

# Hydraulics Section IV: Groundwater and Onsite

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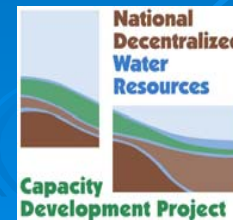
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# Section Objectives:

- Know the factors that directly impact soil water movement
- Know Darcy's Law and its components

# Groundwater Overview

Wastewater can be:

- Released to flow over ground to the nearest surface drainage feature or
- Retained in a lined Evapo-Transpiration (ET) until it dissipates as gas into the atmosphere or
- Discharged to a subsurface feature designed to allow the infiltration of the effluent.

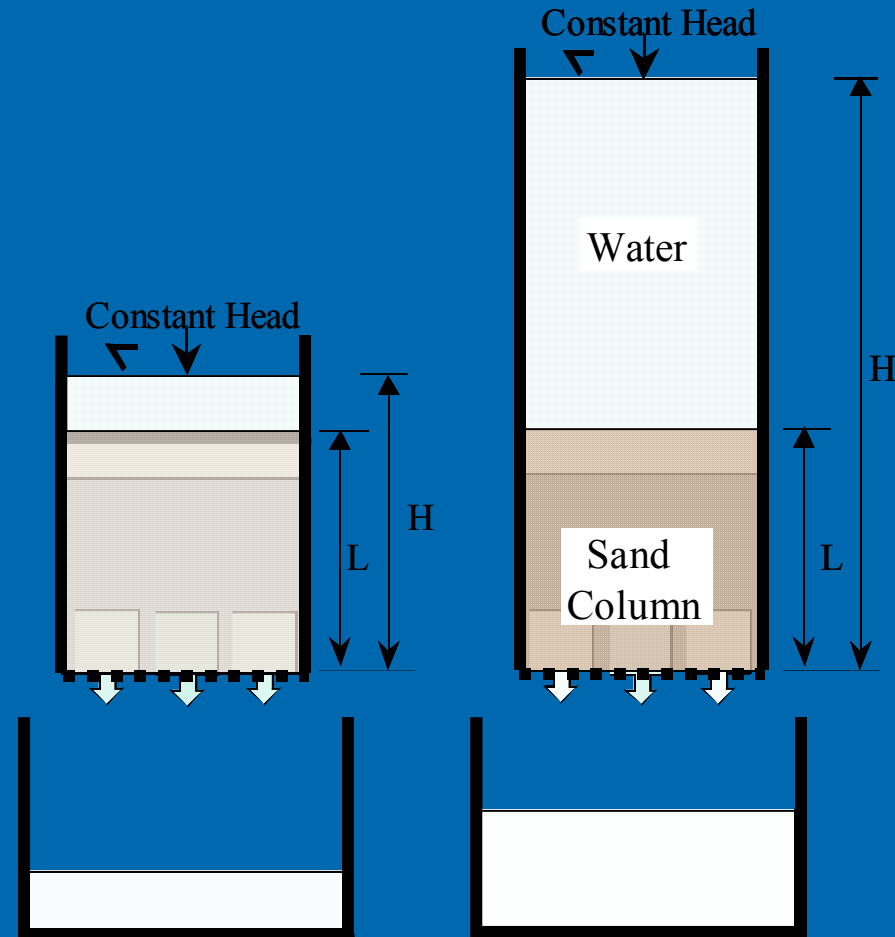
By far the most common method of dispersal of treated effluent back into the environment is through infiltration into the local soils.

# Principles of Soil Water Flow

- Water is the main carrier for the transport of pollutants through soils.
- For practical applications, we look at water flow in soils and aquifers at macroscopic levels.

# Darcy's Law

- Henry Darcy observed that increasing the head of water over a sand column of a given length increases the rate of water flow through the column.
- $Q/(At) = v = K_{\text{sat}} \times \Delta H/L$



# Water Flow Through Soils

- The direction of the flow depends on the direction of the gradient, and the rate of water movement depends on the magnitude of the hydraulic gradient and hydraulic conductivity of the medium.
- Knowing the saturated hydraulic conductivity of the column and applying Darcy's law, one can determine the quantity of water that can pass through the column during a specified time period.

# Water Flow Through Soils

## Various Conditions

- **Saturated Flow:** The flow of water through soil when all available pore space is occupied by water.
- **Unsaturated Flow:** movement of water in a soil or media that is not filled to capacity with water; the flow is along the surface of the particles rather than through the larger pore spaces.

# Water Flow Through Soils Various Conditions

- **Steady-state and Transient flow:** The rate of water movement through a volume of a soil under a steady-state condition is constant
- **Infiltration and Soil Water profile:** In an infiltration gallery, water enters the soil in a relatively small area.

# Water Flow Through Soils

## Various Conditions

- **Infiltration rate** : The rate of water entry into the soil from a surface is referred to as infiltration rate.
- **Cumulative infiltration**: The total amount of water entering the soil since the start of infiltration into the soil.
- **Effect of initial soil water content on infiltration rate**: The rate of water entry into the soil depends on the amount of water in the soil; the wetter the soil, the lower is the rate of water infiltration into the soil.

# Water Flow Through Soils

## Various Conditions

- **Runoff occurrence:** Runoff occurs when the rate of rainfall exceeds the infiltration rate of a soil.
- **Using the infiltration curve for a given initial soil water content, the amount of runoff can be estimated based on the rate and duration of the rainfall event.**
- **The infiltration rate and the amount of runoff generated at the site for a given rainfall event illustrates this effect.**

# Application of Groundwater Movement to Onsite Systems

- Darcy's equation may be used in most Onsite designs with some further computations using Calculus.
- $K_{\text{sat}}$  values (used in Darcy's equation) differ depending on soil types ranging from 0.001 m/day for Clay to 1000 m/day for gravel.