HYDROLOGIC DATA FOR THE LOWER COPPER RIVER, ALASKA MAY TO SEPTEMBER 1991

By Timothy P. Brabets

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CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
ton per day (ton/d)	0.9072	megagram per day

Abbreviations used in report:

mg/L, milligram per liter

mm, millimeter

National Geodetic Vertical Datum of 1929 (NGVD of 1929):

A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

A geomorphology study of the lower Copper River was begun in April 1991. As part of this study, discharge, suspended sediment, and bedload data were collected at 12 sites along the Copper River Highway from May to September 1991. In addition, a common datum was established in the study area by use of Global Positioning System (GPS) techniques.

INTRODUCTION

The lower Copper River (fig. 1), including the Copper River Delta, is a highly complex and dynamic system. Near its mouth, the river drains approximately 24,000 mi^2 and has an average discharge of about 67,000 ft^3/s, the third largest discharge in the State of Alaska. Large amounts of sediment are transported from glaciers in the basin and also from erodible banks. Channels in the approximately 300-square-mile delta constantly scour and fill, shifting the flow from one channel to another. In addition, the lower Copper River floods approximately every 5 years because of the outburst of glacier-dammed Van Cleve Lake.

The Copper River Highway begins at Cordova and crosses 11 bridges as it traverses the Copper River Delta to the east (fig. 2). The road presently ends after 48 miles at the Million Dollar Bridge. Several of the bridges on the delta have been damaged by excessive scour around their piers, and one, Bridge 342, has undergone major reconstruction to repair damage caused by lateral migration of the channel.

In April 1991, under a cooperative water resources agreement with the State of Alaska Department of Transportation and Public Facilities, the U.S. Geological Survey began a study of the geomorphology of the lower Copper River. The objectives of this study are: (1) to document the lateral migration and vertical scour of channels in the lower Copper River, (2) to determine the ongoing processes causing the lateral migration and vertical scour of these channels, and (3) to predict areas within the lower Copper River that will be subject to future erosion or deposition. This report summarizes data collected from May to September 1991.

DISCHARGE

The USGS has operated a daily streamflow station on the Copper River at the Million Dollar Bridge since 1988. In water year 1991, continuous streamflow data were collected from May 22 (shortly after breakup) through the remainder of the water year. During this period, mean daily discharge ranged from about 43,000 to about 230,000 ft^3/s (fig. 3). Two distinct high flow periods occurred: the first, on around June 24, was caused by snowmelt runoff in the basin; and the second, on around August 18, was the result of rainfall runoff.

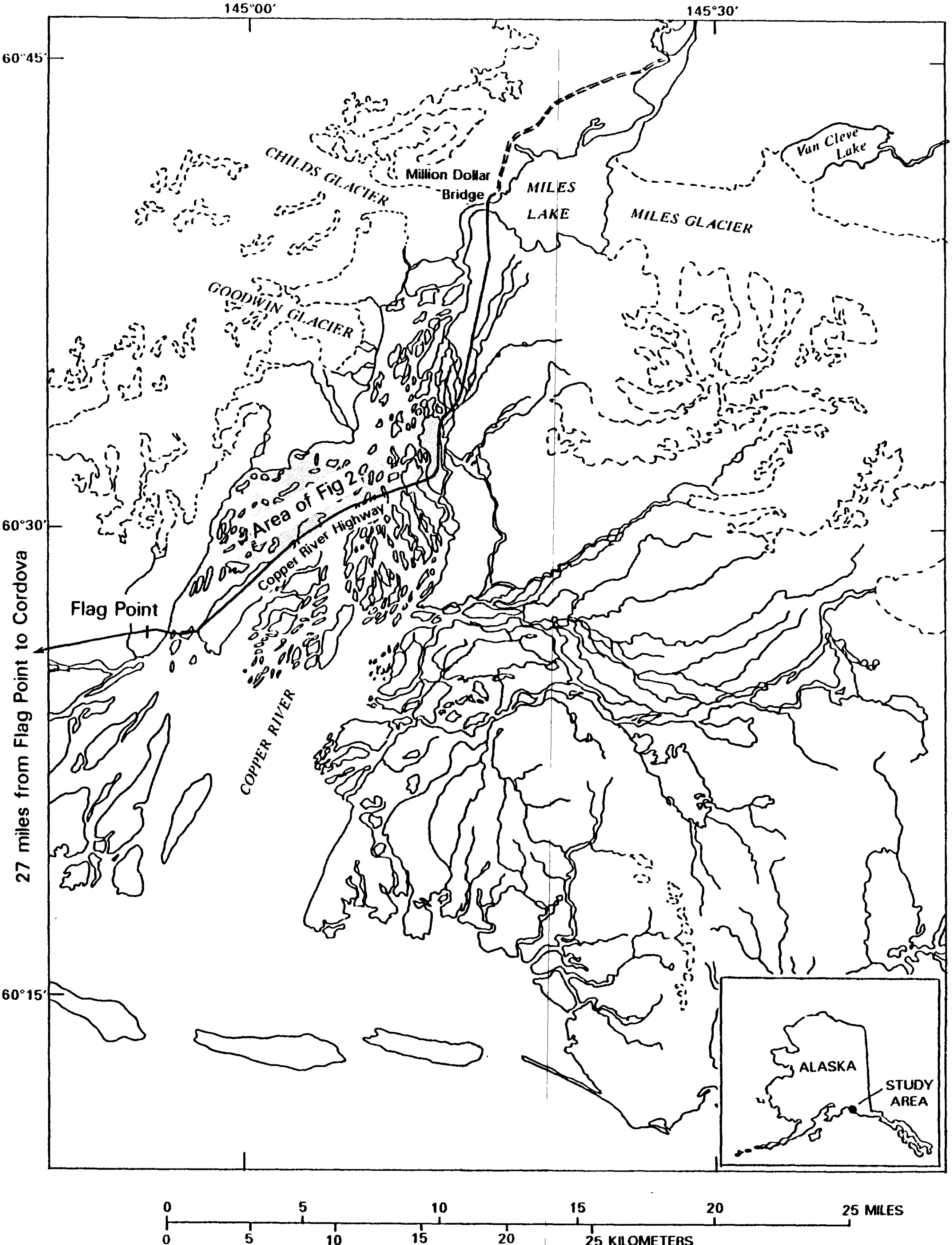

Figure 1.--The lower Copper River delta.

