UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

LOW-FLOW CHARACTERISTICS OF STREAMS ON THE KITSAP PENINSULA AND SELECTED ADJACENT ISLANDS, WASHINGTON

By
J. E. Cummans

Prepared in cooperation with the
State of Washington Department of Fisheries

OPEN-FILE REPORT 76-704

Tacoma, Washington
1976

CONTENTS

ILLUSTRATIONS

TABLES

The following factors are provided for conversion of English values used in this report to metric values:

Multiply	By	To obtain
Inches	25.40	millimeters (mm)
Feet (ft)	.3048	meters (m)
Square miles (mi^2)	2.590	square kilometers (km^2)
Cubic feet per second (ft^3/s)	.02832	cubic meters per second (m^3/s)
Cubic feet per second per square mile [$(ft^3/s)/mi^2$]	.01093	cubic meters per second per square kilometer [$(m^3/s)/km^2$]
Acre-feet (acre-ft)	1233.	cubic meters (m^3)

LOW-FLOW CHARACTERISTICS OF STREAMS ON THE KITSAP PENINSULA AND SELECTED ADJACENT ISLANDS, WASHINGTON

By J. E. Cummans

ABSTRACT

Streams in the study area drain relatively small basins; only three streams have drainage areas greater than 20.0 square miles (51.8 square kilometers), and only nine other streams have drainage areas greater than 10.0 square miles (25.9 square kilometers). Mean annual precipitation during the period 1931-60 ranged from about 25 inches (640 millimeters) near Hansville to about 70 inches (1,780 millimeters) near Tahuya; it may be greater in the Green and Gold Mountain area. July is normally the month of least precipitation, and the lowest streamflows generally occur in September.

Low-flow frequency data are tabulated for 90 streamflow sites in the study area; also listed are data for 56 additional sites which have insufficient measurements for frequency analysis but which have been observed having no flow at least once during the low-flow period. At the time of collection of field data, no effort was made to evaluate the effects of man on the streams' low flows.

The eight streamflow gaging stations used in the low-flow analysis were all established after 1945, but all have had 10 or more years of record since then, and all were operated through the period of deficient rainfall, 1962-67. Low flows varied considerably during the periods of record of the stations. For example, variations in the 7-day low flows of Gold Creek near Bremerton ranged from 0.24 cubic foot per second (0.0068 cubic meter per second) in 1967 (at end of 6-year period of deficient rainfall) to 0.77 cubic foot per second (0.022 cubic meter per second) in 1948, a year of above average rainfall.

Low-flow-frequency curves plotted from records of streamflow at the eight long-term gaging stations were used to determine data for low-flow durations of 7, 30, 60, 90, and 183 days. Regression techniques then were used to estimate low flows with frequencies up to 20 years for stations with less than 10 years of record and for miscellaneous sites where discharge measurements have been made.

INTRODUCTION

The purpose of this report is to present low-flow information for stream sites in the study area by utilizing available records of streamflow at continuous-record gaging stations and miscellaneous discharge measurements. Data are presented on the low-flow characteristics of streams at 90 sites, and an additional 56 sites are listed as having been observed with no flow. Low-flow characteristics of many of the area's streams are determined from low-flow-frequency curves developed from long-term streamflow records and regressions of flows from short-term streamflow records and from miscellaneous discharge measurements with the long-term records.

Streams in the study area vary in annual volumes of runoff per square mile and in their basins' ability to sustain flows during the middle and late summer. Periods of low streamflow are of particular interest to many water users, because during this time competition for the available water supply is the greatest. The study was made in cooperation with the Washington Department of Fisheries because of its interest in maintaining streamflows adequate for fish spawning and rearing activities, which occur during the low-flow season.

The present study augments the data given in an earlier generalized study of the area by Hidaka (1973). Streamflow records used in this study were collected by the U.S. Geological Survey in cooperation with the State of Washington Department of Fisheries, and with many other State, Federal, and municipal agencies. Several records were collected by the State of Washington Division of Water Resources in 1961.

DESCRIPTION OF THE AREA

The area of Kitsap Peninsula for which data are presented is in the Puget Sound lowland of western Washington (fig. 1). The peninsula is bounded on the west by Hood Canal, on the north by Admiralty Inlet, and on the east and south by various channels and inlets that together are popularly defined as Puget Sound. Also included in the study are selected adjacent islands (Bainbridge, Vashon, Maury, Fox, and Anderson Islands) for which data are available. The total drainage area covered by this study is about 700 mi^2 or 1,800 km^2. Most parts of the area have maximum altitudes of about 400 to 600 feet (120 to 180 m), but Green and Gold Mountains (pl. 1), in the upland west of Bremerton, respectively rise to altitudes of 1,689 and 1,761 feet (514.8 and 536.8 m).

Principal streams of the area with drainage areas greater than 20.0 mi^2 (51.8 km^2) include Tahuya River, 46.8 mi^2 (121 km^2); Union River, 23.5 mi^2 (60.9 km^2), and Dewatto River, 22.0 mi^2 (57.0 km^2). Other streams with drainage areas greater than 10.0 mi^2 (25.9 km^2) are Rocky, Chico, Minter, Curley, Coulter, Big Beef, Mission, Blackjack, and Burley Creeks.

Mean annual precipitation, as recorded at climatological stations, ranges from about 25 inches (640 mm) at Hansville at the northern part of the area to 70 inches (1,800 mm) near the great bend of Hood Canal, near Tahuya. However, streamflow records indicate precipitation may be greater in the vicinity of Green and Gold Mountains.

Figure 2 depicts a typical pattern of seasonal precipitation at Grapeview (just outside the southwestern margin of the study area; fig. 1), based on average monthly precipitations during 1931-60. The Grapeview record was used because it covers the longest period in the general area. Normal monthly precipitation is highest in December and lowest in July. The variations in annual precipitation at Grapeview are depicted in figure 3, where annual deviations from the 1931-60 average are shown for the periods 1931-46 and 1948-71. For example, the figure indicates that below-average annual precipitation occurred consecutively during the ~~seven~~ 7 years 1938-44 and the ~~six~~ 6 years 1962-67.

Mean annual runoff per square mile of drainage area is generally largest in streams in the western part of the study area, near Hood Canal, based on records of streamflow at eight long-term gaging stations (table 1). The largest observed average annual runoff during the period 1946-56 (the only ~~ten-year~~ period of contemporaneous record at all eight stations) was at Union River near Bremerton (station 12063000) and was 4.05 $(ft^3/s)/mi^2$ [0.0443 $(m^3/s)/km^2$]. The smallest observed average annual runoff during this period was at Dogfish Creek near Poulsbo (station 1207000) and was 1.78 $(ft^3/s)/mi^2$ [0.0195 $(m^3/s)/km^2$]. Mean average runoff is doubtless both larger and smaller from other, ungaged basins in the study area.

SEASONAL AND YEARLY VARIATIONS IN LOW FLOWS

Streamflow patterns closely follow the seasonal trend of precipitation. High runoff results from the greater precipitation during winter, most of which occurs as rain and quickly becomes surface runoff. Occasionally, some precipitation occurs as snow but the temperature rises soon enough to preclude much sustained accumulation on the ground. As precipitation diminishes in the summer, streamflows become dependent on ground-water seepage to maintain the flows. Also, the release of natural and artificial storage, as provided by many lakes in the area, tends to maintain streamflows during the season of little precipitation. No effort was made in this study to evaluate the effects of the artificial storage on low-flow values, because regulation, as well as diversion, is somewhat random and poorly documented.

Low flows in the area generally occur during the period July-October and are most likely to occur in September. Dogfish Creek is an observed exception, tending to have its lowest flows in early August.

