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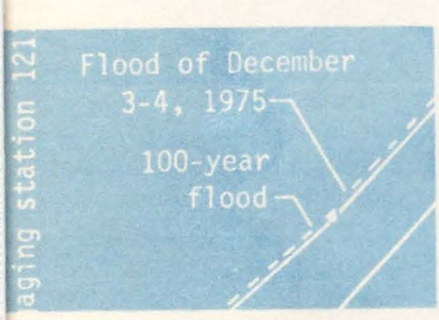
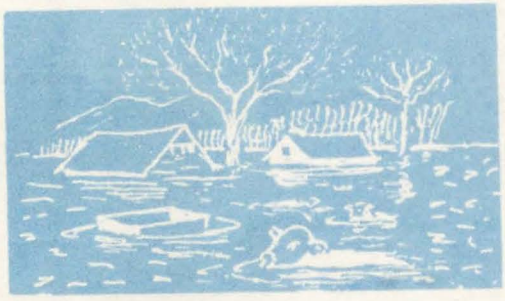
FLOOD PROFILES ALONG THE CEDAR RIVER, KING COUNTY, WASHINGTON





U.S. GEOLOGICAL SURVEY
Water-Resources Investigations 78-84

Prepared in Cooperation With
State of Washington Department of Ecology

FLOOD PROFILES ALONG THE CEDAR RIVER, KING COUNTY, WASHINGTON

By O. C. Hettick

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Tacoma, Washington
1979

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

H. William Menard, Director

Open-File Report

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METRIC CONVERSION FACTORS

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile	2.590	square kilometer (km^2)
cubic foot per second (ft^3/s)	.02832	cubic meter per second (m^3/s)

FLOOD PROFILES ALONG THE CEDAR RIVER, KING COUNTY, WASHINGTON

By O. C. Hettick

ABSTRACT

Flood profiles on the Cedar River from 21.1 to 33.65 miles upstream from the mouth were developed for the flood of December 3-4, 1975, and for a 100-year flood. Estimated water-surface elevations during a 100-year flood indicate virtually all the flow would be contained in the river channel.

Since 1914, Cedar River flows have been affected by impoundment and release of storage from Chester Morse Lake at river mile 35.6, and since 1901 by diversion for water supply at river mile 21.6. Flood-frequency analysis, based on 62 years of regulated flows (period 1915-76), indicate the 100-year flood would have a discharge of 8,600 cubic feet per second at river mile 23.4 (U.S. Geological Survey Cedar River near Landsburg, gaging station 12117500) and 6,870 cubic feet per second at river mile 33.2 (U.S. Geological Survey Cedar River at Cedar Falls, gaging station 12116500). The highest flood since regulation began occurred December 3 and 4, 1975, and was 7,930 cubic feet per second at river mile 23.4 and 6,860 cubic feet per second at river mile 33.2.

Recurrence interval of this flood is about 70 years at river mile 23.4 and about 100 years at mile 33.2 under present conditions of storage and regulation.

INTRODUCTION

The objectives of this study were to develop flood profiles and delineate areas that probably would be inundated by a 100-year flood along a 12.55 mile reach (Cedar Falls powerplant to Landsburg Bridge) of the Cedar River in King County, Washington (fig. 1). High-water marks were obtained along the reach for the December 3-4, 1975 flood. A summary of the flood-profile data obtained for the December 1975 flood, and the estimated 100-year flood profile are given for the reach of the river studied. The study was conducted as part of the cooperative program between the U.S. Geological Survey and the State of Washington Department of Ecology. The author acknowledges the help of personnel of the Redmond office of the State Department of Ecology who assisted in field-data collection.

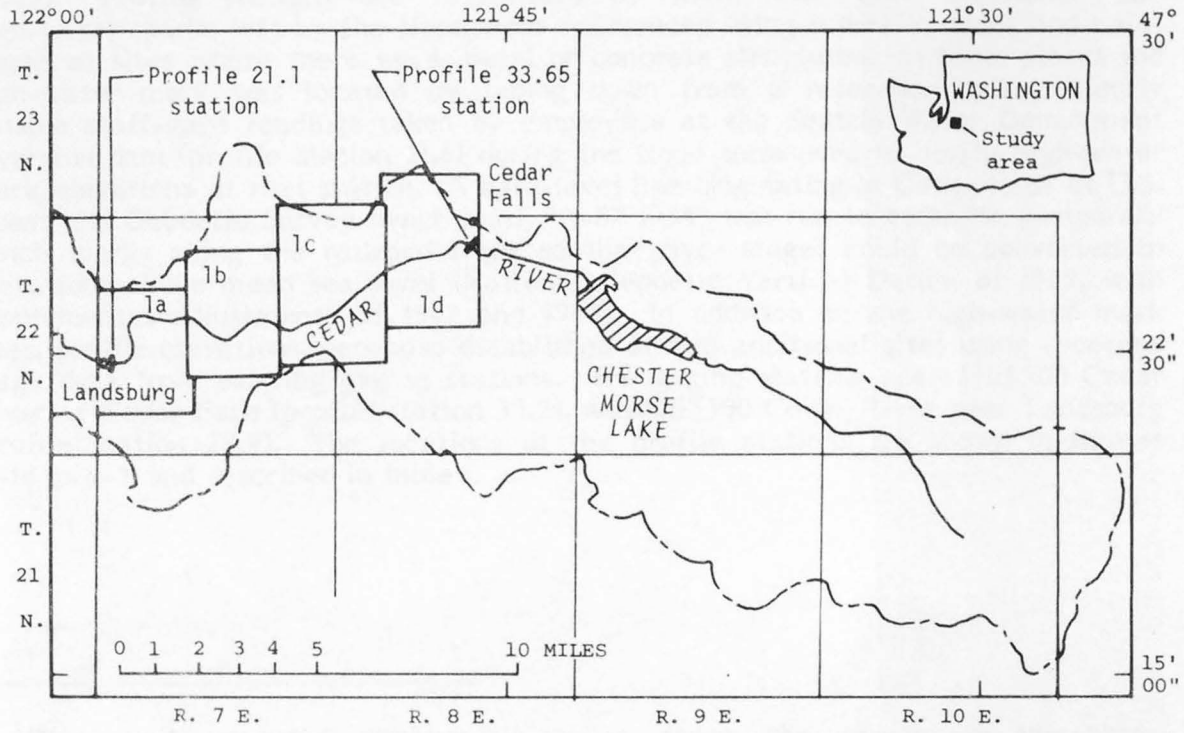

FIGURE 1.--Cedar River basin, Washington, showing limits of study reach; downstream end at profile station 21.1 and upstream end at profile station 33.65. Inset for figures 1a-1d (p. 4-7) are shown for parts of Cedar River basin study reach.

DATA-COLLECTION SITES

River-Profile Stations

High-water marks of the December 3-4, 1975 flood were flagged by field parties on December 5, 10, and 11, 1975, at 27 sites (profile stations) on the Cedar River extending upstream from Landsburg bridge (river mile[1] 21.1), to a point 250 feet downstream from City of Seattle Cedar Falls powerplant penstocks (river mile 33.65). Profile stations are referenced by their river mile locations. The high-water marks left by the flood were referenced using spikes in trees and paint marks at sites where there were metal or concrete structures. In some places the high-water mark was located by taping down from a reference spike. Hourly outside staff-gage readings taken by employees at the Seattle Water Department diversion dam (profile station 21.6) during the flood were used to verify high-water mark elevations at that station. A base-level line originating in Cedar Falls at U.S. Coast and Geodetic Survey bench mark "H-67 1934" was run to establish temporary bench marks along the railroad track so that river stages could be converted to elevations above mean sea level (National Geodetic Vertical Datum of 1929, with supplemental adjustments of 1947 and 1960). In addition to the high-water mark sites, profile elevations were also established at two additional sites using recorded stage data from existing gaging stations. The gaging stations are 12116500 Cedar River at Cedar Falls (profile station 33.2), and 12117500 Cedar River near Landsburg (profile station 23.4). The locations of the profile stations are shown in figures 1a-1d (p. 4-7) and described in table 1.

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[1]River mile denotes distance in miles above the mouth of the river.

