STREAMFLOW AND SEDIMENT TRANSPORT CHARACTERISTICS OF THE LOWER CAMPBELL CREEK BASIN ANCHORAGE, ALASKA, 1986-88

by Stephen W. Lipscomb

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CONTENTS

ILLUSTRATIONS

TABLES

CONVERSION FACTORS AND ABBREVIATED WATER QUALITY UNITS

Multiply	By	To obtain
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
acre-foot (acre-ft)	1,233	cubic meter
cubic foot per second (ft^3/s)	0.028317	cubic meter per second
ton, short	0.9072	megagram
ton per day (ton/d)	0.9072	megagram per day
degree Fahrenheit (°F)	°C = 5/9 x (°F-32)	degree Celsius (°C)

Abbreviated water-quality units used in report:

mg/L, milligram per liter

mm, millimeter

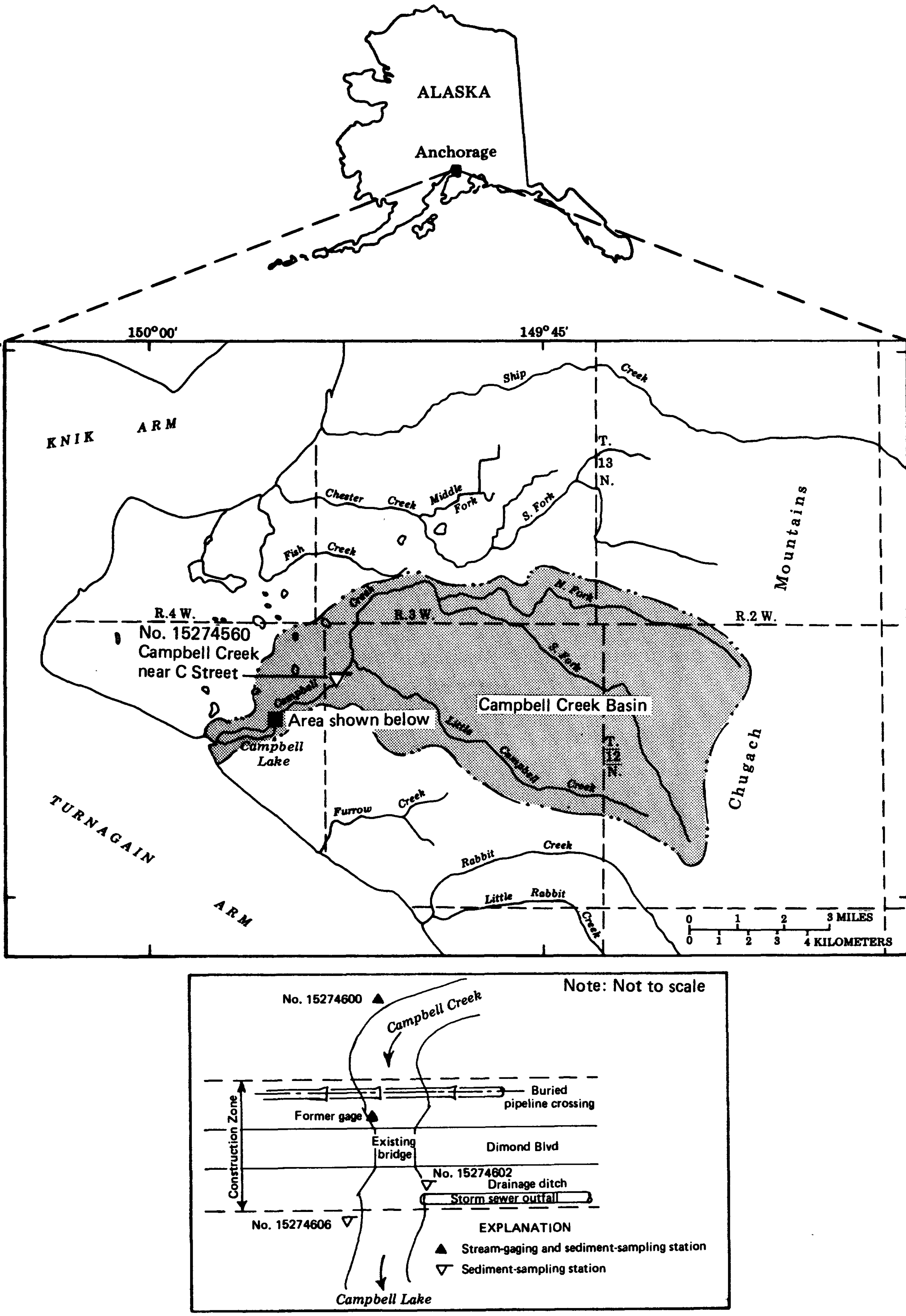

Figure 1.--Locations of the Campbell Creek basin, the study reach, and the stream-gaging and sediment-sampling sites.

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ABSTRACT

Streamflow and sediment data were collected at three sites in the lower Campbell Creek basin between 1986 and 1988. Sediment data were collected during the ice-free periods only, which included the months of May through October in 1986 and May through September in 1987 and 1988. A comparison of the mean stream discharge volumes for each of the 3 years with the mean volume for the 21-year period of record indicates that 1986 and 1987 were dryer than average years and 1988 was wetter than average. Storms are the most significant factor in the production of suspended sediment in lower Campbell Creek. A large storm on October 10-14, 1986 produced 643 tons of suspended sediment, which was 27 percent of the total suspended sediment transported between May and October 1986. A storm in June 1988 produced 593 tons of suspended sediment, equaling 39 percent of the total May-through-September production for that year. No trends of increased sediment discharge were apparent in Campbell Creek between 1986 and 1988. However, a longer term trend toward increased sediment discharge, suggested by comparison of recent data with data collected intermittently since 1967, is likely the result of general urbanization of the basin.

INTRODUCTION

In May 1986, the U.S. Geological Survey, in cooperation with the Alaska Department of Transportation and Public Facilities (ADOT&PF), began a study of suspended-sediment transport and streamflow characteristics in the lower reach of Campbell Creek near Anchorage, Alaska (fig. 1). The ADOT&PF was planning to construct a new bridge on Dimond Boulevard, which crosses the creek within the reach. Sediment and streamflow data were collected between May 1986 and September 1988 at two sites on the creek (stations No. 15274600 and No. 15274606) in the vicinity of the proposed bridge. Data were collected during a pre-construction period (May to October 1986), during the construction period in 1987, and following construction during the summer of 1988. In 1987, the study area was expanded to include an additional site (station No. 15274560) near C Street, about 2 mi upstream from Dimond Boulevard, where future construction was also planned. With few exceptions, suspended-sediment samples were collected during open-water periods of the 3 years (generally May through September). Samples were collected at one of the sites only (station No. 15274606) during a major storm in October 1986, and under winter, low-flow conditions in February 1987 and January 1988. Summaries of the data collected during the 1986 and 1987 water years are published in two earlier reports (Lipscomb, 1987 and 1988).

This report presents a summary and statistical analysis of streamflow and sediment data collected from Campbell Creek between 1986 and 1988. Available historical data have been incorporated in some analyses to aid in describing the longer term sediment transport characteristics of lower Campbell Creek.

DESCRIPTION OF STUDY REACH

The Campbell Creek drainage basin, which encompasses an area of 74 mi^2, has its headwaters in the Chugach Mountains east of Anchorage (fig. 1). The creek empties into the Turnagain Arm of Cook Inlet south of the city. The lower part of the basin includes Campbell Lake, a shallow, man-made impoundment. The area adjacent to Campbell Lake is almost fully developed and the lake itself is used extensively for recreation and as a floatplane base. The main study reach is located just upstream from the inlet to Campbell Lake and includes the site of the new bridge at Dimond Boulevard. In addition, a reach 2 mi upstream at a proposed bridge site near C Street was included in the study.

DATA COLLECTION

Streamflow data were recorded continuously during open-water conditions at station No. 15274600. Because no appreciable inflow was observed at any time during the study period between this site (station No. 15274600) and the site downstream of the Dimond Boulevard bridge (station No. 15274606), the flow data collected at the gage site were assumed to be representative of station No. 15274606 as well. Streamflow at the C Street site (station No. 15274560) was calculated using a least-squares correlation (Riggs, 1966) between discharge measurements at this site and at the gage site (station No. 15274600).

Repetitive, point sediment samples were obtained at the three sites by means of PS-69 automatic pumping samplers. Cross-section and point samples were also collected at all sites using a DH-75 handheld depth-integrating sampler. These data were used to determine the efficiency of the sampler for collecting representative samples at the locations of the intakes and to determine how well the pumped samples represent the mean suspended-sediment concentration of the entire cross section. From these data, cross-section coefficients were derived and used to adjust results from the pumped samples to better reflect the mean concentration for each cross section. Factors affecting sampler efficiency are: distance of the sampler from the stream, water stage at the time the sample was pumped, and flow and channel characteristics at the sampler intake location. All samples were analyzed for concentration of suspended sediment, and selected samples were further analyzed for percentage sand (0.062 to 2.0 mm) and silt-clay (less than 0.062 mm) size materials.

Six bedload samples were collected at the two Dimond Boulevard sites in 1986 and 1987, using a handheld Helley-Smith bedload sampler (Helley and Smith, 1971). These samples were analyzed for particle-size distribution over the full range of sizes from silt-clay to gravel.

More detailed descriptions of the various data collection and analysis techniques are included in two earlier data reports (Lipscomb, 1987 and 1988). Results of laboratory analyses of suspended sediment in cross-section samples and summaries of calculated daily sediment loads and water discharges for the 3-year period of this study are shown on tables 1-4, at the end of this report.

STREAMFLOW

The U.S. Geological Survey has collected streamflow data at station No. 15274600 (Campbell Creek near Spenard) since June 1966. On the basis of 21 years of record (1967-87), the average discharge at this gaging station is 65.2 ft^3/s (47,240 acre-ft/yr). During that period, the largest computed instantaneous discharge was 472 ft^3/s, on October 11, 1986, and the minimum daily discharge was 2.2 ft^3/s, on February 5, 1969 (U.S. Geological Survey, 1988, p. 95). Discharges during the open-water period (May through September) typically range from about 40 to 200 ft^3/s.

Summer Flow Regime

The period of ice-free flow in Campbell Creek is typically from early May through late September or, as in 1986, through October. This period can be divided into three distinct flow regimes. In May, June, and early July, the predominant source of streamflow is the melting of the winter snowpack in the upper, mountainous part of the basin. In late July and early August, the snowmelt contribution to streamflow declines, leading to reduced base flow. However, rainfall typical of this period results in peaks from storm runoff superimposed on the lower base flows. In the final part of the open-water period, from late August until about the end of September, generally declining temperatures and the consequent beginning of "freeze-up" in the upper basin lead to a further reduction of base flow. However, the largest rainstorms and corresponding highest peak flows of the year commonly occur during this period.

The trends and variations in flow in lower Campbell Creek described in the preceding paragraph reflect "average" conditions. However, during individual years, flows may never conform exactly to this pattern. In fact, three distinctly different hydrographs of flow (figs. 2a, 3a, and 4a) characterize the three open-water periods in this study. The hydrographs and corresponding graphs of suspended-sediment discharge are discussed in more detail in a later section of this report.

Comparisons with Long-Term Record

Variations in Summer Flow Regime

In 1986, monthly mean flows in May, June, and July were lower than average for those months over the 21-year period of record (1967-87) (fig. 5). These lower flows were probably due to a less-than-average winter snowpack. Monthly means for August and September were nearer the long-term average due to the occurrence of several storms.

In 1987, the open-water period was again characterized by comparatively low snowmelt-dominated streamflows. This below-average flow condition continued through the remainder of the summer. No significant storms occurred until early September.

In 1988, there was a reversal in the pattern of streamflow observed in the preceding two summers. Flows in early May were above average for the period of record, owing to relatively warm temperatures and rapid runoff from an unusually large snowpack in the upper basin. This relatively high-flow condition continued and became more pronounced with the occurrence of a major rainstorm in early June. No additional significant runoff-producing storms occurred in the remainder of the summer and fall and, consequently, streamflows in August and September fell below the average for the period of record.

