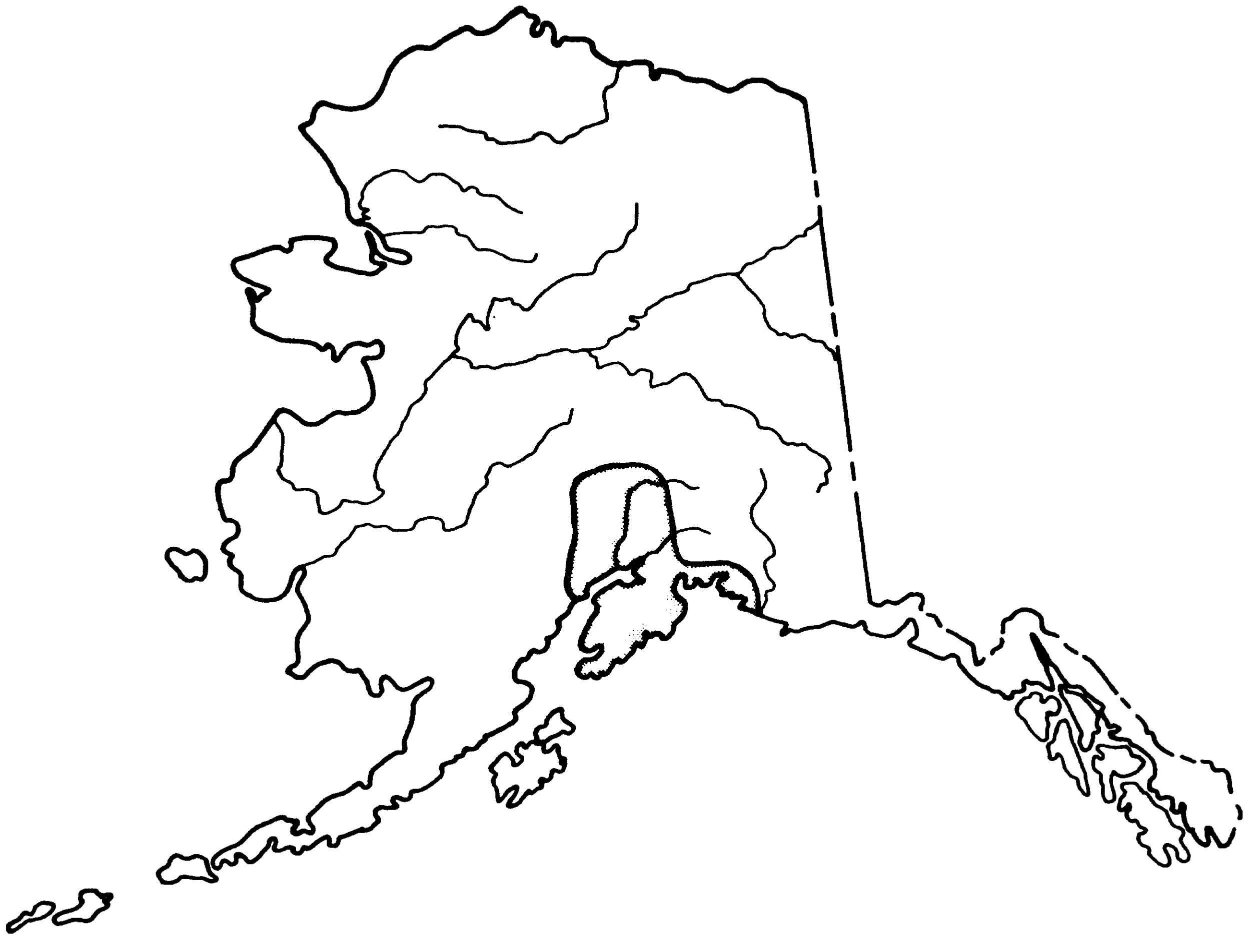
FLOODS OF OCTOBER 1986
IN
SOUTHCENTRAL ALASKA



U.S. GEOLOGICAL SURVEY
OPEN- FILE REPORT 87-391 REVISED 1988

Prepared in cooperation with the:
ALASKA DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES
ALASKA DIVISION OF EMERGENCY SERVICES
FEDERAL HIGHWAY ADMINISTRATION

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by Robert D. Lamke and Bruce P. Bigelow

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Anchorage, Alaska

1988

DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

U.S. GEOLOGICAL SURVEY

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CONVERSION TABLE

For readers who may prefer to use metric (International System) units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

Multiply	by	To obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
cubic foot (ft^3)	0.02832	cubic meter (m^3)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [(ft^3/s)/mi^2]	0.01093	cubic meter per second per square kilometer [(m^3/s)/km^2]
degree Fahrenheit (°F)	°C = 5/9 x (°F-32)	degree Celsius (°C)

Sea level:

In this report "sea level" refers to the 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 "Mean Sea Level of 1929."

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ABSTRACT

Heavy precipitation associated with a large storm system resulted in major flooding in several areas of southcentral Alaska during October 10-12, 1986. Flooding was particularly severe in the Seward area of the Kenai Peninsula and in tributaries to Susitna River from Talkeetna downstream. Flood damage has been estimated at $20 million and the region was declared a Federal disaster area.

The report includes a brief discussion of meteorological conditions that caused the unusual amounts of precipitation, a summary of flood stages and discharges, a comparison to prior floods, flood-frequency estimates, a brief description of flood areas, and hydrologic data for each area.

INTRODUCTION

Unusually large amounts of rainfall that began during mid-morning of October 9 and generally persisted until the evening of October 11 caused flooding in many areas in southcentral Alaska. Flooding generally began on the 10th and most streams peaked on the 11th (with the exception of larger streams, which peaked later). The areas hardest hit by the flooding were near Seward on the Gulf of Alaska and the lower Susitna River Valley -- west of Talkeetna, southward from Talkeetna to Willow, and then southwest toward Tyonek. The most extensive damage was in Seward and along the Susitna River tributaries that cross the Parks Highway. Total damage has been estimated to be in excess of $20 million; a large part of the damage was to the Alaska Highway system and the Alaska Railroad.

Purpose and Scope

This report presents a brief description of the floods, a summary of pertinent streamflow data, and estimated flood frequencies. Data on the magnitude and frequency of peak discharges and volumes of floodflows are useful to agencies involved in planning and design. The area covered in this report is shown in figure 1. The peak-discharge measurement sites shown in figure 1 (and more detailed maps of selected portions of the flood area) are in the downstream order system used by the U.S. Geological Survey. This revised report replaces the initial report of 1987. It incorporates additional data not previously available; some of the discharge values, originally called provisional, have been verified and others were changed after additional review.

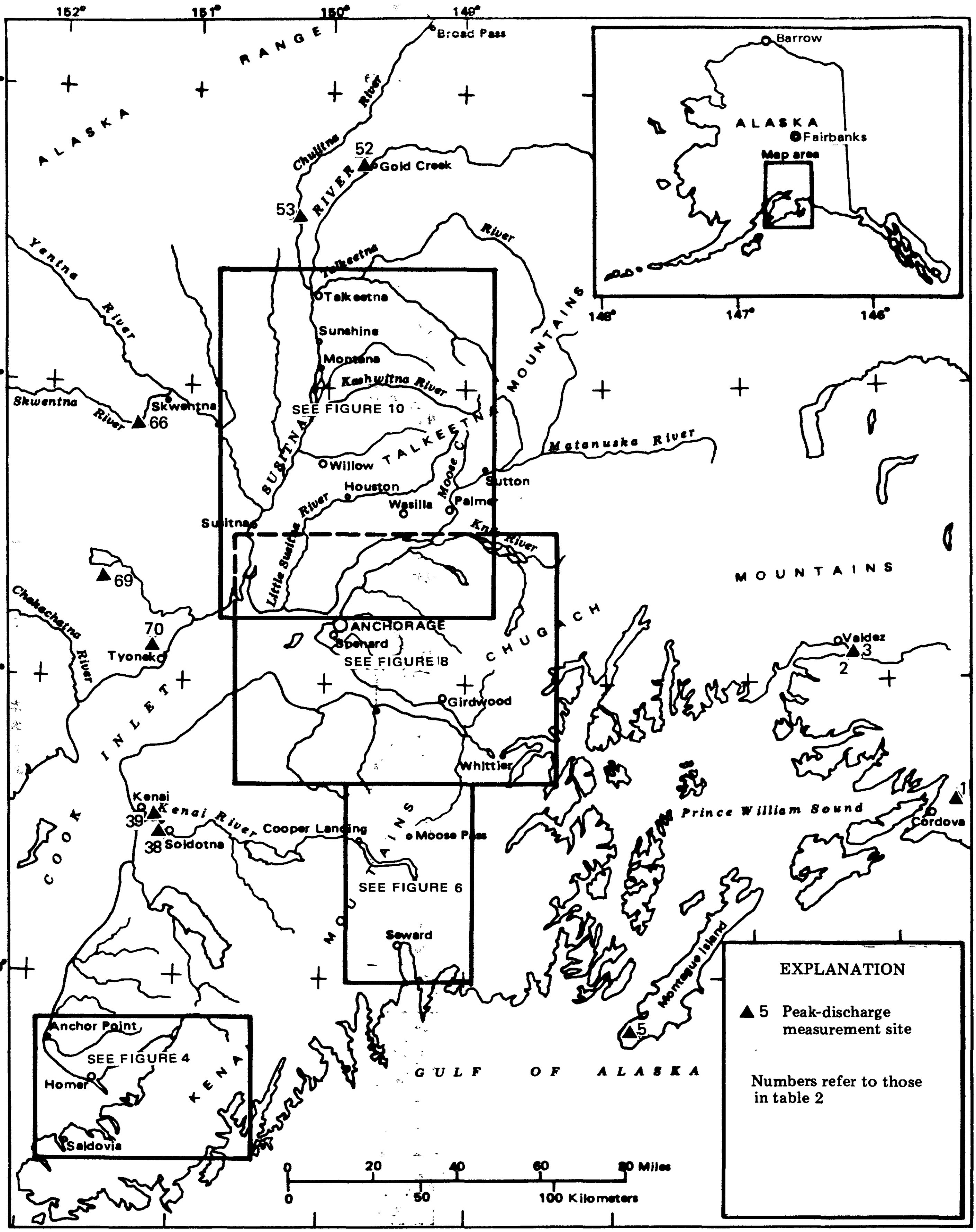


Figure 1. -- Index to location of peak-discharge measurement sites for flood of October 10-12, 1986 in Southcentral Alaska.

Acknowledgements

The data in this report were collected as part of the cooperative programs between the Geological Survey and various State of Alaska agencies: Department of Transportation and Public Facilities, Division of Geological and Geophysical Surveys of Department of Natural Resources, and Department of Fish and Game; and in cooperation with Kenai Peninsula Borough and the Municipality of Anchorage. Supplementary funding for the fieldwork and preparation of this report was furnished by the Alaska Division of Emergency Services, Alaska Department of Transportation and Public Facilities, and the Federal Highway Administration. Meteorological data were furnished by Gerald Nibler (1986) of the National Weather Service and an assessment of the flood was made by the Federal Emergency Management Agency (1986). The U.S. Forest Service and the U.S. Army Corps of Engineers each provide funds for two gaging stations used in the report.

PRECIPITATION

Precipitation totals for the 3-day storm period, October 9-11, are listed in table 1. An isohyetal map (fig. 2) shows that the rains were concentrated around Seward and in the lower Susitna River basin. Intense rainfall began first in the lower Kenai Peninsula and then moved eastward toward Seward. Precipitation data collected at Seward (fig. 3A) show that a period of heavy precipitation began the evening of October 9 and continued into the morning of October 11. The heaviest precipitation within a 6-hour period occurred on October 10 from 4 to 10 a.m., during which 6.00 in. of rain were recorded. The 24-hour period between October 10 at 4 a.m. and October 11 at 4 a.m. had 15.05 in. According to U.S. Weather Bureau data (1963), these rainfall totals have return periods of 50 years and of more than 100 years, respectively. Precipitation accumulations for two other stations on the Kenai Peninsula, Kenai and Lawing, are shown in figure 3B. The heavy rains around Seward were caused by a low-pressure trough oriented along 150° west longitude that was blocked by a high-pressure ridge along the coast of British Columbia and southeast Alaska. The resultant storm front was stationary for 36 hours and the combined dynamic actions of the storm and orographic uplift produced a long period of intense precipitation around the Seward area. The system weakened and slowly shifted eastward to cause flood-producing rains near Cordova (Nibler, 1986) about 24 hours later. Accumulated precipitation at the Cordova Airport weather station is shown in figure 3D.

The unusually large precipitation in the vicinity of Talkeetna and Willow had an added factor in its cause (Nibler, 1986). A moisture-bearing jet in the lower atmosphere moved northward from the Kenai Peninsula, into upper Cook Inlet and Susitna Valley. During this time, a low-pressure trough over Barrow and an associated cold front moved southeastward across interior Alaska towards Fairbanks. When the two systems met, the circulation pattern of the trough was superimposed on the northward-moving jet of moist air and turned it eastward. This resulted in exceptionally heavy rains along the western slopes of the Talkeetna Mountains and in the Susitna Valley west of Talkeetna. The largest 6-hour precipitation observed at the Talkeetna precipitation gage was 1.78 in. between 10 a.m. and 4 p.m. on October 10; the greatest 24-hour amount observed was 5.14 in. from 10 a.m. on October 10 to 10 a.m. on October 11. These values have return periods of 10 and 100 years, respectively (U.S. Weather Bureau,

Table 1. -- Rainfall totals for October 9-11, 1986 storm in flood area

[Station names and locations from U.S. Department of Commerce, 1986, except those footnoted below. Rainfall totals from Nibler, 1986 and U.S. Department of Commerce, 1986. Some sites are National Weather Service observer stations read once daily; totals from most of these were adjusted to reflect period between midnights of October 8 and October 11.]

