Problem 5.16

Given: Pump test in confined aquifer.

Q = 200 gpm 38503 cu ft/d

r = 250 ft

b = 35 ft

Find: Plot time-drawdown data on semilog plot. Get T&S by Cooper-Jacob Method.

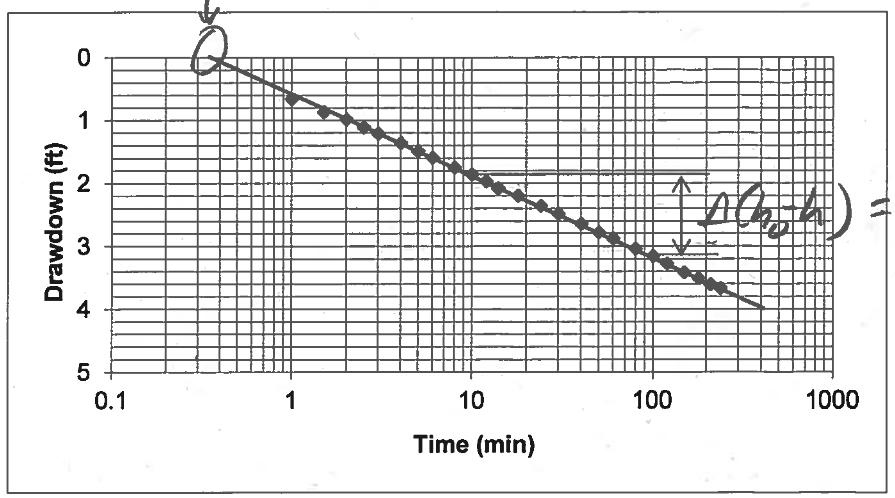
20 total

[2]

Time (min)	h_o-h (ft)
0	0.00
1	0.66
1.5	0.87
2	0.99
2.5	1.11
3	1.21
4	1.36
5	1.49
6	1.59
8	1.75
10	1.86
12	1.97
14	2.08
18	2.20
24	2.36
30	2.49
40	2.65
50	2.78
60	2.88
80	3.04
100	3.16
120	3.28
150	3.42
180	3.51
210	3.61
240	3.67

t_o = 0.35 min [1]

[5] graph



$\Delta(h_o-h) = 3.16 - 1.84$ ft [2]

$\Delta(h_o-h) = 3.16\text{ ft} - 1.84\text{ ft} = 1.32\text{ ft}$

Allow some leeway

$t_o = 0.35$ min

[5] $T = \dfrac{2.3Q}{4\pi\,\Delta(h_o-h)} = \dfrac{2.3(38500\,ft^3/d)}{4\pi(1.32\,ft)}$

$T = 5340\ ft^2/d$

[5] $S = \dfrac{2.25\,T\,t_o}{r^2} = \dfrac{2.25\,(5340\,ft^2/d)\left(\dfrac{0.35\,min}{1440\,min/d}\right)}{(250\,ft)^2}$

$S = 4.7\times10^{-5}$

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ASCE STUDENT CHAPTER

10/10 total

HW # 4

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1 Given: Fully penetrating well $Q = 300$ gpm
Confined aquifer $T = 11500$ gpd/ft $S = 0.00043$
Find: [a] $h_0 - h$ (125 ft, 3 hr) w/ Theis & C-J eqs.
[b] At $r = 125$ ft, at what t does C-J diverge from Theis?

[a] Theis

$$h_0 - h = \frac{Q}{4\pi T} W(u) \qquad u = \frac{r^2 S}{4Tt}$$

$$u = \frac{(125\,ft)^2 (0.00043)}{4 (11500 \frac{gpd}{ft})(3 hr)(\frac{1 d}{24 hr})(\frac{1 ft^3}{7.48 gal})}$$

$$u = 8.74 \times 10^{-3}$$

$$\Rightarrow W(u) = 4.17$$

$$h_0 - h = \frac{300 gpm (\frac{1440 min}{d})}{4\pi (11500 \frac{gpd}{ft})} (4.17)$$

