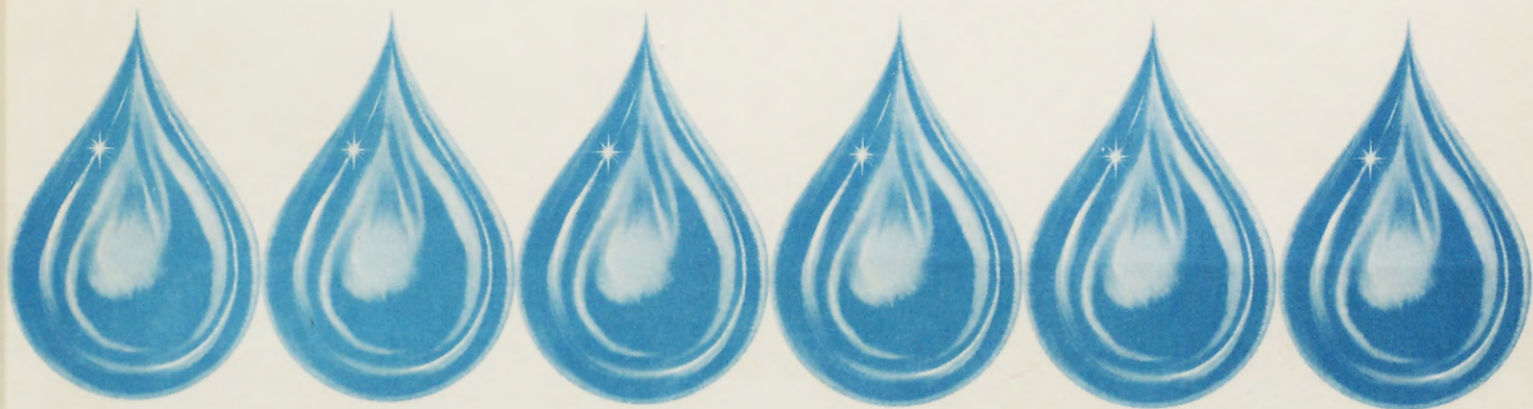


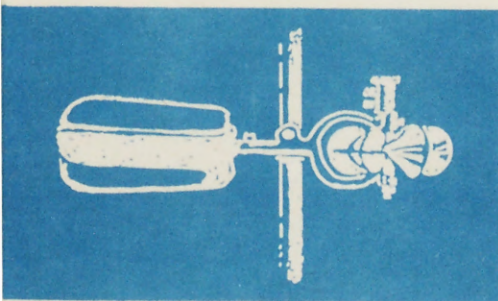
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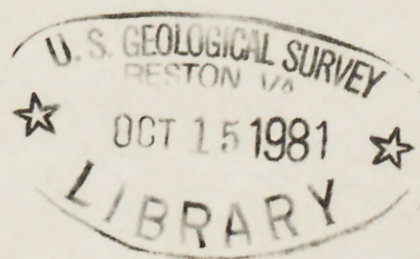
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LOW-FLOW CHARACTERISTICS OF
STREAMS IN THE DESCHUTES RIVER
BASIN, WASHINGTON



U.S. GEOLOGICAL SURVEY
Open-File Report 81-639



Prepared in Cooperation With
State of Washington Department of Fisheries

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



LOW-FLOW CHARACTERISTICS OF STREAMS
IN THE DESCHUTES RIVER BASIN, WASHINGTON

By J. E. Cummins

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Tacoma, Washington
1981

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UNITED STATES DEPARTMENT OF THE INTERIOR

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METRIC (SI) CONVERSION TABLE

<u>Multiply</u>	<u>By</u>	<u>To Obtain</u>
inch (in.)-----	2.540	centimeter (cm)
square mile (mi ²)-----	2.590	square kilometer (km ²)
cubic foot per second--- (ft ³ /s)	0.02832	cubic meter per second (m ³ /s)

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." NGVD of 1929 is referred to as sea level in this report.

LOW-FLOW CHARACTERISTICS OF STREAMS IN THE DESCHUTES RIVER BASIN, WASHINGTON

By J. E. Cummins

ABSTRACT

The purpose of the study was to determine the magnitude and frequency of low flows of streams in the Deschutes River basin.

The streams in the basin usually have their low flows in August and September. Seven-day low flows were smallest in 1952 when annual rainfall at the Olympia airport was also the least during the 1945-75 period of continuous gaging-station records in the basin.

The magnitude and frequency of seven-day low flows were estimated for 23 streamflow sites, either from frequency analysis of data at long-term stations or from correlation of measured or computed discharges at a streamflow site with data at a long-term station.

Seven-day low flows ranged from no-flow at one tributary of Deschutes River having a drainage area of 1.85 square miles to 98 cubic feet per second for Deschutes River near its mouth, where the drainage was 162 square miles.

Mean monthly flows were determined for two long-term stations and estimated for the months of July to September for the other streamflow sites.

Miscellaneous streamflow measurements made over the years by the U.S. Geological Survey are listed in the Appendix.

INTRODUCTION

The purpose of this report is to present low-flow information for stream sites in the Deschutes River basin (figs. 1 and 4). The low-flow statistics presented are based on a continuous record from two long-term (greater than 10 years of record) and one short-term gaging stations and from low-flow discharge measurements at 20 miscellaneous streamflow sites in the basin. The study and report were made in cooperation with the State of Washington Department of Fisheries to support its interest in determining and maintaining streamflows adequate for fish spawning and rearing.

The present study augments and updates low-flow data for Deschutes River basin reported earlier (Hidaka, 1973; and Puget Sound Task Force, 1970).

DESCRIPTION OF THE AREA

The Deschutes River heads in hills south of LaGrande and flows westward across lowland to discharge into Budd Inlet at the southern end of Puget Sound at Olympia. The drainage area of the basin is 162 mi².

