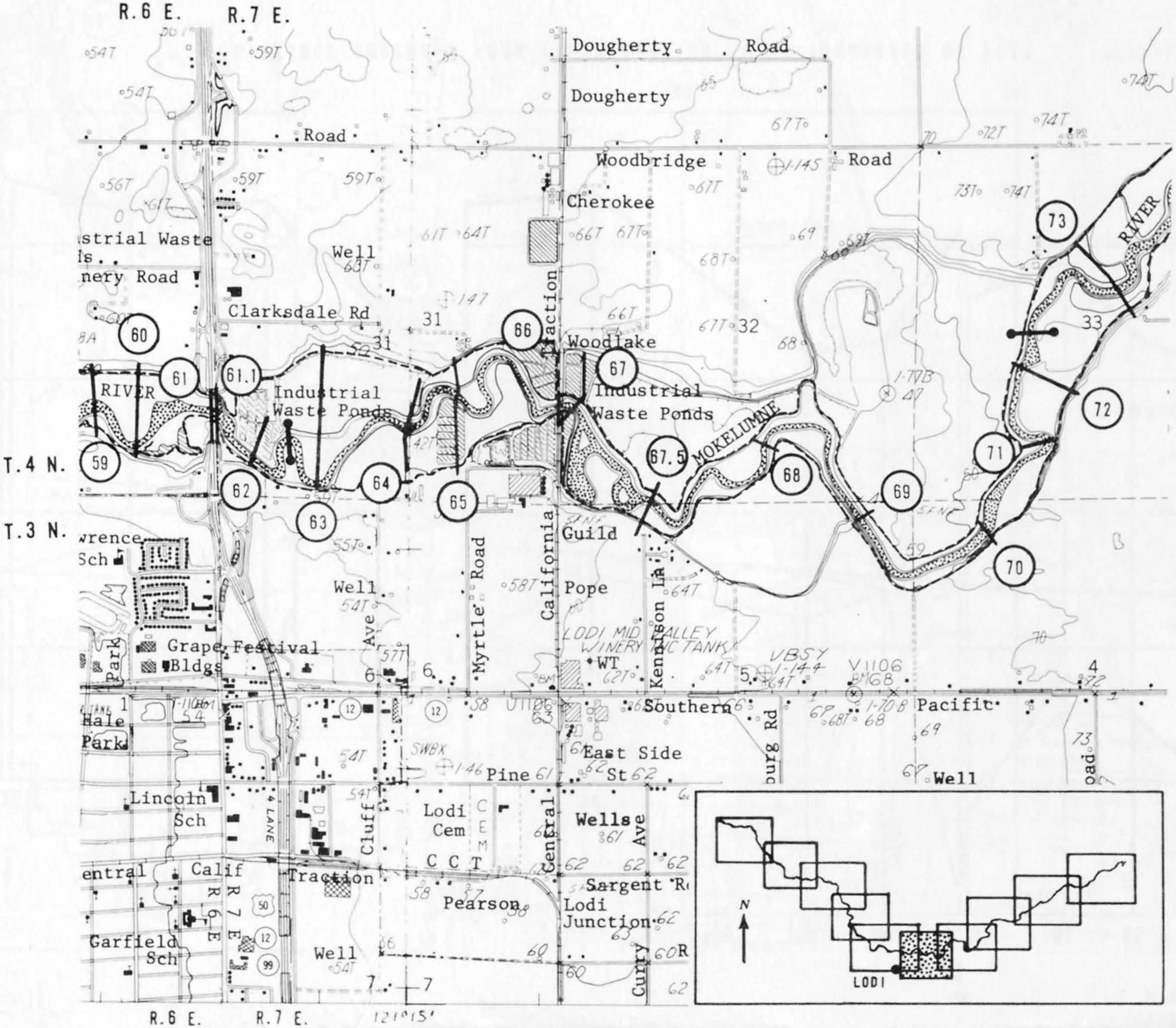

PELTIER ROAD
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
50
40
30
20
10
0
-10
35
40
45
50
55
SEA LEVEL
ELEVATION, IN FEET
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET

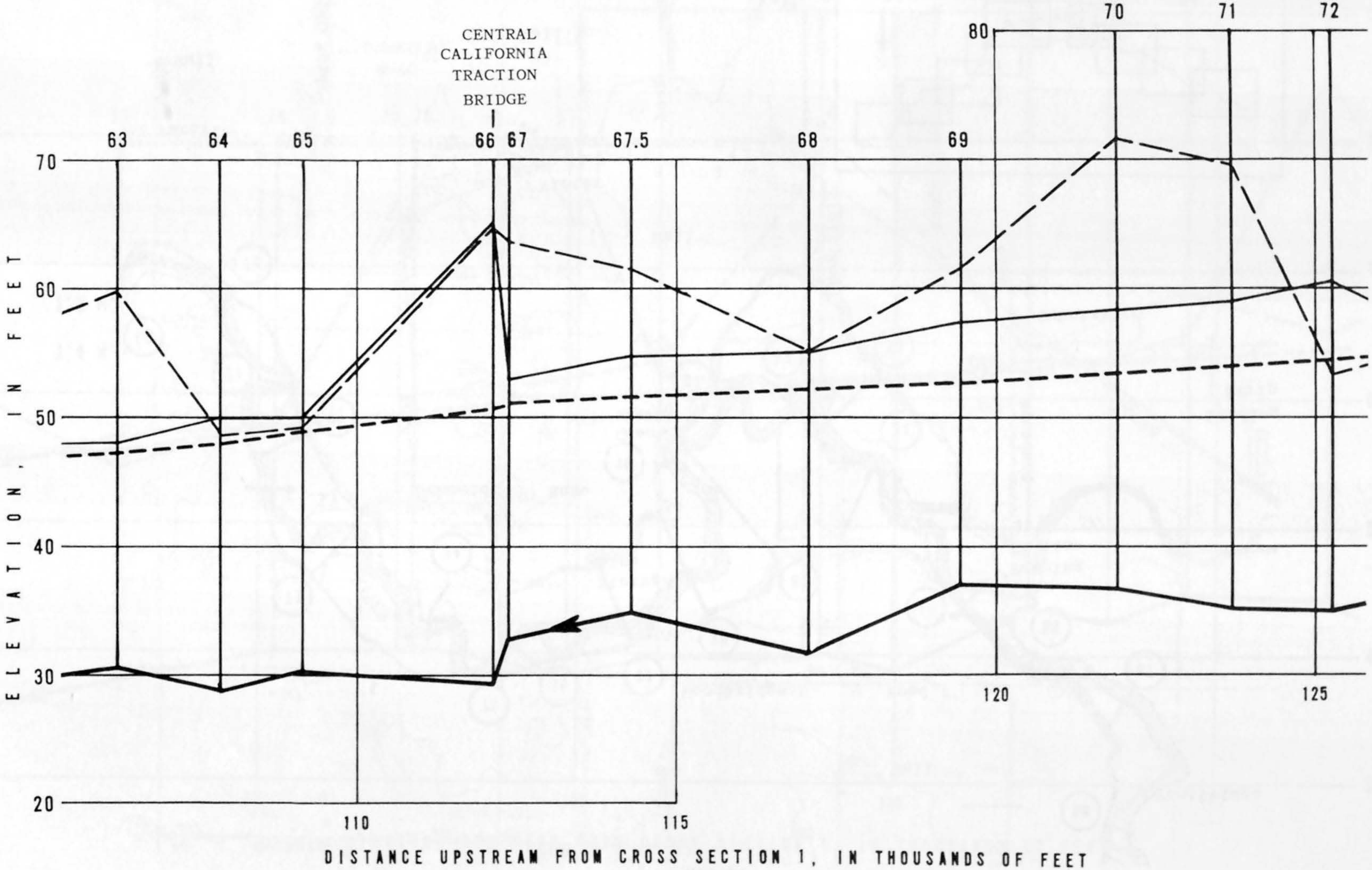

R.6 E.
T.4 N.
Taddei
Road
Lower
Peltier
Taddei Road
May
Road
Siphon
Rode Rd
Main
Road
Well
Acampo
Canal
Disposal Ponds
Woodbridge
Country Club
Sewage
Station
LODI
N
41
42
43
44
44.5
45
46
47
48
48.5
48.7
49
50
51
52

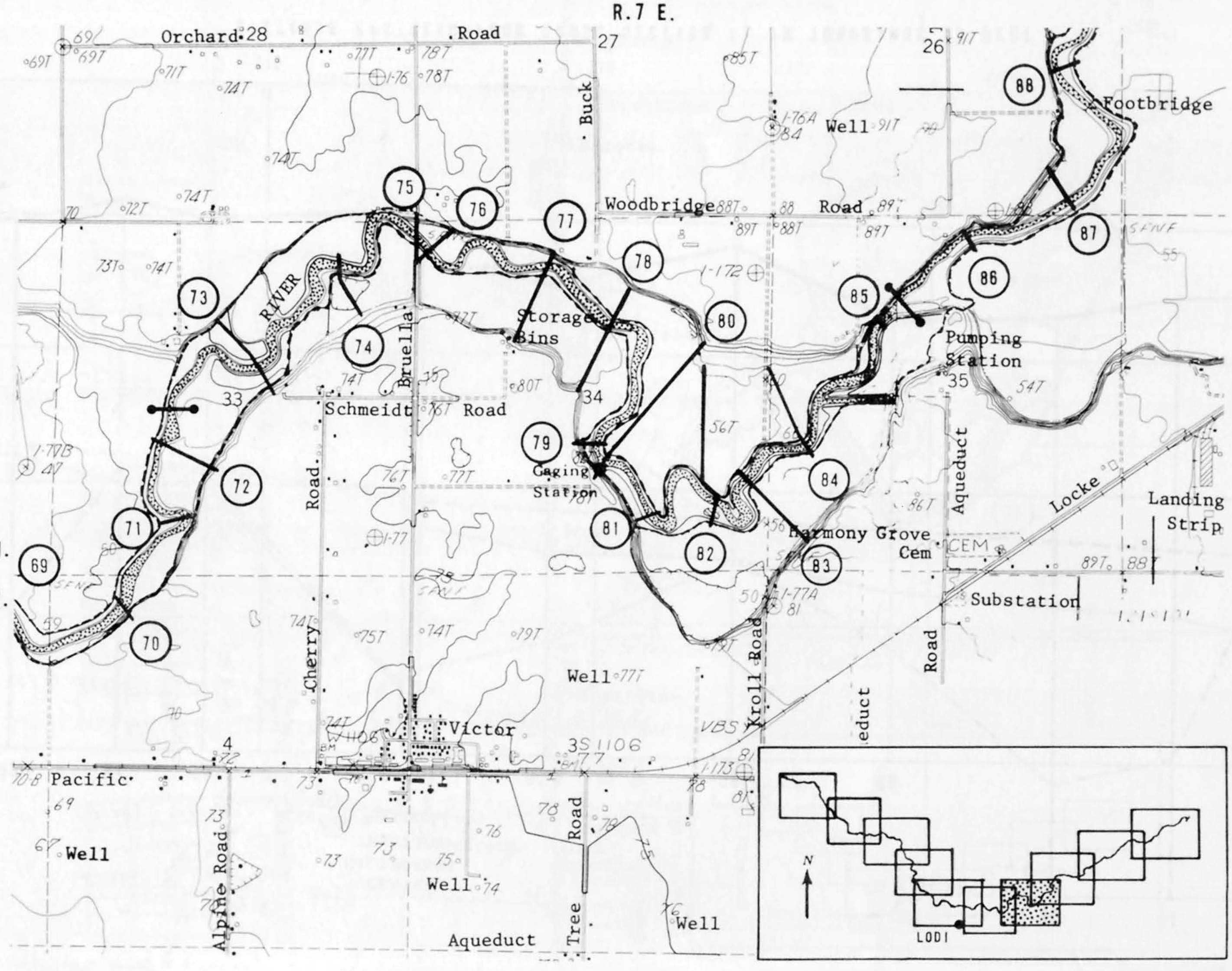

43
44
44.5
45
46
47
48
48.5
48.7
49
50
40
30
20
10
0
ELEVATION, IN FEET
SEA LEVEL
60
65
70
75
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET

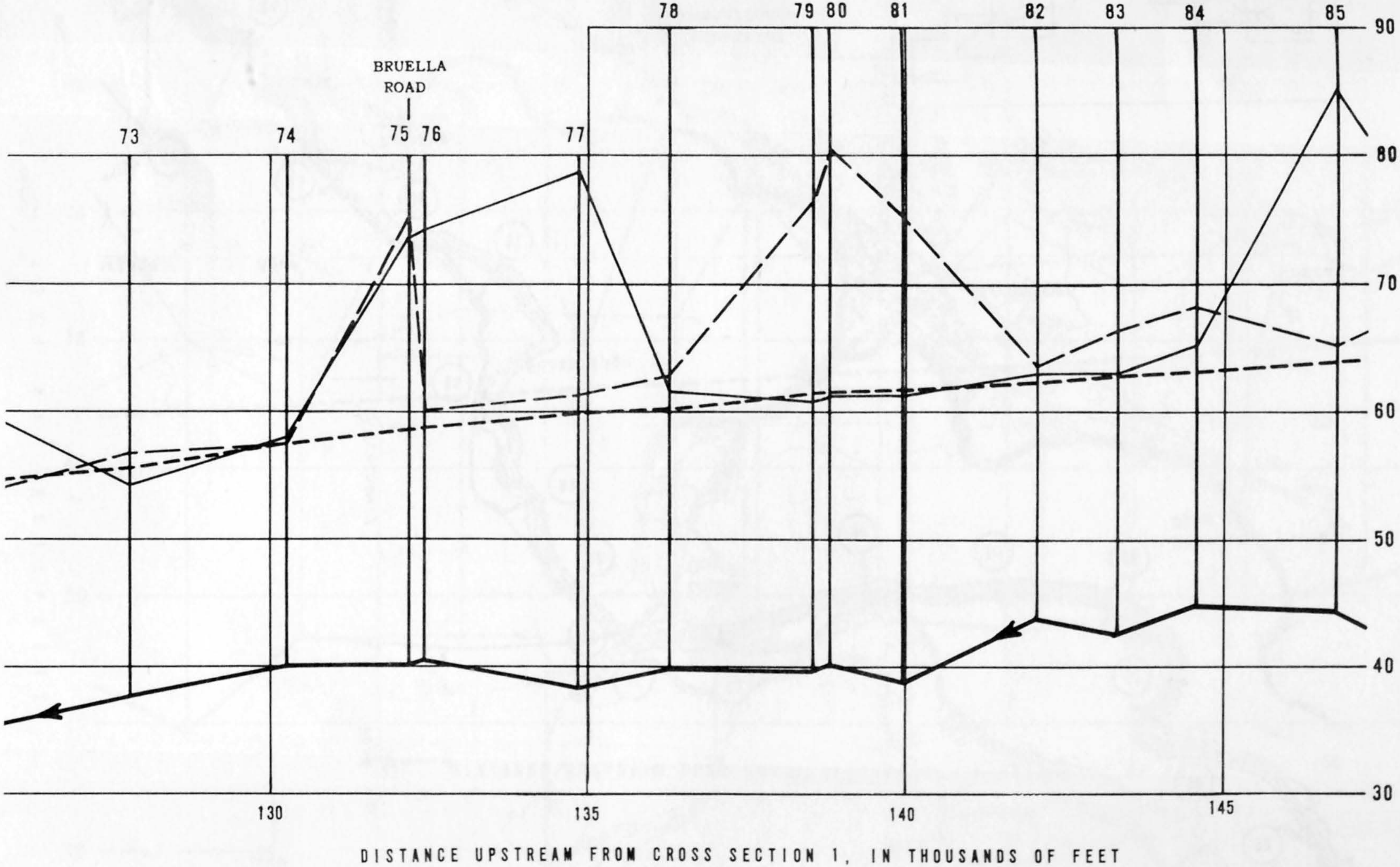

R.6 E.
R.7 E.
T.4 N.
T.3 N.
48
48.5
48.7
49
50
51
52
52.4
53
54
55
56
57
58
59
60
61
61.1
62
63
64
65
Ponds
Woodbridge Country Club
Well
Sewage Disposal Ponds
Gaging Station
Woodbridge
Woodbridge Reservoir
Woods Sch
Lilac Road
Lodi Lake
MOKELUMNE
RIVER
Lakewood Sch
Turner Road
Louie Ave
Van Buskirk Park
Municipal Stadium
Lawrence Sch
Industrial Waste Ponds
Woodbridge
Urgon
Southern
Winery Road
Clarksdale Rd
Road
Southern
Holly
Park
Drive
Washington Sch
Lockeford
Shopping Center
Elm
Lutheran Sch
Pacific
Fire Sta
Hale Park
Park
Civic Center
Oak
St
Lane
East Campus
St Annes
PO
LODI
Lincoln Sch
Grape Festival Bldgs
Cluff Ave
Myrtle Road
Lodi Cem
Sacramento
South
RADIO TOWER
N
LODI