Site No. (fig. 2)	Station	Latitude	Longitude	Rainfall (inches)
1	Cordova FAA FSS AP	60° 30'	145° 30'	7.41
2	Cordova North	60° 33'	145° 46'	12.57
3	Valdez WSO	61° 08'	146° 21'	3.26
4	Whittier	60° 46'	148° 41'	8.24
5	Main Bay	60° 30'	148° 05'	10.09
6	Port San Juan	60° 03'	148° 04'	7.10
7	Seward 9 NW	60° 12'	149° 37'	10.14
8	Seward	60° 07'	149° 27'	17.97
9	Tutka Bay Lagoon	59° 26'	151° 25'	14.30
10	Homer WSO AP	59° 38'	151° 30'	1.86+
11	Homer 8 NW	59° 45'	151° 39'	4.28
12	Kasilof 3 NW	60° 20'	151° 22'	3.92
a13	Lawing	60° 24'	149° 22'	8.10
14	Moose Pass 3 NW	60° 30'	149° 26'	4.96
15	Cooper Lake Project	60° 23'	149° 40'	8.43
16	Cooper Landing 6 W	60° 29'	149° 58'	2.07+
17	Tri-nal Acres	60° 33'	150° 32'	1.13
18	Kenai FAA AP	60° 34'	151° 15'	6.38
19	Kenai 9 N	60° 40'	151° 19'	7.49
20	Portage 1 S	60° 49'	148° 58'	4.70
21	Alyeska	60° 58'	149° 08'	3.51
22	Glen Alps	61° 06'	149° 41'	1.13

Site No. (fig. 2)	Station	Latitude	Longitude	Rainfall (inches)
b23	Anchorage Hill-side	61° 07'	149° 45'	1.07
24	Anchorage WSCMO AP	61° 10'	150° 01'	2.19
25	Mirror Lake Scout Camp	61° 26'	149° 25'	0.87
26	Eklutna Project	61° 28'	149° 10'	0.91
27	Plant Material Center	61° 32'	149° 05'	1.03
28	Lazy Mountain	61° 38'	149° 02'	1.38
29	Palmer 1 AS	61° 36'	149° 06'	0.78
30	Ben's Farm	61° 34'	149° 08'	0.67
31	Anderson Lake	61° 37'	149° 20'	1.96
32	Matanuska Agr Exp Stn	61° 34'	149° 16'	0.22
33	Wasilla 3 S	61° 32'	149° 26'	2.18
34	Houston	61° 38'	149° 48'	3.40
35	Point Mackenzie 5 SW	61° 22'	150° 06'	2.86
c36	McKinley Park	63° 43'	148° 58'	1.75
37	Chulitna River Lodge	62° 53'	149° 50'	8.36
38	Talkeetna WSCMO AP	62° 18'	150° 06'	8.11
a39	Twelvemile Lake	61° 46'	149° 43'	4.70
a40	Willow	61° 46'	150° 03'	6.40
c41	Puntilla	62° 06'	152° 45'	1.57
42	Skwentna	61° 58'	151° 12'	6.15
43	Beluga	61° 11'	151° 02'	6.35

a Not official National Weather Service precipitation station; recording rain gage operated by another agency.
b Unofficial National Weather Service rain gage.
c Not on figure 2; outside map area.

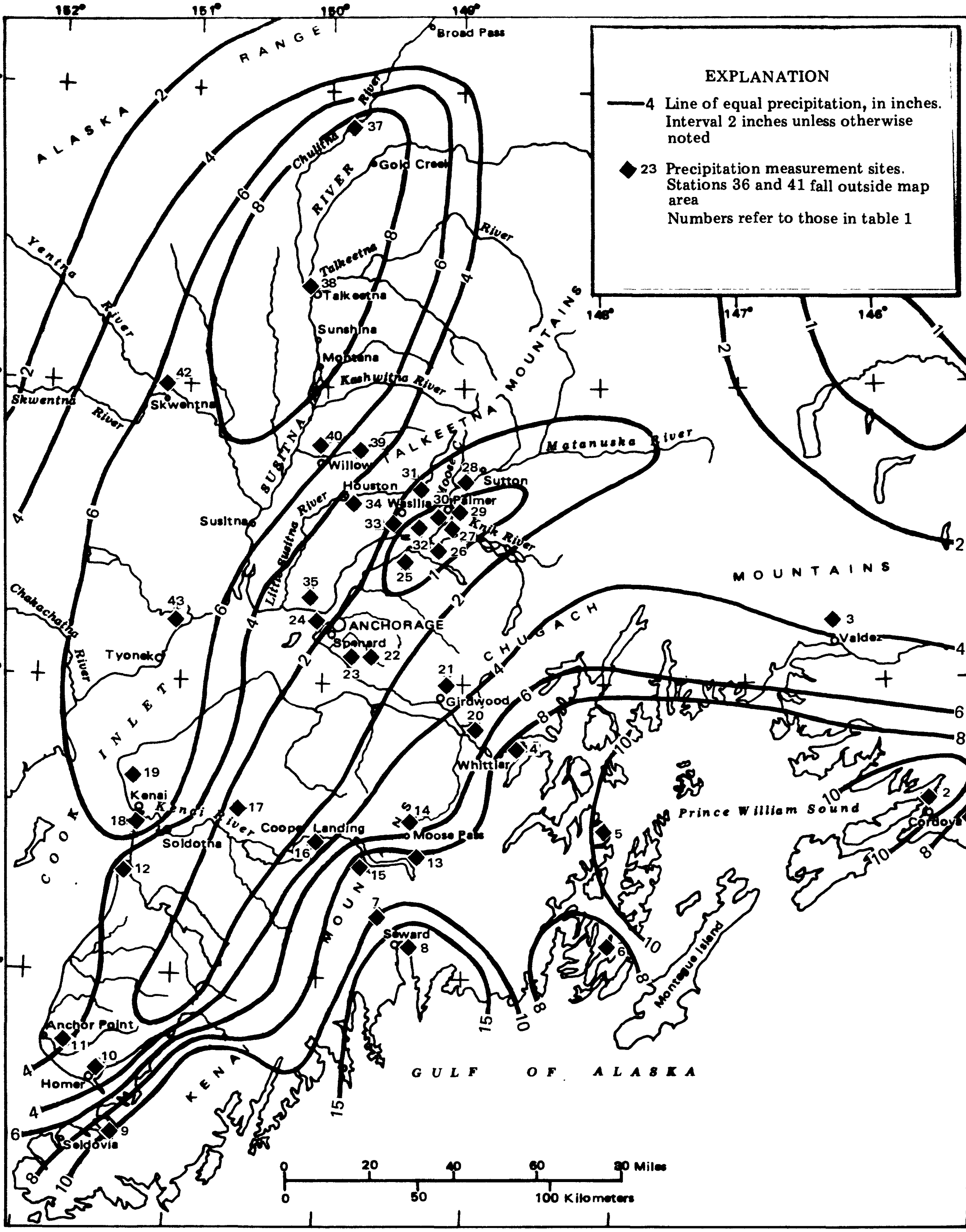


Figure 2.--Selected rainfall measurement sites 1 to 43 and isohyets of total precipitation, October 9-11, 1986, for Southcentral Alaska. Adapted from map furnished by National Weather Service.

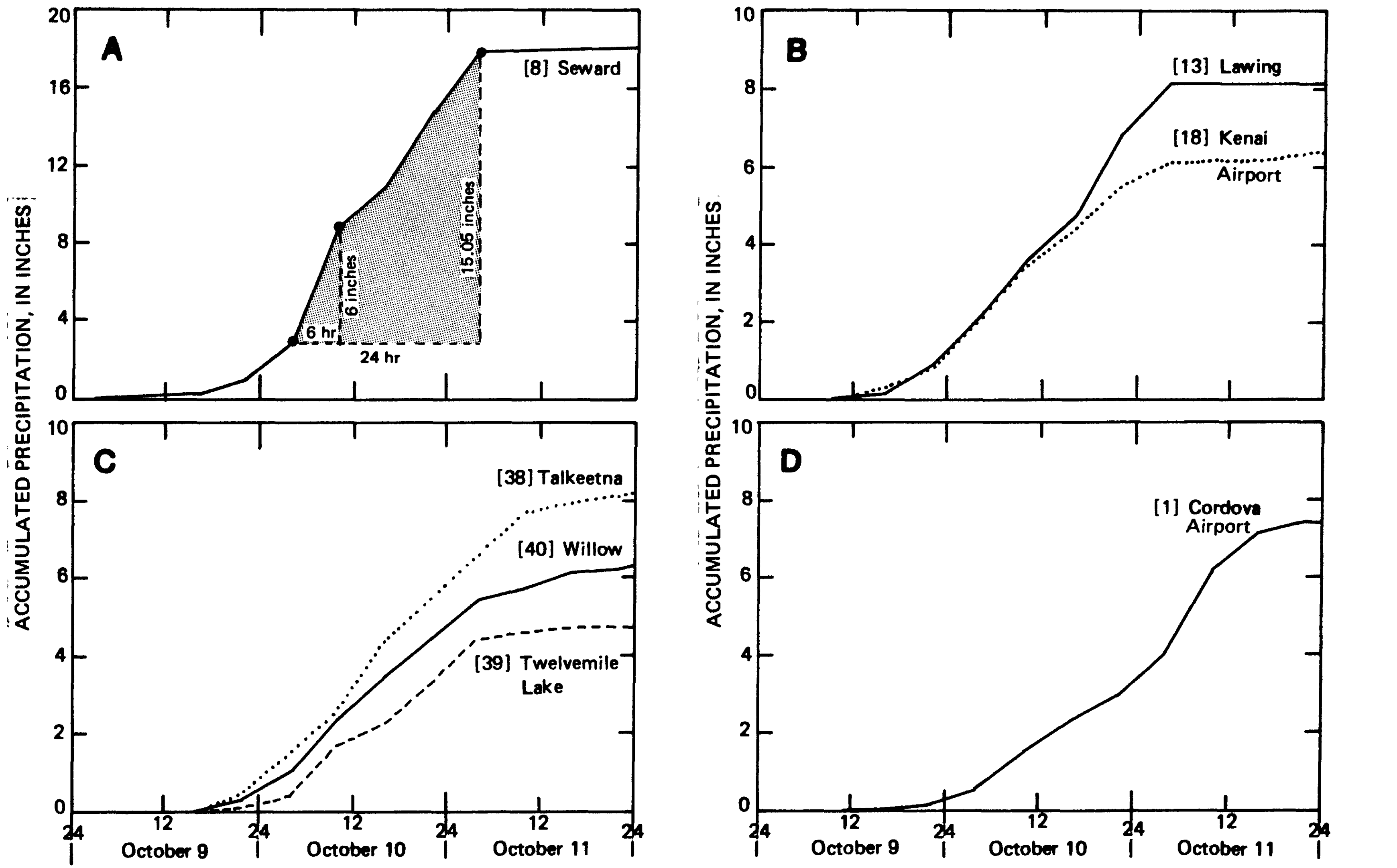


Figure 3.--Accumulated precipitation at selected sites, October 9-11, 1986. Data furnished by the National Weather Service. Site numbers in brackets refer to those in figure 2 and table 1.

1963 and Nibler, 1986). The precipitation at three sites in the area is graphed in figure 3C.

The freezing levels during this storm period were at comparatively high altitudes. For example, freezing levels during the early morning of October 10 were at about 7,000 ft at Fairbanks and Anchorage. In contrast, freezing levels the night of October 8 were at ground level at Fairbanks and at 3,000 ft over Anchorage. Normally, most precipitation in October at higher altitudes occurs as snow. (See Nibler, 1986.)

DISCHARGE DATA

Peak Stage and Discharge Table

Peak stages and discharges were determined at many gaging stations, crest-stage gage sites, and miscellaneous sites affected by the October floods. Table 2 lists the data for these sites. The site numbers shown in table 2 correspond to the numbers on figures 1, 4, 6, 8, and 10, which show site locations. Table 2 includes information about: (1) the downstream order station number; (2) the stream name and location; (3) drainage area; (4) the period of record during which systematic collection of discharge data occurred, and at a few sites, the year that peak discharge data were collected during prior outstanding floods; (5) date, peak stage (gage height), and discharge for the maximum flood previously documented; and (6) the date, peak stage (gage height), and discharge for the October 1986 flood.

The indicated recurrence interval, or frequency, of the floods (table 2) is the average number of years between floods with maximum discharges equal to or greater than those of October 10-12, 1986. A given recurrence interval does not imply that it will be that many years before a flood of that magnitude occurs again. In fact, floods of similar or greater magnitude can occur in the same year or the following year. Recurrence intervals are the reciprocal of the probability of a flood event, of a given size or larger, occurring during any given year. That is, a 100-year flood has a 0.01 probability or 1 percent chance of occurring in any one year. All frequencies, or recurrence intervals, were determined from station data using log-Pearson III frequency analysis procedures described by the Water Resources Council (1981). Individual station frequency curves used the "skew" and "standard deviation" statistics computed by Lamke (1979). Most of the stations have short periods of record; the recurrence interval for these stations is shown as a range in years or qualified as "about"; a ratio of the October maximum to the computed 100-year flood discharge is shown for three stations, Montana (57) and Caswell Creeks (60) and Deshka River (65), with recurrence intervals greater than 100 years. (Hereafter, the site numbers, for example (57) and (60), are included for those sites mentioned in the description of the flood. Site numbers for the precipitation measurement sites listed in table 1 are bracketed; for example, Homer Airport [10].)

