10. WELL HYDRAULICS

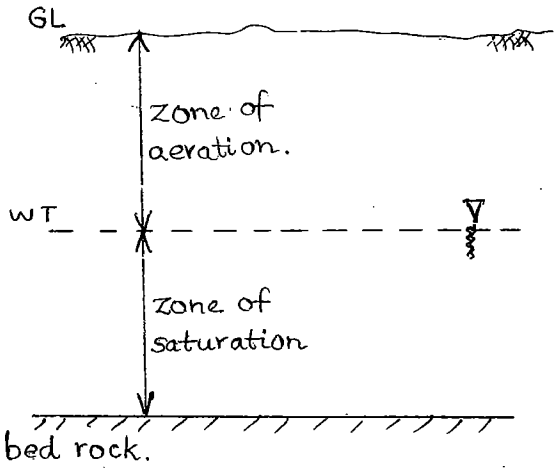
- Thirty percent of world's fresh water is available in the form of groundwater, compelled to use in the absence of surface water source.

- Before extraction and usage of groundwater it is necessary to know the graundwater potential.

- Water present in soil mantle is known as Groundwater. Based on the availability of water in the ground, ground is classified into:

(i) Zone of aeration.

(ii) Zone of saturation.



- Saturation formations of Earth further classified into:-

(i) Aquifer - formations which are porous and permeable. They only yield reliable amounts of water.

Eg: Sandy soils.

(ii) Aquitard - formations which are porous & semi permeable.

Eg: Sandy - clayey soils.

(iii) Aquiclude - porous and impermeable formations.

Eg: Clayey soils.

(iv) Aquifuge - formations which are neither porous nor permeable.

Eg: Granite, rock etc.

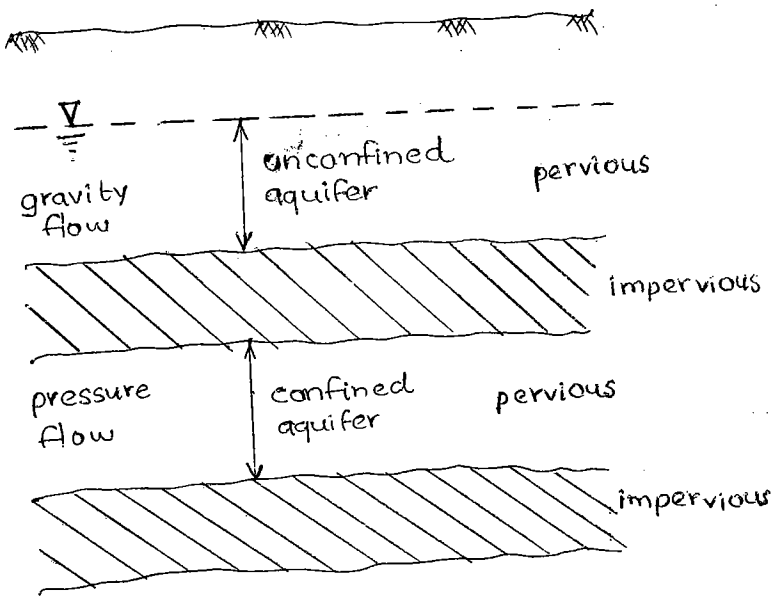
- Aquifers are further classified into:

1. Unconfined Aquifer
2. Confined Aquifer.

Unconfined aquifer is also called as 'Water Table Aquifer'.

Confined aquifer is also called as 'Artesian Aquifer'.

Flow in unconfined aquifer is under gravity whereas that in confined aquifer is under pressure.



→ Aquifer Properties:

1. Porosity, 'n'
2. Specific Yield, 'Sy'
3. Specific retention, 'Sr'

* Porosity (n):

Storage capacity of soil depends on porosity.

$$n = \frac{V_v}{V}$$

$n > 20\%$ → adequate water

$5 < n < 20\%$ → moderate amounts of water

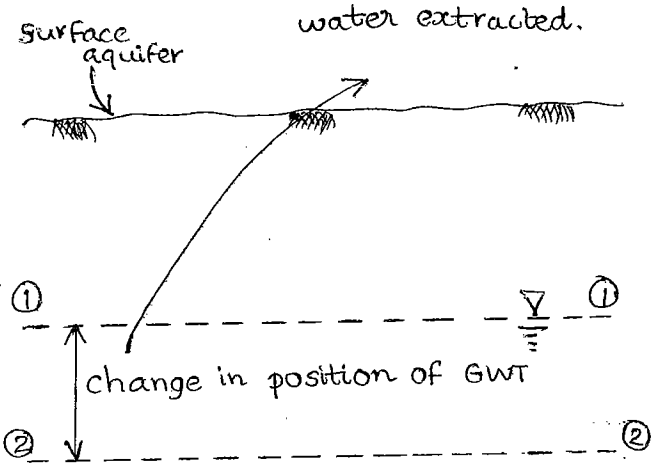
$n < 5\%$ → very less amount of water.