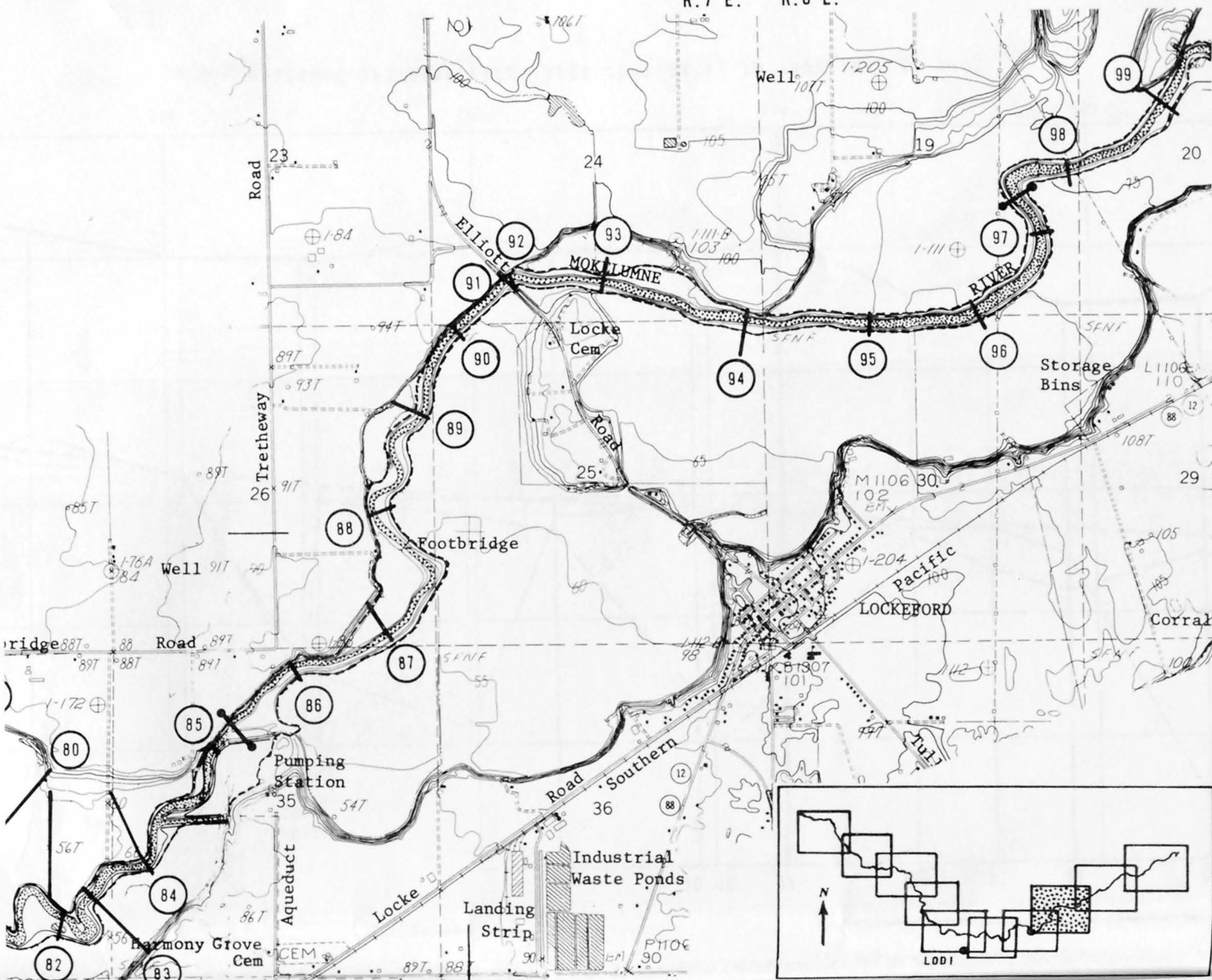

STATE HIGHWAY 99
U.S. HIGHWAY 50
SP
LOWER SACRAMENTO ROAD
DAM
50
51
52
52.4
53
54
55
56
57 58
59
60
61 61.1
62
70
60
50
40
30
20
10
ELEVATION, IN FEET
WOODBRIDGE RESERVOIR 12,350 FEET
75
95
100
105
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET

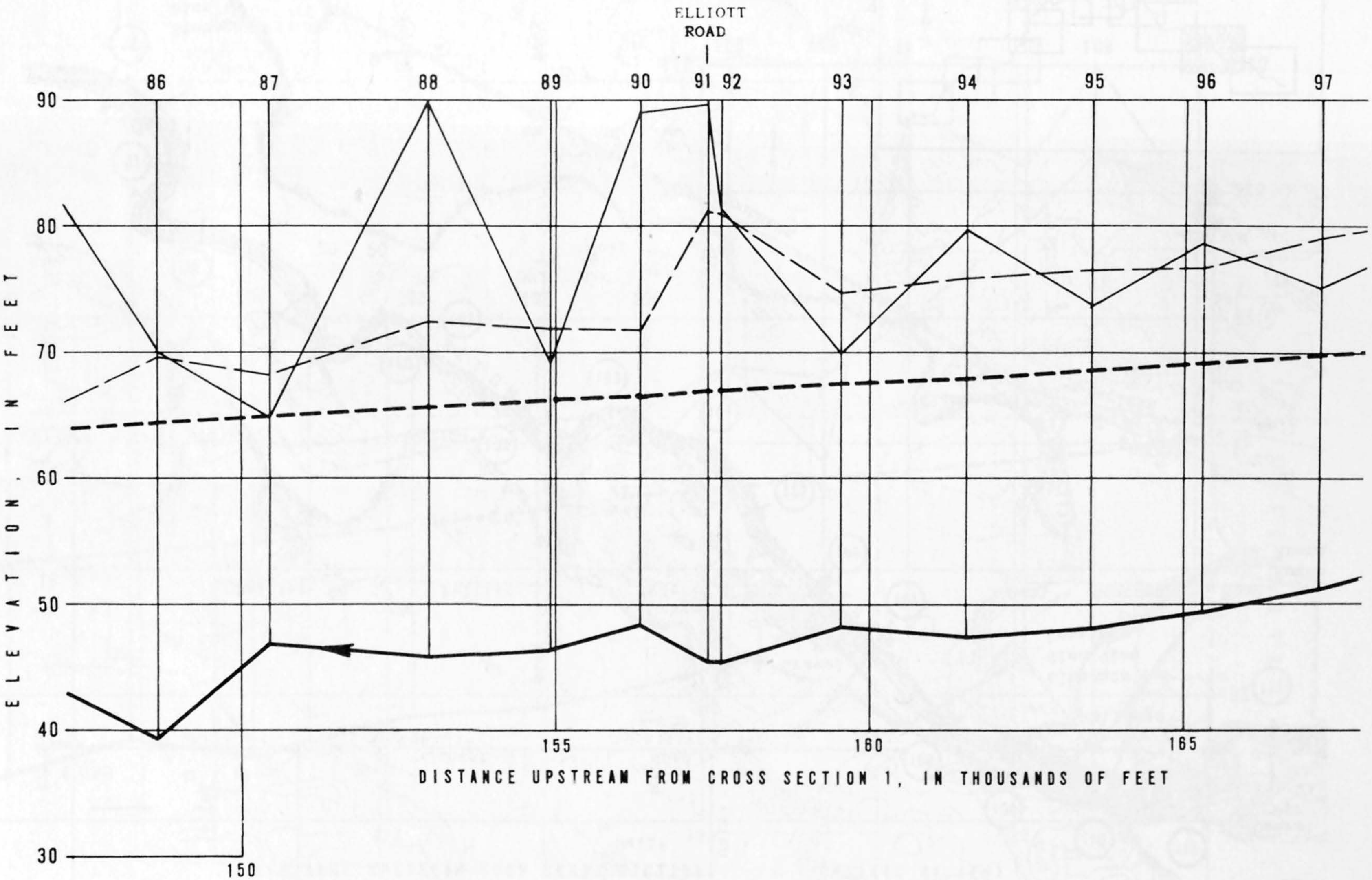

R.6 E.
R.7 E.
T.4 N.
T.3 N.
Dougherty
Road
Woodbridge
Cherokee
Clarksdale Rd
Industrial Waste Ponds
Woodlake
Traction
RIVER
MOKELUMNE
Guild
Pope
California
Myrtle Road
Kennison La
LODI MID VALLEY WINERY
Grape Festival Bldgs
Southern Pacific
East Side
Pine
Lincoln Sch
Lodi Cem
Wells Ave
Sargent
Lodi Junction
Pearson
Garfield Sch
Hale Park
Central
Cluff Ave
Curry
Well
59
60
61
61.1
62
63
64
65
66
67
67.5
68
69
70
71
72
73
N
LODI
121°15'

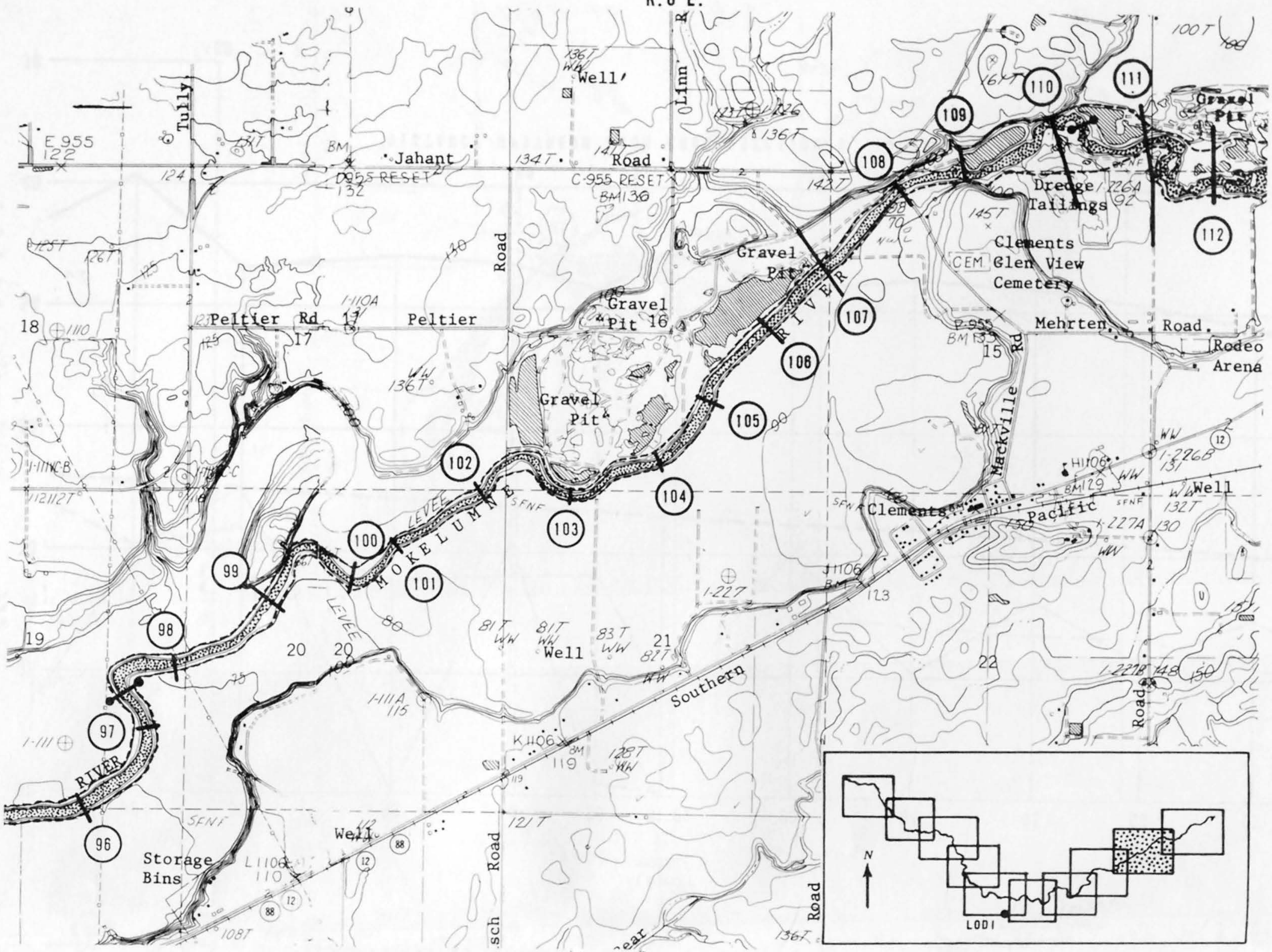

CENTRAL CALIFORNIA TRACTION BRIDGE
63
64
65
66
67
67.5
68
69
70
71
72
80
70
60
50
40
30
20
110
115
120
125
ELEVATION, IN FEET
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET

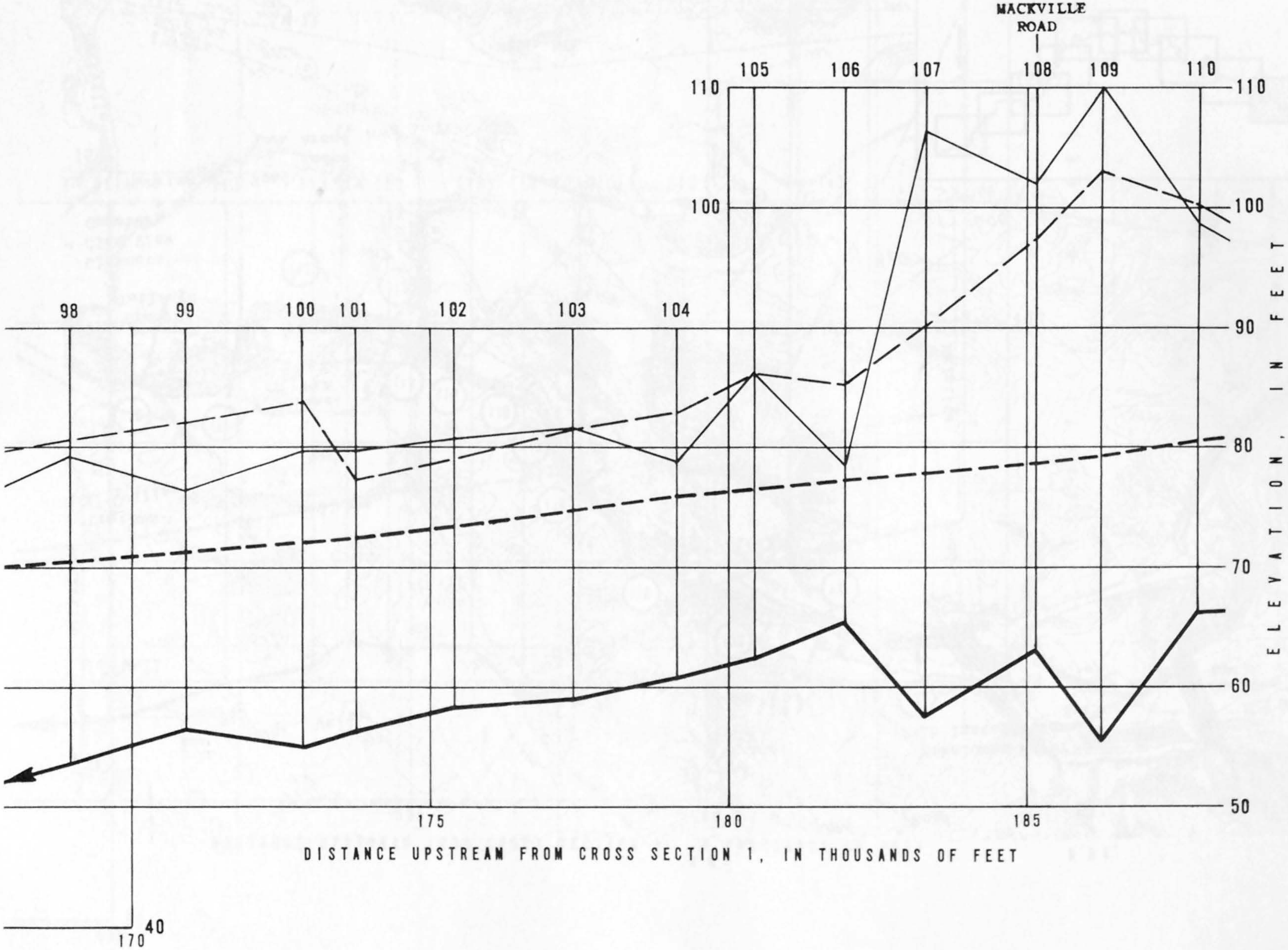

R.7 E.
T.4 N.
T.3 N.
Orchard
Road
Woodbridge
Road
Buck
RIVER
Bruella
Storage Bins
Schmeidt
Road
Gaging Station
Cherry
Road
Pumping Station
Aqueduct
Locke
Landing Strip
Harmony Grove Cem
CEM
Substation
Road
Kroll Road
Footbridge
Well
Victor
Pacific
Alpine Road
Tree
Road
Aqueduct
Well
LODI
N
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
85
86
87
88

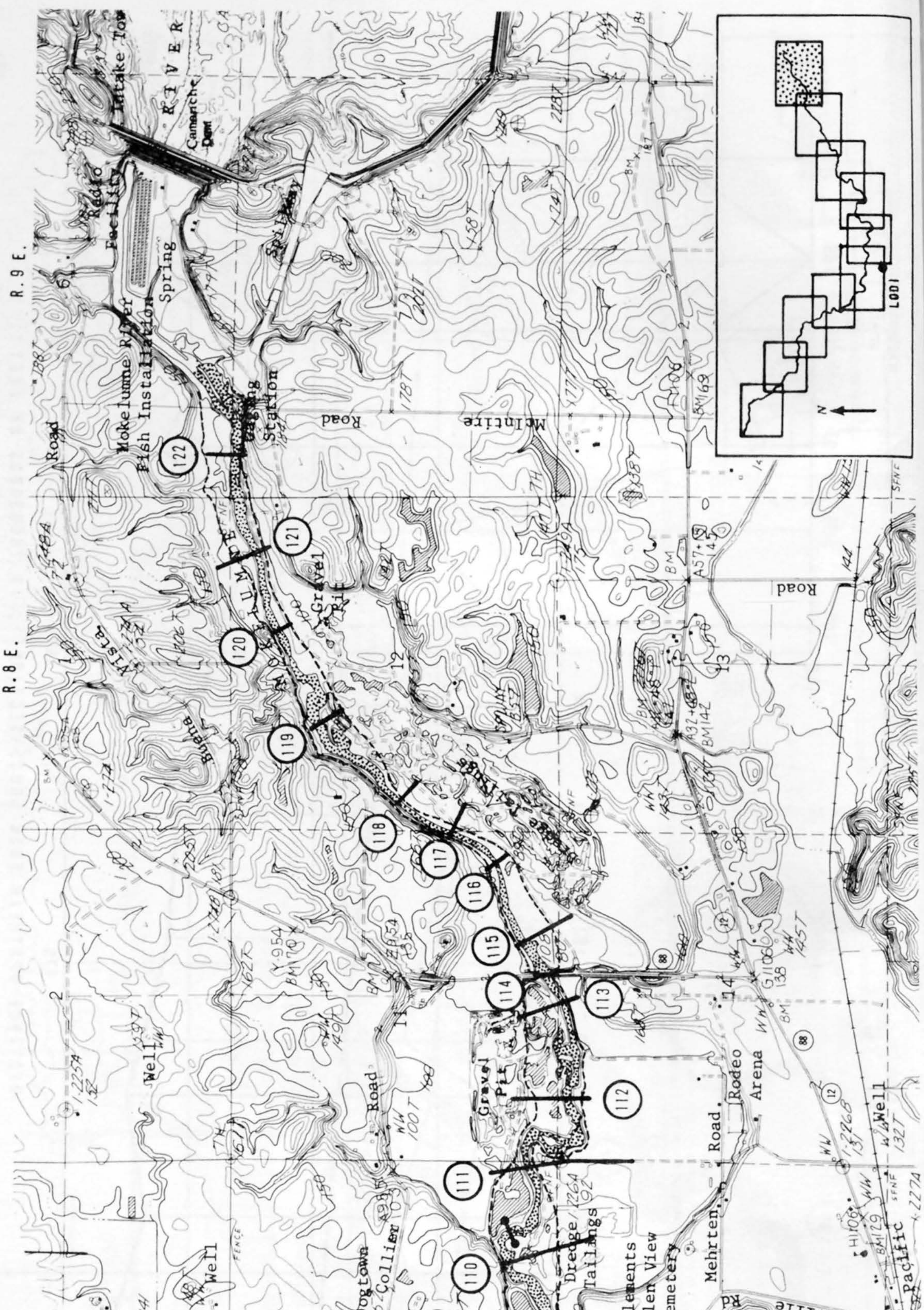

BRUELLA ROAD
73
74
75 76
77
78
79 80
81
82
83
84
85
90
80
70
60
50
40
30
130
135
140
145
ELEVATION, IN FEET
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET

