LOW-FLOW CHARACTERISTICS

In the arid and semiarid parts of the study area, most of the summer precipitation evaporates or is transpired by plants, leaving little water to support streamflow. The ephemeral streams generally flow only several days in any one year and fail to flow during many years. The relations between hydrologic parameters and low flows generally are unknown for the low precipitation areas in eastern Washington and Oregon. Thus, insufficient data are available to describe the low-flow characteristics in large parts of the study area.

The daily streamflow in ephemeral streams varies considerably, due principally to the amount and type (rain or snow) of precipitation and the gradient of the drainage area. In the study area, streamflow data at the gaging stations are representative of (1) drainages having low gradient and low precipitation, or (2) drainages having both low and high precipitation and low and high gradients. The lowest streamflows generally occur in basins with a low gradient and precipitation generally falling as rain. Providence Coulee is an example of the streamflow from such an area (fig. 11b, sheet 3). The drainages of Douglas and Willow Creeks include both low and high gradients and drier low elevations of the plateau. Low flows originate in the mountains and diminish as the water flows through the flatter low elevations. The low flows reflect the streamflow originating in the mountains and do not represent the drier low elevations where the flow is zero or nearly zero. However, in irrigated areas, formerly dry ephemeral streams are now flowing all or much of the year because of irrigation return flows.

The flow-duration curves for representative streams in the study area are shown in figures 19a through 30a. A flow-duration curve is a cumulative frequency curve that shows the percentage of time that specified discharges are equaled or exceeded. For example, the discharge for Meadow Creek near Central Ferry (fig. 26a) was greater than 1 ft^3/s about 80 percent of the time for the period of record, but was greater than 5 ft^3/s only about 10 percent of the time. The duration curve shows the temporal distribution of discharges but not the chronological sequence. Data shown by these curves reflect both cyclic seasonal and irregular annual variations in streamflow; thus, deficiencies may occur when water demand exceeds supply during low-flow periods in late summer and early fall.

The curves shown in figures 19b through 30b present the annual low-flow non-exceedance probabilities for each of the representative sites. The low-flow frequency curves present N-day low-flow values. The N-day low-flow values are the lowest mean discharge for N consecutive days during the climatic year beginning April 1. The non-exceedance probability is the probability that, in any given climatic year, the minimum mean flow for N-consecutive days will be less than or equal to the specified value. For example, the annual 7-day low flow for Meadow Creek near Central Ferry (fig. 26b) is less than 0.36 ft^3/s with a 50-percent probability (probability of 0.5) and is less than 0.08 ft^3/s with a 10-percent probability. The reliability of an available streamflow supply can be partly evaluated with the aid of these curves.

During a low streamflow period, August 1985, 253 low-flow measurements in Washington and 120 in Oregon were made to aid in describing the low-flow conditions of 35 streams. These low-flow conditions also were used to help estimate the location and quantity of water that the regional aquifer system discharges to or receives from the selected streams. Low-flow measurement sites were chosen on the basis of geology, access, location of tributary inflow, and distance between sites. Many of the streams were dry or nearly dry. Gaining and losing reaches of the flowing streams were determined by examining the change in streamflow in the channels, because they could not be defined using a generalized geologic map of the study area (Gonthier and others, 1988). Streams tended to gain streamflow at the base of steep slopes and to lose streamflow approaching flatter incised canyons. Once in a canyon, streams tended to lose or gain streamflow from the unconsolidated materials in and around the streambeds. A number of gaining and losing streamflow reaches were determined for Washington (this sheet). In Oregon, the streamflows were measured in Meacham, Birch, Butte, Little Butte, Willow, Rhea, and Rock Creeks and the upper Umatilla River. These measurements indicated the low flows along these streams. However, because of the many diversions of streamflow for irrigation, the gaining and losing reaches could not be clearly defined. The losing and gaining reaches for Oregon streams were not estimated or shown on this sheet.

