CE 5364 Groundwater Transport Phenomena
Exam 1 (Alternate) , Fall 2024

Students should write their name on **all sheets of paper**.
Students are permitted to use the internet to help answer questions.
Students are permitted to use their own notes and the textbook.
Students are **forbidden** to **communicate with other people** during the examination.

1. Provide short answers to the following questions:

   a) What is an adsorbtion isotherm?

   b) Why is it important in contaminant hydrology?

   c) What is the advection-dispersion equation?

   d) Why is it important in contaminant hydrology?

2. Consider the concentration profiles in Figure 1. The elapsed time, 10 days, is the time since the injection of a constituient bolous. Assuming the porosity is 0.50 and the initial mass of constituient is 200 mg. Determine:

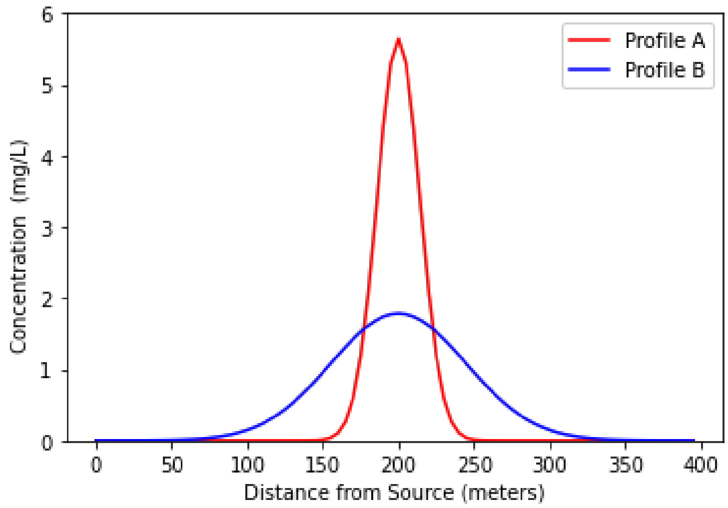


Figure 1: Concentration profile(s)

(a) The profile (A) or (B) that indicates greater dispersive behavior.

(b) The model that describes the type of transport indicated by the profile.

(c) The pore velocity and apparent dispersion for each profile.

Continued (show work here)

3. Consider the concentration histories in Figure 2. The elapsed time is the time since the release of the constituients. The observation location is 100 meters away from the source zone. Determine:

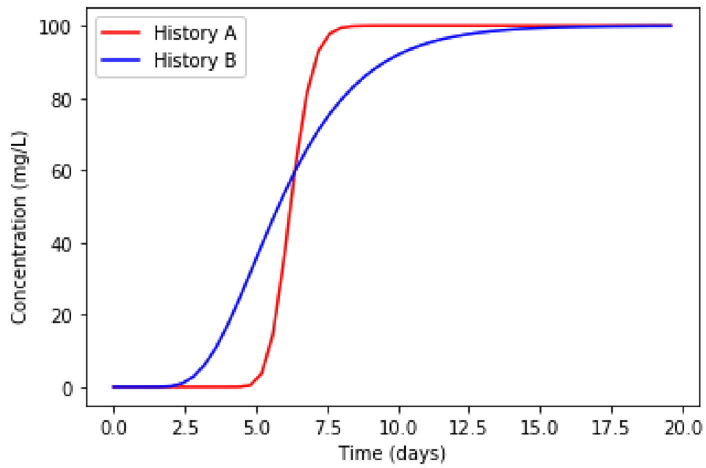


Figure 2: Concentration histories

(a) The history (A) or (B) that indicates greater dispersive behavior.

(b) The model that describes the type of transport indicated by the history.

(c) The pore velocity and apparent dispersion for each history.

Continued (show work here)

4. Assume that one-dimensional transport tools are adequate to simulate the transport of a contaminant through an aquifer depicted in Figure 3 For each situation described

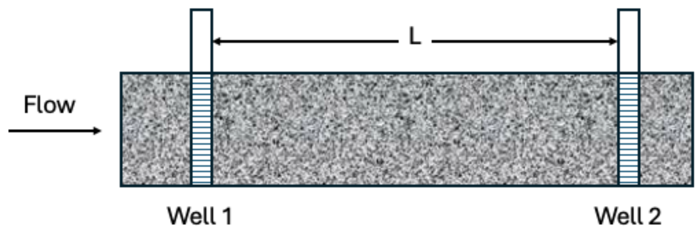
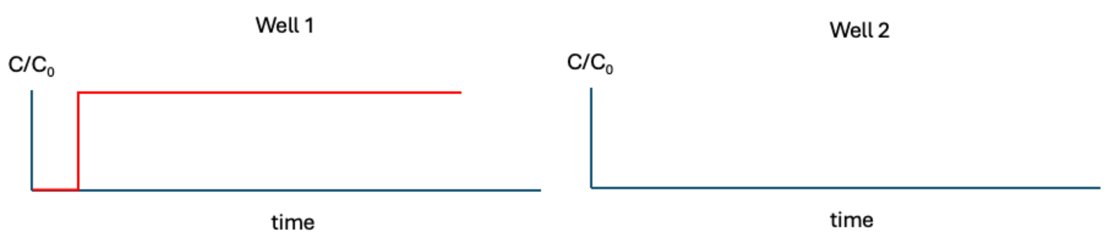