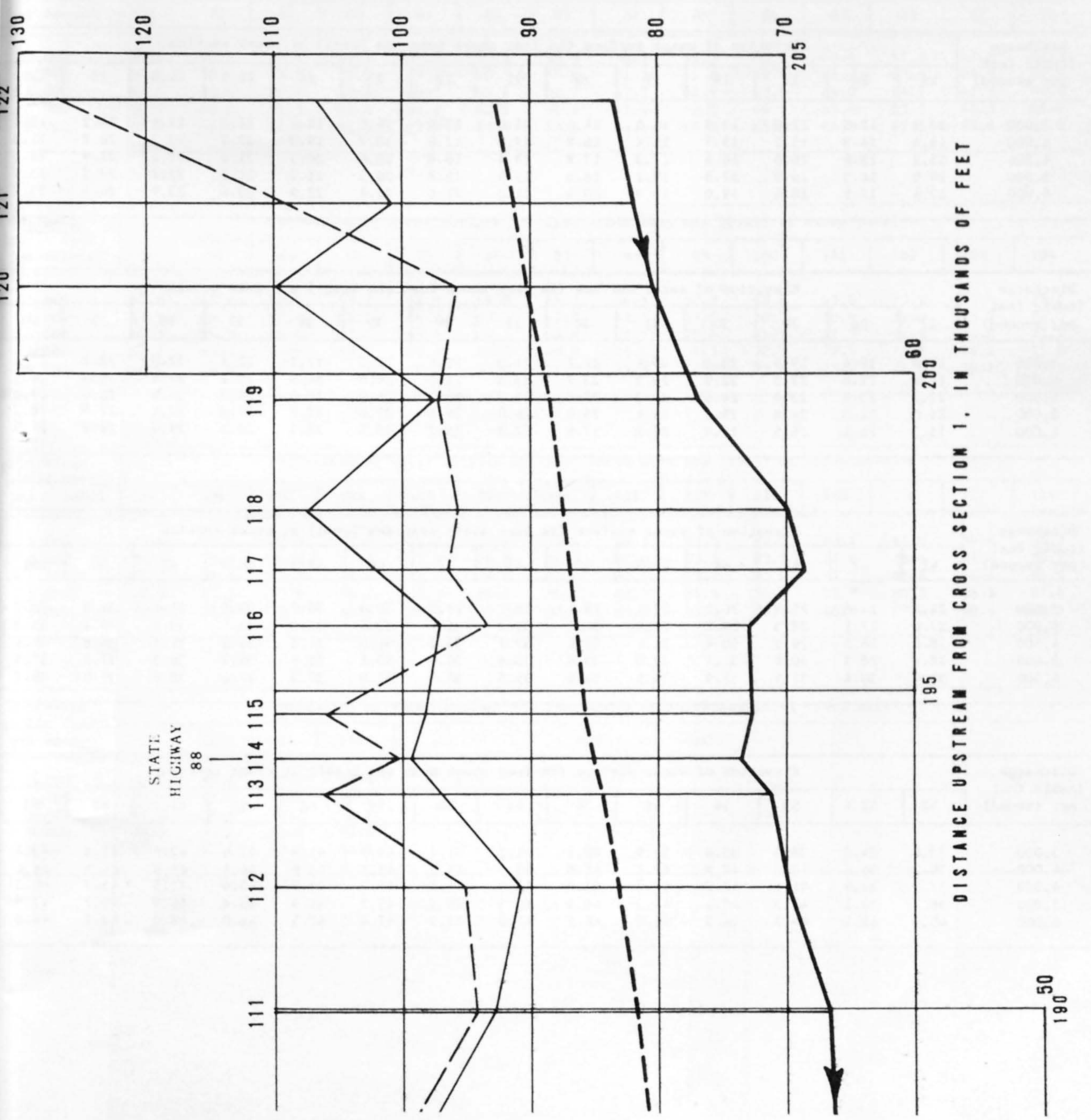

R.7 E.
R.8 E.
Well
19
20
23
24
Road
Elliott
MOKELUMNE
RIVER
Locke
Cem
Road
Tretheway
25
26
Footbridge
Well
Storage
Bins
M 1106
102
30
29
Pacific
LOCKEFORD
Corral
ridge
Road
Pumping
Station
35
Road
Southern
36
Locke
Aqueduct
Industrial
Waste Ponds
Landing
Strip
Harmony Grove
Cem
CEM
LODI
N
80
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99


ELLIOTT
ROAD
86
87
88
89
90
91
92
93
94
95
96
97
90
80
70
60
50
40
30
ELEVATION, IN FEET
150
155
160
165
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET


R. 8 E.
MOKELUMNE RIVER
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
Gravel Pit
Dredge Tailings
Clements Glen View Cemetery
CEM
Mehrten Road
Rodeo Arena
Clements
Mackville Rd
Southern Pacific
Peltier Rd
Peltier
Jahant Road
Linn Road
Tully
Well
Storage Bins
LEVEE
LODI
N


MACKVILLE ROAD
98
99
100
101
102
103
104
105
106
107
108
109
110
110
100
90
80
70
60
50
40
170
175
180
185
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET
ELEVATION, IN FEET


R. 8 E.
R. 9 E.
110
111
112
113
114
115
116
117
118
119
120
121
122
Mokelumne River Fish Installation
Camanche Dam
Spillway
Spring
Station
Road
McIntire Road
Gravel Pit
Buena Vista Road
Dredge Tailings
Dogtown
Collier
Clements
Glen View Cemetery
Mehrten
Road
Rodeo Arena
Well
Mackville Rd
Pacific
LODI
N


ELEVATION, IN FEET
130
120
110
100
90
80
70
60
50
DISTANCE UPSTREAM FROM CROSS SECTION 1, IN THOUSANDS OF FEET
190
195
200
205
STATE HIGHWAY 88
111
112
113
114
115
116
117
118
119
120
121
122

APPENDIX B

Elevation of water surface at cross sections 1-122 for minimum measured backwater conditions

(Location of cross sections shown in appendix A)

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
3,000	6.9	7.1	7.3	7.6	8.0	8.3	8.6	9.1	9.4	9.8	10.2	10.4	10.9	11.5
4,000	8.8	9.0	9.2	9.5	9.9	10.3	10.6	11.0	11.3	11.7	12.2	12.4	13.0	13.7
4,500	9.2	9.4	9.7	10.0	10.4	10.8	11.2	11.5	11.8	12.4	12.8	13.1	13.8	14.5
5,000	9.5	9.7	10.0	10.3	10.9	11.3	11.7	12.0	12.4	13.0	13.5	13.8	14.5	15.3
6,000	10.0	10.2	10.6	11.0	11.8	12.2	12.6	13.0	13.4	14.1	14.6	15.0	15.8	16.7

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	15	16	17	18	19	20	21	22	23	24	24.5	24.8	25	26
3,000	12.1	12.5	12.8	13.3	14.0	14.6	15.0	15.4	16.0	16.7	17.3	17.6	18.2	18.6
4,000	14.4	14.8	15.2	15.7	16.4	16.9	17.5	17.9	18.7	19.3	20.0	20.2	20.8	21.3
4,500	15.2	15.6	16.0	16.6	17.3	17.8	18.4	18.8	19.6	20.3	21.0	21.2	21.9	22.4
5,000	16.0	16.5	16.9	17.5	18.2	18.8	19.4	19.8	20.5	21.2	21.9	22.2	22.9	23.5
6,000	17.4	17.9	18.4	19.0	19.8	20.4	21.0	21.4	22.1	22.9	23.6	23.9	24.8	25.3

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	27	28	29	30	31	32	33	34	35	36	37	38	39	40
3,000	19.0	19.4	19.9	20.3	20.6	21.1	21.3	21.6	22.2	22.2	22.4	22.8	23.2	23.6
4,000	21.6	22.0	22.5	22.9	23.2	23.7	23.8	24.2	24.8	24.9	25.2	25.4	25.8	26.1
4,500	22.8	23.2	23.6	24.0	24.3	24.8	25.0	25.3	25.9	26.0	26.3	26.6	26.9	27.2
5,000	24.0	24.3	24.8	25.1	25.4	25.9	26.0	26.4	27.0	27.0	27.3	27.6	27.8	28.1
6,000	25.7	26.1	26.5	26.8	27.2	27.6	27.8	28.2	28.8	28.9	29.2	29.4	29.7	29.9

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	41	42	43	44	44.5	45	46	47	48	48.5	48.7	49	50	51
3,000	24.7	24.8	25.9	26.5	27.1	28.1	28.7	29.2	30.0	30.2	30.5	31.1	31.8	32.7
4,000	27.0	27.1	28.3	29.0	29.6	30.6	31.2	31.7	32.6	32.8	33.1	33.7	34.4	35.3
4,500	28.0	28.0	29.5	30.4	31.1	32.0	32.7	33.2	34.0	34.2	34.5	35.1	35.8	36.6
5,000	28.8	28.9	30.4	31.4	32.0	33.0	33.8	34.4	35.2	35.4	35.7	36.3	37.0	37.8
6,000	30.4	30.4	31.9	32.9	33.5	34.6	35.5	36.1	37.0	37.3	37.6	38.2	39.0	39.8

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	52	52.4	53	54	55	56	57	58	59	60	61	61.1	62	63
3,000	33.6	34.2	38.0	38.6	39.9	40.7	41.2	41.2	41.7	41.9	42.5	42.5	42.8	43.4
4,000	36.2	36.6	40.3	40.9	42.1	42.8	43.3	43.3	43.7	43.9	44.5	44.5	44.7	45.4
4,500	37.5	37.9	41.4	42.0	43.2	43.8	44.3	44.3	44.7	44.9	45.4	45.5	45.7	46.3
5,000	38.7	39.1	42.5	43.1	44.3	44.9	45.3	45.3	45.7	45.9	46.4	46.5	46.7	47.3
6,000	40.8	41.1	44.2	44.8	46.0	46.5	47.0	47.0	47.4	47.5	48.0	48.0	48.2	48.8

APPENDIX B--Continued

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	64	65	66	67	67.5	68	69	70	71	72	73	74	75	76
3,000	44.4	45.2	47.0	47.2	47.7	48.3	48.9	49.5	50.0	50.5	51.6	53.4	54.5	54.6
4,000	46.3	47.1	49.0	49.2	49.7	50.3	50.9	51.5	52.0	52.4	53.6	55.5	56.7	56.8
4,500	47.2	48.0	49.9	50.1	50.7	51.3	51.8	52.4	52.9	53.5	54.9	56.6	57.7	57.8
5,000	48.1	48.8	50.7	51.0	51.6	52.1	52.7	53.4	53.9	54.4	55.7	57.4	58.5	58.6
6,000	49.5	50.2	52.2	52.5	53.0	53.5	54.0	54.7	55.1	55.6	57.0	58.6	59.8	59.9

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	77	78	79	80	81	82	83	84	85	86	87	88	89	90
3,000	55.7	56.2	57.2	57.3	57.4	57.9	58.3	58.8	59.5	60.1	60.6	61.3	61.8	62.3
4,000	57.9	58.4	59.5	59.6	59.7	60.3	60.6	61.1	61.8	62.4	62.9	63.6	64.3	64.7
4,500	58.9	59.4	60.5	60.6	60.7	61.4	61.7	62.2	62.9	63.5	64.0	64.7	65.3	65.8
5,000	59.7	60.2	61.3	61.4	61.6	62.3	62.7	63.1	63.9	64.5	65.0	65.8	66.3	66.7
6,000	61.0	61.5	62.6	62.6	62.6	63.4	63.8	64.4	65.2	65.8	66.3	67.1	67.6	68.0

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	91	92	93	94	95	96	97	98	99	100	101	102	103	104
3,000	62.8	62.9	63.2	63.7	64.4	65.0	65.7	66.5	67.3	68.4	69.0	70.1	71.4	72.5
4,000	65.1	65.3	65.6	66.1	66.7	67.3	67.9	68.7	69.5	70.4	70.9	72.0	73.2	74.3
4,500	66.2	66.3	66.6	67.1	67.7	68.3	68.9	69.7	70.4	71.2	71.7	72.8	74.0	75.1
5,000	67.1	67.2	67.6	68.1	68.7	69.2	69.8	70.6	71.3	72.1	72.5	73.5	74.7	75.8
6,000	68.4	68.5	68.9	69.4	70.0	70.6	71.2	72.0	72.7	73.4	73.9	74.8	76.1	77.2

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	105	106	107	108	109	110	111	112	113	114	115	116	117	118
3,000	73.4	74.3	75.0	75.7	76.3	77.3	78.6	80.5	82.0	82.7	83.4	84.0	84.4	84.7
4,000	75.1	75.8	76.5	77.3	77.9	79.0	80.3	82.0	83.2	83.9	84.6	85.4	85.8	86.2
4,500	75.8	76.5	77.2	78.0	78.6	79.8	81.0	82.5	83.7	84.4	85.2	85.9	86.4	86.8
5,000	76.5	77.2	77.9	78.7	79.3	80.5	81.7	83.1	84.3	85.0	85.7	86.5	86.9	87.4
6,000	77.9	78.7	79.4	80.2	80.8	82.0	83.1	84.3	85.3	86.1	86.8	87.6	88.0	88.5

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section			
	119	120	121	122
3,000	85.6	87.8	88.8	90.4
4,000	87.2	89.1	90.2	91.6
4,500	87.8	89.6	90.7	92.1
5,000	88.4	90.2	91.2	92.6
6,000	89.5	91.1	92.1	93.4

APPENDIX C

Elevation of water surface at cross sections 1-35, for maximum measured backwater conditions measured at cross section 1

(Location of cross sections shown in appendix A)

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2,000	15.6	15.6	15.6	15.6	15.6	15.6	15.7	15.8	15.8	15.8	15.8	15.8	15.8	15.9
3,000	15.6	15.6	15.6	15.7	15.8	15.8	15.8	15.9	15.9	16.0	16.1	16.2	16.3	16.5
4,000	15.6	15.7	15.8	15.8	15.9	16.0	16.1	16.2	16.3	16.4	16.6	16.7	17.0	17.3
5,000	15.7	15.8	15.8	15.9	16.1	16.2	16.3	16.5	16.6	16.9	17.1	17.2	17.6	18.1

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section													
	15	16	17	18	19	20	21	22	23	24	24.5	24.8	25	26
2,000	16.0	16.1	16.2	16.3	16.4	16.6	16.8	16.9	17.1	17.3	17.6	17.8	18.0	18.2
3,000	16.7	16.8	17.0	17.2	17.5	17.8	18.0	18.2	18.6	19.0	19.4	19.6	20.0	20.2
4,000	17.6	17.8	18.0	18.3	18.8	19.1	19.4	19.7	20.2	20.7	21.2	21.4	21.9	22.3
5,000	18.5	18.8	19.1	19.5	20.0	20.4	20.8	21.1	21.7	22.2	22.8	23.1	23.8	24.3

Discharge (cubic feet per second)	Elevation of water surface (in feet above mean sea level) at cross section								
	27	28	29	30	31	32	33	34	35
2,000	18.4	18.6	18.9	19.1	19.3	19.6	19.8	20.0	20.3
3,000	20.5	20.8	21.2	21.5	21.8	22.1	22.2	22.6	23.0
4,000	22.6	22.9	23.3	23.7	23.9	24.3	24.5	24.8	25.3
5,000	24.7	25.0	25.4	25.7	26.0	26.4	26.5	26.9	27.3

APPENDIX D

Elevations of ground and top of levees

[In leveed areas, the ground elevation listed is the elevation of natural ground on the shoreward side of the levee. In unleveed areas, the ground elevation listed indicates the elevation of the land surface adjacent to the main channel]

(Location of cross sections shown in appendix A)

