PATTERNS OF RUNOFF

Runoff is the part of precipitation that appears in surface streams that are not regulated. Quantitatively runoff can be expressed for a given basin for a given time period by the equation:

Runoff = Precipitation - (losses ± change in storage) where losses include the sum of all natural losses and change in storage is the total change in storage within the basin during the period.

The runoff map shows the areal distribution of average annual runoff, in inches, in the Willamette River and Sandy River basins, which collectively are referred to as the Willamette Basin in this report. Runoff is expressed by lines that connect points of equal value. Runoff at any point on a stream is the integrated total from all the drainage area above that point. Therefore, the value of the line that crosses a stream does not represent the runoff of the stream at that point. The runoff from a basin is the average, weighted by area, of runoffs from the incremental areas of that basin.

Runoff for a desired point is determined by locating the drainage area on the map and integrating the lines of equal runoff within the area, visually for small areas or with a transparent grid for large areas.

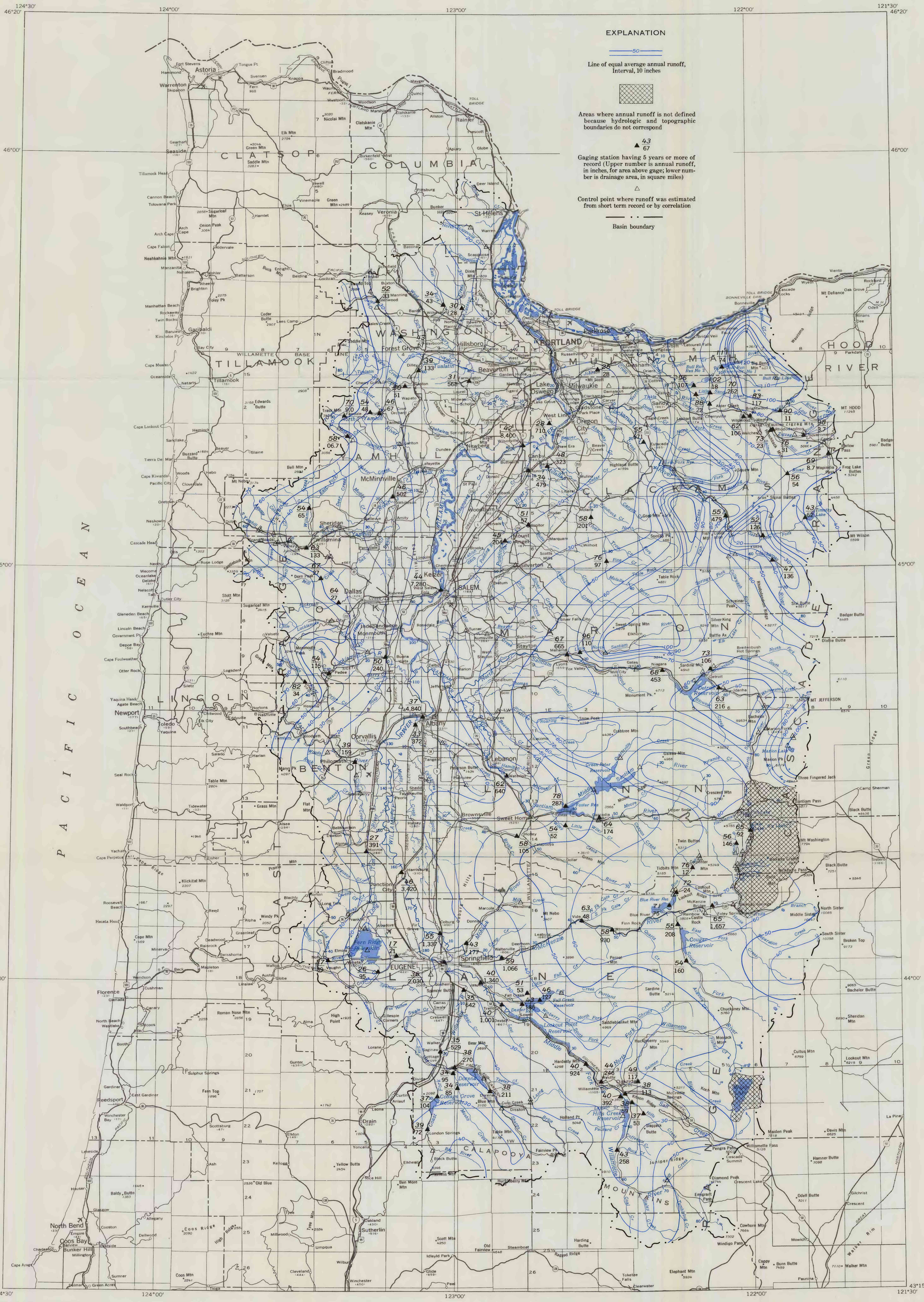
The pattern of average annual runoff follows closely the pattern of average annual precipitation and generally increases with altitude. Runoff ranges from about 20 to 90 inches in the Coast Range; from less than 10 to about 20 inches on the floor of the Willamette Valley; and from 20 to 120 inches, with local variations, in the western slope of the Cascade Range.