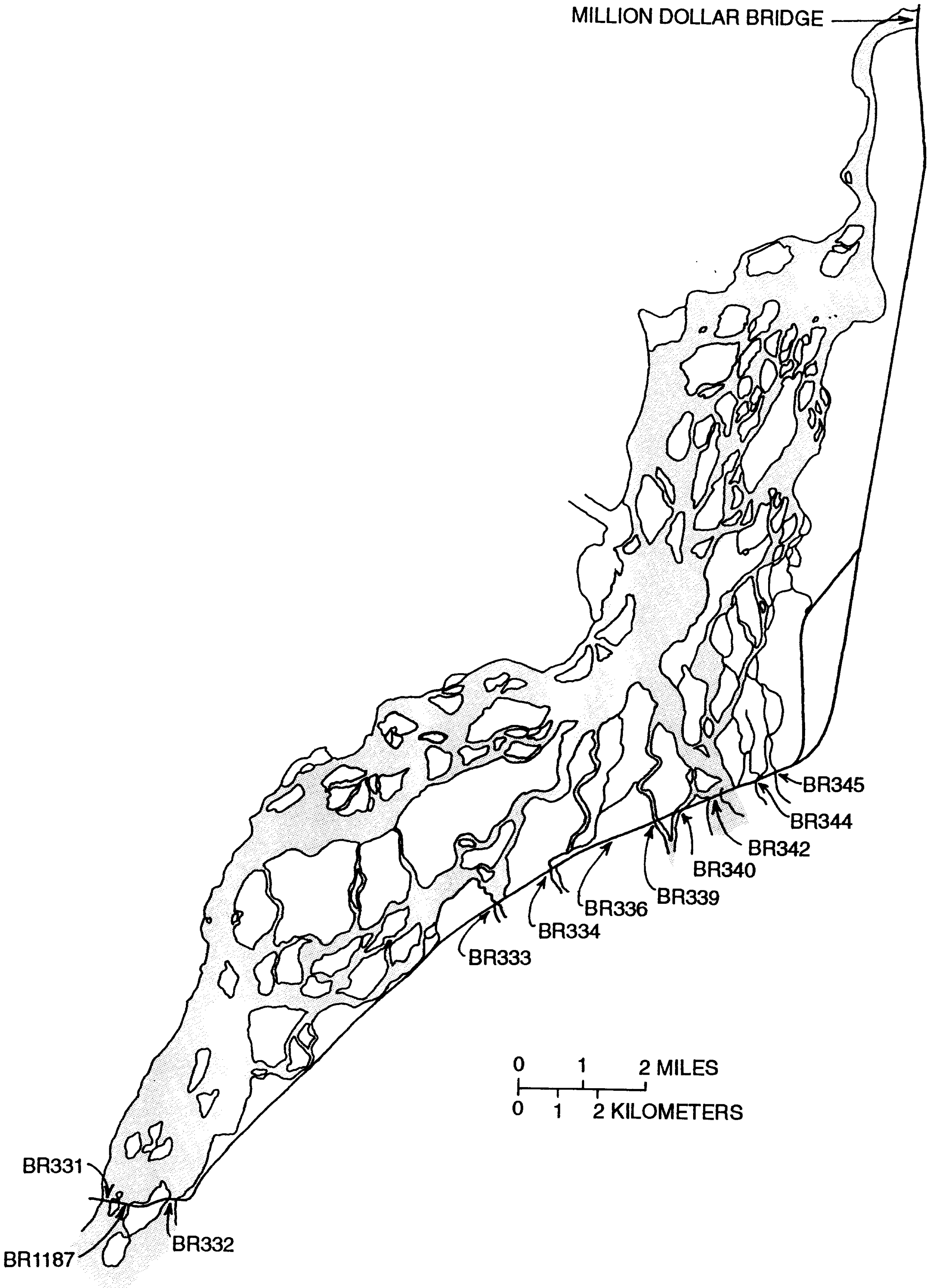

Figure 2.--Locations of bridges along the Copper River Highway.

