Assignment #4 Cover Page

Name:

1 ______________________________

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#	Part A	Part B	Part C	Part D	Part E	Total
1	/5	/5	/2	/3	/5	/20
2	/3	/3	/2	/2		/10
3	/5	/8	/2	/5	--	/20
4	/10	/5			--	/15
Total						/65

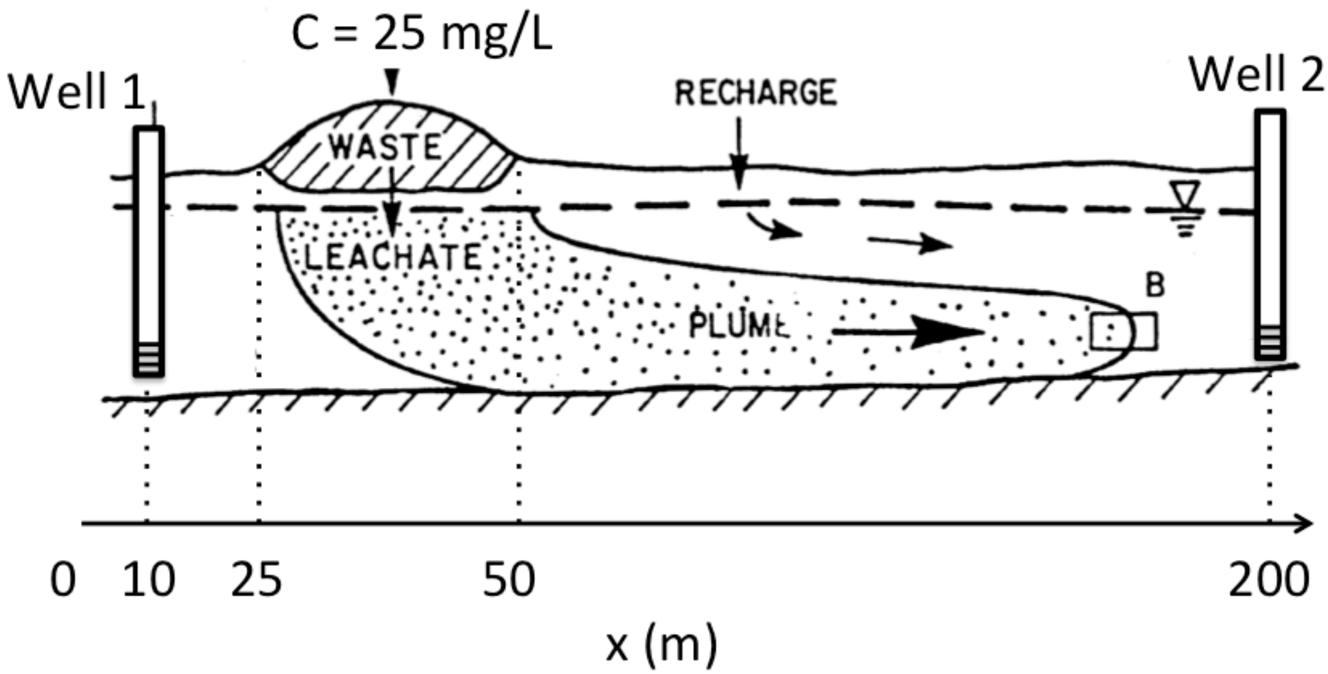
Note: All assignments must use this cover page (assignments will not be marked without the cover page).

Earth 458
Assignment # 4
Groundwater Contamination

Assigned: November 22, 2016
Due: November 30, 2016
Total Possible Marks: 65

Question 1 (in class)

An unlined landfill is leaking into the subsurface and creating a constant concentration plume with a concentration of 25 mg/L. The flow system is at steady state conditions with a mean groundwater velocity of 3.5E-6 m/s, and a hydrodynamic dispersion of 2.0E-7 m^2/s. The MCL (Maximum Contamination Limit) for this species is 5 mg/L. Assume 1D horizontal flow



A) Plot the breakthrough curves for Well #1 and Well #2 using the supplied ade.R code. (5 marks)
B) Plot the concentration distribution profile for 5 separate times. (5 marks)
C) Consider that plume is reactive and has a retardation factor of 2.5.
   -Plot the breakthrough curves and concentration distribution profile. (2 marks)
D) Now consider that the plume is an instantaneous source of 25 mg/L (R = 1).
   -Plot the breakthrough curves and concentration distribution profile. (3 marks)
E) Compare the results from A, B, C, and D. When do Wells #1 and Wells #2 exceed the MCL? (5 marks)

Question 2

A. Qualitatively describe the Advection Dispersion Equation. (3 marks)
B. Describe Fick's first law. (3 marks)
C. What is the influence of the retardation factor on a plume? (2 marks)
D. What is the role of porosity on the plume? (2 marks)

Question 3 (in class)

Assume that there is a hazardous waste landfill located in till deposits that contains a liquid waste that has concentration (C_o) of 100 mg/L (milligram per liter) of tetrachloroethylene (PCE) in it. Answer the following questions, using the following characteristics for the till (mean grain diameter = 4.0×10^{-4} cm) and PCE and assuming 1-dimensional vertical flow in the system shown in the figure.

