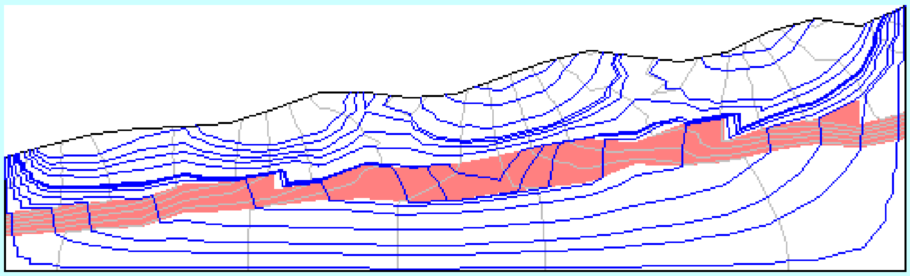
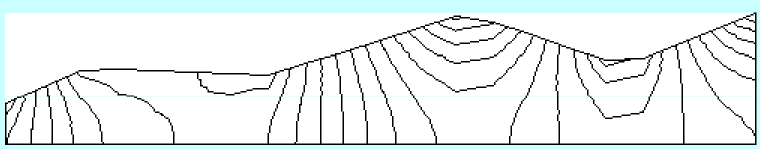
UPPER BOUNDARY IS
CONSTANT HEAD
EQUAL TO WATER TABLE ELEVATION
LIKE MANY RESERVOIRS PROVIDING AND RECEIVING WATER

