2018/08/03

Final Exam
Geo-environmental Engineering

Answer the following questions as much as you can (you can use the backside of the sheet)

1. Briefly explain the following terms about hydrogeology and geo-environment. For the explanation you may draw a key sketch about the terms. (30)

   1) Dacry's law, 2) hydrodynamic dispersion coefficient, 3) Soil vapor extraction

2. Consider a deep pit solid waste disposal facility constructed in 18m thick horizontal saturated clay layer as shown in Fig.1. Underneath the clay layer, there is a sand aquifer with constant thickness (10m). In the waste leachate, two chemicals, lead (Pb) and chloride (Cl) are dissolved in relatively high concentration. Two monitoring wells are installed at the upstream side (Well_1) and downstream side (Well_2). Using the hydrogeological conditions and the others given below, answer the following questions. (50)
   - Datum line to define the elevation head: Ground surface z=0m
   - Leachate level in the pit: Ground surface
   - Hydraulic conductivity of clay: K=10^{-9}m/s,
   - Porosity of clay: n=0.5; density of clay grains: ρ_s=2.6g/cm^3,
   - Effective diffusion coefficient of clay: D_m=2x10^{-9}m^2/s,
   - water depths of Well_1 and Well_2: 5m and 9m from the ground surface,
   - In the sand layer, horizontal flow can be approximated from Well_1 to Well_2.
   - One dimensional vertical flow can be assumed in the 3m thick clay beneath the pit.

   (1) How much are the void ratio (e) and moisture content (w) of the clay?
   (2) How much is the transmissivity of sand layer?
   (3) How much are the elevation head (h_e) and pressure head (h_p) at points A and B respectively?
   (4) How much are the hydraulic gradient and interstitial velocity in the sand layer?
   (5) How much is the interstitial velocity of the downward flow in the clay under the pit center?
   (6) Calculate the average time (years) for a pollutant to reach the bottom of clay liner in the case with no dispersion condition, assuming zero concentration as the initial condition in the clay.
   (7) Explain why the mechanical dispersion can be negligible in the process of contaminant transport in the clay.
   (8) From the monitoring at Well_2, which chemical will be first detected, Chloride (Cl) or Lead (Pb)? Also explain the reason of the answer.
   (9) Finding the risk of ground water contamination in this site, propose the countermeasures against the risk.

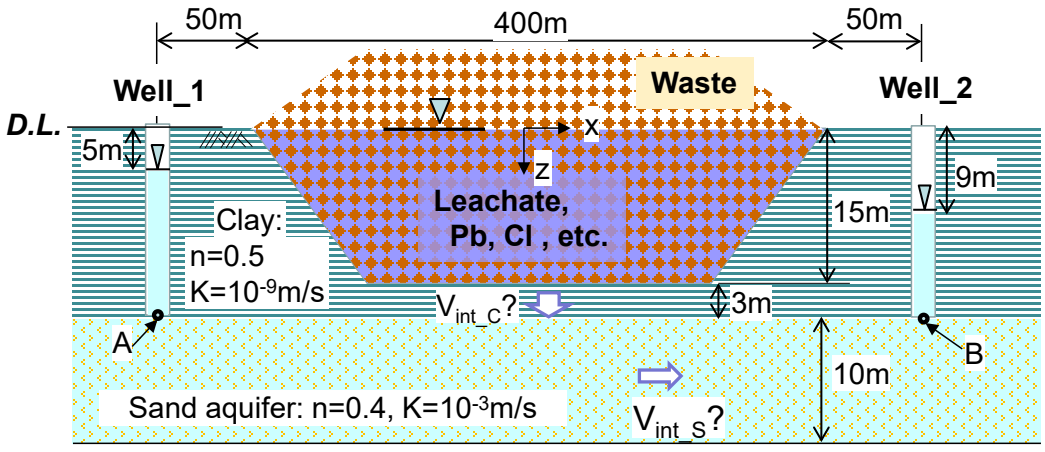

Fig.1

3. Fig.2 shows a result of tracer test as a form of concentration contours of tracer plume obtained at different times (30days, 60days, 120days). Non-reactive and conservative tracer was used. Two dimensional, advective-dispersive and non-reactive transport under a steady state ground water flow in a homogeneous and isotropic confined aquifer with constant thickness can be assumed in this test site.

