National Exams December 2015

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 FIVE (5) 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.

6. Justify assumptions made.

Introduction to engineering, regulatory and management aspects of site assessments and restoration. Fundamentals and interactions between soils, groundwater, contaminants, and microorganisms. Site characterization and investigations. Monitoring and sampling strategies and techniques. Remedial action screening. Engineered solutions for site remediation including: physical, chemical, biological and in-situ and ex-situ techniques. Risk assessment. Brownfields. Computer modeling for assessment and remediation

Section A: **Three** out of the **Five** Questions

A-1) Crude oil was spilled at a railway marshalling yard (place where trains are shunted back and forth to change tracks). A derailment happened at one of switches, with the result being three tankers carrying crude oil tipped over and ruptured, releasing 200,000 L of crude oil. No fire or explosion occurred due to the quick response of the first responders. However, some water and fire retarding foam were released. The soil type for the entire property is clay, with a 0.3 m thick gravel layer on which the tracks are laid. There is a creek flowing along the entire east side of the property approximately 200 m away. Describe the sampling needed to determine the extent of the spill. Also comment and discuss how these samples are to be collected, where they are to be stored and how they are shipped to the analytical lab for analysis.

A-2) Describe the advantages and disadvantages of using *in-situ* and *ex-situ* remediation technologies to remediate a former munitions factory that comprised of 100 buildings on 500 ha. The contaminants on site are an assortment of strong inorganic acids, , metals, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, volatile organic compounds, pesticides, cyanide, and explosives. Identify technology or technologies that would be appropriate to remediate the site.

A-3) Describe the difference between Phase I and Phase II assessments. Comment on when and where they are used, and the ultimate information that they provide.

A-4) Discuss the advantages/disadvantages for remediating a Brownfield site. The Brownfield site is located in the central core of a typical Southern Ontario municipality.

A-5) Models are very helpful to an engineering consultant. Describe the parameters and mathematical relationships needed to model the release of gasoline from an underground storage tank, located in a typical Ontario gas bar. Comment on the challenges of obtaining some of these parameters.

Section B: **Two** out of the **Three** Questions

B-1) A drum recycling facility rinses empty toluene drums before sending them to a smelter. The drums are triple rinsed with water, with the resulting wastewater stored in a large aboveground tank, having a volume of 25,000 L. Analysis of the wastewater solution showed that the concentration of toluene was 500 mg/L. There was a sudden failure of the tank and the wastewater flowed into the retention dyke. The liner and dyke was made of clay, with the clay having a bulk density of 1300 kg/m^3, porosity of 50 %, water content at 15 % and f_{oc} of 1.5 %.

i) Assuming that the Freundlich Isotherm applies, with K_f = 0.2 L/kg, how deep does the wastewater penetrate in to the soil surface if the surface area is restricted to 35 m^2.

iii) Based on the penetration, what type of remediation would you recommend first?

iii) How would you classify the mobility of toluene in this soil?

B-2) A subsurface investigation was completed at a computer board manufacturing facility and the presence of trichloroethylene (TCE) was detected in the ground water. Analysis of the groundwater showed that the average concentration of TCE was 150 mg/L. Review of the company records revealed that approximately 3,000 L of TCE were unaccounted for in the degreasing building. A site investigation showed that the spill was located in a space of 3 m x 4 m x 10 m in the unconfined aquifer. Since the building is still in operation, pump and treat is the only remediation option available. The porosity of the aquifer is 0.3, with specific gravity of TCE at 1.47.

i) How long will it take the TCE to migrate away from the building if the groundwater flow was 0.03 m/d?

ii) How long would it take to remove the contamination if pump and treat was used to increase the groundwater flow rate to 0.3 m/d? Assume that the average concentration of dissolved TCE increased to 250 mg/L?

iii) Since 0.3 m/d is the maximum pumping rate for the aquifer, what else could be done to shorten the time to extract the TCE?

B-3) Approximately 200 kg of gasoline were spilled on a site. The soil was excavated into a pile approximately 300 m^3 in size to permit bioventing. The gasoline can be represented by C_7H_{16}. Soil conditions are sandy loam (Sand @ 62%; Clay @ 14%; OM @ 2.1 %, CEC @ 5.5 cmol/kg) with a density of 1400 kg/m^3, porosity of 0.35. water content of 25% (wt) and temperature 20°C.

i) How many air exchanges are needed to satisfy O_2 consumption and promote bioventing if oxygen conversion is 50% efficient?

ii) If the C:N ratio is 10:1, how many kg of ammonium sulphate ($(NH_4)_2 \cdot SO_4$) are needed to stimulate the microorganisms if the efficiency is 50%. (MWT N=14; S=32; O=16)

Marking Scheme

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1. 20 marks
2. 20 marks
3. 20 marks
4. 20 marks
5. 20 marks
6. (i) 11 marks; (ii) 4 marks; (iii) 5 marks
7. (i) 12 marks; (ii) 6 marks; (iii) 2 marks
8. (i) 13 marks; (ii) 7 marks