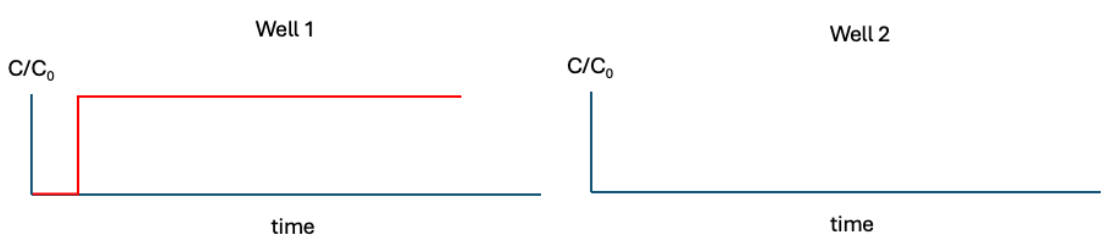
Figure 3: Aquifer Schematic

below, write the governing equation(s) (not the solutions) describing the transport (and any reactions). Sketch the expected concentration history at Well 2 for the history given at Well 1.

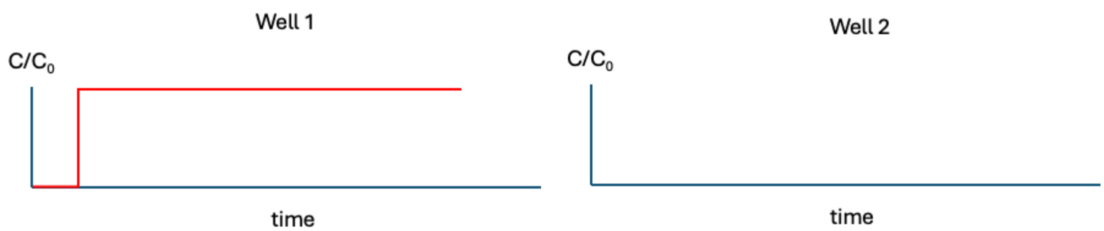
(a) Constant source; no dispersion, reactions, or decay.



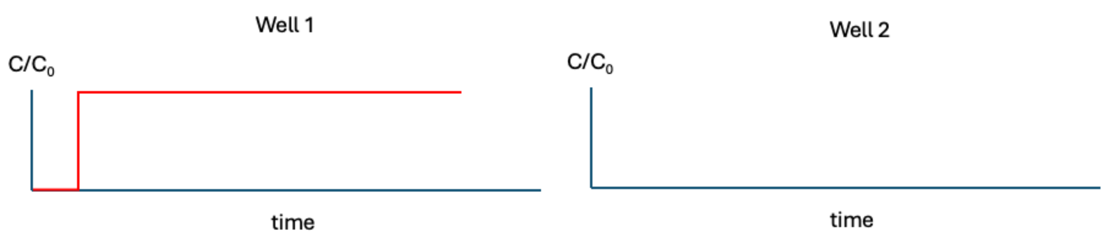
(b) Constant source with dispersion, no reactions, or decay.



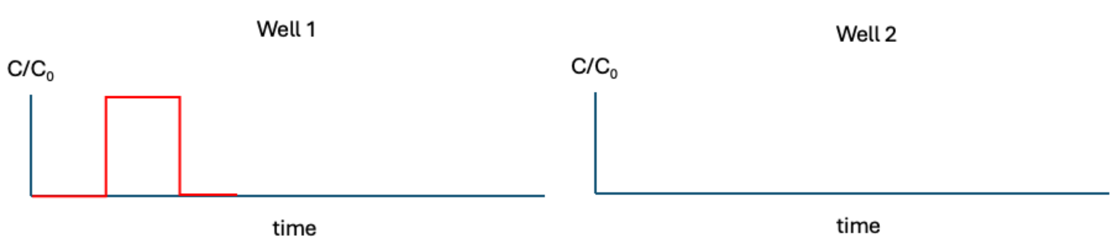
(c) Constant source with dispersion, linear equilibrium adsorbtion, but no decay.