Mean annual precipitation in the basin is about 57 in. (U.S. Weather Bureau, 1965b). U.S. Weather Bureau precipitation records beginning in 1942 at the Olympia airport (49.5 in. annually) indicate the greatest and the least mean monthly precipitations to be in December (9 in.) and July (0.8 in.) respectively.

Variations in annual precipitation during the 1942-79 period at the Olympia airport (fig. 2) indicate a relatively dry period in the early forties and a generally wetter than average period since then.

DATA AVAILABLE

Continuous streamflow records have been collected at three gaging stations in the basin. Records were obtained: June 1949 to September 1975 at USGS gaging station 12079000, Deschutes River near Rainier; April 1945 to November 1954 and June 1957 to June 1964 at 12080000, Deschutes River near Olympia; and June 1949 to November 1950 at 12079500, Spurgeon Creek near Olympia.

Miscellaneous discharge measurements of streams in the basin (table 4, Appendix) have been made since 1938 to obtain discharges particularly during the low-flow periods. A concentrated effort was made to obtain measurements of flow during low-flow periods of water years 1977-79 at most tributary streams and at the sites of the above three discontinued gaging stations. Low flows in the basin generally occur during the period July to October and are most likely to occur in August or September.

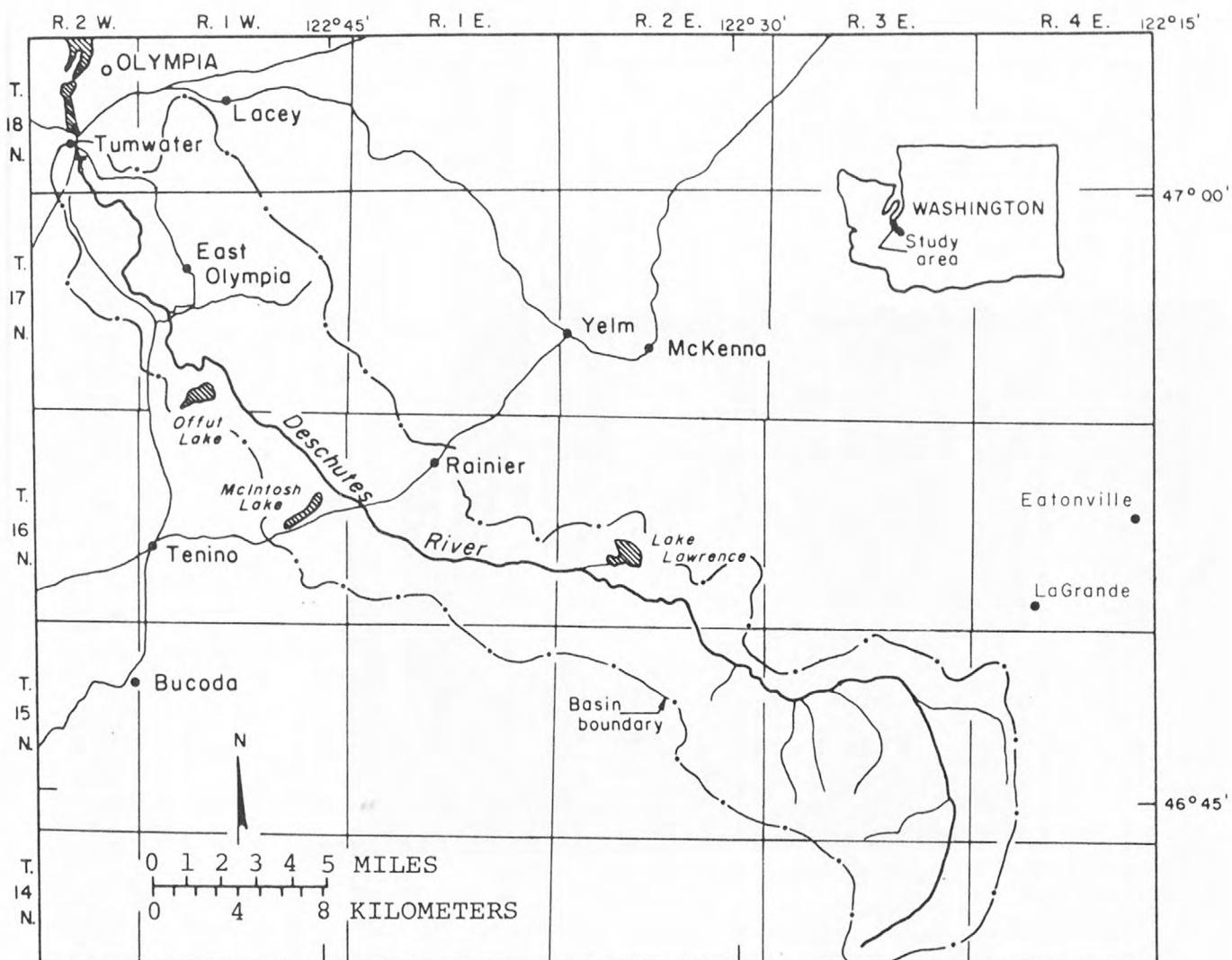


FIGURE 1.--Deschutes River basin, Washington, showing boundary of study area.