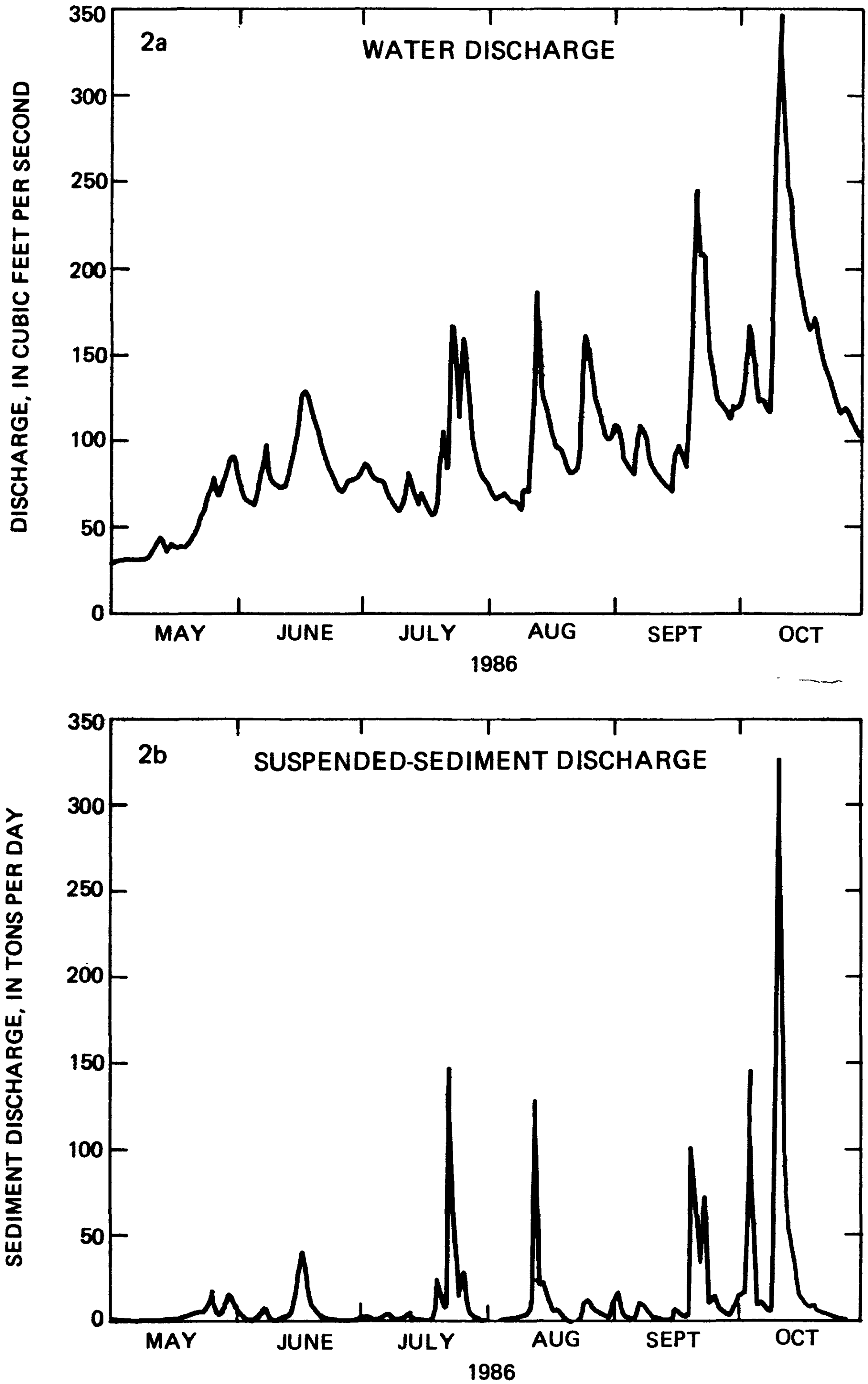

Figure 2. -- Daily water and sediment discharge at station No. 15274606 (Campbell Creek below outfall), May to October 1986.

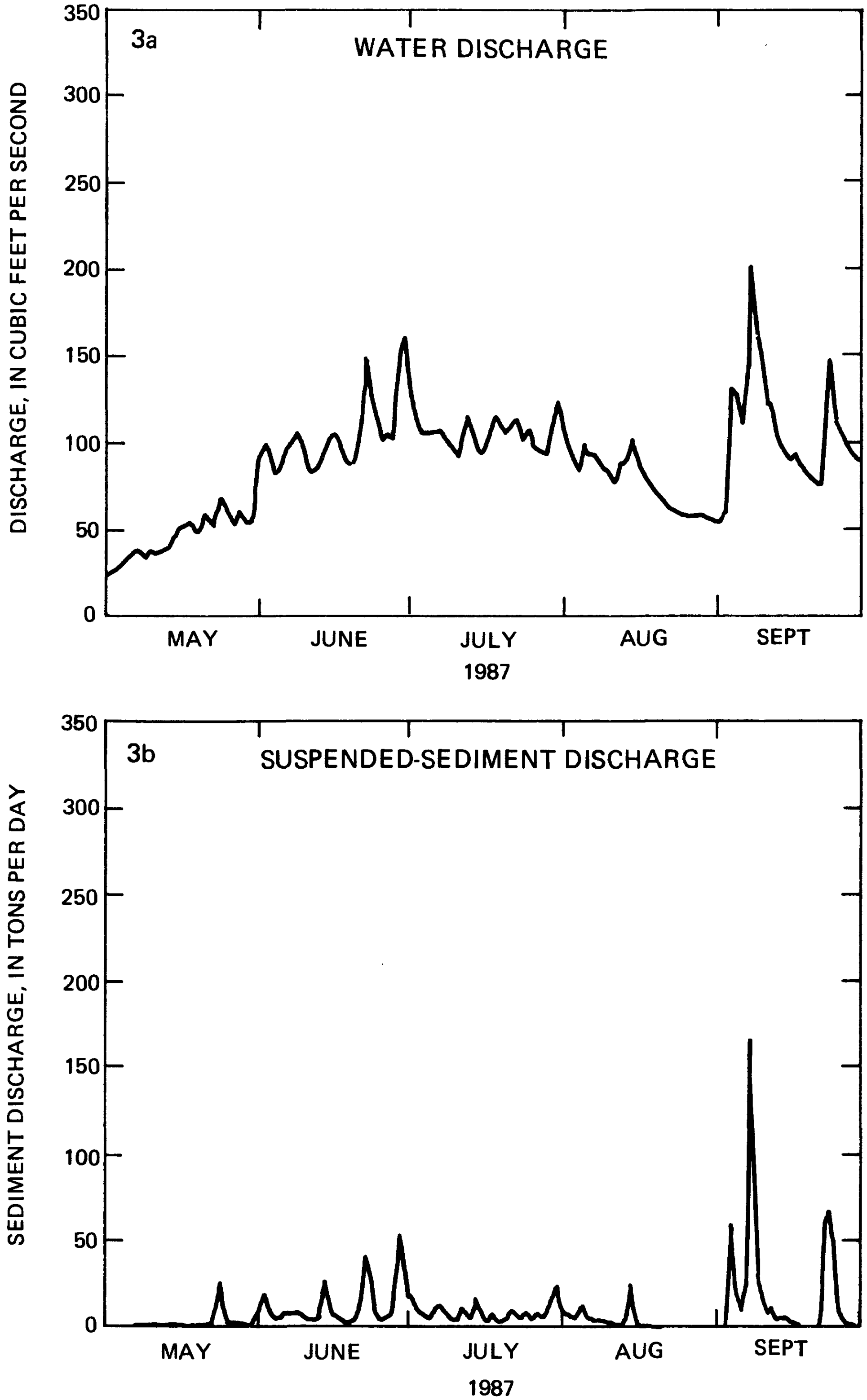

Figure 3. -- Daily water and sediment discharge at station No. 15274606 (Campbell Creek below outfall), May to September 1987.

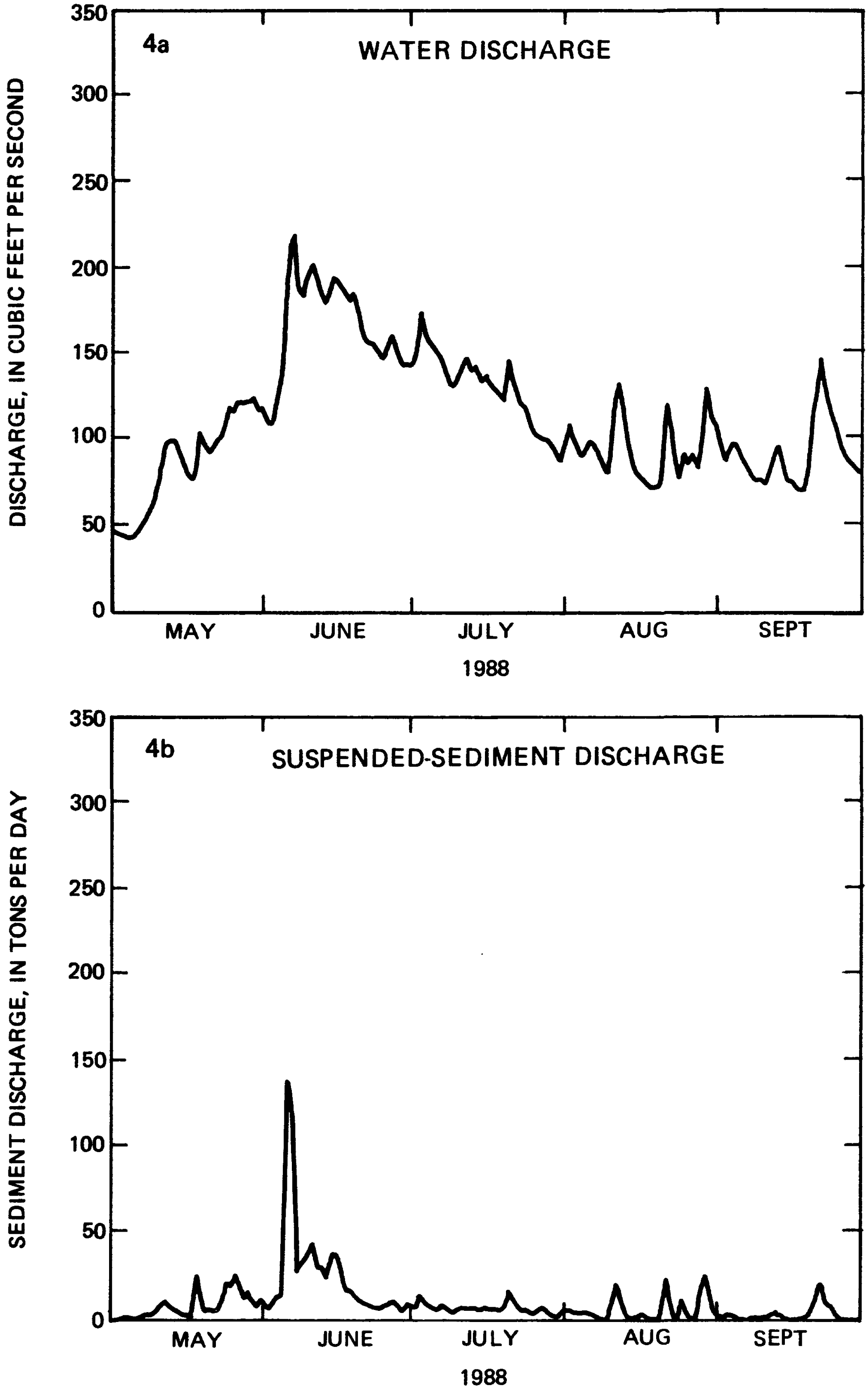

Figure 4. -- Daily water and sediment discharge at station No. 15274606 (Campbell Creek below outfall), May to September 1988.

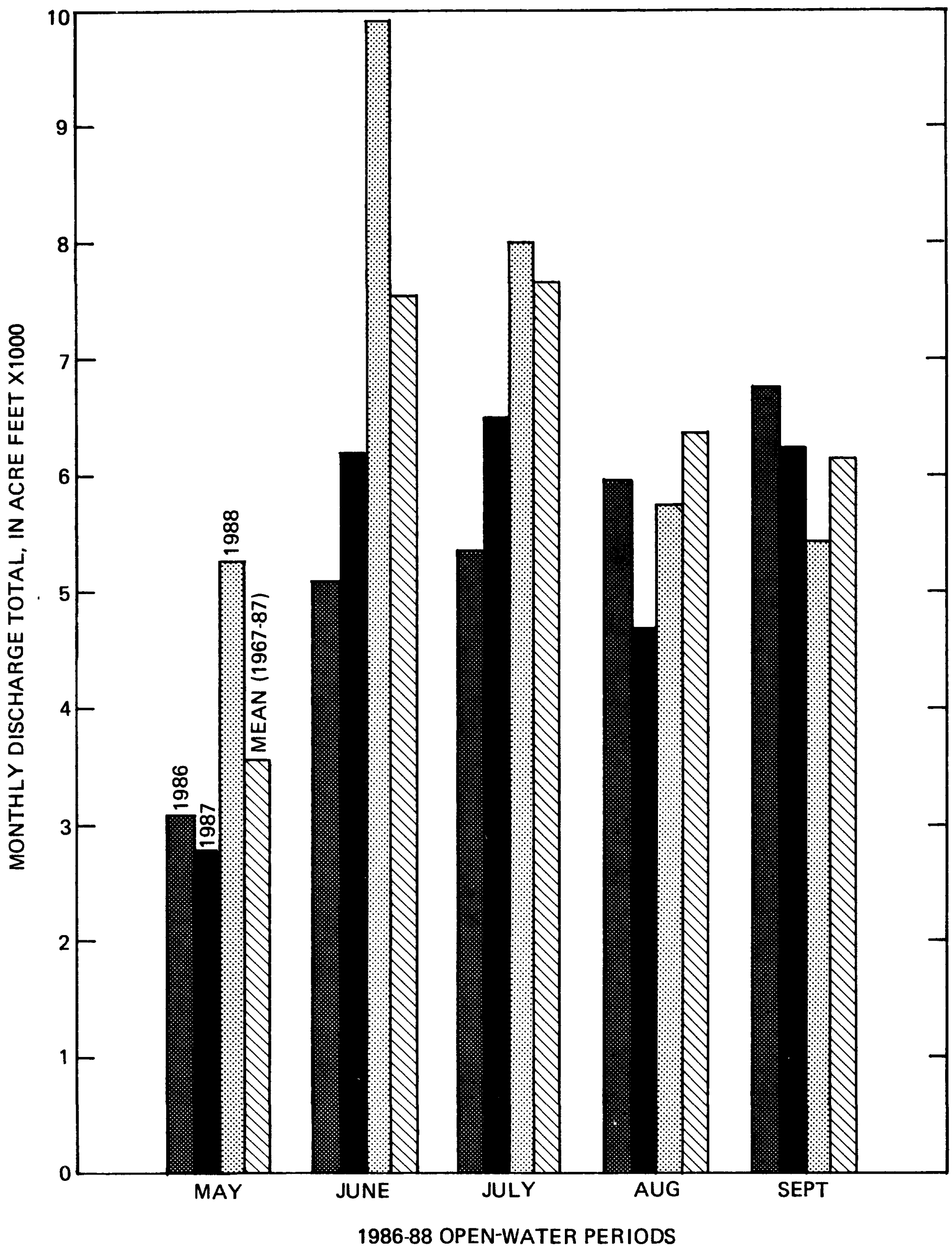

Figure 5.--Monthly mean streamflow volumes for 1986-88 and the 21-year monthly means at station No. 15274600 (Campbell Creek near Spenard).