no exaggeration -- head distribution
with aquitard

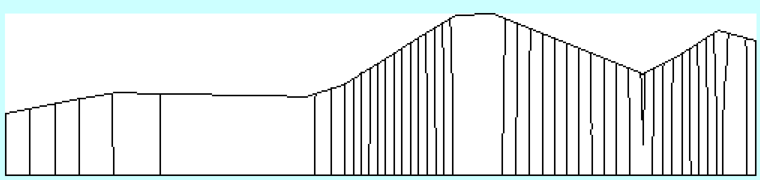


NOTE THAT
POROSITY DOES NOT EEFECT FLOW FIELD
IT ONLY CHANGES TRAVEL TIME

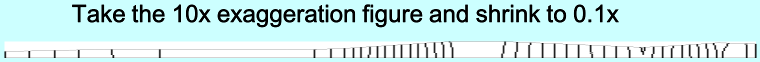
no exaggeration -- head distribution

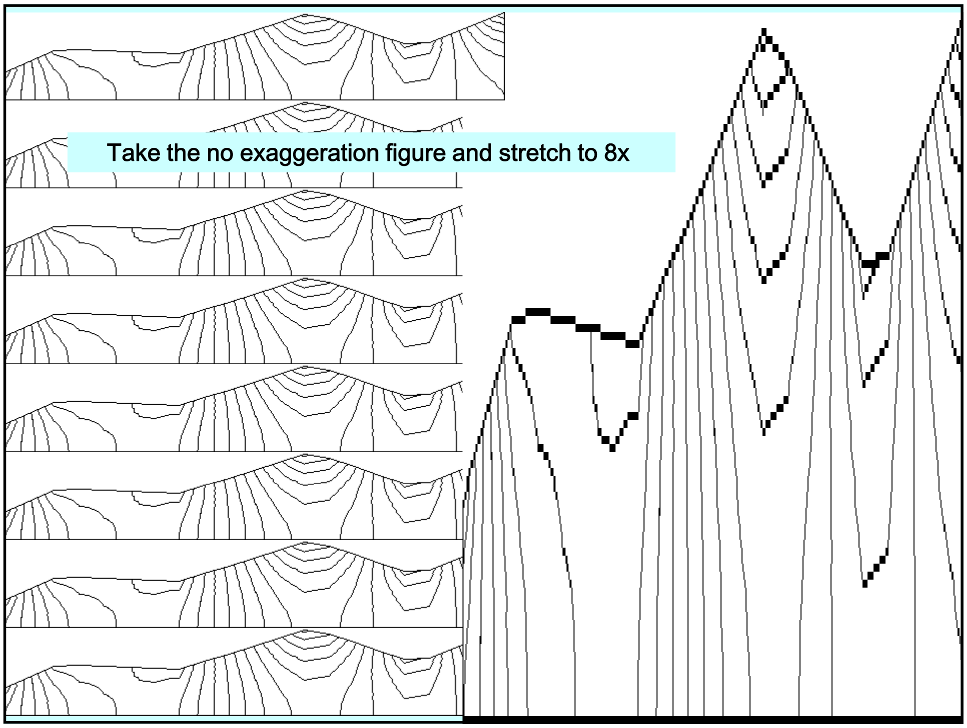


draw similar shape but under10x exaggeration – head distribution

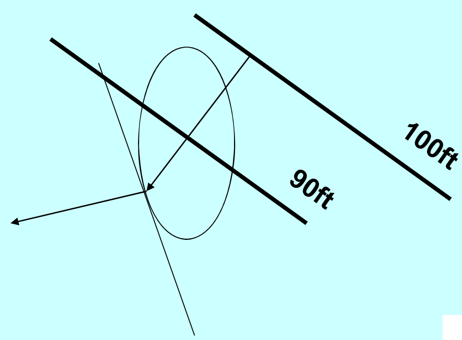


Take the 10x exaggeration figure and shrink to 0.1x





$$try \text{ it for } K_x = 16\, ft/day \quad and \quad K_z = 4\, ft/day$$



1 - Draw an INVERSE K ellipse for semi-axes $\frac{1}{\sqrt{K_x}}$ and $\frac{1}{\sqrt{K_z}}$
2 - Draw the direction of the hydraulic gradient through t ellipse and note where it intercepts the ellipse
3 - Draw the tangent to the ellipse at this point
4 - Flow direction is perpendicular to this line

http://inside.mines.edu/~epoeter/_GW/09FlowNets/Exercises_9ckey.html

http://inside.mines.edu/~epoeter/_GW/09FlowNets/Exercises_9dkey.html

A PLAN VIEW FLOW NET BY CONTOURING USING FIELD HEADS AND DRAWING FLOW LINES PERPENDICULAR: can't assume constant K or b

assuming no inflow from above or below, we can evaluate relative T:

$$Q = A_A V_1 = A_B V_2$$

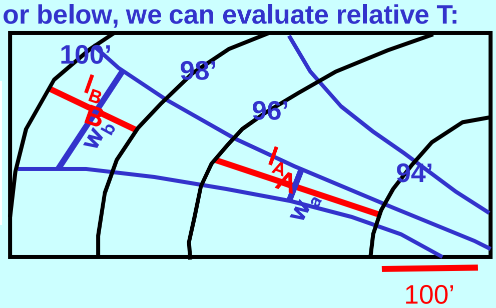
$$A_A K_A \frac{\Delta h}{l_A} = A_B K_B \frac{\Delta h}{l_B}$$

$$\frac{A_A K_A}{l_A} = \frac{A_B K_B}{l_B} \qquad \frac{K_A}{K_B} = \frac{A_B l_A}{A_A l_B}$$

$$A = wb \quad (b = \text{aquifer thickness})$$

$$\frac{K_A}{K_B} = \frac{w_B b_B l_A}{w_A b_A l_B}$$

$$\frac{K_A b_A}{K_B b_B} = \frac{w_B l_A}{w_A l_B} = \frac{T_A}{T_B}$$



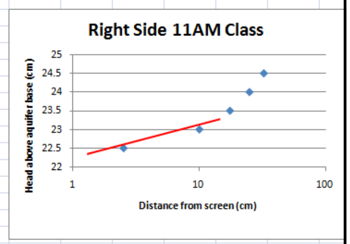
"Irregularities" in "Natural" flow nets

- **varying K**
- **varying flow thickness**
- **recharge/discharge**
- **vertical components of flow**