10 total

1 $$h_0 - h = 12.47 ft$$

C-J

$$h_0 - h = \frac{2.3 Q}{4\pi T} \log \frac{2.25 Tt}{r^2 S}$$

$$= \frac{2.3 (300 gpm)(\frac{1440 min}{d})}{4\pi (11500 gpd/ft)} \log \frac{2.25 (11500 \frac{gpd}{ft})(\frac{1 ft^3}{7.48 gal})(3 hr)(\frac{1 d}{24 hr})}{(125 ft)^2 (0.00043)}$$

$$h_0 - h = 12.44 ft$$

[b]

$$u = 0.01 = \frac{r^2 S}{4Tt}$$

$$t = \frac{r^2 S}{0.01 (4T)} = \frac{(125 ft)^2 (0.00043)}{(0.01) 4 (11500 \frac{gpd}{ft})(\frac{1 ft^3}{7.48 gal})}$$

3 $$= 0.11 d \left(\frac{24 hr}{d}\right)$$

$$t = 2.6 hr$$

Homework 4

Problem 2

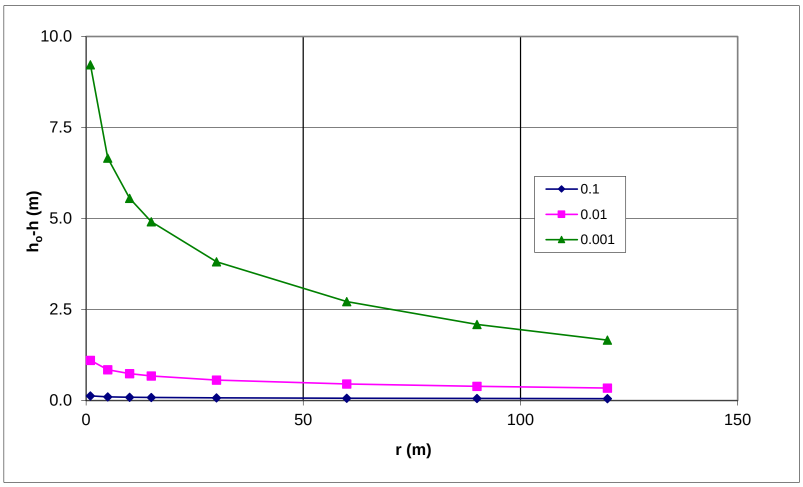
Given: Confined aquifer Q = 10 L/sec = 0.60 m^3/min
r = 1,5,10,15,30,60,90,120 m t = 400 min

Find: [a] h_o-h vs. r for S = 0.0005 and T = 0.1, 0.01, and 0;001 m^2/sec
[a] h_o-h vs. r for T = 0.01 m^2/sec and S = 0.005, 0.0005, and 0.00005

[a] Can use Theis or Cooper-Jacob solution, I'll use Theis so it works for all u.
S = 0.0005

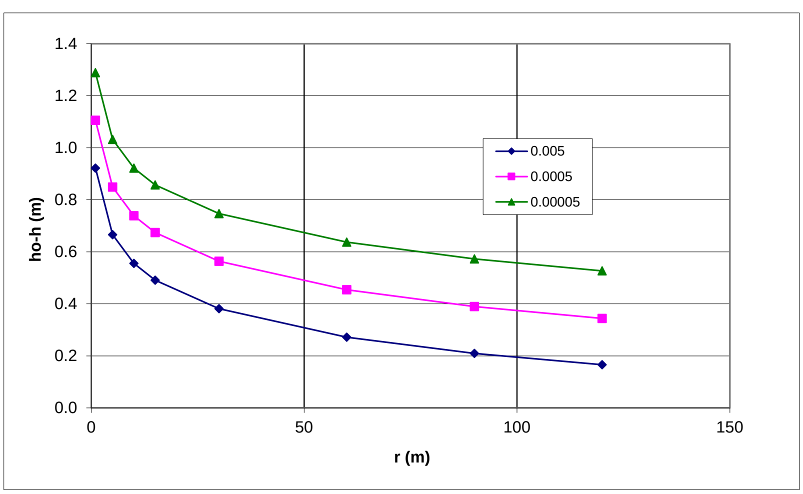
30 total points
[a] 10 for calculations, 5 for graphs
[b] 10 for calculations, 5 for graphs

