Variations in Low-Water Streambed Elevations at Selected Stream-Gaging Stations in Northwestern California

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ABSTRACT

Graphs and a table are presented showing the variations in streambed elevations that have occurred over the years in the low-water channels at selected gaging stations in northwestern California. The streambed elevations are calculated from data obtained during discharge measurements. The greatest elevation changes that were recorded occurred between the 1964 and 1965 low-water periods. Those streambed changes are related to the flood of December 1964 and probably reflect large quantities of sediment placed in the streams from bank erosion and landslides. At 25 of 51 stations with data for that period, elevation changes exceeded 1 foot, and at 42 stations the changes represented fill, rather than scour.

INTRODUCTION

PURPOSE AND SCOPE

Streambeds commonly tend toward a stable condition by adjusting to the discharge and to the character and quantity of sediment supplied. However, major deviations from this stable condition may occur during a stream's history because of floods of large magnitude. This was dramatically illustrated in northwestern California by the major streambed alterations associated with the flood of December 1964, in which vast quantities of sediment entered the channels and caused a general rise in streambed elevations.

Knowledge of how much these elevations exceeded the prior streambed elevations is very important for the design of hydraulic structures. This is especially true for the design of bridge footings and of invert elevations for river inflow and outflow conduits.

In California, very little, if any, work has been done to determine and to compile the available streambed data. This report fills that need, in part, by compiling the historical low-water streambed eleva-

tions at selected stream-gaging stations in the northwestern drainage basins of the State.

The low-water streambed elevations in this report are the mean elevations of the low-flow channels. This particular value was used because it is a good index from which to view the long-term effects of channel fill and scour. Also, this value may be the most significant for the design of river structures.

The part of northwestern California investigated is shown on plate 1 and is approximately between lats 39°15′ and 42°00′ N., and between longs 120°15′ and 124°10′ W. The area is drained principally by the Eel, Mad, Klamath, and Smith Rivers and Redwood Creek. Smaller streams, such as the Elk and Little Rivers and Jacoby Creek, drain the slopes immediately adjacent to the coast. Bed material for most of the streams is gravel (1–100 mm), and the most common particle size is in the pebble range (4–64 mm). The surface-water hydrology of this region was discussed by Rantz (1964).[1]

ACKNOWLEDGMENTS

This study was made under the terms of a cooperative agreement between the U.S. Geological Survey and the California Department of Water Resources. The report was prepared under the general supervision of R. Stanley Lord, California district chief for the Water Resources Division of the U.S. Geological Survey, and under the immediate supervision of L. E. Young, chief of the Menlo Park subdistrict office. J. Ned Dempsey assisted in the calculation and preparation of the data.

CALCULATION OF LOW-WATER STREAMBED ELEVATIONS

The streambed elevations in this report were calculated from discharge measurements obtained during low-flow periods in the vicinity of the selected gaging stations (pl. 1). The average depth of water was subtracted from the gage height of the water surface to give the average streambed elevation with reference to gage datum. Because the data were collected during low-flow periods, the calculated streambed elevations were those of the low-water channels. Two or more streambed elevations for each year were averaged to obtain a mean yearly value. That value was used to illustrate the year-to-year changes in streambed elevation at each gaging station ("Graphs of Yearly Streambed Elevations," p. E7–E29).

[1] Rantz, S. E., 1964, Surface-water hydrology of the coastal basin of northern California: U.S. Geol. Survey Water Supply Paper 1758, 77 p.

Eighty-six of the calculated streambed elevations were compared with measurements of the lowest elevation at gaging-station control sections. Seventy-seven of the calculated elevations were within ±0.50 foot of the control-section elevations, and 84 were within −0.50 to +0.70 foot. These comparisons indicated that the data and method yielded a representative index of the actual channel elevation.

Because the measurement error of each calculated elevation is unknown, the determination of significant streambed changes is hindered. However, the above comparisons suggest that a 1-foot difference between yearly average elevations is a valid indication of change. For that reason, a change of more than 1 foot between yearly elevations is considered to be indicative of significant natural streambed modifications.

LONG-TERM AND SHORT-TERM RECORDS

The streamflow records from the selected gaging stations are categorized in this study as long-term and short-term records. Long-term records are those that exceed 5 years in length and generally include September 1965. Short-term records are those that are less than or equal to 5 years in length, and include both September 1964 and September 1965. Graphs showing the variations in low-water streambed elevations for the long-term records are shown on pages E7–E29. The short-term records were not plotted as graphs but were incorporated into the study because of the major streambed changes that occurred between September 1964 and September 1965.

The gaging station sites chosen were those not affected significantly by streamflow regulation or by manmade stabilizing influences, such as concrete gaging-station control sections. Of the 70 gaging stations operating in the report area in September 1965, 54 were selected; and 46 of these have long-term records and eight have short-term records. The 54 stations are shown on plate 1 and are identified in table 1 by name and number. The pages on which the long-term records are plotted are also shown in table 1. Of the 46 long-term records, 43 have data for both September 1964 and 1965. So, 51 out of the 54 stations shown on plate 1 have data for the 1964 and 1965 low-water periods.