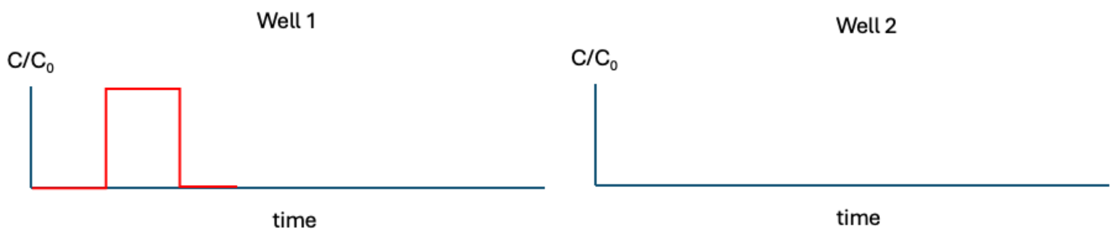
(d) Constant source with dispersion, linear equilibrium adsorbtion, and 1st-order decay.



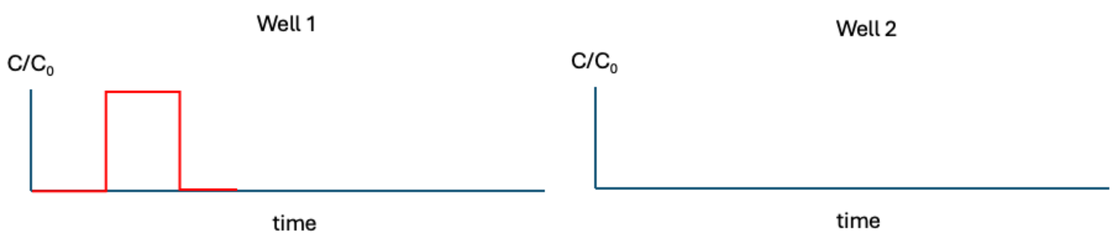
(e) Finite duration source; no dispersion, reactions, or decay.



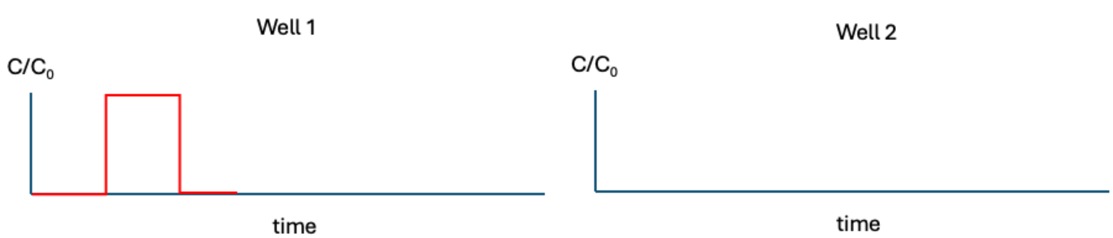
(f) Finite duration source with dispersion, no reactions, or decay.



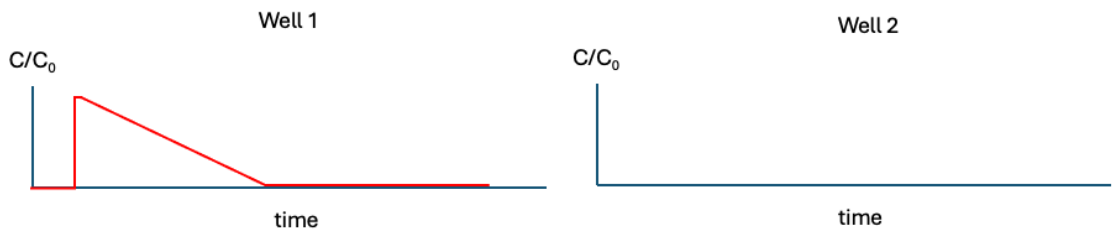
(g) Finite duration with dispersion, linear equilibrium adsorbtion, but no decay.



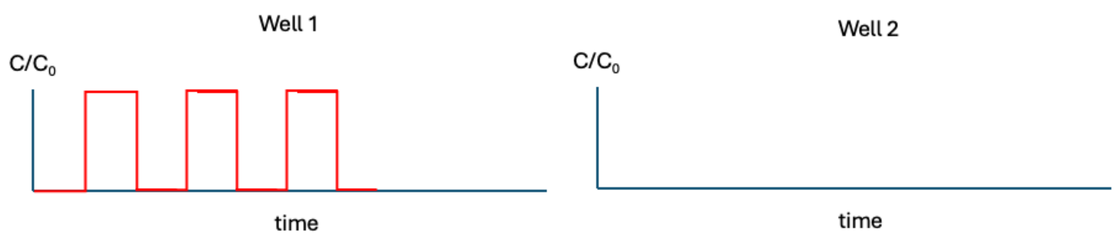
(h) Finite duration with dispersion, linear equilibrium adsorbtion, and 1st-order decay.