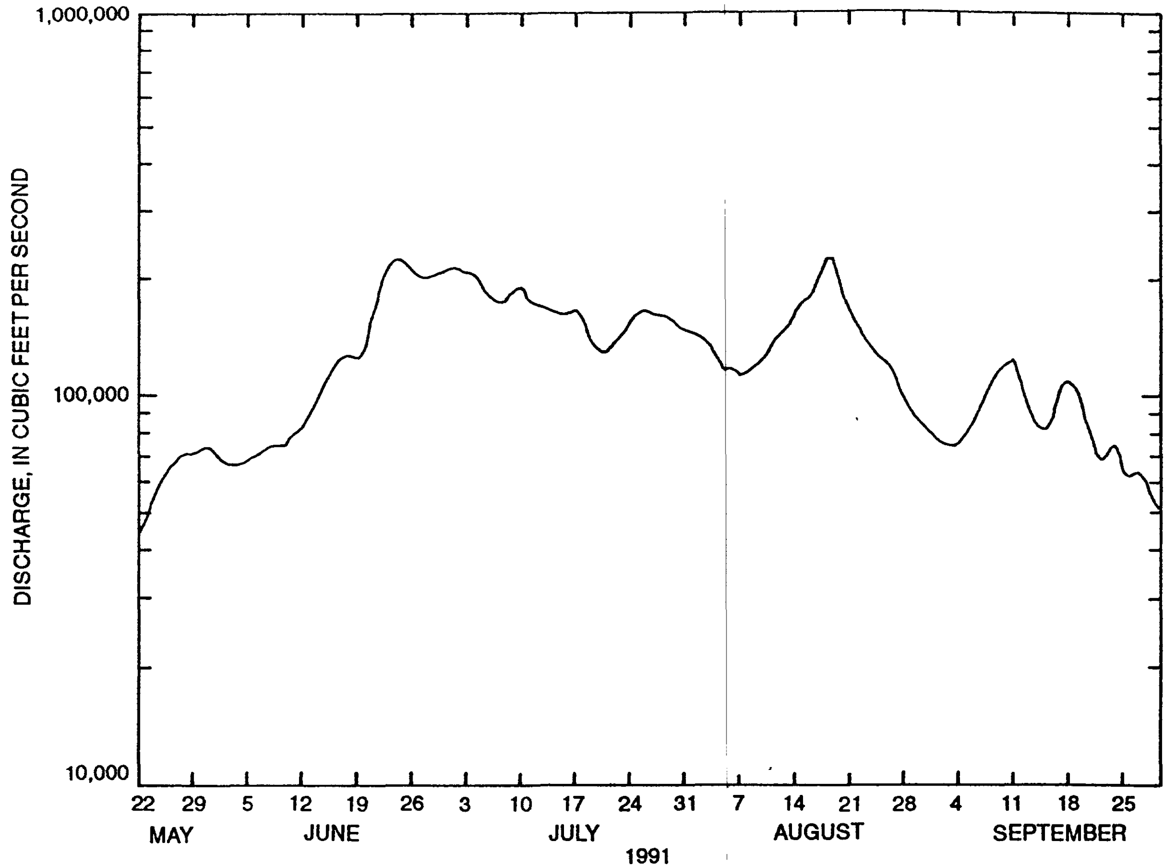

Figure 3.--Mean daily discharge of the Copper River at Million Dollar Bridge, May 22 to September 30, 1991.

Discharge measurements were made at the 11 bridges (fig. 2) along the Copper River Highway at approximately 2-week intervals from June through September (table 1). The measurements determined flow distribution of the Copper River as it passed under the highway. The highest discharges were measured at Bridge 342; they were between 42 and 54 percent of the concurrent flow at the Million Dollar Bridge. At Bridge 331, measured flows were between 28 and 40 percent of the flow at the Million Dollar Bridge. No flow occurred at Bridge 336.

SUSPENDED SEDIMENT

Suspended-sediment samples were collected concurrently with the discharge measurements. Samples at the Million Dollar Bridge, Bridges 331, 1187, 332, and 342 were collected using a P-63 point sampler or a D-74 depth integrating sampler. The samples were obtained by the equal-discharge increment (EDI) method as described by Guy and Norman (1970). Suspended-sediment samples at the remaining bridges were collected by dip sampling.

Concentrations of suspended sediment were primarily flow dependent (table 2). The lowest concentrations were found in samples collected in September, a low-flow period. Highest concentrations of suspended sediment were found in July or August during high-flow periods. It is during this period that the majority of the sediment is transported past the bridge sites. Most of the suspended sediment is composed of silt and clay material.

Table 1.--Discharge of the Copper River at bridges along the Copper River Highway

[Data values in cubic feet per second]

Date 1991	Bridge name 331	1187	332	333	334	336	339	340	342	344	345	Million Dollar
6/7	[1]29,000	[1]8,700	[1]7,800	0	0	0	0	0	37,900	0	0	66,000
6/18-6/20	36,100	16,700	15,000	2,600	1,800	0	1,200	4,100	64,300	0	0	[2]128,000
7/1-7/2	52,800	35,000	29,400	5,800	12,000	0	5,400	11,800	91,400	100	1,100	[3]216,000
7/24	44,600	26,100	19,700	4,700	5,000	0	2,300	6,800	73,900	0	0	159,000
8/13-8/14	48,800	29,500	21,600	5,000	6,000	0	1,900	7,700	78,600	0	0	[4]158,000
8/28-8/29	35,800	14,400	9,000	2,200	600	0	600	1,100	45,500	0	0	[5]95,400
9/12	38,300	19,000	13,000	2,500	1,000	0	1,000	1,500	54,400	0	0	108,000
9/23	31,700	11,500	7,200	800	400	0	40	200	40,000	0	0	71,500

[1]Estimated
[2]Average from 6/18 to 6/20
[3]Average from 7/1 to 7/2
[4]Average from 8/13 to 8/14
[5]Average from 8/28 to 8/29

Table 2.--Suspended-sediment and bedload data for the Copper River at bridges along the Copper River Highway

[ft^3/s, cubic feet per second; mg/L, milligrams per liter; mm, millimeter; ton/d, tons per day; --, no data]