There is a considerably range in seasonal low flows from year to year and between basins. Figure 4 illustrates the difference between the variability of the 7-day low flow of Gold Creek near Bremerton and that of Dogfish Creek near Poulsbo during their respective periods of record within the 1946-71 water years. The figure shows that the 7-day low flow[1] of Gold Creek ranged from 0.77 ft^3/s (0.022 m^3/s) in 1948 to 0.24 ft^3/s (0.0068 m^3/s) in 1967, whereas that of Dogfish Creek ranged from 3.63 ft^3/s (0.103 m^3/s) in 1956 to 1.83 ft^3/s (0.052 m^3/s) in 1959.

---

[1]Lowest average daily flow for 7 consecutive days in a given year.

LOW-FLOW-FREQUENCY ANALYSIS

Continuous-Record Gaging Stations

Eight streamflow-gaging stations that were used in the low-flow analysis were all established after 1945, but all have had 10 or more years of record since then. All were operated during the 1962-67 period of deficient rainfall, but none were in existence during the 1938-44 period of deficient rainfall. Low-flow-frequency curves were prepared by Log-Pearson Type III computer analysis of the daily streamflows recorded at these stations; the low-flow data for the stations are listed in table 1. The 7-day low flows, at recurrence intervals[1] of 2, 5, 10, and 20 years (7-day Q_2, Q_5, Q_{10}, and Q_{20}, respectively) are taken from the curves. Data from the frequency curves for periods greater than 7 days also are listed in table 1.

Streamflows at 13 other sites in the study area have been gaged for periods of less than 10 years. Daily discharges during low-flow periods at these short-term gaging stations were regressed with concurrent discharges from a nearby station having a longer record, and then estimates of the 7-day Q_2, Q_5, Q_{10}, and Q_{20} were made by use of the regression. Data for these sites are listed in table 2. Correlation coefficients for the regressions were generally greater than 0.90.

---

[1]Recurrence interval is the average number of years between minimum flows less than those indicated by the frequency curve. The reciprocal of the recurrence interval is the probability that a low flow in any one year will be equal to or less than the discharge given.

Miscellaneous Discharge Sites

Miscellaneous discharge measurements, most of which were made specifically for low-flow information, have been obtained over the years in the study area, generally since 1947. Using methods similar to those for short-term gaging stations, miscellaneous discharge values were regressed with concurrent discharges at each long-term gaging station to obtain eight different estimates of 7-day Q_2, Q_5, Q_{10}, and Q_{20}. The regression finally used was that which gave the smallest standard error of estimate. Low-flow-frequency data for these miscellaneous sites having five or more measurements of discharge are listed in table 2. Correlation coefficients for the regressions were generally greater than 0.90.

Although many sites had insufficient data for analysis, the data recording no flow were considered significant to list in table 2. If sufficient years of "no flow" observations at such sites were available when nearby long-term stations had flows lower than those of a 2-year recurrence interval, it was assumed that "no flow" would also suffice for the Q_2, Q_5, Q_{10}, and Q_{20} values.

In 1961 the State of Washington Division of Water Resources made a comprehensive inventory of low streamflows in the study area at many sites on small streams where prior data were unavailable. This single set of observations included discharge measurements and estimates of flow which are presented in a resulting report (Garling, Molenaar, and

others, 1965, table 48, p. 118). However, because analysis of low-flow frequency cannot be made for such sites with only one streamflow observation, sites which were observed "dry" during that 1961 inventory and which could be located on a map, have been listed in table 2 of the present report. Approximately 30 other sites at which no flows were observed were not listed in the present report.

MONTHLY STREAMFLOW DATA

The estimated streamflow and quantity of water available both during and outside of the low-flow period also is of interest in fish management and to other water users and planners. Therefore, this study included an estimation of monthly mean flows at the 2-year recurrence interval, the median values. Because monthly mean discharges are not normally distributed, the medians are less than the averages of monthly discharges.

Log-Pearson Type III computer analysis was utilized for long-term gaging stations to obtain the median monthly discharges (monthly average flows at the 2-year recurrence interval) for all months of the year. The median values at the short-term gaging stations and miscellaneous sites were estimated from regression analysis with records of the long-term gaging stations. The data are listed in table 3. Omitted are monthly discharges that are greater than the range of concurrent discharges utilized in defining the regression at a site.

SOME FACTORS THAT INFLUENCE LOW FLOWS

No effort has been made to evaluate the effects of man on the low flows of the streams studied. Footnotes in table 2 list a few of man's uses, which include municipal, domestic, stock, and irrigation supplies. However, because low-flow measurements were made at the critical time of the year when man's use of stream water is at a maximum, the measurements probably represent the "as-used" condition.

SELECTED REFERENCES

Collings, M. R., and Hidaka, F. T., 1974, Low-flow characteristics of streams in the Willapa Bay drainages, Washington: U.S. Geol. Survey Water-Resources Inv. 8-74, 12 p.

Garling, M. E., Molenaar, Dee, and others, 1965, Water resources and geology of the Kitsap Peninsula and certain adjacent islands: Washington Div. Water Resources Water Supply Bull. 18, 309 p.

Hidaka, F. T., 1973, Low-flow characteristics of streams in the Puget Sound region, Washington: U.S. Geol. Survey open-file report, 55 p.

Riggs, H. C., 1972, Low-flow investigations: U.S. Geol. Survey Techniques Water-Resources Inv., book 4, ch. B1, 18 p.

U.S. Geological Survey, 1955, Pacific Slope basins in Washington and upper Columbia River basin, Part 12 of Compilation of records of surface waters of the United States, through 1950: U.S. Geol. Survey Water-Supply Paper 1316, p. 26-51.

-----1961-64, Surface water records of Washington, 1958-64: Tacoma, Wash., annual reports published for years indicated.

-----1964, Pacific Slope basins in Washington and upper Columbia River basins, part 12 of Compilation of records of surface waters of the United States, October 1950 to September 1960: U.S. Geol. Survey Water-Supply Paper 1736, p. 19-31.

-----1965-74, Water resources data for Washington, Part 1,

Surface water records, 1965-74: Tacoma, Wash., annual reports published for years indicated.

-----1971, Pacific Slope basins in Washington except Columbia River basin, v. 1, part 12 of Surface water supply of the United States 1961-65: U.S. Geol. Survey Water-Supply Paper 1932, p. 45-95.

U.S. Weather Bureau, 1956, Climatology of the United States No. 11-39, Climatic summary of the United States - Supplement for 1931 through 1952, Washington: Washington, U.S. Govt. Printing Office, p. 1 and 7.

-----1965, Climatology of the United States No. 86-39, Decennial census of United States climate - Climatic summary of the United States - Supplement for 1951 through 1960, Washington: Washington, U.S. Govt. Printing Office, p. 2 and 4.

-----1965, Mean annual precipitation, 1930-1957, State of Washington: Portland, Oreg., U.S. Soil Conserv. Service map M-4430.

Washington Division of Water Resources, 1964, Miscellaneous streamflow measurements, State of Washington, 1890 to January 1961: Washington Div. Water Resources Water Supply Bull. 23, p. 10-33.