IRRIGATION

Most irrigation occurs during the low-flow periods (April to September) when surface water is diverted from the major streams and applied as irrigation water. The extent of the application areas is shown in figure 31. In 1982, surface water was used to irrigate 981,374 acres in 15 Washington counties (table 4) and 228,370 acres in 7 Oregon counties (table 5) that make up the study area (U.S. Department of Commerce, 1982a,b). Small areas of irrigation in these counties lie outside of the study area. The application rate for irrigation ranges from 1 to 7 feet annually, and averages about 4 feet.

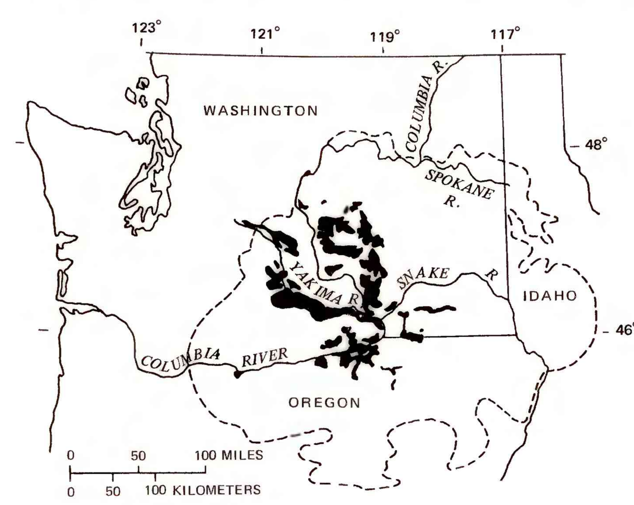

FIGURE 31.--Areas of major surface-water irrigation (dark areas) in the study area.

TABLE 4.--Area of surface-water application in Washington during 1982

County	Area, in acres	County	Area, in acres
Asotin	1,365	Klickitat	15,823
Benton	124,288	Lincoln	5,511
Columbia	2,915	Walla Walla	62,338
Douglas	155,939	Whitman	4,733
Grant	293,913	Yakima	239,045
Kittitas	75,504		

TABLE 5.--Area of surface-water application in Oregon during 1982

County	Area, in acres	County	Area, in acres
Gilliam	6,555	Union	37,192
Morrow	63,138	Wallowa	42,666
Sherman	214	Wasco	21,005
Umatilla	57,600		

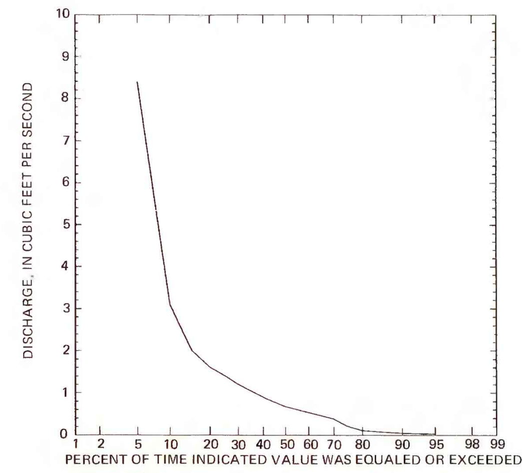
FIGURE 21a.--Flow duration curve for Douglas Creek.

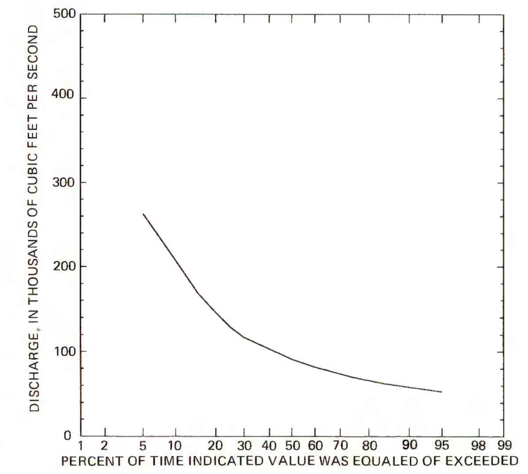
FIGURE 22a.--Flow duration curve for Columbia River.

