

Purpose : The purpose of the UHG is to characterize quantitatively the relationship between rainfall and runoff for a particular basin. The UHG is used to synthesize streamflow hydrographs resulting from multi-intensity storms of variable duration. The synthesized hydrograph is a prediction of the streamflow anticipated in the basin and is useful for water resources planning, or flood control.

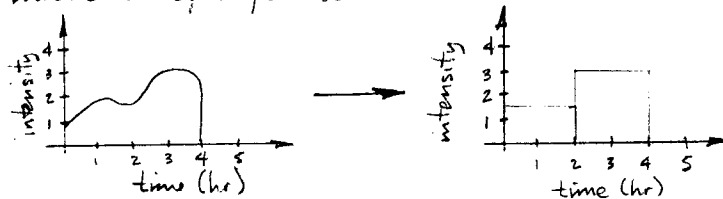
Derivation : The UHG is derived from a streamflow hydrograph having a direct runoff (DR) component equivalent to approximately one unit of effective rainfall over the basin area.

Parameters : The UHG is defined only by the storm duration from which it was derived.

Basin Linearity : An assumption of time invariance of basin response characteristics with respect to runoff.

Synthesizing Hydrographs from the UHG :

- (1) decompose the multiple intensity storm into average effective intensities of a particular duration. For example;



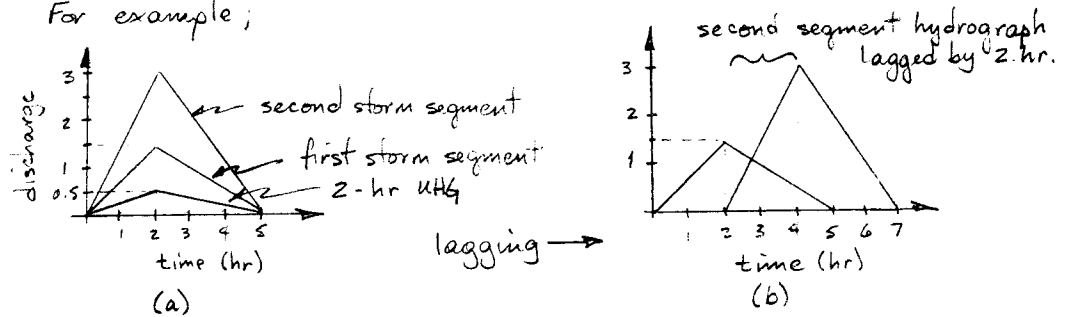
- (2) obtain the UHG corresponding to the storm duration of the segments of the decomposed rainfall record.

In the example above we need the 2-hr UHG.

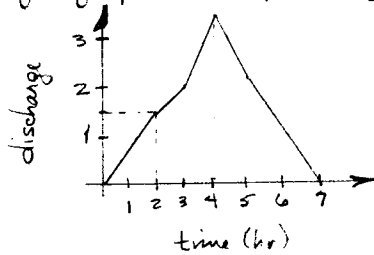
- (3) multiply the ordinates (y-axis) values of the UHG by the ratio of the storm segment intensity to the UHG intensity.

For this example, the ratios would be $\frac{1.5}{0.5} = 3$ and $\frac{3}{0.5} = 6$, respectively.

- (4) Lag the hydrographs obtained in (3) by the number of hours corresponding to the beginning of the next storm segment.
For example;



- (5) to obtain synthesized hydrograph for the multiple intensity storm of (1), sum the discharges for each time of the lagged hydrographs corresponding to each storm segment (b) above.



Synthesizing a UHG of different storm duration: Use superposition.

- (1) the t -hr storm duration UHG is lagged by t hr and the two hydrographs are summed (steps 4 & 5 above).
- (2) the resulting hydrograph is for 2 units of runoff for a storm lasting $2t$ hours.
- (3) the $2t$ -hr UHG is obtained by dividing the hydrograph ordinates of (2) above by two. Note that the rainfall intensity is now half of the original intensity but for twice the duration.
- (4) this procedure can be extended by repeated superposition of UHG's.

Table 4-6

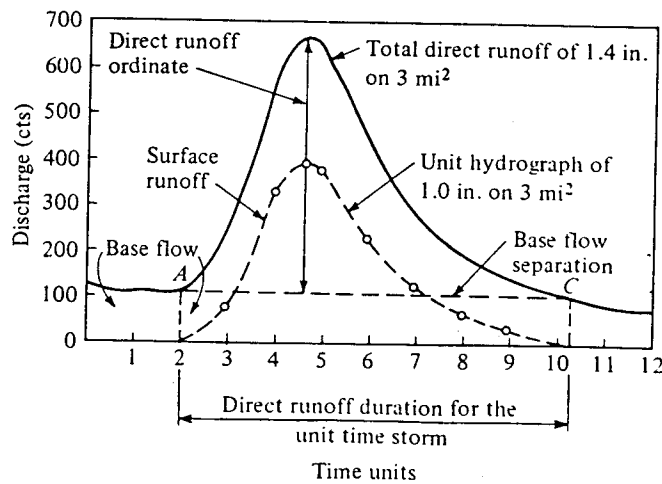
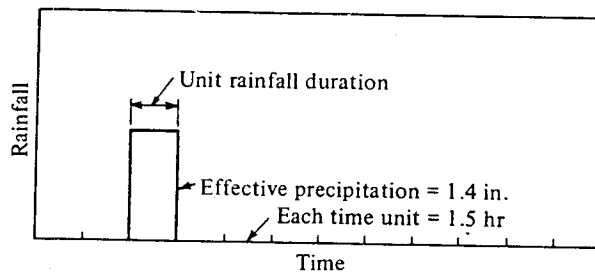
Interval	DR (cfs)	Δt (hrs)	Direct Runoff (ft ³) $DR \times \Delta t \times 3600$
2-3	60	1.5	324,000
3-4	290	1.5	1,566,000
4-5	550	1.5	2,970,000
5-6	435	1.5	2,349,000
6-7	255	1.5	1,377,000
7-8	120	1.5	648,000
8-9	70	1.5	378,000
9-10	20	1.5	108,000

$$\sum (DR \times \Delta t) = 9,720,000 \text{ ft}^3$$

$$\text{Total direct runoff} = \frac{9,720,000}{3 \times (5280)^2} = 1.4 \text{ in.}$$