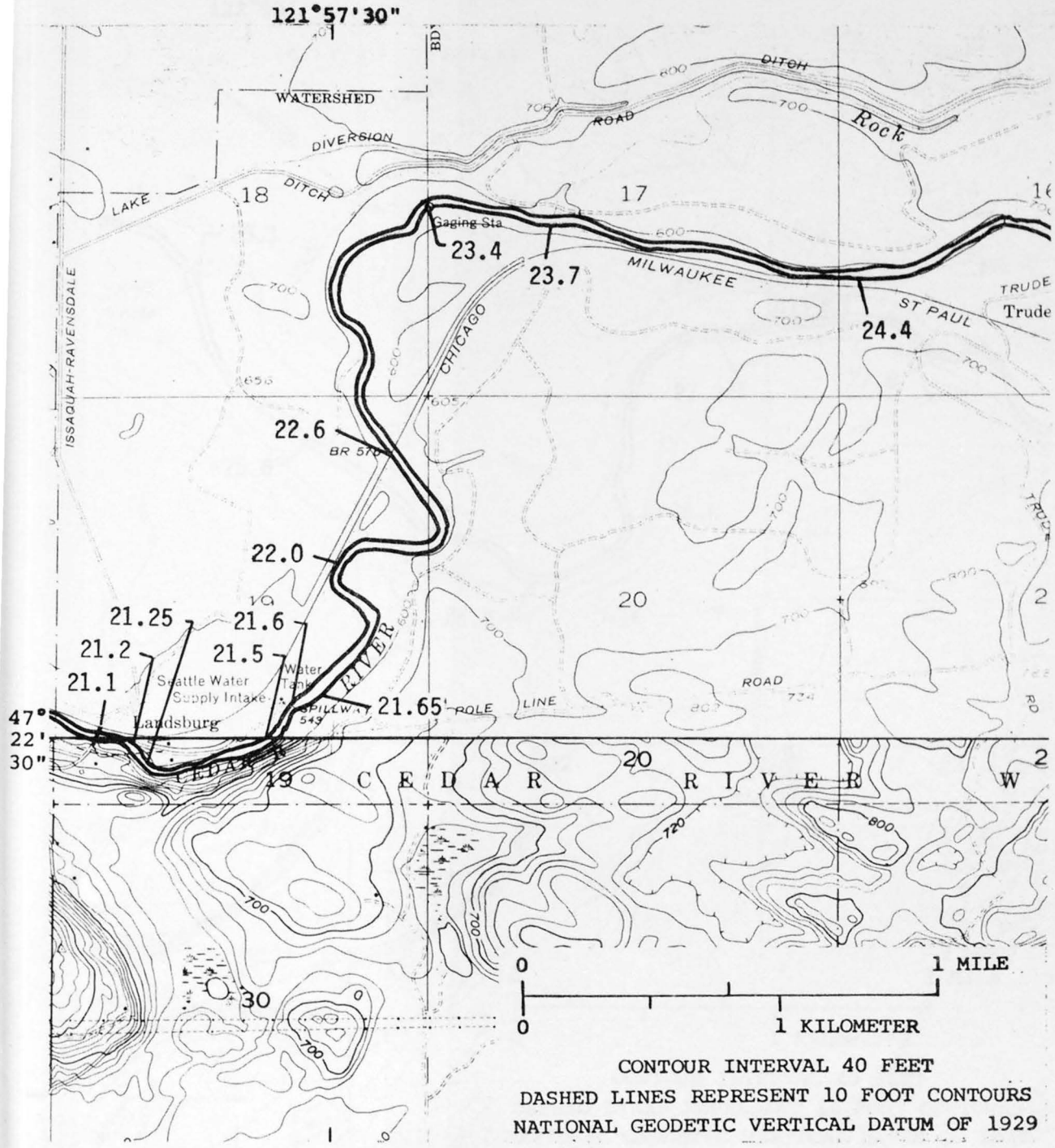

FIGURE 1a.--Parts of Cedar River basin, showing locations of flood-profile stations.

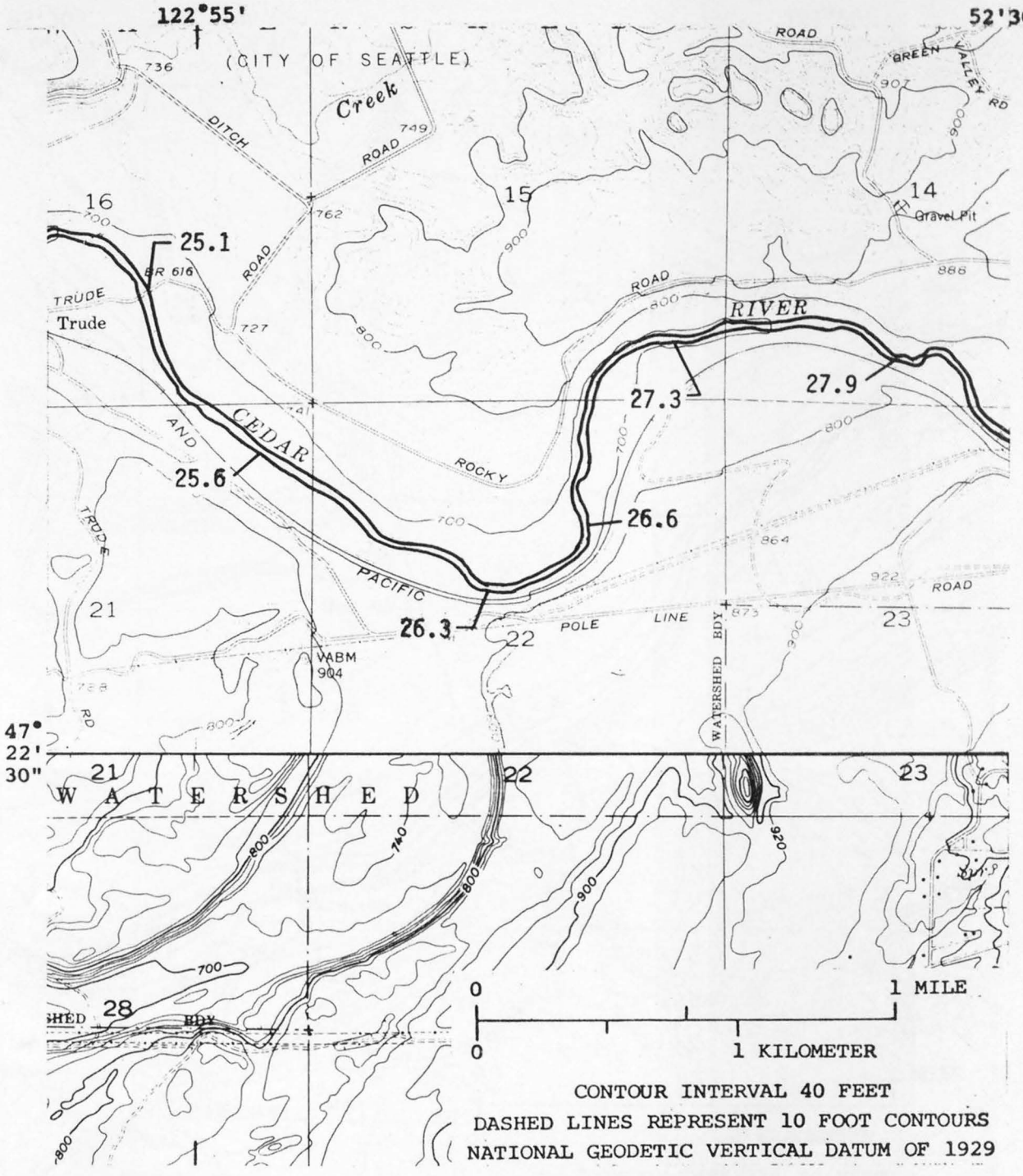

FIGURE 1b.--Parts of Cedar River basin, showing locations of flood-profile stations.

