CE 3354 Engineering Hydrology
Exercise Set 10

Exercises

1. Figure 1 depicts a cubic meter of material that when saturated contains 0.26 cubic meters of liquid.

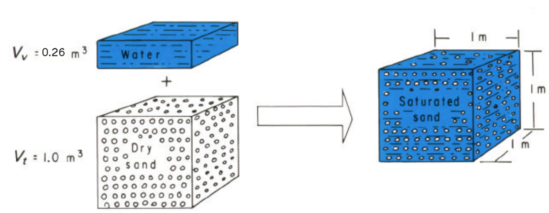

Figure 1: Cubic meter of saturated geologic material

   (a) What is the volume of voids in the material?

   (b) Write the equation that relates void volume (V_v), sample volume(V_b), and porosity (n).

   (c) If the density of the liquid is 9800 N/m^3, what would be the weight change of a saturated sample is completely dried (all liquid removed)? Show your arithmetic.

2. Water flows through the aquifer system shown in Figure 2. The heads in the two monitoring wells are 77.0 m and 71.0 m.

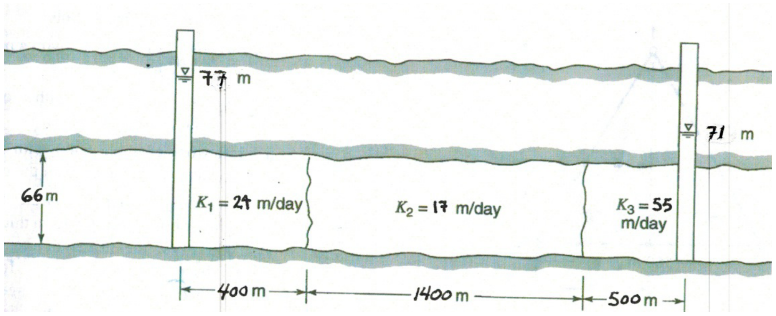

Figure 2: Confined aquifer system with three formations in series

(a) Write the equation for flow rate through a 1-meter wide (into the figure) portion of aquifer.

(b) Using the equation, estimate flow rate through a 1-meter wide (into the figure) portion of aquifer.

3. Three wells monitor water levels in a confined aquifer. Well MW-A is located 3000 feet south of Well MW-B. Well MW-C is located 2000 feet due west of Well MW-B. The top of casing (TOC) elevations for the three wells are 480 feet, 610 feet, and 545 feet. The depth to water (DTW) in the three wells are 40 feet, 140 feet, and 85 feet. Table 1 is a listing of these values.

Table 1: Casing elevations and depth to water in three monitoring wells.

Well	TOC (feet)	DTW (feet)	Head (feet)
MW-A	480	40	
MW-B	610	140	
MW-C	545	85	

Figure 3 is a sketch that shows the relationship between the top of casing elevation, depth to water, and head in the confined aquifer.

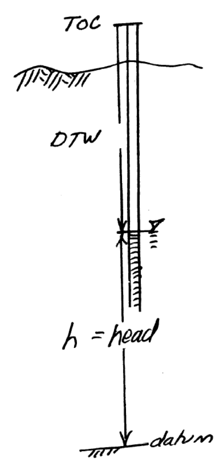

Figure 3: Sketch showing the relationship of top of casing (TOC) and depth to water (DTW)

(a) Using Figure 3 as a guide, write the formula to convert the depth-to-water (DTW) measurements and top-of-casing (TOC) values into head.

(b) Using Figure 3 as a guide, compute the head in MW-A. Show your arithmetic.

(c) Using Figure 3 as a guide, compute the head in MW-B. Show your arithmetic.

(d) Using Figure 3 as a guide, compute the head in MW-C. Show your arithmetic.

(e) Complete Table 1 by entering your values computed above into the table.

(f) A sketch of the orientation of the three wells is shown on Figure 4 (Next Page). Write the value of head you computed next to each well on the sketch.

(g) Determine the direction of flow using three-well triangulation. Show your arithmetic.

(h) Draw a flowline that passes through MW-B

(i) Draw and label the equipotential line that passes through well MW-B.

(j) Draw and label the equipotential line that passes through well MW-C.

