Solution

CE6361 Groundwater Hydrology , HW#4, Fall 1993 Due: ________________

1) Piezometric heads are measured simultaneously in thirteen wells penetrating an isotropic confined aquifer of thickness B=50 meters, hydraulic conductivity K = 20 meters/day, and effective porosity of n=0.23.

Well	1	2	3	4	5	6	7	8	9	10	11	12	13
x	4.3	16.5	7.0	3.0	11.0	22.0	8.0	3.2	18.1	13.5	4.0	8.7	19.5
y	1.0	3.5	5.1	6.5	7.0	6.5	9.0	11.8	10.0	12.9	15.5	16.1	16.3
h	34.6	35.1	32.8	32.1	31.5	34.5	33.3	34.4	34.3	35.2	35.2	37.3	36.3

Each x,y coordinate unit = 200 meters

(a) Draw a contour map of the head distribution (1 meter contour intervals) and the flowlines.

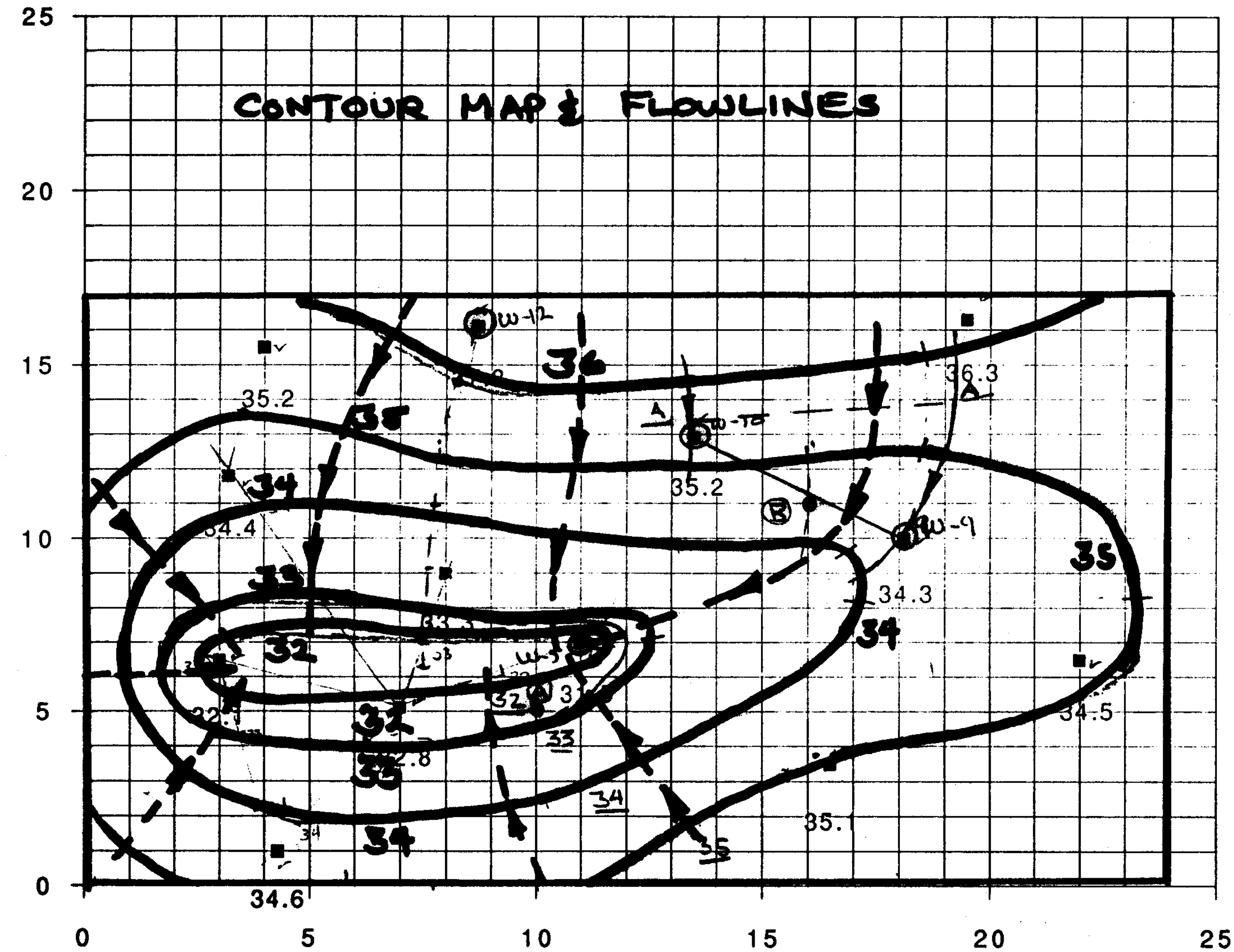
(b) Use inverse-distance weighting to grid the data onto a 40 x 40 grid (with the lower left corner of the grid at (0,0)). Use the gridded data to draw a second contour map and compare the results to the map in part (a). What are the advantages to gridding data for mapping? What are the disadvantages?