				Suspended sediment			Bedload	
Bridge name	Date	Time	Water discharge (ft^3/s)	Concentration (mg/L)	Percent finer than 0.062 mm	Discharge (ton/d)	Median diameter (d50) (mm)	Discharge (ton/d)
331	6-20-91	0920	36,100	805	84	78,500	1.9	4,300
	7-02-91	1500	52,800	1,690	90	241,000	1.5	1,300
	7-24-91	1600	44,600	1,290	88	155,000	.4	750
	8-14-91	1530	48,800	2,005	83	264,000	2.3	1,850
	8-29-91	1540	35,800	503	99	48,600	1.0	550
	9-12-91	1845	38,300	963	78	99,600	--	--
	9-23-91	1200	31,700	664	98	56,800	--	--
1187	6-20-91	0830	16,700	840	81	37,900	.6	1,700
	7-02-91	1400	35,000	1,780	86	168,000	.6	2,200
	7-24-91	1445	26,100	1,240	88	87,400	1.8	3,500
	8-14-91	1500	29,500	2,022	84	161,000	.9	3,600
	8-29-91	1445	14,400	772	93	30,000	.4	1,300
	9-12-91	1830	19,000	913	82	46,800	--	--
	9-23-91	1215	11,500	564	98	17,500	--	--
332	6-19-91	1700	15,000	750	85	30,400	.6	2,000
	7-02-91	1300	29,400	1,530	92	121,000	.9	2,000
	7-24-91	1300	19,700	1,170	90	62,200	.6	2,500
	8-14-91	1410	21,600	1,865	85	109,000	.6	4,100
	8-29-91	1345	9,000	875	94	21,300	.7	400
	9-12-91	1800	13,000	861	85	30,200	--	--
	9-23-91	1240	7,200	664	98	12,900	--	--
333	7-02-91	1725	5,800	1,310	99	20,500	--	--
	7-25-91	1220	4,700	1,060	97	13,400	--	--
	8-15-91	1350	5,000	1,410	--	19,000	--	--
	8-28-91	1310	2,200	781	96	4,600	--	--
	9-25-91	1145	800	546	93	1,200	--	--
334	7-02-91	1720	12,000	1,321	96	42,800	--	--
	7-25-91	1215	5,000	1,050	97	14,200	--	--
	8-15-91	1345	6,000	1,560	93	25,300	--	--
	8-28-91	1225	600	624	98	1,000	--	--
	9-25-91	1130	400	304	99	300	--	--

Table 2.--Suspended-sediment and bedload data for the Copper River at bridges along the Copper River Highway--Continued

Bridge name	Date	Time	Water discharge (ft^3/s)	Suspended sediment: Concentration (mg/L)	Suspended sediment: Percent finer than 0.062 mm	Suspended sediment: Discharge (ton/d)	Bedload: Median diameter (d50) (mm)	Bedload: Discharge (ton/d)
339	7-02-91	1710	5,400	1,140	98	16,600	--	--
	7-25-91	1155	2,300	1,060	97	6,500	--	--
	8-15-91	1330	1,900	2,230	--	11,400	--	--
	8-28-91	1130	600	634	100	1,000	--	--
	9-23-91	1115	40	212	98	23	--	--
340	6-20-91	1600	4,100	786	91	8,700	--	--
	7-02-91	1705	11,800	1,321	96	42,100	--	--
	7-25-91	1150	6,800	1,040	98	19,100	--	--
	8-15-91	1310	7,700	1,370	95	28,500	--	--
	8-28-91	1100	1,100	707	99	2,100	--	--
	9-25-91	1100	200	372	100	200	--	--
342	6-18-91	1500	64,300	790	84	137,000	12.5	14,700
	7-02-91	1630	91,400	1,340	91	331,000	--	--
	7-24-91	1100	73,900	1,210	90	241,000	--	--
	8-14-91	1100	78,600	1,375	89	292,000	--	--
	8-29-91	0900	45,500	882	93	108,000	9.6	1,700
	9-12-91	1320	54,400	791	92	116,000	--	--
	9-23-91	1030	40,000	530	96	57,200	--	--
Million Dollar	6-28-91	1150	206,000	1,201	94	668,000	--	--
	8-07-91	1520	120,000	1,014	95	328,500	--	--
	8-29-91	1020	94,500	1,396	98	356,200	--	0
	9-11-91	1500	120,000	829	94	268,600	--	--
	9-24-91	1531	78,100	528	94	111,300	--	0

BEDLOAD

Bedload samples were collected from the beginning of June through the end of August at Bridges 331, 1187, 332, and 342. Two bedload samples were collected at the Million Dollar Bridge. Bedload samples were collected using a Helley-Smith bedload sampler (Helley and Smith, 1971) which is designed to sample coarse material (0.062-76.2 mm) within 0.3 ft of the streambed. The sampler was held on the bed for 30-second intervals at 15 to 20 equally spaced points across the channel.

Some general observations can be made concerning the limited amount of bedload data collected (figs. 4-7). No bedload was found in the two samples from the Million Dollar Bridge at the outlet of Miles Lake. Also, a distinct difference is apparent in the size of the bedload transported past Bridge 342 and the size of bedload transported past Bridges 331, 1187, and 332. On June 18, and 20, 1991, for example, median grain diameter was 12.5 mm at Bridge 342 and 1.9, 0.6, and 0.6 mm, respectively at Bridges 331, 1187, and 332.

SURVEY AND CROSS-SECTIONAL DATA

Because part of this study will probably involve flow and (or) sediment modeling, a common datum was established for the entire study area. Monuments were placed at all bridges, and control was established using the Global Positioning System (GPS) (table 3). Additional monuments are planned for the study area in 1992, and control will be established by GPS methods.

Severe erosion problems have occurred at Bridge 342. During the winter of 1990-91, spur dikes were constructed at this bridge in order to protect the structure from further erosion. In May 1991, a survey was done in the vicinity of the dikes and bridge to document conditions before the runoff season began.

Noted features from this survey are the gravel bar upstream from the bridge and a scour hole about 50 ft deep located about 100 ft off the tip of the upstream left spur dike (fig. 8). Additional cross sections of the channel obtained from the discharge measurements show the channel filling on the left side and scouring on the right side from June to September (fig. 9).

REFERENCES CITED

Guy, H.P., and Norman, V.W., 1970, Field methods for measurement of fluvial sediment: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chapter C2, 59 p.

Helley, E.J., and Smith, Winchell, 1971, Development and calibration of a pressure-difference bedload sampler: U.S. Geological Survey Open-File Report, 18 p.

