UNIT HYDROGRAPH:

The unit hydrograph is defined as the hydrograph of storm runoff resulting from an isolated rainfall of some unit duration occurring uniformly over the entire area of the catchment, produces a unit volume (i.e., 1 cm) of runoff. Derivation of the unit hydrographs. The following steps are adopted to derive a unit hydrograph from an observed flood hydrograph.

(i) Select from the records isolated (single-peaked) intense storms, which occurring uniformly over the catchment have produced flood hydrographs with appreciable runoff (>1 cm, say, 8 to 16 cm). The unit period selected should be such that the excess rainfall (i.e., Pnet) occurs fairly uniformly over the entire drainage basin. Larger unit periods are required for larger basins. The unit periods may be in the range of 15-30% of the 'peak time' period, i.e., the time from the beginning of surface runoff to the peak, and the typical unit periods may be 3, 6, 8, 12 hours. (The time of concentration may be a little longer than the peak time). The unit storm is a storm of such duration that the period of surface runoff is not much less for any other storm of shorter duration.

(ii) Select a flood hydrograph, which has resulted from a unit storm chosen in item (i) above.
(iii) Separate the base flow from the total runoff (by the well-known base flow separation procedures).
(iv) From the ordinates of the total runoff hydrograph (at regular time intervals) deduct the corresponding ordinates of base flow, to obtain the ordinates of direct runoff.
(v) Divide the volume of direct runoff by the area of the drainage basin to obtain the net precipitation depth over the basin.
(vi) Divide each of the ordinates of direct runoff by the net precipitation depth to obtain the ordinates of the unit hydrograph.

(vii) Plot the ordinates of the unit hydrograph against time since the beginning of direct runoff. This will give the unit hydrograph for the basin, for the duration of the unit storm (producing the flood hydrograph

Unit hydrograph assumptions

- Effective rainfall should be uniformly distributed over the basin, that is, if there are 'N' rain gauges spread uniformly over the basin, then all the gauges should record almost same amount of rainfall during the specified time**.**
- Effective rainfall is constant over the catchment during the unit time
- The direct runoff hydrograph for a given effective rainfall for a catchment is always the same irrespective of when it occurs. Hence, any previous rainfall event is not considered.
- The ordinates of the unit hydrograph are directly proportional to the effective rainfall hyetograph ordinate

Unit hydrograph limitations

- Under the natural conditions of rainfall over drainage basins, the assumptions of the unit hydrograph cannot be satisfied perfectly.
- However, when the hydrologic data used in the unit hydrograph analysis are carefully selected so that they meet the assumptions closely, the results obtained by the unit hydrograph theory have been found acceptable for all practical purposes
- In theory, the principle of unit hydrograph is applicable to a basin of any size. However, in practice, to meet the basic assumption in the derivation of the unit hydrograph as closely as possible, it is essential to use storms which are uniformly distributed over the basin and producing rainfall excess at uniform rate
- The size of the catchment is, therefore, limited although detention, valley storage, and infiltration all tend to minimize the effect of rainfall variability. The limit is generally considered to be about 5000 sq. km. beyond which the reliability of the unit hydrograph method diminishes.
- When the basin area exceeds this limit, it has to be divided into sub-basins and the unit hydrograph is developed for each sub-basin. The flood discharge at the basin outlet is then estimated by combining the subbasin floods, using flood routing procedures.

Application of the unit hydrograph

- The development of flood hydrographs for extreme rainfall magnitudes (for use in the design of hydraulic structures)
- Extension of flood flow records based on rainfall records
- Development of flood forecasting and warning systems based on rainfall
- Calculations of direct runoff hydrograph in catchment due to a given rainfall event

(with recorded rainfall values), is easy if a unit hydrograph is readily available.