Discuss the dominant transport mechanisms of the pollutant (among advection, molecular diffusion, and mechanical dispersion) in this specific site with proper reasons. (20)

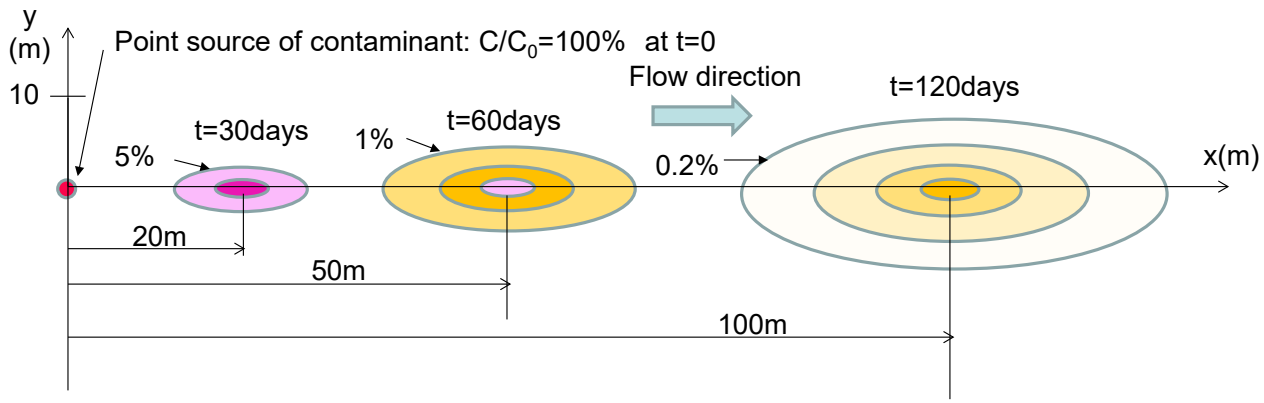

Fig.2

4. There is a former site of chemical factory with waste piles on the ground surface. As this waste contains hazardous chemicals, such as benzene, arsenic, this land is designated as a contaminated site for which the land owner or the polluter should take necessary action to prevent the harmful effects to human health and the surrounding environment. Fig.3 shows the ground conditions of the site, e.g,

- 15 meters from the ground surface is relatively permeable sandy soil layer,
- The ground water level of the top permeable layer is about 5 meters below the ground surface,
- Below the sandy layer a very low permeable thick clay layer exists.

With these conditions above, make plans of the necessary actions for the two objectives below respectively. (50)

(1) to prevent the harmful effects in economical manner,

(2) to revitalize this brown field for the positive use of this land, such as selling the land, or constructing residential or shopping complex.

In the plan making, you can presume any additional conditions, which could be reasons of the actions in your proposal. But the assumptions should be described accordingly.

***Key words for the plans**: risk evaluation, risk communication, prevention, cleaning, monitoring, economical feasibility,*

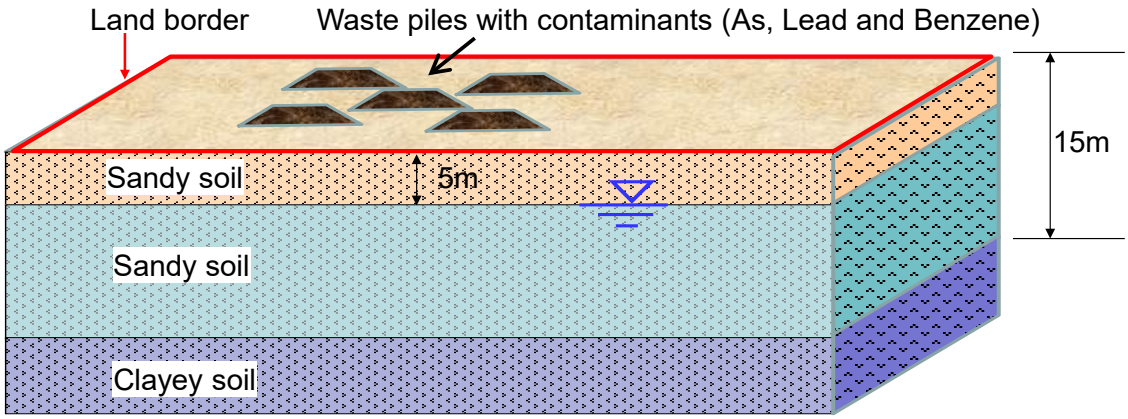

Fig.3