Discharge Data for October 1986

Discharge data for October 1986 were computed for six selected stream-gaging stations, at which the peak of the period of record occurred during the month. Daily discharges for the month along with gage height and discharge data sufficient to prepare hydrographs for the flood period are presented later in

Table 2.--Summary of flood stages and discharges for the flood of October 10-12, 1986

[Site numbers refer to those on figures 1, 4, 6, 8, and 10; mi^2, square miles; w. y., water year; ft^3/s, cubic feet per second]

Site No.	Permanent station number	Stream name and location	Drainage area (mi^2)	Annual peak flow records (w. y.)	Maximum discharge previously known: Date	Maximum discharge previously known: Gage height (feet)	Maximum discharge previously known: Discharge (ft^3/s)	Maximum discharge in flood period: Day	Maximum discharge in flood period: Gage height (feet)	Maximum discharge in flood period: Discharge (ft^3/s)	Maximum discharge in flood period: Recurrence interval (years)
1	15216000	Power Creek near Cordova	20.5	1948-	9-25-49	7.65	5,540	11	5.89	3,040	3
2	15225998	Solomon Gulch Bypass near Valdez	(a)	1986-	9-20-86	9.25	1,290	11	12.11	3,370	---
3	15226000	Solomon Gulch near Valdez	19.7	1950-56, 86-	9- 4-51	b6.50	2,420	11	---	c2,230	---
4	15236200	Shakespeare Creek at Whittier	d1.61	1970-80, 84-	9-13-79	12.61	620	11	11.2	475	3
5	15237360	San Juan River near Seward	12.4	1986-	9-8-86	7.98	1,730	11	6.80	1,140	---
6	---	Godwin Creek near Seward	13.8	---	---	---	---	11	44.10	ge30,000	---
7	---	Sawmill Creek near Seward	7.85	---	---	---	---	11	51.30	2,900	---
8	---	Sawmill Creek at Nash Road near Seward	10.6	---	---	---	---	11	f29.99	eg4,000	---
9	---	Resurrection River at Exit Glacier bridge	106	---	---	---	---	11	f353.28	(h)	---
10	15237700	Resurrection River at Seward	169	1965-67	8-21-66	b10.68	18,900	11	f31.02	g19,000	---
11	15238000	Lost Creek near Seward	d8.42	1949, 63-72, 76	9-20-76	12.30	920	11	(h)	ge14,000	---
12	---	Grouse Creek near Seward	4.78	---	---	---	---	11	84.65	1,890	---
13	---	Lost Creek at Bridge 600 near Seward	23.6	---	---	---	---	11	f143.00	e8,500	---
14	---	Salmon Creek near Seward	7.10	---	---	---	---	11	50.03	4,200	---
15	---	Clear Creek near Seward	---	---	---	---	---	11	f43.01	j2,800	---
16	---	Salmon Creek at Nash Road near Seward	---	---	---	---	---	11	f23.44	gj10,300	---
17	---	Rudolph Creek near Seward	1.00	---	---	---	---	11	---	1,020	---
18	15238500	Lowell Creek at Seward	4.02	1966-68	8-21-66	(k)	1,200	11	(k)	(h)	---
--	---	Spruce Creek above debris avalanche near Seward	8.98	---	---	---	---	11	---	5,420	---
19	15238600	Spruce Creek near Seward	9.26	1966-	9-15-82	9.46	3,420	11	m13.96	m13,600	---
20	15238648	Upper Nuka River near Homer	n83	1985-	9-27-85	4.42	709	11	4.48	777	---
21	15238820	Barbara Creek near Seldovia	20.7	1973-	11-29-83	6.08	2,050	10	4.26	1,590	10-15
22	15238990	Upper Bradley River near Homer	n10	1980-	8-27-86	9.30	2,150	10	9.86	2,530	5-10
23	15239000	Bradley River near Homer	n54	1958-	8-10-79	9.46	6,020	10	10.90	8,800	50
24	15239050	Bradley River tributary near Homer	9.25	1980-	7-11-80	8.05	765	10	8.53	1,120	10-15
25	15239070	Bradley River near tidewater near Homer	n82	1984-	8-28-86	10.32	4,160	11	13.73	11,000	---
26	15239500	Fritz Creek near Homer	10.4	1963-	10-22-80	b18.53	852	p15	p10.85	p112	<2
27	15239900	Anchor River near Anchor Point	137	1966-74, 79-	11-29-83	7.42	6,050	10	5.17	2,210	5
28	15240000	Anchor River at Anchor Point	224	1954-66, 84-	11-30-83	8.51	11,000	10	6.30	5,900	25
29	15243900	Snow River near Seward	128	1967,70, 74,77,86	8-31-67	b42.6	q55,000	11	f480.24	17,500	---
30	---	Sixteen Mile Creek near Seward	3.19	---	---	---	---	11	21.44	2,550	---
31	---	Snow River at Seward Highway near Seward	165	1970,74, 77,85,86	9-20-74	---	q28,300	11	---	g15,400	---
32	15243950	Porcupine Creek near Primrose	16.8	1963-	9-18-82	r13.44	3,350	11	13.03	4,000	80
33	15248000	Trail River near Lawing	181	1948-77	9-18-67	11.93	7,480	12	9.7	e4,800	5
34	15251800	Quartz Creek at Gilpatricks	9.41	1963-70, 1976	10-6-69	11.54	633	11	(h)	897	50
35	15254000	Crescent Creek near Cooper Landing	31.7	1950-83	10-9-69	12.73	1,500	11	11.73	680	10
36	---	Quartz Creek near Cooper Landing	111	---	---	---	---	11	---	2,400	---
37	15258000	Kenai River at Cooper Landing	634	1948-	9-21-74	17.18	q23,100	14	13.84	13,400	4
38	15266300	Kenai River at Soldotna	2,010	1965-	9-9-77	13.45	33,700	18	10.26	16,300	<2
39	15266500	Beaver Creek near Kenai	51	1968-78, 80-83,85-	5-8-72	b10.55	598	11	9.43	700	20
40	15271000	Sixmile Creek near Hope	234	1970, 1980-	7-12-80	13.22	8,070	10	12.73	6,320	5

Table 2.--Summary of flood stages and discharge for the flood of October 10-12, 1986--Continued

Site No.	Permanent station number	Stream name and location	Drainage area (mi²)	Annual peak flow records (w. y.)	Maximum discharge previously known: Date	Gage height (feet)	Discharge (ft³/s)	Maximum discharge in flood period: Day	Gage height (feet)	Discharge (ft³/s)	Recurrence interval (years)
41	15272530	California Creek at Girdwood	6.96	1967-	10-6-69	20.20	600	12	15.81	250	3
42	15274600	Campbell Creek near Spenard	69.7	1966-	8-13-81	b3.54	451	11	20.89	472	@7
43	15276000	Ship Creek near Anchorage	90.5	1947-	6-21-49	b3.44	1,860	11	6.06	1,310	15
44	15277600	East Fork Eklutna Creek near Palmer	38.2	1961-62, 65-	9-12-61	b3.86	1,320	11	9.19	1,500	@6
45	15277800	West Fork Eklutna Creek near Palmer	25.4	1961-62, 85-	6-29-62	b3.84	1,470	11	9.05	606	<2
46	15283500	Eska Creek near Sutton	13.4	1966, 1971-	6-10-71	b26.82	1,660	11	6.74	223	3
47	15285000	Wasilla Creek near Palmer	16.8	1971, 1976-	8-10-71	17.74	700	11	9.56	99	<2
48	15285200	Wasilla Creek near Wasilla	39.5	1960-	9-16-80	3.46	243	11	2.47	92	<2
49	15290000	Little Susitna River near Palmer	61.9	1949-	6-10-71	@13	7,640	11	8.17	2,510	3
50	15290100	Little Susitna River near Houston	166	1980-81, 1984-	9-16-80	15.31	3,200	12	15.30	3,600	10-15
51	15290200	Nancy Lake tributary near Willow	6.00	1980, 1983-	6-21-80	12.42	295	11	13.21	465	10-15
52	15292000	Susitna River at Gold Creek	6,160	1950-	6-7-64	16.58	90,700	11	11.82	36,500	<2
53	15292400	Chulitna River near Talkeetna	2,570	1958-77, 1979-	7-20-67	22.48	75,900	11	17.98	57,700	10-15
54	15292700	Talkeetna River near Talkeetna	2,006	1964-	6-10-71	16.35	67,400	11	17.38	75,700	40
55	15292780	Susitna River at Sunshine	11,100	1971, 1981-	8-10-71	b62.10	200,000	11	16.5	165,000	25-50
56	---	Rabideux Creek near Sunshine	@27	---	---	---	---	11	19.13	2,700	---
57	15292800	Montana Creek near Montana	164	1963-72	8-10-71	12.96	6,970	11	s20.0	15,300	t1.3
58	15292900	Goose Creek near Montana	NOTE	1963-71, 1984-	8-10-71	b19.69	3,270	11	5.80	7,000	---
59	15292990	Sheep Creek near Willow	NOTE	1984	8-25-84	2.82	1,910	11	5.39	6,200	---
60	15293000	Caswell Creek near Caswell	19.6	1963-	8- -65	12.89	207	11	19.00	960	t1.43
61	15293700	Little Willow Creek near Kashwitna	155	1980-	8-12-65	13.30	2,500	11	15.25	6,500	@30
62	15294005	Willow Creek near Willow	166	1979-	7-28-80	b8.80	4,450	11	9.01	12,000	@50
63	15294010	Deception Creek near Willow	48	1978-85	6-21-80	8.44	751	11	8.89	900	10-15
64	15294025	Moose Creek near Talkeetna	52.3	1972-	7-10-81	b26.73	2,500	11	31.80	5,790	100
65	15294100	Deshka River near Willow	592	1979-	11-13-79	6.16	9,920	12	13.5	48,000	t1.3
66	15294300	Skwentna River near Skwentna	2,250	1960-82	6-09-77	15.09	51,600	11	17.3	69,000	100
67	15294345	Yentna River near Susitna Station	6,160	1981-	8-13-81	18.61	116,000	12	19.21	130,000	@10
68	15294350	Susitna River at Susitna Station	19,400	1975-	7-29-80 8-16-81	20.26 20.27	230,000 230,000	12	22.58	312,000	40
69	15294410	Capps Creek below North Capps Creek near Tyonek	10.5	1980-85	9-15-82	7.60	550	10	11.30	>1,200	(u)
70	15294450	Chuitna River near Tyonek	131	1976-	9-15-82	10.07	4,800	10	16.46	>10,000	(u)

(NOTE: Flood flows from Sheep and Goose Creeks intermingle; combined drainage area is 157 mi².)

@ About.
\> Greater than value shown.
< Less than value shown.
a Regulated.
b At different datum or location.
c Maximum daily discharge.
d Revised from previously published annual reports.
e Discharge affected by landslide, debris flow, or other slope failures causing storage releases.
f At National Geodetic Vertical Datum of 1929.
g Total discharge; see text for explanation of how total was determined.
h Not determined.
j Includes water diverted from Box Canyon Creek.
k Flood stage was 2 ft below crest of upstream diversion dam in 1966 and 0.7 ft below in 1986.
m Stage and discharge affected by debris-avalanche release flood.
n Drainage area varies with position of terminus of Nuka Glacier.
p Peak occurred during a period of questionable gage-height record, Oct. 10-15. Gage-height shown was the highest recorded in the period, but a higher peak discharge may have occurred earlier.
q Glacier-dammed lake outburst flood.
r Backwater from Kenai Lake.
s Maximum stage might have occurred prior to maximum disharge.
t Ratio to estimated discharge of a flood with a 100-year recurrence interval.
u Probably greater than 100-year flood discharge; extraordinary channel changes.

tables 3, 4, and 5; discharge hydrographs for October 9-15, were graphed and also are shown later in the report. Alaska Daylight Savings Time (ADST) is used throughout the report.

FLOOD DESCRIPTION

The greatest rainfall intensity in the lower Kenai Peninsula occurred the afternoon and night of October 9 (see Homer [10], fig. 5); the storm then moved eastward to Seward, where the highest intensities were at mid-morning of October 10 (fig. 3A). The center of heavy rainfall then moved northward to the Anchorage area on the afternoon and evening of October 10 (see fig. 9). In the Susitna River basin, still farther north, the high intensity precipitation began the morning of October 10 and continued throughout the day (fig. 3C). To the southeast near Cordova, the highest 6-hour intensities occurred during mid-morning of October 11, 1986 (fig. 3D). The description of the flood will generally follow the above sequence.

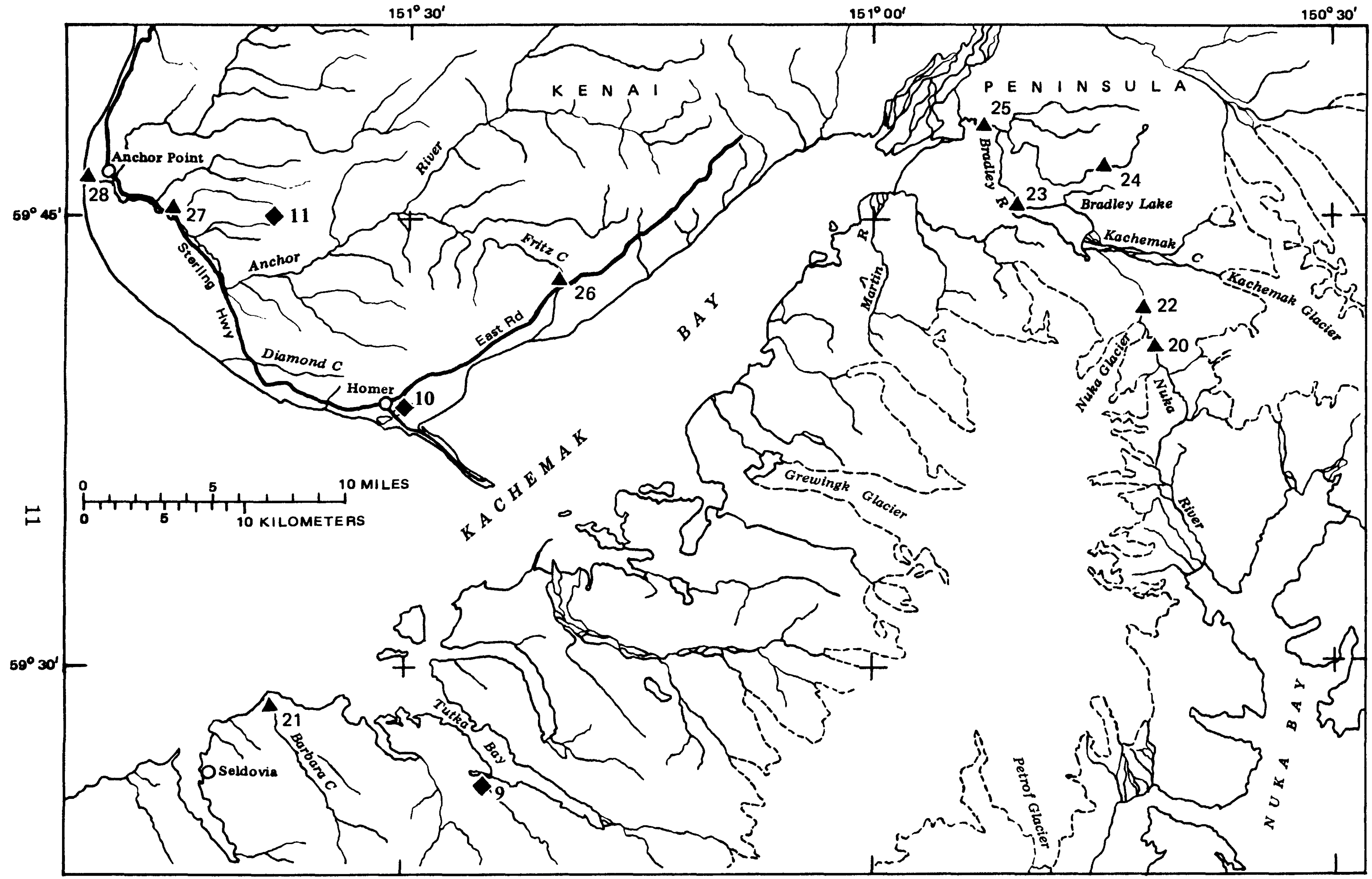
Kenai Peninsula

Bradley Lake and Homer Area Streams

The most extreme flooding documented in the lower Kenai Peninsula was in the Bradley River basin (fig. 4). Stream stage and discharge at Upper Nuka River (20), Upper Bradley River (22), Bradley River (23), Bradley River tributary (24), and Bradley River near tidewater (25) exceeded all prior maximums. These stations have seven or fewer years of flood record except for Bradley River (23), which has 27 years. Upper Bradley River (22), which originates at Nuka Glacier, had a peak discharge of 2,530 ft^3/s with an estimated recurrence interval of about 10 years. The peak recurrence interval downstream at Bradley River (23), at the downstream end of Bradley Lake, was 50 years. Much of the flood flow probably was from Kachemak Creek, which begins at Kachemak Glacier; this stream has about 80 percent of the drainage area tributary to Bradley Lake.