Cross section number	Distance upstream from cross section 1 (feet)	Elevation, in feet, above mean sea level			
		Left bank		Right bank	
		Top of levee	Ground elevation	Top of levee	Ground elevation
1	0	24.8	-	-	8.5
2	650	21.7	9.0	-	11.8
3	1,640	23.3	9.0	-	16.1
4	2,540	22.3	-	22.2	-
5	3,475	23.5	7.0	17.0	-
6	4,500	22.1	8.0	17.3	-
7	5,435	24.1	8.6	18.7	-
8	6,825	22.7	10.3	17.2	-
9	7,915	23.3	15.0	18.8	-
10	9,155	23.6	11.5	20.4	-
11	10,530	24.0	10.7	18.6	11.8
12	11,125	25.3	-	25.4	-
13	12,115	24.1	11.1	18.2	11.9
14	13,205	25.0	11.9	18.3	12.0
15	14,310	25.0	13.0	18.1	14.1
16	15,400	24.7	13.2	17.8	12.0
17	16,235	24.5	16.7	18.5	13.2
18	17,405	25.8	13.8	18.6	14.0
19	18,885	25.4	14.1	22.9	14.9
20	20,255	25.4	14.2	20.6	16.6
21	21,525	26.0	16.0	21.6	15.5
22	22,605	26.4	16.4	22.1	17.9
23	24,475	27.2	16.6	21.7	17.3
24	26,305	26.5	18.0	25.7	18.6
24.5	27,985	25.7	19.0	24.7	21.1
24.8	28,835	26.9	19.0	24.7	17.8
25	30,635	28.1	19.7	27.4	24.7
26	32,355	29.0	21.7	28.1	21.2
27	33,960	29.5	21.0	30.0	21.8
28	35,535	32.1	23.1	31.3	27.0

Cross section number	Distance upstream from cross section 1 (feet)	Elevation, in feet, above mean sea level			
		Left bank		Right bank	
		Top of levee	Ground elevation	Top of levee	Ground elevation
29	37,275	31.1	24.8	a24.2	21.2
30	38,535	31.0	25.0	a31.1	-
31	39,840	32.0	25.0	a27.2	25.0
32	41,445	32.4	26.4	a26.4	-
33	42,055	30.9	26.8	a29.0	-
34	43,410	31.8	28.0	a28.0	-
35	45,130	-	28.9	32.4	30.3
36	46,260	33.4	29.4	30.7	25.3
37	47,440	34.7	27.3	28.5	26.7
38	49,010	35.4	30.0	a27.0	-
39	50,390	35.9	31.6	a28.2	-
40	51,570	36.0	31.8	a30.2	-
41	53,490	37.1	34.3	a33.2	-
42	53,590	37.9	-	38.3	-
43	57,040	39.4	35.2	a30.5	29.2
44	58,690	40.0	33.2	38.2	-
44.5	60,640	39.9	-	38.5	30.0
45	64,360	41.5	36.8	a35.2	32.0
46	66,040	42.3	36.8	a34.0	31.7
47	67,235	42.8	37.0	a34.8	33.8
48	69,670	43.4	34.0	a37.0	32.0
48.5	70,100	a36.3	-	a36.8	32.2
48.7	71,100	a35.5	-	a38.1	29.5
49	72,780	44.2	35.0	38.8	35.0
50	75,130	a38.2	34.3	44.3	36.6
51	76,950	a41.2	36.2	42.0	36.8
52	78,990	51.6	-	51.4	-
52.4	79,415	46.5	-	48.0	-
53	91,775	53.4	49.1	a43.5	40.0
54	93,625	a52.0	-	a44.6	41.2

See footnote at end of appendix.

APPENDIX D--Continued

Cross section number	Distance upstream from cross section 1 (feet)	Elevation, in feet, above mean sea level				Cross section number	Distance upstream from cross section 1 (feet)	Elevation, in feet, above mean sea level			
		Left bank		Right bank				Left bank		Right bank	
		Top of levee	Ground elevation	Top of levee	Ground elevation			Top of levee	Ground elevation	Top of levee	Ground elevation
55	96,865	a44.8	43.2	a48.0	-	88	152,975	72.5	63.3	a90.0	-
56	98,000	a45.7	45.0	46.1	41.2	89	154,920	72.0	63.5	a69.4	65.0
57	99,160	69.5	-	69.8	-	90	156,340	71.8	64.8	a89.0	-
58	99,230	a60.6	-	62.1	-	91	157,450	81.4	-	89.8	-
59	100,710	a54.7	-	41.8	41.5	92	157,750	81.2	-	a81.6	79.3
60	101,710	a55.0	-	a45.5	43.0	93	159,430	74.8	65.8	a70.0	67.7
61	103,110	61.4	-	61.3	-	94	161,540	76.0	68.2	a80.0	-
61.1	103,180	60.9	-	61.3	-	95	163,530	76.6	67.6	a74.0	70.0
62	104,115	a56.7	-	48.0	45.2	96	165,290	76.9	67.2	a78.6	70.5
63	106,210	a59.6	59.4	48.0	42.0	97	167,130	79.3	71.0	a75.2	73.8
64	107,850	48.6	44.0	50.0	44.2	98	168,950	80.7	71.8	79.3	72.1
65	109,075	a49.2	47.2	50.0	43.3	99	170,900	82.1	73.4	76.6	71.5
66	112,100	64.7	-	65.0	-	100	172,850	83.7	74.1	79.8	75.7
67	112,340	a63.5	-	53.1	-	101	173,720	a77.5	77.2	79.8	76.8
67.5	114,245	a49.5	46.7	54.7	46.2	102	175,400	a79.0	79.0	80.9	78.2
68	117,020	55.2	46.8	55.2	46.8	103	177,390	a81.6	80.3	a81.5	-
69	119,420	a61.5	-	57.5	45.0	104	179,110	a83.0	82.0	a78.8	78.4
70	121,885	a71.6	-	58.3	49.7	105	180,420	86.1	83.0	a86.1	-
71	123,685	a69.6	-	59.0	50.0	106	181,970	a85.3	84.5	a78.5	72.0
72	125,265	53.2	48.5	60.6	52.7	107	183,290	a87.6	84.7	a81.9	75.2
73	127,795	56.7	52.3	a53.5	52.3	108	185,120	97.3	-	102.1	-
74	130,235	57.3	48.3	a58.0	53.5	109	186,250	a103.0	-	a110.0	-
75	132,175	75.0	-	73.3	-	110	187,870	a100.4	-	a98.8	-
76	132,415	60.0	52.5	a74.0	-	111	189,980	a91.4	-	a87.3	81.7
77	134,865	61.1	53.5	a78.6	-	112	191,900	a95.1	-	a88.8	77.3
78	136,255	62.6	55.8	a61.5	50.0	113	193,360	a106.0	-	a97.2	-
79	138,525	a76.2	-	a60.9	56.8	114	193,930	100.1	-	99.2	-
80	138,800	a80.5	80.5	a61.2	53.0	115	194,610	a90.0	81.5	a98.3	97.6
81	139,975	a75.1	-	a61.3	58.0	116	196,030	a93.4	-	a97.0	-
82	142,040	63.5	53.0	a62.8	58.0	117	196,900	a96.4	-	a102.0	-
83	143,310	66.4	54.3	a62.8	62.8	118	197,820	a95.7	-	a107.6	-
84	144,550	68.2	59.0	a65.2	60.0	119	199,580	a97.1	-	a97.7	-
85	146,775	a65.1	-	a85.0	-	120	201,370	a95.9	-	a110.0	-
86	148,655	69.6	60.0	a70.0	-	121	202,660	a108.9	-	a100.8	-
87	150,430	68.4	59.1	a65.1	62.9	122	204,290	a127.1	-	a106.7	-

a. Indicates no levee.

APPENDIX E

Mean velocity at cross sections 1-122 for minimum measured backwater conditions

(Location of cross sections shown in appendix A)

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross section													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1,500	1.7	1.9	2.7	2.7	2.1	2.2	1.9	2.2	2.3	2.5	1.7	1.7	2.1	2.4
3,000	2.0	2.3	3.0	3.4	2.4	2.9	2.6	2.9	2.9	2.7	2.3	2.1	2.8	2.8
5,000	2.0	3.0	3.8	4.4	3.0	3.7	3.4	3.7	3.8	3.2	3.0	2.7	3.5	3.3

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross section													
	15	16	17	18	19	20	21	22	23	24	24.5	24.8	25	26
1,500	2.2	2.1	1.9	2.2	2.0	2.3	1.9	2.1	2.2	2.8	2.2	2.6	2.8	2.3
3,000	2.4	2.6	2.3	2.5	2.1	2.4	2.2	2.4	2.5	3.0	2.3	2.7	2.9	2.6
5,000	2.8	3.2	2.8	3.0	2.4	2.9	2.5	2.5	2.9	3.5	2.7	3.1	3.4	2.8

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross section													
	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1,500	1.7	2.0	2.1	2.1	2.4	2.1	2.3	2.0	2.8	2.1	1.5	2.2	1.6	2.7
3,000	2.0	2.2	2.2	2.1	2.7	2.4	2.7	2.4	2.7	2.5	1.5	2.2	1.5	3.0
5,000	2.1	2.3	2.3	2.3	3.0	2.5	3.1	2.7	2.9	2.9	1.6	1.8	1.6	2.1

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross section													
	41	42	43	44	44.5	45	46	47	48	48.5	48.7	49	50	51
1,500	1.9	1.6	2.5	2.0	1.8	2.1	2.1	2.4	1.2	1.6	2.1	1.5	1.8	2.1
3,000	2.1	1.8	3.0	2.5	2.1	2.5	2.5	2.9	1.3	1.9	2.6	1.9	2.2	2.4
5,000	2.3	2.0	3.5	2.7	1.9	2.9	2.9	3.3	1.4	2.2	2.9	2.0	2.4	2.8

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross section													
	52	52.4	53	54	55	56	57	58	59	60	61	61.1	62	63
1,500	1.9	-	2.3	1.9	2.1	2.5	0.8	1.8	1.1	2.1	2.0	1.8	2.1	2.4
3,000	2.1	5.1	2.9	2.7	2.5	2.4	1.1	2.0	1.4	2.4	2.3	2.2	2.7	2.8
5,000	2.4	3.9	3.0	3.1	2.7	2.5	1.3	2.2	1.6	2.6	2.2	2.0	3.1	2.8

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross section													
	64	65	66	67	67.5	68	69	70	71	72	73	74	75	76
1,500	2.5	2.4	2.6	2.2	2.3	2.3	2.6	2.0	2.1	2.1	2.1	2.1	2.2	2.5
3,000	2.7	2.7	3.0	2.3	2.5	2.6	2.4	2.6	2.7	2.9	2.7	2.3	2.7	2.9
5,000	2.9	3.1	3.6	2.3	2.6	2.6	2.6	2.9	2.6	3.3	2.9	2.5	3.0	3.2

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross section													
	77	78	79	80	81	82	83	84	85	86	87	88	89	90
1,500	1.8	1.9	1.9	2.2	2.2	1.8	2.1	2.2	2.0	1.9	2.1	2.1	1.9	2.5
3,000	2.2	2.3	2.2	2.6	2.4	2.5	2.6	2.2	2.3	2.3	2.4	2.2	2.5	2.7
5,000	2.3	2.6	2.7	3.1	3.1	2.8	2.8	3.1	2.4	2.6	2.4	2.8	2.1	2.8

APPENDIX F

Mean velocity at cross sections 1-35, for maximum measured backwater conditions at cross section 1

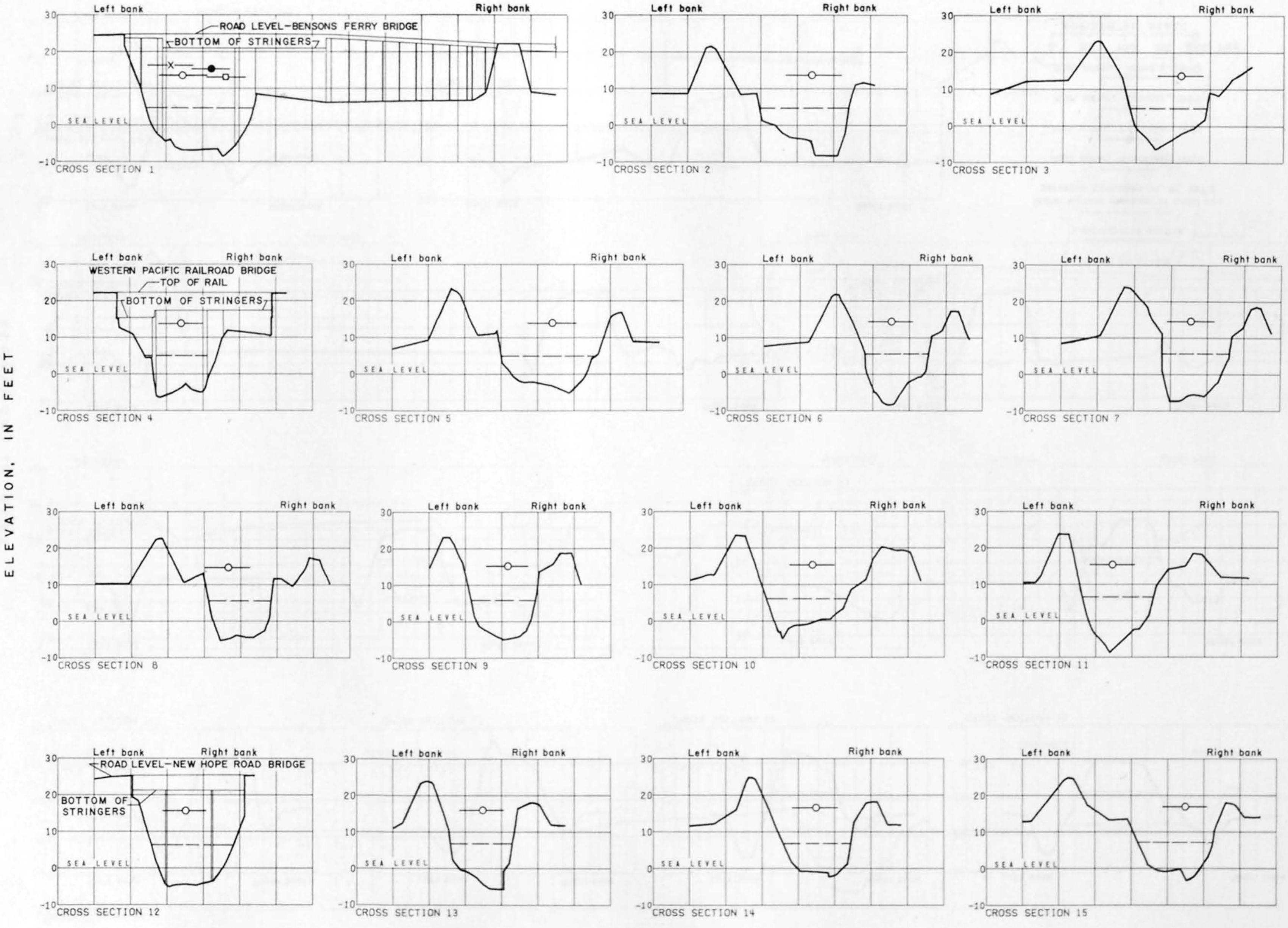
(Location of cross sections shown in appendix A)

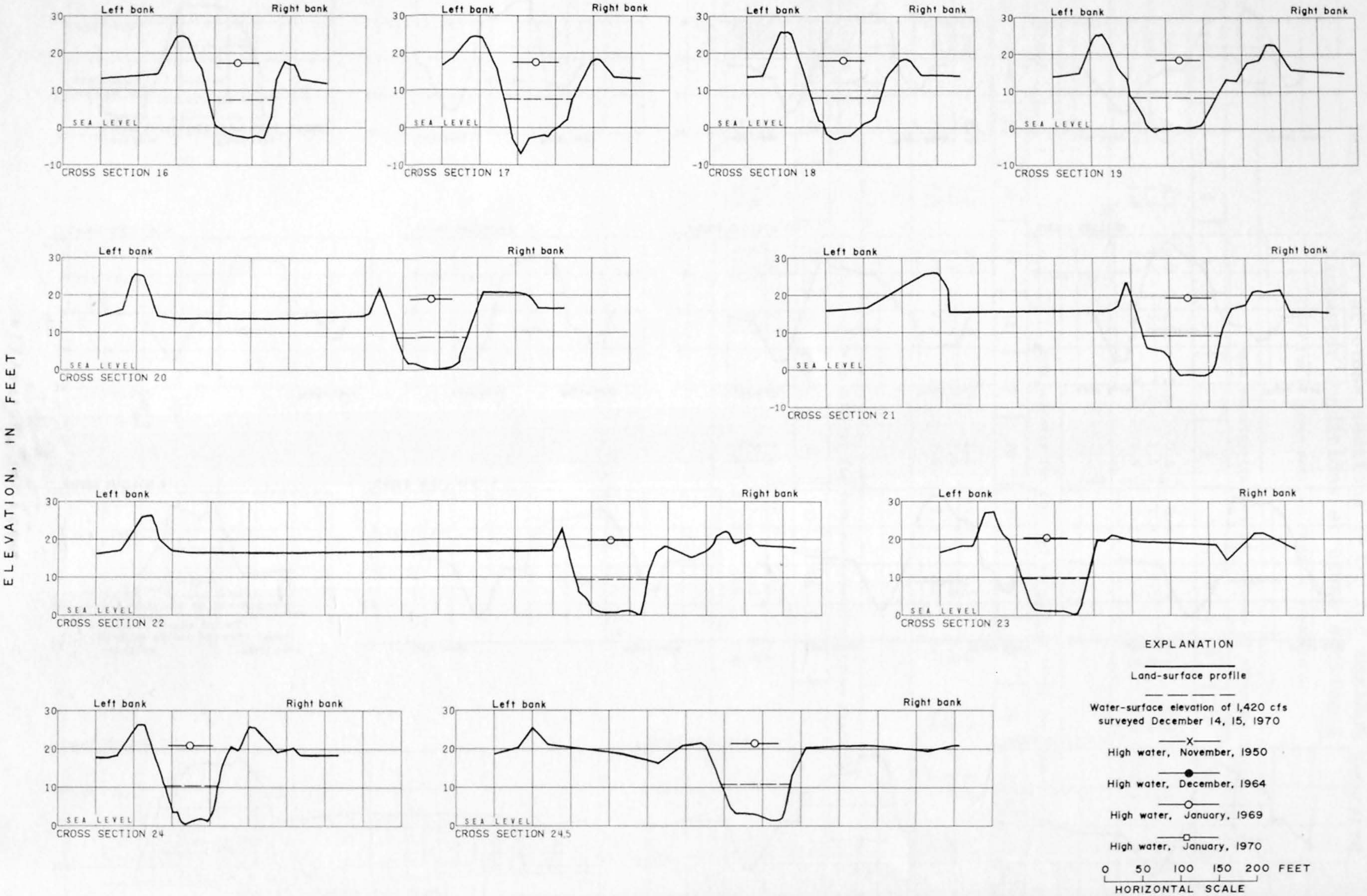
Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross sections													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1,500	0.3	0.5	0.7	0.8	0.6	0.8	0.8	0.8	0.9	0.8	0.8	0.7	1.0	1.0
3,000	.6	1.1	1.4	1.5	1.2	1.6	1.5	1.5	1.8	1.5	1.5	1.4	1.9	1.8
5,000	1.0	1.8	2.3	2.4	1.9	2.6	2.5	2.3	2.8	2.4	2.3	2.2	2.9	2.7