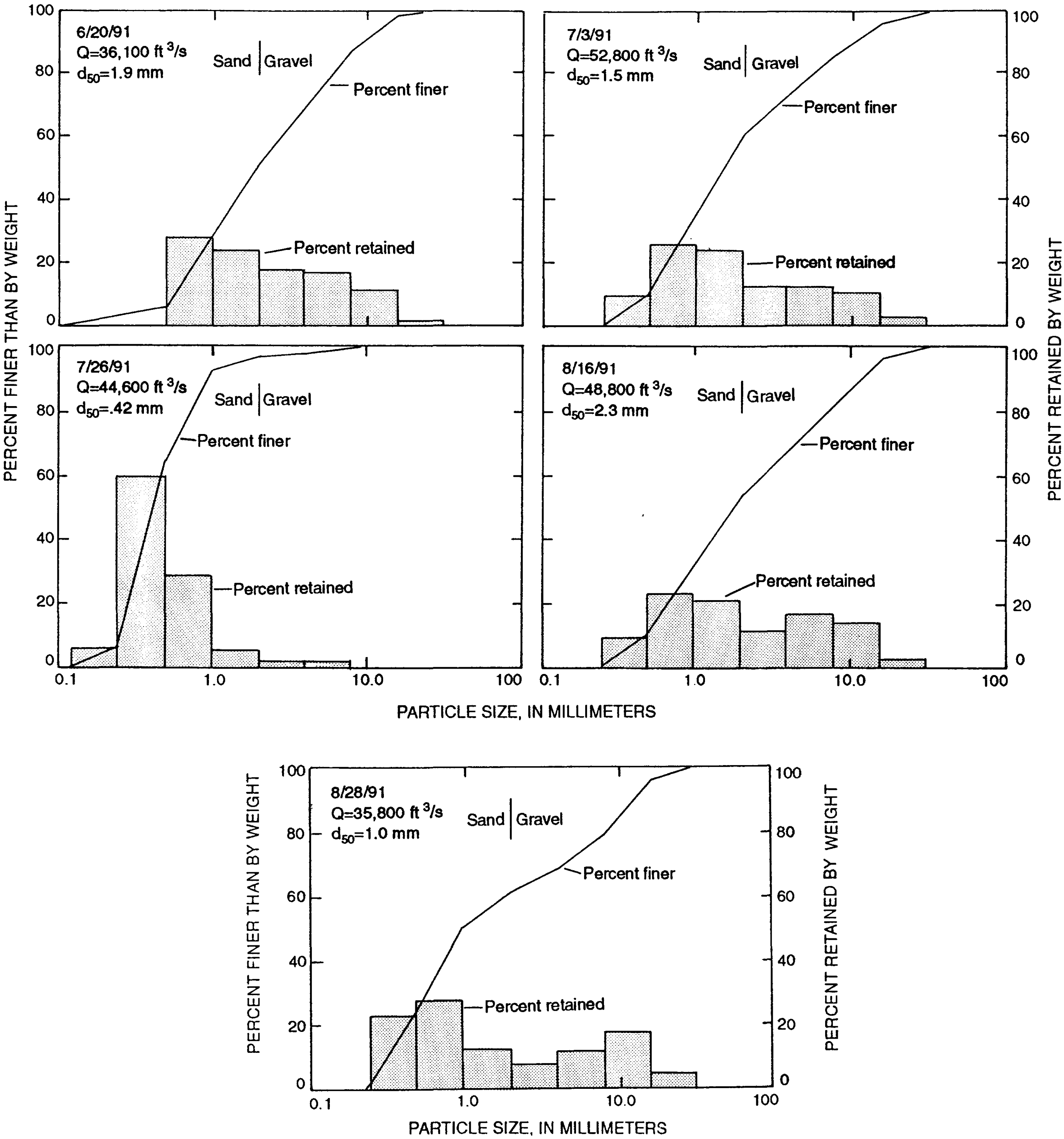

Figure 4.--Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 331.

