

### CE 3354 Engineering Hydrology Exercise Set 9

#### Exercises

- Figure 1 is a plan view of a waste cell at a solid waste disposal site. Two borings are completed in the water table aquifer underlying the disposal site property.

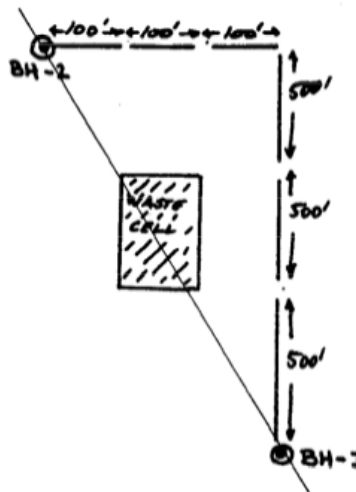


Figure 1: Plan View of an Waste Disposal Cell

The ground surface elevation at borehole BH-1 is 263.75 ft. The ground surface elevation at borehole BH-2 is 249.75 ft. The water table elevation in borehole BH-1 is 223.25 ft. The water table elevation in borehole BH-2 is 229.75 ft. The soil types in the area are silty-clay with a hydraulic conductivity of  $K = 3 \times 10^{-5} \frac{ft}{sec}$  and an effective porosity of  $n = 0.40$ . A 100 x 500 foot waste cell is located between the two boreholes as shown. The bottom of the waste cell must be at least 5 feet above the water table.

Determine:

- The hydraulic gradient (magnitude) from the provided information.
- The direction of groundwater flow from the provided information.
- The average linear (pore) velocity of groundwater.
- The minimum allowable elevation of the bottom of the waste cell.
- The anticipated travel time for contaminated leachate to reach the downstream borehole if the waste cell liner fails.

2. Figure 2 is a contour map of head in an aquifer system.

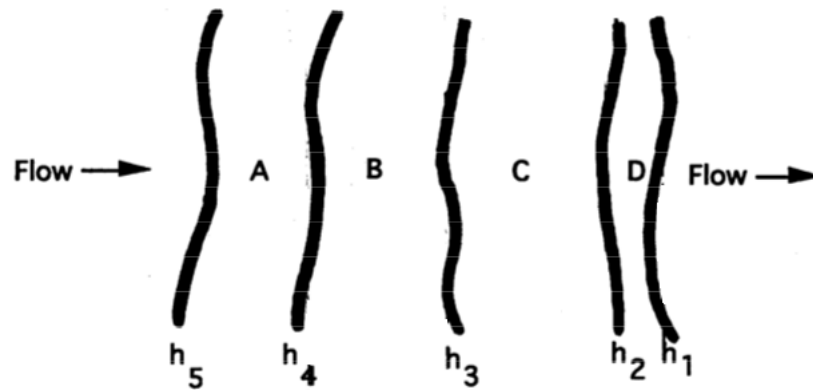


Figure 2: Elevation View of an Aquifer

The aquifer medium is isotropic and inflow equals outflow. The hydraulic conductivity of area A is  $K = 1 \times 10^{-6} \frac{m}{sec}$

Determine:

- a) The hydraulic conductivity in area B
- b) The hydraulic conductivity in area C
- c) The hydraulic conductivity in area D

3. Figure 3 is a profile (elevation) view of an aquifer system.

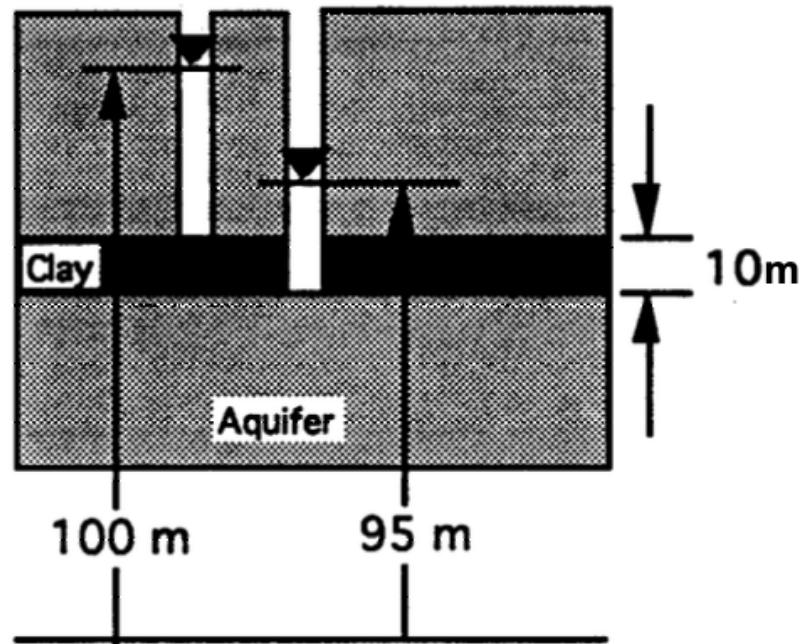


Figure 3: Elevation View of an Aquifer

The vertical hydraulic conductivity of the clay layer is  $K_v = 1 \times 10^{-7} \frac{\text{cm}}{\text{sec}}$

Determine:

- The distance (in meters) from the datum to the water level in the left piezometer.
- The distance (in meters) from the datum to the water level in the right piezometer.
- The vertical hydraulic gradient in the clay layer.
- The specific discharge across the clay layer in cm/sec.
- The direction of leakage.

4. Table 1 is a list of observations of piezometric heads in three observation wells that penetrate the same homogeneous, isotropic, confined aquifer of thickness  $B = 20\text{ m}$

Table 1: Noname USA Aquifer Data

Well ID	Easting (m)	Northing (m)	Head (m)
LJ-65-21-226	100.0	110.0	12.0
LJ-65-21-227	400.0	100.0	13.5
LJ-65-21-228	100.0	310.0	10.4

Drilling cuttings from the wells indicate that the effective porosity is  $n = 0.20$ , the hydraulic conductivity is  $K = 15 \frac{\text{m}}{\text{day}}$ . The piezometric surface between the wells can be approximated as a plane.

Determine:

- The hydraulic gradient indicated by the data (magnitude and direction).
- The discharge in the aquifer per unit width.
- The average pore velocity at point P=(200,200).

5. Table 2 is a list piezometric heads measured simultaneously in 13 wells penetrating an isotropic confined aquifer of thickness  $B = 50 \text{ m}$ , hydraulic conductivity  $K = 20 \frac{\text{m}}{\text{day}}$ , and effective porosity  $n = 0.23$ .

Table 2: Somewhere USA Aquifer Data

Well ID	Easting (m)	Northing (m)	Head (m)
MW-01	4300	1000	34.6
MW-02	16500	3500	35.1
MW-03	7000	5100	32.8
MW-04	3000	6500	32.1
MW-05	11000	7000	31.5
MW-06	22000	6500	34.5
MW-07	8000	9000	33.3
MW-08	3200	11800	34.4
MW-09	18100	10000	34.3
MW-10	13500	12900	35.2
MW-11	4000	15500	35.2
MW-12	8700	16100	37.3
MW-12	19500	16300	36.3

Determine:

- A contour map of the head distribution (1-meter contour intervals)
- Specific discharge (direction and magnitude) at location  $A = (10000, 4000)$
- Specific discharge (direction and magnitude) at location  $B = (16000, 11000)$
- An estimate of total flow through the aquifer between wells MW-10 and MW-9.
- An estimate of travel time for a conservative tracer introduced near well MW-12 to reach MW-5