(k) Determine the distance along the flowline between the two equipotential lines.

(l) Estimate the magnitude of the hydraulic gradient.

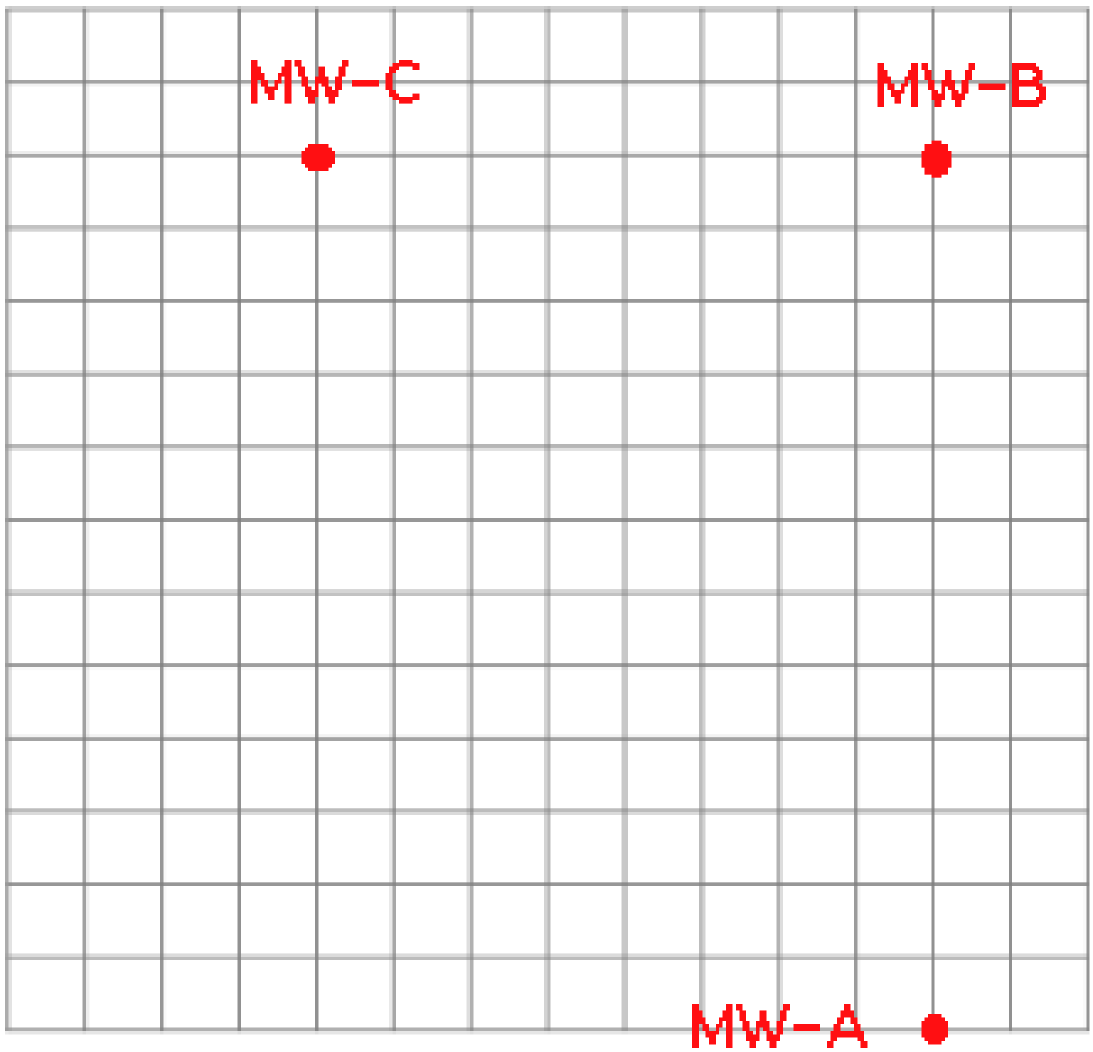

Figure 4: Three-wells monitoring a confined aquifer.