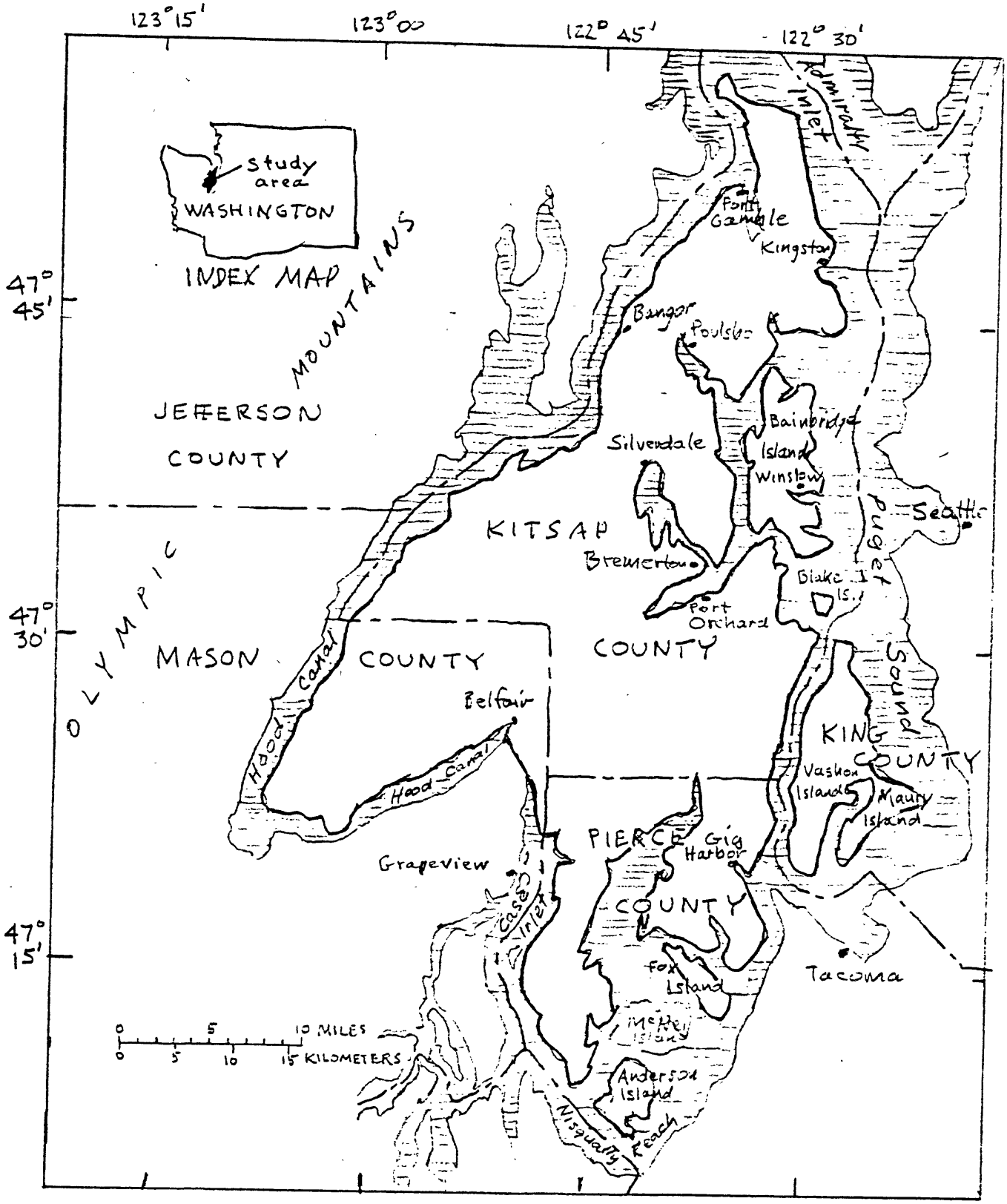


FIGURE 1.— Location of study area.

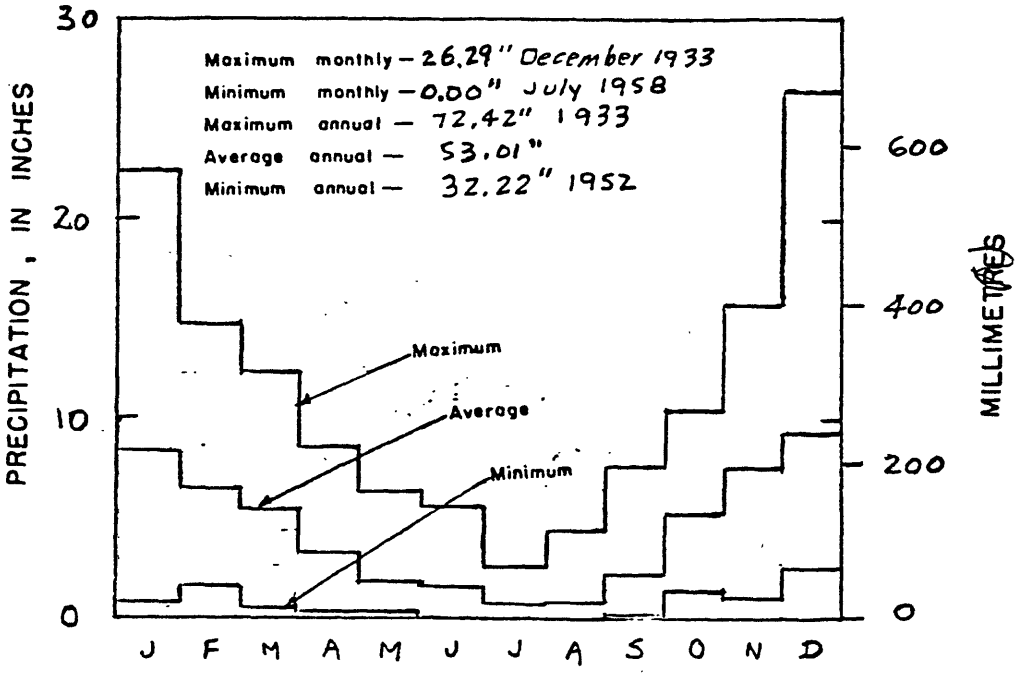


FIGURE 2.--Maximum, minimum, and average monthly precipitation at Grapeview, 1931-60.

Data from U.S. ~~Department of Commerce~~ Weather Bureau (1960, 1965).