	T =	0.1	m^2/sec	T =	0.01	m^2/sec	T =	0.001	m^2/sec
r (m)	u	W(u)	h_o-h (m)	u	W(u)	h_o-h (m)	u	W(u)	h_o-h (m)
1	5.21E-08	16.19	0.13	5.21E-07	13.89	1.11	5.21E-06	11.59	9.22
5	1.30E-06	12.97	0.10	1.30E-05	10.67	0.85	1.30E-04	8.37	6.66
10	5.21E-06	11.59	0.09	5.21E-05	9.29	0.74	5.21E-04	6.98	5.56
15	1.17E-05	10.78	0.09	1.17E-04	8.47	0.67	1.17E-03	6.17	4.91
30	4.69E-05	9.39	0.07	4.69E-04	7.09	0.56	4.69E-03	4.79	3.81
60	1.88E-04	8.00	0.06	1.88E-03	5.70	0.45	1.88E-02	3.42	2.72
90	4.22E-04	7.19	0.06	4.22E-03	4.90	0.39	4.22E-02	2.63	2.09
120	7.50E-04	6.62	0.05	7.50E-03	4.32	0.34	7.50E-02	2.09	1.66



[b] Can use Theis or Cooper-Jacob solution, I'll use Theis so it works for all u.
T = 0.01 m^2/sec

	S =	0.005		S =	0.0005		S =	0.00005	
r (m)	u	W(u)	h_o-h (m)	u	W(u)	h_o-h (m)	u	W(u)	h_o-h (m)
1	5.21E-06	11.59	0.92	5.21E-07	13.89	1.11	5.21E-08	16.19	1.29
5	1.30E-04	8.37	0.67	1.30E-05	10.67	0.85	1.30E-06	12.97	1.03
10	5.21E-04	6.98	0.56	5.21E-05	9.29	0.74	5.21E-06	11.59	0.92
15	1.17E-03	6.17	0.49	1.17E-04	8.47	0.67	1.17E-05	10.78	0.86
30	4.69E-03	4.79	0.38	4.69E-04	7.09	0.56	4.69E-05	9.39	0.75
60	1.88E-02	3.42	0.27	1.88E-03	5.70	0.45	1.88E-04	8.00	0.64
90	4.22E-02	2.63	0.21	4.22E-03	4.90	0.39	4.22E-04	7.19	0.57
120	7.50E-02	2.09	0.17	7.50E-03	4.32	0.34	7.50E-04	6.62	0.53



3] Given: Single well in ideal confined aquifer.
$b = 82$ ft $\quad r_w = 1$ ft $\quad (h_0-h)_w = 42$ ft $\quad r_{obs} = 138$ ft $\quad (h_0-h)_{obs} = 7.5$ ft
$Q = 155$ gpm
Find: [a] T in ft²/d & K in ft/d
[b] r_0 in ft

[a] $h_2 - h_1 = \frac{Q}{2\pi K b} \ln \frac{r_2}{r_1}$ let $r_1 = r_w, h_1 = h_w, r_2 = r_{obs}, h_2 = h_{obs}$

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

$h_2 - h_1 = h_{obs} - h_w = (h_0 - h_w) - (h_0 - h_{obs})$

6 $T = \frac{158 \frac{gal}{min} \left(\frac{1 ft^3}{7.48 gal}\right) \frac{1440 min}{d}}{2\pi (42 ft - 7.5 ft)} \ln \frac{138 ft}{1 ft}$

$T = 680$ ft²/d

$K = \frac{T}{b} = \frac{680 ft^2/d}{82 ft}$

$K = 8.3$ ft/d

[b] let $r_2 = r_0, h_2 = h_0, r_1 = r_{obs}, h_1 = h_{obs}$

$h_0 - h_{obs} = \frac{Q}{2\pi K b} \ln \frac{r_0}{r_1}$

$r_0 = r_1 \exp\left[\frac{2\pi T (h_0 - h_{obs})}{Q}\right]$

4 $= 138 ft \exp\left[\frac{2\pi (680 ft^2/d)(7.5 ft)}{\left(155 \frac{gal}{min}\right)\left(\frac{1 ft^3}{7.48 gal}\right)\left(\frac{1440 min}{d}\right)}\right]$

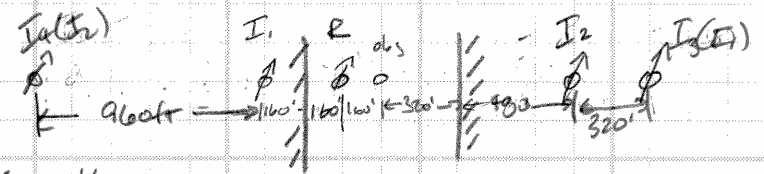
$r_0 = 410$ ft get same answer with $r_1 = r_w, h_1 = h_w$

4) Given: Unconfined aquifer in buried river channel.