* Specific Yield (Sy):

Volume of water extracted by force of gravity from unit volume of aquifer is known as Specific Yield.

$$S_y = \frac{\text{volume of water extracted}}{\text{volume of aquifer}}$$

ΔGWT = thickness of aquifer from which water extracted.



Volume of aquifer = Surface area of aquifer * ΔGWT

Change in groundwater storage = volume of water extracted = S_y * volume of aquifer

* Specific Retention (S_r):

Fraction of water retained by the soil against force of gravity is known as Specific Retention.

- Relation among Porosity, Specific Yield & Specific Retention

$$n = S_y + S_r$$

-54.

01. $n = 0.4$, $S_r = 0.15$

$\Rightarrow S_y = 0.4 - 0.15$

$= 0.25$

Volume of aquifer $= 150 \times 10^4 \times (23-20)$.

$= 112.5 \times 10^4$ m^3 $= 112.5$ ha.m

Change in ground water storage of aquifer = S_y * volume of aquifer

$= 0.25 \times 150 \times 3 = 112.5$ ha.m

02. Volume of water extracted $= 3 \times 10^6$ m^3

Volume of aquifer $= (102-99) \times 5 \times 10^6$.

Specific yield $= \frac{\text{volume of water extracted}}{\text{volume of aquifer}}$

$= \frac{3\times10^6}{3\times10^6\times5} = \frac{1}{5} = \underline{0.2}$

03. $n = 0.3$; $S_y = 0.2$, $\Delta GWT = 0.25\,m$, $A = 100\,km^2$

Volume of water lost = volume of water extracted

$= S_y * \text{volume of aquifer}$

$= 0.2 * 100\times10^6\times0.25$

$= 5\times10^6\ m^3 = \underline{5 \text{ million } m^3}$

- Groundwater flow is governed by 'Darcy's Law'.

$$\boxed{V = ki}$$

where $V \rightarrow$ apparent velocity of flow.

$i \rightarrow$ slope of HGL = slope of water table.

$$\boxed{Q = kiA.}$$

where $A \rightarrow$ area perpendicular to flow direction.

$K \rightarrow$ permeability of soil. (horizontal hydraulic conductivity of soils)

⊙ Infiltration is the vertical hydraulic conductivity of soils.

Actual flow velocity $= Va = \frac{V}{n}$ $\frac{0.6}{240} =$

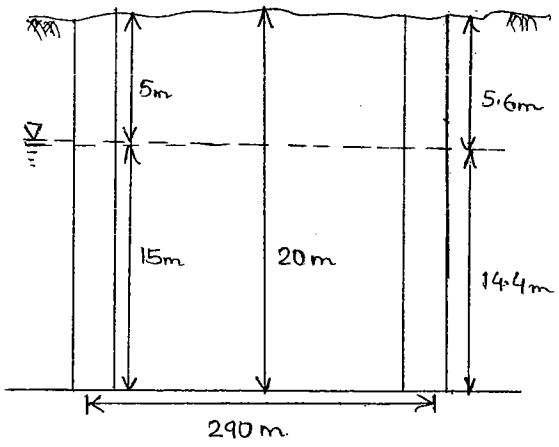
04 $K = 4\times10^{-3}\ cm/s = \frac{4\times10^{-3}\times10^{-2}}{1/86400} = \underline{3.456\ m/day}$

$i = \frac{5.6-5}{290} = 2.069\times10^{-3}$

$$A = \left(\frac{15 + 14.4}{2} * 1\right)$$

$$Q = 3.456 \times 2.069 \times 10^{-3} \times \left(\frac{15+14.4}{2}\right)$$

$$= 0.105 \ m^3/day/m$$



05. $i = \frac{50-25}{1500} =$

$k = 30$ m/day.

$$V = ki = \frac{25}{1500} \times 30 = 0.5 \text{ m/day.}$$

$$Va = \frac{V}{n} = \frac{0.5}{0.25} = 2 \text{ m/day.}$$

Time of travel = $\frac{\text{Distance b/w wells}}{Va}$

$$= \frac{1500 \text{ m}}{2 \text{ m/day}} = 750 \text{ days}$$

09. $i = \frac{45-39.5}{2000} = \frac{5.5}{2000}$

Thickness = 25 m.

Width = 2000 m.

$k = 30$ m/day.

(i). Total daily flow through aquifer $= 30 \times \frac{5.5}{2000} \times (25 \times 2000)$.

$= 4125 \ m^3/day$

(ii) $i = \frac{45-39.5}{2000} = \frac{45-h}{300}$

$\Rightarrow h = 44.175$ m

THE END