Variations for the Total Ice-Free Period

A comparison of each year's total discharge for May through September with the 21-year mean for the same period provides an indication of a dry, wet, or average year with respect to summer streamflow. The long-term mean streamflow at station No. 15274600 for May through September is 31,250 acre-ft (equal to sum of monthly totals on figure 5). Total discharges for 1986 and 1987 fell short of the mean by about 5,000 acre-ft, or 16 percent. In both years, below-average flows during the snowmelt period continued into July and August. In October 1986, however, runoff generated by two large storms made up for the deficiency in streamflow for that year. The second storm, on October 11, produced the peak flow of record for Campbell Creek and was responsible for severe flooding throughout southcentral Alaska.

Cumulative discharge for the May-through-September period in 1988 exceeded the mean by 3,080 acre-ft, or 10 percent. This was due almost entirely to unusually high flows during the snowmelt period (May to early July). Flows during the remainder of the summer were slightly below the mean because of an absence of storms.

SUSPENDED-SEDIMENT TRANSPORT

The transport of suspended sediment is closely related to variations in streamflow. As a result, each of the years during the study period had distinctive sediment discharge characteristics related to that year's flow regime. The daily sediment discharges for the 1986-88 open-water periods at station No. 15274606 are shown in figures 2b, 3b, and 4b. These plots serve to illustrate some general characteristics of sediment transport within the basin.

Sediment transport during rainfall-runoff generated flows is generally three to four times greater than that during snowmelt-generated flows of equal magnitude. The largest percentage of the seasonal (May to October) sediment load is consequently transported during the latter part of the summer and into fall. Sediment transport during the winter months is insignificant because of low flow and frozen soils adjacent to the channel.

The shape of the sediment discharge hydrograph shows a characteristic of hydrographs for the Campbell Creek basin where peak sediment discharge coincides with peak water discharge. The falling limb of the sediment hydrograph is much steeper than that of the water discharge. This is due to the immediate drop in sediment concentration when the rainfall has ended. The water discharge typically remains high for periods of several hours to a few days, and then falls off slowly as stored water is released within the basin.

Variations in Sediment Discharge and Load, 1986-88

In 1986, the relatively low sediment discharge in May and June is typical of the snowmelt period (fig. 2b). In late July and early August the first major storms of the summer generated significant sediment discharges. This is also evident in the histogram that compares monthly sediment loads for 1986-88 (fig. 6). Runoff from one large storm at the end of September and two more in early October carried significant portions of the total summer's suspended-sediment load. In 1986, data were collected through October because of the forecast and occurrence of unusually large storms. In the two succeeding years, the continuous sampling program was discontinued at the end of September because of freeze-up; however, a few cross-section samples were obtained during these

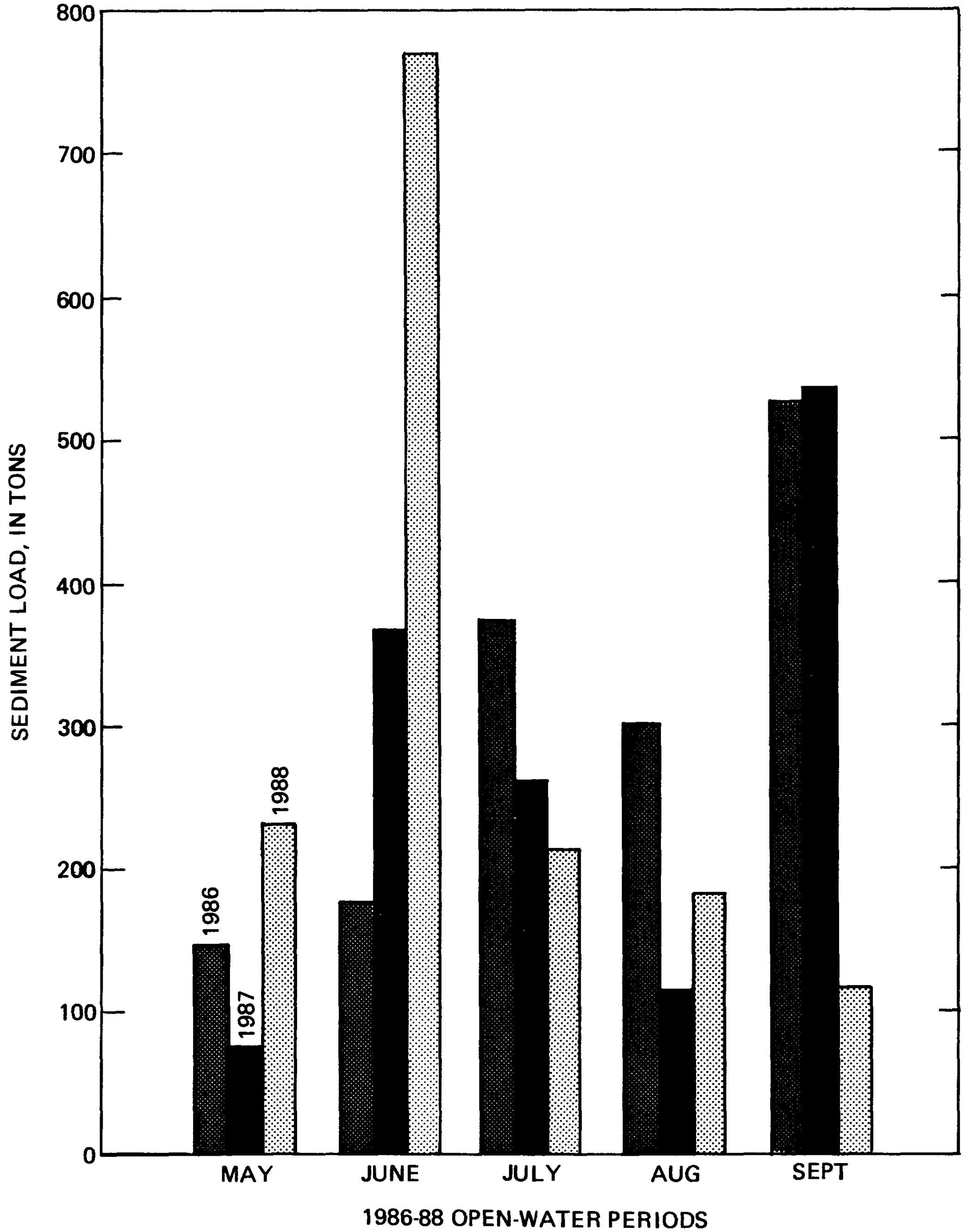

Figure 6.--Monthly sediment loads at station No. 15274606 (Campbell Creek below outfall), 1986-88.

two winters to quantify suspended-sediment concentrations during the low-flow ice-covered period. The lowest and highest computed daily suspended-sediment discharge values were for dates in 1986: 0.45 ton/d on August 23 and 328 ton/d on October 11.

The 1987 plot of daily suspended-sediment discharge (fig. 3b) shows two peaks during the snowmelt period due to two storms in late June and early July. The lack of storms during the remainder of July and August resulted in an absence of any pronounced peaks in sediment discharge. Storms in September, however, produced a significant percentage of the total sediment load for the summer (fig. 6).

The sediment transport pattern for 1988 was different from that for the other two years, as indicated by the sediment discharge plots (figs. 2b, 3b, 4b) and histogram of monthly loads (fig. 6). The 1988 open-water period began with higher-than-average water and sediment discharges in both May and June. The higher streamflows were due to runoff from the above-average snowpack discussed earlier in this report. The first major rainstorm of the summer occurred on June 6 and, in conjunction with the high snowmelt flows, produced a large percentage of the summer's total sediment load. The lack of significant storms during the remainder of the summer and fall resulted in very little additional sediment discharge in the stream.

The dependence of sediment discharge on storms is demonstrated by comparing the amounts of sediment produced by individual storms with total load over the course of the open-water period. This comparison is depicted here by the use of pie charts (fig. 7a-7c). For each May-through-September period (except May through October in 1986), the sediment loads for several individual storms are shown along with the days encompassed by the storm. The suspended-sediment load resulting from these storms can then be compared with the total sediment load for the remainder of the period.

In 1986, for example, almost 65 percent of the total suspended-sediment load was produced by five rainstorms (fig. 7a). Further, the number of days encompassed by the five storms is 20, which is only 11 percent of the total number of days in the May-through-October period included in this illustration. It is also notable that the 5-day (storm) period October 10-14 accounted for 27 percent of the entire summer's (May through October) sediment load.

Fewer major storms occurred in 1987, but the relative impact of storm runoff on sediment production is similar to that in 1986. Three storms, encompassing less than 7 percent of the total days from May through September, produced 38 percent of the total suspended-sediment load (fig. 7b).

In 1988, the sole storm that produced any significant amount of sediment began on June 6 and continued until June 17. This 12-day period produced 593 tons, or 39 percent of the total suspended-sediment load for the period May through September (fig. 7c).

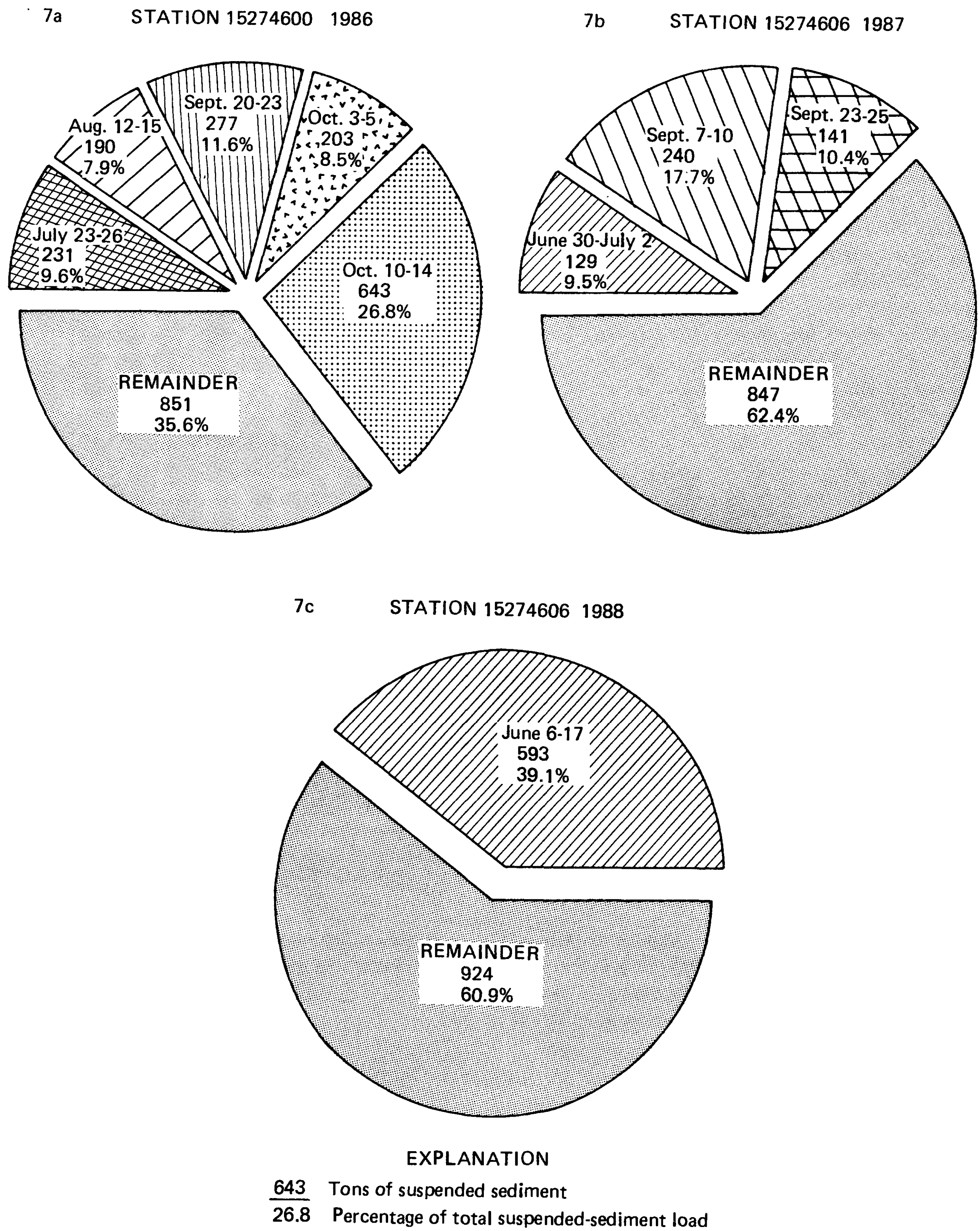

Figure 7.--Suspended-sediment load produced by significant storms and the remainder of the open-water period, for each year, 1986-88.