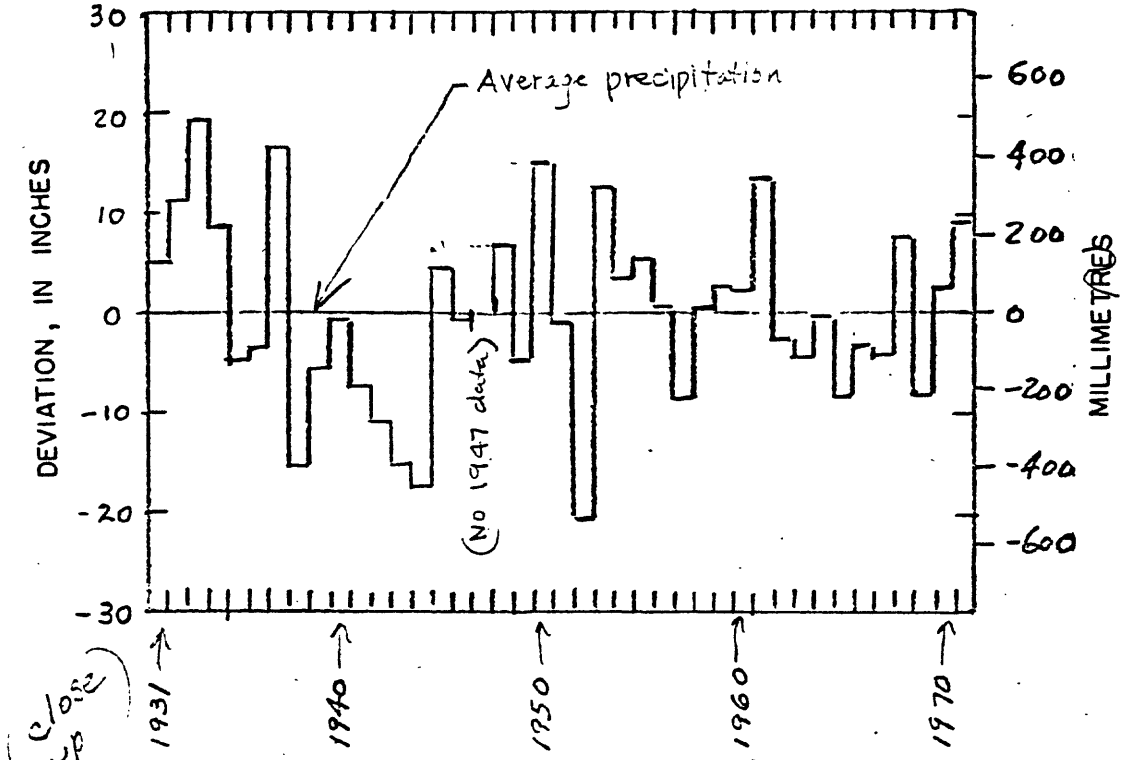


FIGURE 3.--Deviation from mean annual precipitation at Gropeview during the years 1930-71

Data from U. S. Weather Bureau (1960, 1965).

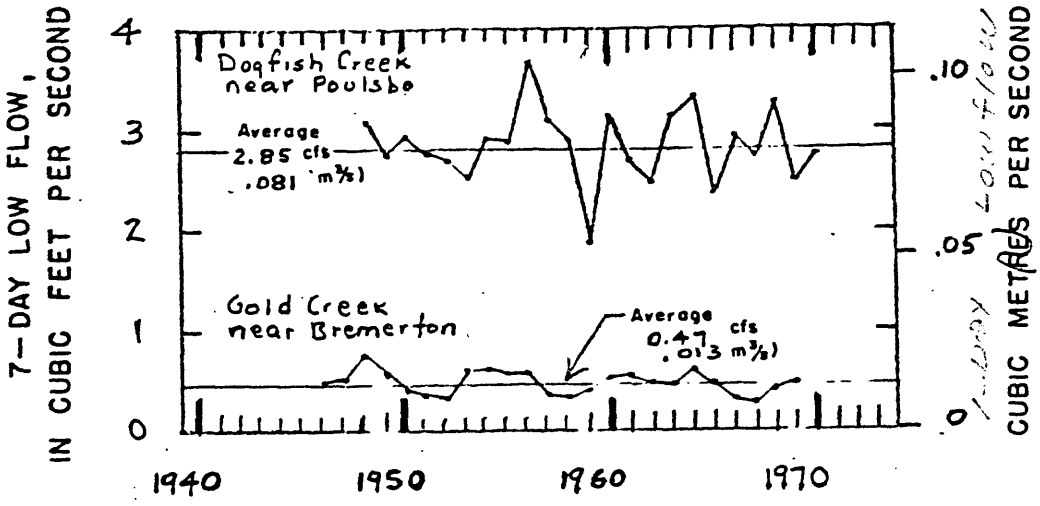


FIGURE 4.— Annual 7-day low flows at two gaging stations, ~~during the climatic years indicated.~~ 1940-70,

All Tables revised as of 6/24/76

TABLE 1. -- Low-flow frequency data for long-term streamflow gaging stations in ~~the~~ study area[1]

Site no. on Plate 1 | Gaging-station name and number | Number of consecutive days | Streamflow (ft^3/s), for indicated recurrence interval (years) 2 | 5 | 10 | 20

Site no. on Plate 1	Gaging-station name and number	Number of consecutive days	2	5	10	20
~~0630~~ 1	Union River near Bremerton (~~1~~) 12063000	7	0.55	0.44	0.39	0.35
		30	.64	.48	.41	.36
		60	.72	.55	.48	.43
		90	.80	.61	.53	.48
		183	1.7	1.2	1.1	.95
~~0635~~ 5	Union River near Belfair (~~3~~) 12063500	7	18	16	15	14
		30	19	17	15	14
		60	20	18	16	15
		90	21	18	17	16
		183	25	22	21	20
~~0650~~ 16	Gold Creek near Bremerton (~~13~~) 12065500	7	.46	.36	.32	.28
		30	.54	.42	.36	.32
		60	.61	.48	.41	.36
		90	.68	.54	.47	.42
		183	1.3	1.0	.88	.79
~~0660~~ 17	Tahuya River near Bremerton (~~17~~) 12066000	7	.31	.15	.10	.08
		30	.48	.25	.18	.14
		60	.61	.34	.25	.20
		90	.78	.41	.28	.21
		183	2.3	1.4	1.1	.83
~~0685~~ 31	Dewatto River near Dewatto (~~31~~) 12068500	7	12	11	11	10
		30	13	12	12	11
		60	14	13	12	12
		90	15	14	13	13
		183	21	18	17	16
~~0700~~ 60	Dogfish Creek near Poulsbo (~~60~~) 12070000	7	2.9	2.5	2.3	2.2
		30	3.1	2.7	2.6	2.4
		60	3.3	3.0	2.8	2.7
		90	3.5	3.2	3.0	2.9
		183	4.5	4.1	3.9	3.7
~~0720~~ 80	Chico Creek near Bremerton (~~80~~) 12072000	7	.99	.53	.35	.24
		30	1.3	.83	.64	.51
		60	1.7	1.1	.80	.63
		90	2.1	1.4	1.1	.96
		183	5.7	4.2	3.6	3.1

1 of –

TABLE 1 continued.

USGS

site no. on plate 1 ~~Station no.~~	Gaging-station name and ~~site number on figure 1~~	Number of consecutive days	Streamflow (ft^3/s) for indicated recurrence interval (years)			
			2	5	10	20
~~0735~~ 106	Huge Creek near Wauna (~~106~~) 12073500	7	4.2	3.9	3.7	3.6
		30	4.5	4.1	3.9	3.8
		60	4.6	4.2	4.1	4.0
		90	4.7	4.3	4.1	4.0
		183	5.4	4.8	4.6	4.4

1/ See footnotes for these sites in table 2 concerning diversions and regulation.

2/ Prefix "12" and last two zeros deleted from ~~this~~ station numbers. Formal U.S. Geological Survey

OK Jue

2 of 2

(Note: column headings to follow format of this (1st) sheet)

TABLE 2.--7-day low-flow-frequency data for all sites in the study area

Site no. on pl. 1	Gaging-station name and USGS number if given (in parentheses) and period of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges (ft^3/s) for indicated recurrence intervals in years			
				2	5	10	20
1	Union River near Bremerton (12063000) 1946-56[3]	SW,NE 34 24/1 W	3.16	0.6 0.55	0.44	0.4 0.39	0.4 0.35
2	Union River at Old Navy Yard Way 1942-43, 1947, 1958-59	NE,SW 3 23/1 W	6.96	1.8	1.5	1.2	1.1
3	Bear Creek at Old Navy Yard Way 1947-48, 1957-59	NW,SE 9 23/1 W	1.40	.8	.7	.7	.6
4	Union River tributary at Old Navy Yard Way 1958-59	NW,NW 16 23/1 W	.20	0	0	0	0
5	Union River near Belfair (12063500) 1947-59[3], 1960, 1973	SE,NE 20 23/1 W	19.8	18	16	15	14
6	Courtney Creek 1947, 1958-59, 1966-71	SE,SW 17 23/1 W	1.43	3.0	2.8	2.7	2.7
7	Union River tributary at North Shore Road 1947, 1958-59	SE,SE 30 23/1 W	.20		[5]		
8	Mission Lake tributary 1969-70	NE,NE 32 24/1 W		0	0	0	0
9	Mission Creek near Bremerton (12064500) 1945-53[3], 1954, 1958-59, 1969-70	NE,NW 32 24/1 W	1.83	0	0	0	0
10	Mission Creek near Belfair (12065000) 1945-53[3], 1958-59	NW,NW 18 23/1 W	4.43	.11	.08	.07	.06

