CE 5364 Groundwater Transport Phenomena
Exam 2 , Fall 2024

Provide short answers to the following questions:

1. Distinguish between the application of a numerical groundwater transport model as a predictive tool and as a screening tool. Which type (predicitve or screening) of model use takes more effort by a model user?

2. Explain why it is important to have a proper conceptual model of the system to be simulated before moving forward to discretization and selection of parameters.

3. Explain how MODFLOW6 and FloPy allows the user to establish the initial concentration distribution in a similation domain. Is the approach generic to where it can be applied for other initial conditions or parameters?

4. Describe how one could determine particle travel times from an initial location or the particle until its exit point from the solution domain? Does MODFLOW6 and FloPy have necessary tools to make such calculations?

5. What are the four types of transport processes that MODFLOW6 readily simulates?

6. What four types of site characterization information can be obtained from consturction and use of a monitoring well?

7. Suggest four possible sources of soil characteristic curve data that may be used when describing flow and transport in the unsaturated zone.

8. Explain the concept of capillary pressure head for water in the unsaturated zone. Why is it negative?

9. Identify and describe three main categories of groundwater and soil remediation, including approaches for containment, source control, and mass reduction.

10. Explain the concept of entry pressure as it applies to DNAPL movement through the capillary fringe.

11. Distinguish between the conditions for DNAPL residuals in the unsaturated zone, saturated zone, and free phase zone. Which zone tends to have the highest DNAPL saturation? Which zone tends to have the lowest?

12. Describe a possible groundwater contaminant situation in which the application of a structural containment barrier would be appropriate. State what type of barrier you would specify.

13. An LPST site has been characterized for subsurface total petroleum hydrocarbons contamination in ths soil and groundwater. The impacted aquifer is unconfined, and the subsurface sediments have an average porosity of 0.37 and bulk density of $130 \frac{lb}{ft^3} (2080 \frac{kg}{m^3})$

The free phase LNAPL (specific gravity = 0.80) has been found in several monitoring wells, and the average thickness of LNAPL in the monitoring wells was 1.50 ft. The estimated extent of the LNAPL lens is about 40 ft. by 60 ft, and the average LNAPL saturation in the lens is estimated at 0.75.

Determine:

(a) The thickness of the free phase LNAPL in the formation in ft.

(b) The volume of LNAPL in the free phase in gallons.

14. Continuing with the previous scenario. Residual TPH concentrations in the soil beneath the leaking tank pit were found to average 2500 mg TPH/kg soil. These residuals lie beneath the pit area of 20 ft by 40 ft and extend from the bottom of the pit downward 25 ft to the capillary fringe/water table.

Determine:

(a) The mass of TPH in the unsaturated zone in kg.

(b) The volume of TPH in gallons.

15. Continuing with the previous scenario. A plume of contaminated groundwater has also been delkineated. The plume is 200 ft. long, 80 ft. wide and extends across the saturated thickness of the aquifer, which is 80 ft. The average concentration in the plume is 0.50 mg/L.

Determine:

(a) The mass of TPH in the saturated zone in kg.

(b) The volume of TPH (not the water) in gallons.

16. Continuing with the previous scenario. The site owner estimates from inventory checks, that 3500 gallons of fuel are lost.

Determine:

(a) If this estimate compares well with your results.

(b) What other fates of hydrocarbons have not been accounted for in the estimates above.

17. Groundwater samples have been collected quarterly for the last 18 months and analyzed for TCE in parts per billion. The table lists the results for one monitoring well.

Table 1: TCE Observations in an Aquifer

Date	TCE (ppb)
3/2019	15
6/2019	12
9/2019	28
12/2019	16
3/2020	10
6/2020	30

Determine:

a) An appropriate method to detect and quantify a trend for small sample sizes.

b) If the data show a trend.

c) If the trend is increasing or decreasing.