Trends in Transport Rates

It is commonly thought that sediment transport rates tend to increase as a drainage basin is developed or urbanized. This increase usually results from the removal of vegetal cover, leading to accelerated erosion and increased runoff.

South Anchorage, which encompasses most of the lower Campbell Creek drainage basin, including the study reach, has experienced rapid urbanization over the last 10 years, with the largest changes occurring during the economic boom years of 1982-85. The expansion of Dimond Boulevard, including the construction of the new bridge at Campbell Creek, is an example of the activities taking place. Other examples include the building of three shopping centers and their associated parking lots in the immediate locale, and medium- to high-density residential construction throughout the lower basin. In an effort to identify any trends in sediment transport rates that may be related to this urbanization, comparisons were made between current and historical data as well as between data collected at the three sites within the study reach on Campbell Creek.

The two sampling sites near Dimond Boulevard (stations No. 15274600 and No. 15274606) were selected to isolate and detect any effects on the sediment discharge from road and bridge construction activities. The site near C Street was added in 1987 to gather baseline sediment data in anticipation of similar construction at that site in the near future.

Seasonal Sediment Loads

One method of identifying any trends in sediment discharge between the two Dimond Boulevard sites is simply to compare their total sediment loads for the May-through-September period for each of the three years studied. The total suspended-sediment load for 1986, prior to the bridge construction, was 1,420 tons at the upstream site (station No. 15274600) and 1,527 tons at the site downstream of the bridge (station No. 15274606). In 1987, the mean daily values at the upstream site were not published due to problems with the automatic sediment sampler, which may have produced errors in the results. However, the same comparison for 1988, following construction of the bridge, shows 1,235 tons of suspended sediment transported past the upstream site and 1,516 tons transported past the downstream site. These values indicate an increase of 8 percent for the pre-construction period and 23 percent for the post-construction period.

Some of this increase can be attributed to the contribution of the intervening watershed between the two sites, not including the area directly impacted by construction. The pre- and post-construction differences in sediment loads between the upstream and downstream sites are not significant in view of the accuracy generally associated with the computation of sediment records.

Instantaneous Sediment Concentrations

Differences in sediment transport at the three study sites were also assessed using instantaneous sediment concentration data obtained from cross-section samples. The cross-section samples were obtained at each of the three sites for the primary purpose of calibrating the automatic pumping samplers. These depth-integrated samples are collected at several points across the stream's width. The values obtained from analysis of the cross-section samples are thus more representative of the suspended sediment in the stream than are values from samples taken at a single, discrete point within the channel, which is the case for the pumped samples.

A comparison of suspended-sediment concentrations at the two Dimond Boulevard sites is illustrated in figure 8. The data were included on the graph only if the samples were obtained (1) within an hour (usually 30 minutes) of each other and (2) during periods of relatively stable stream stage. These criteria were necessary to insure a valid comparison. The data points are designated by the year obtained, and the line is fitted to the data using standard linear regression methods on data from all 3 years. The data scatter around the predicted line indicates no apparent trend of increasing sediment concentration at the downstream site (station No. 15274606) between 1986 and 1988. This observation was verified by a multivariate analysis of the data. A "dummy" variable was assigned to each original data pair. A zero was assigned to data pairs collected in 1986 (before construction) and a value of one was assigned to those collected in 1988 (after construction). A multivariate regression analysis was performed and the coefficient assigned to the dummy variable was used to indicate whether data collected in 1988 varied significantly from those collected in 1986. The results from this analysis indicate that an increase in sediment-transport rates from 1986 to 1988 cannot be substantiated.

Attempts to identify trends in sediment transport by direct comparison of values of concentration, discharge, or load during a relatively short study period may be hampered by the small amount of data available and the restricted range of hydrologic conditions represented by those data. Additionally, results of the analyses may be inconclusive if either the magnitude of changes or rate at which they occur is small. Because sediment transport in a stream is affected by many variables, the most reliable analyses require data obtained over a long period of time as well as a wide range in hydrologic conditions.

Sediment Transport Curves

An alternative method of trend investigation utilizes the sediment transport curve. This method has the advantage of being able to incorporate data from cross-section samples collected during the 3-year study period with historical sediment data collected at or near the site (Brabets and Wittenberg, 1983). The sediment transport curve is a plot, usually on logarithmic graph paper, of instantaneous suspended-sediment discharge against water discharge. An equation of the "best-fit" line is computed using least-squares regression analysis of the log-transformed data. Sediment-transport curves for the three sites on Campbell Creek (stations No. 15274560, No. 15274600, and No. 15274606) were constructed using the data collected from 1986-88 (figs. 9-11).

A combined plot of the 1986-88 suspended-sediment transport curves for the upstream and downstream stations at Dimond Boulevard (fig. 12) indicates no significant difference between the two stations. A multivariate regression analysis was again employed by assigning the dummy variable zero to data collected at the upstream site (station No. 15274600) and a value of one to data collected at the downstream site (station No. 15274606). Results of the analysis provide no evidence to substantiate an increase in sediment discharge between the upstream and downstream sites from 1986 to 1988.

Suspended-sediment samples were collected at station No. 15274600 (Campbell Creek near Spenard) from 1967-73 and from 1980-81. The sediment-transport curve was recomputed after adding the older data to the 1986-88 data set. The new transport curve was computed using a least-squares analysis of the log-transformed data (fig. 13). The slope of this transport curve is slightly less than the slope for the 1986-88 data as indicated by the exponent of the regression equation (greater exponents equal larger slopes). This is a possible indication of a long-term trend of increasing sediment discharge at this site.

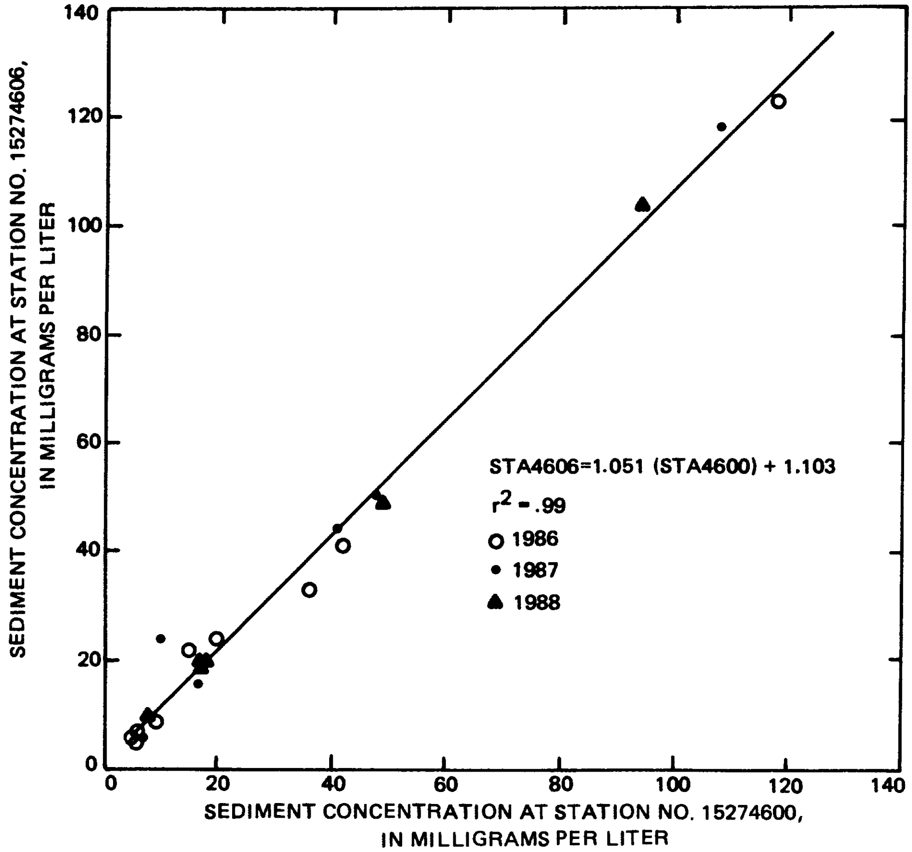

Figure 8.--Relation between suspended sediment concentrations at station No. 15274600 and No. 15274606, 1986-88.

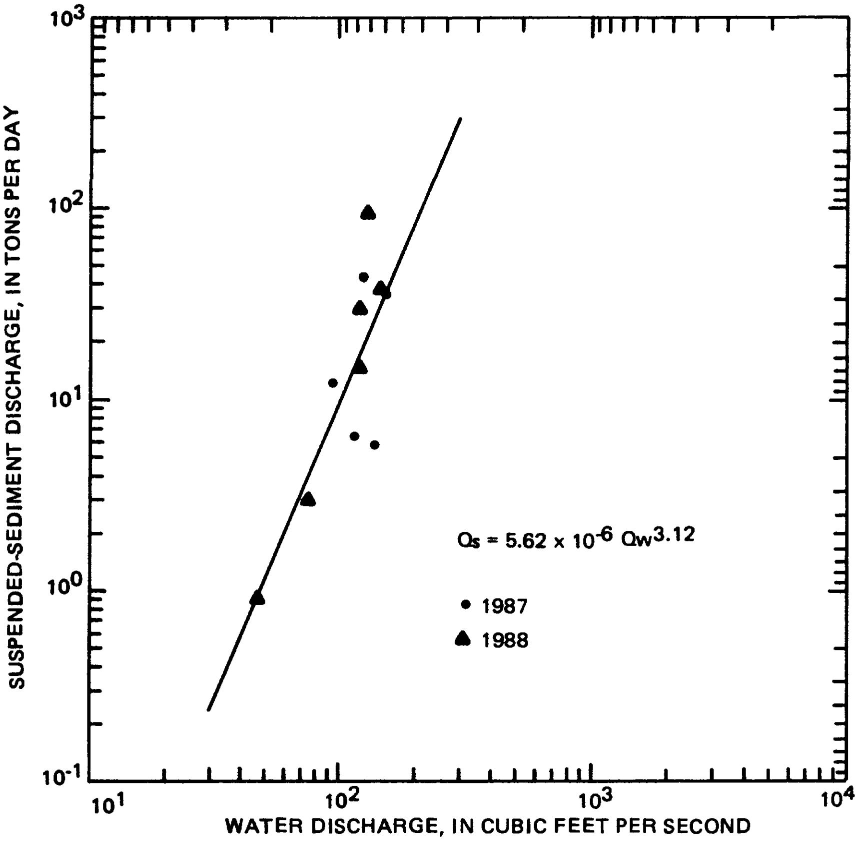

Figure 9.--Suspended sediment transport curve for station No. 15274560 (Campbell Creek near C Street), 1987-88.

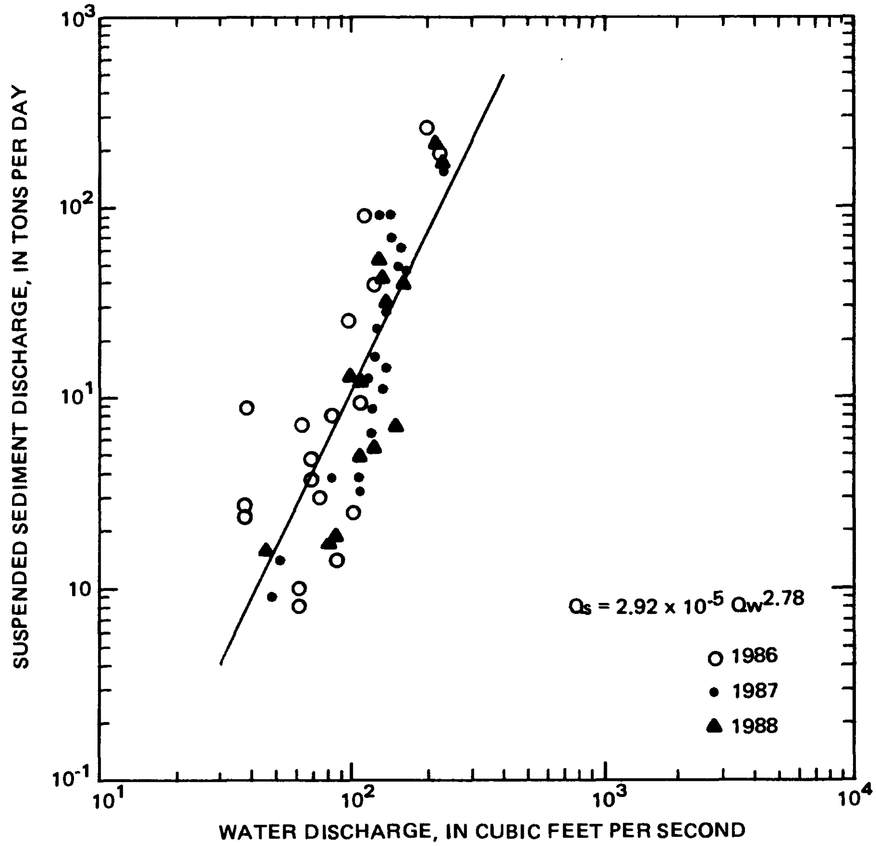

Figure 10. -- Suspended sediment transport curve for station No. 15274600 (Campbell Creek near Spenard), 1986-88.

