

National Exams May 2011

04-Env-B4: Site Assessment and Remediation 3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is an OPEN BOOK EXAM.
Any non-communicating calculator is permitted.
3. Answer:
 - a) THREE (3) of the SIX (6) questions in Section A
 - b) TWO (2) of the THREE (3) questions in Section B.

Only the first three and the first two questions in each section will be marked as they appear in the answer booklet.

4. Each question is of equal value at 20 marks.
5. Questions require calculation and/or answer in essay format. Clarity and organization of the answer are important.

Section A: Three out of the Six Questions

- A-1) Identify the various phases of a spilled organic chemical as it migrates through the unsaturated soil. Use appropriate equations to express the various phases. How are the various phases handled to ensure continuity and mass balances are maintained?
- A-2) A manufacturing facility that handled heavy metals, PCBs and a variety of organic solvents is being sold. Identify the type of samples that need to be collected as part of a Phase II investigation? How are these samples collected and stored for submission to the analytical lab?
- A-3) Discuss the benefits and challenges facing an environmental engineering professional in selecting and using a computer package to model site remediation efforts (typical Brownfield scenarios). List no more than three programs that could be used and discuss why you would use them.
- A-4) An underground storage tank leaks and releases 2000 L of gasoline in a sandy loam soil. The soil has a water content of 15% (wt), porosity of 0.48 and a bulk density of 1425 kg/m^3 . The bottom of the tanks is 3 m below grade, with the top of the unconfined aquifer 1 m below the tanks. Investigations have revealed floating product, groundwater contamination and soil contamination all in excess of government regulations. Describe the remediation plan that you would implement to restore the site to appropriate levels. The site use will change to commercial, with no retail gasoline allowed. The site is connected to all municipal services, including drinking water. Discuss why the various components are included.
- A-5) Describe the steps needed to submit a Record of Site condition for a Brownfield site undergoing remediation. The Brownfield site housed a metal plating factory and metal stamping plant. As a result, Cr-VI, Cr-III and hydrocarbons were released over the site. The site consists of silty loam, with the water table 6.5 m below grade. Chromium contamination (both species) was found to a depth of 1.7 m, while a variety of hydrocarbons have migrated all the way to the ground water table. The entire site is surrounded by residential housing, with the intended use of the redeveloped site to be high density housing. Drinking water is provided via the municipal system.
- A-6) An environmental impact assessment is required of a Brownfield site that previously housed an automobile assembly facility.
- Outline the biospherical environmental indicators that need to be considered, discussing why? Which one is more important?
 - What are the social and economic environmental indicators? Discuss their importance, and rank them.

Section B: Two out of the Three Questions

B-1) Two separate chemical spills of equal size (2000 L) occur simultaneously on different areas of an industrial property. Chemical 1 is trichloroethylene, with a viscosity of $0.6 \text{ mm}^2/\text{s}$. Chemical 2 is kerosene, with a viscosity of $2.4 \text{ mm}^2/\text{s}$. The soil is classified as sandy loam, has a water content of 20% (wt), porosity of 0.52 and a bulk density of $1350 \text{ kg}/\text{m}^3$. Soil temperature is 20°C . Which chemical travels further in the unsaturated soil? Why?

B-2) Ten tonnes of hydrocarbons were spilled on a site, which can be represented by hexane:



Soil conditions are sandy loam with a density of $1410 \text{ kg}/\text{m}^3$, porosity of 0.35 and water content of 25% (wt). If the spilled concentration is $3000 \mu\text{g}/\text{g}$ (dry basis), estimate the following:

- Air flowrate needed to promote bioventing. Assume that the O_2 respiration rate is 10% O_2/d .
 - Amount of nitrogen needed as NH_4^+ if C:N is 10:1
 - Identify and discuss any other operational factors that need to be controlled and monitored.
- B-3) Gasoline is spilled in a layer 2 mm thick on a road. The gasoline is made up of 2% benzene. Make a rough calculation of the time for the benzene to volatilize into the air. Assume a wind speed of 2 m/s 10 m above the ground. Assume all gasoline constituents volatilize at essentially the same rate so that the gasoline composition does not change significantly. The density of gasoline is $0.88 \text{ g}/\text{ml}$. Assume a temperature of 25°C and pressure of 1 atm. Use an air-phase mass transfer coefficient of $2000 \text{ cm}/\text{h}$.