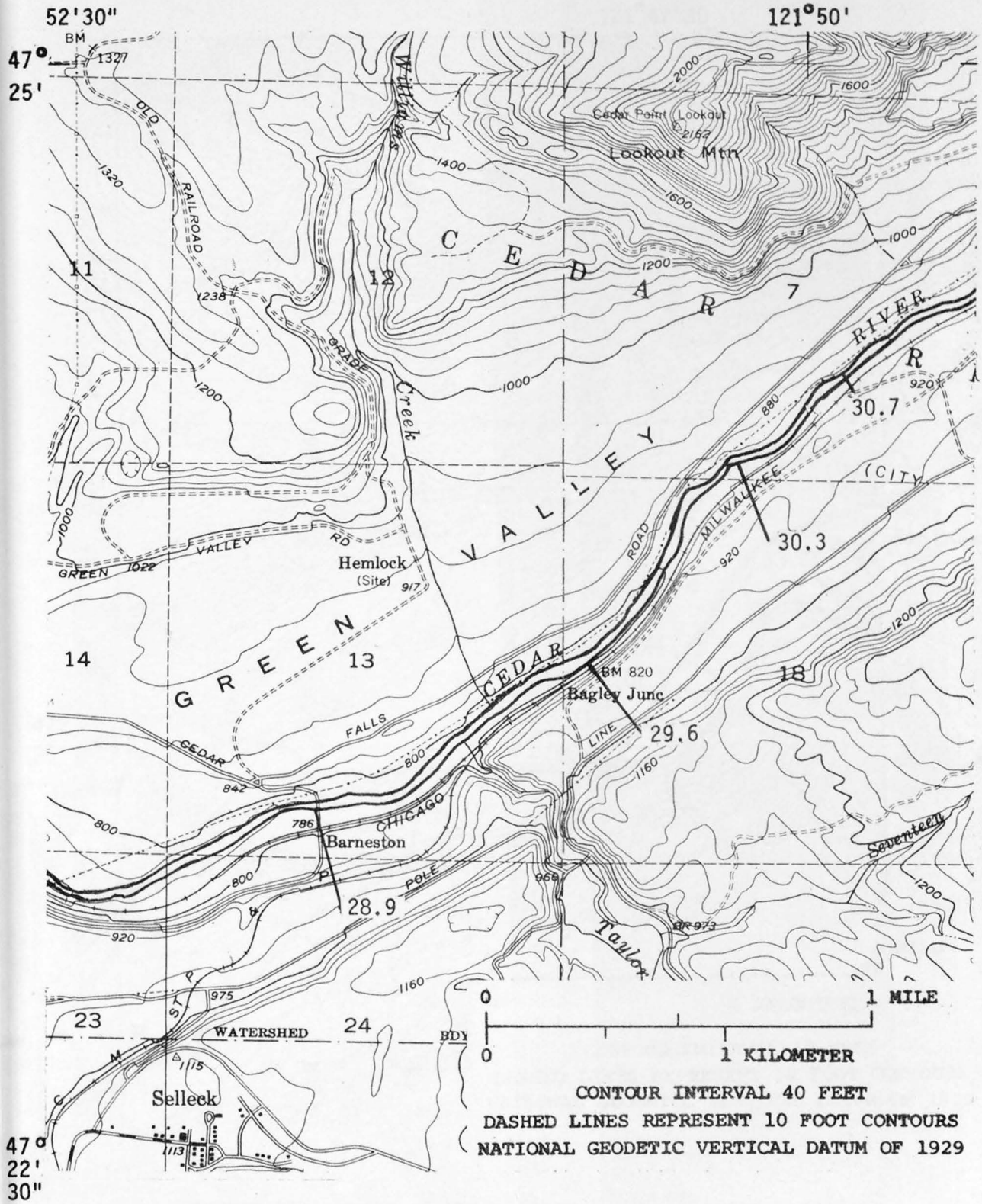

FIGURE 1c.--Parts of Cedar River basin, showing locations of flood-profile stations.

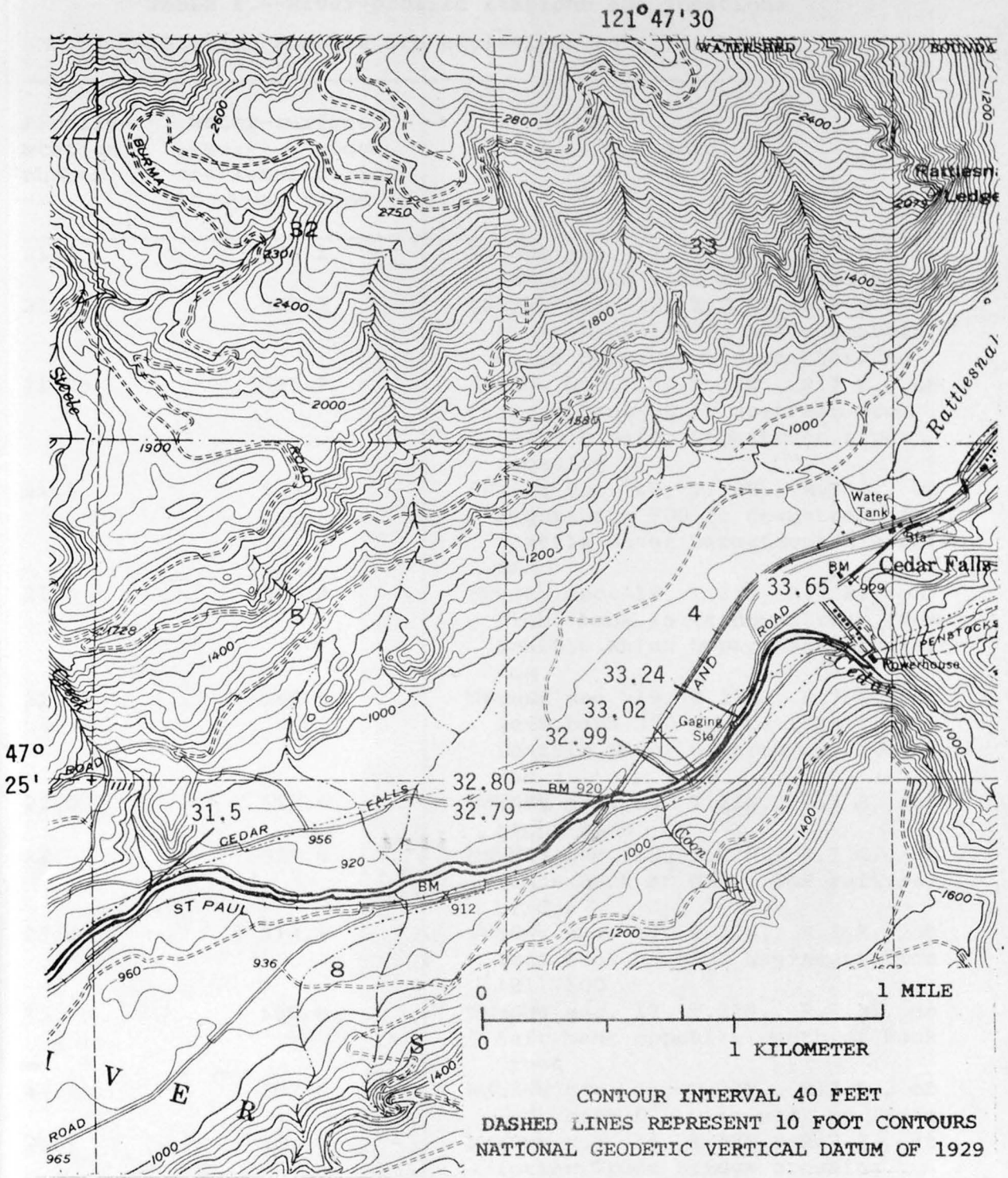

FIGURE 1d.--Parts of Cedar River basin, showing locations of flood-profile stations.

TABLE 1.--River-profile stations and locations

(Station numbers are equivalent to river miles)

Profile-station number	Water-surface elevation above sea level during 100-year flood (ft)	Location
21.1	524.1	SW¼SW¼ sec. 19, T.22N., R.7 E., at downstream side of Landsburg bridge
21.2	527.3	SW¼SW¼ sec. 19, T.22N., R.7 E., on right bank 100 ft below Seattle Water Department pipe crossing
21.25	527.7	SE¼SW¼ sec. 19, T.22N., R.7 E., on right bank 80 ft upstream from Seattle Water Department pipe crossing
21.5	535.5	SW¼SE¼ sec. 19, T.22N., R.7 E., on right bank 500 ft downstream from Seattle Water Department diversion dam
21.6	540.8	SW¼SE¼ sec. 19, T.22N, R.7 E., on right bank 15 ft downstream from Seattle Water Department diversion dam
21.65	548.9	NW¼SE¼ sec. 19, T.22N., R.7 E., on left bank 300 ft upstream from Seattle Water Department diversion dam
22.0	552.4	SW¼NE¼ sec. 19, T.22N., R.7 E., on right bank
22.6	559.6	NE¼NE¼ sec. 19, T.22N., R.7 E., on right bank at CMSt. P&P railroad bridge
23.4	574.9	NW¼SW¼ sec. 17, T.22N., R.7 E., on left bank at USGS gaging station 12117500
23.7	580.6	NE¼SW¼ sec. 17, T.22N., R.7 E., on left bank opposite mouth of Rock Creek
24.4	592.6	NW¼SW¼ sec. 16, T.22N., R.7 E., on left bank 0.3 mile west of Trude
25.1	608.0	NW¼SW¼ sec. 16, T.22N., R.7 E., at former Trude bridge crossing
25.6	618.2	NE¼NE¼ sec. 21, T.22N., R.7 E., on left bank 0.5 mile upstream from former Trude bridge crossing
26.3	647.0	SE¼NW¼ sec. 22, T.22N., R.7 E., on left bank north of railroad sign "station, one mile".

TABLE 1.--River-profile stations and locations--con.