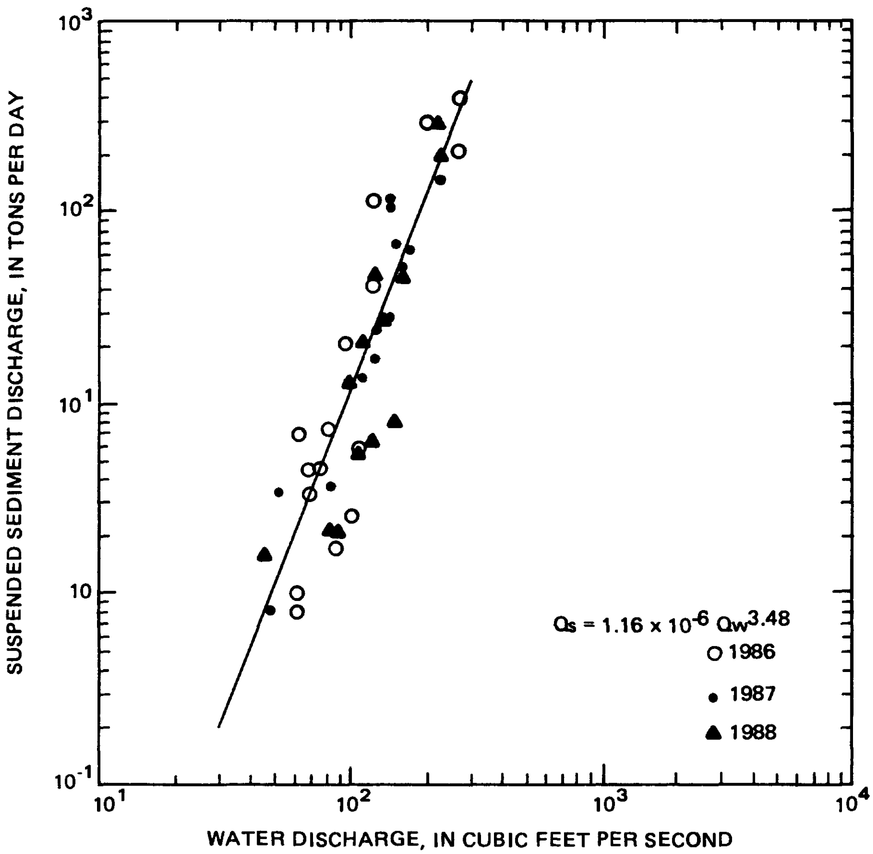

Figure 11. -- Suspended sediment transport curve for station No. 15274606 (Campbell Creek near Spenard below outfall), 1986-88.

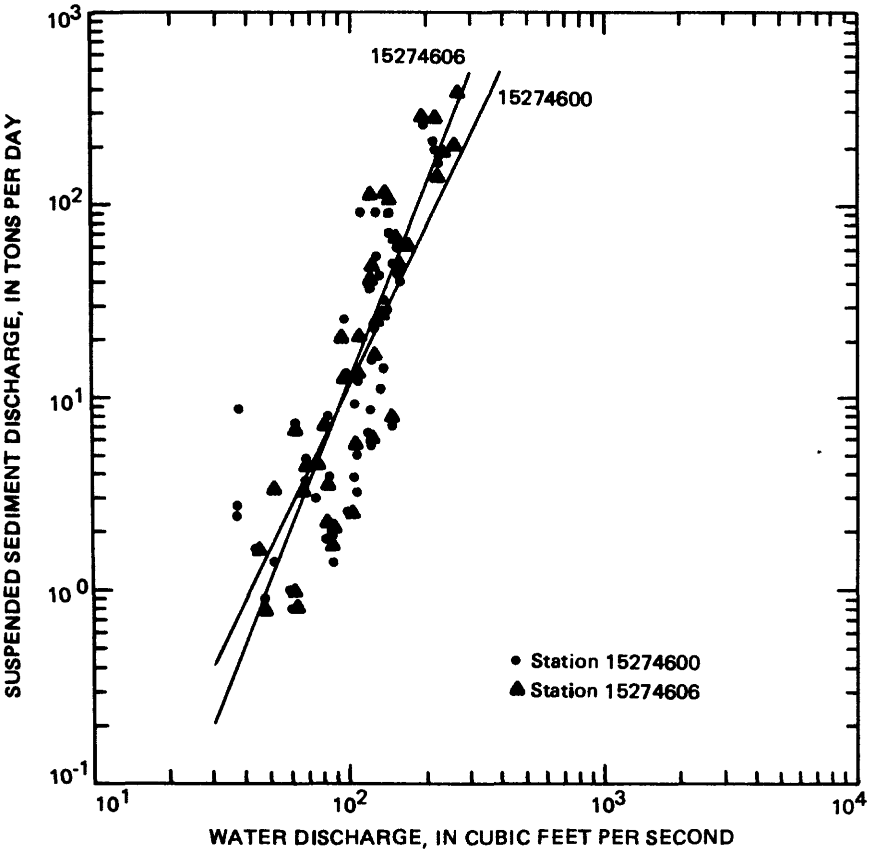

Figure 12.--Suspended sediment transport curve for station No. 15274600 and station No. 15274606, 1986-88.

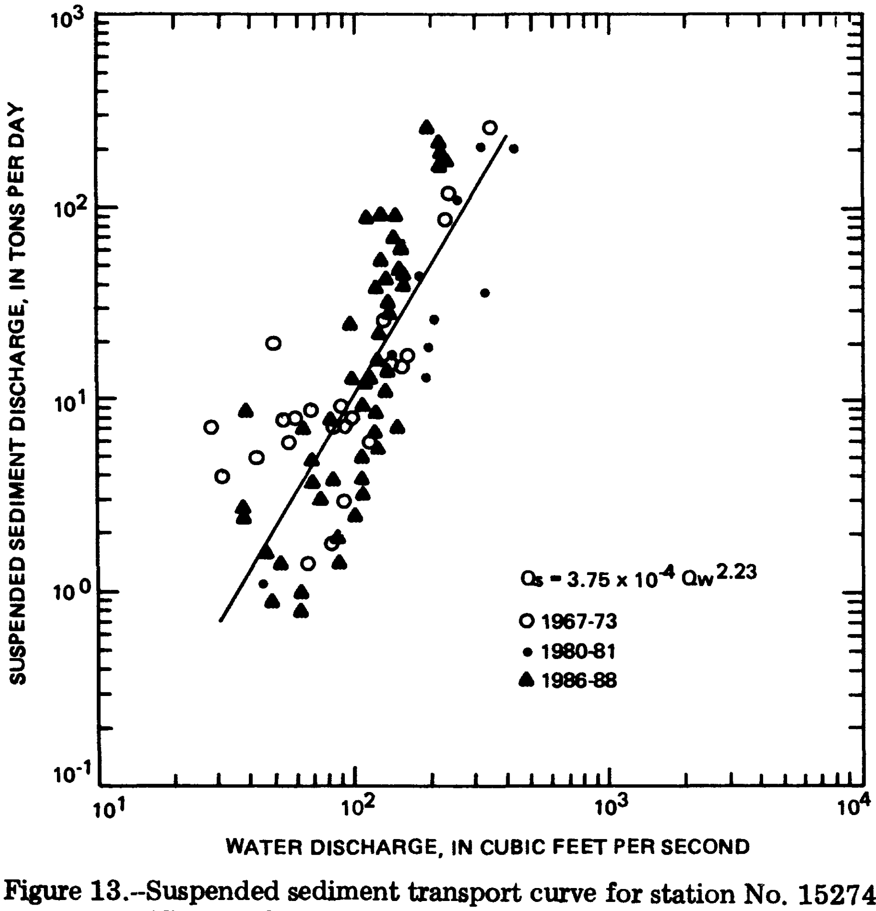

Figure 13.--Suspended sediment transport curve for station No. 15274600 (Campbell Creek near Spenard) including all historic data, 1967-88.

A closer inspection of figure 13 reveals that, particularly at higher streamflows, the more recent data points generally plot to the left of the transport curve. This can be better illustrated by a plot of predicted sediment discharge against residual values (fig. 14). The residual value is calculated as the distance along the y-axis between the value of sediment discharge predicted from the regression equation and the observed discharge. These residuals are minimized in the least-squares routine with the data points being about evenly distributed on both sides of the regression line. It is evident from this plot (fig. 14) that samples collected between 1986 and 1988 show a strong tendency towards positive residual values, especially at the higher range of sediment discharges. The samples collected in earlier years are more scattered on both sides of the zero-line and have smaller residuals.

The above analysis of residuals indicates an upward trend in sediment transport rates in the basin between the time period of the earlier samples (1967-81) and the period of this study (1986-88). A similar plot was made of residual values for each of the 3 years of this study (fig. 15). The random scatter of points, both positive and negative, indicates that the trend toward higher sediment transport rates cannot be related to changes or activities in the basin in any particular year during the 1986-88 period; more likely it is due to steady urbanization of the entire basin.

Sand-Silt Ratios

During the study period, selected cross-section samples of suspended sediment were analyzed for the percentage of sand and silt-clay size materials. On the average, the ratio between these two size classes was about 25 percent sand to 75 percent silt-clay. This ratio ranged from 15/85 to 63/37, sand/silt-clay; the makeup of the sample was primarily dependent upon the magnitude of the water discharge at the time of sample collection. At higher discharges, the increased stream energy is capable of suspending greater quantities of larger size materials from the bed. As a result, the percentage of sand-size materials was highest during peak streamflows.

BEDLOAD

Bedload discharge is subject to wide temporal and spatial variation. The few samples collected during this study are of limited value in describing bedload transport characteristics in lower Campbell Creek.

On July 6 and 7, 1987 bedload samples were collected at both Dimond Boulevard sites. Both samples were taken during a period (July 1-15) when the stream was being directly affected by the bridge construction or related activities. The resulting analyses (table 5) show that during the time that these samples were collected, there was no increase in bedload between the upstream and downstream sites. In fact, in both cases, the calculated downstream load was smaller than the upstream load. A more thorough sampling program would be necessary to draw further conclusions regarding the bedload transport characteristics of Campbell Creek.

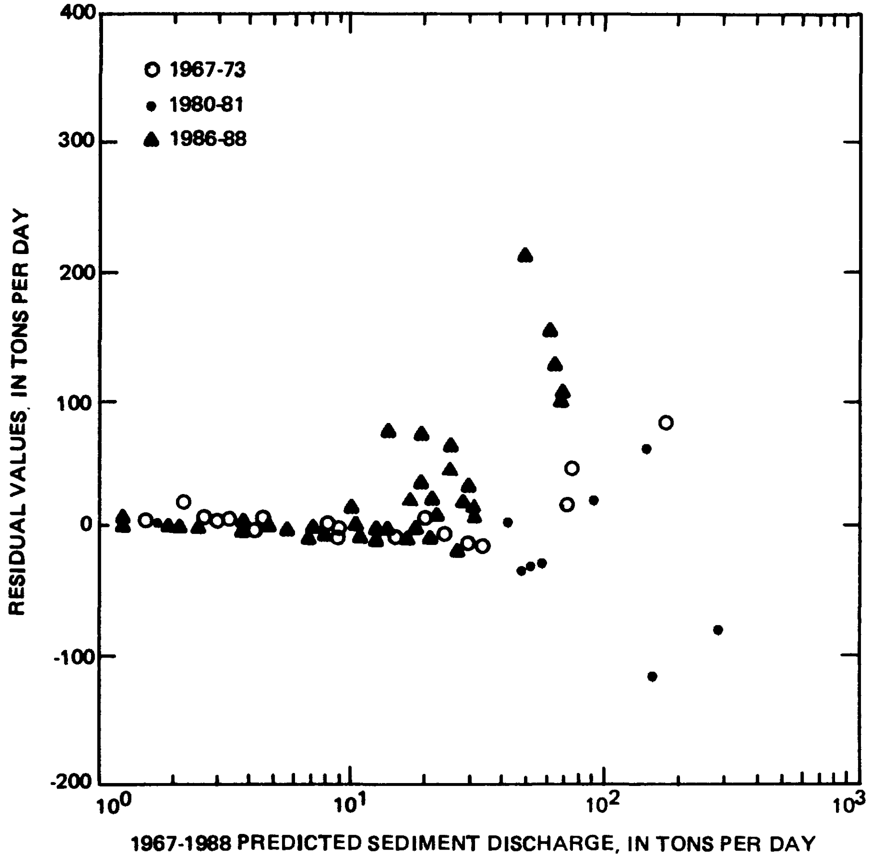

Figure 14.--Predicted sediment discharge versus residuals for station No. 15274600 (Campbell Creek near Spenard), 1967-88.