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
11	Mission Creek near mouth 1947-48, 1958-59, 1966-71	SW,NE 36 23/2 W	13.1	5.2	4.8	4.5	4.3
12	Little Mission Creek at North Shore Road 1947, 1958-59, 1966-70	NW,NW 1 22/2 W	1.51	2.0	1.8	1.8	1.7
13	Hood Canal tributary at North Shore Road 1961	SW,SW 2 22/2 W	6/ .02		(5/)		
14	Stimson Creek at North Shore Road 1947, 1958-59, 1974	NW,NW 11 22/2 W	1.86	.8	.6	.6	.5
15	Hood Canal tributary at North Shore Road 1961	SW,NW 17 22/2 W	6/ 0.04		(5/)		
16	Gold Creek near Bremerton (12065500) 1946-70	NE,SW 21 24/1 W	1.51	~~0.5~~ c.46	~~0.4~~ 0.36	0.32	~~0.3~~ 0.28
17	Tahuya River near Bremerton (12066000) 1945-57, 1958-59	SW,SE 19 24/1 W	5.99	.31	~~.2~~ .15	.10	.08
18	Panther Creek near Bremerton (12067000) 1945-53, 1954, 1958-59, 1969-71	SW,NW 31 24/1 W	.98	0	0	0	0
19	Tahuya River tributary 1947, 1958-59	SW,NW 2 23/2 W	2.03	0	0	0	0
20	Tahuya River near Belfair (12067500) 1945-57, 1958-59	NE,SE 10 23/2 W	15.0	0	0	0	0
21	Tahuya River tributary 1958-59	NW,SE 33 23/2 W	4.19		(5/)		

2/15

TABLE 2.-- continued

Site no. on pl. fig. 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
22	Tahuya River near Tahuya (12068000)[3] 1947[2], 1958-59	SE,SW 12 22/3 W	42.2	7.4	6.2	5.7	5.3
23	Tahuya River Tributary 1958-59	NE,SE 22 22/3 W	1.20	0	0	0	0
24	Rendsland Creek 1947, 1974	NE,NW 19 22/3 W	8.74				
25	South Fork Dewatto River 1970-72	SW,NE 5 23/2 W	2.00	.4	.3	.3	.3
26	North Fork Dewatto River 1970-72	SW,SE 32 24/2 W	2.97	.5	.4	.4	.4
27	Dewatto River 1970-72	NE,NW 5 23/2 W	5.39	1.1	1.0	.9	.9
28	Ludvick Lake Creek 1947, 1958-59	SW,NE 6 23/2 W	1.01	0	0	0	0
29	Dewatto River 1970-72	SE,NW 7 23/2 W	9.33	4.2	3.8	3.6	3.4
30	Dewatto River 1970-72	NE,SE 13 23/3 W	13.2	8.8	8.1	7.6	7.4
31	Dewatto River near Dewatto (12068500) 1947-55[2], 1956-57, 1958-74[3]	NE,SW 23 23/3 W	18.4	12	11	11	10

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
32	Dewatto River tributary at Dewatto Bay Road 1947, 1958-59	NE,SE 27 23/3 W	1.77	1.3	1.2	1.2	1.1
33	Dewatto River at mouth 1968-69	SW,NE 27 23/3 W	21.7	16	14	14	13
34	Thomas Creek at Holly 1947, 1958-59, 1966-70	NE,NE 19 24/2 W	.37	2.3	2.2	2.2	2.1
35	North Fork Anderson Creek 1970-72	SW,NE 21 24/2 W	1.91	.3	.3	.3	.2
36	South Fork Anderson Creek 1970-72	SE,NW 21 24/2 W	1.98	2.0	1.9	1.8	1.8
37	Anderson Creek 1970-72	SE,SE 17 24/2 W	4.68	3.9 ~~3.2~~	3.6	3.5 ~~2.8~~	3.4 ~~2.7~~
38	Anderson Creek near Holly (12-69000) 1947-~~48~~, 1951, 1958-59	SE,SW 17 24/2 W	5.17	5.1	4.8	4.7	4.6
39	Anderson Creek 1970-72	SW,SW 17 24/2 W	5.54	5.4	5.2	5.0	4.9
40	Hood Canal tributary 1961	SW,SE 26 25/2 W	6/ .13 ~~.07~~		(5) ~~est~~		
41	Stavis Creek near Seabeck (12069500) 1947-~~48~~, 1951, 1958-59	SE,SW 25 25/2 W	5.91	6.7	6.4	6.3	6.2

5/15

TABLE 2.-- continued

Site no. on pl. fig. 1	Stream and periods of low-flow records	Location[1]/	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
42	Hood Canal tributary 1961	NE,NE 25 25/2 W	6/ .45		(5)		
43	Seabeck Creek 1947, 1958-59	NW,NW 29 25/1 W	5.06	.5	.4	.3	.2
44	Big Beef Creek at Camp Union 1947, 1958-59	SW,SW 5 24/1 W	5.69	.7	.5	.5	.4
45	Big Beef Creek near Seabeck (12069550) 1947, 1958, 1966-68, 1969-74	NW,SE 22 25/1 W	13.8	3.7	3.0	2.6	2.4
46	Anderson Creek at Anderson Hill Road 1947, 1958-59, 1966-71	SW,NW 13 25/1 W	4.04	2.3	2.2	2.1	2.1
47	Port Gamble tributary 1947, 1958-59	NE,NE 31 27/2 E	4.87	.6	.5	.4	.4
48	Hood Canal tributary near Port Gamble 1961	SW,NE 5 27/2 E	6/ 1.86		(5)		
49	Buck Lake Outlet at Hansville 1947, 1958-59	NW,SW 16 28/2 E	.32		(5)		
50	Eglon Creek at Eglon 1958	SW,NW 2 27/2 E	2.24		(5)		
51	Carpenter Lake Outlet 1947, 1958-59	NE,SW 26 27/2 E	2.35	0	0	0	0

6/15

TABLE 2.-- continued

Site no. on pl. fig. 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
52	Appletree Cove tributary 1961	NE,NW 35 27/2 E	.60				
53	Appletree Cove tributary 1961	NW,NE 35 27/2 E	0.35				
54	Grovers Creek 1947, 1958	SW,NW 4 26/2 E	6.45	0.3	0.2	0.2	0.2
55	Port Orchard Tributary 1961	NE,NW 32 26/2 E	.47				
56	Port Orchard tributary at Sandy Hook 1961	NW,SW 32 26/2 E	.28				
57	Port Orchard tributary 1947, 1958-59	NW,NW 31 26/2 E	1.79	0	0	0	0
58	Liberty Bay tributary 1961	SE,SW 23 26/1 E	.11				
59	West Fork Dogfish Creek 1947, 1958-59, 1974	NW,SE 11 26/1 E	2.76	1.6	1.5	1.4	1.3
60	Dogfish Creek near Poulsbo (12070000) 1947-71[3]	SE,SW 11 26/1 E	5.01	2.9	2.5	2.3	2.2
61	Johnson Creek near Poulsbo 1947, 1958-59, 1974	SE,NW 22 26/1 E	3.28	.7	.6	.6	.5

