Steady Flow to a Well

Continuity Eq. 2.3.32 & Others

$\longrightarrow$ Laplace's equation (if no recharge)

or Poison's equation (if recharge)

Assumptions:

- Steady flow (storage term change = 0)
- Aquifer is homogeneous and isotropic
- Q_{pump} = constant
- Wells fully penetrate aquifer (or horiz. flow)

Confined Aquifer.

$$\nabla^2(h) = \frac{1}{r}\frac{d}{dr}\left(r\frac{dh}{dr}\right) = 0 \qquad (3.2.1)$$

and integrating

$$h(r) = A\ln(r) + B$$

$$\underset{(flux)}{U_r(r)} = -T\frac{dh}{dr} = -T\frac{A}{r}$$

~~But~~ $Q_r = -2\pi r\,U_r(r) = 2\pi T A$

$$\therefore \quad h(r) = \frac{Q}{2\pi T}\ln(r) + B$$

If R = radius of influence:

$$h(R) = h_R$$

$$\underset{drawdown}{s(r)} = h_R - h(r) = \frac{Q}{2\pi T}\ln\left(\frac{R}{r}\right) \qquad (3.2.3)$$

or THIEM EQ

Also $s_1 - s_2 = Q/2\pi T \ln(r_2/r_1)$

$h_2 - h_1 = Q/2\pi T \ln(r_2/r_1)$

Unconfined Aquifers:

See Eq. 2.3.18 w/ recharge

$$\therefore \quad H^2(r) = \frac{Q}{\pi K} \ln(r) - \frac{Wr^2}{2K} + B \qquad (3.2.7)$$

If $W \cong 0$ & B.C.'s apply as $H = H_R$ at $r = R$ (R = r.o.i.)

$$H^2(r) = H_R^2 - \frac{Q}{\pi K} \ln\left(\frac{R}{r}\right) \qquad (3.2.8)$$

(Dupuit Eq. for radial flow)

(like the Thiem Eq. for conf. aq.)

If $H = H_R - s$ (s = drawdown):

or corrected drawdown

$$s'(r) = \frac{Q}{2\pi K H_R} \ln\left(\frac{R}{r}\right)$$

$$= \left(s - \frac{s^2}{2H_R}\right) \qquad (3.2.9)$$

and $$s = H_R\left(1 - \sqrt{1 - \frac{2s'}{H_R}}\right) \qquad (3.2.10)$$