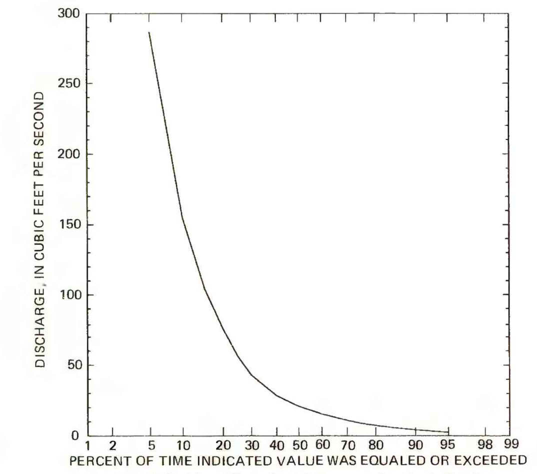
FIGURE 23a.--Flow duration curve for Crab Creek.

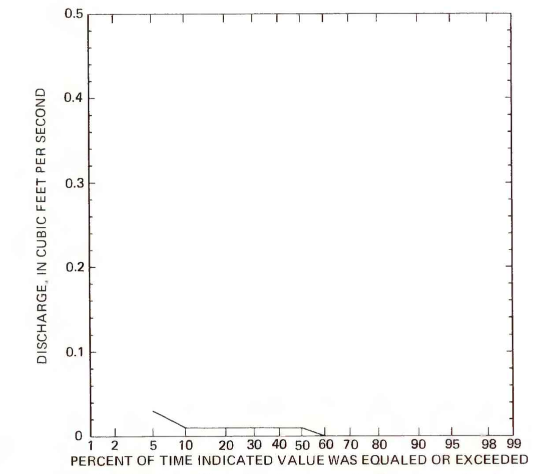
FIGURE 24a.--Flow duration curve for Providence Coulee.

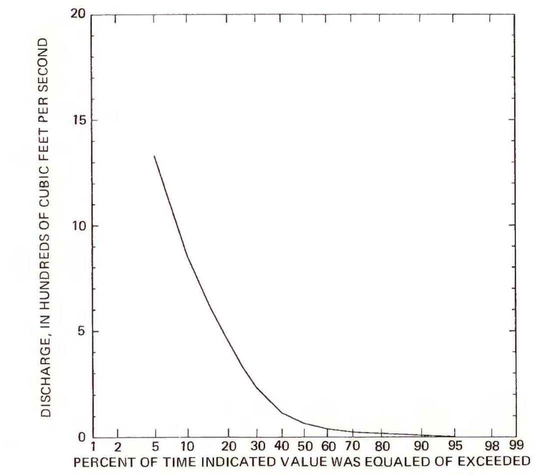
FIGURE 25a.--Flow duration curve for Palouse River.

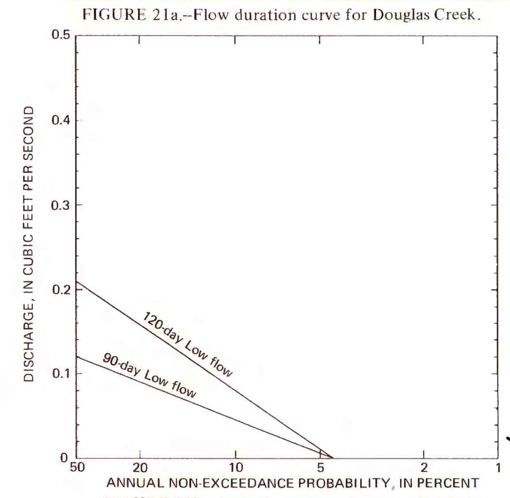
FIGURE 21b.--Annual non-exceedance probabilities for Douglas Creek.

