Example 8.7

The basic premise of discharge at the outlet being a linear response to precipitation excess (runoff volume) is illustrated by comparing three hydrographs representative of a particular 2,975-acre (1,208-ha) watershed for a specific rainfall duration. Simple triangular-shaped hydrographs are used for this hypothetical illustration. Hydrographs A, B, and C in the table and Fig. 8.9 have a time base of 5.0 hrs. There is no base flow for this watershed, since flows are zero at the beginning and end.

DISCHARGES FOR HYDROGRAPHS

Time (hrs)	Hydrograph A (ft^3/s)	Hydrograph B (ft^3/s)	Hydrograph C (ft^3/s)
0	0	0	0
1	600	900	1,200
2	1,200	1,800	2,400
3	800	1,200	1,600
4	400	600	800
5	0	0	0

The runoff volume V_R is represented by the area under the hydrograph. For these hydrographs with a simple triangular shape, the runoff volume may be computed as the area of a triangle.

$$\text{Area} = 0.5\,(\text{base})\,(\text{height})$$

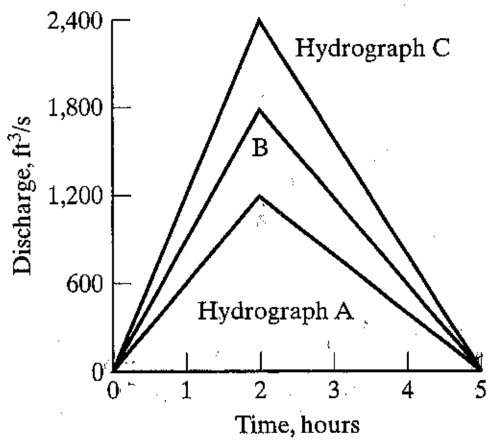

Figure 8.9 The discharges for these hydrographs from Example 8.7 vary in direct proportion to the runoff volume.

Hydrograph A: $V_R = 0.5(1{,}200\ ft^3/s)(5\ hrs)(3{,}600\ s/hr) = 10{,}800{,}000\ ft^3$

Hydrograph B: $V_R = 0.5(1{,}800\ ft^3/s)(5\ hrs)(3{,}600\ s/hr) = 16{,}200{,}000\ ft^3$

Hydrograph C: $V_R = 0.5(2{,}400\ ft^3/s)(5\ hrs)(3{,}600\ s/hr) = 21{,}600{,}000\ ft^3$

Alternatively, the hydrographs can be numerically integrated as

$$V_R = \text{area} = \Sigma Q_t \Delta t = \Delta t \Sigma Q_t$$

where Q_t are the hydrograph ordinates and Δt is the 1.0-hr time interval. For hydrograph A,

$$V_R = (600 + 1{,}200 + 800 + 400\ ft^3/s)(3{,}600\ s) = 10{,}800{,}000\ ft^3$$

The volumes are converted to an equivalent depth covering the 2,975-acre watershed. For hydrograph A,

$$V_R = \left[\frac{10{,}800{,}000\ ft^3}{(2{,}975\ ac)(43{,}560\ ft^2/ac)}\right](12\ in./ft) = 1.00\ in.$$

Likewise, the V_R for hydrographs B and C are computed to be 1.5 and 2.0 inches, respectively. Notice that the ordinates Q_t of the hydrographs vary in direct proportion to runoff volume. For example, hydrographs A and C have runoff volumes of 1.0 and 2.0, respectively. Thus, for any time t, the Q_t for hydrograph C is twice the value for hydrograph A.

SOURCE: Wurbs & James, 2002