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**HWRS 482, HW 2**

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**The Challenge**

Chart

Description automatically generated**#3**

The plan views of head gradients support 1D flow because of the distinctiveness of the zones. Here, qx = -K dh/dl but if we also considered qy or qz, it would not give the same dh/dl as qx alone.

Mathematically, the equivalent hydraulic conductivity (Keq) is closer to the lower K value by:

A screenshot of a computer

Description automatically generated with medium confidenceKeq = n/ ((1/Klow)+(1/Khigh)) Meaning, 1 divided by a low value is larger than 1 divided by a higher value and will have more weight.

Conceptually, these plots show how much less area the high K column occupies to maintain steady state with the rest of the system.

Graphical user interface

Description automatically generated

**#4**

The boxed area of low K greatly affects the head values in this system along the flow lines that originate in the box. This fits with the mathematical and conceptual understanding of low K impact on Keq for a 1D system. The region of low K has less impact beyond the immediate flow lines, which suggests the overall Keq would be less skewed toward the lower K than in a 2D system.

**#5**

Type 1: Specified heads, Type 2: Specified fluxes

The steady state homogeneous model is defined with Type I constant head boundaries. A Type II boundary of constant flux should give the same equipotentials, with q = .0021 m/d across the domain. For the heterogeneous model, the Type II boundary at each edge is also q = .002 m/d. The third model, with a boxed distribution of low K, has dramatically different flux profiles through the center and along the edges of the domain. This seems like it would need a more sophisticated boundary to produce the same head distribution, but by q = -K dh/dl, it should still be the same.

**Glossary Questions**

**1** MODFLOW is a simulation of multidimensional finite-difference or finite-volume groundwater models. Packages are like tool kits for the model to do its work. For example, .nam files contain the names of input and output files and packages to be run, .oc files tell the model what to return, and .pcg files operate as the ‘solver’ function. The inputs are properties controlling the direction and rate of groundwater transport. Specifically: boundary conditions and hydraulic conductivity.

**2** By Darcy’s Law, q = -K dh/dl which, for steady state, must have q remain constant. This states a directly proportional relationship between hydraulic conductivity and head gradients, with a decrease in K corresponding to an increase in h to maintain the constant q.

**3** A model is constructed on a grid composed of cells that represent real spatial distribution. Depending on model resolution, a single cell could be on the order of square meters or square kilometers (for example). A model node is the location, inside each cell, where the calculations are made. For numerical solutions the node is in the middle of the cell, however, quantities like hydraulic conductivity are associated with the boundaries between cells.

Node

**4** A Type I boundary condition is a constant specified head, and Type II is constant flux. Type II is useful for applications with infinite flow, such as infiltration from a perennial stream or seepage from a mine site. Type I can represent systems required to maintain a constant water level, such as a surface reservoir or an aquifer.

Special case type II = zero flux (at bedrock, or rock unit, across faults/divides, **watershed boundaries**)

The challenge is to translate the real world into Modflow. Could even use a river as a constant boundary and just consider the watershed enclosed by it.

<250 meters resolution for hillslope