THE PENNSYLVANIA STATE UNIVERSITY
DEPARTMENT OF ENERGY AND GEO-ENVIRONMENTAL ENGINEERING
GEOEE 408 CONTAMINANT HYDROLOGY

Mid-term Examination – Tuesday March 1st, 2005 – 75 minutes
Answer all three questions.
For water: $\sigma = 7.3 \times 10^{-2}$ *N/m*; $\mu = 1.12 \times 10^{-3}$ *N.s/m*^{2}

Name: _____

Question	Points	Score
1	100	
2	100	
3	100	
Total	300	

Include extra sheets, as needed, and return entire packet

Question 1

Define the following terms, and identify the units [MLT] of the quantity, where relevant. Be as specific and as exhaustive in your definitions as possible.

1. Effective saturation, S_e .

2. Darcy's law, written in terms of pressure gradients.

3. Capillary pressure, p_c .

4. Diffusion coefficient, D .

5. Effective moisture content, θ_e .

6. Advective velocity, v_a .

7. Critical ganglion height, $h_{\min}$.

8. Permeability, k , and hydraulic conductivity, K .

9. Suction Lysimeter.

10. Hollow stem auger

Question 2

At the scale of a few meters the bulk fracture permeability of rocks at Yucca Mountain is of the order $k = 10^{-14} m^2$. Matrix permeabilities are so low ($k = 10^{-18} m^2$) that they can be ignored.

1. Evaluate the height of fluid that may be held in vertical fractures of uniform spacing of $0.2 m$. Vertical fracture sets strike both E-W and N-S, at the same spacing.

2. What is the corresponding magnitude of van Genuchten's α parameter? Define the units.

3. If the relative permeability of the wetting fluid, $k_{r_w} = 0.8$, at 70% water saturation of the vertical fractures, what is the volumetric flow rate in the vertical direction per unit plan area of $1 m^2$. The vertical gradient is $\partial h / \partial z = 1$.

4. How does this flux compare with the net infiltration at the site, equivalent to rainfall of $5 mm / yr$.

Question 3

A dissolved plume of Trichlorobenzene (TCB) is detected in sands and gravel present at the site of a semiconductor plant. The form of the plume is as shown in the figure, where isopleths are in ppb. You have been retained to determine the source of the plume. Assume the aqueous TCB component is conservative.

1. A potential source for the plume is a pulse spill of TCB that occurred 10 years previously. Is it possible to suggest the possible coordinates of the source? State your assumptions. If not, what additional data are needed?

2. The regional hydraulic head gradient is measured as 0.01. Hydraulic conductivity of the material is $K = 10^{-3} cm/s$, and mean porosity is $n = 25\%$. Are you able to estimate the coordinates of the source?

3. Where will the center of mass of the plume be in a further 5 years?

4. If you wished to have greater constraint on both the source location and where the plume will be in 5 years time, what information would you desire?