2. Saturated flow application of the Darcy equation (vertical flow)

- water ponded to a depth of 1 m
- depth (length) of soil = 20 m
- $K_s = 0.4$ m/hr

taking $z=0$ datum at G.W. aquifer

$$q = +K\left(\frac{y+L}{L}\right) = 0.4 \text{ m/hr}\left(\frac{1+20}{20}\right) = 0.42 \text{ m/hr}$$

The average speed of the wetting front from the pond is 0.42 m/hr.
The time required to move 20 m is $t = \frac{L}{q} = \frac{20}{.42} = \underline{47.6 \text{ hr}} \simeq 2$ days

Letting the basin desaturate or drain would lower the recharge rate.

4. At steady-state, the flow through the sand filter column is equal to the leakage

$$q = \frac{Q}{A} = K_s \frac{\Delta h}{\Delta l} = (0.2 \text{ cm/s})(\Delta h)/300 \text{ cm} = 0.0007\Delta h$$

$$\frac{Q}{A} = \frac{(0.5 \text{ cm}^3/\text{s})}{(6.25 \pi \text{ cm}^2)} = 0.0255 \text{ cm/s}$$

$$\Delta h = \frac{0.0255 \text{ cm}}{0.0007} = \underline{\underline{38.25 \text{ cm}}}$$

6. Intrinsic permeability is a property of the porous medium only, therefore, as with any length measurement it is independent of where it is measured.

(a) $k = 0.8\ \mu m^2$ on earth, moon, mars & UC Davis

(b) if $\rho = 0.75$ & $\mu = 0.025$

$$K_{earth} = \frac{(0.8\ \mu m^2)(10^{-8} \text{cm}^2/\mu m^2)(0.75)(980)}{0.025} = \underline{2.35 \times 10^{-4} \text{ cm/s}}$$

$$K_{moon} = K_{earth}/6 = \underline{0.39 \times 10^{-4} \text{ cm/s}} \text{ since } g_e = 6 g_{moon}$$

(c) for water, $\rho = 1.0$ & $\mu = 0.01$

$$K_e = \frac{(8\times 10^{-9} \text{cm}^2)(1.0)(980)}{0.01} = \underline{7.84 \times 10^{-4} \text{ cm/s}}$$

$$K_m = K_e/6 = \underline{1.31 \times 10^{-4} \text{ cm/s}}$$

8. The saturated zone above the water table is associated with the "capillary fringe" and its thickness is given by $h_d = 85$ cm.
Using the capillary rise equation surface tension of water = .0728 N/m

$$h = \frac{2\sigma\cos\alpha}{\rho g r}$$ and replacing r with the hydraulic radius $R = \frac{r}{2}$

$$h_d = \frac{\sigma\cos\alpha}{\rho g R}$$ and noting that $\underline{\sigma\cos\alpha \simeq 60 \text{ dynes/cm}}$ for soil-water, and solving for R yields

$$R = \frac{(60 \text{ dynes/cm})}{\rho g h_d} = \frac{60}{(1)(980)(85)} = 0.0007 \text{ cm} = \underline{0.0072 \text{ mm}}$$

.0087 mm

10. Plot $h_c = z$ for the z-layer profile using Brooks-Corey Eq'n.

$$\theta_e = \frac{\theta - \theta_r}{\theta_m - \theta_r} = \left(\frac{h_d}{h_c}\right)^{\lambda}$$ where z is positive ↑ from W.T.

Range in z	θ
0 - 25 cm	0.36
25 - 80 cm	$\left(\frac{25}{z}\right)^3 (0.36 - 0.05) + 0.05$
80 - 95 cm	0.50
95 - 120 cm	$\left(\frac{95}{z}\right)^{1.5} (0.5 - 0.2) + 0.2$