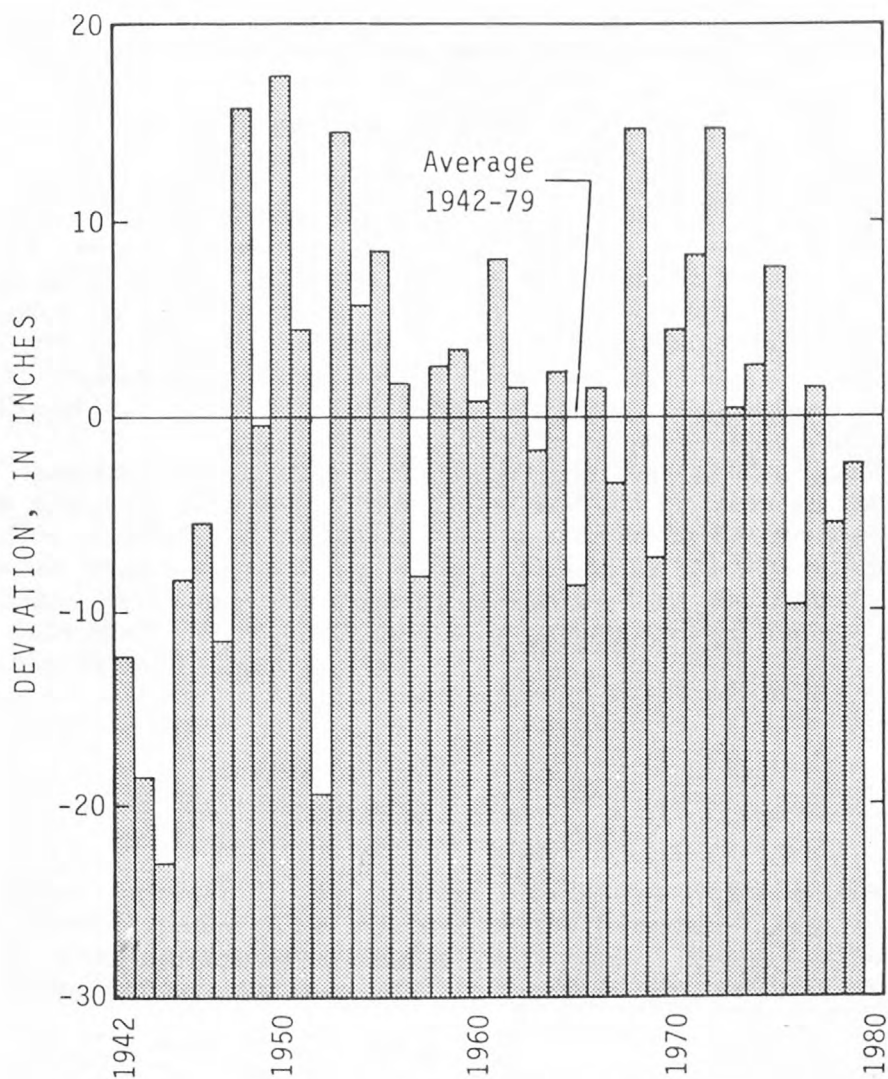


FIGURE 2.--Deviations of annual precipitation during 1942-79 from average annual precipitation during 1942-79 at Olympia Airport Station. Data from U.S. Weather Bureau Science Services Administration (annual summaries) and National Oceanic and Atmospheric Administration (annual summaries).

ANALYSIS OF LOW FLOWS

Long-Term Stations

The annual seven-day low flows at two long-term streamflow stations (fig. 3) do not suggest any significant trends during their periods of record. However, the seven-day low flows do exhibit minimum values during 1952, when average annual precipitation (fig. 2) was significantly below normal. Seven-day low flows during 1952 were 23 ft³/s and 75 ft³/s at the gaging stations "near Rainier" and "near Olympia", respectively. Locations of these stations are shown on figures 4b and 4c.

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 seven-day low flow, at recurrence intervals¹ of 2, 5, 10, and 20 years (seven-day Q₂, Q₅, Q₁₀, and Q₂₀, respectively), are taken from the frequency curves. Data from the frequency curves for periods greater than seven days are also listed in table 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.

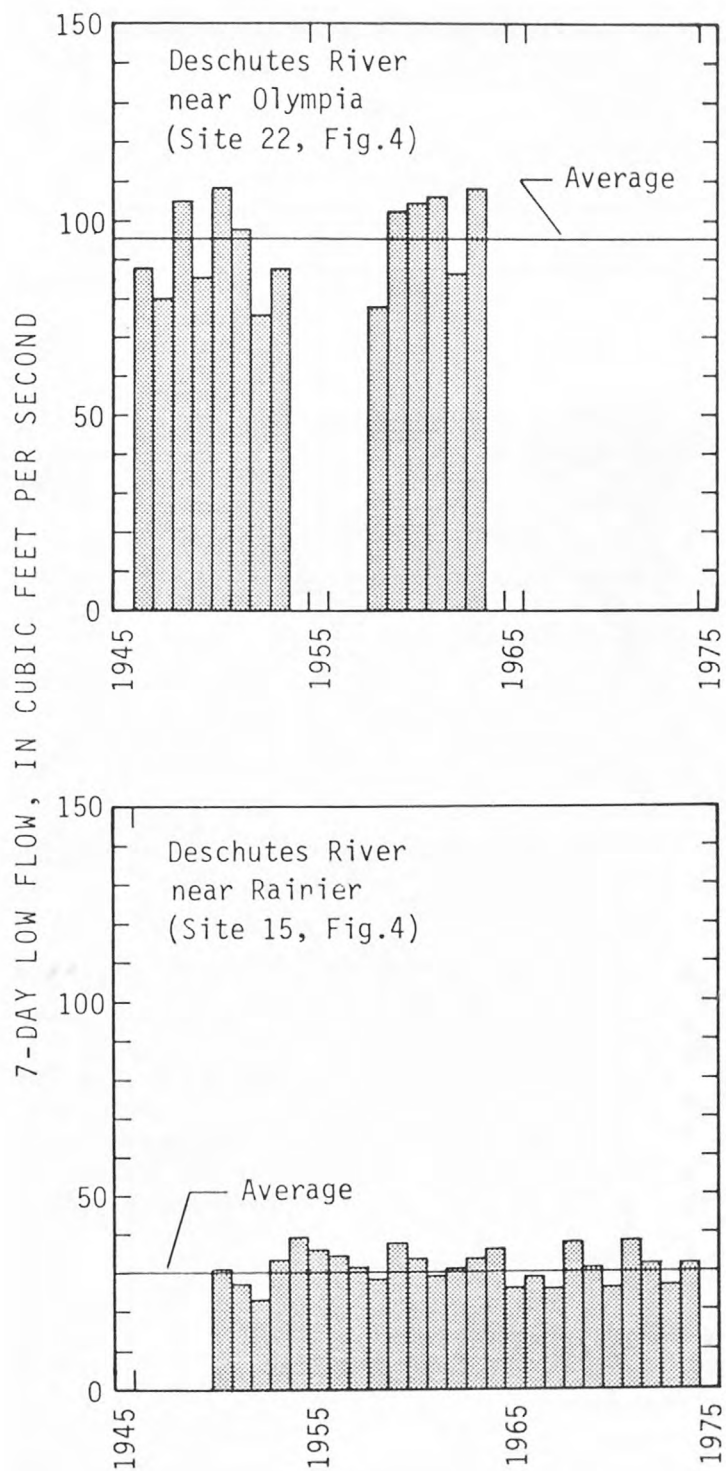


FIGURE 3.--Annual 7-day low flows at two gaging stations.

