HW1 Box Model

Exercise

Build a steady state box model. The model should have 25x25 cells, each 100 m in x and in y. There is one layer, 10 m thick. The medium is homogeneous with K = 1.0 m/day in x and y and 0.1 m/day in z. The porosity is 0.35, specific yield is 0.3, and storage coefficient is 0.001. The right boundary is constant flow with a total of 25 m^3/day entering the domain. The left boundary is a constant head of 7 m relative to the datum, which is located at the bottom of the domain.

Question:

Describe the slope of the water table as a function of distance from the left boundary – in particular, does the water table slope increase or decrease with distance from the left boundary. Then, explain why the water table has this general slope. Be sure to include concepts of steady state flow and saturated thickness (distance from the water table to the base of the aquifer - the thickness through which water is flowing).

Solution

Model setup:

Refer to the i-python notebook to see all of the steps in the model setup.

For the right boundary note that you need to first calculate the flux entering every cell. The right boundary has a total of 25 m3/day entering the domain over 25 cells. So, each cell has an assigned flow of 1.0 m^3/day. This value should be entered as a positive value to represent flow into the domain.

How does the slope change as a function of distance from the left boundary?

Figures 1 and 2 show the head gradients across the domain. The head decreases more steeply with distance with as you move from the right boundary to the left.

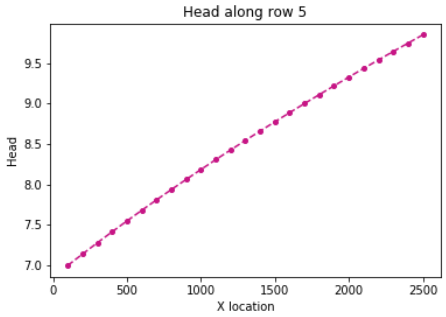

Figure 1: Head along Row 5 of the steady state solution

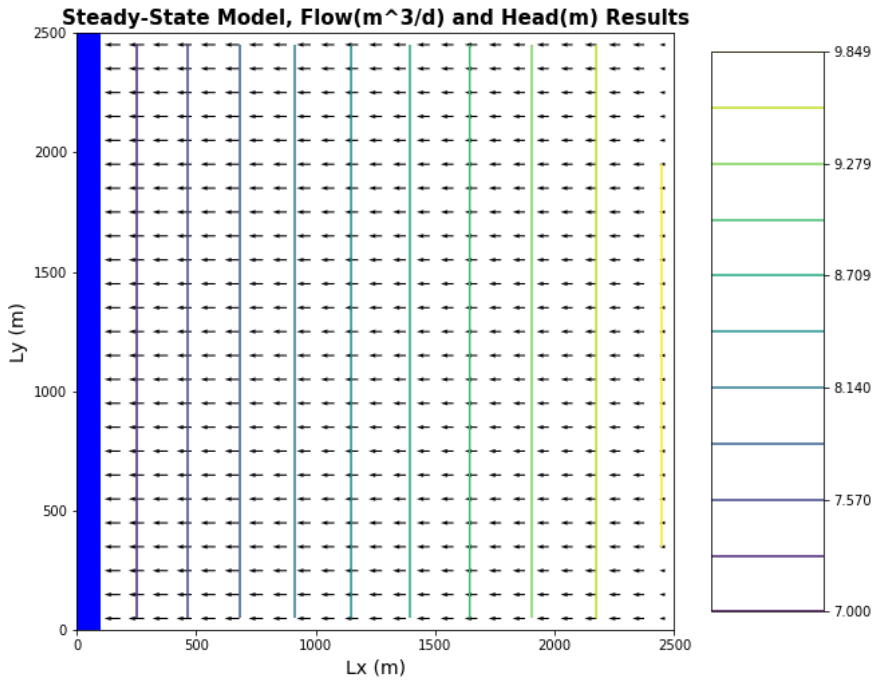

Figure 2: Head contours for the steady state solution

Why is this?

The model is under steady state conditions. For the rectangular domain, the same total flow must pass through each cross section (left to right). Because the water table is below the ground surface (the system is unconfined), a lower water table results in a smaller cross-sectional area available for flow. To provide the same total flow, a reduced saturated thickness requires a higher gradient. As a result, the gradient increases continuously from right to left.