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross sections													
	15	16	17	18	19	20	21	22	23	24	24.5	24.8	25	26
1,500	0.8	1.0	0.9	1.0	0.9	1.1	1.0	1.1	1.2	1.5	1.2	1.4	1.6	1.4
3,000	1.5	1.9	1.7	1.8	1.5	1.9	1.7	1.8	2.0	2.5	2.0	2.3	2.6	2.2
5,000	2.2	2.8	2.4	2.5	2.0	2.6	2.3	2.2	2.7	3.2	2.5	2.7	3.2	2.7

Discharge (cubic feet per second)	Mean velocity (in feet per second) at cross sections								
	27	28	29	30	31	32	33	34	35
1,500	1.1	1.3	1.4	1.4	1.7	1.6	1.7	1.6	2.1
3,000	1.7	2.0	1.9	1.9	2.4	2.1	2.5	2.2	2.5
5,000	2.0	2.2	2.2	2.2	2.9	2.4	3.0	2.6	2.8

APPENDIX G.--Cross sections 1-222

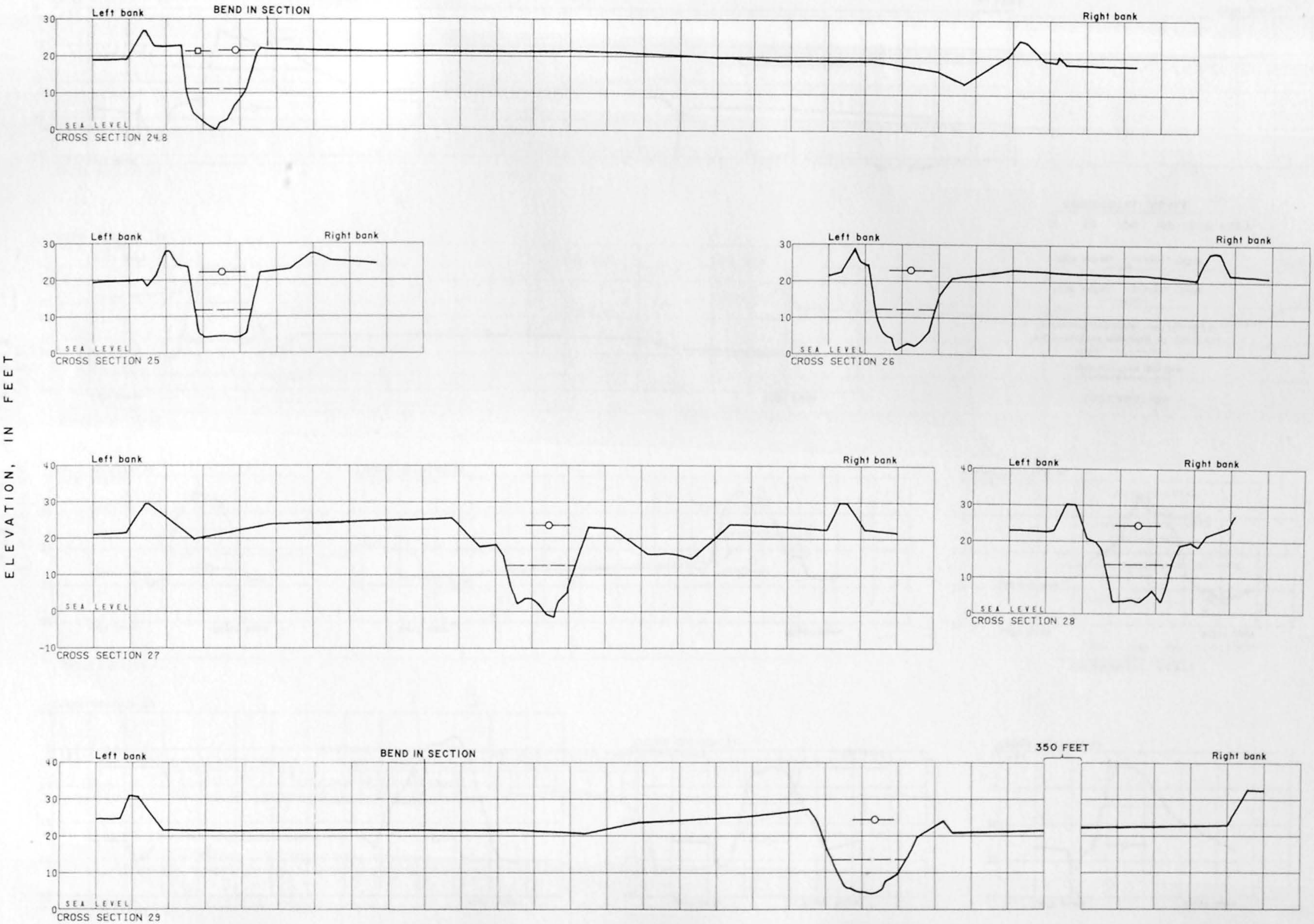


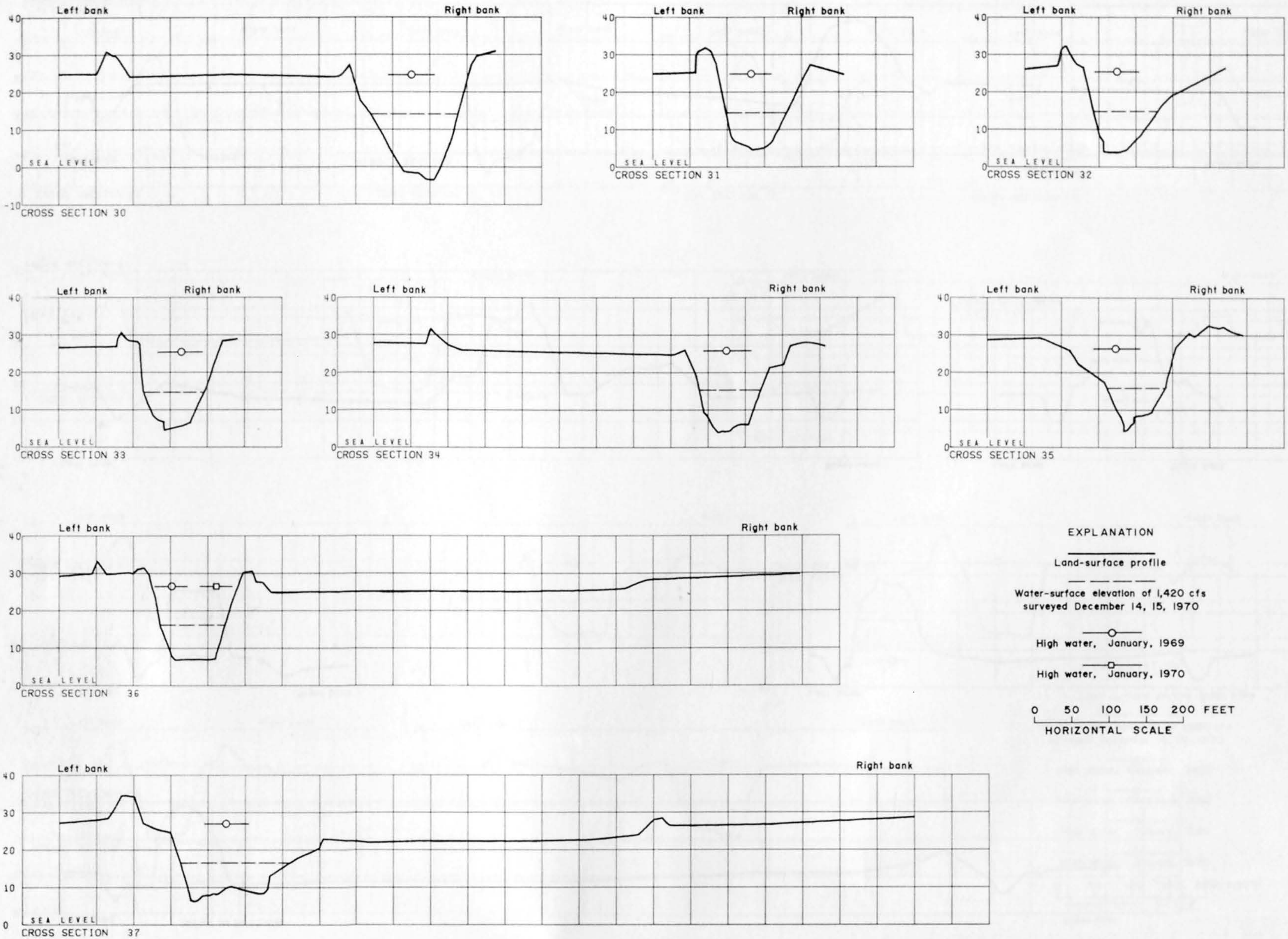


CHANNEL CAPACITY, MOKELUMNE RIVER, CALIFORNIA

CROSS SECTIONS 16-24.5