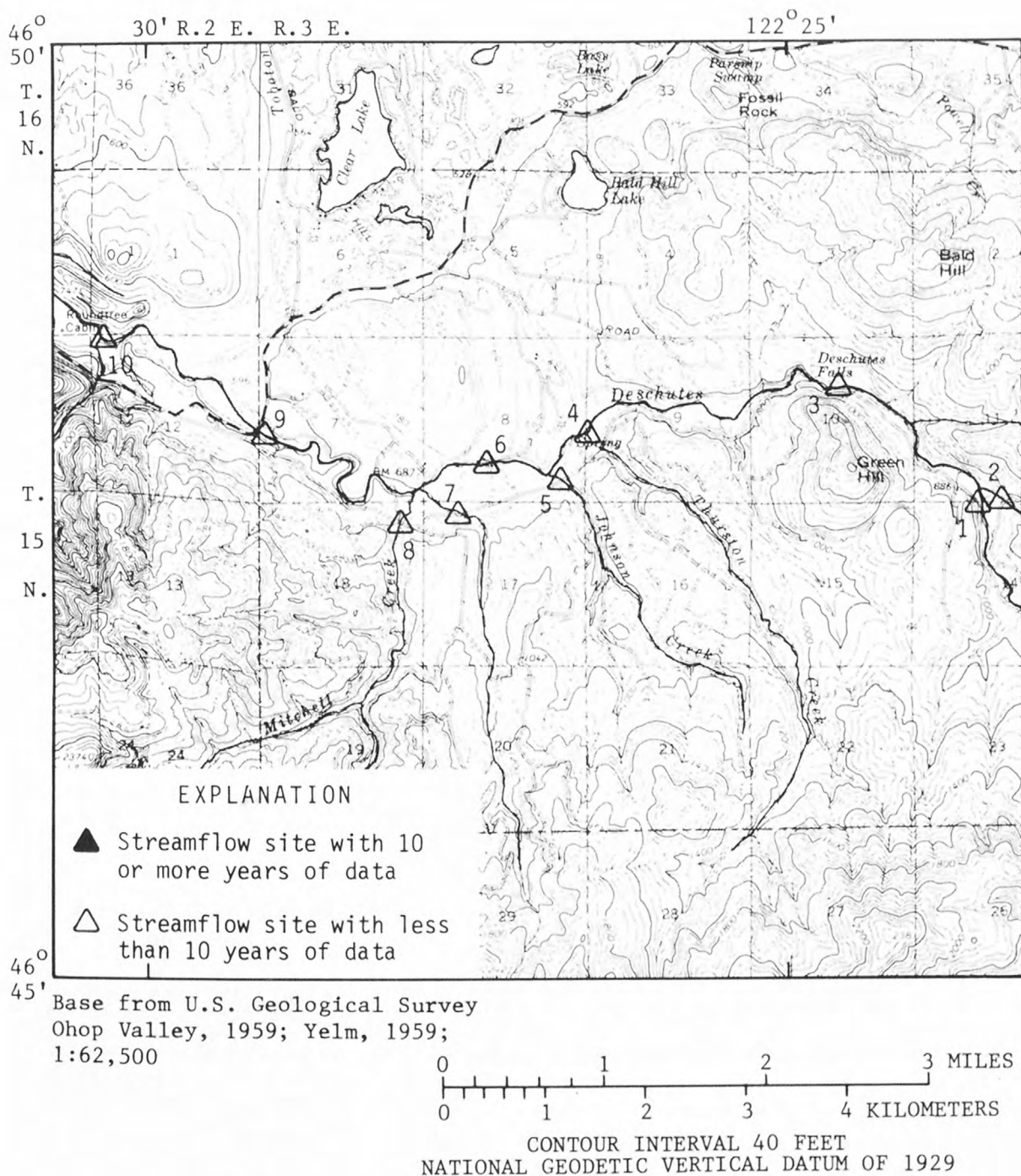


FIGURE 4a.--Part of Deschutes River basin, showing locations of low-flow sites.