Discharge data for Upper Bradley River (22) are presented in table 3 and a discharge hydrograph is shown in figure 5. Precipitation at Homer [10] was less than in the Bradley River drainage (fig. 2), but the timing of the highest intensities probably coincides. The peak discharge occurred just after midnight October 9. The increase in discharge (fig. 5) on the afternoon of October 10 might have been caused by fringes of the storm around Seward [8] (figs. 3 and 5) or the rise might be due to snow and glacier melt resulting from above-freezing temperatures at high altitudes. The gaging station is at an altitude of about 1,200 ft above sea level.

Southwest of Bradley Lake, about 14.3 in. of rain fell at Tutka Bay Lagoon [9] during the 3-day storm period; this was the second highest recorded rainfall in southcentral Alaska. The 6 p.m. reading on October 10 was 10.31 in.; the gage is read once daily at 6 p.m. (ADST). (See U.S. Dept. of Commerce, 1986.) However, peak discharge at Barbara Creek near Seldovia (21), which is about 9 mi northwest of the Tutka Bay precipitation gage, was not as high as that of November 29, 1983. The recurrence interval of the peak discharge, 1,590 ft^3/s, was about 10 to 15 years. West of Homer, along the Sterling Highway, peak discharges at gaging station, Anchor River near Anchor Point (27) and Anchor



EXPLANATION

◆ 9 Rainfall measurement site

▲ 20 Peak-discharge measurement site

Numbers refer to tables 1 and 2 respectively

Figure 4.--Rainfall measurement sites 9 to 11 and peak-discharge measurement sites 20 to 28, Bradley Lake to Homer.

Table 3.--Discharge data for Upper Bradley River during October 1986

(22) 15238990 UPPER BRADLEY RIVER NEAR HOMER

LOCATION.--Lat 59°42'15", long 150°42'15", Kenai Peninsula Borough, Hydrologic Unit 19050002, on left bank 1.2 mi downstream of Nuka Glacier terminus, 2.5 mi upstream of mouth at Kachemak Creek, 3.5 mi southeast of Bradley Lake, and 29 mi east of Homer.

DRAINAGE AREA.--About 10 mi^2. Drainage area varies according to position of terminus of Nuka Glacier; it became smaller on June 1983 as snowmelt runoff from Nuka Glacier began to flow again into both the Nuka and Bradley River drainage basins.

GAGE-HEIGHT RECORD.--Water-stage recorder graph except Oct. 1-6. Elevation of gage is 1,200 ft above National Geodetic Vertical Datum of 1929, from topographic map.

DISCHARGE RECORD.--Stage-discharge relation defined by current-meter measurements below 450 ft^3/s and slope-area measurement at 2,530 ft^3/s. Discharge Oct. 1-6 estimated by comparison with nearby station records.

MAXIMUM FOR PRIOR FLOOD RECORD.--(Water years 1980-86), 2,150 ft^3/s, Aug. 27, 1986, gage height, 9.30 ft; maximum gage height, 13.09 ft, Dec. 17, 1981, backwater from ice.

MAXIMUM FOR OCTOBER FLOOD.-- 2,530 ft^3/s, 0030 hours Oct. 10, gage height, 9.86 ft, from recorder, 9.8 ft, from high-water mark.

Mean discharge, in cubic feet per second, October 1986

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	170	6	130	11	1,070	16	81	21	101	26	32
2	140	7	94	12	730	17	55	22	83	27	29
3	400	8	60	13	614	18	47	23	48	28	27
4	280	9	521	14	186	19	43	24	40	29	24
5	190	10	1,440	15	127	20	42	25	36	30	22
										31	22
Total	6,884	Mean	222	Maximum	1,440						

Gage height, in feet; discharge, in cubic feet per second; at indicated date and time in 1986

Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge
Oct. 9	0000	6.32	57	Oct. 10	2130	9.26	1,760	Oct. 13	0030	8.61	1,120
	0400	6.30	40		2400	9.44	1,970		0130	8.89	1,370
	0600	6.32	57						0200	8.92	1,400
	0930	6.37	62	Oct. 11	0130	9.75	2,380		0230	8.87	1,350
	1100	6.46	98		0300	9.14	1,630		0330	8.45	987
	1500	6.78	306		0500	8.84	1,320		0500	8.16	776
	1630	7.10	552		0800	8.69	1,190		0530	8.24	831
	1800	7.24	665		1000	8.47	1,000		0600	8.10	737
	1930	7.92	1,180		1200	8.23	824		1000	7.79	553
	2000	8.52	1,610		1230	8.42	963		1600	7.57	442
	2030	8.50	1,600		1300	8.21	810		2200	7.19	287
	2100	8.68	1,730		1330	8.64	1,140		2400	7.11	260
	2200	8.51	1,610		1400	8.19	776				
	2300	9.14	2,040		1630	8.07	717	Oct. 14	0300	7.01	228
	2400	9.66	2,400		1700	8.17	783		0430	7.06	244
					2000	7.97	655		0800	6.92	200
Oct. 10	0030	9.86	2,530		2400	7.87	597		1200	6.81	169
	0130	9.14	1,630						1330	6.75	153
	0430	8.82	1,300	Oct. 12	0300	7.90	614		1800	6.73	147
	0530	8.63	1,130		0400	7.97	655		2100	6.75	153
	0600	8.77	1,260		0600	7.83	575		2330	6.81	169
	0630	8.60	1,110		0830	7.65	481		2400	6.76	155
	0830	8.75	1,240		1030	7.82	569				
	1000	8.45	987		1130	7.80	558	Oct. 15	0230	6.77	158
	1200	8.71	1,200		1200	7.85	586		0400	6.75	153
	1330	8.45	987		1300	7.81	563		1200	6.64	125
	1530	8.65	1,150		1400	7.95	644		1500	6.59	113
	1730	9.00	1,480		1700	8.07	717		1900	6.58	111
	1830	9.14	1,630		2000	8.54	1,060		2030	6.54	102
	1930	9.43	1,960		2130	8.67	1,170		2400	6.51	95
	2000	9.28	1,780		2330	8.83	1,310				
	2030	9.53	2,080		2400	8.75	1,240				

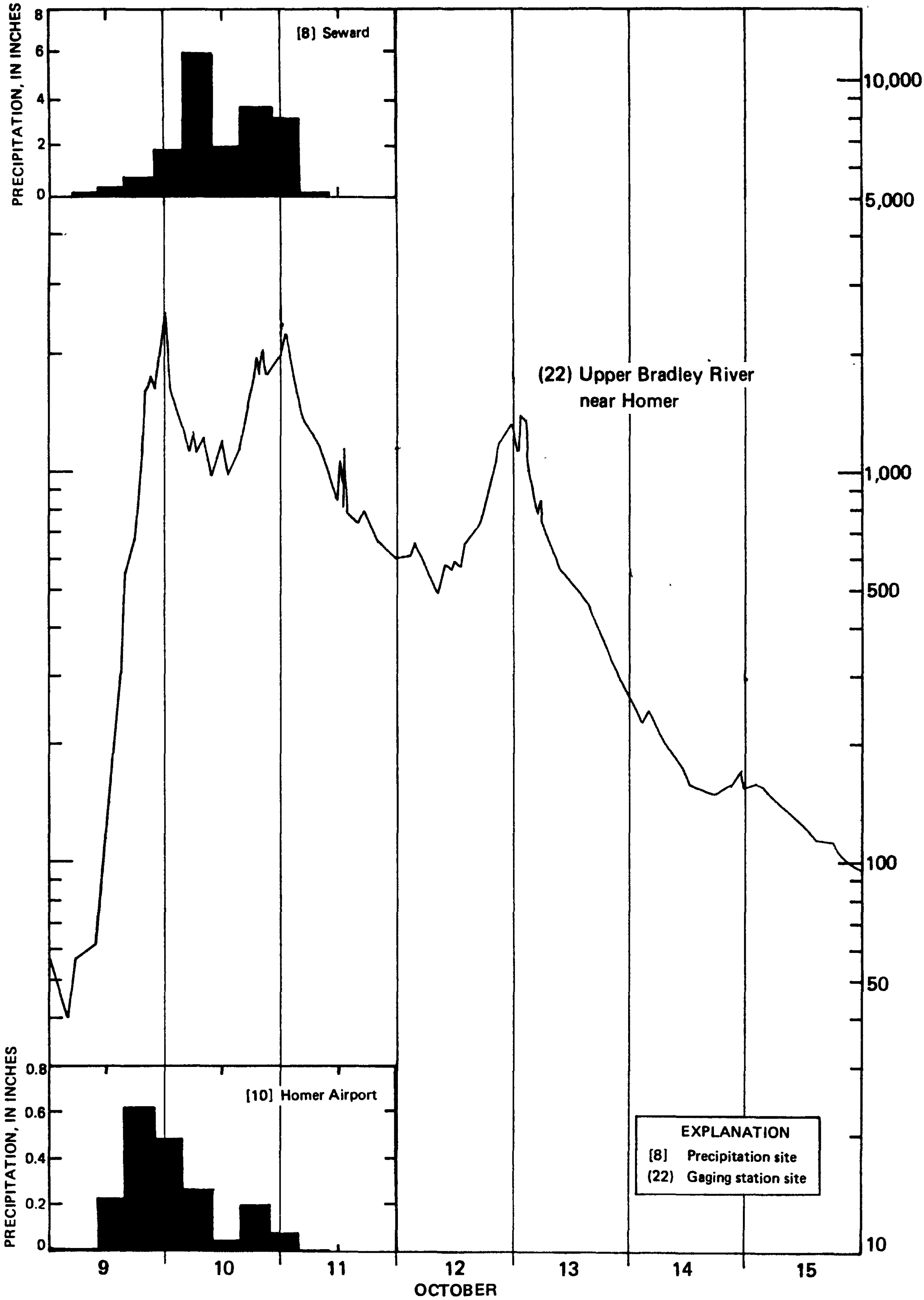


Figure 5.--Flood discharge hydrograph and concurrent 6-hour storm precipitation at selected sites in Kenai Peninsula. See table 3 for discharge data.

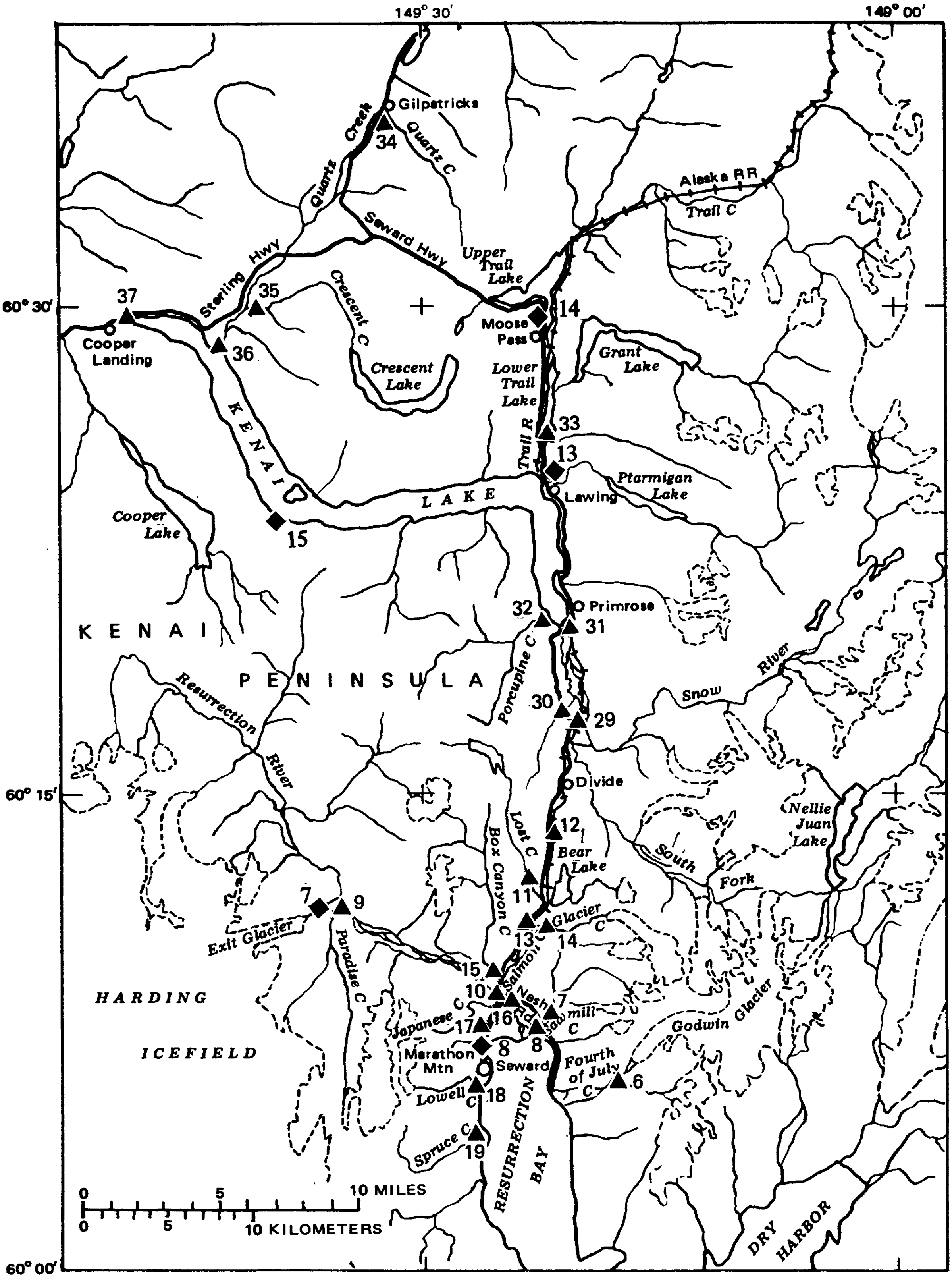
River at Anchor Point (28), had recurrence intervals of 5 and 25 years, respectively. There was some minor erosion along Anchor River, which had much higher peak discharges on November 29 and 30, 1983. North of Homer, the maximum peak flow of record occurred at Beaver Creek near Kenai (39) and had a 20-year recurrence interval. Peaks at the sites mentioned above occurred October 10, except at Beaver Creek, where the peak occurred on October 11. (See fig. 3B for accumulated precipitation at Kenai.)

