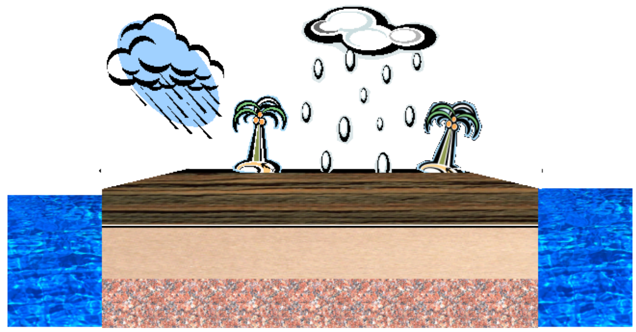
GLY-4822 Assignment 5

1. (5 pts) Beginning with the 1-D, steady-state, general mass (volume) balance equation $M_{in} - M_{out} = 0$, derive the 1-D Poisson equation ($\frac{\partial^2 h}{\partial x^2} = -\frac{R}{T}$). Show all steps. Indicate all assumptions.

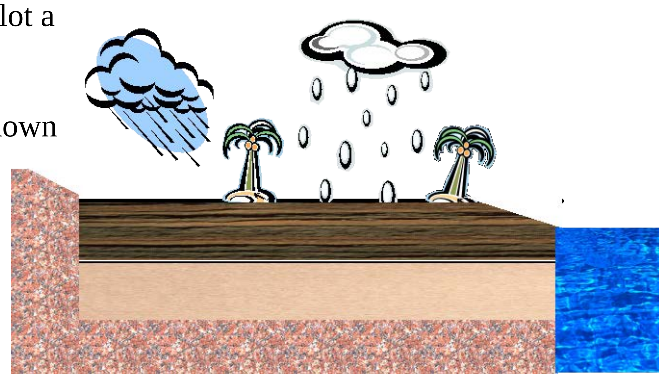
2. (5 pts) Solve the 1-D Poisson equation ($\frac{\partial^2 h}{\partial x^2} = -\frac{R}{T}$) analytically by integration. That is, write a general analytical solution for *h(x)*.

3. (10 pts) Using a transmissivity of 10 m^2 d^{-1}, and a recharge rate of 0.001m d^{-1}, together with the boundary conditions h(0 m) = 0 m and h(100 m) = 1 m, solve for the constants in your general expression and write the specific solution to this boundary value problem. Prove that the solution satisfies the boundary conditions.
Plot a graph of *h(x)*.



This problem corresponds to the situation shown on the right. Constant head reservoirs at x = 0 and x = 100 maintain the aquifer boundary heads. The aquifer is confined by shale above and by granite below. The aquifer receives recharge through the upper confining layer.

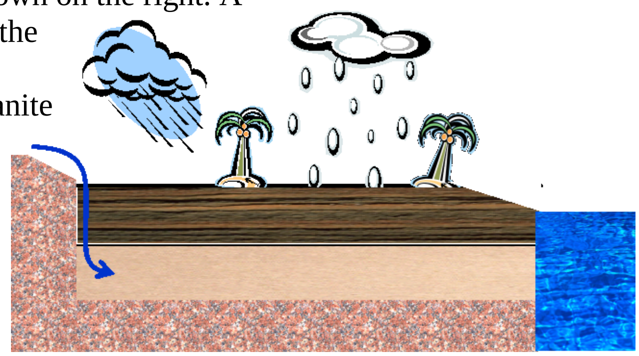
4. (10 pts) Using a transmissivity of 10 m^2 d^{-1}, and a recharge rate of 0.001 m d^{-1}, together with the boundary conditions $dh/dx|_{x = 0\ m} = 0$ and h(100) = 1 m, solve for the constants in your general expression and write the specific solution to this boundary value problem. Prove that the solution satisfies the boundary conditions. Plot a graph of *h(x)*.



This problem corresponds to the situation shown on the right. A constant head reservoir at x = 100 m maintains the aquifer boundary head at that location. The aquifer is confined by shale above and by granite below. The aquifer receives recharge through the upper confining layer. In this case, there is a no-flow boundary at x = 0; physically, this might represent a low K rock material or simply a ground water divide.

5. (20 pts) Using a transmissivity of 10 m^2 d^{-1}, and a recharge rate of **0.01** m d^{-1}, together with the boundary conditions $dh/dx|_{x = 0\ m} = \mathbf{-10^{-2}}$ and h(100 m) = 1 m, solve for the constants in your

general expression and write the specific solution to this boundary value problem. Prove that the solution satisfies the boundary conditions. Plot a graph of *h(x)*.



This problem corresponds to the situation shown on the right. A constant head reservoir at x = 100 maintains the aquifer boundary head at that location. The aquifer is confined by shale above and by granite below. The aquifer receives recharge through the upper confining layer. In this case, a constant flux of water is also added through the boundary at x = 0; physically, this might represent the recharge of the aquifer by streams draining the granitic highlands to the west.

6. (30 pts) Show that the applied recharge is equal to the respective ground water discharge (computed from Darcy's law as demonstrated in class) for Problems 3, 4, and 5. Don't forget to check the flow directions to be sure you are correctly differentiating inflows from outflows and be sure to include the constant boundary flux in the water balance for Problem 5.)

7. (20 pts) Repeat Problems 3 and 4 for R = -0.001 m d^{-1}. Now evaporation dominates