Example 2.12: Steady Flow in a Confined Aquifer

A river and a drainage channel are shown in **Figure 2.22**. The average elevation of the water surface in the river is 144.6 meters, and in the channel 142.20 meters. The hydraulic conductivity of the confined inter-granular aquifer developed in medium alluvial sand is 3.5×10^{-4} m/s. The hydrologic cross section in **Figure 2.23** shows the relationship between the aquifer, the overlying silty clay (aquitard) and the underlying dense (impermeable) clay.

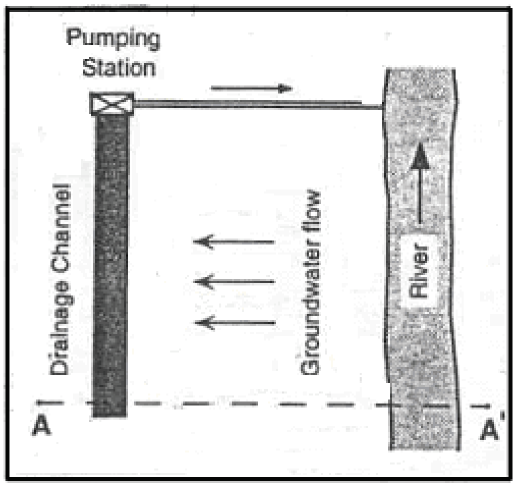


Figure 2.22 Plan view of the river and the drainage channel

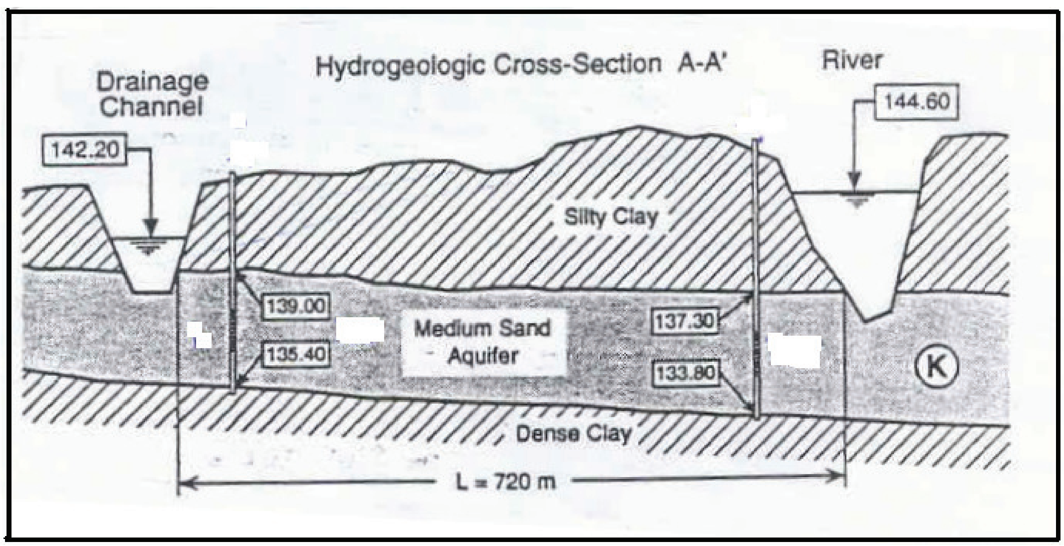


Figure 2.23 Hydrogeological cross-section between the river and the drainage channel shown in Figure 11 as determined by filed investigations.

(i) Calculate the groundwater flow per unit width between the river and the drainage channel?

(ii) What is the height z of the piezometric surface at a midpoint between the river and the channel?

Answer 2.12

(i) According to Darcy law $Q = -K.A.\dfrac{\Delta h}{\Delta x} \quad = -K.b.w.\dfrac{\Delta h}{\Delta x}$

So, $q = -K.b.\dfrac{\Delta h}{\Delta x}$

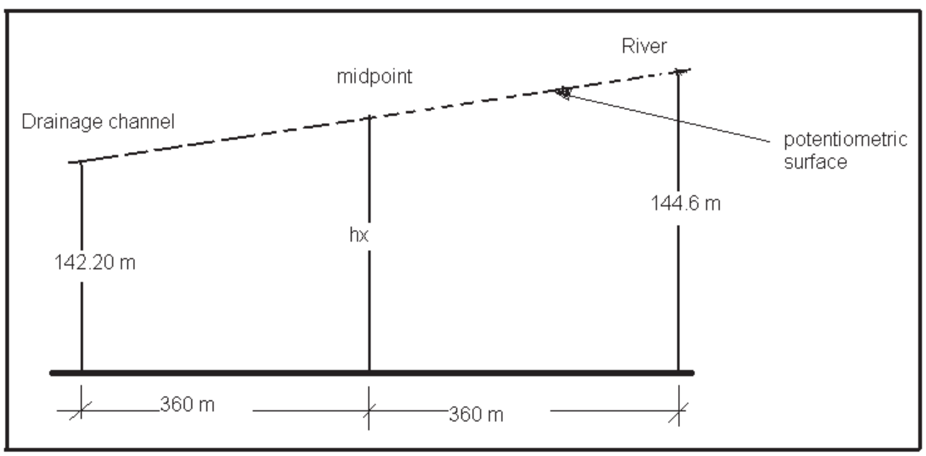
$$q = -K.b.\frac{h_2 - h_1}{L}$$

$$but,\ b = \frac{(137.30 - 133.80) + (139.00 - 135.40)}{2} = \frac{3.5 + 3.6}{2} = 3.55\,m$$

$$\Rightarrow q = -\frac{(3.5x10^{-4})(3.55)(142.20 - 144.5)}{720}$$

$$\Rightarrow q = \quad 4.14\,x10^{-6}\ m^2/s$$

(ii) The position of the potentiometric surface at a midpoint between the river and the channel. Since the aquifer is confined, the piezometric surface is linear.



$$q = -K.b.\frac{h_2 - h_1}{x}$$

$$\Rightarrow q = -\ K.b\frac{h_x - h_1}{x}$$

$$\Rightarrow h_x = h_1 - \frac{q}{Kb}x$$

$$\Rightarrow h_x = 144.6 - (\frac{4.14x10^{-6}}{3.5x10^{-4}\,x\,3.55}\,x\,3.55)$$

$$\Rightarrow h_x = 143.4\,m\,asl$$