4. A well in the center of a circular island (an unconfined aquifer) is pumped to dewater a cylindrical portion of the aquifer for constructing a foundation. The desired drawdown 100 meters from the well is 5 meters. The radial distance from the well to the surrounding water 10,000 meters. The head at the edge of the island is 100 meters. Figure 5 is a sketch of the situation. The hydraulic conductivity of the aquifer material is 11 meter/day.

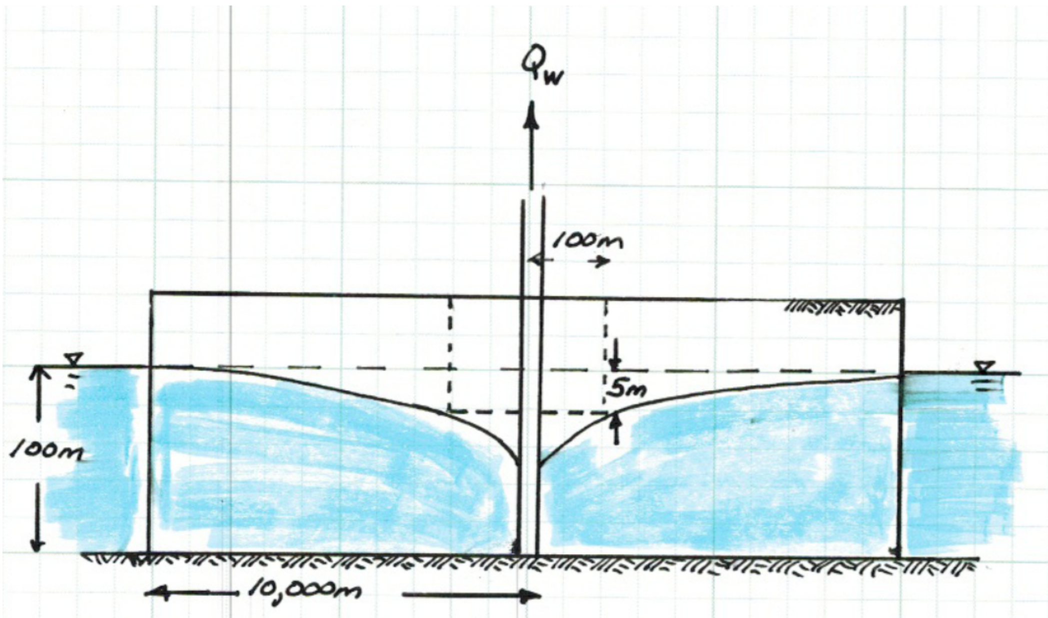

Figure 5: Pumping well in circular, unconfined aquifer.

(a) What is the head at the center of the island (in the well) before turning on the pump?

(b) What is the head 100 meters from the well before turning on the pump?

(c) What is the head 10,000 meters from the well before turning on the pump?

(d) What is the head 100 meters from the well when the pump is operating at the desired flow rate?

(e) What is the head 10,000 meters from the well when the pump is operating at the desired flow rate?

(f) Write the equation that relates the pump rate, head, and hydraulic conductivity for a well in an unconfined aquifer.

(g) Apply the equation and estimate the required pumping rate to produce the desired head 100 meters from the well. Show your arithmetic.

5. Figure 6 (next page) is a map of the piezometric surface (head) in the Floridian aquifer.
   (a) What is the head in the aquifer near Altamonte Springs (A1)?
   (b) What is the head in the aquifer near Sanlando Springs (A2)?
   (c) What is the head in the aquifer near Lake Mary (A3)?
   (d) What is the head in the aquifer near Golden Lake (A4)?
   (e) What is the head in the aquifer near location (A5)?
   (f) Sketch flowlines near Altamonte Springs (A1).
   (g) Sketch flowlines near Sanlando Springs (A2).
   (h) Sketch flowlines near Lake Mary (A3).
   (i) Sketch flowlines near Golden Lake (A4).
   (j) Sketch flowlines near location (A5).
   (k) Based on the flowlines, is Altamonte Springs a recharge or discharge area? (Explain your reasoning)
   (l) Based on the flowlines, is Sanlando Springs a recharge or discharge area? (Explain your reasoning)
   (m) Based on the flowlines, is Lake Mary a recharge or discharge area? (Explain your reasoning)
   (n) Based on the flowlines, is Golden Lake a recharge or discharge area? (Explain your reasoning)
   (o) Based on the flowlines, is location (A5) a recharge or discharge area? (Explain your reasoning)