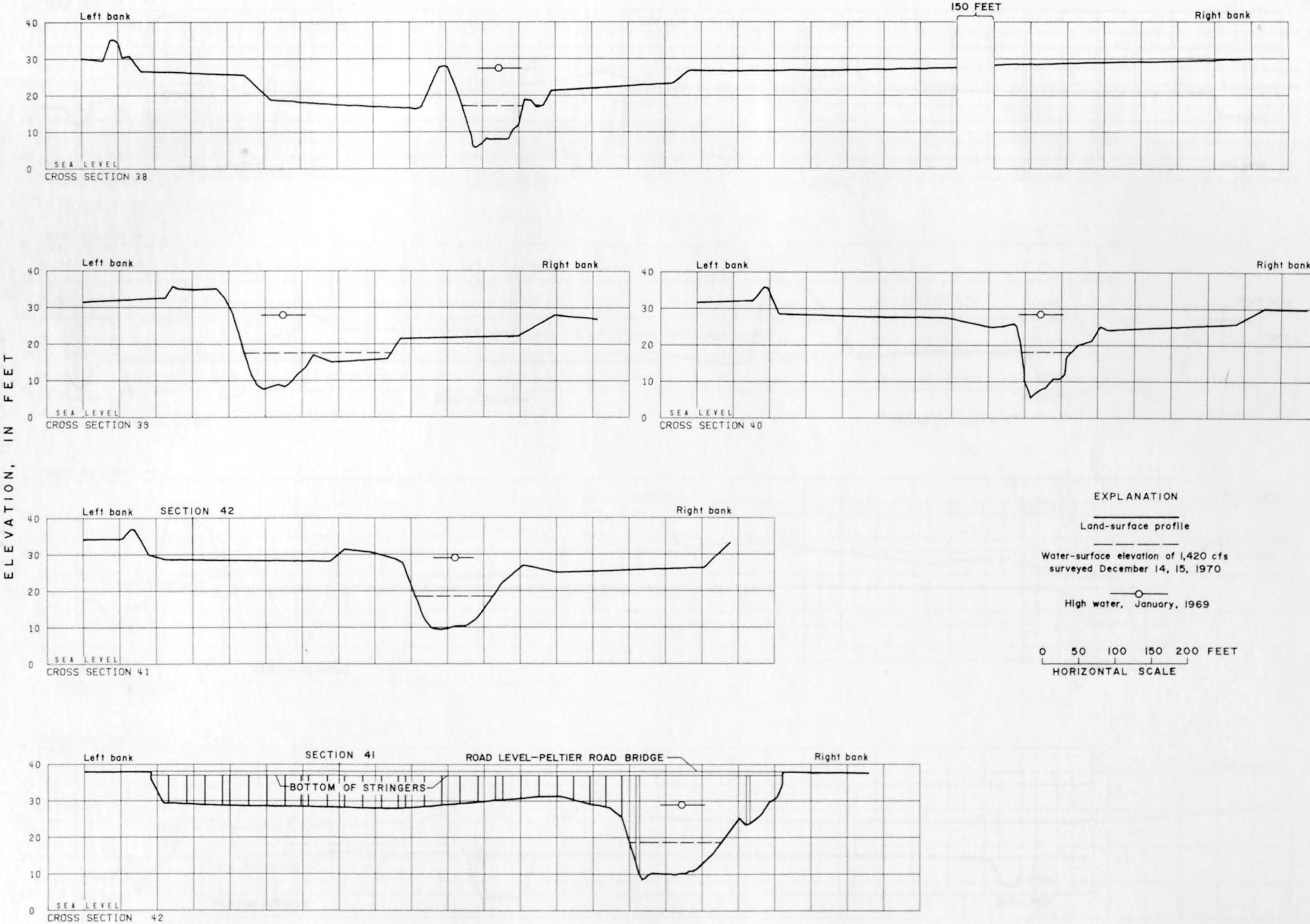
CROSS SECTIONS 24.8–29



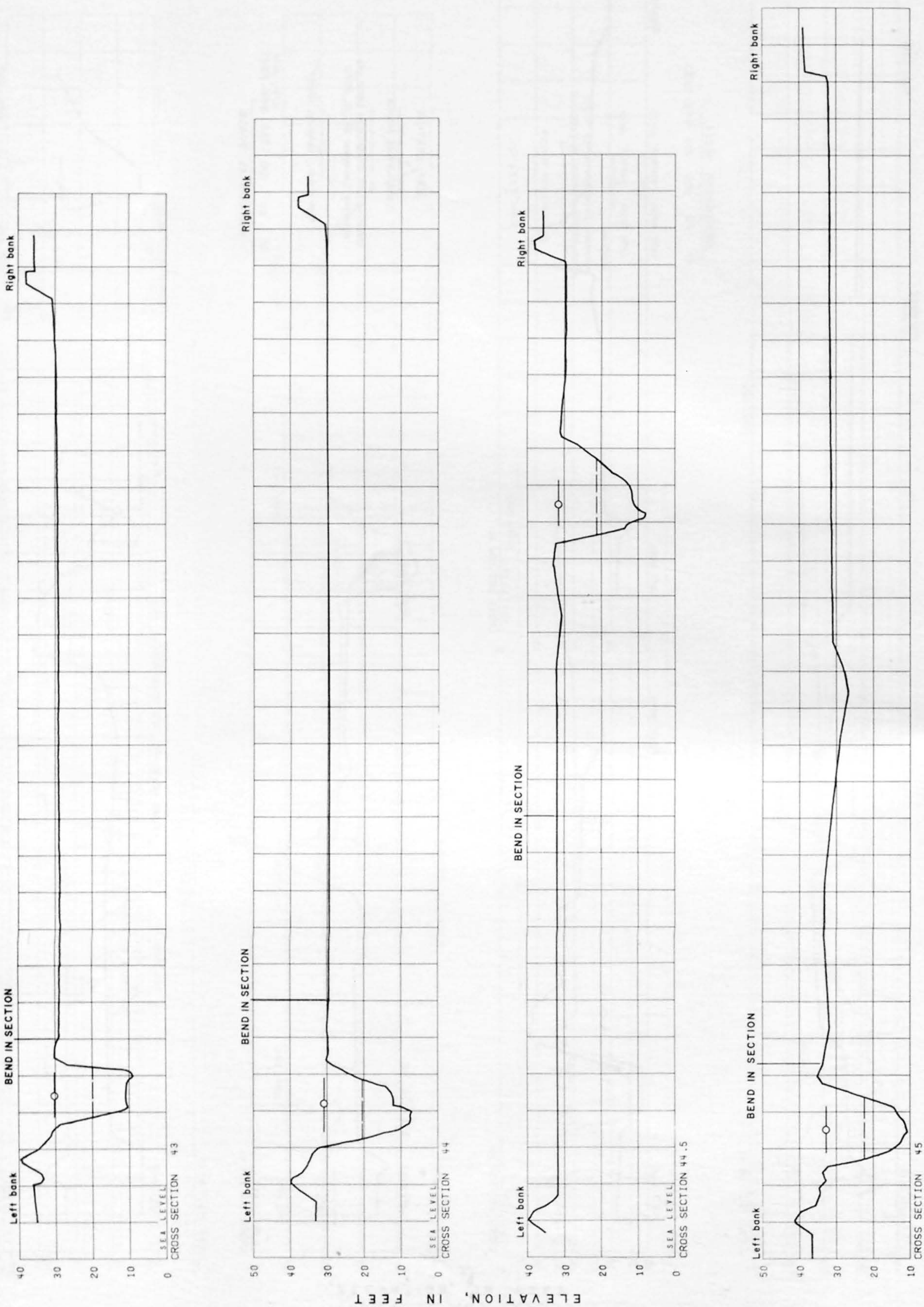


CROSS SECTIONS 30-37

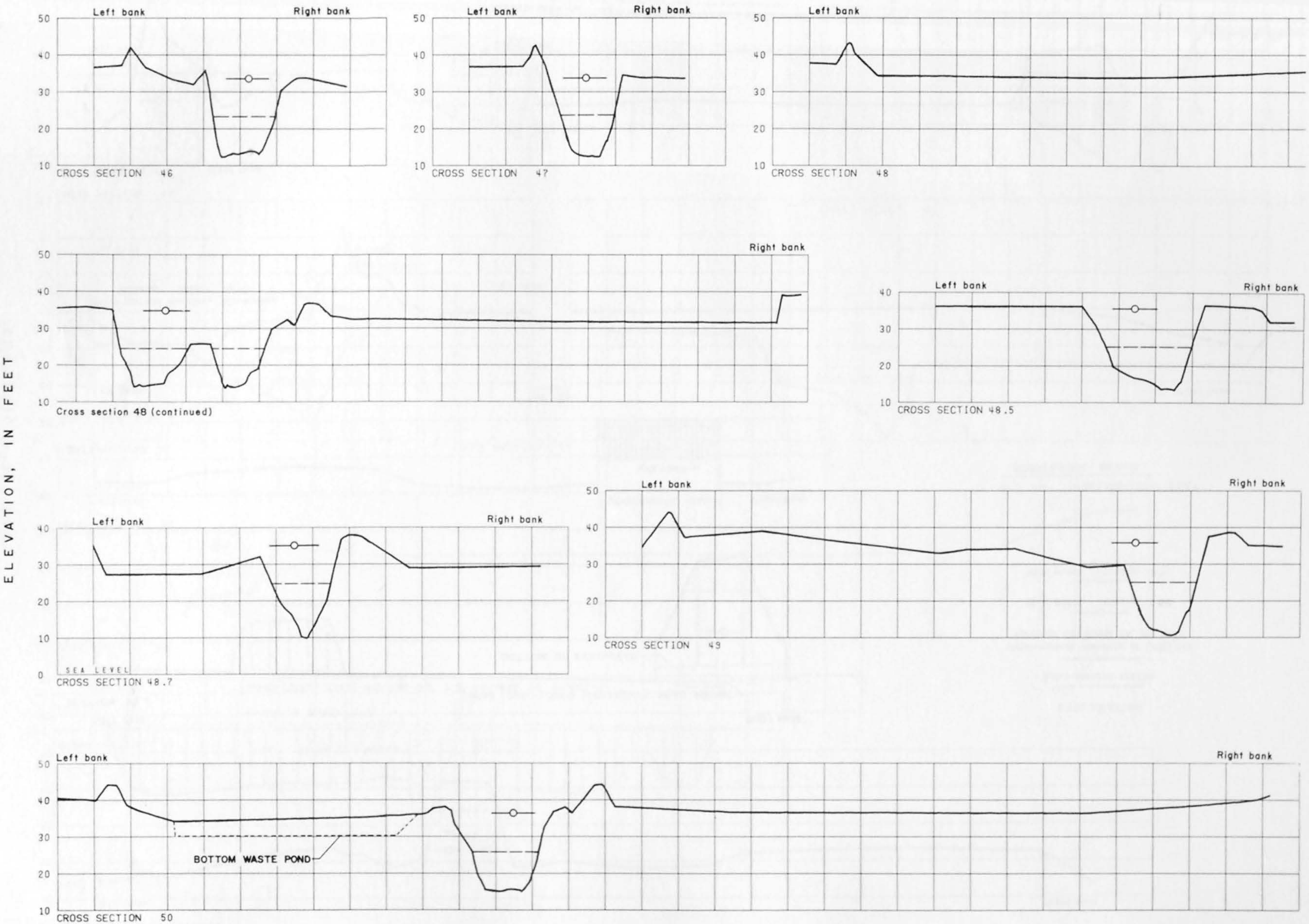
CROSS SECTIONS 38-42

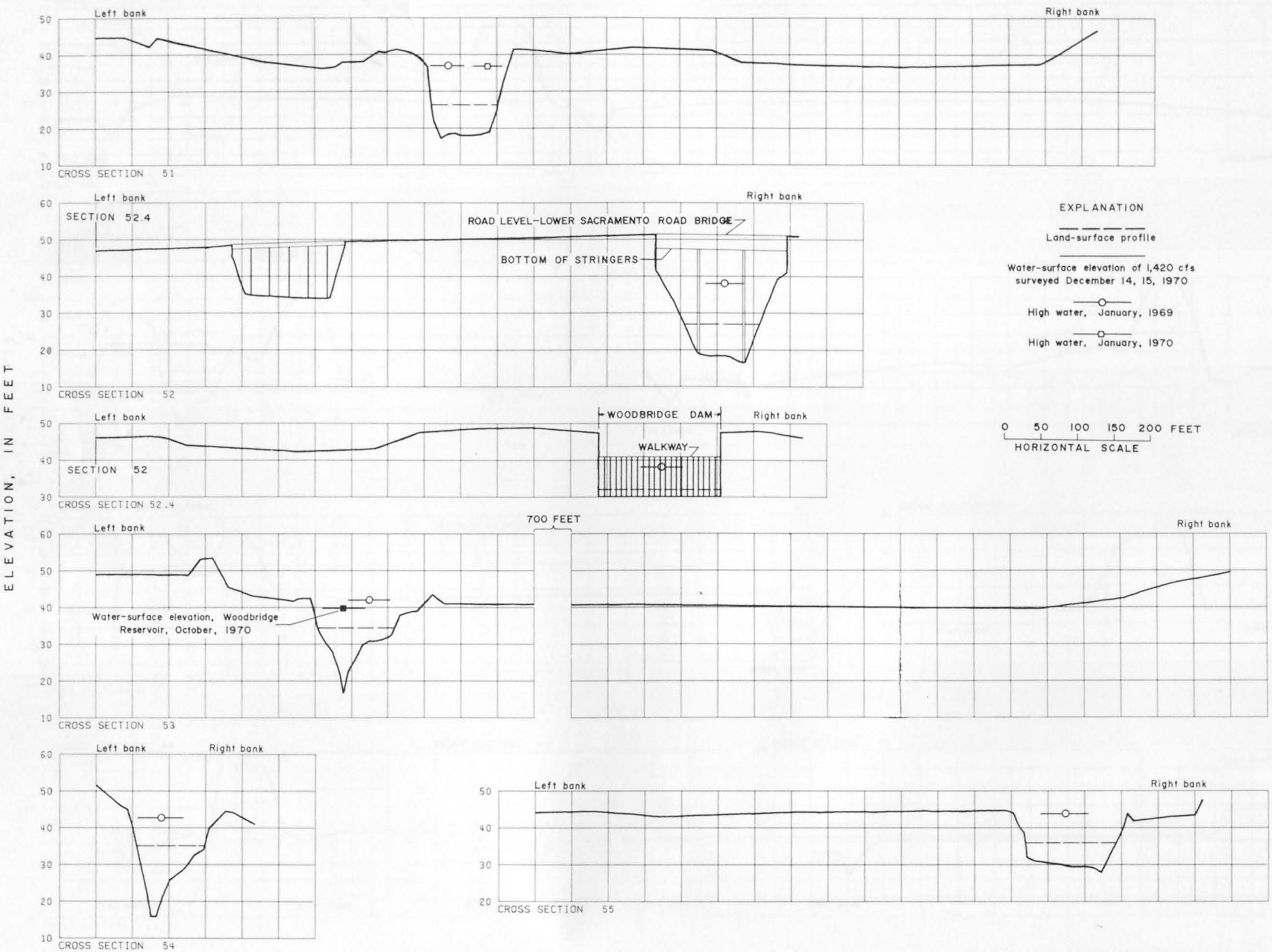


CROSS SECTIONS **43–45**

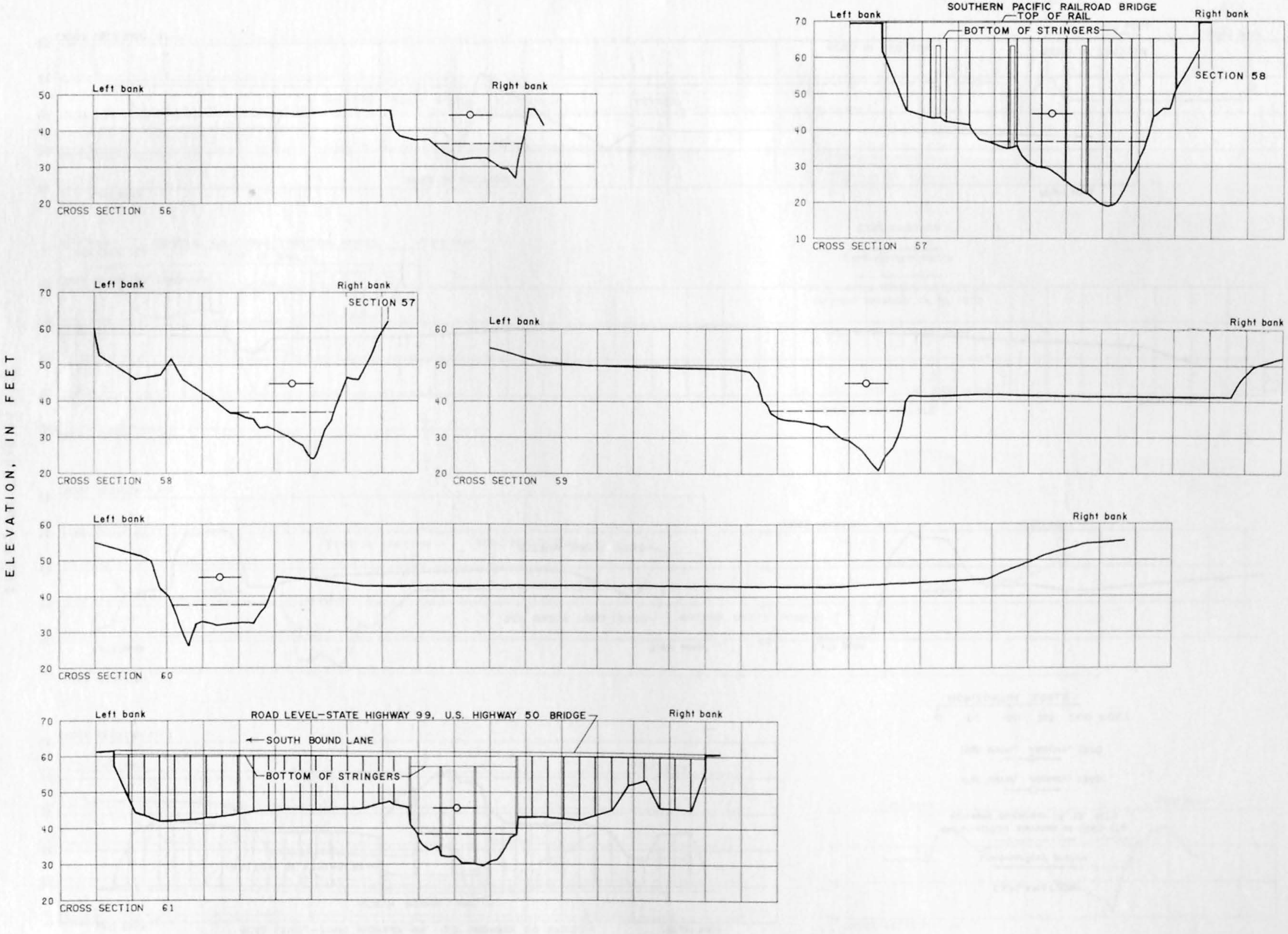


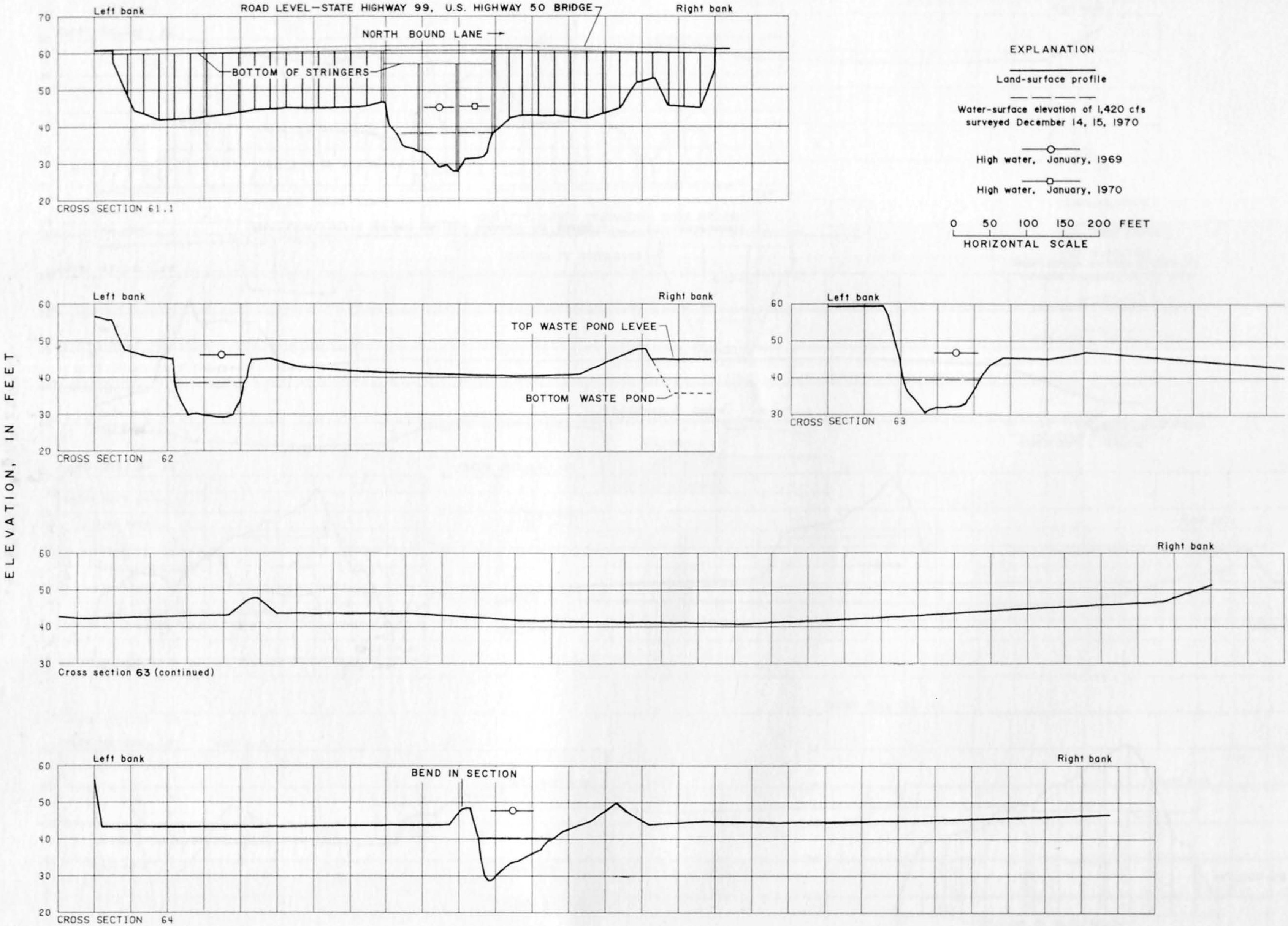
CROSS SECTIONS 46–50



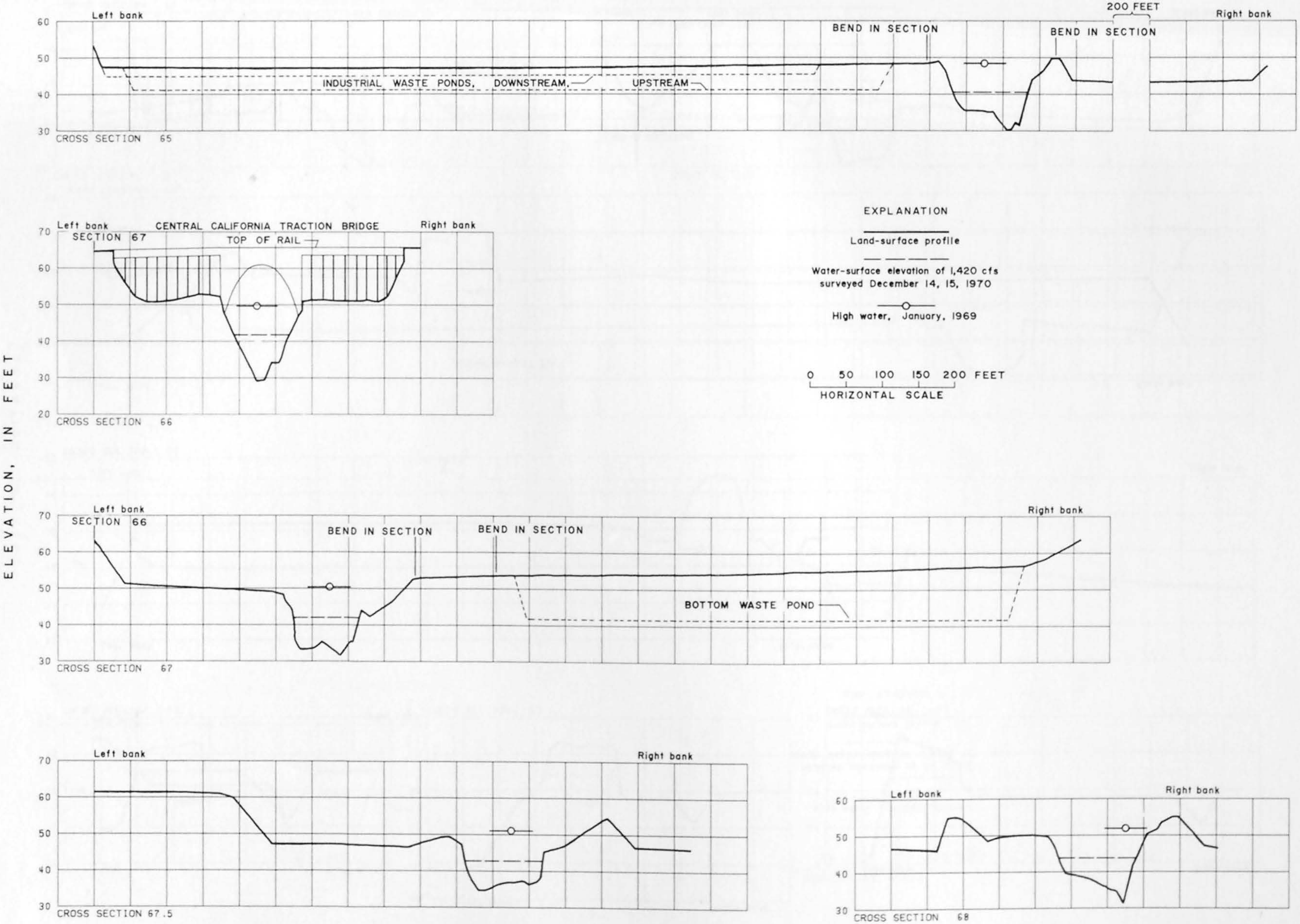


CROSS SECTIONS 51–55


ELEVATION, IN FEET
Left bank
Right bank
CROSS SECTION 56
SOUTHERN PACIFIC RAILROAD BRIDGE
TOP OF RAIL
BOTTOM OF STRINGERS
SECTION 58
CROSS SECTION 57
SECTION 57
CROSS SECTION 58
CROSS SECTION 59
CROSS SECTION 60
ROAD LEVEL–STATE HIGHWAY 99, U.S. HIGHWAY 50 BRIDGE
SOUTH BOUND LANE
BOTTOM OF STRINGERS
CROSS SECTION 61