Nature's flow nets provide clues to geohydrologic conditions

Q	510 ml	10 sec	
	height of water level above base of sand		
	height	distance from well wall to center of observation well	
left		cm	cm
	1	23.5	2.5
	2	24.5	10
	3	25	17.5
	4	25.5	25
	5	25.5	32.5
right		cm	cm
	1	24.25	2.5
	2	25.25	10
	3	25.75	17.5
	4	26.5	25
	5	26.75	32.5

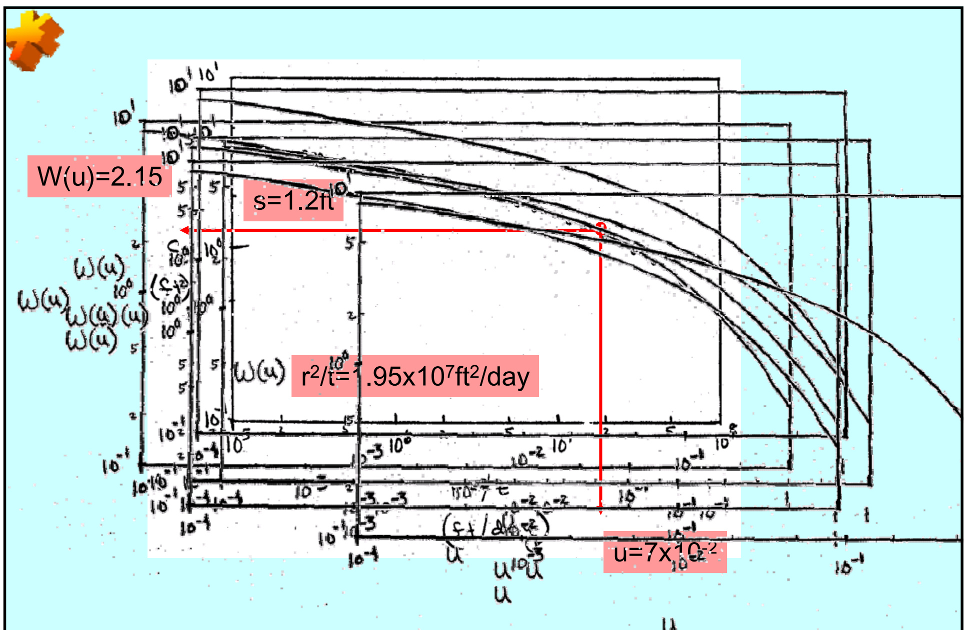
Q	491 ml	16 sec	
	height of water level above base of sand		
	height	distance from well wall to center of observation well	
left		cm	cm
	1	23	2.5
	2	23.5	10
	3	23.75	17.5
	4	24	25
	5	24.75	32.5
right		cm	cm
	1	22.5	2.5
	2	23	10
	3	23.5	17.5
	4	24	25
	5	24.5	32.5



$$K = \frac{Q\ln(\frac{r_2}{r_1})}{\pi(h_2^2 - h_1^2)}$$

Fit a line through data and use points from that line
If data points happen to fall on the lineyou can use those

EARLY LEFT	EARLY RIGHT
1st and last points fall on lin	1st and 3rd points fall on line
0.42489 cm/sec	0.43422 cm/sec
LATE LEFT	LATE RIGHT
2nd and 3rd points fall on lii	1st and 2nd points fall on line
0.46276 cm/sec	0.59523 cm/sec



Work with a partner to calculate T, K, S, S_s

$$T = \frac{Q}{4\pi s} W(u) = \frac{500\frac{gal}{min}\frac{1ft^3}{7.48gal}\frac{60(24)min}{day}2.15}{4\pi 1.2ft} = 13724ft^2/day \approx 1.4x10^4 \frac{ft^2}{day}$$

K = T/b = 140 ft/day

$$S = \frac{4Tu}{(r^2/t)} = \frac{4(13724ft^2/day)(7x10^{-2})}{1.95x10^7 ft^2/day}$$ = $2x10^{-4}$

specific storage = $\frac{S}{b} = 2x10^{-6} ft^{-1}$

Any point can be used. It need not be on the curve. Why?