(Station numbers are equivalent to river miles)

Profile-station number	Water-surface elevation above sea level during 100-year flood (ft)	Location
26.6	664.0	SW¼NE¼ sec. 22, T.22N., R.7 E., on left bank 400 ft west of railroad sign "2144"
27.3	695.6	SE¼SE¼ sec. 15, T.22N., R.7 E., on left bank north of road 50.3
27.9	706.6	SE¼SW¼ sec. 14, T.22N., R. 7E., on left bank 850 ft east of railroad signals 60/8 and 60/9
28.9	765.1	SE¼SW¼ sec. 13, T.22N., R.7 E., on left bank at Barneston bridge
29.6	791.8	NW¼SW¼ sec. 18, T.22N., R.8 E., on left bank at Bagley Junction
30.3	815.0	SE¼SW¼ sec. 7, T.22N., R.8 E., on left bank
30.7	838.4	NW¼SE¼ sec. 7, T.22N., R.8E., on left bank north of road 51.1
31.5	868.8	SW¼NW¼ sec. 8, T.22N., R.8 E., on right bank at Steele Creek
32.0	882.0	SW¼NE¼ sec. 8, T.22N., R.8 E., on left bank north of railroad sign 2139
32.79	904.6	NE¼NW¼ sec. 9, T.22N., R.8 E., on left bank 50 ft downstream from railroad bridge
32.8	906.1	NE¼NW¼ sec. 9, T.22N., R.8 E., on left bank at railroad bridge
32.99	909.7	NE¼NW¼ sec. 9, T.22N., R.8 E., on left bank 50 ft downstream from log road bridge
33.02	911.6	SW¼SE¼ sec. 4, T.22N., R.8 E., on left bank 120 ft upstream from log road bridge
33.2	913.9	SW¼SE¼ sec. 4, T.22N., R.8 E., on right bank at gaging station 12116500
33.65	939.9	NE¼SE¼ sec. 4, T.22N., R.8 E., on right bank 250 ft downstream from Cedar Falls powerplant penstocks

Streamflow-Gaging Stations

The Geological Survey has obtained continuous record at the gaging station on the Cedar River near Landsburg (12117500) at river mile 23.4 since July 1895. The drainage area above the station is 121 mi^2. The maximum discharge during the 81-year period of record was 14,200 ft^3/s November 19, 1911. The peak was caused by failure of flashboards at the Crib Dam. The Crib Dam was completed in 1904 at river mile 37.2; the Masonry Dam, at a site 1.6 miles downstream from the Crib Dam, was completed in 1914. The maximum discharge since storage began in Chester Morse Lake (1914) was 7,930 ft^3/s December 4, 1975. The Geological Survey also obtained continuous record at the gaging station on the Cedar River at Cedar Falls (12116500) at river mile 33.2 since April 1914. The drainage area above this gaging station is 84.2 mi^2, and the maximum discharge during the 62-year period of record was 6,860 ft^3/s December 3, 1975. The annual peak flows during the concurrent period of record for these stations and since storage began in Chester Morse Lake are listed in tables 2 and 3.

FLOOD FREQUENCIES

Flood-frequency curves, based on annual peak discharges during the period 1915-76 (period reflects regulation at the Masonry Dam at Chester Morse Lake), were developed for profile stations 23.4 and 33.2, using the log-Pearson Type III method of curve fitting. These curves are shown in figure 2. From these curves the 100-year flood is 8,600 ft^3/s at profile station 23.4 and 6,870 ft^3/s at profile station 33.2. The discharges of floods of selected recurrence intervals at profile stations 23.4 and 33.2 are as follows:

Recurrence interval (years)	Discharge, in cubic feet per second	
	Cedar River near Landsburg (12117500) profile station 23.4	Cedar River at Cedar Falls (12116500) profile station 33.2
2	2,480	1,480
5	3,780	2,450
10	4,770	3,260
25	6,180	4,500
50	7,340	5,600
100	8,600	6,870

These curves (fig. 2) are used also to obtain the frequency of observed floods. The recurrence interval for the flood of December 3-4, 1975, at the Landsburg gage (profile station 23.4) was about 70 years and at the Cedar Falls gage (profile station 33.2) was about 100 years.

TABLE 2.--Annual peak discharges of the Cedar River at Cedar Falls gaging station (12116500), river-profile station 33.2

Water year	Discharge (ft^3/s)	Water year	Discharge (ft^3/s)
1915	1,160	1945	946
16	1,830	46	1,140
17	1,980	47	2,880
18	6,290	48	1,380
19	1,280	49	1,340
1920	776	1950	2,050
21	748	51	3,860
22	4,500	52	800
23	2,790	53	2,250
24	915	54	1,370
1925	1,880	55	1,240
26	765	56	1,760
27	1,210	57	2,140
28	3,430	58	958
29	714	59	1,980
1930	964	1960	3,560
31	802	61	1,120
32	1,740	62	1,140
33	3,050	63	1,280
34	6,440	64	1,620
1935	3,270	1965	965
36	1,940	66	881
37	1,600	67	1,280
38	2,020	68	1,600
39	1,100	69	1,250
1940	1,310	1970	746
41	742	71	1,320
42	822	72	2,460
43	924	73	1,620
44	866	74	1,920
		75	1,250
		76	6,860
		77	724

TABLE 3.--Annual peak discharges of the Cedar River near Landsburg gaging station (12117500), river-profile station 23.4

Water year	Discharge (ft^3/s)	Water year	Discharge (ft^3/s)
1915	1,330	1945	1,970
16	2,630	46	2,040
17	2,240	47	4,190
18	7,500	48	1,940
19	3,160	49	1,750
1920	1,860	1950	3,050
21	1,920	51	6,200
22	5,960	52	1,740
23	4,160	53	3,370
24	3,100	54	2,770
1925	2,740	1955	2,720
26	1,720	56	3,280
27	1,820	57	3,240
28	4,860	58	1,570
29	1,180	59	3,460
1930	1,350	1960	4,840
31	1,200	61	2,350
32	4,860	62	1,960
33	4,300	63	1,930
34	7,520	64	2,340
1935	4,160	65	4,640
36	1,900	66	1,380
37	1,800	67	2,170
38	2,360	68	2,240
39	1,500	69	2,440
1940	1,880	1970	1,620
41	1,050	71	2,240
42	1,830	72	3,840
43	2,140	73	2,310
44	1,380	74	2,770
		75	2,320
		76	7,930
		77	1,250

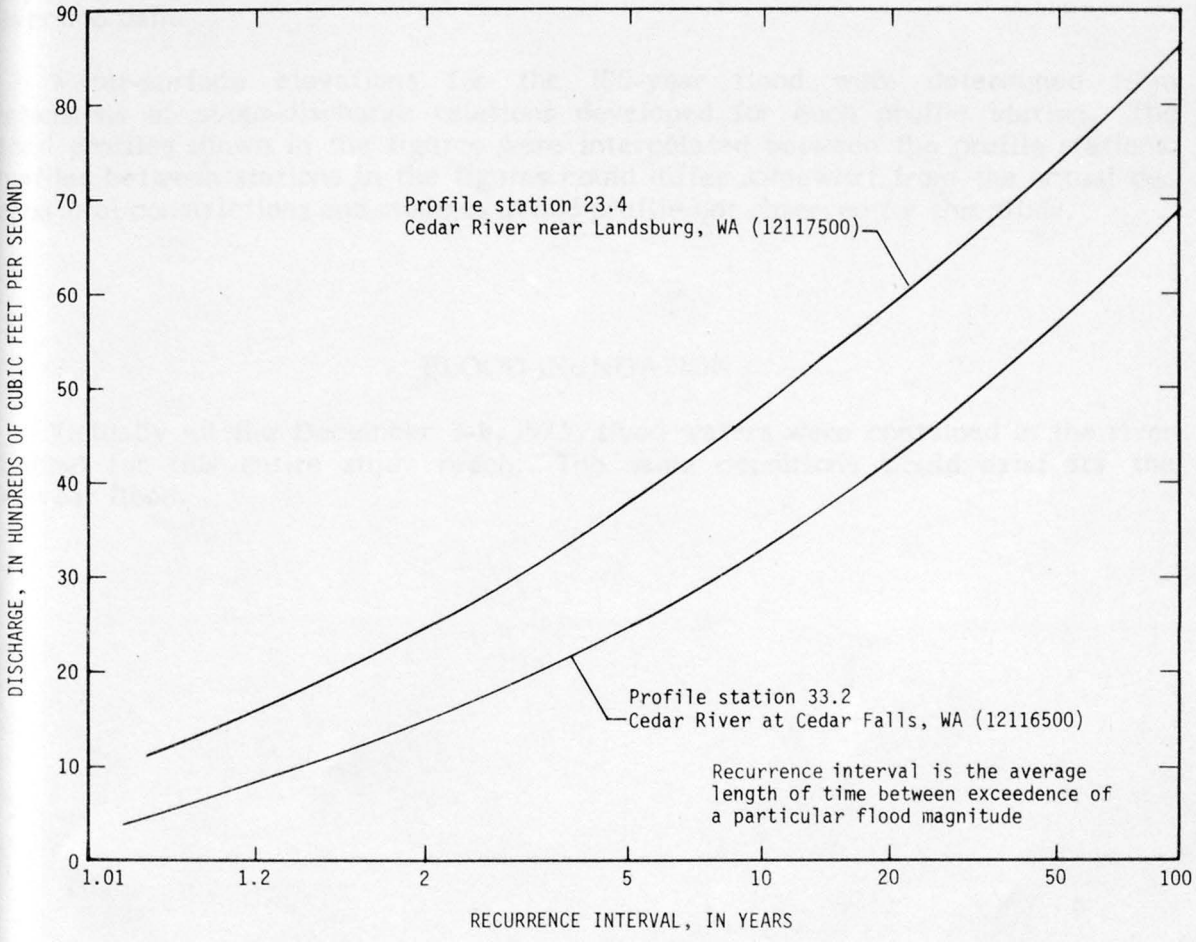

FIGURE 2.--Flood-frequency curves for profile stations 23.4 and 33.2, from data for period 1915-76.

