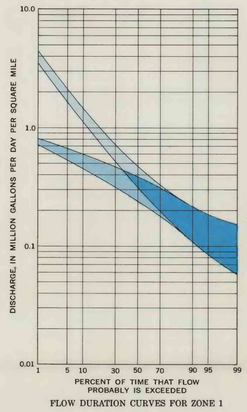
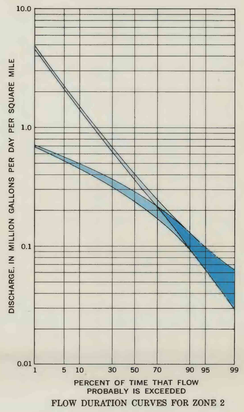
STREAMFLOW

By
James W. Crooks and Stanley M. Longwill



FLOW DURATION CURVES FOR ZONE 1



FLOW DURATION CURVES FOR ZONE 2

EXPLANATION

Total runoff from precipitation and ground water inflow

Ground water contribution to streamflow

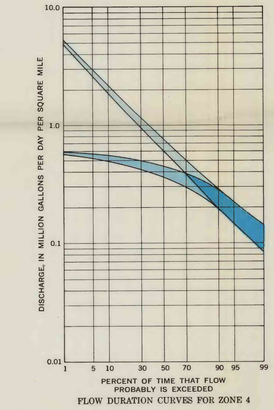
Overlap areas; represents either total runoff or ground water contribution

1 Hydrologic zone and boundary

Basin boundary

FLOW DURATION CURVES FOR ZONE 3

Streams in zone 3 will have a flow equal to or less than about 0.08 and 1.08 mgd per square mile 90 percent of the time and all this amount probably is contributed by ground water



FLOW DURATION CURVES FOR ZONE 4

Streams in zone 4 will have a flow equal to or greater than about 1.8 to 2.2 mgd per square mile 10 percent of the time. A stream with a drainage area of 10 square miles will have a runoff of about 18 to 22 mgd 10 percent of the time. Ground water contribution to total runoff is about 0.49 to 0.56 mgd per square mile 10 percent of the time

DISCHARGE OF WATER

An average of nearly 2 billion gallons of rain and snow per day falls on the Patuxent River basin. Approximately two-thirds of this is lost from the basin by evapotranspiration and other consumptive uses; the remainder, nearly 700 mgd (million gallons per day), is discharged from the basin as streamflow. During periods of extremely low flow, one percent or less of the time, the total amount of water discharged from the basin may be as low as 36 mgd. During periods of extremely high flows—those equaled or exceeded only one percent of the time—the basin yield may exceed 4,500 mgd.

High flows occurring 1 percent or less of the time may be found in streams in any or all parts of the basin at any time of the year but appear most frequently in March. They consist of direct runoff of precipitation. Low flows are most frequent in October and consist almost entirely of seepage to the streams from ground-water sources. Low flows that are equaled, or exceeded 90 percent or more of the time probably are derived entirely from ground water sources.

Stream characteristics—such as flood runoff, sustained low flow, and the relation between water entering the ground from the stream or discharging to the stream from the ground—differ as a result of local conditions. These conditions include geology, topography, vegetative cover, and human activities. Flow durations of streams in and adjacent to the basin vary regionally and warrant a division of the basin into 4 hydrologic zones as shown on the map.

The four duration curves shown indicate the probable flows that can be expected for various percents of time. The upper envelope curves show the total flow in streams of the represented zone. The flow duration curves of most streams within the zone will fall within the upper envelope shown. The lower envelope curves represent the flow duration of that portion of water contributed to the streams by the ground.

The frequency at which a specific discharge may occur may be estimated for most streams within the basin by the use of these curves. A few small streams, because of the influence of some local factor, may not fit the pattern shown.