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
62	Liberty Bay tributary near Keyport 1947, 1958-59	NE,SW 35 26/1 E	.36				
63	Steel Creek at Burke Bay 1947, 1958-59	SE,SE 14 25/1 E	4.75	1.0	.9	.8	.8
64	Port Washington Narrows tributary 1961	NE,NW 13 24/1 E	.31				
65	Dyes Inlet tributary near Tracyton 1947, 1958	SW,NE 34 25/1 E	.42	0	0	0	0
66	Dyes Inlet tributary at Fairview 1947, 1958	NE,NW 34 25/1 E	.27				
67	Barker Creek at Island Lake Outlet 1969-71	NW,NE 10 25/1 E	.71	0	0	0	0
68	West Fork Clear Creek 1947, 1958-59, 1966-71	SE,SW 9 25/1 E	3.68	2.5	2.3	2.2	2.1
69	Clear Creek near Silverdale (12070500) 1947, 1951, 1958-59, 1975	SE,SW 9 25/1 E	7.46	3.3	2.8	2.6	2.4
70	Strawberry Creek at Silverdale 1947, 1958, 1974	NE,NE 20 25/1 E	3.01	1.0	.9	.9	.8
71	Knapp Creek (Koch Creek) 1958	NW,SE 20 25/1 E	.28				

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
72	Wildcat Lake tributary 1969-71	SE,NE 3 24/1 W	--		~~0~~[5]		
73	Wildcat Lake tributary 1969-71	NE,SW 2 24/1 W	--		~~0~~[5]		
74	Wildcat Creek 1947-50, 1958-59, 1961, 1969-71	SE,NE 2 24/1 W	2.50	~~0~~.01	~~0~~.01	0	0
75	Wildcat Creek above Lost Creek 1961	SW,NW 7 24/1 E	6.20	.12	.09	.07	.07
76	Lost Creek near mouth 1961	SW,NW 7 24/1 E	3.08	.6	.5	.5	.5
77	Dickerson Creek near mouth 1947, 1958-59, 1961	SW,NW 8 24/1 E	2.19	.07	.05	.04	.03
78	Kitsap Lake tributary 1969-71	NE,NW 20 24/1 E	--	1.1	1.0	1.0	.9
79	Kitsap Creek 1947-51, 1958-59, 1961, 1969-71	SW,SW 8 24/1 E	2.73	.5	.3	.2	.2
80	Chico Creek near Bremerton (12072000) 1947-50[3], 1958-59, 1961-74[3]	NE,NW 8 24/1 E	15.3	~~1.0~~ .99	.53	~~.4~~ .35	.24
81	Gorst Creek (above Heins Creek) 1947, 1958-59, 1966-68, 1970-71	SW,NW 32 24/1 E	4.35	7.1	6.8	6.7	6.6
82	Blackjack Creek tributary 1947, 1958, 1966-71	NW,NW 23 23/1 E	1.41	3.3	3.2	3.2	3.1

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1/]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
83	Blackjack Creek 1947, 1958, 1966-71	NW,NW 11 23/1 E	10.5	5.5	5.1	4.9	4.8
84	Blackjack Creek at Port Orchard (12072500) 1947-50[3/], 1958-59	SE,SE 26 24/1 E	12.3	7.7	7.4	7.1	7.0
85	Annapolis Creek 1947, 1958, 1974	NE,NE 25 24/1 E	1.86	1.4	1.2	1.1	1.0
86	Port Orchard tributary 1947, 1958	NW,NE 17 24/2 E	.32	0	0	0	0
87	Salmonberry Creek 1947, 1958, 1974	SW,SE 7 23/2 E	4.99	1.2	1.0	.9	.8
88	Curly Creek 1947, 1951, 1958-59	NE,NE 8 23/2 E	11.6	4.8	4.1	3.7	3.4
89	Yukon Harbor tributary 1947, 1958	SE,SW 34 24/2 E	.05	0	0	0	0
90	Yukon Harbor tributary 1947, 1958	SW,SE 34 24/2 E	.96				
91	Yukon Harbor tributary 1947	SW,SE 34 24/2 E	.42				
92	Puget Sound tributary 1958	SE,NW 2 23/2 E	.43				

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
93	Olalla Creek 1947, 1958-59	SW,SE 32 23/2 E	3.88	3.5	3.3	3.1	2.9
94	Crescent Creek 1969, 1971	NW,NE 20 22/2 E	1.18				
95	Crescent Creek 1947, 1958-59	NW,NE 32 22/2 E	4.64	1.3	1.2	1.1	1.0
96	Wollochet Bay tributary 1947, 1958, 1974	NE,NE 24 21/1 E	2.52	.02	.01	0	0
97	Hale Passage tributary at Cromwell 1947, 1958	SE,SW 24 21/1 E	.10	0	0	0	0
98	Carr Inlet tributary ~~1947~~, 1958, 1974	NW,SE 10 21/1 E	2.03	.6	.5	.4	.4
99	Carr Inlet tributary at Rosedale 1947, 1958, 1974	SW,SW 2 21/1 E	.25	.9	.9	.8	.8
100	McCormick Creek 1947, 1958, 1974	NE,NW 25 22/1 E	2.36 →	.9	.8	.7	.7
101	Purdy Creek at Purdy (12072800) 1947, 1958-59, 1960-62~~3~~, 1963-64	NE,NW 24 22/1 E	3.44	1.4	1.3	1.2	1.2
102	Bear Creek 1947, 1958-59, 1966-71	SE,SE 2 22/1 E	1.99	2.2	2.1	2.0	2.0

TABLE 2.-- continued

Site no. on pl. fig. 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
103	Burly Creek at Burley (12073000) 1947-50[3], 1959-65[3], 1966-71	NE,NE 11 22/1 E	10.7	11	10	10	9.5
104	Henderson Bay tributary 1961	NE,SE 28 22/1 E	.40[6]				
105	Minter Creek 1947, 1953, 1958-59, 1966-71	SE,SE 17 22/1 E	5.67	5.7	5.4	5.2	5.1
106	Huge Creek near Wauna (12073500) 1947-69[3], 1973	NE,NE 20 22/1 E	6.47	4.2	3.9	3.7	3.6
107	Minter Creek tributary 1947, 1958-59	NE,SE 20 22/1 E	2.34	0	0	0	0
108	Minter Creek above fish hatchery 1952, 1974	SW,SE 20 22/1 E	15.4	16	15	14	13
109	Lackey Creek 1947, 1958-59	SE,SW 30 22/1 E	1.78	0	0	0	0
110	Van Geldern Cove tributary 1958-59	SE,NW 35 21/1 W	2.60				
111	Van Geldern Cove tributary 1961	NE,NE 35 21/1 W	.30[6]				
112	Filuce Bay tributary 1961	SW,SE 13 20/1 W	0.32[6]				

TABLE 2.-- continued

12/15

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1/]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
113	Dutcher Creek 1947, 1958-59, 1974	SE,SW 11 21/1 W	2.25	.13	.11	.09	.08
114	Vaughn Bay tributary 1961	SW,NE 2 21/1 W	.08 ~~(d)~~ 6/		~~(e)~~ (5/)		
115	Vaughn Bay tributary 1961	SE,NE 2 21/1 W	.30 ~~(d)~~ 6/		~~(e)~~ (5/)		
116	Vaughn Bay tributary 1961	NW,NW 2 21/1 W	.18 ~~(d)~~ 6/		~~(e)~~ (5/)		
117	Vaughn Bay tributary 1961	NW,NE 3 21/1 W	.19 ~~(d)~~ 6/		~~(e)~~ (5/)		
118	Rocky Creek 1947, 1958-59, 1966-71	NE,NE 27 22/1 W	18.1	3.8	3.5	3.4	3.2
119	Coulter Creek tributary 1947, 1958-59	SE,NW 9 22/1 W	1.03		~~(e)~~ (5/)		
120	Coulter Creek 1947, 1958-59, 1966-71	SW,SW 9 22/1 W	14.1	16	~~15.5~~ 16	15	15
	BAINBRIDGE ISLAND						
121	Murden Cove tributary 1961, 1975	SE,SE 15 25/2 E	1.54	.11	.09	.08	.07