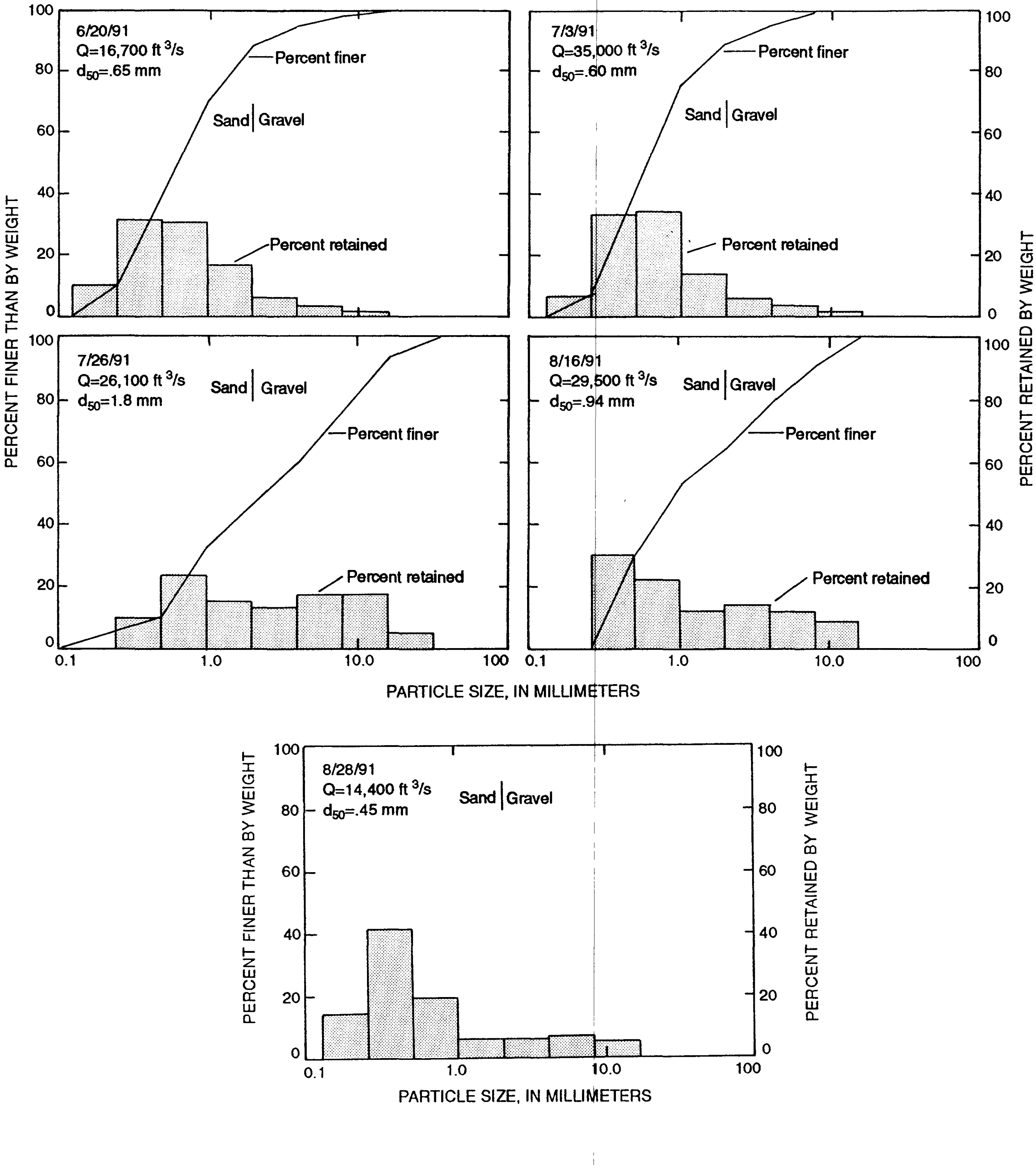

Figure 5.--Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 1187.

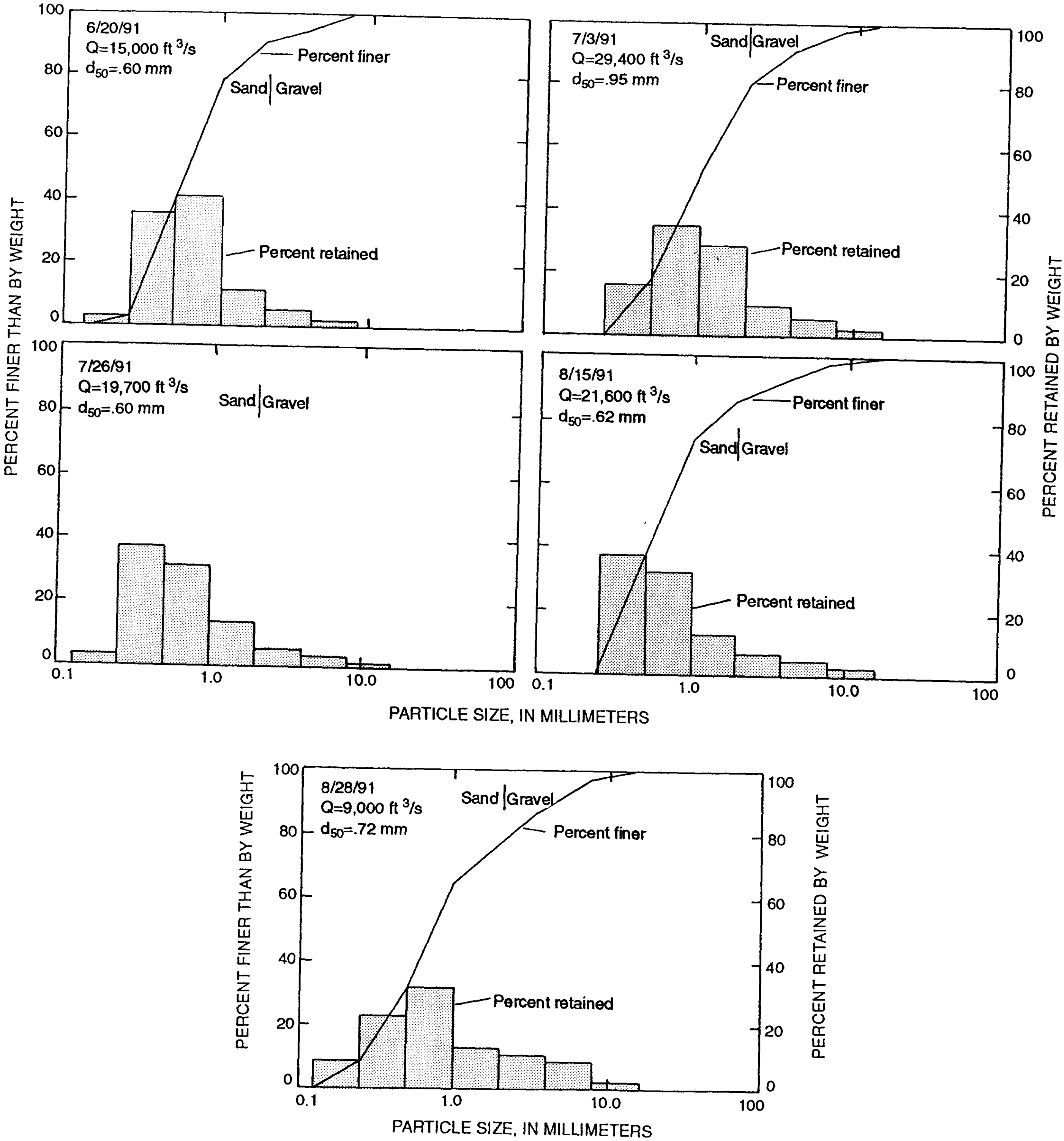

Figure 6.--Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 332.