$Q = 250$ gpm, $r_0 = 1000$ ft, $K = 15$ ft/d, $h_0 = 120$ ft

Find: $h_0 - h$ @ obs. well

$$Q = 250 \frac{gal}{min}\left(\frac{1 ft^3}{7.48 gal}\right)\left(\frac{1440 min}{d}\right) = 48100 ft^3/d$$



From obs. well

$r_R = 160$ ft

$r_{I_1} = 160 ft + 160 ft + 160 ft = 480 ft$

$r_{I_2} = 320 ft + 480 ft = 800 ft$

$r_{I_3} = 320 ft + 320 ft + 480 ft = 1120 ft > 1000 ft$

$r_{I_4} = 960 ft + 160 ft + 160 ft = 1280 ft > 1000 ft$

[10]

Steady-state

[20]

$$h_0^2 - h^2 = \frac{Q}{\pi K} \ln \frac{r_0}{r}$$

$$(h_0 - h)_{obs} = \sum_{i=1}^{3} h_0 - \left[h_0^2 - \frac{Q_i}{\pi K} \ln \frac{r_{0i}}{r_i}\right]^{1/2}$$

[10]

$$= 120 ft - \left[(120 ft)^2 - \frac{48100 ft^3/d}{\pi (15 ft/d)} \ln \frac{1000 ft}{160 ft}\right]^{1/2} + 120 ft - \left[120 ft^2 - \frac{48100}{\pi (15)} \ln \frac{1000}{480}\right]^{1/2}$$

$$+ 120 ft - \left[120^2 - \frac{48100}{\pi (15)} \ln \frac{1000}{800}\right]^{1/2}$$

$$= 8.07 ft + 3.16 ft + 0.95 ft$$

$$\boxed{(h_0 - h)_{obs} = 12.18 ft}$$

Problem 5. Given: A single pumping well fully penetrates a confined aquifer.

Q = 250 gpm = 48128 ft^3/d

K = 20 ft/d

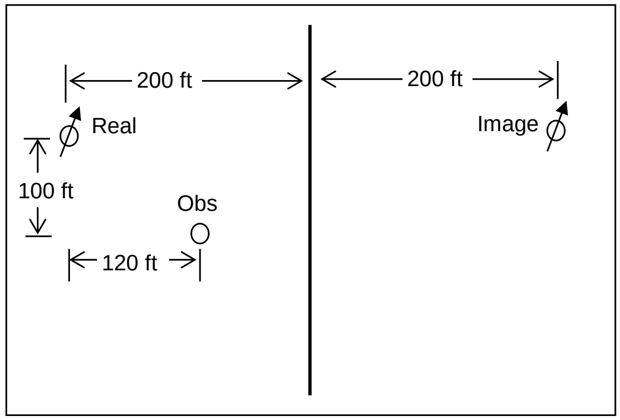
S = 0.0005

b = 110 ft

Find: h_o-h at Obs for t values shown below.

Plot ho-h vs. t on semilog graph.

What is the result with constant head boundary?