Table 4-4 Determination of a Unit Hydrograph from an Isolated Storm

1	2	3	4	5
Time Unit	Total Runoff (cfs)	Base Flow (cfs)	Total Direct Runoff, (2) - (3) (cfs)	Unit Hydrograph Ordinate, (4) \div 1.4 (cfs)
1	110	110	0	0
2	122	122	0	0
3	230	120	110	78.7
4	578	118	460	328
4.7	666	116	550	393
5	645	115	530	379
6	434	114	320	229
7	293	113	180	129
8	202	112	90	64.2
9	160	110	50	35.7
10	117	105	12	8.6
10.5	105	105	0	0
11	90	90	0	0
12	80	80	0	0



(b)

Fig. 4-16. (a) Dimensionless unit hydrograph; (b) illustration of derivation of a unit hydrograph from an isolated storm.

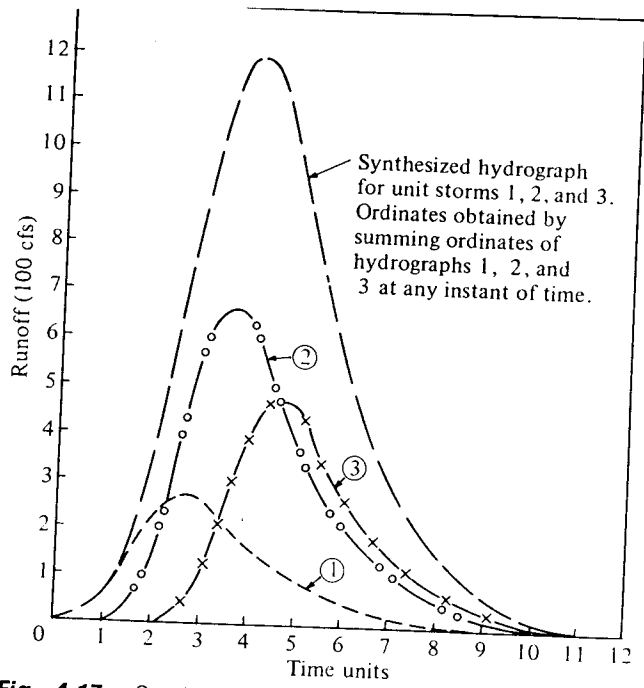


Fig. 4-17. Synthesized hydrograph derived by the unit hydrograph method.

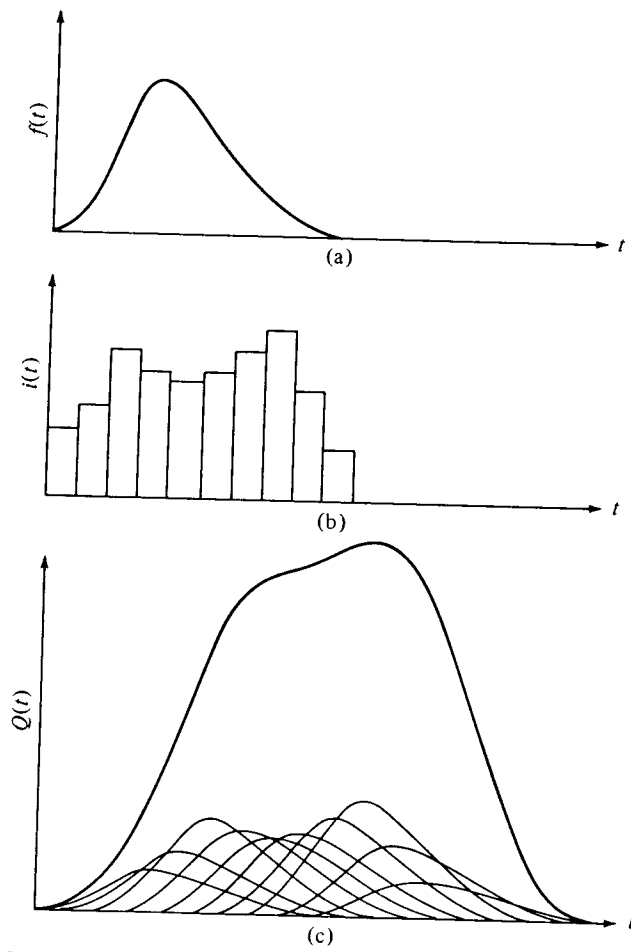


Fig. 4-18. Unit hydrograph description of the runoff process. (a) Unit hydrograph; (b) a sequence of 1-min storms; (c) superposition of runoff hydrographs for each of the 1-min storms. (After John C. Schaake, Jr., "Synthesis of the Inlet Hydrograph," Tech. Rept. No. 3, Department of Sanitary Engineering and Water Resources, Baltimore, Md., 1965.)