At places, recorded values of runoff between adjacent areas are inconsistent because geologic conditions permit an interchange between surface water and ground water. In the young lava formations of the High Cascades the hydrologic-drainage boundaries may be considerably different from the topographic-basin boundaries. Values of runoff based on topographic-drainage area alone are not applicable in those areas which are crosshatched on the runoff map. For example, Anderson Creek near Belknap Springs has an average runoff of 51 inches from 7.13 square miles of drainage area. Adjacent to Anderson Creek is Olallie Creek, which has an average runoff of 261 inches from 8.14 square miles. These figures of runoff were determined by correlating several miscellaneous discharge measurements at each site with records from a nearby stream-gaging station. A different situation prevails where a reach of stream is losing water to the ground-water body. Examples are Coyote Creek and Long Tom River in the vicinity of Fern Ridge Reservoir. For that area, runoff determined from the runoff map is higher than runoff actually measured in the stream channel.

Runoff varies considerably from season to season and from year to year. The term "average annual" means the average of many years of runoff. The data used in the preparation of the map were adjusted to the 35-year base period 1928-63. A brief study of several long-term streamflow records shows that, during 1928-63, the periods of excessive streamflow nearly balanced the periods of deficient streamflow.

Annual runoff for five selected streams that are typical of Willamette Basin streams is shown by the annual runoff hydrographs. As shown by these hydrographs, the pattern of annual variation is similar in the Coast Range, the Cascade Range, and the valley floor. Generally, runoff was less than average from 1929 to 1945 and has been more than average since 1946. However, years of deficient streamflow are interspersed with years of excessive streamflow without any discernible pattern. For individual years, annual runoff ranges from about ½ the average to about 1½ times the average.