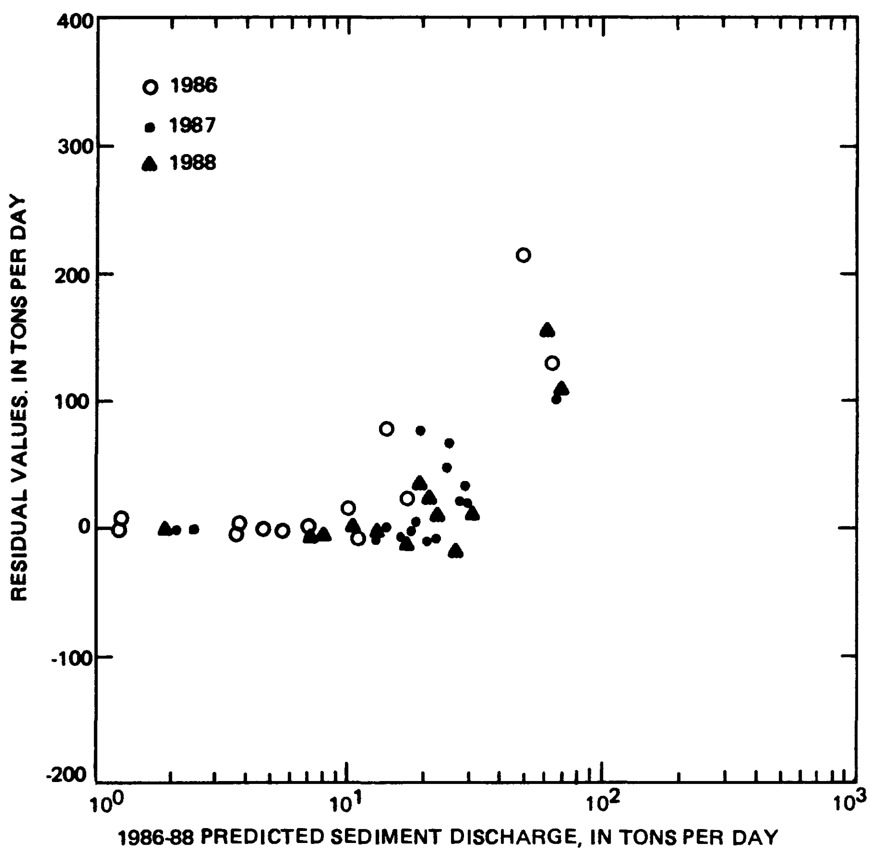

Figure 15.--Predicted sediment discharge versus residuals for station No. 15274600 (Campbell Creek near Spenard), 1986-88.

SUMMARY

Analyses of streamflow and sediment data collected on lower Campbell Creek between 1986 and 1988, in conjunction with similar data from as early as 1966, lead to the following conclusions:

1. In 1986 and 1987, water discharge in Campbell Creek for the periods of May through September was less than the 21-year-of-record mean for the same period.

2. In 1988, the water discharge for the May-through-September period was significantly greater than the 21-year mean. This was due primarily to unusually high flows during the snowmelt period from May through early July.

3. Storms are by far the leading producers of suspended sediment in lower Campbell Creek. A 5-day storm in October 1986 produced 27 percent of the sediment load for the entire open-water period (May through October).

4. No conclusive evidence of increasing sediment discharge was apparent between the two sampling sites near Dimond Boulevard (stations No. 15274600 and No. 15274606) during the study period.

5. A general trend of increasing sediment discharge in the lower Campbell Creek basin is suggested by analysis of combined historical and more recent (1986-88) data. This trend is likely the result of basin-wide urbanization.

6. Analyses of the few bedload samples collected at the Dimond Boulevard sites in July 1987 indicated no increase in bedload between the sites. However, additional sampling would be necessary to fully define the bedload transport characteristics of Campbell Creek.

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Table 1.--Suspended-sediment and streamflow data for three sites on lower Campbell Creek

[mg/L, milligrams per liter; ft, feet; ft^3/s, cubic feet per second; °C, degrees Celsius; --, no data. Data include the percent sand and silt-clay fractions of each suspended-sediment sample. Sand-size particles range in size from 0.062 to 2.0 millimeters; silt-clay size particles range in size from 0.5 microns to 0.062 millimeters (U.S. Geological Survey, 1977).]

Table 1A.--May to October 1986

Station name and number (fig. 1)	Date	Time	Sediment concentration (mg/L)	Percent sand	Percent silt	Gage height (ft)	Water discharge (ft^3/s)	Water temperature (°C)
Campbell Creek	5-7	1410	86	39	61	17.66	37	1.5
near Spenard	5-12	1110	24	--	--	17.66	40	3.5
(15274600)	5-12	1115	27	--	--	17.66	40	3.5
	5-23	1045	42	15	85	18.00	61	5.0
	5-29	0900	36	19	81	18.25	80	5.5
	5-30	0845	98	41	59	18.42	96	6.0
	6-4	1800	26	13	87	18.08	69	7.0
	6-16	0840	120	36	64	18.70	125	10.0
	6-17	1540	86	--	--	18.80	131	11.0
	7-10	1100	5	28	72	17.99	60	10.0
	7-11	1245	6	22	78	17.99	62	12.0
	7-12	1200	20	18	82	18.08	69	--
	7-16	0745	15	24	76	18.15	74	9.5
	7-20	1630	299	32	68	18.60	113	--
	7-23	1055	495	47	53	19.42	196	10.0
	8-30	1045	9	37	63	18.47	101	8.0
	9-2	1055	32	15	85	18.54	108	--
	9-8	1639	43	15	85	18.43	105	8.5
	9-18	1050	6	30	70	18.31	87	7.5
	10-3	1915	320	22	78	19.64	221	6.5
Campbell Creek	7-16	0855	16	33	67	--	77	9.5
above outfall	10-10	0845	486	35	65	19.98	260	--
(15274602)								
Campbell Creek	5-23	1130	41	14	86	--	62	5.5
below outfall	5-29	0940	32	24	76	--	82	5.5
(15274606)	5-30	0955	80	38	62	--	97	6.0
	6-4	1900	18	17	83	--	69	7.0
	6-16	0910	124	39	61	--	123	10.0
	7-10	1310	6	16	84	--	62	11.0
	7-11	1315	5	17	83	--	62	12.5
	7-12	1230	24	15	85	--	69	--
	7-16	0830	19	27	73	--	76	9.5
	7-20	1715	341	32	68	--	124	--
	7-23	1135	549	60	40	--	199	--
	8-30	1125	10	40	60	--	101	--
	9-2	1135	20	23	77	--	108	--
	9-18	1250	7	26	74	--	87	7.5
	9-20	2250	290	49	51	--	264	--
	10-10	0915	535	35	65	--	272	7.0

***Table 1.--Suspended-sediment and streamflow data for three sites on lower Campbell Creek*--Continued**

Table 1B.--February to September 1987

Station name and number (fig. 1)	Date	Time	Sediment concentration (mg/L)	Percent sand	Percent silt	Gage height (ft)	Water discharge (ft^3/s)	Water temperature (°C)
Campbell Creek	5-19	1315	7	28	72	--	28	--
near C Street	6-5	1750	15	53	47	--	45	11.0
(15274560)	6-23	1455	45	53	47	--	124	8.5
	6-29	1515	91	55	45	--	152	--
	7-22	1545	90	23	77	--	67	--
	9-4	1826	266	53	47	--	130	--
Campbell Creek	2-5	1230	8	--	--	--	28	0.0
near Spenard	5-19	1440	7	27	73	17.80	48	--
(15274600)	6-5	1620	17	42	58	18.26	83	10.5
	6-23	1630	48	40	60	18.77	126	9.0
	6-29	0730	146	39	61	19.16	156	8.0
	6-29	0815	116	50	50	19.12	153	--
	6-29	1310	108	48	52	19.18	158	8.0
	7-1	0850	38	53	47	18.96	138	--
	7-1	1515	31	49	51	18.92	134	--
	7-2	0745	26	55	45	18.78	122	8.5
	7-2	1530	20	--	--	18.76	120	--
	7-6	1615	13	--	--	18.60	107	--
	7-7	1000	11	--	--	18.61	108	--
	7-22	1455	66	25	75	18.85	128	10.5
	7-31	0020	78	33	67	18.97	139	--
	8-15	0840	267	29	71	18.86	129	--
	8-15	0945	180	30	70	19.04	145	--
	9-4	1215	231	--	--	19.04	145	--
	9-8	1010	275	--	--	19.86	225	--

Table 1.--Suspended-sediment and streamflow data for three sites on lower Campbell Creek--Continued

Table 1B.--February to September 1987--Continued

Station name and number (fig. 1)	Date	Time	Sediment concentration (mg/L)	Percent sand	Percent silt	Gage height (ft)	Water discharge (ft^3/s)	Water temperature (°C)
Campbell Creek below outfall (15274606)	5-19	1450	6	23	77	--	48	--
	6- 5	1645	16	39	61	--	83	10.5
	6-23	1655	50	46	54	--	127	10.0
	6-29	0800	164	51	49	--	153	8.0
	6-29	1255	118	53	47	--	158	--
	6-30	0835	136	56	44	--	171	--
	7- 1	0815	64	57	43	--	134	--
	7- 1	0915	55	63	37	--	137	--
	7- 1	1100	59	52	48	--	138	--
	7- 1	1300	63	30	70	--	134	--
	7- 1	1500	47	39	61	--	134	--
	7- 1	1640	47	33	67	--	131	--
	7- 1	1910	28	50	50	--	130	--
	7- 2	0725	50	49	51	--	122	--
	7- 2	0905	69	53	47	--	122	--
	7- 2	1130	40	--	--	--	122	--
	7- 2	1315	113	--	--	--	121	--
	7- 2	1515	29	--	--	--	120	--
	7- 6	1520	26	--	--	--	105	--
	7- 7	0705	14	--	--	--	102	--
	7- 7	0900	92	--	--	--	102	--
	7- 7	1100	76	--	--	--	108	--
	7- 7	1305	54	--	--	--	110	--
	7- 7	1500	46	--	--	--	110	--
	7-13	0910	56	18	82	--	114	--
	7-15	0805	140	--	--	--	92	--
	7-15	0905	41	--	--	--	91	--
	7-15	1105	466	--	--	--	90	--
	7-22	1435	71	30	70	--	128	--
	7-30	2350	73	42	58	--	139	--
	8-15	0905	301	39	61	--	143	--
	9- 4	1240	284	--	--	--	144	--
	9- 8	1205	237	--	--	--	226	--

Table 1.--Suspended-sediment and streamflow data for three sites on lower Campbell Creek--Continued

Table 1C.--January to August 1988

Station name and number (fig. 1)	Date	Time	Sediment concentration (mg/L)	Percent sand	Percent silt	Gage height (ft)	Water discharge (ft^3/s)
Campbell Creek	4-21	1235	93	--	--	--	55
near C Street	5-12	1235	48	--	--	17.70	94
(15274560)	5-19	1115	128	--	--	17.83	125
	6-28	1055	15	--	--	18.12	140
	7-19	1155	20	--	--	17.99	116
	7-21	0820	87	32	68	18.18	153
Campbell Creek	1-22	1545	4	--	--	--	34
near Spenard	3-11	1500	28	--	--	--	30
(15274600)	4-18	1355	48	--	--	17.96	52
	4-21	1140	23	--	--	17.97	55
	5- 3	1150	13	--	--	17.84	46
	5-12	1345	49	--	--	18.51	99
	5-19	1210	155	--	--	18.84	129
	6- 6	0730	371	--	--	19.67	216
	6- 6	1105	285	--	--	19.78	229
	6-28	1125	18	--	--	19.04	149
	7-19	1105	17	--	--	18.78	123
	7-21	0720	94	26	74	19.15	160
	8- 2	0945	17	--	--	18.62	108
	8- 9	0845	8	--	--	18.33	83
	8-22	0750	86	--	--	19.02	138
	8-25	0920	119	--	--	18.98	134
	8-26	1200	8	--	--	18.46	87
	8-29	1200	42	--	--	18.72	109
Campbell Creek	4- 4	1543	20	--	--	--	26
below outfall	4-21	1200	22	--	--	--	55
(15274606)	5- 4	1225	13	--	--	--	46
	5-12	1320	49	--	--	--	99
	5-19	1250	141	--	--	--	125
	6- 6	0800	485	--	--	--	220
	6- 6	1120	320	--	--	--	228
	6-28	1225	20	--	--	--	149
	7-19	1040	19	--	--	--	123
	7-21	0745	104	31	69	--	161
	8- 2	1010	20	--	--	--	108
	8- 9	0920	10	--	--	--	83
	8-22	0815	75	--	--	--	136
	8-25	0940	76	--	--	--	136
	8-26	1230	9	--	--	--	87
	8-29	1230	69	--	--	--	112

Table 2.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274560, Campbell Creek near C Street

[ft³/s, cubic feet per second; mg/L, milligrams per liter; ton/d, tons per day]