VARIATIONS IN LOW-WATER STREAMBED ELEVATIONS

Streambed fill and scour are continuous processes that have their most pronounced effect during periods of high-water discharge. In northwestern California, high-water discharges are seasonal and occur primarily between the months of November and June. The period of

low-water discharge, or base flow, occurs between July and October, and during this period streambeds undergo very little change. Each yearly low water streambed elevation calculated for this study, therefore, represents the net effect of the fill and scour that occurred at the gage site during the previous high-water period.

The elevation changes recorded in this report, ranging from negligible to 13 feet, establish a frame of reference from which the magnitude of design problems dependent upon streambed change can be viewed. It is not possible to interpolate or extrapolate magnitudes of expected change directly. However, selection of gaging-station sites were geologic and hydrologic conditions are comparable to those at a proposed construction site should permit determination of a range of elevation changes that might be expected at the construction site.

The greatest recorded changes in streambed elevations generally occurred between the low-water periods of 1964 and 1965 and were related to the floods of December 1964. At 25 of the 51 stations that have records covering this period, the elevation change exceeded 1 foot, and at all but nine of 51 stations the change represented fill. Most of the fill material probably entered the streams from bank erosion and landslides associated with the flood. At several sites, particularly in the vicinity of gaging stations 11–4729 and 11–4730 in the Eel River basin and 11–5290 in the Klamath River basin, fill continued during the high-water period of November 1965 to June 1966. The gravel fill material probably was, in part, derived from continued bank erosion and landslides during the 1965–66 high-water period and, in part, from material that was brought into the upstream reaches of the affected streams during the flood of December 1964 and later transported downstream to the gage sites by the 1965–66 high water. The 1964–65 changes in low-water streambed elevations are tabulated in table 1, and are shown on plate 1. Comparative cross sections for some of the stations with the greatest 1964–65 changes are shown on pages E30–E33. The pages on which these cross sections are plotted are given in table 1.

At some of the stations the streambed elevations were altered over the years in response to manmade as well as natural causes. The principal manmade causes were the addition of sediment as a result of highway construction along the stream and the removal of sediment for channel improvement or for commercial sand and gravel supplies. The effect of these manmade influences is clearly evident in the graphs for gaging stations 11–4725, 11–4765, and 11–4766 in the Eel River basin (p. E7, E12, E13), 11–4810 in the Mad River basin, and (p. E16), and 11–5178, 11–5223, and 11–5265 in the Klamath River basin (p. E19, E21, E25).

In the area studied, most of the observed changes were positive—that is, the streambeds filled. It has to be expected that a long-term decrease in streambed elevation will probably occur in the future, provided that the banks and landslopes stabilize. Any design for structures built in the stream channels will have to take this future reduction in streambed elevations into account.

TABLE 1.—*Summary of changes in streambed elevation at selected gaging stations in northwestern California*

[Symbol (a) in first column indicates short-term record; all others are long term. Minus sign in third column indicates scour; all other differences are fill. Dash leaders in third column indicate no data available for 1965]

	Gaging-station		Difference between 1964 and 1965 low-water streambed elevation (feet)	Page in this report	
	No.	Name		Graph of yearly streambed elevations	Graph of comparative cross sections
		Eel River basin			
(a)	11–4718	Tomki Creek near Willits	0.8		
	4722	Outlet Creek near Longvale	2.5	E7	E30
	4725	Eel River above Dos Rios	1.7	E7	
	4729	Black Butte River near Covelo	7.8	E8	E30
	4730	Middle Fork Eel River below Black Butte River, near Covelo	6.7	E8	E31
(a)	4731	Williams Creek near Covelo	1.3		
(a)	4735.3	Mill Creek below Alder Creek, near Covelo	5.0		
	4736	Short Creek near Covelo	−.9	E9	
	4737	Mill Creek near Covelo	0	E9	
(a)	4738	Elk Creek near Hearst	4.2		
	4740	Eel River below Dos Rios	2.4	E10	
	4745	North Fork Eel River near Mina	1.3	E10	
	4750	Eel River at Alderpoint		E11	
	4755	South Fork Eel River near Branscomb	−.2	E11	
	4757	Tenmile Creek near Laytonville	−.5	E12	
	4765	South Fork Eel River near Miranda	1.1	E12	
	4766	Bull Creek near Weott	2.4	E13	
	4767	Larabee Creek near Holmes	1.9	E13	
	4770	Eel River at Scotia	.3	E14	
(a)	4775	Van Duzen River near Dinsmores	.2		
	4777	South Fork Van Duzen River near Bridgeville	2.3	E14	
	4785	Van Duzen River near Bridgeville	7.2	E15	E31
		Elk River basin			
(a)	11–4797	Elk River near Falk	0.7	E15	
		Mad River basin			
	11–4805	Mad River near Forest Glen	0.2	E16	
	4810	Mad River near Arcata	−2.8	E16	
		Little River basin			
	11–4812	Little River at Crannel	0.2	E17	
		Redwood Creek basin			
	11–4825	Redwook Creek at Orick	0.3	E17	