Seward Area Streams

Within southcentral Alaska, the largest rainfall totals (fig. 2) and greatest rainfall intensity (fig. 3) occurred in the vicinity of Seward (fig. 6), where it caused widespread catastrophic flooding. Landslides in the steep mountains bordering Resurrection Bay, eroding and migrating channels, and the subsequent deposition of debris compounded the problems caused by flood inundation. Most of this discussion of Seward area flooding is based on information provided by the authors' U.S. Geological Survey colleagues (Jones and Zenone, 1988). The record-breaking rains at Seward (see fig. 3 and earlier discussion in "Precipitation") caused widespread flooding near the mouth of Resurrection River and in streams tributary to Resurrection Bay. Peak discharge and stage at two Resurrection River sites, Exit Glacier bridge (9) and the discontinued gaging station at Seward (10), were only slightly higher than previously observed peak discharges. Neither of these sites has enough data to compute a recurrence interval.

The most severe damage and flooding were caused by streams tributary to Resurrection River near its mouth and by other small streams flowing into Resurrection Bay. Flood debris and alluvial sediment in the fast-moving streams clogged channels at bridges and culverts. This action resulted in overtopping and erosion of bridge approaches and railroad and highway embankments, interruption of highway and rail transportation, and damage or destruction of businesses and residences. The floodwaters caused noticeable erosion along the channels of several short, steep mountain streams and resulted in the subsequent deposition and channel migration in alluvial fans that have formed at the mountain front. Landslides on the steep mountain slopes bordering the headwaters of several streams deposited material in their channels and temporarily blocked streamflow. Surge releases of stored water and mass movement of earth, rock, vegetation, and water occurred when the temporary dam was overtopped and eroded; these surges produced peak discharges substantially in excess of previously observed flows. Measurement sites (6), (11), (13), and (19), at which the peak discharge was affected by storage releases are footnoted in table 2.

The greatest peak discharge from the surge release of a debris dam occurred at Godwin Creek (6), where the discharge was estimated as 30,000 ft^3/s. The unit runoff rate from the 13.8 square-mile basin was about 2,200 $(ft^3/s)/mi^2$. Boulders as large as 8 ft in diameter were transported by the flow and subsequently deposited as the slope decreased near the mouth of Godwin Creek on Fourth of July Creek alluvial fan. The computed discharge could be too high because the channel at the survey site might have eroded after the peak stage occurred.



EXPLANATION

◆ 7 Rainfall measurement site. ▲ 7 Peak-discharge measurement site

Numbers refer to tables 1 and 2 respectively

Figure 6.--Rainfall measurement sites 7 to 8, 13 to 15 and peak-discharge measurement sites 6 to 19, 29 to 37, Seward to Kenai Lake.

Proceeding counter-clockwise around the head of Resurrection Bay, the next drainage basin is that of Sawmill Creek; flood discharge was determined at site (7), where the flow was confined, and downstream at Nash Road at site (8). The approximate discharge of 4,000 ft^3/s at Nash Road is the combined flow through the main bridge, No. 855, a secondary bridge, No. 854, and flow that bypassed both bridges and overtopped Nash Road.

The next major basin is Salmon Creek, which is tributary to Resurrection River just upstream from its mouth. Lost Creek is the largest contributor to Salmon Creek; Grouse Creek and Bear Creek are the largest Lost Creek tributaries. Bear Creek did not have a substantial flood peak because it drains Bear Lake, which was at a seasonal low-lake level. Discharges were determined at sites (11) through (16) in the Salmon Creek basin (table 2 and fig. 6). Salmon and Lost Creeks join just downstream from site (14) on Salmon Creek. The only site that has prior record is Lost Creek near Seward (11). The estimated peak discharge of Lost Creek, 14,000 ft^3/s, was affected by the release of dammed water; recurrence intervals for this type of flood cannot be determined by standard flood-frequency analysis. Grouse Creek washed out small sections of the Seward Highway in a 1-mile distance. Downstream from Lost Creek, floating debris and logs in Salmon Creek jammed in the pilings of the Alaska Railroad bridge, mile 6.0, and the pilings were sheared. Railroad bridges downstream, at miles 4.8 and 3.7, were blocked and several hundred feet of track and embankment were washed out; extensive residential flooding occurred and subdivision roads were washed out. The peak flow of Salmon Creek at Nash Road (16) (10,300 ft^3/s), includes inflow from Box Canyon Creek, which was diverted during the flood into Clear Creek (15) -- peak discharge, 2,800 ft^3/s -- and which then entered Salmon Creek. The total flow past Nash Road included about 4,000 ft^3/s of flow through the bridge, about 6,000 ft^3/s that overflowed the road, and bypass flow of about 300 ft^3/s that washed out Nash Road farther east.

Box Canyon Creek flood flows were not entirely diverted into Clear Creek; some of the remainder entered Resurrection River in a channel flowing south beside the Seward Highway embankment, inundating residential and commercial property. Still farther upstream along Resurrection River and Exit Glacier Road on the north bank, high flows in the steep mountain tributaries (including Box Canyon Creek) resulted in washouts, road overflow, and clogged bridges. The peak discharge, 19,000 ft^3/s, at Resurrection River at Seward (10) is the total flow through the three highway bridges upstream of where Salmon Creek enters. The combined flood flows of Resurrection River and Salmon Creek caused extensive damage to residential and commercial property.

Several streams in Seward originate on the steep slopes of Mount Marathon. Japanese Creek, immediately south of Resurrection River, has a history of flooding along its alluvial fan. The flooding is often compounded by landslides and debris flows. Flood-fighting efforts by Seward bulldozer operators on October 10 and 11 contained the creek within its most recent trench at the apex of the fan. The next stream to the south is not named on topographic maps, but is called Rudolph Creek (17) in table 2 of this report. The peak discharge of 1,020 ft^3/s for 1 mi^2 was the highest unit runoff measured in the vicinity of Seward from a basin that did not have a landslide dam upstream. Flood flows in Rudolph Creek and from several small tributaries washed out city streets and culverts, deposited coarse sediment in a lagoon and the small boat harbor, and eroded new channels along the base of Japanese Creek fan.

The business district and most of the residential district of the "original" city of Seward are on the Lowell Creek alluvial fan. A diversion dam and tunnel built in 1940 to divert flood flows away from town and southward into Resurrection Bay prevented extensive flood damage in October 1986. Discharge through the tunnel during the recent flood cannot be determined, but the flood came within 0.7 ft of overtopping the diversion dam. (The water surface of a flood in 1966 was 2 ft below the crest of the diversion dam; see site (18) in table 2.)

In the Seward area, Spruce Creek (19) has the only continuous long-term (20 years) flood record. During the October 1986 storm, a massive debris avalanche occurred just upstream from the gaging station site. An estimated 3 million ft^3 of material was removed; the remaining scar on the steep northern slopes of Spruce Creek canyon is about 0.7 mi long and averages about 0.1 mi wide. The avalanche material, including large trees, blocked the stream. When the temporary dam was breached, lateral bank and channel erosion resulted in the 0.3-mile reach from the former dam to the head of Spruce Creek fan. Cross sections (fig. 7A) surveyed at the gage partially illustrate lateral scour on the north (left) bank. Farther downstream, flood flows on the alluvial fan were diverted northward by trees (from the avalanche area) deposited along the south channel bank, which prevented damage to the Sewage Treatment Plant. Inflow into the temporary catchment formed behind the avalanche debris dam was 5,420 ft^3/s; the peak outflow of 13,600 ft^3/s includes the sudden release of water temporarily in storage before the debris dam failed.

Kenai Lake Tributaries

Flooding generally was less severe north of the divide on the Seward Highway between Seward and Kenai Lake. Peak discharges were determined at four sites, (29) to (32), on streams that flow into the upper end of the lake. An outstanding peak of 2,550 ft^3/s occurred at Sixteen Mile Creek (30); its headwaters lie between those of Grouse and Lost Creeks, which flow southward toward Seward. Unit runoff from Sixteen Mile Creek (30) was twice that in Grouse Creek (12) -- 800 and 400 $(ft^3/s)/mi^2$, respectively. Sixteen Mile Creek is a Snow River tributary, which enters between the gaging station, site (29), and site (31) at the two Seward Highway bridges across Snow River at the head of Kenai Lake. Peaks on Snow River are usually caused by outbursts from a glacier-dammed lake in the headwaters. The last glacier-dammed breakout peak was December 2, 1985; the peak discharge was 12,000 ft^3/s at site (29). Maximum recorded discharge at this site was the August 31, 1967 outburst peak of 55,000 ft^3/s. The October 11, 1986 peak, 17,500 ft^3/s, was from storm runoff and was not from an outburst flood. Peak flow in Snow River decreased in the intervening area between the gage and the highway bridges.

A crest-stage gage has been operated at Porcupine Creek near Primrose (32) since 1963. The peak of record, 4,000 ft^3/s, occurred on October 11, 1986. The stage-discharge relation changed because of changes in the channel cross section, lateral scour, and channel fill during the flood (fig. 7B). The first cross section shown in figure 7B is just downstream from the apex of an alluvial fan, which has formed where the steep upstream-channel slope decreased as the stream approached its mouth; the second cross section is 420 ft downstream and just upstream from Kenai Lake. Normally, during extreme floods, the peak stage of Kenai Lake occurs after the peak on Porcupine Creek and backwater occurs at the crest-stage gage.

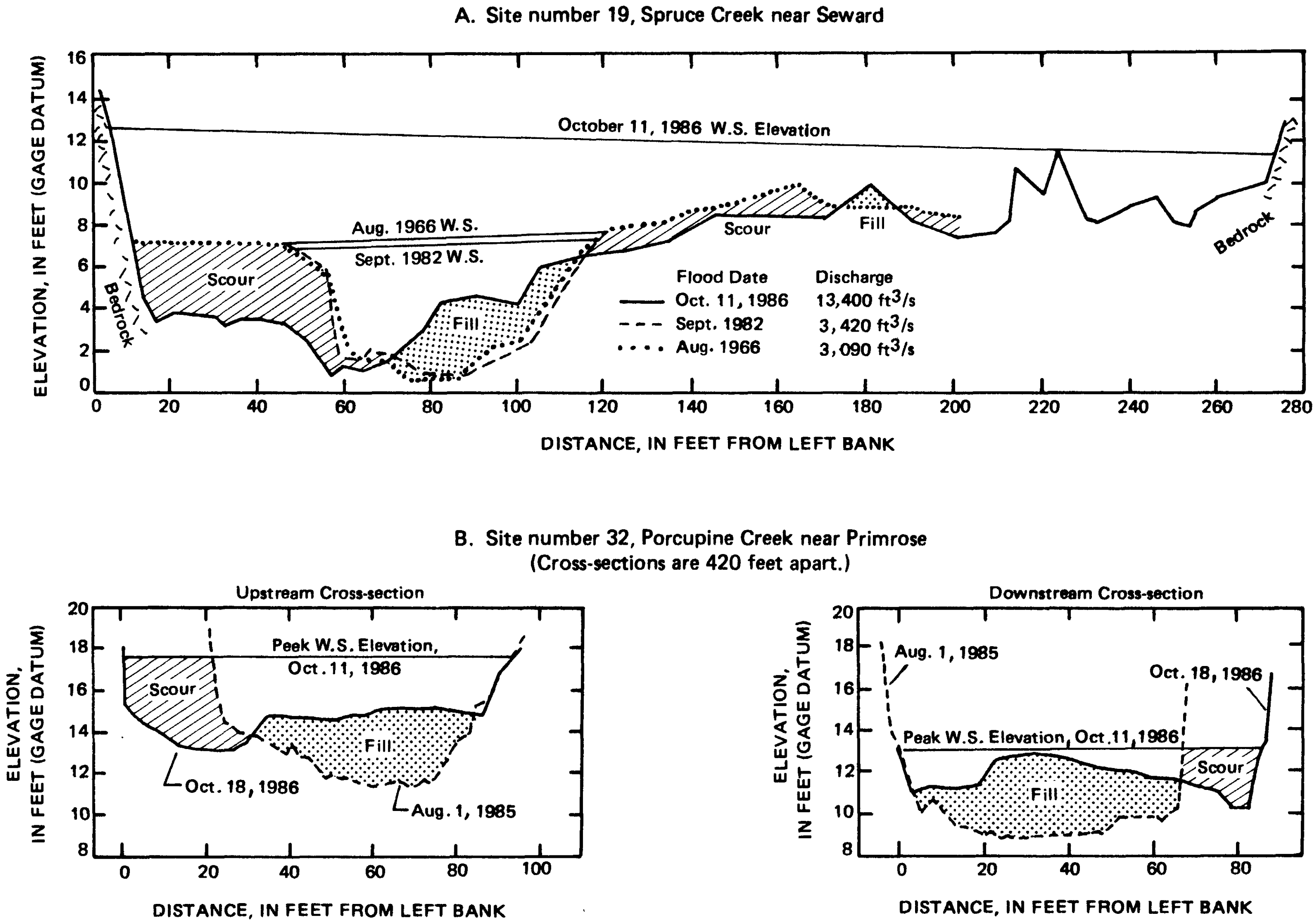


Figure 7.--Cross-sections at selected sites in Kenai Peninsula, showing channel changes after flood of October 11, 1986.