(see next slide)

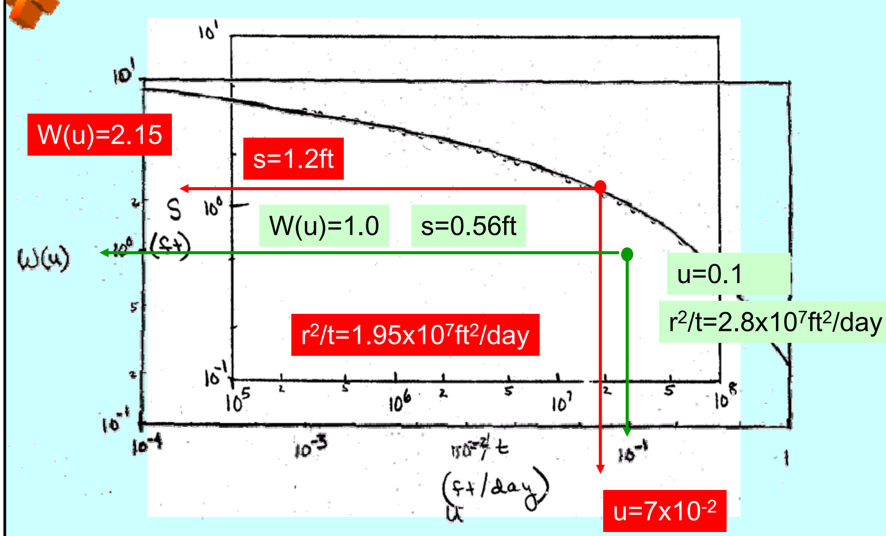
W(u) = 1 s = 0.56

u = 0.1 $r^2/t = 2.8x10^7$

The curve match identifies the appropriate relative values.

T = 13678 ft^2/day approx. 1.4 x 10^4 ft^2/day

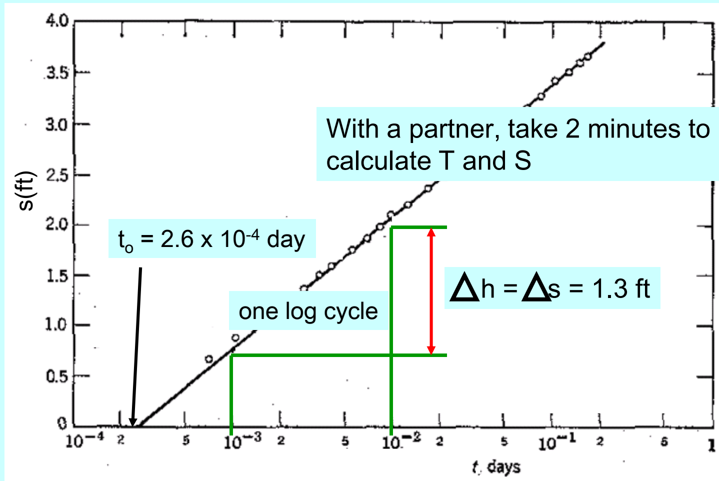
S = $1.95x10^{-4}$ approx. 2 x 10^{-4}



Alternatively, Plot s vs. t & match with W(u) vs. 1/u

For the Ohio example Q=500GPM, b=100ft, r=200ft

Plot s vs t



$$T = \frac{2.3Q}{4\pi \Delta h} \qquad S = \frac{2.25\,T t_o}{r^2}$$

$$T = \frac{2.3Q}{4\pi \Delta h}$$

Δh = drawdown over 1 log cycle of time

$$= \frac{(2.3)\; 500 \frac{gal}{\min} \frac{1 ft^3}{7.48 gal} \frac{60(24)\min}{day}}{4\pi \; 1.3\text{ft}}$$

= 13,552 ft^2/day ~ 1.4x10^4 ft^2/day

$$S = \frac{2.25\,T t_o}{r^2}$$

t_o = time intercept for zero drawdown

$$= \frac{2.25 * 13{,}552 \text{ ft}^2\text{/day} * 2.6\times10^{-4} \text{ day}}{(200\text{ft})^2}$$

= ~ 1.98x10^{-4} ~ 2x10^{-4}