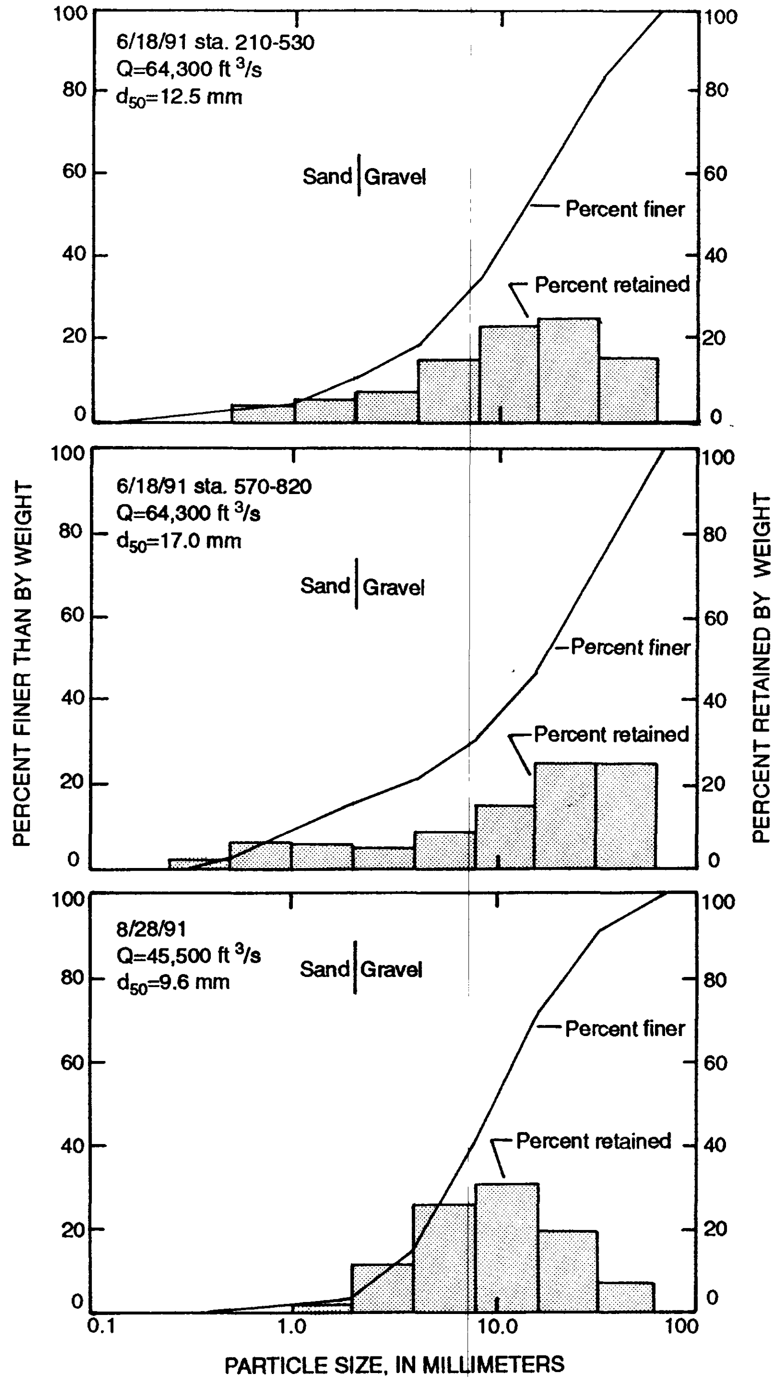

Figure 7.--Particle-size distribution and median diameter (d_{50}) of bedload, Copper River at Bridge 342.

Table 3.--Results of Global Positioning System survey along the Copper River Highway, 1991

Location	Latitude	Longitude	Elevation (feet) (NGVD of 1929)
Bridge 331			
West upstream abutment	60°26'46.460"	145°05'00.951"	43.83
Bridge 1187			
West upstream abutment	60°26'44.333"	145°04'36.566"	43.86
Bridge 332			
West upstream abutment	60°26'45.975"	145°03'25.327"	43.80
East downstream abutment	60°26'44.681"	145°03'09.404"	43.90
Bridge 333			
West downstream abutment	60°30'05.472"	144°55'19.221"	61.45
East downstream abutment	60°30'06.724"	144°55'15.157"	61.55
Bridge 334			
West downstream abutment	60°30'30.560"	144°53'57.679"	58.66
East upstream abutment	60°30'36.789"	144°53'37.316"	58.60
Bridge 336			
West upstream abutment	60°30'52.362"	144°52'24.233"	58.56
East downstream abutment	60°30'52.899"	144°52'19.522"	58.56
Bridge 339			
West upstream abutment	60°31'02.961"	144°51'26.946"	61.15
Bridge 340			
West downstream abutment	60°31'07.882"	144°50'58.514"	62.53
Bridge 342			
West upstream abutment	60°31'17.824"	144°50'06.272"	63.71
East upstream abutment	60°31'20.866"	144°49'49.829"	63.78
Bridge 344			
East upstream abutment	60°31'30.512"	144°48'57.541"	60.37
Bridge 345			
West downstream abutment	60°31'34.169"	144°48'35.689"	62.40
Million Dollar Bridge south end	60°40'16.227"	144°44'39.394"	185.27