Distances to Obs

Real well Δx = 120 ft

Δy = 100 ft

r_R = 156.2 ft

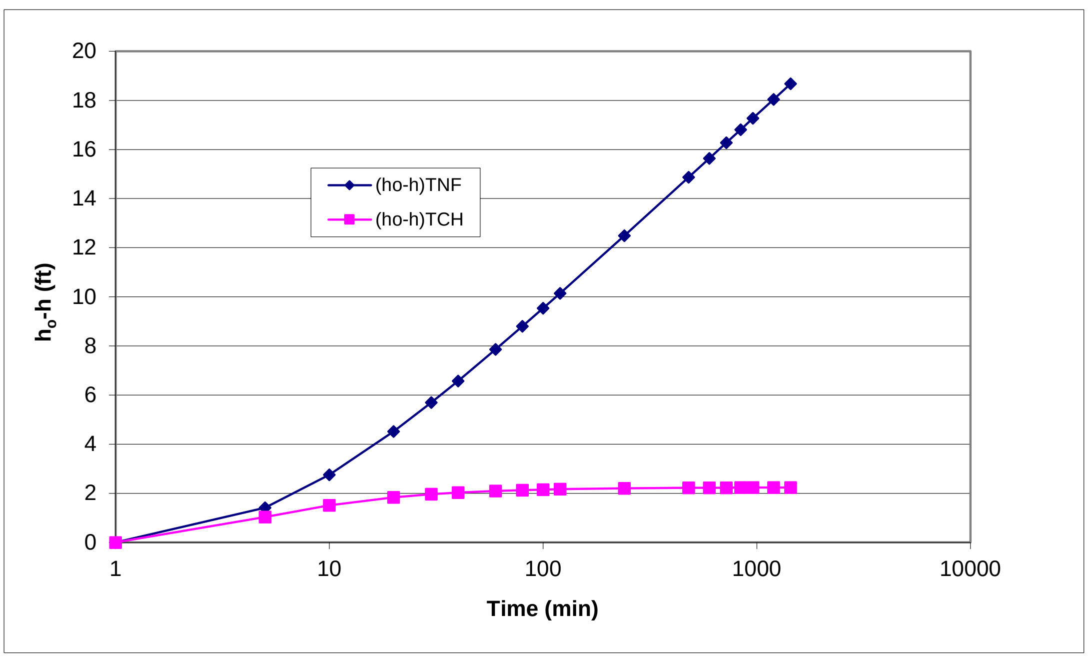
Image well Δx = 280 ft

Δy = 100 ft

r_I = 297.3 ft

		Real Well			Image Well			No flow	Constant head
Time (min)	Time (d)	u_R	$W(u_R)$	$(h_o\text{-}h)_R$	u_I	$W(u_I)$	$(h_o\text{-}h)_I$	$(h_o\text{-}h)_{TNF}$	$(h_o\text{-}h)_{TCH}$
1	6.94E-04	2.00E+00		0.00	7.23E+00	0.00E+00	0.00	0.00	0.00
5	3.47E-03	3.99E-01	7.04E-01	1.22	1.45E+00	1.08E-01	0.19	1.41	1.04
10	6.94E-03	2.00E-01	1.22E+00	2.13	7.23E-01	3.58E-01	0.62	2.75	1.51
20	1.39E-02	9.98E-02	1.82E+00	3.18	3.62E-01	7.71E-01	1.34	4.52	1.83
30	2.08E-02	6.65E-02	2.20E+00	3.83	2.41E-01	1.07E+00	1.87	5.69	1.96
40	2.78E-02	4.99E-02	2.47E+00	4.30	1.81E-01	1.31E+00	2.27	6.57	2.03
60	4.17E-02	3.33E-02	2.86E+00	4.98	1.21E-01	1.66E+00	2.88	7.86	2.09
80	5.56E-02	2.50E-02	3.14E+00	5.46	9.04E-02	1.91E+00	3.33	8.80	2.13
100	6.94E-02	2.00E-02	3.36E+00	5.84	7.23E-02	2.12E+00	3.69	9.53	2.15
120	8.33E-02	1.66E-02	3.54E+00	6.15	6.03E-02	2.29E+00	3.99	10.14	2.17
240	1.67E-01	8.32E-03	4.22E+00	7.35	3.01E-02	2.95E+00	5.14	12.49	2.20
480	3.33E-01	4.16E-03	4.91E+00	8.55	1.51E-02	3.63E+00	6.32	14.87	2.22
600	4.17E-01	3.33E-03	5.13E+00	8.93	1.21E-02	3.85E+00	6.71	15.64	2.23
720	5.00E-01	2.77E-03	5.31E+00	9.25	1.00E-02	4.03E+00	7.02	16.27	2.23
840	5.83E-01	2.38E-03	5.47E+00	9.52	8.61E-03	4.19E+00	7.29	16.81	2.23
960	6.67E-01	2.08E-03	5.60E+00	9.75	7.53E-03	4.32E+00	7.52	17.27	2.23
1200	8.33E-01	1.66E-03	5.82E+00	10.14	6.03E-03	4.54E+00	7.90	18.04	2.23
1440	1.00E+00	1.39E-03	6.01E+00	10.45	5.02E-03	4.72E+00	8.22	18.67	2.23