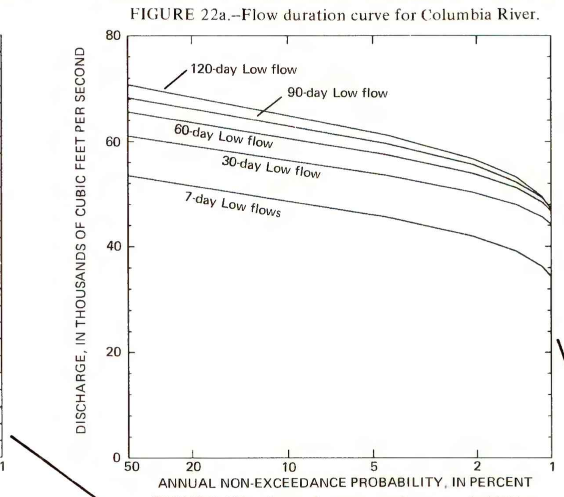
FIGURE 22b.--Annual non-exceedance probabilities for Columbia River.

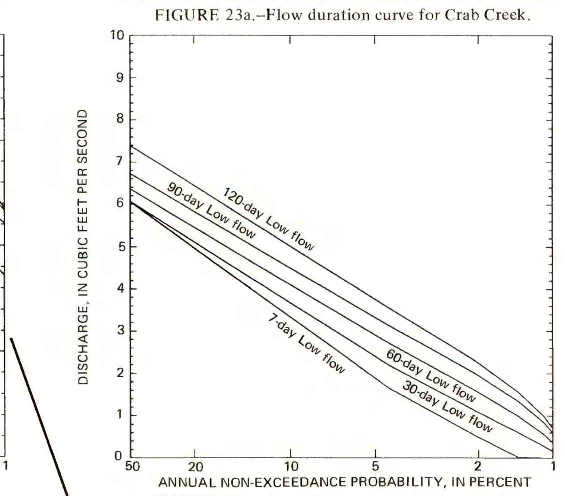
FIGURE 23b.--Annual non-exceedance probabilities for Crab Creek.

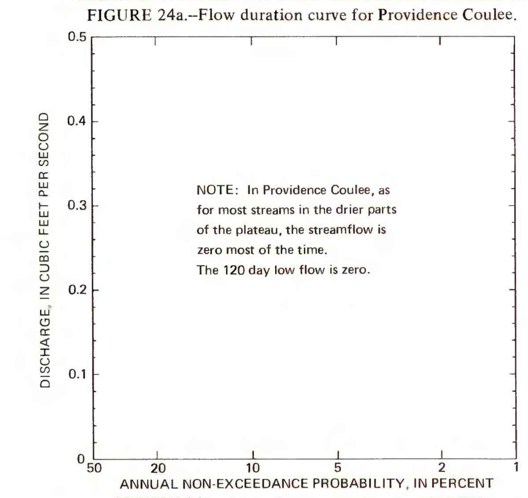

FIGURE 24b.--Annual non-exceedance probabilities for Providence Coulee.

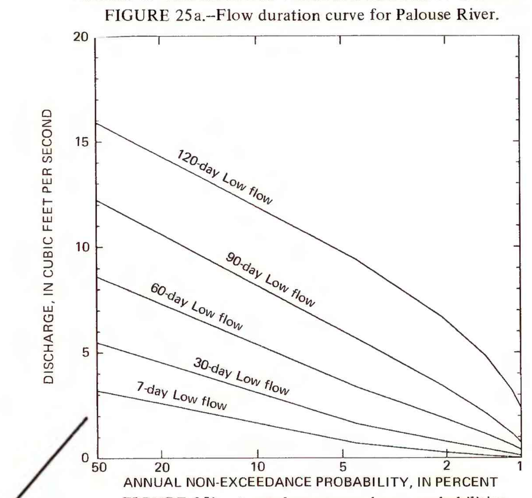
FIGURE 25b.--Annual non-exceedance probabilities for Palouse River.