Zone	Area (sq mi)	Runoff	Low flow (99% duration)		Average flow (about 50% duration for contribution by ground water and about 30% duration for total runoff)		High flow (1% duration)	
			Mgd/mi²	Mgd	Mgd/mi²	Mgd	Mgd/mi²	Mgd
1	241	Ground water	0.058–0.150	14–36	0.26–0.40	63–96	0.71–0.81	170–195
		Total runoff	0.058–0.150	14–36	0.52–0.72	125–173	3.45–4.45	830–1070
2	177	Ground water	0.030–0.060	5–11	0.26–0.30	46–53	0.68–0.71	120–125
		Total runoff	0.030–0.060	5–11	0.64–0.70	114–124	4.50–4.90	800–870
3	335	Ground water	0.006–0.066	2–22	0.22–0.32	74–107	0.51–0.55	170–185
		Total runoff	0.006–0.066	2–22	0.67–0.84	224–281	4.55–4.90	1530–1650
4	177	Ground water	0.084–0.140	15–25	0.35–0.43	62–76	0.56–0.59	100–105
		Total runoff	0.084–0.140	15–25	0.89–1.07	157–190	4.85–5.40	860–960
Total	930	Ground water		36–94		245–332		560–610
		Total runoff		36–94		620–768		4020–4550

WATER BUDGET

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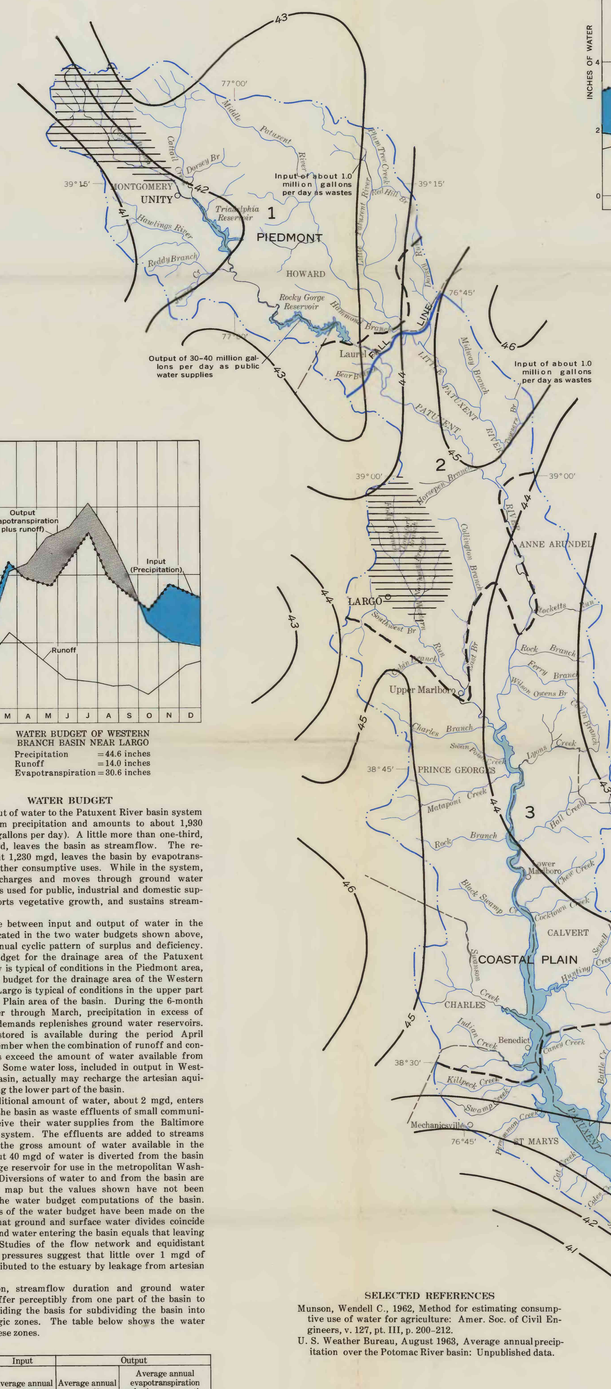
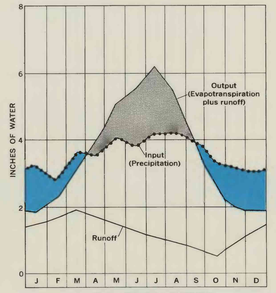