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low-flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
122	Eagle Harbor tributary 1961	NE,NE 34 25/2 E	.18				
123	Blakely Harbor tributary 1961	SW,SW 2 24/2 E	.25				
124	Puget Sound tributary at South Beach 1961, 1975	NW,NE 14 24/2 E	.14				
125	Rich Passage tributary 1961	NW,SW 3 24/2 E	.17				
126	Rich Passage tributary 1961	NW,NE 4 24/2 E	1.04				
127	Rich Passage tributary 1961	NE,NW 4 24/2 E	.07				
128	Fletcher Bay tributary 1961	SE,NW 20 25/2 E	.17				
129	Fletcher Bay tributary[10] 1961, 1975	SE,NE 20 25/2 E	1.36	.10	.08	.07	.06
130	Fletcher Bay tributary 1961	NW,NE 20 25/2 E	.33				
131	Manzanita Bay tributary 1961, 1975	SE,NW 9 25/2 E	1.37	.3	.3	.2	.2

TABLE 2.-- continued

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1]	Drainage area (mi^2)	7-day low flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
VASHON AND MAURY ISLANDS							
132	Puget Sound tributary 1961	NW,NW 17 23/3 E	.17				
133	Puget Sound tributary 1961	SE,NE 15 22/3 E	.24				
134	Puget Sound tributary 1961	SW,NW 23 22/3 E	.05				
135	Puget Sound tributary 1961	SE,NE 22 22/3 E	.05				
136	Puget Sound tributary 1961	SW,SW 22 22/3 E	.07				
137	Quartermaster Harbor tributary 1961	NE,NE 6 21/3 E	.07				
138	Quartermaster Harbor tributary 1961	NW,NE 6 21/3 E	.05				
139	Quartermaster Harbor tributary 1961	SE,NE 20 22/3 E	.23				
140	Quartermaster Harbor tributary 1961	NE,NW 21 22/3 E	.29				
141	Judd Creek near Burton (12091700) 1968-74[3]	NE,SW 7 22/3 E	4.41	1.1	1.0	0.9	0.8

TABLE 3. --Monthly average flows ~~[in cubic feet per second]~~ for the 2-year recurrence interval at selected sites[1/]

[All values are in cubic feet per second]

Site no. on pl. 1	October	November	December	January	February	March	April	May	June	July	August	September
1	5.0	20	22	23	25	13	9.0	5.0	4.0	3.6	2.8	3.0
2									5.0	3.4	2.9	2.6
3										1.3	1.1	1.1
5	34	60	82	100	105	64	50	36	28	24	22	21
6	4.5							5.6	4.5	2.7	2.4	2.4
9	1.1	7.2	15	17	15	9.6	5.9	2.3	.81	.29	.05	.05
10	2.0	13	33	41	25	22	10	4.7	1.5	.59	.39	.32
11	10							15	10	7.4	6.3	6.5
12	3.1							4.1	3.1	2.5	2.2	2.3
14	2.4								2.5	1.4	1.1	1.1
16	2.0	7.7	11	14	12	8.1	5.1	2.4	1.4	.86	.62	.64
17	6.3	39	45	50	52	27	16	4.8	2.9	1.5	.78	.73
18	.43	3.1	7.1	8.3	7.4	4.2	1.9	.90	.18	.04	0	0
20	8.9	78	103	115	119	58	33	7.1	3.0	1.1	.32	.07
22										14	9.3	8.2
25	1.1	5.6	14	16	9.8	11	4.9	2.0	1.1	.67	.52	.55

TABLE 3. --Monthly average flows, in cubic feet per second, for the 2-year recurrence interval at selected sites[1/]

Site no. on pl. 1	October	November	December	January	February	March	April	May	June	July	August	September
26	1.8	8.8	21	26	15	17	7.8	3.4	1.8	1.0	.72	.78
27	3.0	14	33	41	23	25	12	5.3	3.0	1.9	1.5	1.6
29	9.2	32	67	80	49	53	29	15	9.3	6.4	5.4	5.6
30	17	50	94	110	72	77	46	26	17	13	11	11
31	25	74	140	163	108	114	67	37	25	18	15	16
32	2.6								2.6	1.9	1.6	1.7
33	30	82	150	172	118	123	76	43	30	22	19	20
34	3.4	5.2	5.8	7.0	6.5	5.6	5.2	3.9	3.3	2.8	2.5	2.5
35	.87	4.3	11	14	7.5	8.0	3.8	1.6	.88	.55	.44	.45
36	3.4							4.1	3.2	2.5	2.2	2.2
37	5.6	13	28	32	20	21	12	7.2	5.7	4.8	4.3	4.4
38	7.6							9.6	7.6	6.3	5.8	5.9
39	7.8	17	35	42	27	28	16	9.7	7.8	6.6	6.0	6.2
41	9.0								9.0	8.0	7.4	7.5
43											.84	.89
44											1.0	1.0

TABLE 3. --Monthly average flows, in cubic feet per second, for the 2-year recurrence interval at selected sites[1/]

Site no. on pl. 1	October	November	December	January	February	March	April	May	June	July	August	September
45	8.0	41	100	115	90	65	35	15	8.5	6.1	4.6	4.8
46	3.4							3.9	3.3	2.8	2.5	2.5
54										.63	.44	.45
59	3.5								3.5	2.4	2.1	2.1
60	6.0	9.4	13	17	15	13	8.0	5.5	4.5	3.5	3.4	4.2
61	1.6								1.6	1.1	.88	.90
63										1.7	1.3	1.4
68										3.5	2.8	2.9
69										5.6	4.2	4.5
70	2.0								2.0	1.5	1.3	1.3
74	1.5	6.8					6.0	2.6	1.5			
75	1.3								1.3	.49	.29	.31
76	2.6								2.3	1.2	.81	.84
77	.84								.85	.32	.19	.21
78	2.0	4.3	5.6			5.3	4.4	2.6	1.9	1.5	1.3	1.2
80	8.1	27	76	94	58	65	34	14	7.5	3.6	2.0	2.6