30 total points
5 for image well sketch
20 for calculations
5 for graphs



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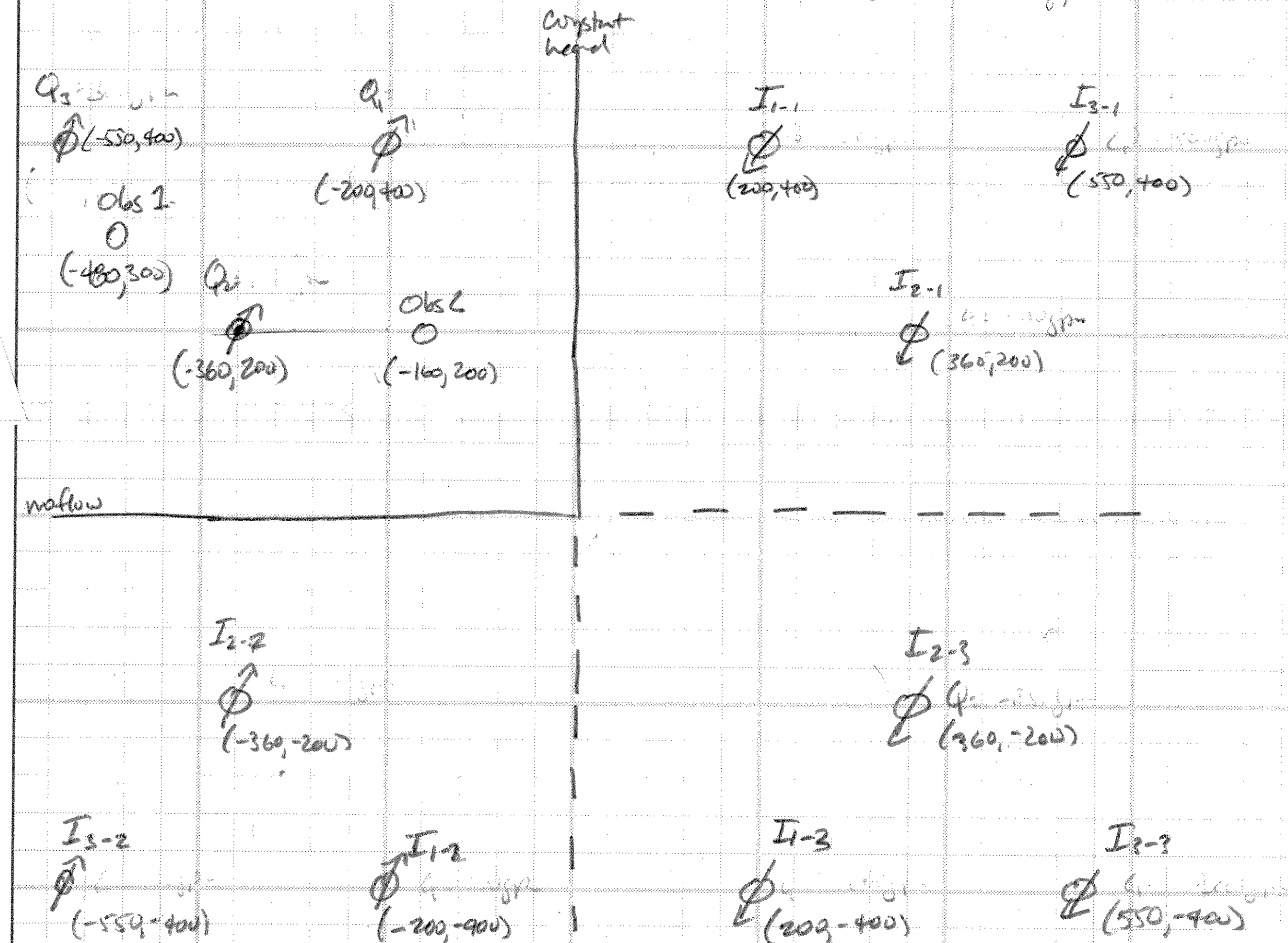
5 Given: Aquifer system with pumping wells & obs. wells as shown.

Find: Image well configuration

10



$$h_0 - h = \frac{2.3\,Q}{4\pi T}\log\frac{2.25\,T t}{r^2 S}$$