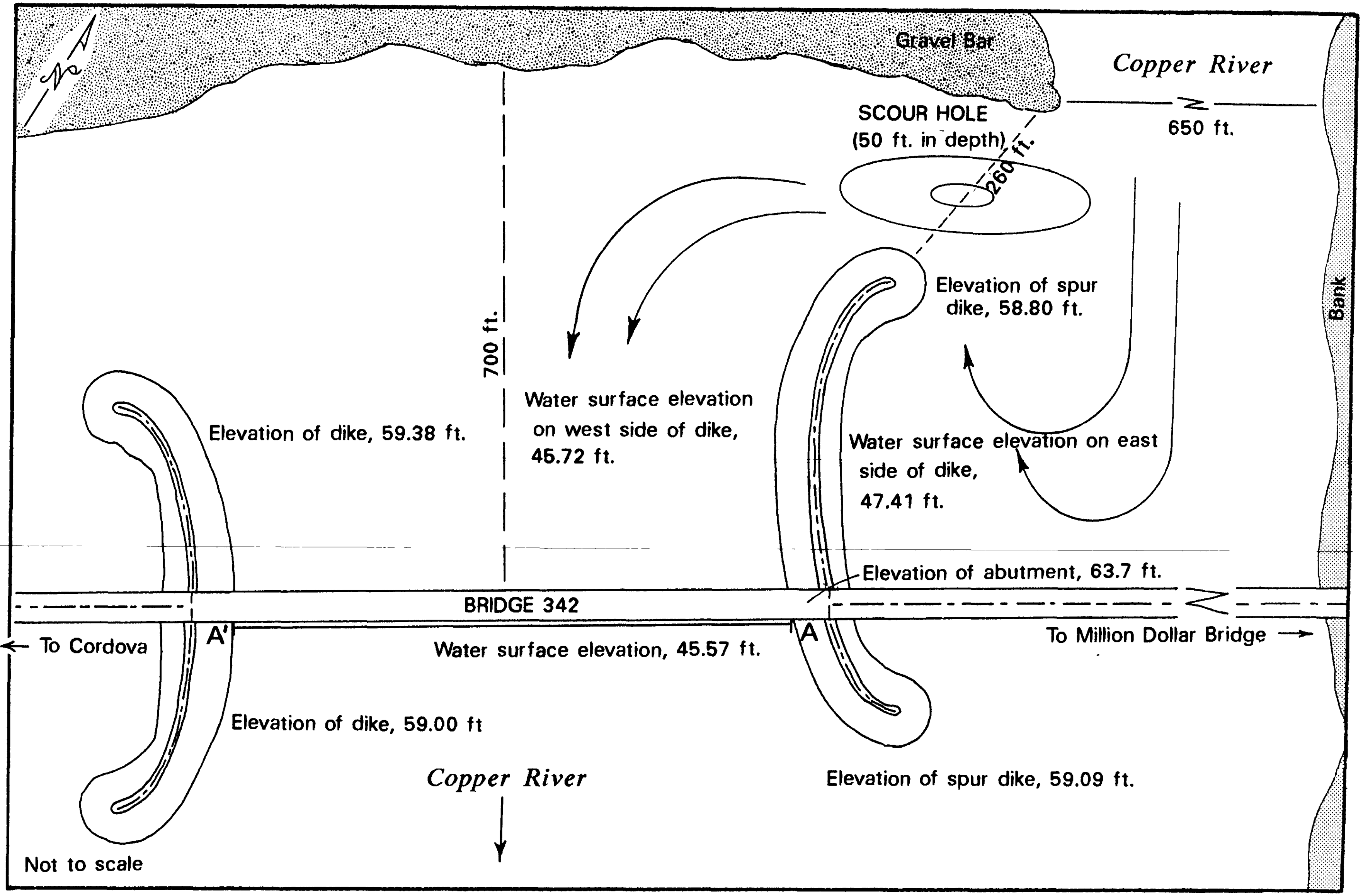

Figure 8.--Bridge 342 area, showing elevation of spur dikes and water surface, and locations of cross section A-A', scour hole and gravel bar, May 23, 1991.

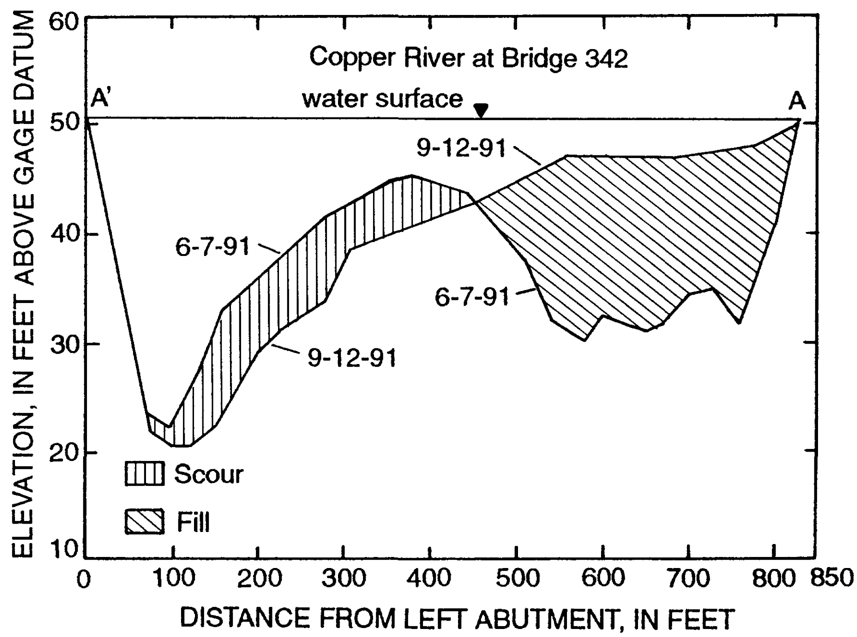

Figure 9.--Cross-section profile, downstream side of Bridge 342, showing scour and fill characteristics (see figure 8 for location of A-A').