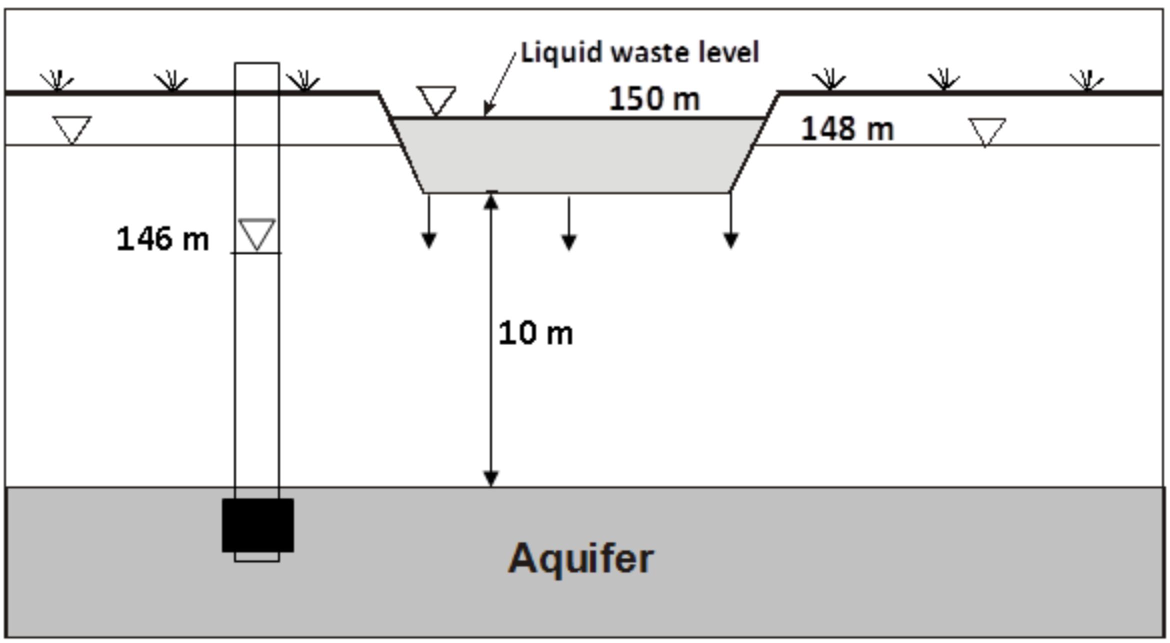


Figure 1. Hazardous waste landfill and water level information

Porosity (n) = 0.30
Hydraulic conductivity (K) = 2.0×10^{-7} cm/s
Longitudinal dispersivity (α_L) = 2.00 cm
Free solution diffusion coefficient for PCE in water (D_o) = 8.2×10^{-6} cm^2/s
Drinking water standard for PCE = 0.03 mg/L
Distribution Coefficient Kd = 0.49 cm^3/g
Bulk Density = 1.6 g/cm^3

A) How long would it take (in years) by a diffusion only process (no advection) for the PCE concentrations to reach the drinking water standard concentration at the top of the aquifer? (5 marks)

B) Calculate the time it would take with advection and dispersion. List your assumptions. (8 marks)

C) Compare your answers from a and b and calculate the Peclet number (Pe). Describe how the Peclet number relates to this problem. Discuss the relative importance of diffusion in the transport of PCE in this situation (2 marks)

D) Plot the break through curve at the aquifer. (5 marks)

Question 4

A student performed two types of tracer tests with four scenarios. In all the scenarios, the tracer concentrations at the sources are continuous and constant; for each case, the groundwater velocity is constant and uniform and the distance between source zone and measuring points are the same.

A) How would the breakthrough curves likely be if the following conditions are applied? Sketch the breakthrough curves for the following transport scenarios assuming the same distance to the measuring point for each case. (10 marks)
   i) Conservative tracer, advection-only.
   ii) Same conservative tracer as i), weak dispersion
   iii) Same conservative tracer as i), strong dispersion
   iv) Same dispersion as iii) but assume that the tracer is now reactive ($R = 2$).

B) Compare the tracer test results (i.e. scenario ii, iii, and iv) with that of scenario i). Explain why the breakthrough curves are different for each case? (5 marks)