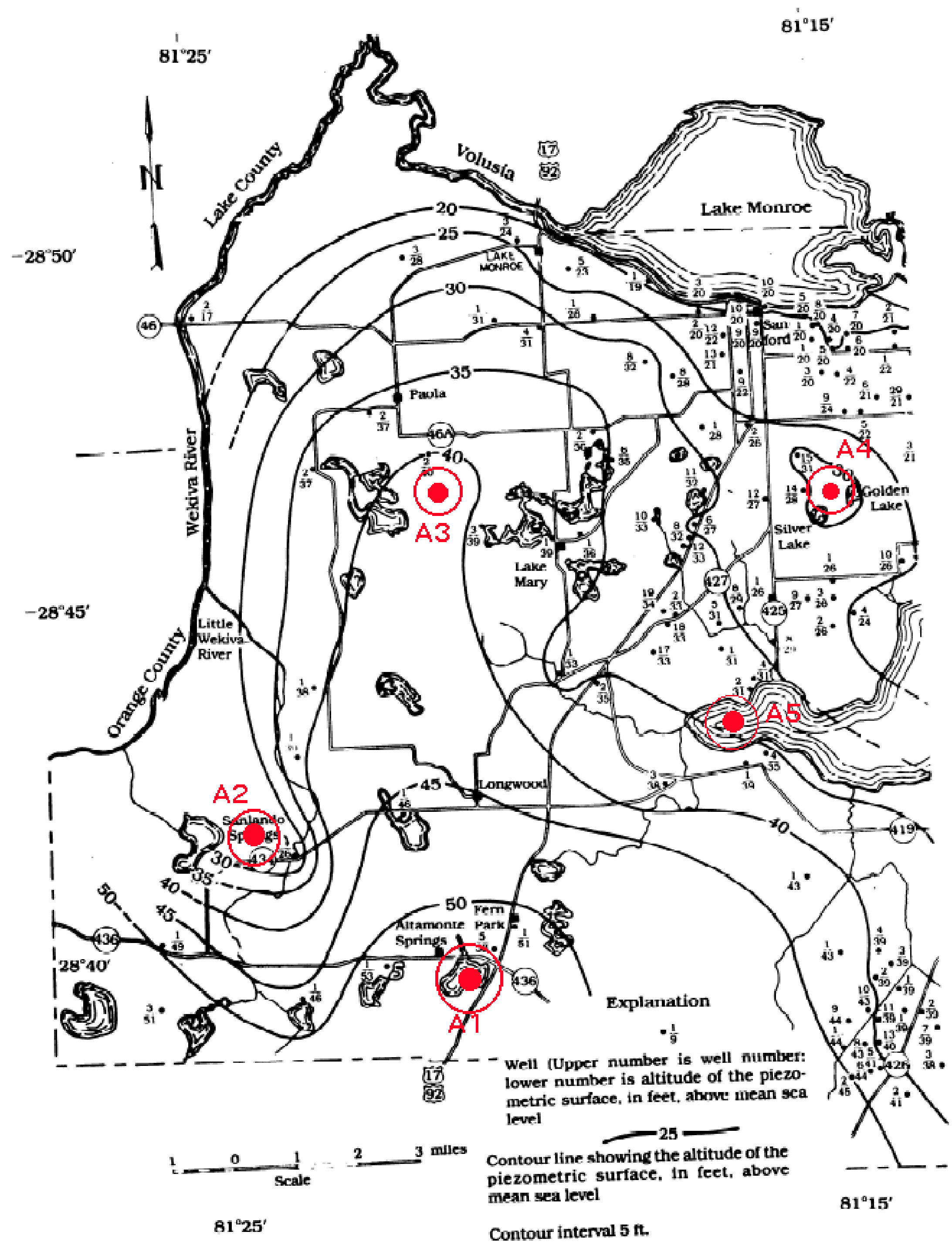

Figure 8.4. The piezometric surface of the Floridan aquifer in western Seminole County, Fla. (After Barraclough, 1962, Fig. 8.)

Figure 6: Piezometric surface map of portion of Floridian aquifer.