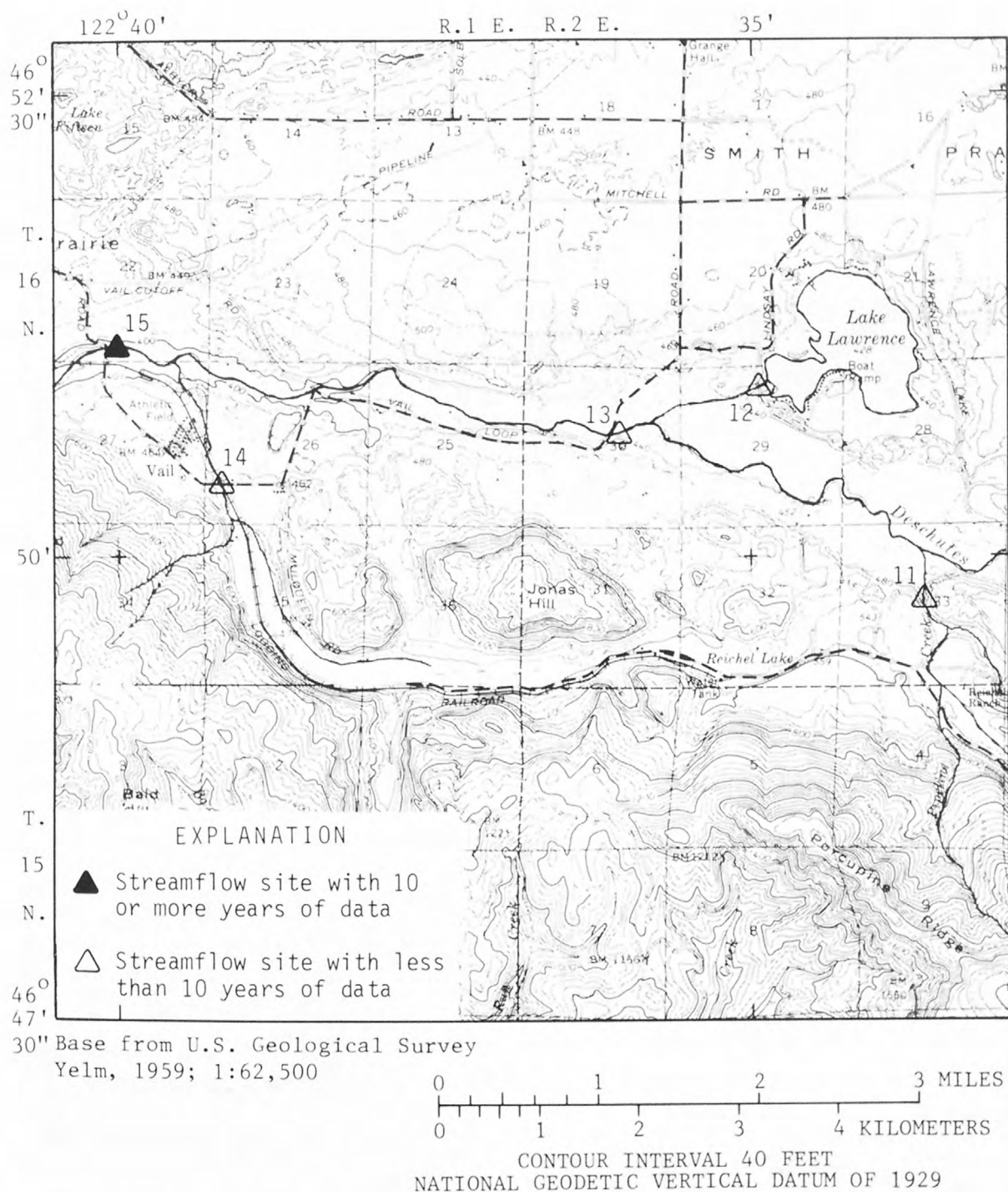


FIGURE 4b.--Part of Deschutes River basin, showing locations of low-flow sites.