(c) Using either map, determine the specific discharge (direction and magnitude) at points A(10,4) and B(16,11).

(d) Estimate the total flow through the aquifer between wells No. 10 and No. 9.

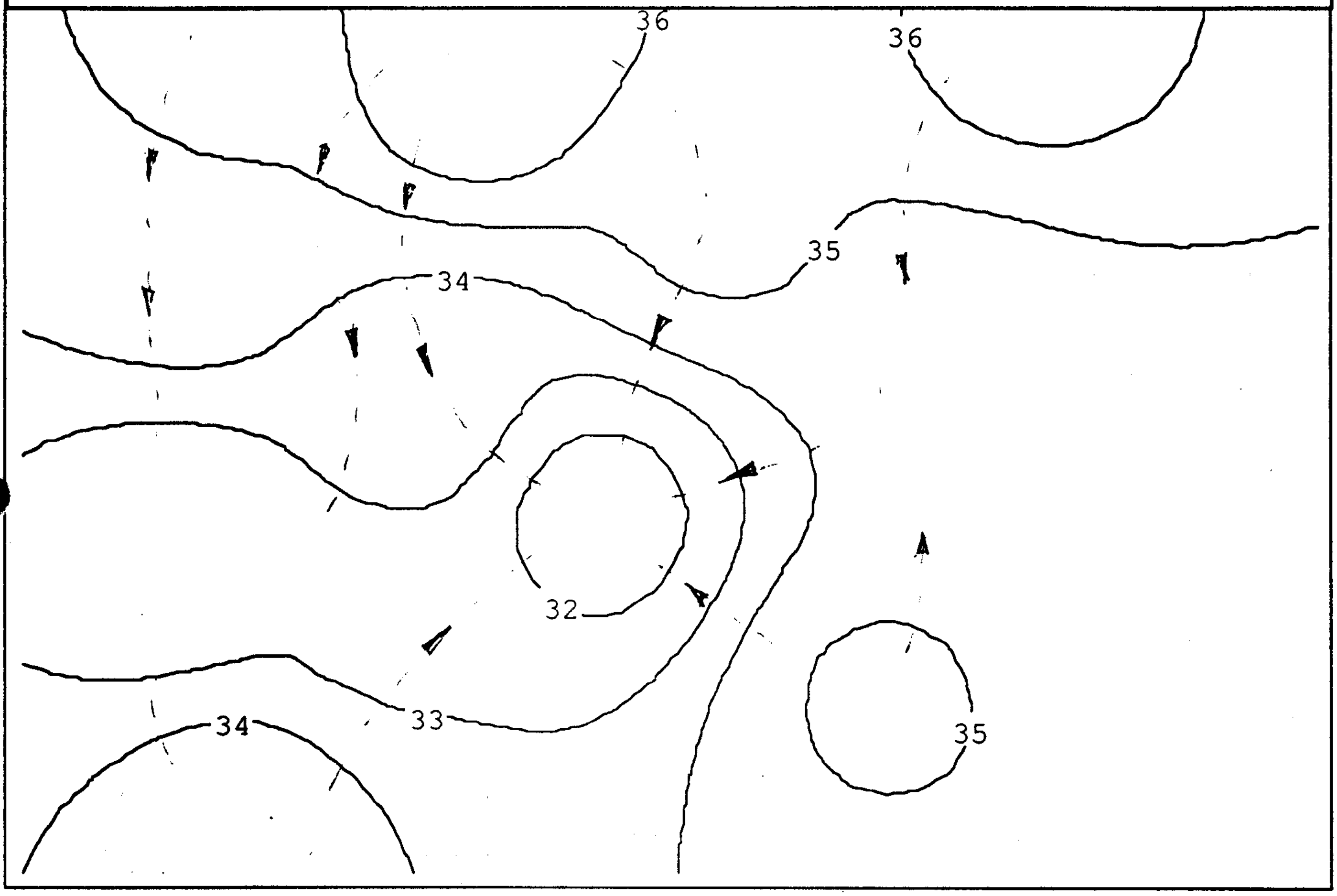
(e) Estimate the time of travel for a pollutant introduced into the aquifer in the vicinity of well No. 12 to reach a pumping well near well No. 5.

