

## GLY 4822, Assignment 9

1. Starting from Inputs – Outputs = Change in Storage, derive the PDE governing 1-D chemical transport in an aquifer with constant water flow rate. Show all steps.
2. Starting from the CDE derived above, derive an explicit finite difference scheme to solve the CDE numerically.
3. Use a spreadsheet model for the explicit numerical solution of the CDE to estimate the dispersion coefficient for the tracer test data we collected in class. Use both the rising and falling salt concentration data and compare the results.

Use  $\Delta x$  and  $\Delta t$  that satisfy the numerical stability parameters. I am sending the data by e-mail. Values in the file are time in seconds and concentration in voltage (proportional to concentration) units. Normalize the concentration data. Base your initial guess for  $D$  on the following rule of thumb for the dispersivity  $\alpha$ :  $\alpha = 0.1 * \text{length scale of problem}$ , where the length scale for our problem is the length of the column, 10 cm. Then use the relationship between  $D$  and  $\alpha$ :  $D = \alpha v$ .

In your spreadsheet model, the  $x = 0$  boundary will be constant (relative) concentration = 1 corresponding to the solution we pumped in. At  $x = 10 \text{ cm}$ , use a “zero dispersive flux” boundary, which is exactly like the no flow boundaries we used before except that it applies to concentration and chemical flux. In the case of water flow, we made the head gradient  $dh/dx$  equal to zero so there would be no flow in accordance with Darcy’s law. Now, we’ll make the concentration gradient  $dC/dx$  equal to zero so there will be no dispersive flux in accordance with Fick’s law. Note that because there are two parts to the total chemical flux (convective and dispersive; see your notes), cutting off the dispersive flux will not stop the discharge of the chemical from the column.

The initial condition will be  $C(x,0) = 0$  (for salt water entering the fresh water-filled column) or  $C(x,0) = 1$  (for fresh water entering the salt water-filled column).