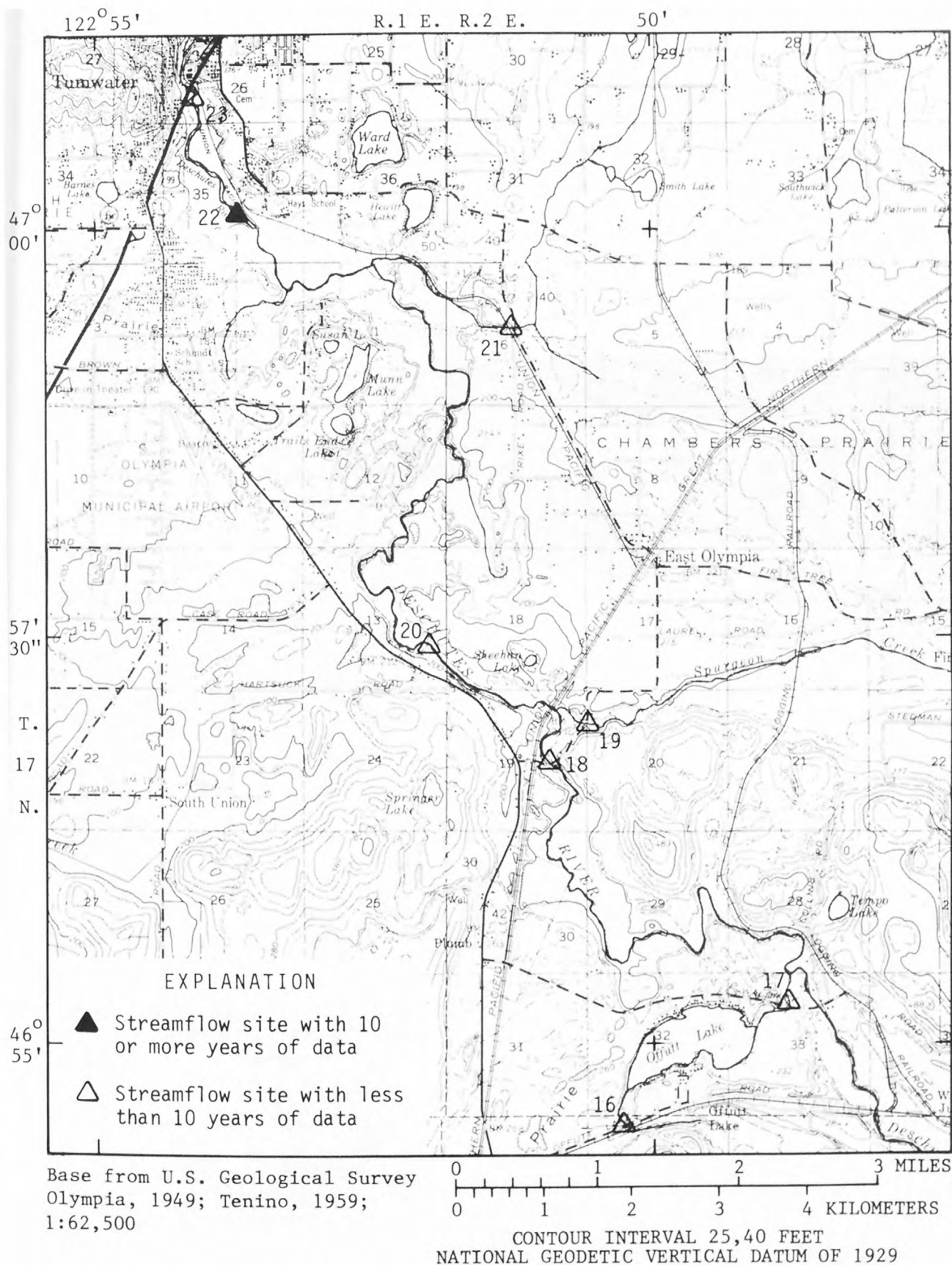


FIGURE 4c.--Part of Deschutes River basin, showing locations of low-flow sites.

TABLE 1.--Low-flow-frequency data for streamflow stations with 10 or more years of data

Site number on figures 4b-4c	Station name and USGS number	Number of consecutive days	Streamflow (ft ³ /s) for indicated recurrence intervals (years)			
			2	5	10	20
15	Deschutes River near Rainier (12079000)	7	31	28	26	24
		30	34	30	28	26
		60	38	33	30	28
		90	42	35	32	30
		183	78	61	53	47
22	Deschutes River near Olympia (12080000)	7	95	87	83	80
		30	99	92	87	83
		60	105	97	92	87
		90	110	102	96	92
		183	165	140	130	120

Short-Term Station and Miscellaneous Sites

Correlation methods were used to estimate the seven-day low flows for the 2-, 5-, 10-, and 20-year recurrence intervals at the short-term gaging station (Spurgeon Creek near Olympia, USGS stations 12079500, site 19) and at 20 other streamflow sites in the basin. For the short-term station, concurrent daily flows or measured discharges at the station and at the Deschutes River near Rainier station were used to determine the regression relationship; for the miscellaneous streamflow sites, measured discharges were regressed with concurrent flows of the same long-term station.

The seven-day low-flow-frequency data calculated for all sites are given in table 2. The standard error of estimate for each of the correlations is shown.

The mean flows for July, August, and September at the 2-year recurrence interval were estimated for the one short-term and 20 miscellaneous sites. The monthly mean flows were estimated by correlating either measured discharges or appropriate monthly mean flows at the short-term and miscellaneous sites with concurrent flows at the Deschutes River near Rainier station. Monthly discharges for July to September (and all year at the two long-term stations) are given in table 3.

TABLE 2.--Seven-day low-flow frequency data for all sites

Site no. on figures 4a-4c	Name of stream or stream- flow station, station number (in parenthesis) and period of record	Location	Drainage area (mi ²)	Flow discharges (ft ³ /s) for indicated recurrence intervals				Standard error of estimate (percent)
				2	5	10	20	
1	Deschutes River 1977-79	SE,SW 11 1t/3E	23.10	12.0	10.0	9.3	8.7	11
2	Little Deschutes R. 1977-79	SW,SE 11 15/3E	7.89	1.3	1.2	1.1	1.0	17
3	Deschutes River 1963, 65-71	SW,NE 10 15/3E	32.80	15.0	13.0	12.0	11.0	15
4	Thurston Creek 1977-79	NW,SW 9 15/3E	4.63	1.9	1.7	1.6	1.6	16
5	Johnson Creek 1977-79	SE,SE 9 15/3E	2.20	.3	.2	.2	.2	32
6	Deschutes R. 1949, 63, 65-71, 77-79	SE,SW 9 15/3E	44.10	14.0	12.0	11.0	11.0	14
7	Deschutes R. Trb. 1963, 65-71	NW,NW 17 15/3E	2/03	.6	.5	.5	.5	14
8	Mitchell Creek 1963, 65-71, 77-79	NE,NE 18 15/3E	8.54	2.3	2.0	1.8	1.7	20
9	Deschutes River 1970, 75	NW,SW 7 15/3E	56.20	19.0	17.0	16.0	15.0	7
10	Fall Creek 1977-79	SW,NW 12 15/2E	2.83	.2	.2	.2	.1	42
11	Pipeline Creek 1977-79	SW,NE 33 16/2E	3.50	.1	.1	.1	.1	35
12	Lawrence Lake Outlet 1974, 77-79	NE,NW 29 16/2E	3.35			(a)		-
13	Deschutes River 1970	SW,NE 30 16/2E	76.00	22.0	19.0	18.0	17.0	3
14	Reichel Lake Outlet 1949, 77-79	NW,SE 26 16/1E	6.82			(b)		-
15	Deschutes River (12079000) 1949-75, 77-79	SE,SW 22 16/1E	89.80	31.0	28.0	26.0	24.0	4
16	Offutt Lake Trb 1972, 79	NE,NW 5 16/1W	.68			(c)		-
17	Offutt Lake Outlet 1949, 72, 77-79	NE,NW 33 17/1W	1.85		0.0	0.0	0.0	-
18	Deschutes River 1977-79	NW,SE 19 17/1W	127.00	54.0	49.0	47.0	45.0	9
19	Spurgeon Cr. (12079500) 1949-51, 77-79	NW,NW 20 17/1W	10.80	6.7	6.2	5.9	5.7	25
20	Deschutes River 1970	NE,SE 13 17/2W	139.00	59.0	54.0	51.0	48.0	4
21	Deschutes R. Trb 1949, 79	SE,NW 6 17/1W	13.80	.7	.6	.5	.4	30
22	Deschutes R. (12080000) 1945-55, 57-64, 77-79	NW,SE 35 18/2W	160.00	95.0	87.0	83.0	80.0	12
23	Deschutes River 1932, 70-72 74-79	SW 26 18/2W	162.00	98.0	90.0	87.0	84.0	11

¹The locations are abbreviated. For example, the complete location for site 1 is Southeast $\frac{1}{4}$, Southwest $\frac{1}{4}$, Section 11, Township 15 North (all are north), Range 3 East.