FLOOD PROFILES

Water-surface profiles for the flood of December 3-4, 1975, the 100-year flood, and for the low-flow condition existing when levels were run to the profile stations September 29, 1976, are shown in figures 3a-3i. On September 29, 1976, the flow was 160 ft^3/s at profile station 33.2, 410 ft^3/s upstream from the Seattle Water Department diversion dam (profile station 21.6) and about 250 ft^3/s below the diversion dam.

Water-surface elevations for the 100-year flood were determined from extensions of stage-discharge relations developed for each profile station. The flood profiles shown in the figures were interpolated between the profile stations. Profiles between stations in the figures could differ somewhat from the actual due to natural constrictions and changes in bed profile not observed for this study.

FLOOD INUNDATION

Virtually all the December 3-4, 1975, flood waters were contained in the river channel for this entire study reach. The same conditions would exist for the 100-year flood.

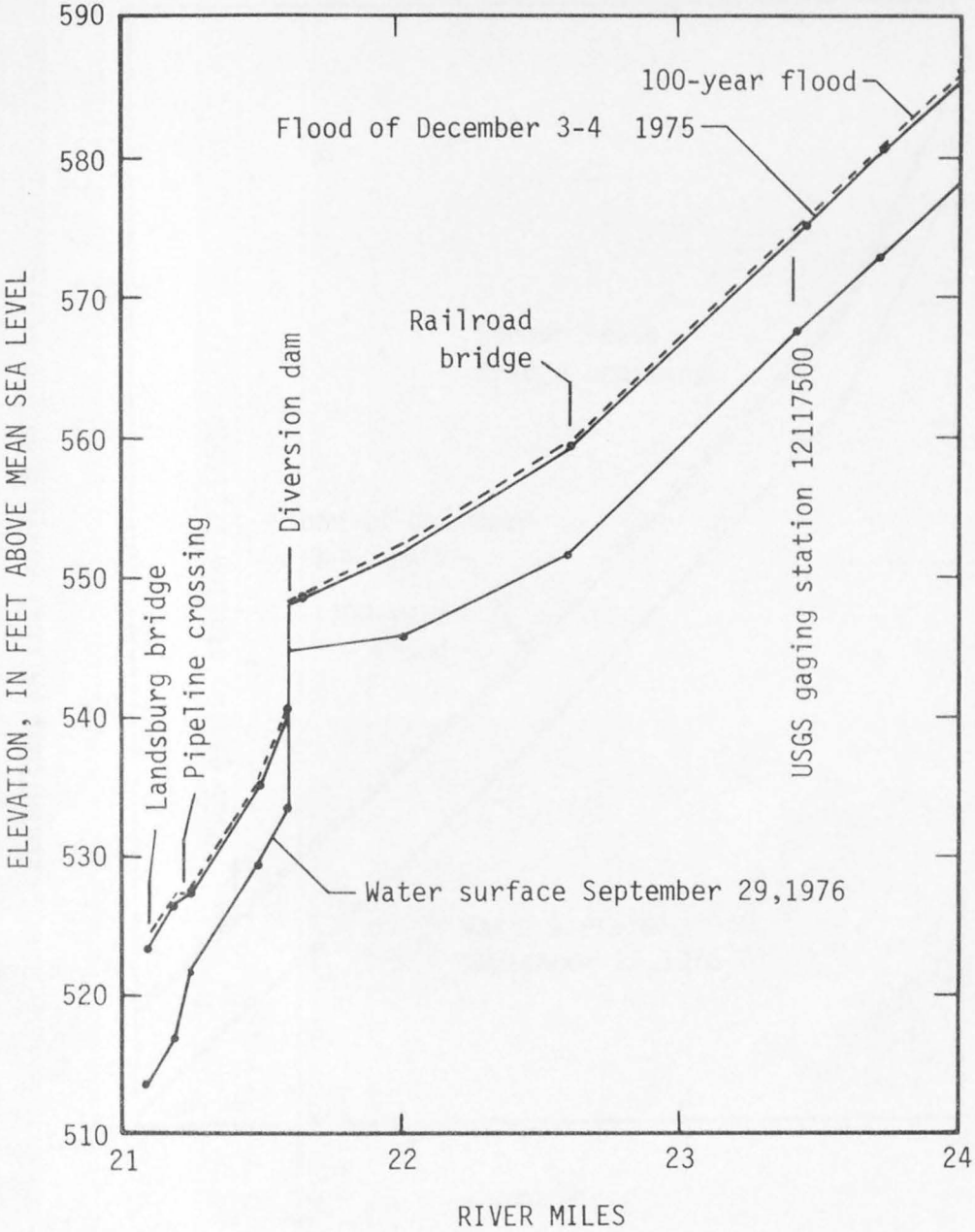

FIGURE 3a.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

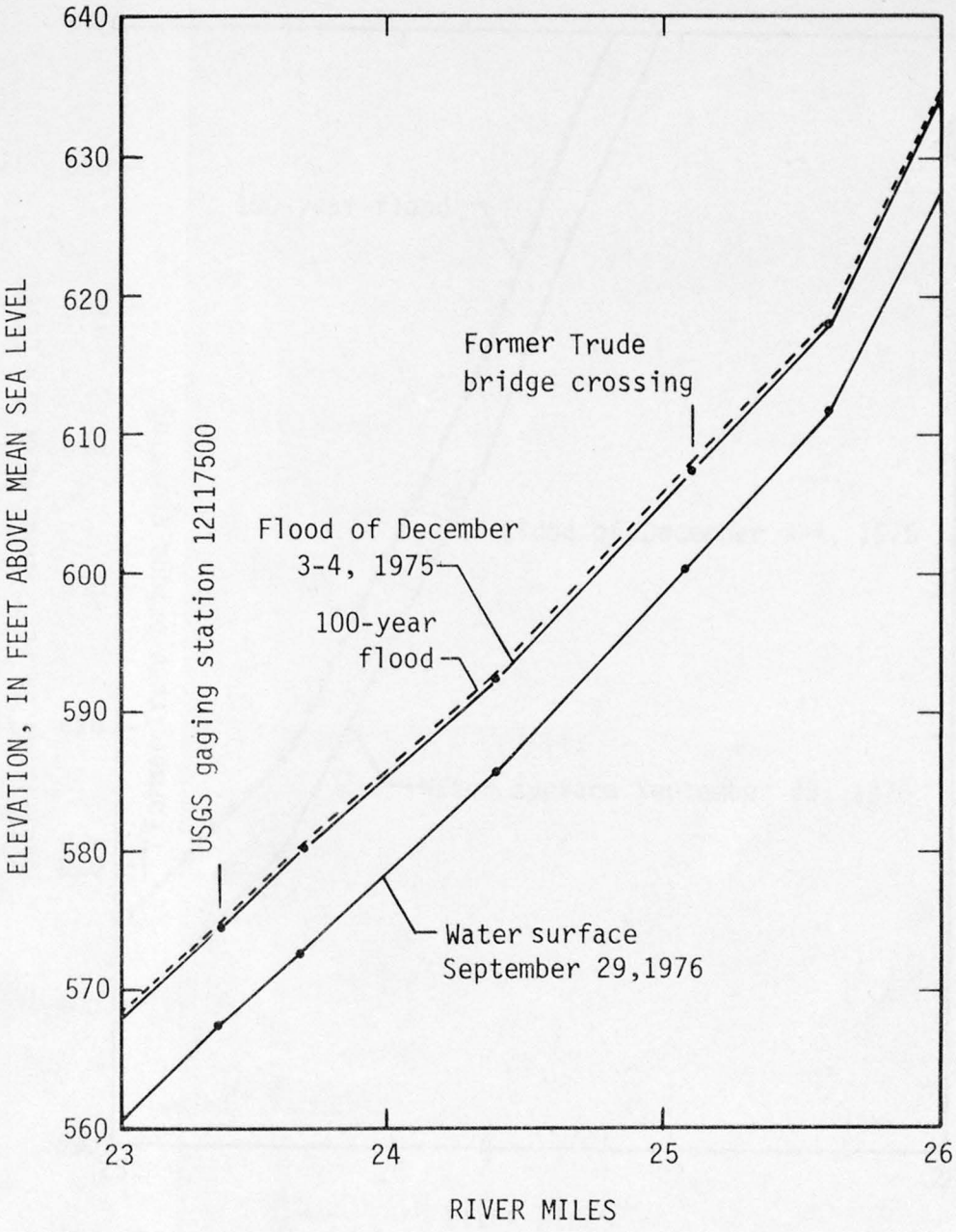

FIGURE 3b.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

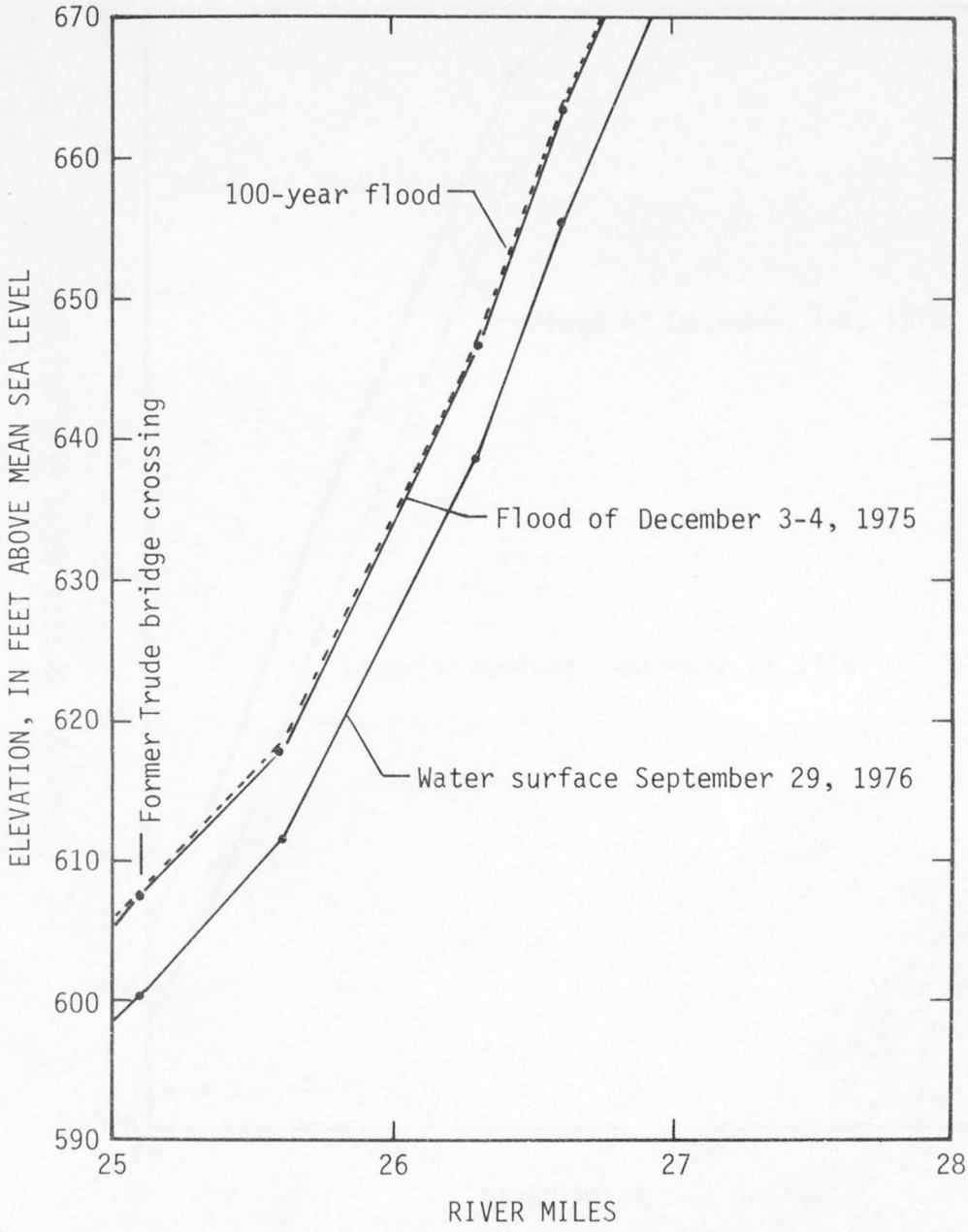

FIGURE 3c.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

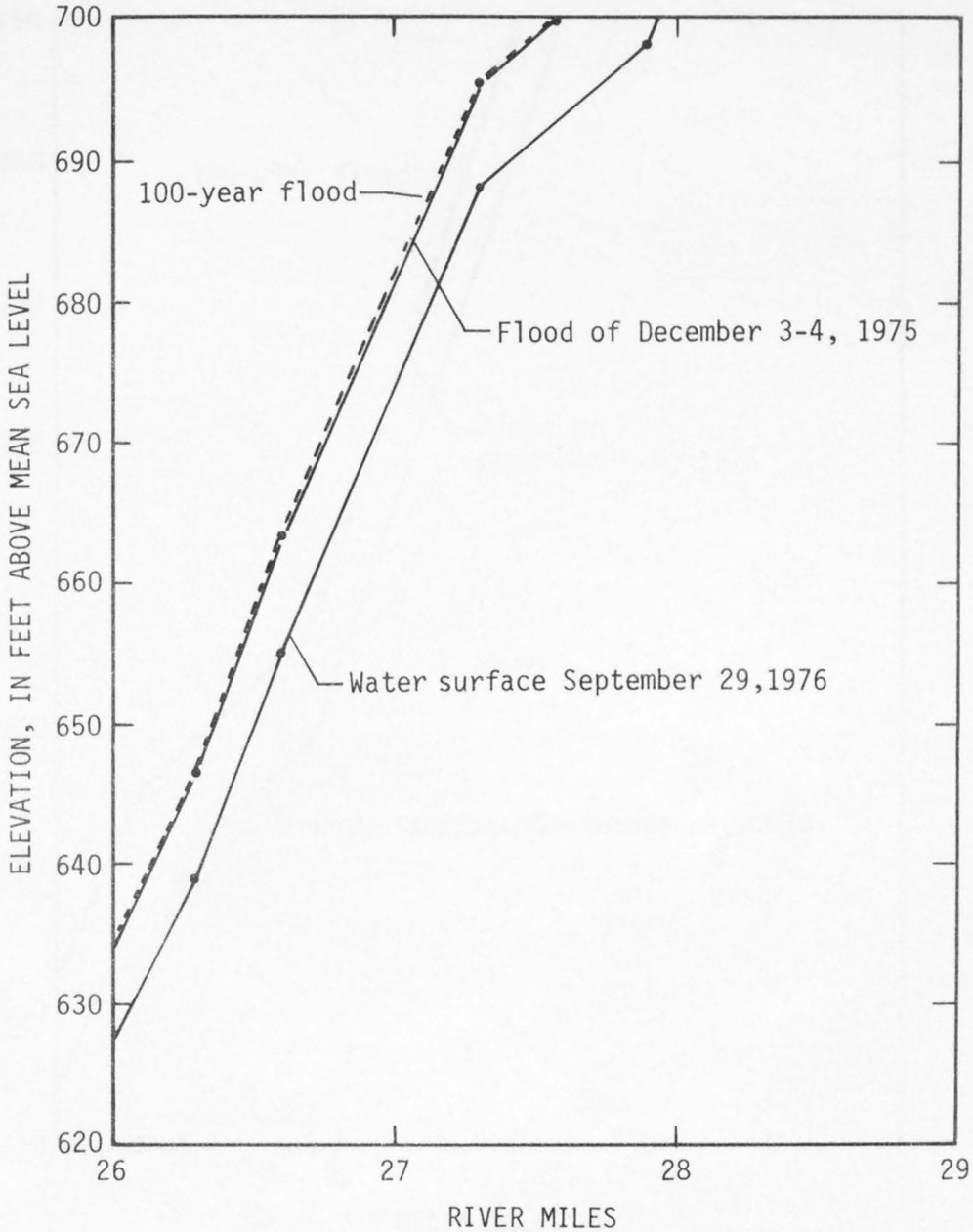

FIGURE 3d.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

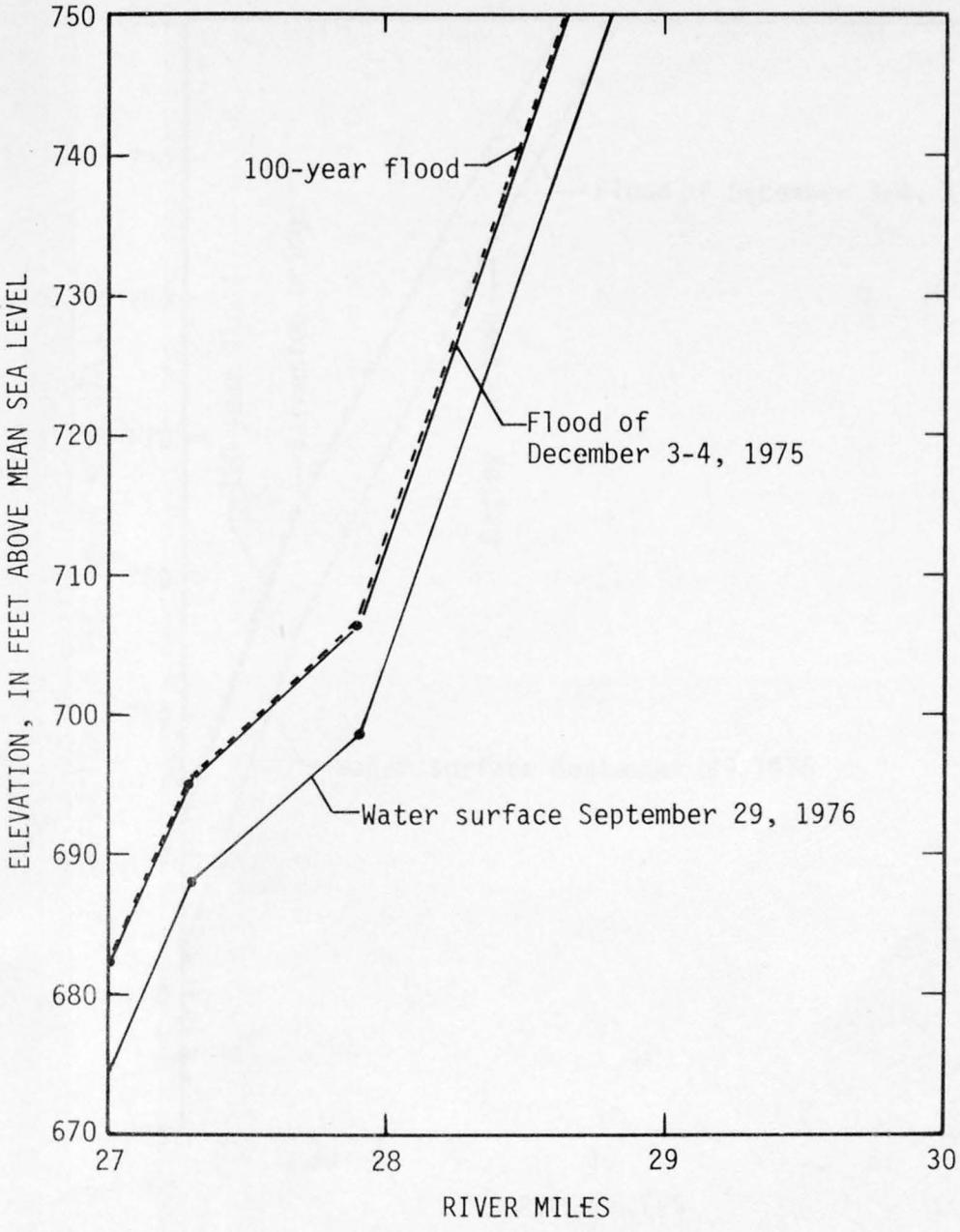

FIGURE 3e.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

