

## 6.10 RUNOFF CYCLE

W.G. Hoyt (1942, 1949) suggested a simplified 5-phase runoff cycle which is completed through 5 phases wherein the cycle begins from dry phase and no runoff, passes through 3 phases of wet period and runoff generation and ends at the termination of rainfall and the cycle returning back to the first stage.

### 1. First phase of no rain and no runoff

The first phase of runoff cycle is characterized by the following salient features :

- There is relatively long dry spell without any type of rainfall and hence soil is dry,
- The water table of groundwater is low which continues to fall down due to absence of recharge through infiltration,
- The elevation of water table varies in different climatic and physiographic regions,
- There is continuous loss of water through evaporation and transpiration where temperature is above freezing point, etc.

### 2. Second phase of initial rainfall period

The following are characteristic features of the second phase of runoff cycle :

- There begins precipitation over almost dry soil surface with some vegetation. Some portion of falling rains is intercepted by vegetation cover, some portion is evaporated, some portion is detained in retention depressions, some portion directly falls in water bodies like streams, and remaining portion enters the soils as infiltration,
- The rainwater gradually increases the soil moisture through infiltration in the **aeration zone** or **vadose zone**,
- In the beginning of second phase no surface runoff is generated because infiltration capacity of the soils far exceeds the rainfall intensity,
- A slight surface runoff may be generated if there is impervious surface,
- There is meager loss of moisture through evaporation and transpiration,
- There may not be any groundwater flow or base flow due to lack of percolation but if rainfall continues and all soil zones are saturated with moisture, there may be some sort of base flow, etc.

### **3. Third phase of continuous rain with variable intensity**

- The third phase of runoff cycle begins with the period of continued rains but of variable intensity,
- With the continued rains the interception capacity of vegetation and surface detention depression is met with (after which no rains can be intercepted by vegetation and no water can be retained in surface retention depressions) and hence surface runoff is generated or overland flow occurs because total rainfall now exceeds infiltration rate,
- The overland flow reaches the stream channels only when overland flow exceeds the retention and detention of water on the surfaces of flow path, otherwise overland flow disappears before reaching the stream channels,
- The aeration or vadose zone is now saturated and thus percolation begins which results in base flow,
- The groundwater table rises, groundwater flow or base flow contributes water to the streams, and water level in the streams rises. All these result in the formation of bank storage of water which also raises the elevation of water table, etc.

### **4. Fourth Phase of saturation of all natural storages**

- Rainfall still continues, with the result all the natural storages (e.g. interception storage, ground surface retention and detention or surface storage, soil moisture storage, groundwater storage, and channel storage) are satisfied (i.e. full to the capacity),
- The infiltration rate becomes equal to the rate of transmission of water through percolation and base flow,
- There is constant rise in water table till the rainfall continues until infiltration rate or maximum rate of recharge, and groundwater runoff are balanced. This condition or situation may be rarely achieved in nature. It may be possible only in the region of almost level flat topography where rainfall is heavy and rainstorm continues for longer duration, etc.

### **5. Fifth or final phase of termination of rainfall**

- The rainfall ultimately stops and the cycle returns back to the 1st phase of longer duration of dry spell,
- The channel and surface storages begin to deplete but it takes longer time duration for their complete depletion,
- Evaporation and transpiration as well as percolation still continue,

- Water in the vadose zone reaches phreatic zone and water table through percolation,
- Stream flow is maintained through the supply of water by subsurface flow, groundwater flow, bank seepage and water released from stored channel storage,
- There is rise and fall in the water table and ultimately one cycle of runoff is completed. It may again begin with the onset of next rainstorm.

It may be opined that the functioning of runoff cycle is not as much simple as discussed above, rather it is a complicated phenomenon in nature because it is affected by a set of factors which are discussed in the next subsection.