#1


CONTOUR MAP & FLOWLINES
25
20
15
10
5
0
0
5
10
15
20
25
W-12
36
35
35.2
34
34.4
33
32
W-10
A
35.2
B
W-9
36.3
35
34.3
34
34.5
35.1
34.6
34
33
32.8
35

B) CONTOUR MAP & FLOWLINES

INVERSE DISTANCE GRIDDING



b) - Results, Pumping bowl more pronounced.
- isolated points produce "injection" features that may not exist
- advantages ① fast ② automatic
- disadvantages unless search distance is limited may identify non-existent features.

c) A (10, 4)

$$q = K \frac{dh}{dl}$$

$dh = 1.0\,m$

$dl = (1.1)(200\,m)$

$K = 20\,m/d$

$q = 0.0909\ m/d$ 

(INTO PUMPING BOWL)

(OR SLIGHTLY W OF DUE NORTH)

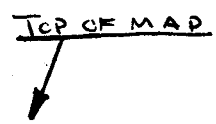
B (16, 11)

$$q = K \frac{dh}{dl}$$

$dh = 1.0$

$dl = (1.9)(200\,m)$

$K = 20\,m/d$

$q = 0.0526\ m/d$ 

(OR SLIGHTLY W OF DUE SOUTH)

d). See map #1

By continuity, flow through section A-A on map same as through section (w-10)-(w-9).

$$Q = KA\frac{dh}{dl}$$

$K = 20 m/d$

$A = Bw$, $B = 50 m$ $w = (5.8)(200 m)$

$dh = 1.0 m$

$dl = (2.0)(200 m)$

$$Q = (\overset{10}{\cancel{20}} m/d)(50 m)(2\cancel{00} m)(5.8)\frac{(1.0 m)}{(\cancel{2.0})(2\cancel{00} m)}$$

$Q = 2900 m^3/day$

e). See map #1

- gradient ≈ constant slope except near pumping bowl.

$$\frac{dh}{dl} \approx \frac{1.0 m}{(2.0)(200 m)} = 0.0025$$

$$v = \frac{q}{n_e} = \frac{K}{n_e}\frac{dh}{dl} = \left(\frac{20 m/d}{0.23}\right)(0.0025) = 0.2174 m/d$$

$$x = vt \therefore \frac{x}{v} = t$$

$$x \approx (7.7)(200 m) = 1540 m$$

$$t = \frac{1540 m}{0.2174 m/d} = 7083.7 \text{ days} \approx 19\tfrac{1}{2} \text{ years}$$