During the 1986 flood, peak stages and discharges were reduced by lake storage in streams with lakes upstream, because lake levels prior to the storm period were at a seasonal low. The Trail River near Lawing (33) gage essentially measured the stage of lake levels in Lower Trail Lake; Upper Trail and Grant Lakes provided additional upstream storage. The nearby precipitation gage at Lawing [13] had a 3-day total of 8.10 in. for October 9-11 (table 1), 8.00 in. of which fell between 4 p.m. on October 9 and 4 a.m. on October 11 (Nibler, 1986) (fig. 3B). Stage at Trail River (33) rose from 4.20 ft (discharge about 300 ft^3/s) at 4 p.m. October 9 to 9.0 ft at 9 a.m. October 11 and to a maximum of 9.7 ft, from high-water marks, on the morning of October 12 (Nibler, 1986). Peak discharge was about 4,800 ft^3/s, based on the prior stage-discharge relation at this discontinued U.S. Geological Survey gaging station. Farther north, the discontinued crest-stage gage site Quartz Creek at Gilpatricks (34) had its highest known discharge in 25 years of observation since 1962. The effect of lake storage on peak discharges can be demonstrated by comparing the recurrence intervals at Trail River to those at Porcupine and Quartz Creeks; which were 5, 80, and 50 years, respectively.

Going downstream along Kenai Lake and River, precipitation generally decreased (fig. 2 and table 1). The effects of lake storage on the Kenai River peaks are shown by the delayed October 14 peak at Cooper Landing (37), which only had a 4-year recurrence interval, and by the October 18 peak at Soldotna (38), which had less than a 2-year recurrence interval.

Anchorage

The storm did not significantly affect the Anchorage area. The measurement sites in the vicinity of Anchorage, at which peak discharge and precipitation data were obtained, are shown in figure 8. The recurrence intervals of the seven sites, (4) and (40) to (45), for which peak discharge data are shown ranged from less than 2 years to 15 years.

Flood hydrograph data and discharge tables (table 4) were compiled for two sites, Campbell Creek near Spenard (42) and East Fork Eklutna Creek near Palmer (44). The October 11 peak discharge on Campbell Creek was the highest in 21 years of record; recurrence interval was about 7 years (S. H. Jones, U.S. Geological Survey, written commun., 1987), as determined from a recent analysis using flood records collected throughout the Campbell Creek basin. Concurrent 6-hour rainfall amounts at Anchorage Airport [24] are shown with the discharge hydrograph (fig. 9).

The hydrograph at East Fork Eklutna Creek near Palmer (44) is included because the drainage basin is at a relatively high altitude (average basin altitude, about 3,900 ft); the Geological Survey operates a weather station at the gage site, which is at an altitude of approximately 1,100 ft above sea level. Streamflow was at a seasonal low of 73 ft^3/s on October 9. Nighttime temperatures were below freezing during the period of October 5-9. However, temperatures increased to the 40 to 50 °F range in the morning of October 9 and increased still further to about 60 °F on October 10. The increased temperature and 0.25 in. of rain on the morning of October 10 caused streamflow to rise significantly to 400 to 500 ft^3/s. Later rains and continued high temperatures resulted in a peak discharge of 1,500 ft^3/s at 5:30 a.m. October 11. (The effect of high-altitude rainfall and accompanying high air temperature on runoff from the glacier area, 19 percent of the basin of East Fork Eklutna Creek, is not known.)

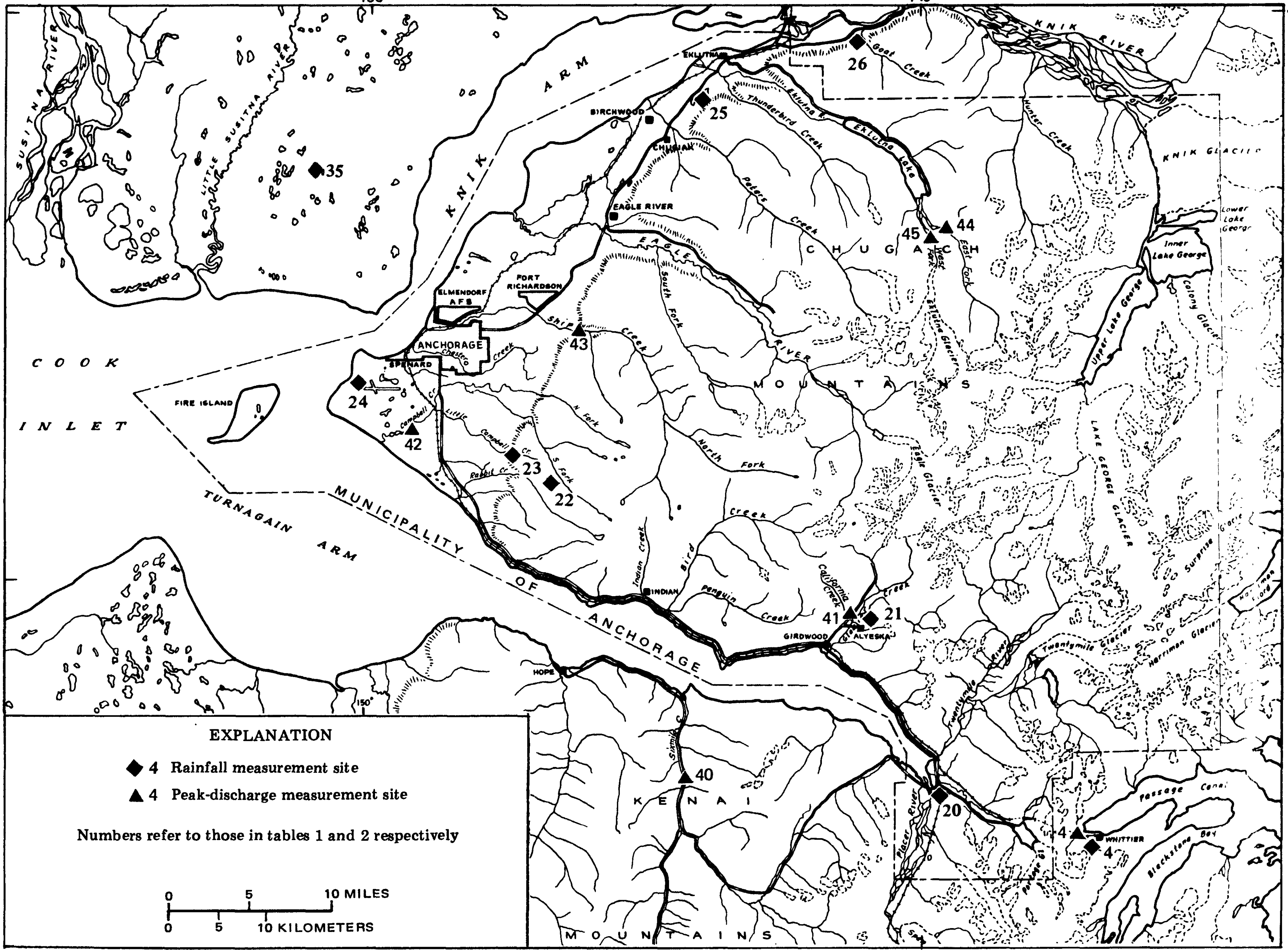


Figure 8.--Rainfall measurement sites 4, 20 to 26, 35 and peak-discharge measurement sites 4, 40 to 45 in Anchorage area.

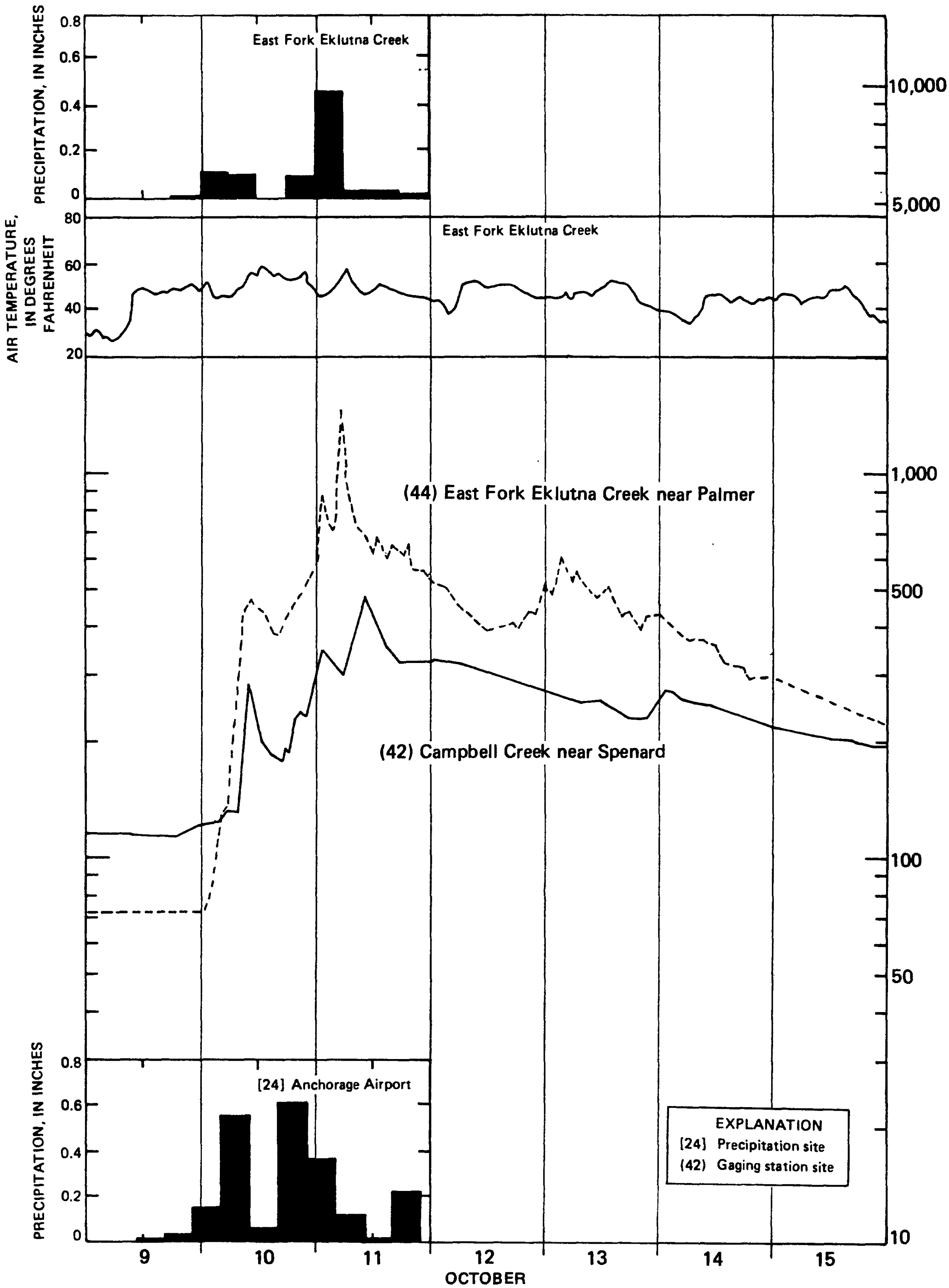


Figure 9.--Flood discharge hydrographs, concurrent 6-hour storm precipitation, and air temperature at selected sites in Anchorage area. See table 4 for discharge data.

Table 4.--Discharge data for Campbell and East Fork Eklutna Creeks during October 1986

(42) 15274600 CAMPBELL CREEK NEAR SPENARD

LOCATION.--Lat 61°08'22", long 149°55'24", in SE¼SE¼ sec.11, T.12 N., R.4 W., Municipality of Anchorage, Hydrologic Unit 19050002, on right bank 400 ft upstream from bridge at Dimond Boulevard, 2.1 mi upstream from mouth, and 4.3 mi south of Spenard.

DRAINAGE AREA.--69.7 mi^2.

GAGE-HEIGHT RECORD.--Water-stage recorder graph. Datum of gage is 1.68 ft above National Geodetic Vertical Datum of 1929. Prior to May 9, 1986, at site 400 ft downstream at datum 16.36 ft higher.

DISCHARGE RECORD.--Stage-discharge relation defined by current-meter measurements to 400 ft^3/s.

MAXIMUM FOR PRIOR FLOOD RECORD.--(Water years 1966-86), 451 ft^3/s, Aug. 13, 1981, gage height, 3.54 ft, site and datum then in use; maximum gage height recorded at prior site, 5.29 ft, Apr. 20, 1976, backwater from ice.

MAXIMUM FOR OCTOBER FLOOD.-- 472 ft^3/s, 1100 hours Oct. 11, gage height, 20.89 ft.

Mean discharge, in cubic feet per second, October 1986

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	120	6	122	11	352	16	192	21	156	26	115
2	121	7	125	12	302	17	172	22	145	27	120
3	155	8	121	13	253	18	164	23	138	28	119
4	168	9	114	14	245	19	165	24	131	29	112
5	137	10	198	15	206	20	172	25	120	30	105
										31	102
Total	4,967	Mean	160	Maximum	352						

Gage height, in feet; discharge, in cubic feet per second; at indicated date and time in 1986

Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge
Oct. 9	0000	18.64	117	Oct. 10	2400	20.22	293	Oct. 13	1800	19.73	231
	0030	18.65	118						2100	19.72	230
	0300	18.64	117	Oct. 11	0030	20.32	316		2200	19.74	232
	0900	18.62	115		0200	20.45	348		2400	19.94	256
	1400	18.60	113		0600	20.26	302				
	1900	18.61	114		1100	20.89	472	Oct. 14	0030	19.97	259
	2400	18.69	122		1500	20.46	351		0130	20.08	272
					1700	20.36	326		0300	20.06	270
Oct. 10	0030	18.70	122		2400	20.35	323		0500	19.97	259
	0400	18.71	123						0800	19.91	252
	0500	18.79	131	Oct. 12	0030	20.36	326		1030	19.90	251
	0800	18.78	130		0230	20.37	328		2000	19.69	226
	1000	20.17	284		0700	20.34	321		2400	19.63	220
	1100	20.02	265		1200	20.28	307				
	1300	19.47	202		2000	20.15	281	Oct. 15	0030	19.62	218
	1500	19.32	185		2400	20.09	274		1100	19.52	207
	1700	19.26	179						1300	19.48	203
	1800	19.37	191	Oct. 13	0030	20.08	272		1700	19.47	202
	1830	19.33	186		0600	19.97	259		1900	19.44	198
	2000	19.72	230		0800	19.94	256		2300	19.41	195
	2100	19.81	240		1130	19.97	259		2400	19.43	197
	2200	19.76	234		1300	19.94	256				

Table 4.--Discharge data for Campbell and East Fork Eklutna Creeks during October 1986--Continued

(44) 15277600 EAST FORK EKLUTNA CREEK NEAR PALMER

LOCATION.--Lat 61°18'44", long 148°57'12", in SW¼SE¼ sec.8, T.14 N., R.3 E., Municipality of Anchorage, Hydrologic Unit 19050002, on left bank 2.4 mi upstream from confluence with West Fork, 3.1 mi upstream from Eklutna Lake and 20.5 mi south of Palmer.