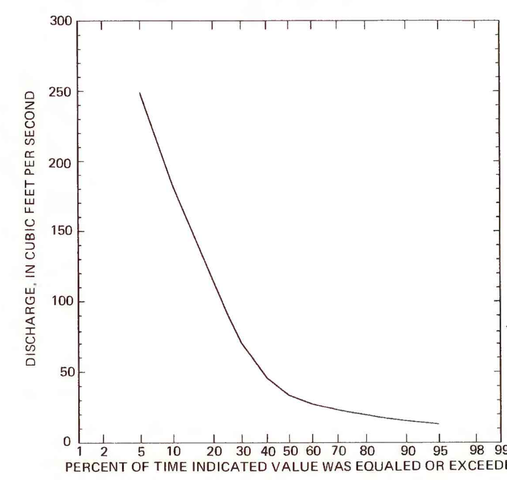
FIGURE 20a.--Flow duration curve for NF Ahtanum Creek.

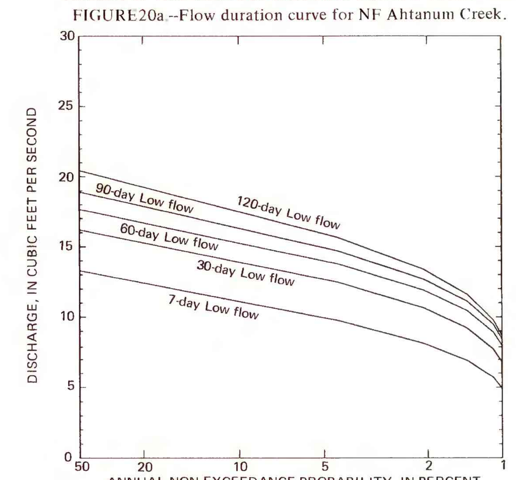
FIGURE 20b.--Annual non-exceedance probabilities for NF Ahtanum Creek.

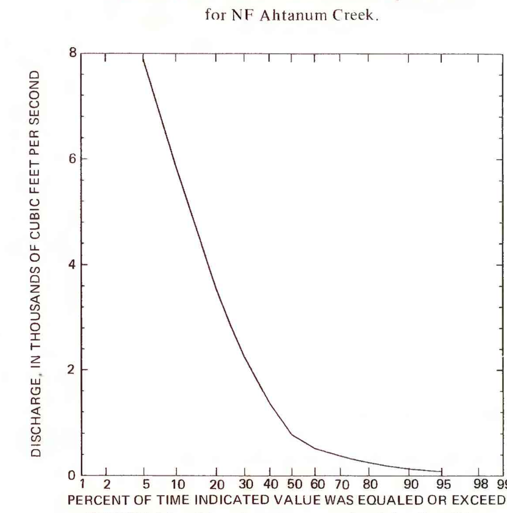
FIGURE 19a.--Flow duration curve for John Day River.

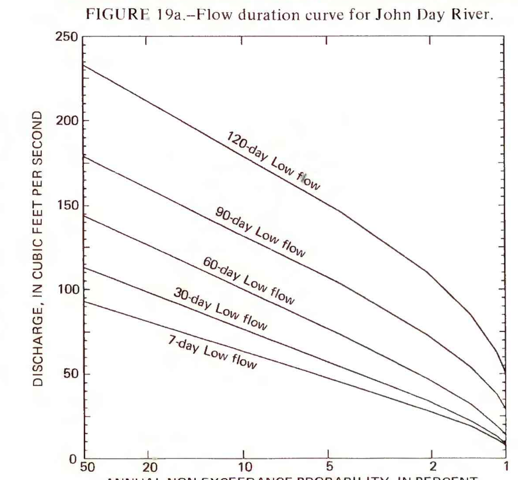
FIGURE 19b.--Annual non-exceedance probabilities for John Day River.

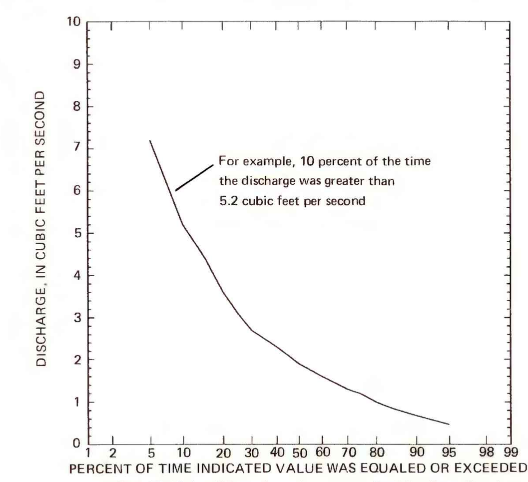

FIGURE 26a.--Flow duration curve for Meadow Creek.