Table 2A.--May to September 1987

	May			June			July		
		Suspended sediment			Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	24	8	0.5	88	46	12	128	25	8.6
2	25	8	.5	94	18	4.5	115	17	5.3
3	27	9	.7	87	17	4.0	105	9	2.6
4	29	10	.8	78	25	5.3	100	8	2.2
5	30	10	.8	80	22	4.8	101	9	2.4
6	35	12	1.1	92	29	7.2	101	13	3.6
7	37	11	1.1	95	31	7.9	102	11	3.0
8	37	12	1.2	100	42	11	99	10	2.7
9	33	9	.8	96	16	4.0	92	9	2.2
10	37	11	1.1	86	14	3.2	89	8	1.9
11	35	12	1.1	79	18	3.8	87	7	1.6
12	36	20	1.9	79	13	2.7	100	19	5.4
13	38	11	1.1	83	10	2.2	109	14	4.1
14	38	10	1.0	93	32	8.0	99	11	2.9
15	48	24	3.1	99	15	4.1	89	10	2.4
16	50	21	2.8	99	12	3.3	89	14	3.4
17	49	17	2.2	93	8	2.0	96	16	4.2
18	52	14	2.0	86	7	1.7	109	24	7.1
19	45	8	1.0	83	12	2.7	106	22	6.3
20	47	9	1.1	86	11	2.6	100	19	5.1
21	57	23	3.5	108	30	8.7	102	21	5.8
22	54	12	1.8	141	102	39	106	41	13
23	49	10	1.3	130	94	33	107	24	6.9
24	66	44	9.1	113	24	7.3	96	18	4.7
25	57	10	1.5	103	14	3.9	102	24	6.6
26	53	7	1.0	96	9	2.3	93	17	4.3
27	50	8	1.1	97	19	5.0	91	19	4.7
28	58	14	2.2	98	11	2.9	89	21	5.0
29	53	8	1.1	143	102	39	88	16	3.8
30	51	10	1.4	153	71	29	104	44	14
31	58	12	1.9	--	--	--	117	53	17
Total			51.8			267.1			162.8

Table 2.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274560, Campbell Creek near C Street--Continued

Table 2A.--May to September 1987--Continued

	August			September		
		Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	102	23	6.3	52	6	0.8
2	93	28	7.0	52	6	.8
3	84	16	3.6	58	11	1.7
4	78	13	2.7	125	175	63
5	95	30	7.7	120	56	18
6	88	16	3.8	102	30	8.3
7	88	18	4.3	126	68	23
8	85	20	4.6	193	339	177
9	80	16	3.5	154	91	38
10	78	14	3.0	136	69	25
11	73	14	2.8	115	49	15
12	73	14	2.8	116	52	16
13	83	21	4.7	101	28	7.6
14	84	22	5.0	91	19	4.7
15	96	50	15	88	16	3.8
16	84	24	5.4	86	12	2.8
17	77	17	3.5	88	12	2.8
18	73	19	3.7	82	9	2.0
19	69	13	2.4	77	8	1.7
20	66	12	2.1	75	7	1.4
21	64	11	1.9	72	7	1.4
22	59	11	1.8	72	7	1.4
23	58	10	1.6	116	138	58
24	57	9	1.4	140	150	62
25	55	9	1.3	107	35	10
26	55	6	.9	101	17	4.6
27	54	6	.9	96	10	2.6
28	54	6	.9	88	8	1.9
29	56	6	.9	86	8	1.9
30	54	6	.9	83	6	1.3
31	52	6	.8	--	--	--
Total			107.2			558.5

Table 2.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274560, Campbell Creek near C Street--Continued

Table 2B.--May to September 1988

	May			June			July		
		Suspended sediment			Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	47	14	1.8	111	16	4.8	136	12	4.4
2	45	14	1.7	103	11	3.1	143	21	8.1
3	43	14	1.6	104	14	3.9	165	29	13
4	43	14	1.6	119	23	7.4	153	17	7.0
5	42	14	1.6	135	40	15	146	15	5.9
6	43	13	1.5	201	210	117	143	15	5.8
7	47	13	1.6	206	83	46	139	13	4.9
8	53	15	2.1	175	52	25	132	11	3.9
9	57	17	2.6	172	50	23	123	12	4.0
10	64	18	3.1	186	69	35	126	14	4.8
11	82	45	10	190	81	42	136	18	6.6
12	93	47	12	179	49	24	139	20	7.5
13	95	32	8.2	168	36	16	132	20	7.1
14	95	22	5.6	173	39	18	134	20	7.2
15	89	19	4.6	182	38	19	126	18	6.1
16	79	17	3.6	181	37	18	128	20	6.9
17	75	14	2.8	175	32	15	125	20	6.8
18	74	9	1.8	170	28	13	121	20	6.5
19	100	55	16	175	30	14	118	21	6.7
20	91	22	5.4	166	25	11	116	24	7.5
21	88	19	4.5	151	22	9.0	138	44	16
22	93	24	6.0	147	22	8.7	123	25	8.3
23	95	21	5.4	147	21	8.3	114	22	6.8
24	98	23	6.1	144	18	7.0	111	19	5.7
25	112	56	17	139	19	7.1	103	20	5.6
26	110	36	11	141	19	7.2	98	17	4.5
27	115	42	13	152	22	9.0	96	18	4.7
28	115	34	11	144	16	6.2	95	14	3.6
29	116	29	9.1	135	13	4.7	93	11	2.8
30	117	30	9.5	136	14	5.1	87	12	2.8
31	111	20	6.0	—	--	--	82	11	2.4
Total			187.8			542.5			193.9

***Table 2.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274560, Campbell Creek near C Street*--Continued**

***Table 2B.--May to September 1988*--Continued**

	August			September		
		Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concen-tration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concen-tration (mg/L)	Discharge (ton/d)
1	92	28	7.0	101	13	3.5
2	103	22	6.1	92	7	1.7
3	93	13	3.3	84	6	1.4
4	86	10	2.3	94	14	3.6
5	88	12	2.9	92	8	2.0
6	95	12	3.1	84	8	1.8
7	93	12	3.0	80	8	1.7
8	85	9	2.1	75	7	1.4
9	80	8	1.7	73	6	1.2
10	77	12	2.5	73	7	1.4
11	109	59	19	70	8	1.5
12	124	34	11	81	11	2.4
13	102	19	5.2	92	17	4.2
14	88	13	3.1	80	8	1.7
15	78	13	2.7	73	5	1.0
16	73	11	2.2	72	5	1.0
17	73	10	2.0	70	6	1.1
18	70	7	1.3	68	4	.7
19	69	7	1.3	70	6	1.1
20	70	6	1.1	89	21	5.0
21	72	15	2.9	120	79	26
22	113	62	21	139	64	24
23	84	10	2.3	118	27	8.6
24	74	6	1.2	107	22	6.4
25	87	29	7.8	98	13	3.4
26	83	8	1.8	90	10	2.4
27	87	9	2.1	86	8	1.9
28	80	7	1.5	83	6	1.3
29	101	44	15	81	6	1.3
30	124	50	18	76	6	1.2
31	105	18	5.1	---	---	--
Total			161.6			115.9

Table 3.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274600, Campbell Creek near Spenard

[ft³/s, cubic feet per second; mg/L, milligrams per liter; ton/d, tons per day]

Table 3A.--May to October 1986

	May			June			July		
		Suspended sediment			Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	60	37	6.0	80	25	5.4	82	13	2.9
2	55	34	5.0	74	20	4.0	86	14	3.3
3	45	33	4.0	65	14	2.5	87	14	3.3
4	40	28	3.0	65	14	2.5	80	11	2.4
5	40	23	2.5	62	11	1.8	78	9	1.9
6	38	24	2.5	68	16	2.9	77	9	1.9
7	38	24	2.5	82	22	4.9	76	13	2.7
8	34	22	2.0	100	36	9.7	68	11	2.0
9	32	22	1.9	81	11	2.4	65	9	1.6
10	32	22	1.9	76	11	2.3	61	9	1.5
11	34	20	1.8	74	11	2.2	60	9	1.5
12	39	22	2.3	73	14	2.8	65	14	2.5
13	45	22	2.7	76	16	3.3	82	25	5.5
14	39	18	1.9	87	25	5.9	75	14	2.8
15	35	20	1.9	98	34	9.0	65	9	1.6
16	42	22	2.5	119	99	32	71	11	2.1
17	39	18	1.9	129	117	41	64	9	1.6
18	37	18	1.8	129	70	24	58	7	1.1
19	39	18	1.9	115	31	9.6	57	7	1.1
20	41	22	2.4	109	27	7.9	75	87	24
21	44	27	3.2	101	18	4.9	106	66	19
22	49	29	3.8	92	13	3.2	82	23	5.1
23	58	38	6.0	86	14	3.3	168	302	151
24	59	36	5.7	81	13	2.8	151	92	38
25	69	56	10	76	9	1.8	113	44	13
26	81	86	19	70	7	1.3	162	65	29
27	69	27	5.0	71	7	1.3	139	18	6.8
28	67	25	4.5	77	7	1.5	108	12	3.5
29	77	40	8.3	79	9	1.9	91	11	2.7
30	91	70	17	79	11	2.3	82	7	1.5
31	92	59	15	–	–	–	77	5	1.0
Total			149.9			200.4			337.9

Table 3.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274600, Campbell Creek near Spenard--Continued

Table 3A.--May to October 1986--Continued

Day	August			September			October		
		Suspended sediment			Suspended sediment			Suspended sediment	
	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	75	4	0.7	110	39	12	119	5	2.9
2	70	4	.76	110	54	17	121	7	4.1
3	67	5	.90	93	16	4.0	157	224	114
4	68	5	.92	87	11	2.6	170	150	69
5	69	7	1.3	82	9	2.0	138	54	20
6	70	11	2.1	80	7	1.5	123	14	8.4
7	64	5	.86	100	35	11	125	19	12
8	65	11	1.9	109	29	8.5	121	10	5.9
9	59	9	1.4	99	25	6.7	114	6	3.3
10	73	14	2.8	86	11	2.6	198	201	118
11	73	11	2.2	82	9	2.0	352	327	328
12	101	56	18	77	9	1.9	302	132	108
13	189	227	130	76	7	1.4	253	72	49
14	132	52	19	73	7	1.4	245	60	40
15	123	68	23	72	5	.97	206	34	19
16	113	40	12	92	24	6.0	192	27	14
17	99	22	5.8	99	22	5.9	172	22	10
18	96	29	7.5	87	13	3.1	164	16	7.2
19	96	16	4.1	84	13	2.9	165	20	8.8
20	85	11	2.5	181	171	103	172	20	9.2
21	81	4	.87	248	101	68	156	13	5.3
22	82	7	1.5	208	61	34	145	13	4.9
23	84	2	.45	207	121	72	138	11	4.0
24	127	24	9.2	151	38	15	131	9	3.2
25	161	31	13	134	30	11	120	7	2.3
26	145	29	11	123	44	15	115	7	2.2
27	124	22	7.4	121	20	6.5	120	4	1.2
28	118	18	5.7	118	14	4.5	119	4	1.2
29	109	16	4.7	113	7	2.1	112	4	1.1
30	100	11	3.0	120	18	5.8	105	4	1.0
31	101	11	3.0	--	--	--	102	4	1.0
Total			297.56			430.37			978.2

Table 3.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274600, Campbell Creek near Spenard--Continued

Table 3B.--May to September 1988

	May			June			July		
		Suspended sediment			Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	49	11	1.5	118	20	6.4	144	19	7.4
2	47	11	1.4	109	14	4.1	152	28	11
3	45	12	1.5	110	14	4.2	175	36	17
4	45	8	.97	126	25	8.5	162	14	6.1
5	43	10	1.2	143	24	9.3	155	11	4.6
6	45	9	1.1	213	190	119	152	12	4.9
7	49	10	1.3	219	96	57	148	13	5.2
8	55	14	2.1	186	62	31	140	13	4.9
9	60	14	2.3	183	62	31	130	13	4.6
10	67	13	2.4	198	70	37	134	5	1.8
11	86	36	8.4	202	66	36	144	6	2.3
12	98	35	9.3	190	38	19	148	16	6.4
13	100	28	7.6	179	16	7.7	140	12	4.5
14	100	38	10	184	26	13	142	13	5.0
15	94	14	3.6	194	26	14	134	11	4.0
16	83	12	2.7	193	26	14	136	13	4.8
17	79	19	4.1	186	28	14	132	10	3.6
18	78	13	2.7	181	25	12	128	10	3.5
19	105	76	24	186	32	16	125	13	4.4
20	96	14	3.6	176	26	12	123	10	3.3
21	93	22	5.5	160	29	13	146	24	9.5
22	98	29	7.7	156	26	11	130	20	7.0
23	100	18	4.9	156	25	11	121	23	7.5
24	104	21	5.9	153	24	9.9	118	20	6.4
25	119	43	14	148	25	10	109	23	6.8
26	116	36	11	150	25	10	103	15	4.2
27	122	46	15	161	18	7.8	101	20	5.5
28	122	40	13	153	19	7.8	100	14	3.8
29	123	37	12	143	22	8.5	98	10	2.6
30	124	34	11	144	23	8.9	92	12	3.0
31	117	26	8.2	--	--	--	86	9	2.1
Total			199.97			563.1			167.7

Table 3.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274600, Campbell Creek near Spenard--Continued