DRAINAGE AREA.--38.2 mi^2.

GAGE-HEIGHT RECORD.--Micrologger with 15-minute recording interval. Elevation of gage is 1,080 ft above National Geodetic Vertical Datum of 1929, from topographic map. June 1960 to Sept. 1962 at site 0.2 mi downstream at different datum.

DISCHARGE RECORD.-- Stage-discharge relation defined by current-meter measurements below 600 ft^3/s and slope-area measurement at 1,500 ft^3/s.

MAXIMUM FOR PRIOR FLOOD RECORD.--(water years 1961-62, 85-86), 1,320 ft^3/s, Sept. 12, 1961, gage height, 3.86 ft, site and datum then in use.

MAXIMUM FOR OCTOBER FLOOD.-- 1,500 ft^3/s, 0530 hours Oct. 11, gage height, 9.19 ft.

Mean discharge, in cubic feet per second, October 1986

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	93	6	82	11	715	16	211	21	126	26	84
2	92	7	79	12	445	17	180	22	115	27	76
3	102	8	76	13	483	18	160	23	102	28	71
4	110	9	73	14	350	19	142	24	94	29	65
5	93	10	345	15	254	20	132	25	91	30	61
										31	62

Total 5,164 Mean 167 Maximum 715

Gage height, in feet; discharge, in cubic feet per second; at indicated date and time in 1986

Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge
Oct. 9	0000	6.76	73	Oct. 11	0900	8.29	731	Oct.13	0200	7.91	482
	2400	6.76	73		1100	8.24	697		0400	8.16	644
					1200	8.12	618		0600	7.98	527
Oct. 10	0030	6.77	75		1300	8.23	690		0700	8.02	557
	0200	6.82	85		1500	8.09	600		1100	7.90	471
	0400	7.02	130		1600	8.17	650		1400	7.95	504
	0500	7.04	132		1900	8.10	606		1600	7.82	423
	0900	7.79	428		2000	8.18	657		1800	7.84	434
	1000	7.85	460		2100	8.03	563		2000	7.77	393
	1100	7.88	476		2300	8.02	557		2100	7.82	423
	1200	7.82	444		2400	7.97	527		2400	7.84	434
	1400	7.79	428								
	1500	7.70	383	Oct. 12	0030	7.98	527	Oct. 14	0030	7.83	428
	1600	7.69	378		0400	7.95	504		0600	7.73	368
	2000	7.87	471		0600	7.88	460		0800	7.72	364
	2400	8.04	569		1200	7.77	393		0900	7.73	368
					1700	7.79	403		1200	7.71	354
Oct. 11	0030	8.14	631		1900	7.78	398		1400	7.64	318
	0200	8.48	869		2100	7.85	439		1800	7.62	309
	0300	8.26	710		2200	7.82	423		1900	7.59	292
	0400	8.23	690		2400	7.96	516		2400	7.59	292
	0530	9.19	1500								
	0700	8.60	962	Oct. 13	0030	7.94	499	Oct. 15	0030	7.58	288
									2400	7.44	221

Wasilla and Lower Susitna Valley

The area affected by the flood is shown in figure 10. Some tributary streams to Knik Arm and Cook Inlet east of the Susitna River mouth had high flows. Recurrence intervals ranged from less than 2 years to about 3 years for the peak discharges of these streams. Rainfall increased going northwestward from Wasilla toward Willow and the recurrence intervals of peak discharges on Little Susitna River near Houston (50) and Deception Creek near Willow (63) were in the 10-to-15-year range.

The heaviest rainfall in the Susitna River basin occurred around Talkeetna (figs. 2 and 3C). Recurrence intervals of flood peaks increased from less than 2 years to almost 50 years moving downstream from Susitna River at Gold Creek (52), past Chulitna (53) and Talkeetna Rivers near Talkeetna (54), and to Susitna River at Sunshine (55). The discharge hydrograph of the flood for Talkeetna River (54) is plotted in figure 11 (values listed in table 5). The previous maximum discharge of record, on August 10, 1971, was less than the October 11, 1986 peak at the Talkeetna River gaging station. However, the 1971 peak at Susitna River at Sunshine (55) was more than the 1986 peak because the contribution from the upper Susitna River basin was larger during the 1971 flood (Lamke, 1972).

Severe flooding occurred in small streams west of Talkeetna. The 27-square-mile drainage basin of Rabideux Creek near Sunshine (56) had a unit runoff of 100 $(ft^3/s)/mi^2$. However, the unit runoff of 110 $(ft^3/s)/mi^2$ at Moose Creek near Talkeetna (64) was the highest in the Susitna basin; recurrence interval of the Moose Creek peak discharge was 100 years. Southward from Talkeetna, flood damage along the Parks Highway was concentrated between Sunshine and Willow. The highway and railway bridges on Montana Creek were washed out and travel in the area was interrupted for a week. Peak discharge at Montana Creek near Montana (57) was 15,300 ft^3/s; and the recurrence interval of the peak was determined to be greater than 100 years. The ratio of the maximum discharge in October 1986 to the peak discharge of a 100-year flood is 1.3 to 1.

Flood flows from Goose Creek overtopped the Parks Highway. The combined peak flow of Goose Creek near Montana (58) and Sheep Creek near Willow (59) was 13,200 ft^3/s; these two streams have intermingled flood flows. Since the 1971 flood, much of the flow from Sheep Creek has been diverted into Goose Creek, which has the smaller natural drainage area. The unit runoff of the combined flows and areas was 84 $(ft^3/s)/mi^2$.

The recurrence interval of the October 1986 flood was 1.43 times the value of the discharge calculated for a 100-year flood at the long-term station, Caswell Creek (60), in operation since 1962. The unit runoff of 49 $(ft^3/s)/mi^2$ was comparatively low for the area because the average basin altitude and channel slope are relatively low. Farther south, Little Willow Creek near Kashwitna (61) had considerable flow over the road. The October 1986 peak discharge was about 2.6 times the previous maximum discharge of the site's 8 years of record. Unit runoff on Little Willow Creek was 42 $(ft^3/s)/mi^2$; recurrence interval is estimated at about 30 years. Unit runoff at Willow Creek near Willow (62) was 72 $(ft^3/s)/mi^2$; peak recurrence interval was about 50 years. An 8-mile stretch of unpaved highway between Willow and Hatcher Pass was severely damaged by Willow Creek, which flows beside the road embankment. Willow Creek's major tributary, Deception Creek (63), did not have the

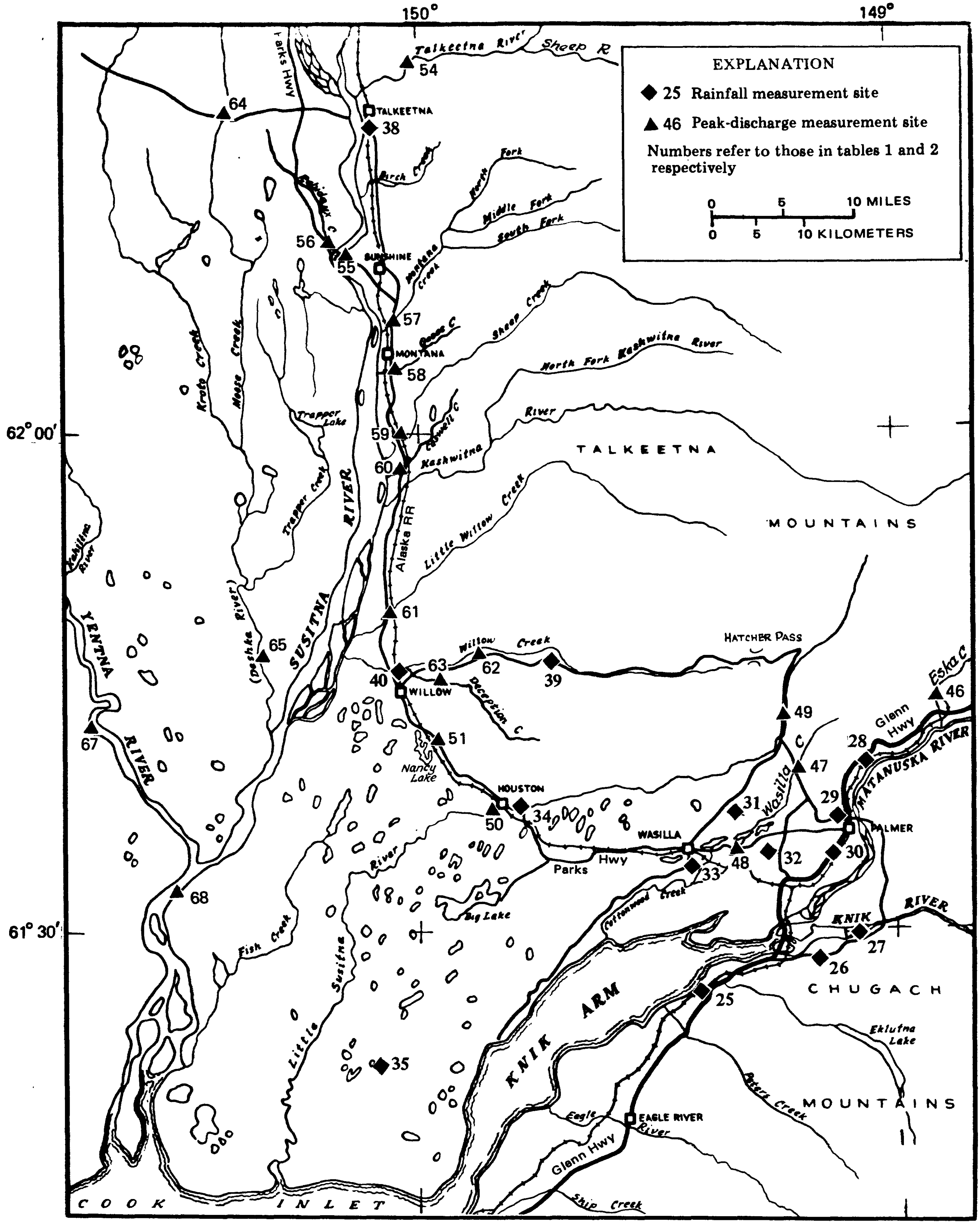


Figure 10.--Rainfall measurement sites 25 to 35, 38 to 40 and peak-discharge measurement sites 46 to 51, 54 to 65, 67 to 68 in Wasilla and lower Susitna Valley area.

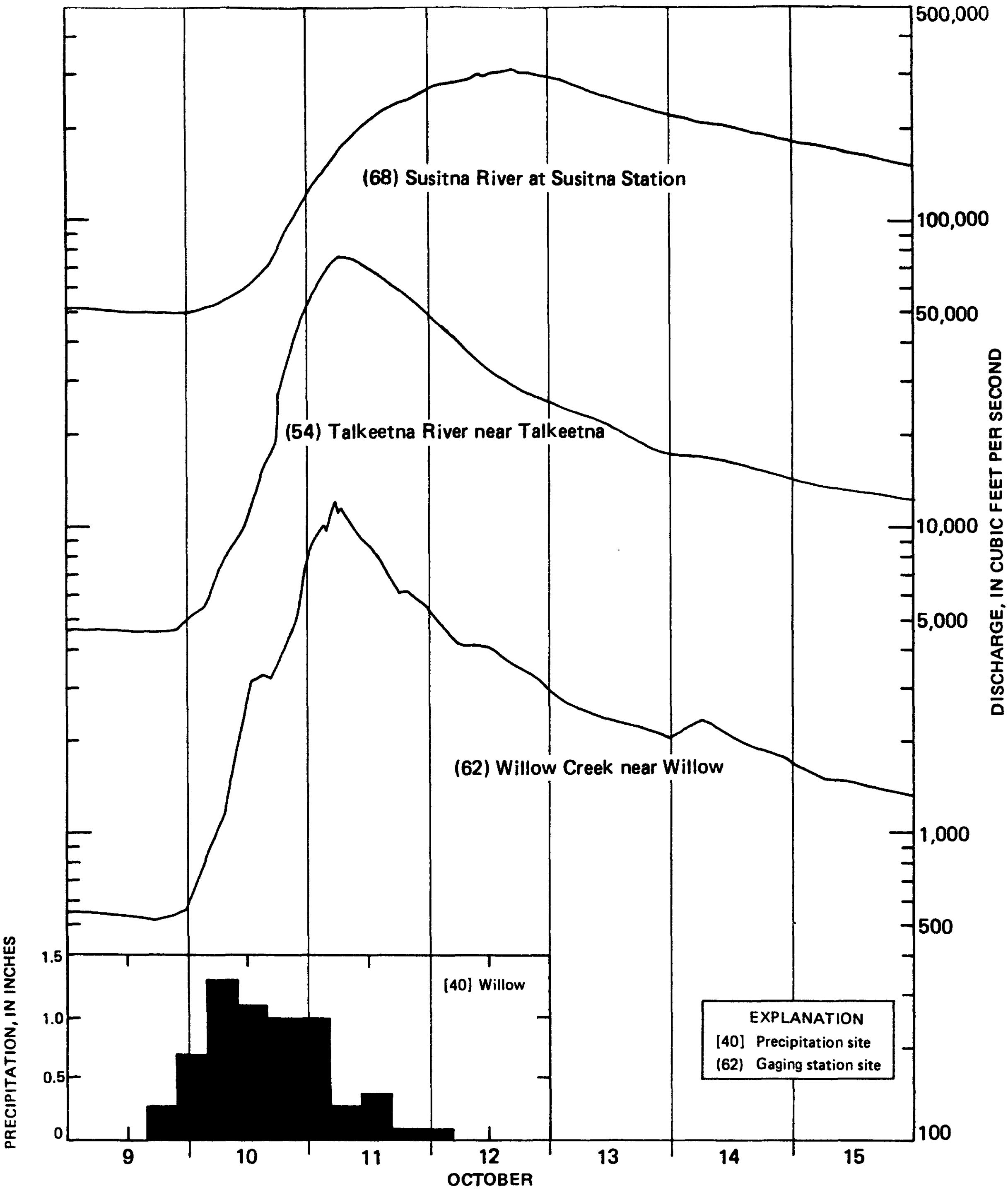


Figure 11.--Flood discharge hydrographs and concurrent 6-hour storm precipitation at selected sites in Susitna River basin. See table 5 for discharge data.