(i) Declining source with dispersion, no reactions, or decay.



(j) Sequence of finite duration sources with dispersion, no reactions, or decay.



5. Figure 4 is a plot of concentration histories of constituients introduced into a 1-meter long column at $t = 0\ minutes$, $x = 0\ cm$. Species 1 is known to be conservative and non-reactive (with the aquifer solids).

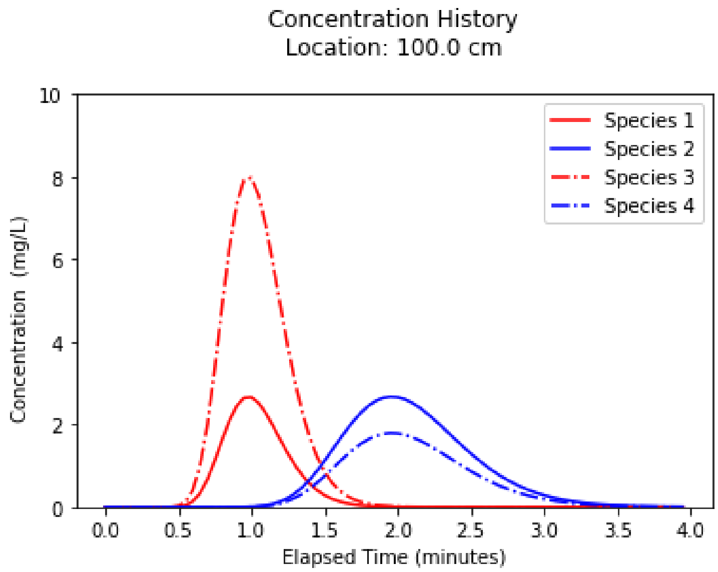


Figure 4: Concentration histories in a porous column

Determine:

a) The specific discharge if the porosity is 0.30.

b) The distribution coefficients (assume linear, instantaneous, equilibrium adsorbtion isotherms) for species 2, 3, and 4, if the solids density is 2.97 $\frac{g}{cc}$.

c) An estimate of the dispersion coefficient for species 3

d) Predict the concentration history for species 3 at $x = 50\ cm$

6. Figure 5 is a schematic of a rectangular excavation cut into surface clay for a sewer pipe which was placed, then backfilled with sand. The hydraulic conductivity of the sand is 20.0 $\frac{ft}{day}$. The hydraulic gradient in the sand is 0.1. The porosity of the sand is 0.30. The longitudinal dispersivity of the sand is 10.0 $\frac{ft}{day}$. The sewer leaks and introduces a steady input of water (that causes the hydraulic gradient) located at the access shaft at a concentration of 1000 $\frac{mg}{L}$ of some constituient. The consituient has a retardation factor of 2.0.

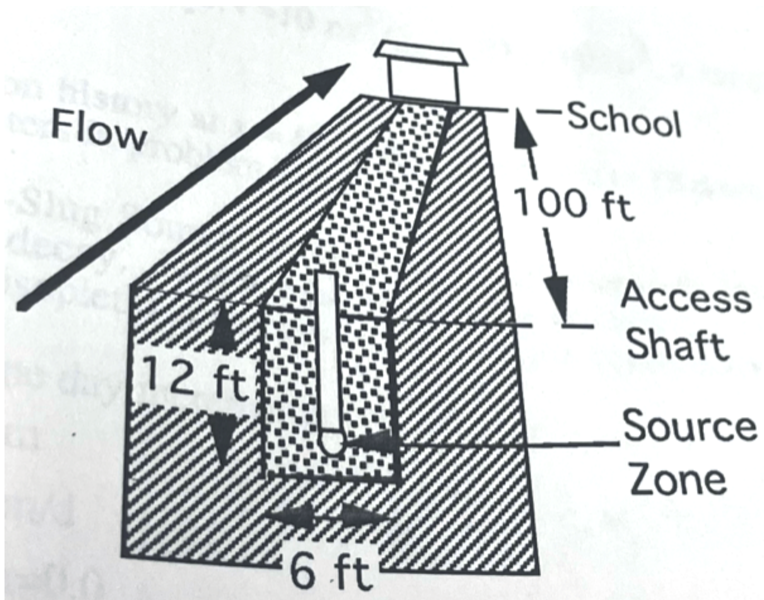


Figure 5: Sewer Pipe Trench near a School

Determine:

The concentration 100 feet away from the release in the sand near the school yard 6,16,25,and 75 days after the leak begins.