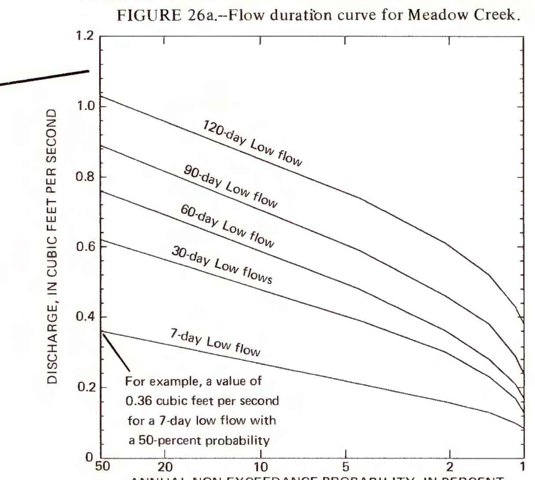

FIGURE 26b.--Annual non-exceedance probabilities for Meadow Creek.

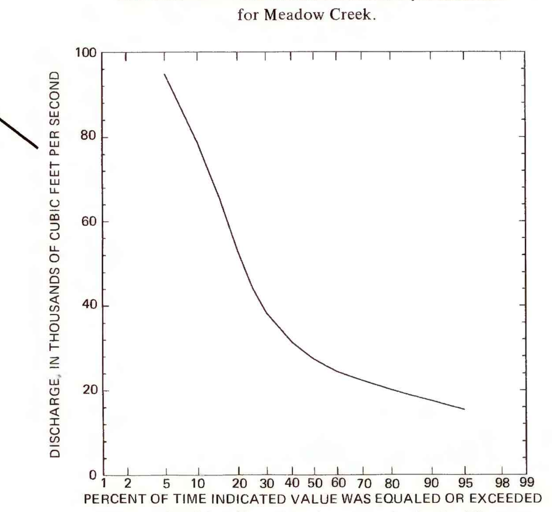
FIGURE 27a.--Flow duration curve for Snake River.

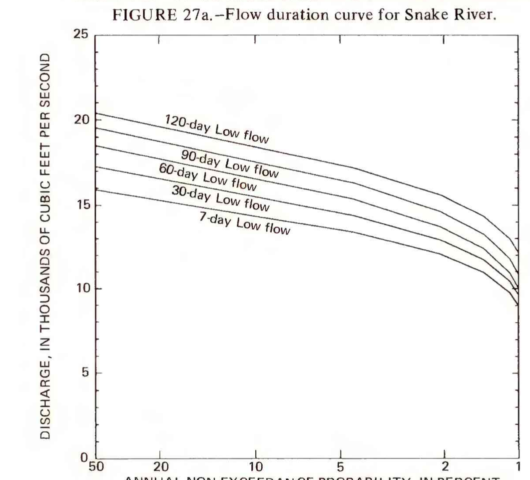
FIGURE 27b.--Annual non-exceedance probabilities for Snake River.

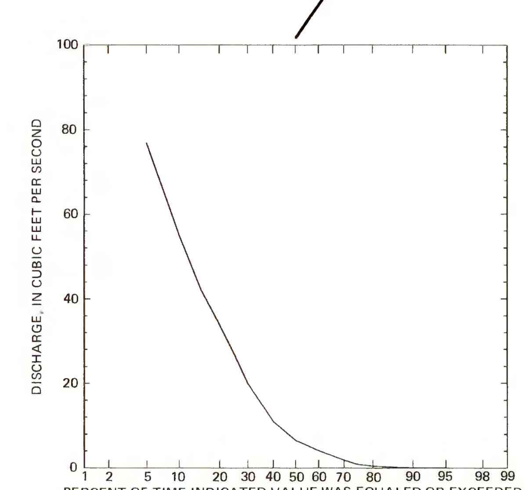
FIGURE 30a.--Flow duration curve for Willow Creek.