^aHas been observed dry. Outflow is controlled by valve.

^bHas been observed dry.

^cLow flow estimated to be greater than zero but less than 0.05 ft³/s.

TABLE 3.--Monthly mean flows with a 50-percent probability of not being exceeded in any year

Site number on figures 4a-4c	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT
1										26.0	17.0	19.0
2										2.3	1.7	1.8
3										28.0	20.0	21.0
4										3.2	2.5	2.6
5										.5	.3	.4
6										28.0	20.0	21.0
7										1.0	.8	.8
8										4.3	3.1	3.3
9										34.0	25.0	27.0
10										.6	.4	.4
11										.3	.2	.2
13										43.0	31.0	33.0
15	110	340	520	630	520	420	300	170	97	57.0	42.0	44.0
18										87.0	69.0	72.0
19										9.6	8.0	8.3
20										99.0	76.0	81.0
21										2.0	1.2	1.3
22	180	440	740	890	790	680	470	290	200	150.0	120.0	120.0
23										150.0	120.0	120.0

REFERENCES CITED

- Hidaka, F. T., 1973, Low-flow characteristics of streams in the Puget Sound region, Washington: U.S. Geological Survey Open-File Report, 55 p.
- Puget Sound Task Force, 1970, Hydrology and natural environment, Appendix III of Comprehensive study of water and related land resources, Puget Sound and adjacent water, State of Washington: Vancouver, Wash., Pacific Northwest River Basins Commission, 205 p.
- U.S. Weather Bureau, 1956, Climatic summary of the United States --Supplement for 1931-52, Washington: Climatology of the United States, no. 11-39, 79 p.
- 1965a, Climatic summary of the United States--Supplement for 1951 through 1960, Washington: Climatology of the United States, no. 86-39, 91 p.
- 1965b, Mean annual precipitation, 1930-57, State of Washington: Portland, Oregon, U.S. Soil Conservation Service, map M-4430.

APPENDIX

TABLE 4.--Compilation of miscellaneous streamflow measurements through September 30, 1979, in the Deschutes River basin, Washington

Site no. on figures 4a-4c	Stream name	Location ¹	Drainage area (mi ²)	Date	Discharge area (ft ³ /s)
1	Deschutes River	SE,SW 11 15/3E	23.10	2-08-77 6-10-77 9-12-77 8-14-78 6-12-79	19.50 77.50 17.40 13.40 23.10
2	Little Deschutes River	SW,SE 11 15/3E	7.89	2-08-77 6-10-77 9-12-77 8-14-78 6-12-79	2.09 5.23 1.69 1.30 2.22
3	Deschutes River	SW,NE 10 15/3E	32.80	5-15-63 7-29-63 7-09-65 9-23-65 8-15-66 8-10-67 9-09-68 8-13-69 5-06-70 8-13-70 5-11-71	70.70 25.00 21.30 13.70 17.10 15.40 22.70 19.70 73.90 14.00 121.00
4	Thurston Creek	NW,SW 9 15/3E	4.63	2-07-77 6-10-77 9-12-77 8-14-78 6-12-79	2.15 6.68 2.64 2.38 3.48
5	Johnson Creek	SE,SE 8 15/3E	2.20	2-07-77 6-10-77 9-12-77 8-14-78 6-12-79	.59 1.13 .33 .26 .34

TABLE 4.--Compilation of miscellaneous streamflow measurements through September 30, 1979, in the Deschutes River basin, Washington--Con.

Site no. on figures 4a-4c	Stream name	Location ¹	Drainage area (mi ²)	Date	Discharge area (ft ³ /s)
6	Deschutes River	SE,SW 8 15/3E	44.10	7-08-49	23.40
				8-03-49	18.10
				8-17-49	15.70
				9-07-49	12.60
				10-03-49	12.40
				5-15-63	75.20
				7-09-65	17.80
				9-23-65	14.60
				8-15-66	16.10
				8-10-67	14.20
				9-09-68	22.60
				8-13-69	18.20
				5-06-70	94.30
				8-13-70	14.30
				5-11-71	120.00
				2-08-77	23.40
				6-10-77	98.50
				9-12-77	22.20
7	Deschutes River tributary	NE, NW 17 15/3E	2.03	8-14-78	16.10
				6-12-79	25.80
				5-15-63	2.70
				7-09-65	.71
				9-23-65	.56
				8-15-66	.79
				8-10-67	.57
				9-09-68	.96
				8-13-69	.84
8	Mitchell Creek	NE,NE 18 15/3E	8.54	5-06-70	2.32
				8-13-70	.52
				5-11-71	2.02
				5-15-63	14.60
				7-09-65	3.06
				9-23-65	2.40
				8-15-66	2.26
				8-10-67	1.97
				9-09-68	3.92
				8-13-69	3.20
				5-06-70	15.50
				8-13-70	2.31
				5-11-71	10.10
				2-07-77	4.17
				6-10-77	14.70
				9-12-77	2.73
				8-14-78	2.51
				6-12-79	4.56

TABLE 4.--Compilation of miscellaneous streamflow measurements through September 30, 1979, in the Deschutes River basin, Washington--Con.