Table 3B.--May to September 1988--Continued

Day	August			September		
		Suspended sediment			Suspended sediment	
	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	97	20	5.2	107	10	2.9
2	109	30	8.8	97	6	1.6
3	98	16	4.2	88	6	1.4
4	91	14	3.4	99	14	3.7
5	93	14	3.5	97	9	2.4
6	100	12	3.2	89	7	1.7
7	98	11	2.9	84	6	1.4
8	90	12	2.9	79	6	1.3
9	84	11	2.5	77	6	1.2
10	81	10	2.2	77	6	1.2
11	116	48	16.	74	5	1.0
12	131	50	18.	85	9	2.1
13	108	26	7.6	97	13	3.4
14	93	14	3.5	84	18	4.1
15	82	15	3.3	77	6	1.2
16	77	14	2.9	76	5	1.0
17	77	10	2.1	73	6	1.2
18	73	14	2.8	71	5	.96
19	72	10	1.9	73	6	1.2
20	73	5	.99	94	24	6.1
21	76	7	1.4	127	52	18.
22	120	60	21.	148	49	20.
23	89	10	2.4	125	29	9.8
24	78	6	1.3	113	23	7.0
25	92	51	13.	103	17	4.7
26	87	10	2.3	95	11	2.8
27	92	7	1.7	91	7	1.7
28	84	7	1.6	87	6	1.4
29	106	61	21.	85	6	1.4
30	131	67	26.	80	6	1.3
31	111	19	5.7	--	--	--
Total			195.29			109.16

Table 4.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274606, Campbell Creek below outfall

[ft^3/s, cubic feet per second; mg/L, milligrams per liter; ton/d, tons per day]

Table 4A.--May to September 1986

	May			June			July		
		Suspended sediment			Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	60	--	6.0	80	27	5.9	82	15	3.4
2	55	--	5.0	74	22	4.4	86	15	3.6
3	45	--	4.0	65	15	2.7	87	14	3.2
4	40	--	3.0	65	17	3.0	80	12	2.6
5	40	--	2.5	62	10	1.7	78	10	2.1
6	38	--	2.5	68	19	3.4	77	10	2.1
7	38	--	2.5	82	22	4.9	76	12	2.4
8	34	--	2.0	100	37	10	68	8	1.6
9	32	20	1.8	81	14	3.0	65	7	1.2
10	32	20	1.8	76	12	2.4	61	8	1.4
11	34	19	1.7	74	14	2.7	60	7	1.1
12	39	19	2.0	73	17	3.4	65	15	2.7
13	45	20	2.5	76	12	2.4	82	31	6.8
14	39	17	1.8	87	17	4.0	75	12	2.4
15	35	17	1.6	98	20	5.4	65	8	1.5
16	42	20	2.3	119	86	28	71	10	2.0
17	39	17	1.8	129	84	29	64	7	1.2
18	37	17	1.7	129	53	18	58	7	1.1
19	39	17	1.8	115	34	10	57	7	1.0
20	41	20	2.3	109	29	8.5	75	94	27
21	44	24	2.8	101	26	7.2	106	61	18
22	49	27	3.6	92	14	3.4	82	24	5.3
23	58	41	6.4	86	10	2.4	168	303	150
24	59	34	5.4	81	10	2.2	151	106	43
25	69	53	9.8	76	7	1.4	113	48	15
26	81	82	18	70	7	1.3	162	96	43
27	69	29	5.4	71	8	1.6	139	38	14
28	67	29	5.2	77	10	2.1	108	23	6.8
29	77	42	8.8	79	8	1.8	91	17	4.2
30	91	68	17	79	10	2.2	82	14	3.0
31	92	58	14	--	--	--	77	12	2.0
Total			147.0			178.4			374.7

Table 4.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274606, Campbell Creek below outfall--Continued

Table 4A.--May to September 1986--Continued

	August			September		
		Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concen-tration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concen-tration (mg/L)	Discharge (ton/d)
1	75	7	1.4	110	29	9.5
2	70	7	1.3	110	82	17
3	67	3	.62	93	15	3.8
4	68	3	.62	87	12	2.8
5	69	8	1.6	82	8	1.9
6	70	12	2.2	80	8	1.8
7	64	10	1.8	100	36	11
8	65	14	2.4	109	30	8.8
9	59	12	1.9	99	27	7.3
10	73	22	4.4	86	10	2.4
11	73	12	2.4	82	7	1.5
12	101	73	23	77	7	1.4
13	189	240	139	76	7	1.4
14	132	48	17	73	7	1.3
15	123	68	23	72	7	1.3
16	113	32	10	92	28	7.6
17	99	17	4.5	99	17	4.5
18	96	24	6.2	87	12	2.8
19	96	14	3.5	84	12	2.7
20	85	8	2.0	181	207	126
21	81	8	1.9	248	166	111
22	82	8	1.9	208	92	52
23	84	7	1.5	207	131	78
24	127	26	9.8	151	59	24
25	161	26	11	134	38	14
26	145	24	9.4	123	36	12
27	124	18	6.0	121	20	6.5
28	118	11	3.4	118	15	4.9
29	109	9	2.6	113	7	2.1
30	100	7	1.8	120	17	5.5
31	101	8	2.3	--	--	--
Total			300.44			526.80

Table 4.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274606, Campbell Creek below outfall--Continued

Table 4B.--May to September 1987

Day	May Water discharge (ft^3/s)	May Suspended sediment Mean concentration (mg/L)	May Suspended sediment Discharge (ton/d)	June Water discharge (ft^3/s)	June Suspended sediment Mean concentration (mg/L)	June Suspended sediment Discharge (ton/d)	July Water discharge (ft^3/s)	July Suspended sediment Mean concentration (mg/L)	July Suspended sediment Discharge (ton/d)
1	24	12	0.8	93	45	12	135	45	16
2	25	12	.8	99	72	19	121	54	18
3	27	12	.9	92	32	7.9	111	24	7.2
4	29	13	1.0	82	20	4.4	105	24	6.8
5	31	14	1.2	84	16	3.6	106	17	4.9
6	36	16	1.6	97	30	7.9	106	25	7.2
7	38	16	1.6	100	28	7.6	107	41	12
8	38	17	1.7	105	31	8.8	104	38	11
9	34	14	1.3	101	29	7.9	97	20	5.2
10	38	16	1.6	91	20	4.9	94	17	4.3
11	36	11	1.1	83	18	4.0	92	20	5.0
12	37	11	1.1	83	16	3.6	105	37	11
13	39	10	1.0	87	20	4.7	115	19	5.9
14	39	9	1.0	98	100	26	104	18	5.0
15	50	19	2.6	104	31	8.7	94	68	17
16	52	19	2.7	104	25	7.0	94	16	4.1
17	51	17	2.3	98	16	4.2	101	14	3.8
18	54	16	2.3	91	14	3.4	115	23	7.1
19	47	8	1.0	87	12	2.8	112	13	3.9
20	49	10	1.3	90	11	2.7	105	13	3.7
21	59	14	2.2	114	30	9.2	108	18	5.2
22	56	13	2.0	149	105	42	112	35	11
23	51	8	1.1	137	92	34	113	25	7.6
24	69	140	27	119	32	10	101	19	5.2
25	59	34	5.4	109	21	6.2	108	27	7.9
26	55	12	1.8	101	18	4.9	98	18	4.8
27	52	12	1.7	105	26	7.4	96	25	6.5
28	61	14	2.3	103	25	7.0	94	23	5.8
29	55	12	1.8	151	128	53	93	27	6.8
30	53	9	1.3	162	97	42	110	50	17
31	61	11	1.8	--	--	--	124	72	24
Total			77.3			366.8			260.9

Table 4.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274606, Campbell Creek below outfall--Continued

Table 4B.--May to September 1987--Continued

	August			September		
		Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concen-tration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concen-tration (mg/L)	Discharge (ton/d)
1	107	33	9.5	54	4	0.6
2	98	27	7.1	54	6	.9
3	88	26	6.2	60	7	1.1
4	82	26	5.8	132	149	60
5	100	44	12	127	63	22
6	93	18	4.5	108	30	8.8
7	93	16	4.0	133	59	21
8	89	16	3.8	205	310	171
9	84	16	3.6	163	72	32
10	82	11	2.4	144	40	16
11	77	8	1.7	121	24	7.8
12	77	19	4.0	122	35	12
13	87	12	2.8	106	19	5.4
14	88	13	3.1	96	18	4.7
15	101	73	24	93	22	5.5
16	88	11	2.6	90	14	3.4
17	81	10	2.2	93	14	3.5
18	77	12	2.5	86	8	1.9
19	72	8	1.6	81	7	1.5
20	69	7	1.3	79	7	1.5
21	67	6	1.1	76	7	1.4
22	62	4	.7	76	7	1.4
23	61	9	1.5	123	139	62
24	59	8	1.3	148	155	67
25	57	6	.9	113	38	12
26	57	6	.9	106	18	5.2
27	56	7	1.1	101	10	2.7
28	56	6	.9	93	7	1.8
29	58	4	.6	90	6	1.5
30	56	5	.8	87	5	1.2
31	54	4	.6	--	--	--
Total			115.1			536.8

Table 4.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274606, Campbell Creek below outfall--Continued

Table 4C.--May to September 1988

Day	May			June			July		
		Suspended sediment			Suspended sediment			Suspended sediment	
	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	49	11	1.5	118	35	11	144	22	8.6
2	47	11	1.4	109	22	6.5	152	18	7.5
3	45	13	1.6	110	22	6.6	175	32	15
4	45	14	1.7	126	39	13	162	21	9.1
5	43	10	1.2	143	36	14	155	18	7.6
6	45	10	1.2	213	228	141	152	13	5.3
7	49	10	1.4	219	208	123	148	20	7.8
8	55	19	2.9	186	55	27	140	23	8.8
9	60	15	2.5	183	62	31	130	16	5.5
10	67	13	2.3	198	65	35	134	13	4.7
11	86	38	8.7	202	88	48	144	20	7.6
12	98	40	11	190	61	31	148	18	7.3
13	100	30	8.2	179	64	31	140	18	6.9
14	100	22	6.0	184	49	25	142	18	7.0
15	94	15	3.9	194	70	37	134	16	5.6
16	83	13	2.9	193	73	38	136	21	7.6
17	79	9	1.9	186	52	26	132	17	6.0
18	78	11	2.4	181	34	17	128	20	6.7
19	105	78	25	186	32	16	125	17	5.7
20	96	20	5.1	176	26	12	123	18	6.0
21	93	15	3.8	160	23	10	146	43	17
22	98	21	5.5	156	20	8.2	130	30	10
23	100	16	4.3	156	18	7.7	121	17	5.5
24	104	29	8.1	153	18	7.5	118	17	5.4
25	119	68	22	148	16	6.2	109	20	5.7
26	116	64	20	150	21	8.4	103	16	4.3
27	122	83	27	161	23	10	101	16	4.5
28	122	36	12	153	27	11	100	22	6.0
29	123	48	16	143	12	4.5	98	20	5.3
30	124	36	12	144	21	8.1	92	10	2.4
31	117	26	8.2	--	--	--	86	6	1.5
Total			231.7			770.7			213.9

Table 4.--Water discharge and suspended-sediment concentrations and discharge for station No. 15274606, Campbell Creek below outfall--Continued

Table 4C.--May to September 1988--Continued

	August			September		
		Suspended sediment			Suspended sediment	
Day	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)	Water discharge (ft^3/s)	Mean concentration (mg/L)	Discharge (ton/d)
1	97	21	5.4	107	12	3.4
2	109	22	6.5	97	8	2.1
3	98	14	3.8	88	10	2.5
4	91	13	3.1	99	14	3.7
5	93	13	3.2	97	6	1.6
6	100	13	3.4	89	6	1.3
7	98	10	2.8	84	6	1.3
8	90	11	2.7	79	6	1.2
9	84	4	.9	77	6	1.2
10	81	5	1.0	77	8	1.7
11	116	42	14	74	10	2.1
12	131	57	20	85	10	2.2
13	108	14	4.2	97	16	4.2
14	93	7	1.8	84	6	1.5
15	82	6	1.4	77	6	1.3
16	77	5	1.0	76	6	1.3
17	77	14	2.8	73	6	1.1
18	73	6	1.3	71	5	.9
19	72	2	.5	73	5	.9
20	73	5	.9	94	17	4.3
21	76	8	1.6	127	62	21
22	120	70	25	148	53	21
23	89	9	2.1	125	32	11
24	78	4	.8	113	34	7.9
25	92	41	11	103	22	6.0
26	87	11	2.6	95	6	1.6
27	92	7	1.8	91	10	2.4
28	84	7	1.6	87	11	2.6
29	106	60	21	85	9	2.0
30	131	73	28	80	6	1.4
31	111	22	6.6	--	--	--
Total			182.8			116.7

Table 5.--Bedload discharge and particle size distribution of samples from lower Campbell Creek

[ft^3/s, cubic feet per second; ton/d, ton per day]

Station name and number	Date	Time	Water discharge (ft^3/s)	Bedload discharge (ton/d)	Particle-size distribution Percentage by weight finer than size (mm) indicated									
					0.062	0.125	0.25	0.50	1.0	2.0	4.0	8.0	16.0	32.0
Campbell Creek near Spenard (15274600)	9-18-86	1130	87	9.2	0	0	1	29	62	78	83	91	95	100
	7-6-87	1600	106	13	0	0	1	17	34	44	55	65	78	100
	7-7-87	1015	107	10	0	0	2	22	36	48	62	78	96	100
Campbell Creek below outfall (15274606)	7-6-87	1430	106	6	0	0	2	43	61	75	84	92	100	--
	7-7-87	0920	107	3	1	3	19	61	75	86	93	96	100	--
	7-15-87	0830	91	4	0	1	6	57	69	77	85	95	100	--

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