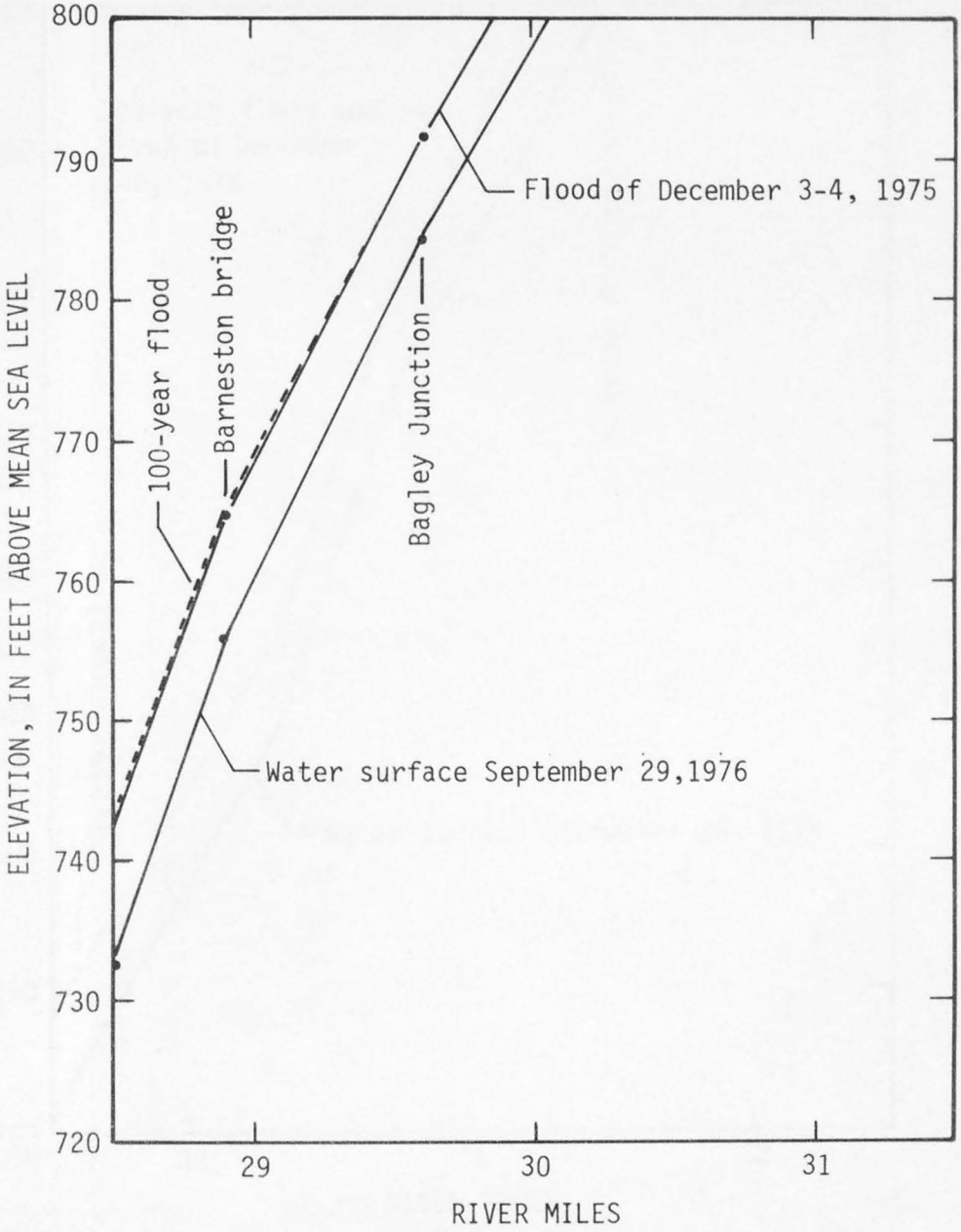

FIGURE 3f.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

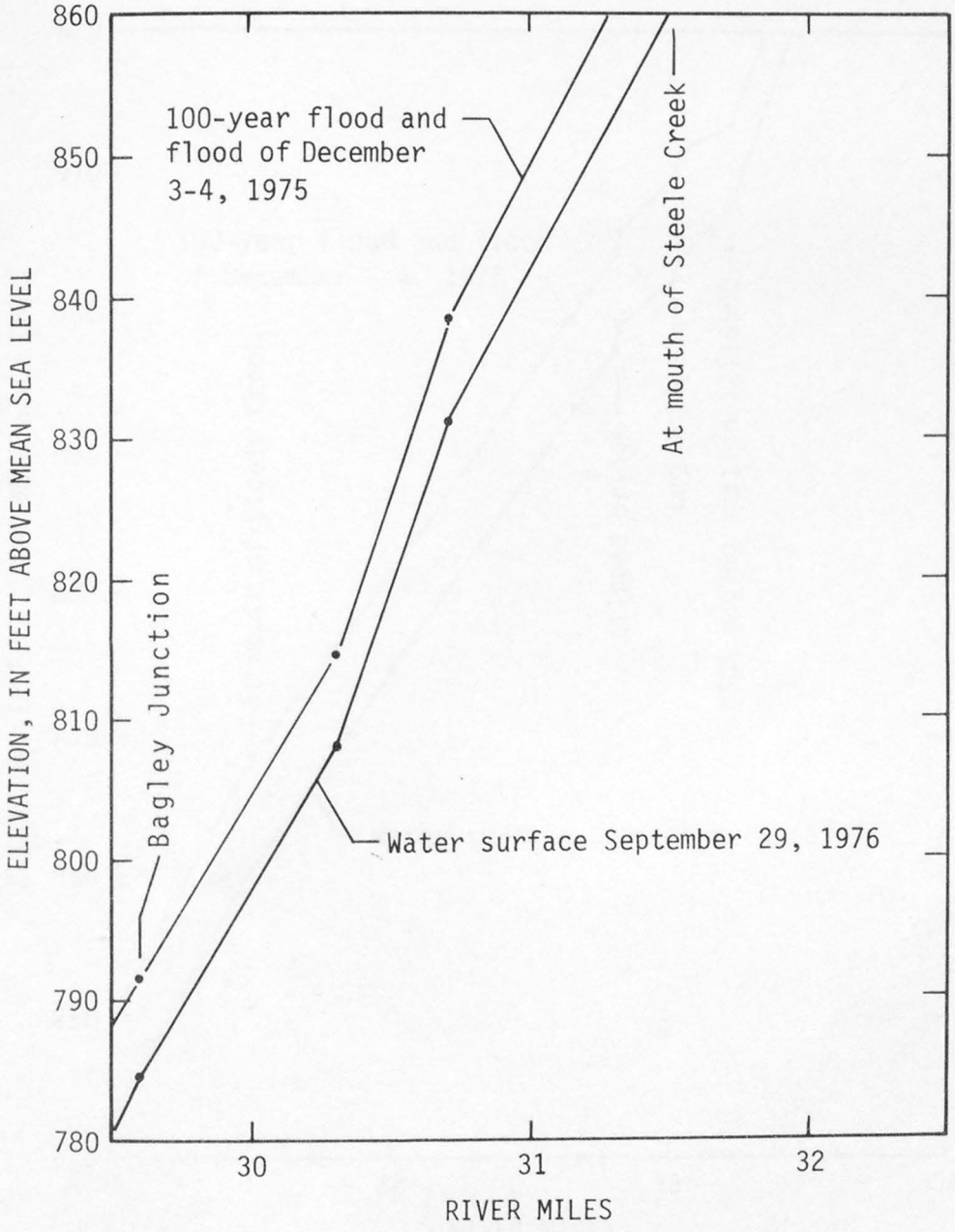

FIGURE 3g.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

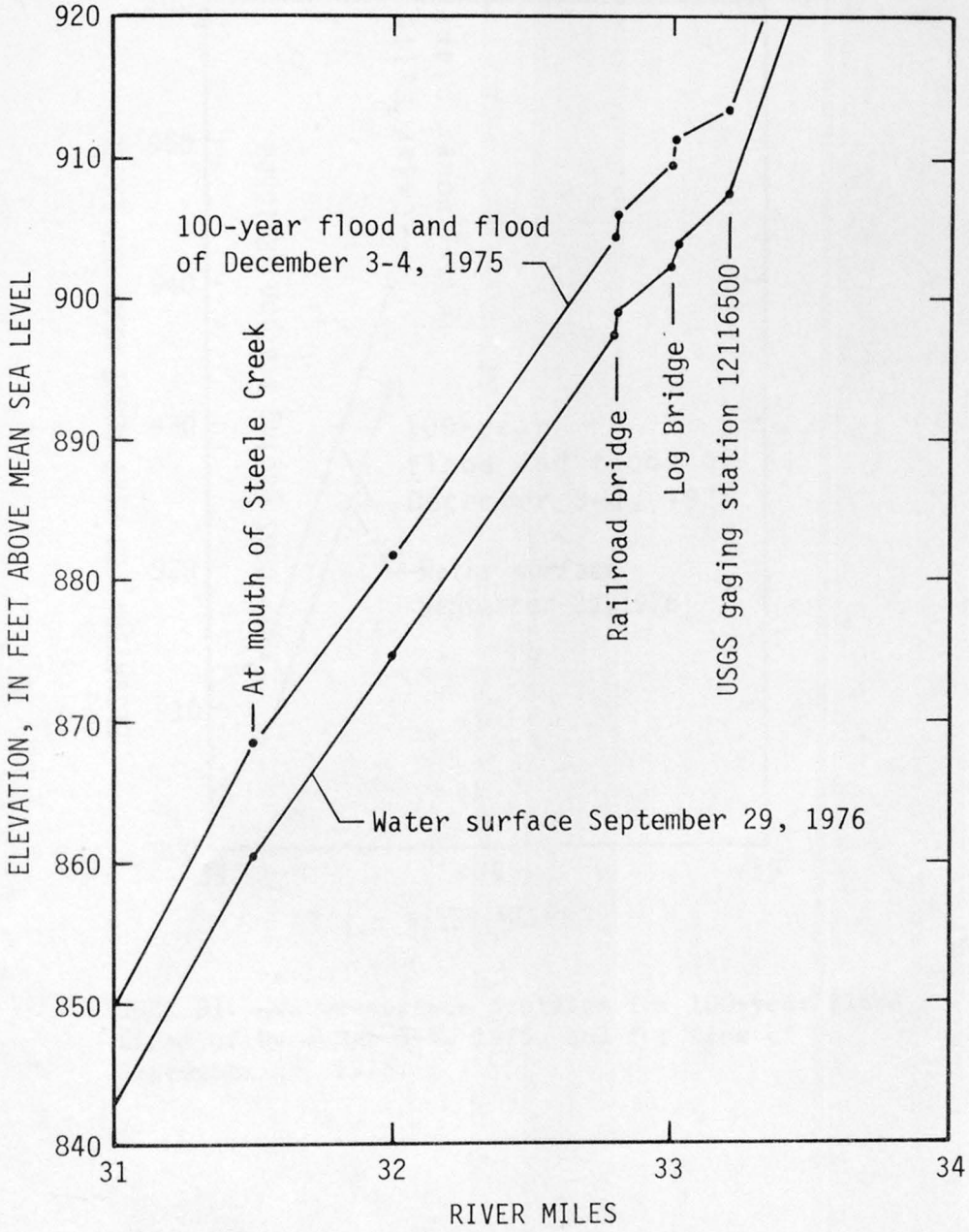

FIGURE 3h.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.

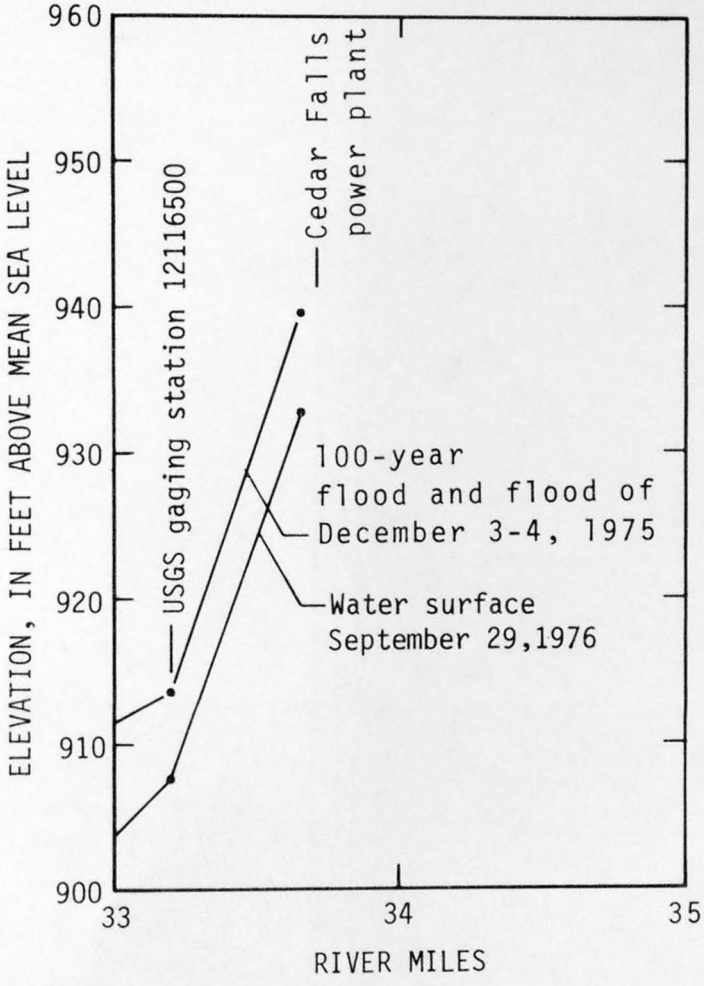

FIGURE 31.--Water-surface profiles for 100-year flood, flood of December 3-4, 1975, and for flow of September 29, 1976.