Site no. on figures 4a-4c	Stream name	Location ¹	Drainage area (mi ²)	Date	Discharge area (ft ³ /s)
9	Deschutes River	NW,SW 7 15/3E	56.20	3-19-70	186.00
				4-08-70	108.00
				4-14-70	154.00
				4-23-70	91.30
				5-20-70	68.40
				5-27-70	54.60
				6-03-70	47.00
				6-22-70	30.70
				7-20-70	21.60
				12-23-70	145.00
				12-29-70	503.00
				1-14-75	1940.00
				2-04-75	132.00
10	Fall Creek	SW,NW 12 15/2E	2.83	2-07-77	.69
				6-10-77	2.90
				9-13-77	.33
				8-14-78	.29
				6-12-79	.33
11	Pipeline Creek	SW,NE 33 16/2E	3.50	2-07-77	.31
				6-13-77	1.15
				9-13-77	.14
				8-14-78	.13
				6-12-79	.18
12	Lawrence Lake outlet	NE,NW 29 16/2E	3.35	3-14-74	6.70
				4-22-74	4.00
				6-18-74	.56 e
				2-07-77	0.00
				6-10-77	0.00
				9-13-77	0.00
				8-14-78	0.00
				6-12-79	0.00
13	Deschutes River	SW,NE 30 16/2E	76.00	3-19-70	250.00
				4-08-70	149.00
				4-14-70	206.00
				4-23-70	124.00
				5-20-70	88.00
				5-27-70	68.00
				6-03-70	58.20
				6-22-70	40.30
				7-20-70	26.10

^e Estimated.

TABLE 4.--Compilation of miscellaneous streamflow measurements through September 30, 1979, in the Deschutes River basin, Washington--Con.

Site no. on figures 4a-4c	Stream name	Location ¹	Drainage area (mi ²)	Date	Discharge area (ft ³ /s)
14	Reichel Lake outlet	NW,SW 26 16/1E	6.82	8-16-49 9-07-49 2-07-77 6-10-77 9-13-77 8-14-78 6-12-79	0.22 .17 1.66 4.73 .91 .77 0.00
15	Deschutes River (Operated as continuous gaging station June 1949 to September 1975 as station number 120790000)	SE,SW 22 16/1E	89.80	10-20-75 2-07-77 6-10-77 9-13-77 1-13-78 3-16-78 5-24-78 7-20-78 8-14-78 10-10-78 12-07-78 2-13-79 4-05-79 6-13-79 8-08-79	211.00 45.80 134.00 39.70 447.00 181.00 113.00 47.30 36.70 50.40 175.00 903.00 160.00 53.20 28.10
16	Offutt Lake tributary	NE,NW 5 16/1W	.68	3-07-72 5-04-72 6-28-72 10-04-72 6-13-79	8.85 .28 .10 e .05 e .05 e
17	Offutt Lake outlet	NE,NW 33 17/1W	1.85	8-16-49 3-07-72 5-04-72 6-28-72 10-04-72 2-08-77 6-10-77 9-13-77 10-16-78 6-13-79	0.00 25.80 2.08 0.00 0.00 0.00 0.00 0.00 0.00 0.00

^e Estimated

TABLE 4.--Compilation of miscellaneous streamflow measurements through September 30, 1979, in the Deschutes River basin, Washington--Con.

Site no. on figures 4a-4c	Stream name	Location ¹	Drainage area (mi ²)	Date	Discharge area (ft ³ /s)
18	Deschutes River	NW,SE 19 17/1W	127.00	2-08-77 6-10-77 9-13-77 10-16-78 6-13-79	72.70 173.00 58.70 74.20 82.80
19	Spurgeon Creek (Operated as continuous gaging station June 1949 to November 1950 as station number 12079500)	NW,NW 20 17/1W	10.80	8-14-51 2-08-77 6-10-77 9-13-77 10-16-78 6-13-79	10.10 8.73 9.17 5.37 6.74 6.92
20	Deschutes River	NE,SE 13 17/2W	139.00	3-19-70 4-08-70 4-14-70 4-23-70 5-20-70 5-27-70 6-03-70 6-22-70 7-20-70	397.00 246.00 313.00 225.00 170.00 139.00 127.00 93.20 67.70
21	Deschutes River tributary	SE,NW 6 17/1W	13.80	7-06-49 8-02-49 8-15-49 9-06-49 9-30-49 6-13-79	1.49 1.27 .99 .76 .47 1.43
<u>a/</u>	Deschutes River	NE,NW 1 17/2W	159.00	11-15-71 2-17-72 10-15-76 12-10-76 2-16-77 7-27-77	423.00 1780.00 97.20 126.00 135.00 71.70
22	Deschutes River (Operated as continuous gaging station April 1945 to November 1954, and June 1957 to June 1964, as station number 12080000)	NW,SE 35 18/2W	160.00	2-09-55 12-13-55 2-25-57 2-08-77 9-13-77 10-16-78 6-13-79	3540.00 6080.00 4210.00 100.00 77.60 103.00 118.00

a/ At Henderson Boulevard bridge. Data not used
in analysis; site not plotted on figures 4a-4c.

TABLE 4.--Compilation of miscellaneous streamflow measurements through September 30, 1979, in the Deschutes River basin, Washington--Con.

Site no. on figures 4a-4c	Stream name	Location ¹		Drainage area (mi ²)	Date	Discharge area (ft ³ /s)
23	Deschutes River	SW	26 18/2W	162.00	9-15-38	87.00
					12-31-70	3680.00
					1-28-71	1730.00
					2-11-71	752.00
					1-03-72	42.60
					4-07-72	1210.00
					6-23-72	178.00
					8-09-72	125.00
					10-03-74	99.70
					12-19-74	725.00
					1-14-75	3560.00
					2-06-75	415.00
					4-17-75	282.00
					6-19-75	149.00
					8-13-75	96.20
					10-15-76	103.00
					12-10-76	131.00
					2-16-77	143.00
					4-18-77	194.00
					6-10-77	206.00
					7-27-77	77.80
					10-05-77	114.00
					1-16-78	681.00
					3-28-78	442.00
					6-07-78	163.00
					7-31-78	101.00
					9-26-78	209.00
					12-06-78	324.00
					2-27-79	1020.00
					4-06-79	266.00
					6-14-79	120.00
					8-08-79	82.50

¹ The locations are abbreviated. For example, the complete location for site 1 is Southeast $\frac{1}{4}$, Southwest $\frac{1}{4}$, Section 11, Township 15 North (all are north), Range 3 East.

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