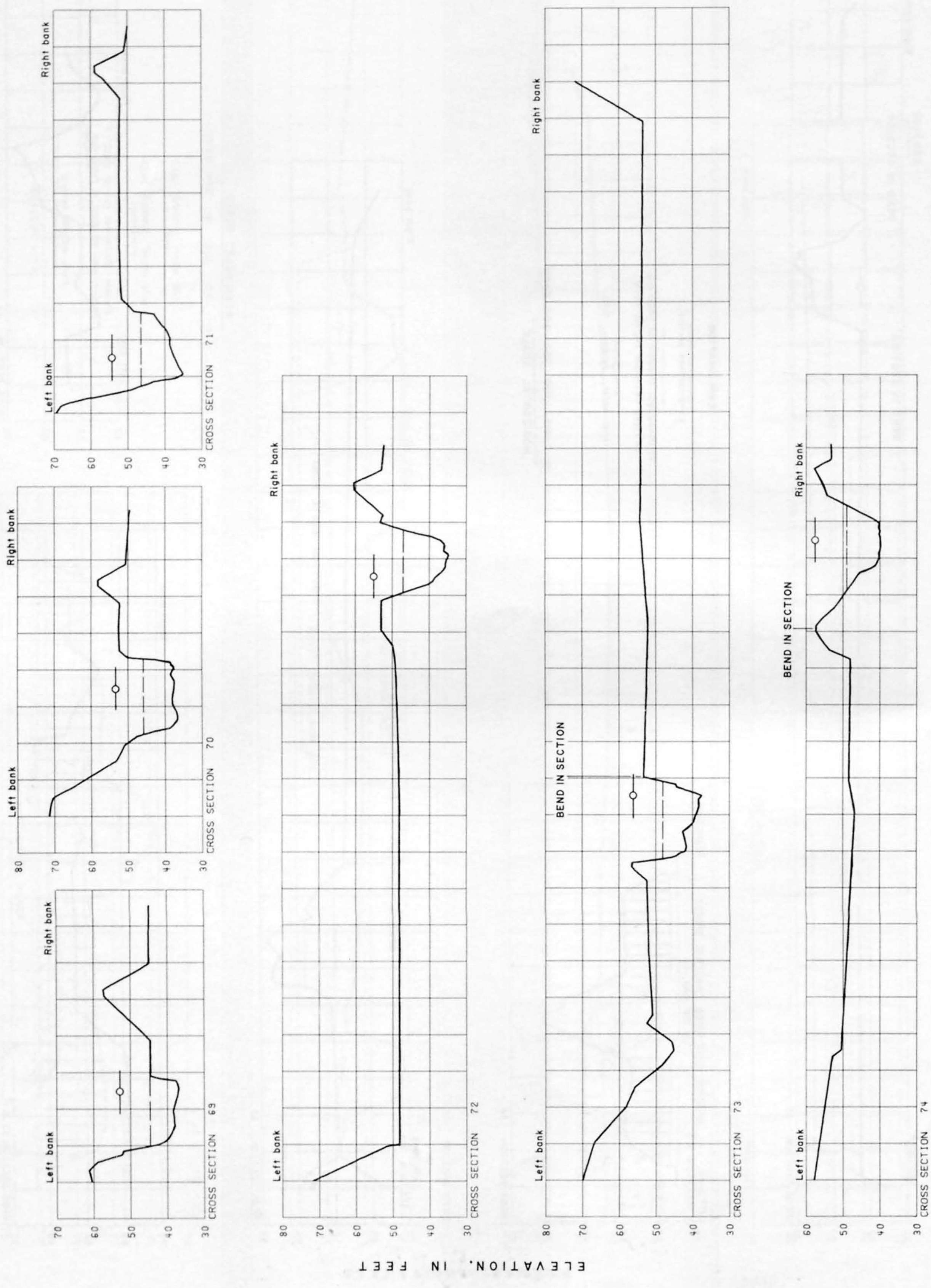


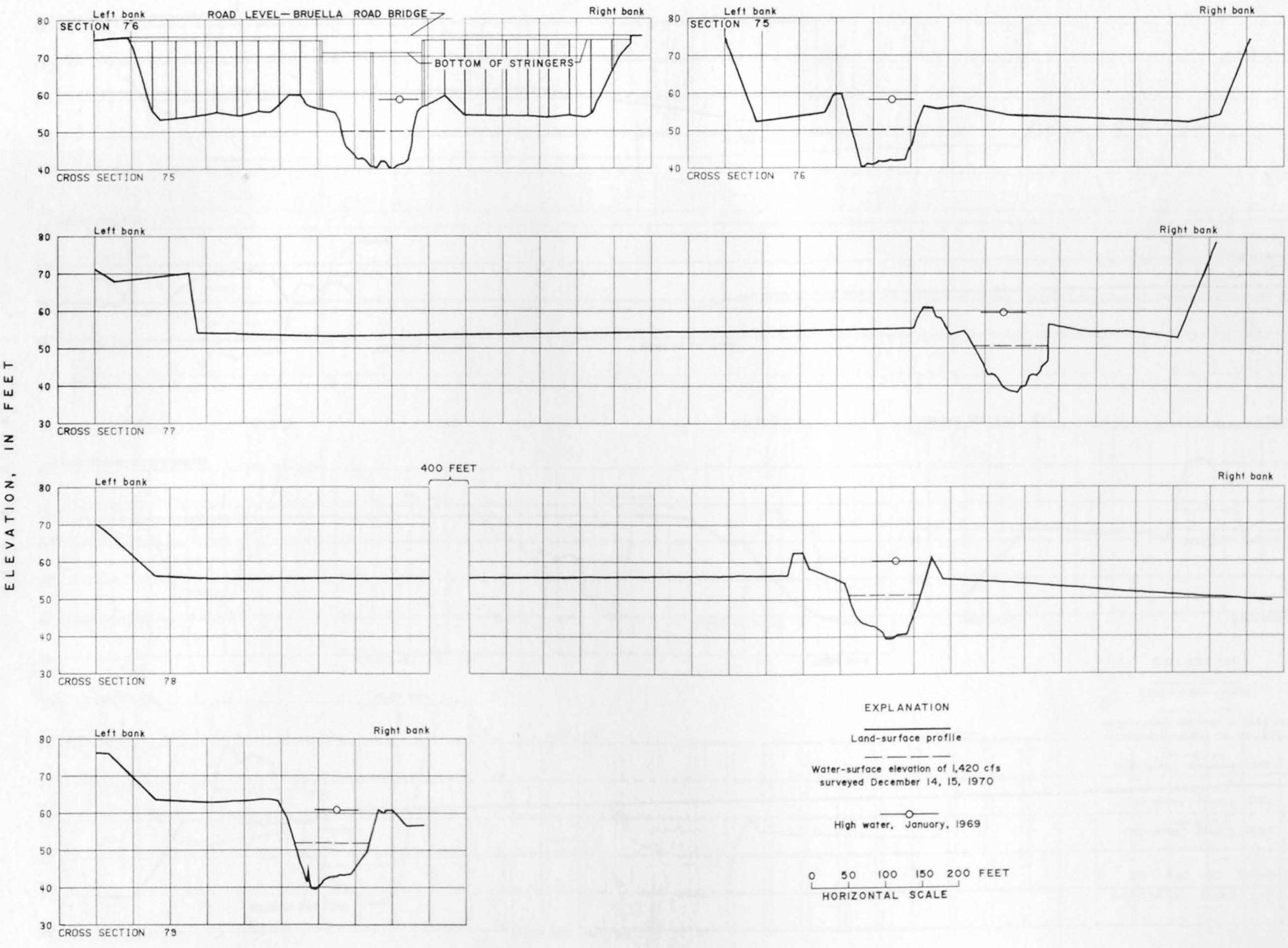
CROSS SECTIONS 61.1–64



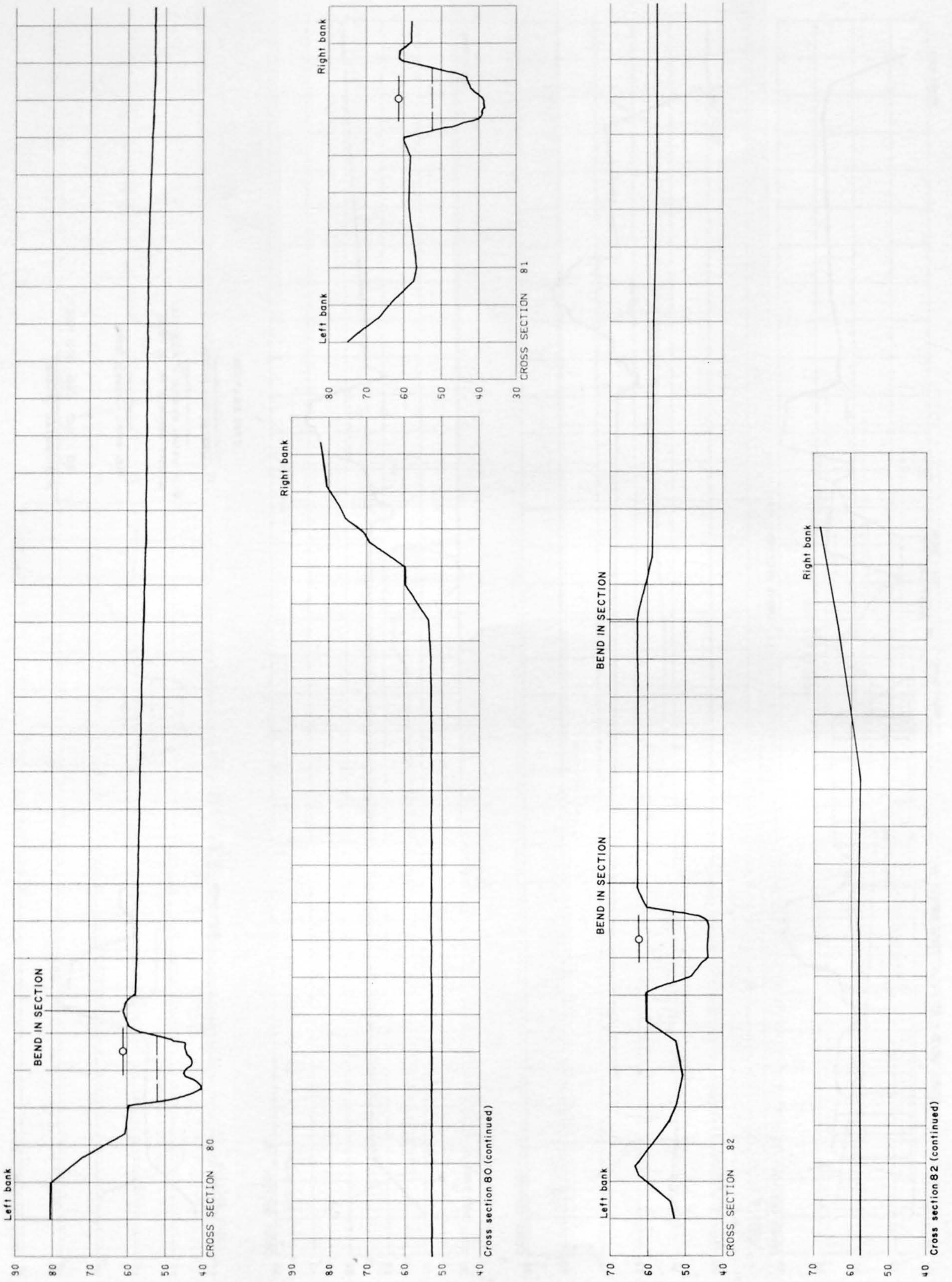
CROSS SECTIONS 65—68

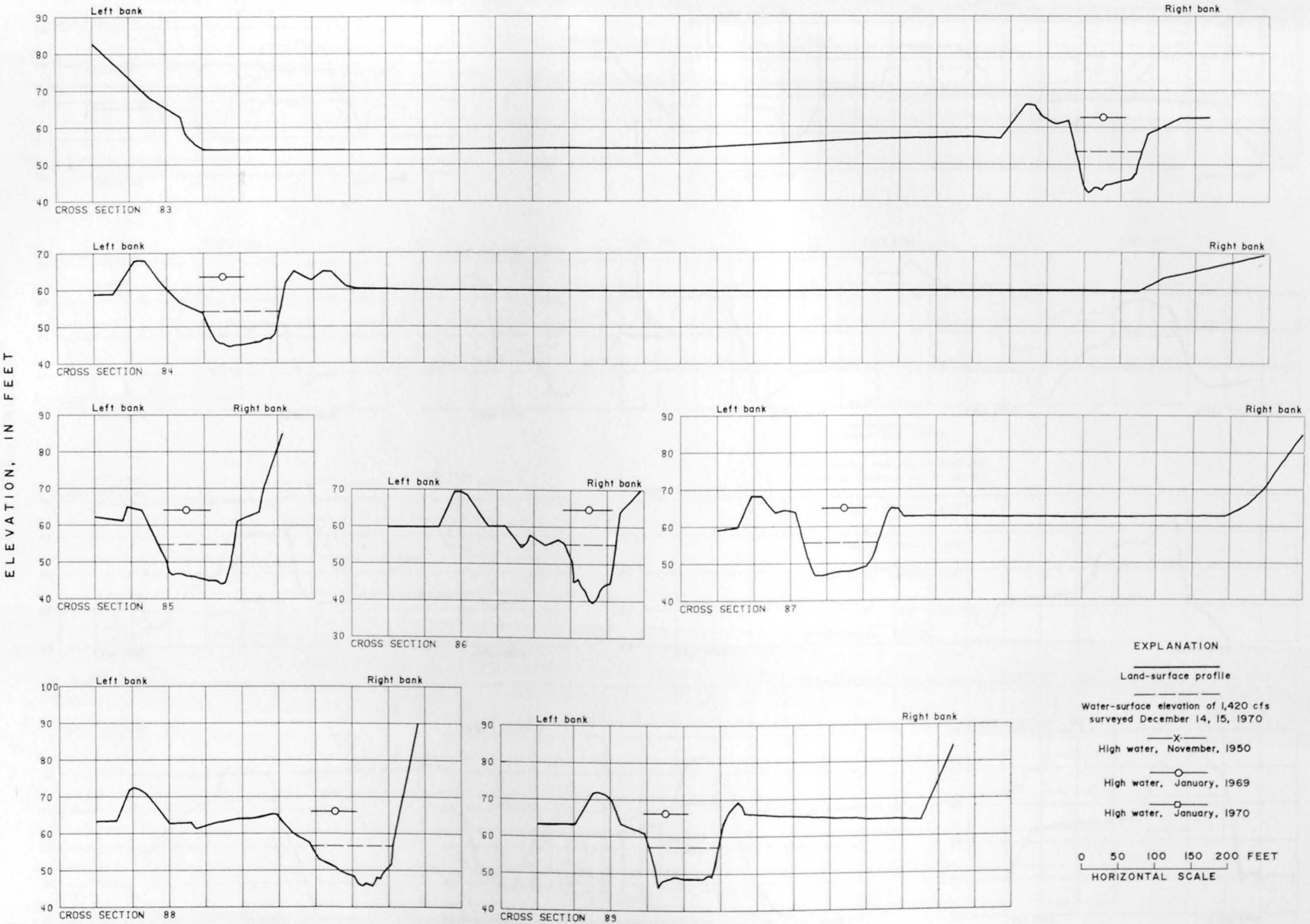
CROSS SECTIONS 69—74

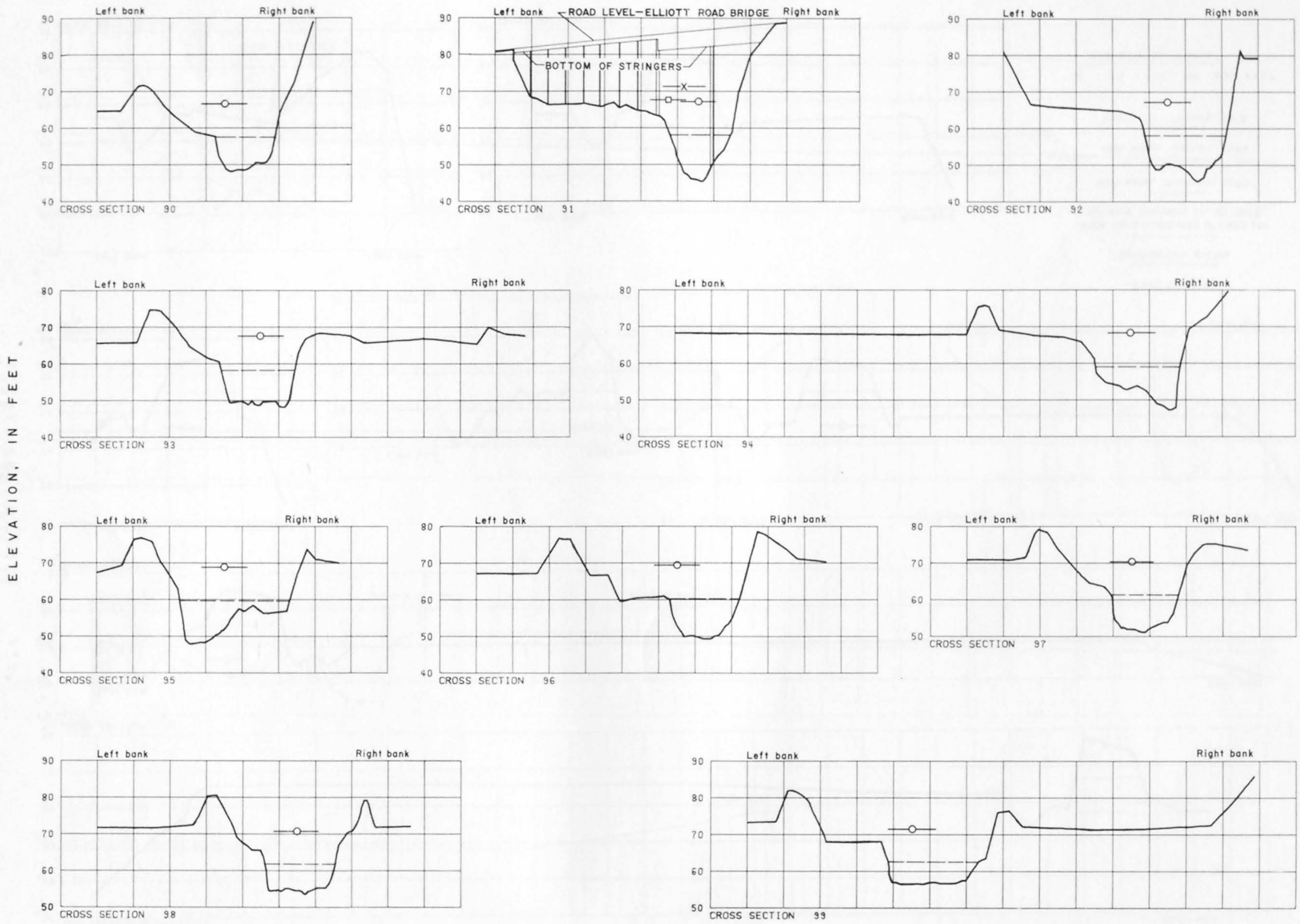



ELEVATION, IN FEET
Left bank
Right bank
SECTION 76
ROAD LEVEL—BRUELLA ROAD BRIDGE
BOTTOM OF STRINGERS
CROSS SECTION 75
SECTION 75
CROSS SECTION 76
CROSS SECTION 77
400 FEET
CROSS SECTION 78
CROSS SECTION 79
80
70
60
50
40
30
EXPLANATION
Land-surface profile
Water-surface elevation of 1,420 cfs surveyed December 14, 15, 1970
High water, January, 1969
0 50 100 150 200 FEET
HORIZONTAL SCALE