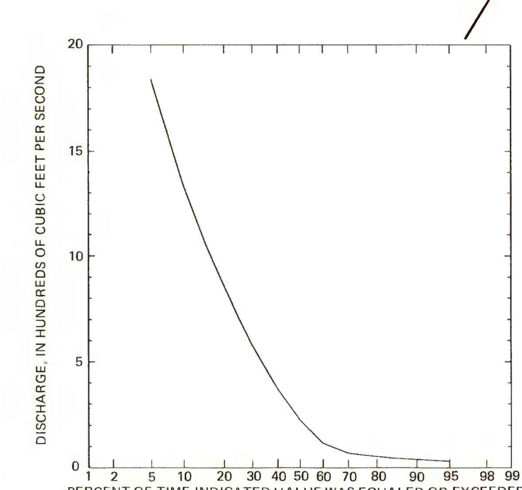
FIGURE 29a.--Flow duration curve for Umatilla River.

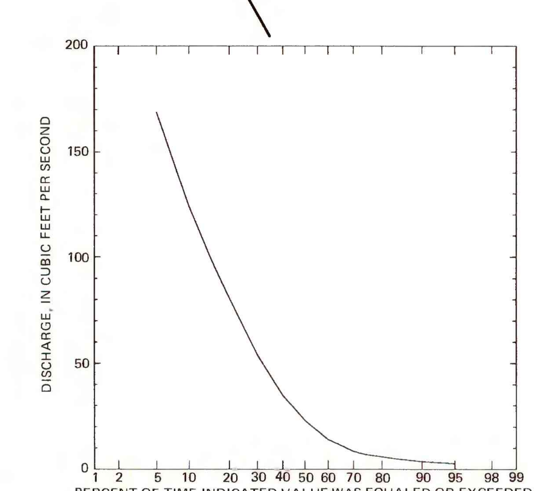
FIGURE 28a.--Flow duration curve for NF Walla Walla River.

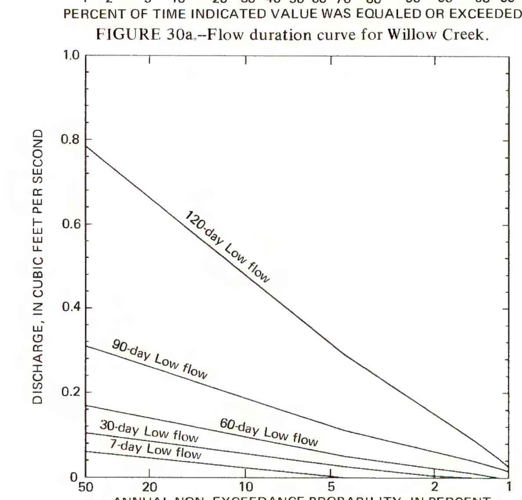
FIGURE 30b.--Annual non-exceedance probabilities for Willow Creek.

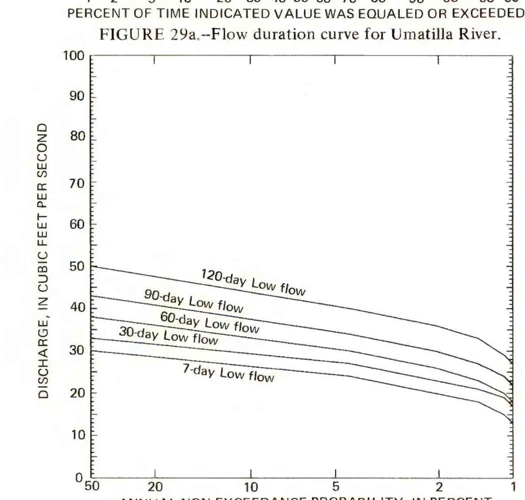
FIGURE 29b.--Annual non-exceedance probabilities for Umatilla River.

