Contaminant Hydrogeology Homework #2, Due, March 26, Friday, 5:00PM, 2010

1 (15). A one-dimensional column test was conducted on a sediment sample. Deionized water was drained through the column until it came to a steady-state condition. A saline solution at a concentration of 200 mg/L was then passed through the column. The length of the column was 0.5m. The seepage velocity was 0.0005m/sec. After 500 seconds the water eluting from the column has 2.0mg/l of chloride, after 770 seconds it was 40 mg/L. and after 1350 seconds it was 170 mg/L. Calculate the value of D_L and α_L for the soil in the column using each of those three measurements separately. Do the results agree with each other?

2 (20). In a column tracer test, a NaCl solute is used. The length of column is 100 cm, the source concentration of Chloride ion is C_0=100mg/l on the left hand side of the column, and pore velocity of flow (v) in the column is 1cm/min. The dispersivity of the porous medium is found to be 1cm for course sand used inside the column. Samples are taken at the exit of the column to determine the concentration. Answer the following questions:

(a) When will you observe the concentration of C=5mg/l at the exit?
(b) When will you observe the concentration of C=16mg/l at the exit?
(c) When will you observe the concentration of C=84 mg/l?

3 (15). A train derails and a tank car leaks its contents onto the ground. The car is carrying phenol. When the phenol reaches the water table it has a concentration of 189 mg/L. There is a private well located 40 m directly down gradient from the location of the spill. The area of the spill is 115 m^2. The average linear groundwater velocity is 0.125 m/day. What would the concentration of phenol be in the private well after 255 days? Assume D_T=0.1D_L and assume the aquifer is shallow enough to ignore the dispersion in the vertical direction (thus a 2-D model can be used). The longitudinal dispersivity is assumed to be 5 meters.

4 (15). A manufacturing facility that manufactures printed circuit boards puts wash water that was used to wash solvents from the circuit boards into an underground tank that discharges into groundwater. The wash water contains 7.34 mg/L of dissolved trichloroethylene (TCE). The daily rate of discharge is 13.6 m^3/day. The underlying aquifer has an average linear groundwater velocity of 0.34 m/day. The discharge has been going on long enough so that steady state conditions have been reached. Assuming no degradation of the TCE, what is the concentration at a monitoring well located x=22 m, y=2 m down gradient of the underground tank discharge. Assume D_T=0.2D_L. (hint: treat the underground tank as a vertical line source here (an injecting well)). The thickness of the aquifer B=1m. The longitudinal dispersivity is assumed to be 5 meters.

5 (15). Explain what is the advective flux, mechanical dispersive flux, and diffusive flux. How to calculate them?

6 (20). Explain the procedure to measure the dispersivity in the lab.

7 (33). In a column tracer test, two reactive solutes A and B are used. These two solutes follow the linear sorption scheme and the solute A has a retardation factor of R=1.25, and the solute B has a retardation factor R=2. The length of column is 100 cm, the source concentration of the solute is C_0=100mg/l on the left hand side of the column, and pore velocity of flow (v) in the column is 1cm/min. The dispersivity of the porous medium is found to be 1cm for course sand used inside the

column. Samples are taken at the exit of the column to determine the concentration. Answer the following questions:

(a) What are the average contaminant transport velocities for solute A and solute B respectively?

(b) When will you observe the concentration of C=5mg/l at the exit?
(c) When will you observe the concentration of C=16mg/l at the exit?
(d) When will you observe the concentration of C=84 mg/l?
(e) Comparing the results with those in Problem 2 of the Homework 3 to draw some conclusions.

8 (34). A manufacturing facility that manufactures printed circuit boards puts wash water that was used to wash solvents from the circuit boards into an underground tank that discharges into groundwater. The wash water contains 5 mg/L of dissolved trichloroethylene (TCE). The underlying aquifer has an average linear groundwater velocity of 0.2 m/day. The underground tank can be simplified as a patch source in a three-dimensional aquifer. The horizontal length of the tank is 10 meters long. The upper boundary is 1 meters below the water table, and the lower boundary is 5 meters below the water table. The thick gray clay is found to be 15 meters below the water table (i.e., the aquifer is 15 meters thick). The longitudinal dispersivity can be assumed to be 5 meters, the horizontal transverse dispersivity is 0.5 meters, and the vertical transverse dispersivity is 0.05 meters. The coordinate system setup is that shown in program ATRAN. Answer the following questions: (if possible, please show me your input file used in ATRAN)

(a) If the tank is regarded as a constant-concentration boundary, and assume the TCE is non-reactive, what is the concentration at a monitoring well located x=22 m, y=2 m, and 3 meters below water table down gradient of the underground tank discharge.

(b) If the tank is regarded as a constant-concentration boundary, and assume the TCE is reactive with a retardation factor of R=1.2, what is the concentration at a monitoring well located x=22 m, y=2 m, and 3 meters below water table down gradient of the underground tank discharge.

(c) If the underground tank is removed and source area is cleaned after leaking about 210 days, then repeated the above questions (a) and (b) respectively.

9. (33) Now this problem setup is identical to Problem 2 except that the underground tank is regarded as a constant-rate patch source. The leaking rate from the patch source is constant across the patch and is 2000 mg per day per m^2. Use the program of Park and Zhan (2001) (the name of the program is called CTINT, a Matlab program, which can be downloaded from Zhan's website). (If possible, please show me your input file used in CTINT)

Answer the same questions (a), (b), and (c) of above question 8.