CROSS SECTIONS 80–82

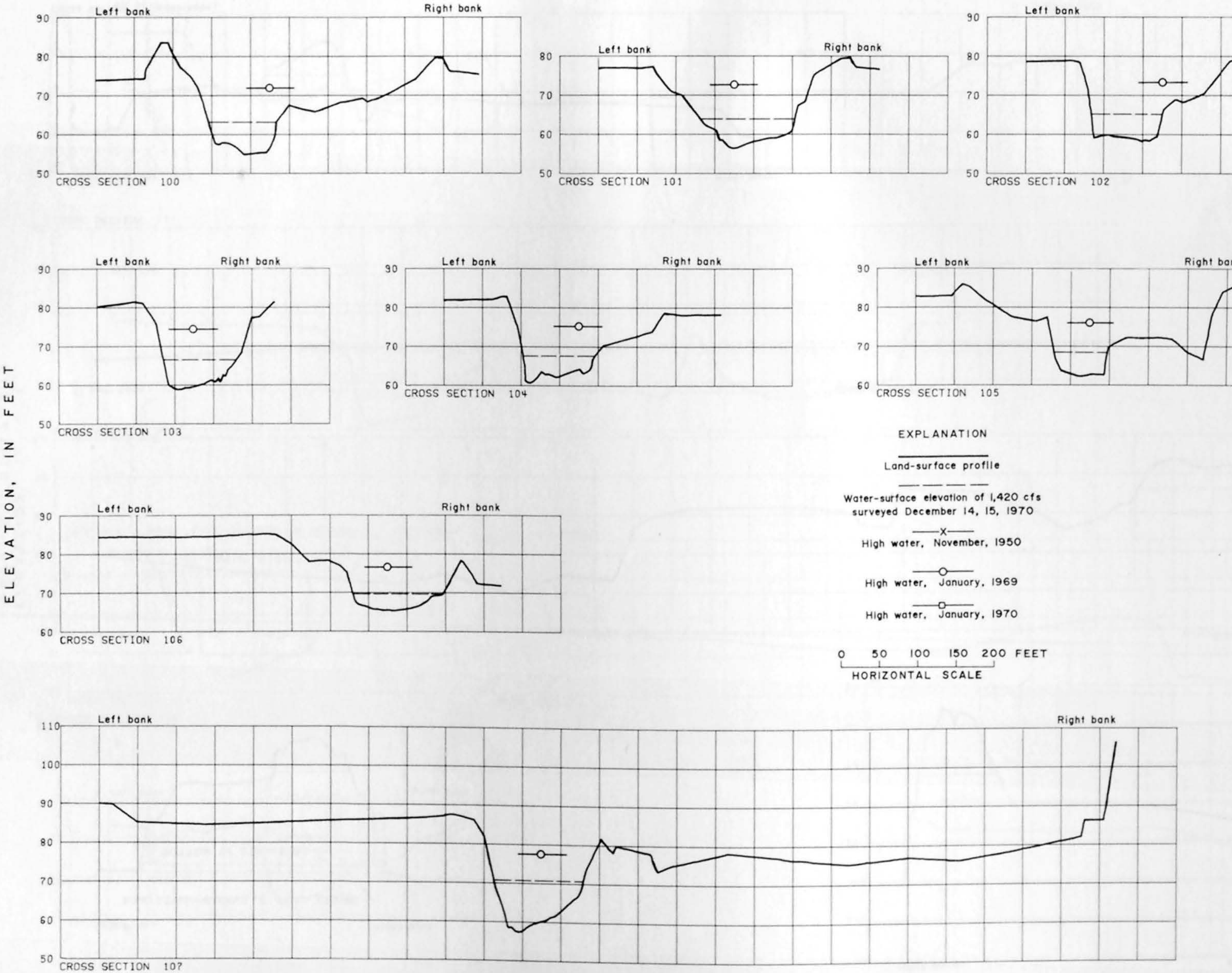



ELEVATION, IN FEET
CROSS SECTION 83
CROSS SECTION 84
CROSS SECTION 85
CROSS SECTION 86
CROSS SECTION 87
CROSS SECTION 88
CROSS SECTION 89
Left bank
Right bank
EXPLANATION
Land-surface profile
Water-surface elevation of 1,420 cfs surveyed December 14, 15, 1970
High water, November, 1950
High water, January, 1969
High water, January, 1970
0 50 100 150 200 FEET
HORIZONTAL SCALE

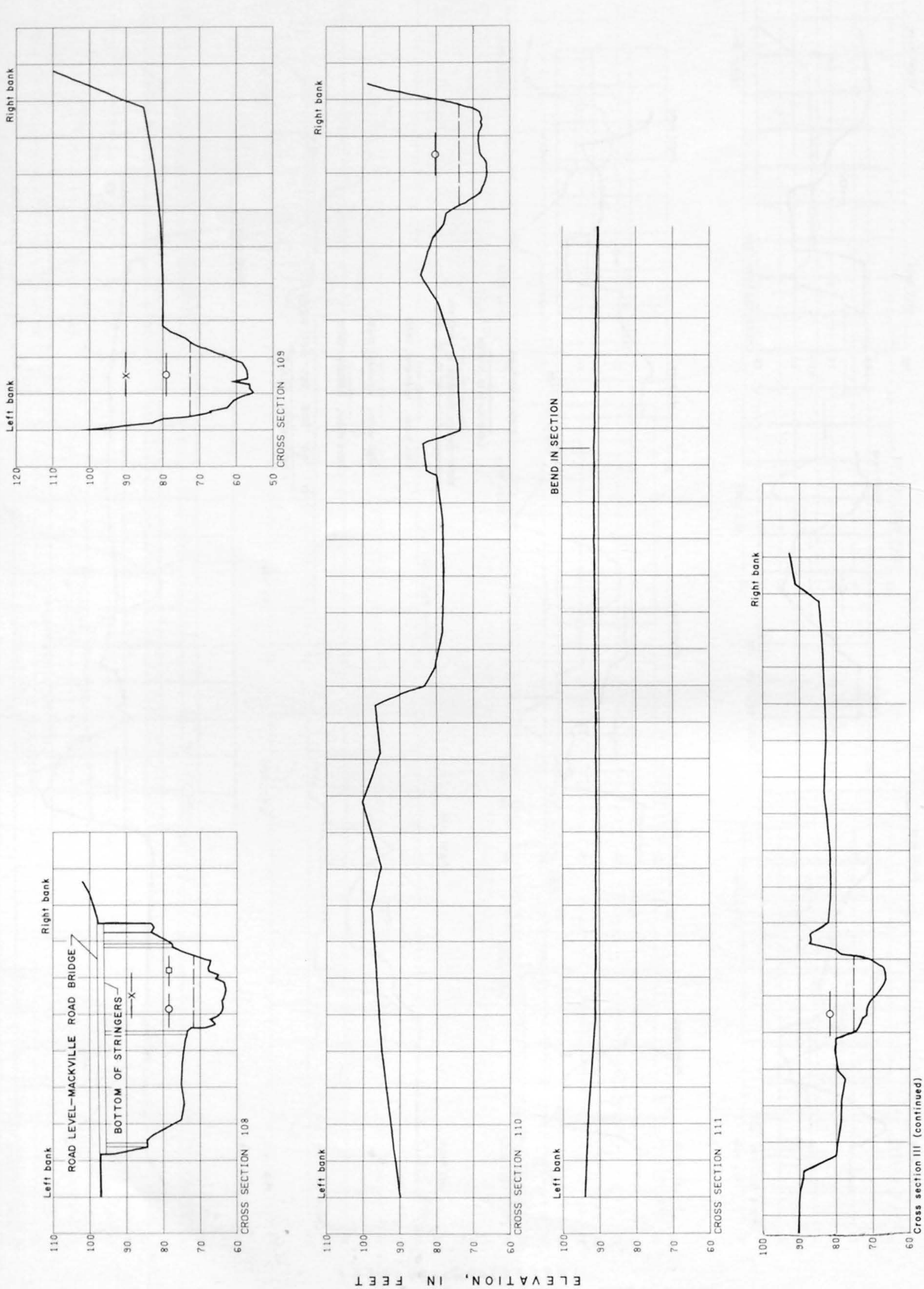


CROSS SECTIONS 90—99

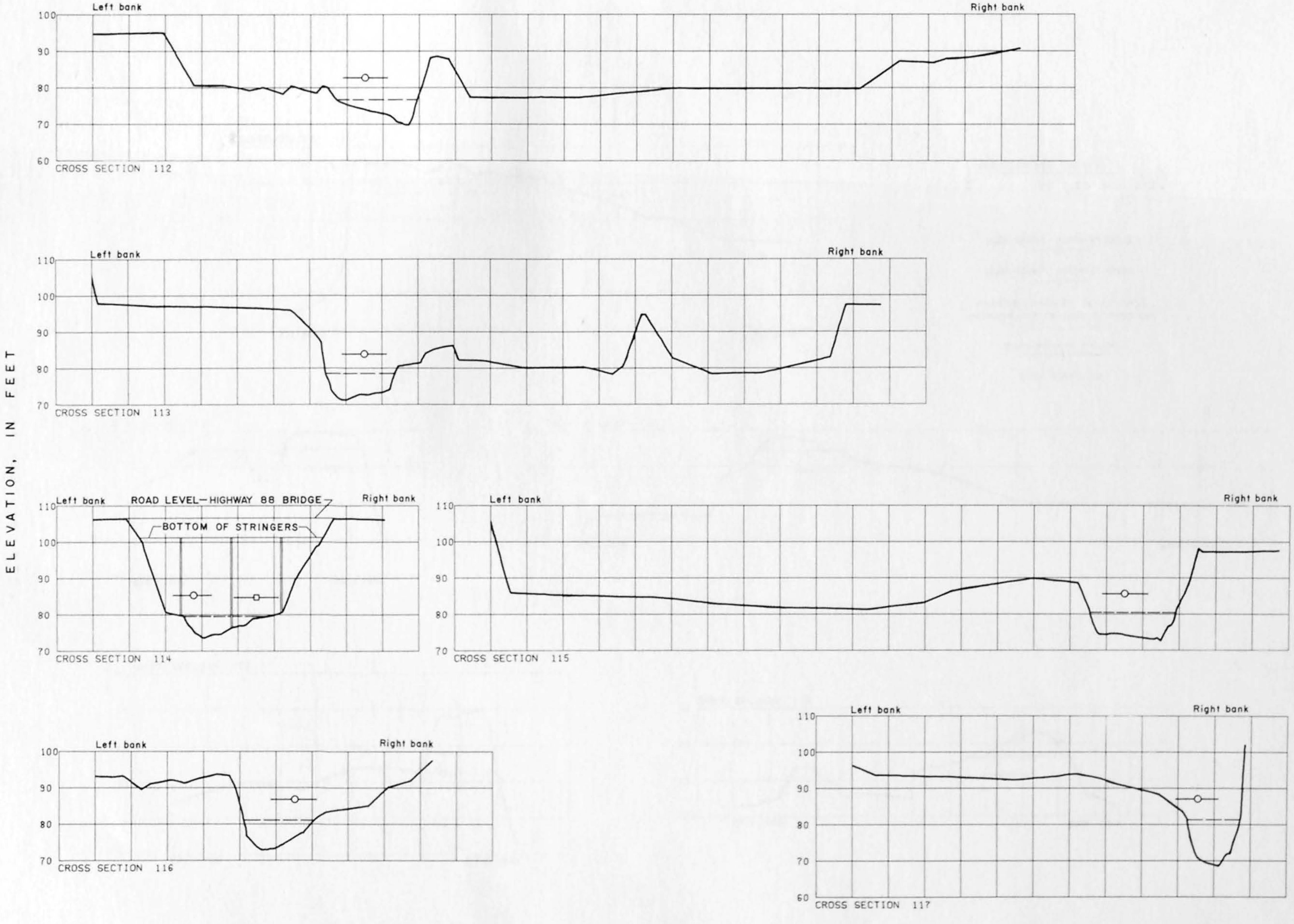
CROSS SECTIONS 100–107

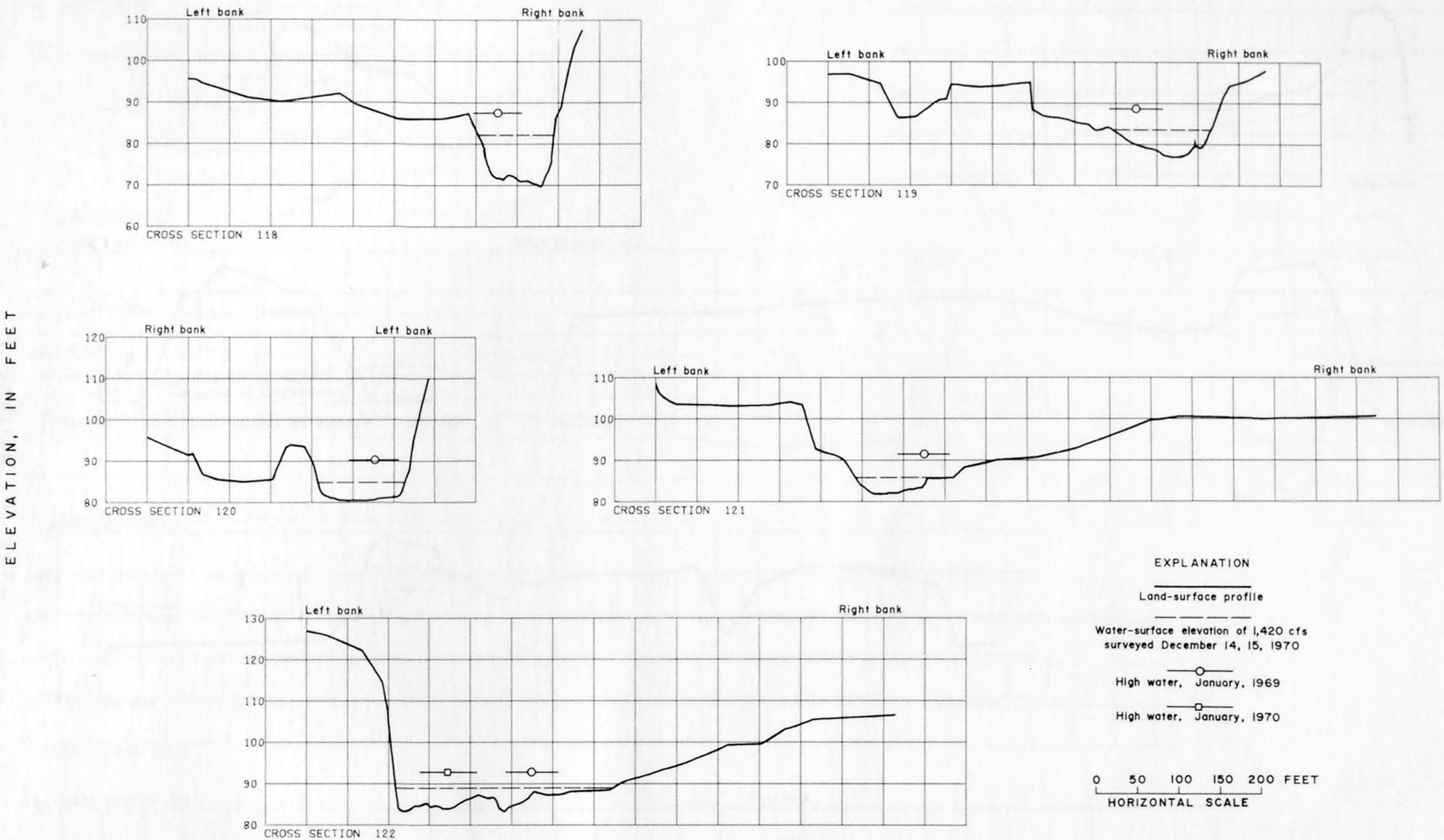


CROSS SECTIONS 108–111



CROSS SECTIONS 112–117





CROSS SECTIONS 118–122