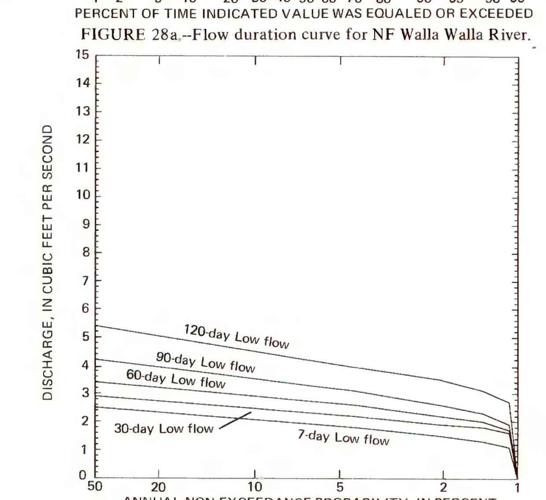
FIGURE 28b.--Annual non-exceedance probabilities for NF Walla Walla River.

EXPLANATION

246 ▲ SURFACE-WATER GAGING STATION -- Reference number, tabulated on sheet 2

▼ 13353200 Snake River at Burbank, WA — NATIONAL STREAMFLOW QUALITY ACCOUNTING STATION -- (NASQAN)

—— Estimated gaining streamflow reaches

– – – Estimated losing streamflow reaches

LOW STREAMFLOW MANAGEMENT

On the Columbia Plateau, streamflow is usually low during the summer and insufficient for its demand. The States of Washington and Oregon have approached the management of these low flows by establishing minimum perennial streamflow to protect the beneficial use of the water.

In Washington, the Department of Ecology has jurisdiction over streamflow, with recommendations from the Washington Department of Fisheries and Department of Game. Minimum flows have been established to protect the quality of the natural environment and to provide for preservation of wildlife and fish.

The minimum flows for the main stem of the Columbia River have been adopted through administrative regulation. These flows range from 10,000 ft^3/s instantaneous to 30,000 ft^3/s average weekly at Chief Joseph Dam. Values for the main stem Columbia River are given in Chapters 173-563 of the Washington Administrative Code. The existing policy for the management of the Snake River provides for a minimum flow of 12,000 ft^3/s at Clarkston, Wash. In the Walla Walla River basin, all surface streams are totally appropriated during irrigation season. Water is not available for protection of minimum flows; thus, many streams are closed to further consumptive appropriations. Chapters 173-532 of the Washington Administrative Code contains regulations for the Walla Walla River basin. As in the Walla Walla River basin, the other streams in the Washington part of the study area are usually dry in the summer because all the available streamflow is diverted for irrigation.

In Oregon, the Water Resources Department has jurisdiction over the streamflow. A minimum perennial streamflow is established by administrative rule to support fish and other aquatic life and minimize pollution. Once adopted, minimum flows are treated as water rights. The minimum perennial streamflows, ranging from 3 to 300 ft^3/s in the study area, are given in the Water Use Program (Oregon Department of Environmental Quality, 1985b).

SURFACE-WATER QUALITY MANAGEMENT

The States of Washington and Oregon have established criteria to protect the natural quality of the streamflow. The water-quality standards for surface waters of the State of Washington are set forth in Washington Administrative Code, chapters 173-201-035 through 173-201-005 (Olympia, Wash.). These criteria are designed to protect the natural quality of the surface water. The water-quality standards for surface waters of the State of Oregon are set forth in the Oregon Administrative Rules, chapter 340, Division 41, Department of Environmental Quality (1985a). These standards were written to protect water for uses beneficial to the public.

The U.S. Geological Survey has designed a water-quality accounting network (National Stream-Quality Accounting Network, NASQAN) to meet many of the information demands of agencies or groups involved in national or regional water-quality planning and management. The primary objective of the network is to depict area variability of water quality and to detect and assess long-term changes in streamflow quality. Seven NASQAN data sites are located in the study area and are shown on this sheet.

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LOW FLOW AND WATER USE

SURFACE-WATER RESOURCES OF THE COLUMBIA PLATEAU IN PARTS OF WASHINGTON, OREGON, AND IDAHO

By
L. M. Nelson

1991