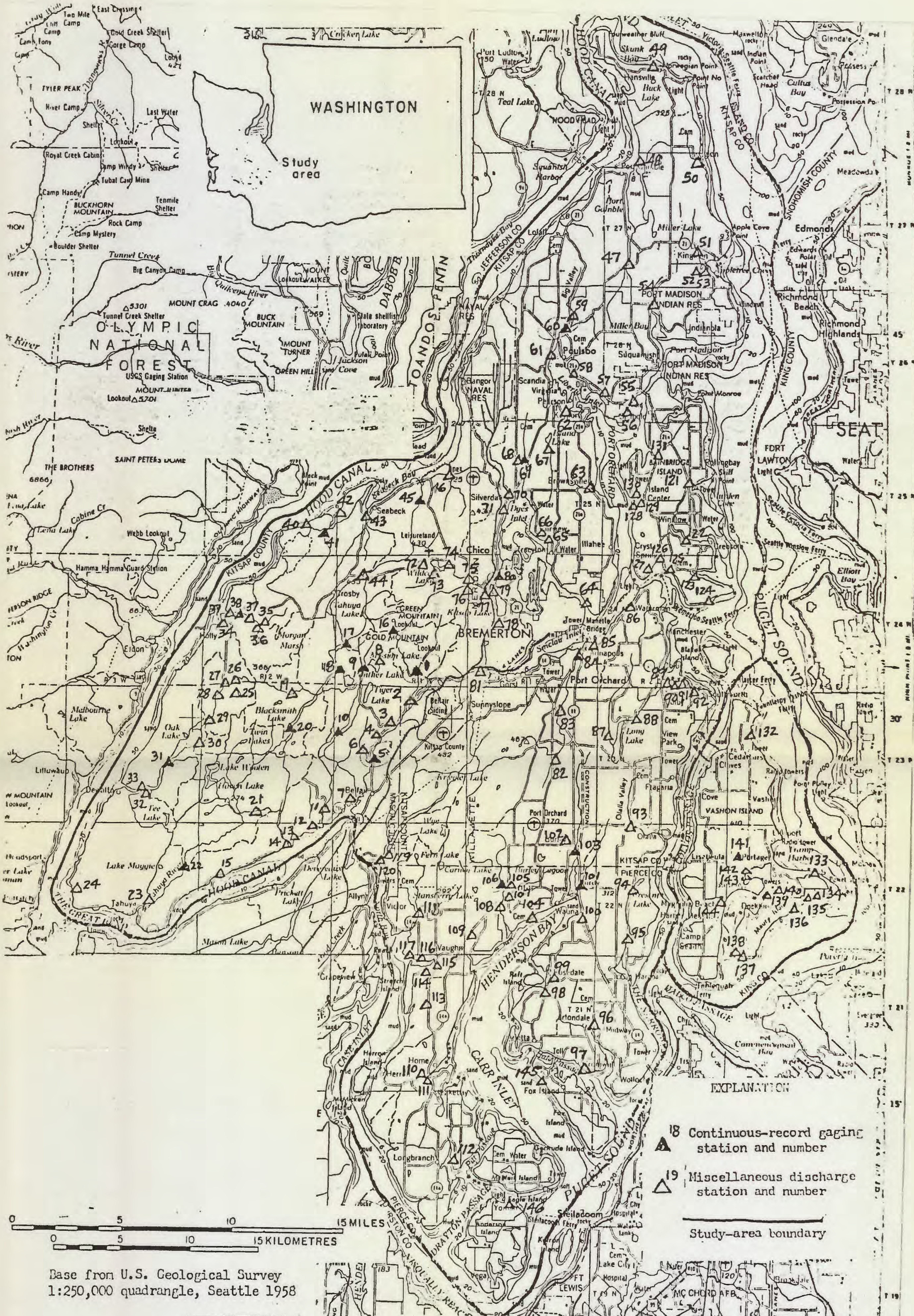
TABLE 3. --Monthly average flows, in cubic feet per second, for the 2-year recurrence interval at selected sites[1/]

Site no. on pl. 1	October	November	December	January	February	March	April	May	June	July	August	September
81	9.5								9.6	8.3	7.8	7.9
83	9.0							11	8.5	6.8	6.0	5.9
84	12								11	9.5	8.8	9.0
85										2.9	2.1	2.2
87	4.1								4.1	2.3	1.7	1.8
88										7.5	5.9	6.1
96	.6								.6	.1	.04	.05
98	1.4								1.4	.90	.73	.76
99	1.3								1.3	1.1	1.0	1.0
100	1.9								1.9	1.3	1.1	1.2
101							6.4	4.2	2.8	2.3	2.0	2.4
103	17	29	35	44	40	33	28	17	15	15	14	15
105	8.4							11	8.5	7.0	6.4	6.5
106	5.7	9.4	16	27	21	14	10	7.3	6.1	5.1	4.7	4.8
108	27								27	21	18	19
113	.66								.67	.31	.22	.23

TABLE 3. --Monthly average flows, in cubic feet per second, for the 2-year recurrence interval at selected sites[1/]

Site no. on pl. 1	October	November	December	January	February	March	April	May	June	July	August	September
118	6.4								5.6	4.7	4.2	4.3
120	19								19	18	17	17
129										.19	.14	.14
131	1.0								.80	.54	.42	.43
141	2.5	4.1	9.2	15	11	10	5.8	3.2	2.2	1.6	1.5	1.7

[1/] See Table 2 for description of site and footnotes concerning known diversions or regulations.



Base from U.S. Geological Survey 1:250,000 quadrangle, Seattle 1958

PLATE I -- Locations and numbers of data-collection sites on the Kitsap Peninsula and certain adjacent islands, Washington.

76-704

TABLE 2.-- continued

15/15 76-704

Site no. on pl. ~~fig.~~ 1	Stream and periods of low-flow records	Location[1/]	Drainage area (mi^2)	7-day low flow discharges, in cubic feet per second, for indicated recurrence intervals in years			
				2	5	10	20
142	Quartermaster Harbor tributary 1961	SE,NE 18 22/3 E	.02(d) 5/			(e)(5/)	
143	Quartermaster Harbor tributary 1961	NE,SE 18 22/3 E	.03(d) 5/			(e)(5/)	
144	Quartermaster Harbor tributary 1961	NE,SE 24 22/2 E	.06(d) 5/			(e)(5/)	
	FOX ISLAND						
145	Carr Inlet tributary 1961	NW,SW 35 21/1 E	.06(d) 5/			(e) (5/)	
	ANDERSON ISLAND						
146	Balch Passage tributary 1961	NE,NW 33 20/1 E	.04(d) 5/			(e)(5/)	

1/ The locations are abbreviated. For example, the complete landline location for site 2 of $SE\frac{1}{4}NW\frac{1}{4}$ sec.10, T.12 N., R.5 W., has been shortened to SE,NW 10 12/5 W. (all townships in the area are north).

3/ Operated as continuous-record gaging station. (4930,000 m³). According to the Washington Division of Water Resources (Garling, Molenaar, and others, 1965, p. 142),

2/ Low-flow statistics are for period of record prior to regulation at Casad Dam which started in 1956. Capacity of the reservoir is about 4,000 acre-feet, ~~Water Supply Bulletin 18 (WSB 18) states:~~ "To supply the City of Bremerton, water is first released from the reservoir outlet to the river channel. Approximately half a mile below the outlet and just above McKenna Falls, a small dam diverts the major part of the flow [up to 10 cfs in winter months] into a pipeline. To maintain fish life, a continual flow, varying from 1 to 3 cfs (0.283 m^3/s) at different times of the year, is bypassed to the river below the falls."

4/ Low-flows do not appear to be significantly affected by regulation and diversion mentioned in footnote "2/." (Garling, Molenaar, and others, 1965, table 48.)

5/ Insufficient data for analysis, has been observed dry.

6/ Drainage area from ~~Table 18, WSB 18~~ (1,970,000 m^3)

7/ Low-flow statistics are for a period prior to 1961. In 1961 a dam was constructed raising the lake about 8 feet, and increasing storage about 1,600 acre-feet. ~~W.S.B. 18~~ indicates that natural inflow to Tahuya Lake is allowed to outflow. The low-flow regimin is possibly different than for the pre-dam condition due to effects of the larger natural storage. (The Washington Division of Water Resources (Garling, Molenaar, and others, 1965)

8/ Flow may be partially regulated by Lake Symington.

9/ Outflow of Island Lake affected by glory hole pipe outlet.

10/ Low flow values based on measurements in 1975 may be greatly in error as long-term effects of reservoir storage in section 28 are not known.