Table 5.–Discharge data for three selected gaging stations in the lower Susitna River basin during October 1986

(54) 15292700 TALKEETNA RIVER NEAR TALKEETNA

LOCATION.--Lat 62°20'49", long 150°01'01", in NE¼ sec.16, T.26 N., R.4 W., Matanuska-Susitna Borough, Hydrologic Unit 19050002, on left bank 1.7 mi downstream from Chunilna Creek, 3.5 mi northeast of Talkeetna, and about 5 mi above mouth.

DRAINAGE AREA.--2,006 mi^2.

GAGE-HEIGHT RECORD.--Water-stage recorder graph except Oct. 26-31. Elevation of gage is 400 ft above National Geodetic Vertical Datum of 1929, from topographic map.

DISCHARGE RECORD.--Stage-discharge relation defined by current-meter measurements to 67,400 ft^3/s. Discharge estimated Oct. 26-31.

MAXIMUM FOR PRIOR FLOOD RECORD.--(Water years 1964-86), 67,400 ft^3/s, Aug. 10, 1971, gage height, 16.35 ft.

MAXIMUM FOR OCTOBER FLOOD.-- 75,700 ft^3/s, 0600 hours Oct. 11, gage height, 17.38 ft.

Mean discharge, in cubic feet per second, October 1986

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	6,360	6	5,140	11	63,200	16	11,600	21	6,900	26	4,300
2	6,070	7	4,790	12	33,300	17	9,640	22	6,240	27	4,000
3	6,120	8	4,700	13	20,800	18	8,560	23	5,560	28	3,800
4	6,200	9	4,560	14	16,800	19	8,050	24	5,160	29	3,600
5	5,740	10	16,300	15	13,800	20	7,500	25	4,660	30	3,400
										31	3,200
Total	310,050	Mean	10,000	Maximum	63,200						

Gage height, in feet; discharge, in cubic feet per second; at indicated date and time in 1986

Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge
Oct. 9	0000	4.95	4,630	Oct. 11	0130	15.05	57,800	Oct. 13	0500	9.91	22,900
	2000	4.92	4,560		0230	15.65	62,000		1000	9.58	21,200
	2230	4.97	4,670		0330	16.19	66,200		1330	9.39	20,200
	2400	5.07	4,900		0430	16.65	69,900		1800	9.16	19,100
					0600	17.38	75,700		2400	8.92	18,000
Oct. 10	0300	5.35	5,530		0630	17.20	74,200				
	0500	5.63	6,230		0730	17.33	75,300	Oct. 14	0200	8.85	17,600
	0700	5.95	7,070		1100	16.78	70,500		0700	8.74	17,200
	0900	6.35	8,210		1400	16.20	65,600		1000	8.73	17,100
	1100	6.75	9,520		1700	15.61	60,800		1200	8.73	17,100
	1300	7.20	11,100		1900	15.03	56,200		1400	8.68	16,900
	1400	7.55	12,400		2100	14.50	52,000		1600	8.60	16,500
	1500	8.00	14,100		2300	14.03	48,700		1830	8.50	16,100
	1600	8.50	16,200		2400	13.85	47,300		2400	8.34	15,400
	1700	9.00	18,300								
	1800	9.70	22,000	Oct. 12	0130	13.50	44,900	Oct. 15	0600	8.14	14,600
	1900	10.40	26,200		0330	13.00	41,500		1200	7.93	13,700
	2000	11.20	31,000		0600	12.50	38,200		1700	7.77	13,100
	2100	12.00	36,500		0830	12.00	35,000		2000	7.69	12,800
	2200	12.75	42,400		1200	11.46	31,700		2200	7.65	12,600
	2300	13.50	47,000		1500	11.07	29,400		2400	7.62	12,500
	2400	14.11	51,300		1900	10.70	27,200				
					2400	10.31	25,000				

(62) 15294005 WILLOW CREEK NEAR WILLOW

LOCATION.--Lat 61°46'51", long 149°53'04", in NW¼SE¼ sec.31, T.20 N., R.3 W., Matanuska-Susitna Borough, Hydrologic Unit 19050002, on right bank 0.9 mi downstream from unnamed tributary, 5.5 mi northeast of Willow, and 6.7 mi upstream from Deception Creek.

DRAINAGE AREA.--166 mi^2.

GAGE-HEIGHT RECORD.--Water-stage recorder graph except for Oct. 31. Elevation of gage is 350 ft above National Geodetic Datum of 1929, from topographic map. Prior to Apr. 2, 1981, at site 0.2 mi upstream at different datum.

DISCHARGE RECORD.-- Stage-discharge relation defined by current-meter measurements to 3,900 ft^3/s and extended to peak stage by indirect measurement.

MAXIMUM FOR PRIOR FLOOD RECORD.--(Water years 1978-1986), 4,450 ft^3/s, July 28, 1980, gage height, 8.80 ft, at site and datum then in use.

MAXIMUM FOR OCTOBER FLOOD.-- 12,000 ft^3/s, 0530 hours Oct. 11, gage height, 9.01 ft.

Mean discharge, in cubic feet per second, October 1986

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	694	6	612	11	8,670	16	1,230	21	708	26	466
2	731	7	565	12	4,020	17	1,010	22	654	27	435
3	746	8	565	13	2,420	18	868	23	603	28	361
4	516	9	548	14	2,040	19	789	24	572	29	335
5	700	10	2,790	15	1,460	20	765	25	536	30	318
										31	395
Total	37,122	Mean	1,199	Maximum	8,670						

Gage height, in feet; discharge, in cubic feet per second; at indicated date and time in 1986

Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge
Oct. 9	0000	3.47	558	Oct. 11	0700	8.77	11,400	Oct. 13	0400	4.87	2,690
	1700	3.41	521		0800	8.54	10,900		0900	4.75	2,480
	2000	3.44	539		1000	7.98	9,580		1100	4.68	2,370
	2400	3.62	659		1100	7.73	9,000		1700	4.61	2,260
					1330	7.48	8,420		2100	4.53	2,130
Oct. 10	0400	3.84	822		1400	7.31	8,030		2300	4.48	2,060
	0730	4.23	1,160		1900	6.46	6,100		2400	4.47	2,040
	1000	4.93	1,900		2000	6.46	6,100				
	1300	5.81	3,070		2400	6.16	5,430	Oct. 14	0200	4.51	2,100
	1500	5.95	3,290						0600	4.65	2,320
	1630	5.97	3,320	Oct. 12	0400	5.79	4,610		0900	4.60	2,240
	2000	6.50	4,280		0700	5.58	4,150		1400	4.44	2,000
	2200	6.96	5,280		0830	5.59	4,170		1900	4.33	1,840
	2400	7.85	7,690		1000	5.59	4,170		2200	4.29	1,790
					1200	5.56	4,100		2400	4.21	1,690
Oct. 11	0200	8.26	9,050		1500	5.40	3,750				
	0300	8.51	9,960		1900	5.26	3,450	Oct. 15	0700	4.06	1,500
	0330	8.42	9,630		2200	5.12	3,160		1600	3.98	1,410
	0530	9.01	12,000		2400	5.02	2,960		2400	3.89	1,310
	0600	8.61	11,100								

Table 5.--Discharge data for three selected gaging stations in the lower Susitna River basin during October 1986 --Continued

(68) 15294350 SUSITNA RIVER AT SUSITNA STATION

LOCATION.--Lat 61°32'41", long 150°30'45", in SE¼SE¼ sec.22, T.17 N., R.7 W., Matanuska-Susitna Borough, Hydrologic Unit 19050002, on left bank at Susitna Station, 1.5 mi downstream from Yentna River, and 12.5 mi upstream from Alexander Creek.

DRAINAGE AREA.--19,400 mi^2, approximately.

GAGE-HEIGHT RECORD.--Water-stage recorder graph except Oct. 17-31, when the record was lost because of vandalism at the gaging station. Elevation of gage is 40 ft above National Geodetic Vertical Datum of 1929, from topographic map.

DISCHARGE RECORD.--Stage-discharge relation defined by current-meter measurements to 221,000 ft^3/s. Discharge for Oct. 17-31 estimated by comparison with nearby station record.

MAXIMUM FOR PRIOR FLOOD RECORD.--(Water years 1975-1986), 230,000 ft^3/s, July 29, 1980 and Aug. 16, 1981; maximum gage height, 20.27 ft, Aug. 16, 1981.

MAXIMUM FOR OCTOBER FLOOD.-- 312,000 ft^3/s, 1700 hours Oct. 12, gage height, 22.58 ft.

Mean discharge, in cubic feet per second, October 1986

Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge	Day	Discharge
1	61,100	6	66,300	11	202,000	16	142,000	21	68,000	26	41,000
2	58,800	7	57,700	12	293,000	17	120,000	22	60,000	27	38,000
3	59,500	8	52,800	13	252,000	18	100,000	23	55,000	28	35,000
4	67,100	9	50,400	14	201,000	19	90,000	24	48,000	29	33,000
5	74,500	10	68,300	15	167,000	20	78,000	25	44,000	30	31,000
										31	29,000

Total 2,743,500 Mean 88,500 Maximum 293,000

Gage height, in feet; discharge, in cubic feet per second; at indicated date and time in 1986

Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge	Date	Hour	Gage height	Discharge
Oct. 9	0000	9.83	51,300	Oct.11	1230	19.00	214,000	Oct. 13	1100	21.51	253,000
	0800	9.74	50,500		1500	19.64	230,000		1400	20.13	243,000
	1700	9.68	49,900		1700	20.00	239,000		1800	19.69	231,000
	2100	9.69	50,000		1900	20.25	246,000		2100	19.45	225,000
	2400	9.73	50,400		2200	20.62	256,000		2400	19.23	220,000
					2400	20.86	263,000				
Oct. 10	0030	9.74	50,500					Oct.14	0030	19.20	219,000
	0300	9.81	51,200	Oct. 12	0030	20.91	264,000		0200	19.12	217,000
	0600	9.93	52,300		0400	21.36	276,000		0400	18.95	213,000
	0800	10.07	53,900		0900	21.92	293,000		0600	18.80	209,000
	1100	10.37	57,400		1030	22.09	298,000		0900	18.64	206,000
	1300	10.66	61,200		1100	22.02	296,000		1100	18.52	203,000
	1500	11.06	66,800		1330	22.31	304,000		1400	18.30	198,000
	1700	11.62	73,900		1400	22.23	302,000		1700	18.08	193,000
	1900	12.38	84,500		1500	22.32	304,000		2000	17.88	188,000
	2100	13.30	98,900		1600	22.45	308,000		2400	17.63	183,000
	2230	13.95	110,000		1700	22.58	312,000				
	2400	14.61	121,000		1800	22.35	305,000	Oct. 15	0030	17.60	182,000
					2030	22.25	302,000		0300	17.43	178,000
Oct. 11	0030	14.80	124,000		2400	21.98	294,000		0400	17.38	177,000
	0300	15.70	142,000						1000	17.03	170,000
	0500	16.37	155,000	Oct. 13	0030	21.93	293,000		1400	16.79	164,000
	0700	17.04	170,000		0400	21.47	280,000		2100	16.45	157,000
	0900	17.73	185,000		0700	21.07	268,000		2400	16.32	154,000
	1100	18.51	202,000								

outstanding flows of the streams farther north. (See fig. 11 and table 5 for discharge hydrograph plot and data for Willow Creek.)

Moose Creek is a major tributary of the Deshka River. The gaging station on Deshka River near Willow (65) was washed out; overbank flood flows were spread out, slow-moving, and deep between the gage and 8 mi downstream at the mouth. Peak discharge was 48,000 ft^3/s. This discharge is about 1.3 times the estimated 100-year flood discharge. Skwentna River near Skwentna (66) had a peak stage of 17.3 ft, using highwater marks at the site (see fig. 1 for location). The stage-discharge relation in use when the station was discontinued, was used to determine that discharge was 69,000 ft^3/s, which is higher than any peak discharge observed in 22 years of operation. A peak discharge of this size has a recurrence interval of 100 years. The maximum discharges at stations downstream near Susitna Station, Yentna (67) and Susitna Rivers (68), had recurrence intervals of about 10 and 40 years, respectively. The flood hydrograph of Susitna River at Susitna Station is shown in figure 11. (See table 5 for discharge data.)

Flooding also occurred in the small streams within the area between the Susitna River mouth and Tyonek (fig. 1). The precipitation gage at Beluga [43] had a total 3-day storm rainfall of 6.35 in. (table 1), most of which fell in the 24-hour period prior to 4 p.m. (ADST) on October 10 (U.S. Dept. of Commerce, 1986). Three discontinued stream-gaging stations west of the Susitna River mouth were checked for flood evidence. Two of the three sites had peak discharges higher than were experienced during their periods of operation. Channel changes at Capps Creek below North Capps Creek near Tyonek (69) were so extreme that a peak discharge value could not be determined. Based on the flood stage from high-water marks at the gage site and the prior stage-discharge rating at the gaging station, the discharge was estimated to have been greater than 1,200 ft^3/s. This is twice as high as any peak experienced in the 6 years of prior flood record. The recurrence interval of the October 10 flood at Chuitna River near Tyonek (70) probably was in the 50-to-100-year range. Unit runoff rates at both of these stations were near or greater than 100 $(ft^3/s)/mi^2$. Chakachatna River near Tyonek, the other site that was checked, did not have any evidence of extraordinary flooding.

Prince William Sound

Precipitation ranged from 3.26 in. at Valdez [3] to 12.57 in. at Cordova North [2] (table 1). The only reported flood damage was locally in Cordova. Peak discharge at Power Creek near Cordova (1) (fig. 1) had a recurrence interval of 3 years. The recently re-established gage at Solomon Gulch near Valdez (3) experienced high flows. The maximum daily discharge of the October flood was almost as high as the maximum instantaneous peak of the 7 years of prior flood record. The stream (and Solomon Gulch Lake) are currently being used for a hydropower plant. A dam was constructed at the lake outlet to increase storage. The discharge over the flood spillway was determined at the gage on Solomon Gulch Bypass (2) and was 1.4 times as great as the previous instantaneous maximum. The streams around western Prince William Sound did not have especially high peaks.

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