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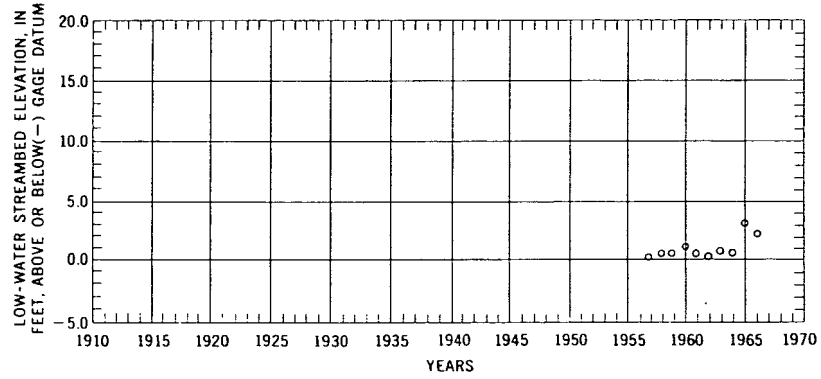
TABLE 1.—*Summary of changes in streambed elevation at selected gaging stations in northwestern California*—Continued

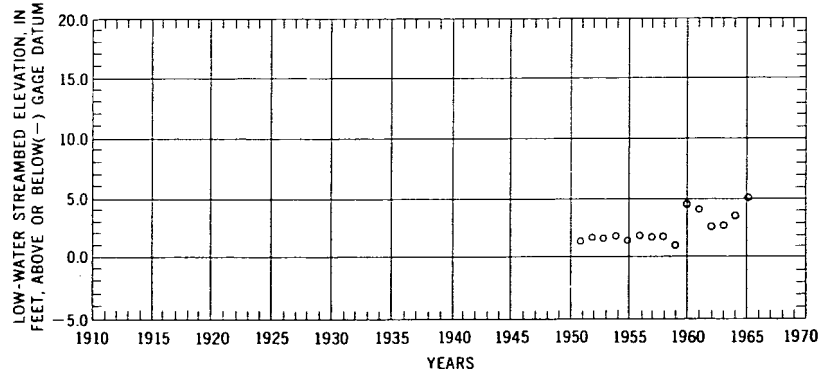
Gaging-station No.	Gaging-station Name	Difference between 1964 and 1965 low-water streambed elevation (feet)	Page in this report: Graph of yearly streambed elevations	Page in this report: Graph of comparative cross sections
	Klamath River basin			
11–4895	Antelope Creek near Tennant	0.1	E18	
(a)5166	Cottonwood Creek at Hornbrook	.6		
5169	Little Shasta River near Montague	...	E18	
5175	Shasta River near Yreka	.2	E19	
5178	Beaver Creek near Klamath River	−1.1	E19	
(a)5180.5	East Fork Scott River at Callahan	.4		
(a)5186	Moffett Creek near Fort Jones	0		
5195	Scott River near Fort Jones	−.1	E20	
5205	Klamath River near Seiad Valley	.1	E20	
5215	Indian Creek near Happy Camp	3.1	E21	
5223	South Fork Salmon River near Forks of Salmon	2.5	E21	E32
5225	Salmon River at Somesbar	...	E22	
5230	Klamath River at Somesbar	3.0	E22	
5232	Trinity River above Coffee Creek, near Trinity Center.	−.3	E23	
5237	Coffee Creek near Trinity Center	1.4	E23	
5258	Weaver Creek near Douglas City	−.3	E24	
5259	Browns Creek near Douglas City	−.1	E24	
5265	North Fork Trinity River at Helena	.8	E25	
5270	Trinity River near Burnt Ranch	.6	E25	
5274	New River at Denny	4.0	E26	E32
5281	South Fork Trinity River at Forest Glen	2.2	E26	
5284	Hayfork Creek near Hayfork	.3	E27	
5285	Hayfork Creek near Hyampom	.6	E27	
5290	South Fork Trinity River near Salyer	12.9	E28	E33
5298	Willow Creek near Willow Creek	13.0	E28	
	Smith River basin			
11–5310	Middle Fork Smith River at Gasquet	1.5	E29	E33
5325	Smith River near Crescent City	−.3	E29	

GRAPHS OF YEARLY STREAMBED ELEVATIONS

EEL RIVER BASIN



Gaging-station number: 11–4722.
Gaging-station name: Outlet Creek near Longvale, Calif.
Elevation of gaging-station datum, in feet, above msl: 1,020.
Notable flood peaks: 26,500 cfs Feb. 8, 1960; 77,900 cfs Dec. 22, 1964.



Gaging-station number: 11–4725.
Gaging-station name: Eel River above Dos Rios, Calif.
Elevation of gaging-station datum, in feet, above msl: 950.
Notable flood peaks: 123,000 cfs Dec. 22, 1955; 184,000 cfs Dec. 22, 1964.

Remarks: During 1960, sediment placed in channel above and below gage site by road construction along right bank. Gage discontinued September 1965.