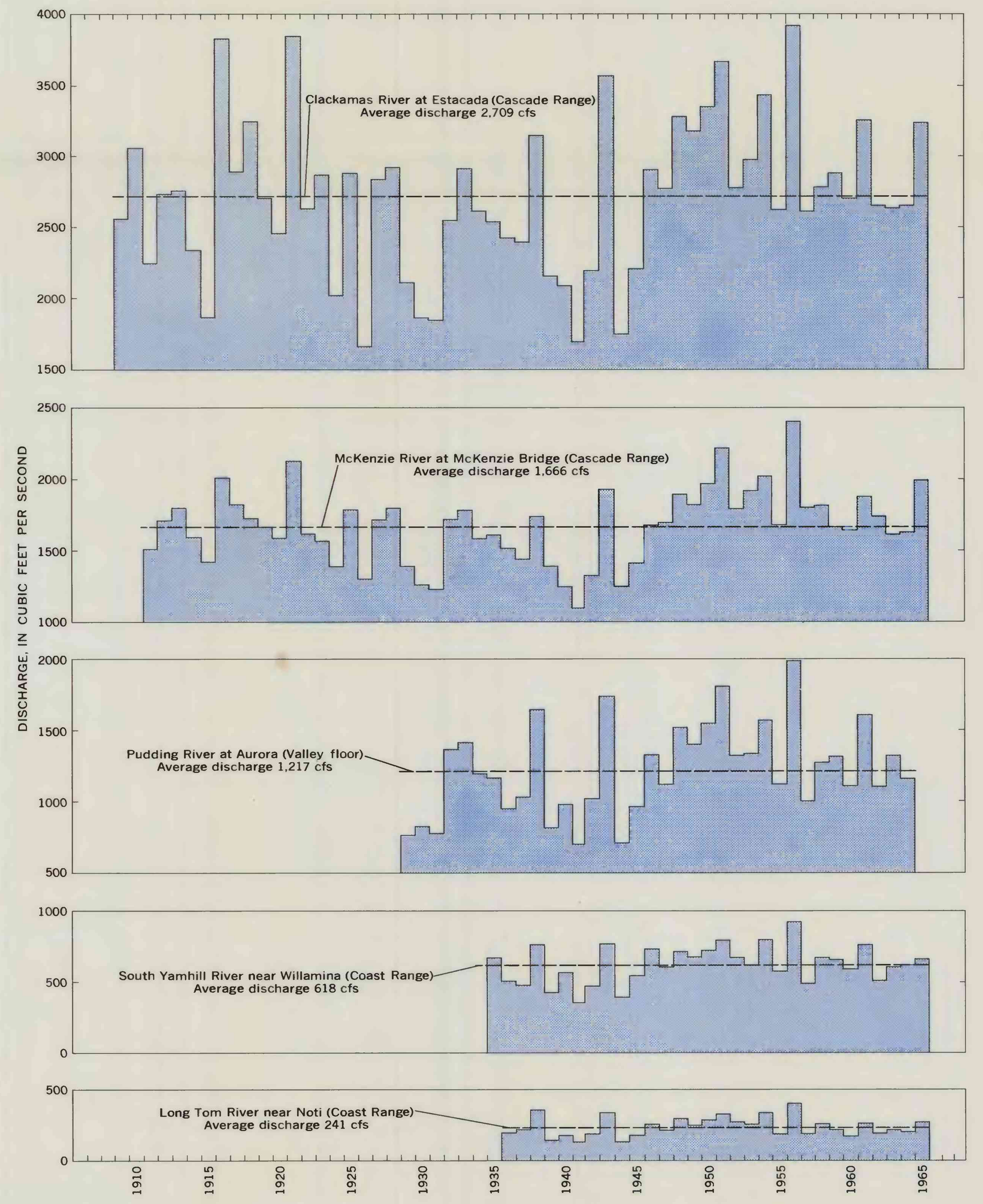
Seasonal variation of streamflow, which is related to precipitation and temperature, is shown by the daily streamflow hydrograph. The seasonal pattern of runoff in both wet and dry years is quite similar to the pattern for average years, although the total runoff is very different. Light rains during summer and the first rains of early fall are largely absorbed by the soil and produce little runoff. Runoff begins to increase after the ground has become thoroughly wetted. During the winter, precipitation can occur as either rain or snow, depending on the temperature. High flows occur throughout the basin during late fall and winter as a result of heavy rains and some early snowmelt. Warm temperatures combined with heavy rains falling on snow can result in extremely high rates of runoff such as occurred during the flood of December 1964. Runoff is also high during the spring when streams draining the Cascades carry large amounts of snowmelt. Throughout the basin, streams recede to minimum flows during late summer and early fall when precipitation is very light and the temperature is relatively high.



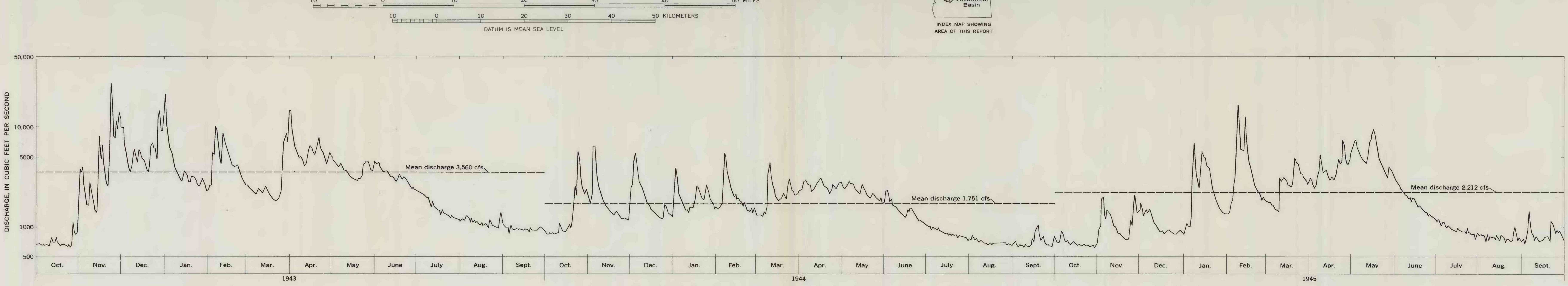
RUNOFF MAP

SCALE 1:500 000

INDEX MAP SHOWING AREA OF THIS REPORT



ANNUAL RUNOFF OF SELECTED STREAMS



DAILY STREAMFLOW OF CLACKAMAS RIVER AT ESTACADA, 1943-45 WATER YEARS

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PATTERNS OF RUNOFF IN THE WILLAMETTE BASIN, OREGON

By
Eugene A. Oster

1968

For sale by U.S. Geological Survey, price 50 cents