Groundwater Storage

Saturday, February 15, 2020 8:07 AM

$$S = \frac{\partial V_w}{\partial h}\frac{1}{A} = S_s b + S_y$$

Where:
V_w is the volume of water released form the aquifer [L^3]
h is the hydraulic head [L]
A is the areal area of the aquifer you are evaluating [L^2]
S_s is the specific storage [1/L]
b is the aquifer thickness [L]
S_y is the specific yield [-]

Using the foldable aquifer models given below answer the following questions assuming that the volume of water released in each of the aquifers is 945 m^3.

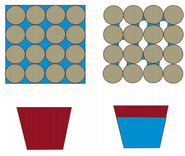
A. Quantify the specific yield in the unconfined aquifer.

Specific Yield

Specific Yield (S_y) is the ratio of the volume of water that drains from a saturated rock, owing to the attraction of gravity, to that of the total volume of the rock.

$$S_y = \frac{V_{drained}}{V_{rock}} = \frac{dV_{water}}{A\,dh}$$

Another way to think about S_y is as drainable porosity



Specific Retention (S_r) is the water that clings due to surface tension

$$n = S_y + S_r$$

$$S_y = \frac{dV_{water}}{A\ dh}$$

$dV_{water} = 945\ m^3$

$A = 15m \times 15m = 225\ m^2$

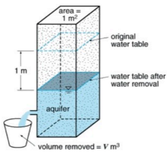
$dh = 50m - 30m = 20m$

$$S_y = \frac{945m^3}{(225m)(20m)}$$

$S_y = 0.21$

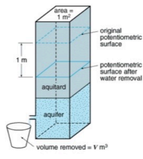
B. Quantify the specific storage in the confined aquifer.

Specific Yield vs Specific Storage



$$S_y = \frac{V_w}{A\Delta h}$$

$$0.01 \le S_y \le 0.30$$



$$S_s = \frac{V_w}{V_{aquifer}\Delta h}$$

$$S = S_s b$$

$$0.00005 \le S \le 0.005$$

$$S_s = \frac{dV_{water}}{V_{Aquifer}\ dh}$$

$dV_{water} = 945\ m^3$

$V_{aquifer} = 15m \times 15m \times 20m = 4{,}500\ m^3$

$dh = 50m - 30m = 20m$

$$S_s = \frac{945m^3}{(4{,}500m^3)(20m)}$$

$S_s = 0.0105\ m^{-1}$

C. Describe the difference between the storage mechanism in the unconfined aquifer as compared to the confined aquifer.

In the unconfined case, S_y comes from draing of the pores. In the confined case, S_s comes from compressibility of the aquifer/rock matrix and/or compressibility of water (see eqs below).

$$S_s = \rho_w g(n\beta + \alpha)$$

Density of Water

Gravitational Constant

Porosity

Compressibility of Water

Compressibility of Rock