WATER BUDGET OF WESTERN BRANCH BASIN NEAR LARGO
Precipitation = 44.6 inches
Runoff = 14.0 inches
Evapotranspiration = 30.6 inches



WATER BUDGET OF PATUXENT RIVER BASIN AT UNITY
Precipitation = 42.8 inches
Runoff = 15.0 inches
Evapotranspiration = 27.8 inches

EXPLANATION

Ground water storage

Deficiency

EXPLANATION

Pattern shows area of data sources for graphs

1 Hydrologic zone and boundary

45 Line of equal precipitation shows average annual precipitation interval, 1 inch

Basin boundary

WATER BUDGET

Natural input of water to the Patuxent River basin system is derived from precipitation and amounts to about 1,930 mgd (million gallons per day). A little more than one-third, about 700 mgd, leaves the basin as streamflow. The remainder, about 1,230 mgd, leaves the basin by evapotranspiration and other consumptive uses. While in the system, the water recharges and moves through ground water reservoirs; it is used for public, industrial and domestic supplies, it supports vegetative growth, and sustains streamflow.

The balance between input and output of water in the basin, as indicated in the two water budgets shown above, follows an annual cyclic pattern of surplus and deficiency. The water budget for the drainage area of the Patuxent River at Unity is typical of conditions in the Piedmont area, and the water budget for the drainage area of the Western Branch near Largo is typical of conditions in the upper part of the Coastal Plain area of the basin. During the 6-month period October through March, precipitation in excess of consumptive demands replenishes ground water reservoirs. Water thus stored is available during the period April through September when the combination of runoff and consumptive uses exceed the amount of water available from precipitation. Some water loss, included in output in Western Branch basin, actually may recharge the artesian aquifers underlying the lower part of the basin.

A small additional amount of water, about 2 mgd, enters from outside the basin as waste effluents of small communities that receive their water supplies from the Baltimore water supply system. The effluents are added to streams and increase the gross amount of water available in the system. About 40 mgd of water is diverted from the basin at Rocky Gorge reservoir for use in the metropolitan Washington area. Diversions of water to and from the basin are noted on the map but the values shown have not been included in the water budget computations of the basin.

Calculations of the water budget have been made on the assumption that ground and surface water divides coincide and that ground water entering the basin equals that leaving the basin. Studies of the flow network and equidistant aquifer head pressures suggest that little over 1 mgd of water is contributed to the estuary by leakage from artesian aquifers.

Precipitation, streamflow duration and ground water movement differ perceptibly from one part of the basin to another, providing the basis for subdividing the basin into four hydrologic zones. The table below shows the water budgets of these zones.

Zone	Area (sq mi)	Input: Average annual precipitation		Output: Average annual runoff		Output: Average annual evapotranspiration and other consumptive uses	
		In/yr	Mgd	In/yr	Mgd	In/yr	Mgd
1	241	42.4	487	13.0	150	29.4	337
2	177	44.4	374	14.2	119	30.2	255
3	335	44.1	703	15.9	253	28.2	450
4	177	43.4	366	20.5	173	22.9	193
Total	930	43.6	1930	15.6	695	28.0	1235

SELECTED REFERENCES

Munson, Wendell C., 1962, Method for estimating consumptive use of water for agriculture: Amer. Soc. of Civil Engineers, v. 127, pt. III, p. 200–212.
U. S. Weather Bureau, August 1963, Average annual precipitation over the Potomac River basin: Unpublished data.

SCALE 1:250 000

5 0 5 10 15 MILES

5 0 5 10 15 KILOMETERS

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WATER RESOURCES OF THE PATUXENT RIVER BASIN, MARYLAND

By
James W. Crooks, Deric O'Bryan, and others

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