

## National Exams May 2013

### 09-MMP-A6, Mining and the Environment

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. FIVE (5) questions constitute a complete exam paper.  
The candidate may answer any five of the six questions posed.  
Only the first five questions as they appear in the answer book will be marked.  
An additional copy of any table or diagram to be completed is included at the end of the exam. These may be removed and inserted into the answer booklet.
4. Each question is of equal value (20 marks). Marks are allocated as indicated.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

**1. Basic terms and knowledge**

True/False. Answer each of the five questions below with a “true” or “false” in your answer booklet and provide a one to three sentence explanation of your answer.

/2 each

10 marks  
total

- a) In Canada mineral rights fall under federal jurisdiction.
- b) Federal environmental approval is normally required for mining projects in Canada.
- c) Fisheries are regulated by the provinces.
- d) Progressive reclamation is a requirement under the Mining Act in Ontario.
- e) Liquid effluent discharges from metal mining operations to water frequented by fish are allowed in certain concentrations and circumstances.

Define ANY FIVE of the following terms. One to two sentences, including equations where appropriate, are sufficient for each term. You may define any five terms, but only the first five definitions provided in the answer booklet will be marked.

Define FIVE of:

/2 each

10 marks  
total

- Phreatic surface
- Plasticity index
- Atterberg limits
- Creep
- Subsidence
- Financial surety/assurance (for reclamation)
- Freeboard
- Probable maximum flood

**2. Regulatory issues and management best practices**

20 marks  
total

Discuss the role of FIVE of the following in the regulation or management of mine waste materials and mine closure.

Your discussion should include the activities governed by the legislation/regulations or addressed by the voluntary guidelines, the responsibilities assigned to the mine operator, including engineering staff, and the powers held by the government, where applicable.

Discussion of each item should take four to eight sentences.

Select AT LEAST ONE of:

**Federal Legislation and Regulations**

- Canadian Environmental Assessment Act
- National Pollutant Release Inventory (under the *Canadian Environmental Protection Act, 1999*)
- Metal Mining Effluent Regulations (MMER) (under the *Fisheries Act*)

Select NO MORE THAN FOUR of:

**Industry Associations and Voluntary Guidelines**

- Canadian Dam Association – Dam Safety Guidelines
- Mining Association of Canada – Towards Sustainable Mining Tailings Working Group
- International Cyanide Management Code for the Gold Mining Industry
- International Council on Mining and Metals
- International Network for Acid Prevention-Global Acid Rock Drainage Guide

**3. Acid rock drainage**

- a) Provide a detailed description of conventional active treatment of acid rock drainage (ARD) impacted mine water (i.e., a water treatment plant).

10 marks

Your description should include an overview of the steps involved in the method, including relevant chemical reactions involved, a discussion of the benefits and disadvantages of the method, and an indication of the relative cost and effectiveness of the method when compared to other technologies.

Discussion of part (a) should take approximately ten sentences.

- b) The neutralizing potential ratio (NPR) is one of the indicators used in assessing the acid generating potential of an ore body.

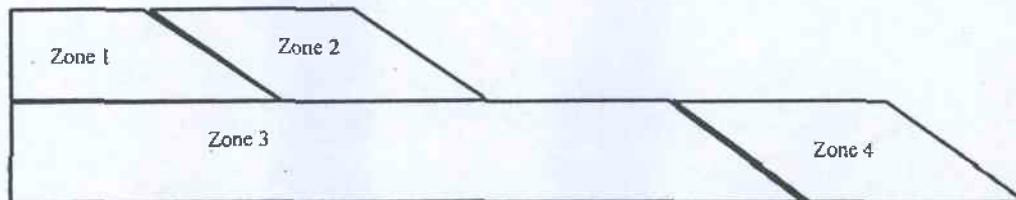
5 marks

- i. How is the neutralizing potential ratio calculated?
- ii. Complete the following table by identifying the ratio values used for each category (an additional copy of the table is included at the end of the exam).

NPR Value(s)	Potential for ARD	Interpretation
	Likely	Likely acid generating unless sulphides are non-reactive.
	Possible/uncertain	Possible acid generating if neutralizing potential is not sufficiently reactive or is depleted at a rate faster than sulphides.
	Non-acid generating	Not potentially acid generating unless there is significant preferential exposure of sulphides or extremely reactive sulphides in combination with insufficiently reactive NP (neutralization potential).

- c) The following cross-sectional diagram represents a generic approach to waste rock encapsulation as a means of preventing acid rock drainage. For each of the four zones indicated on the diagram identify the material type as acid generating, acid neutralizing, other, etc. Indicate the locations of any required covers or barriers on the diagram (an additional copy of the diagram is included at the end of the exam).

5 marks



**4. Reclamation and mine closure**

- 5 marks a) Reclamation of tailings dams may present special challenges due to difficulties in establishing suitable ground conditions for earth moving equipment. Identify three methods of limiting pond water collection and/or reducing pore water pressures in tailings impoundments.
- 15 marks b) Mine closure planning is a requirement of the mine permitting process in most jurisdictions in Canada. Identify what engineering investigations need to be considered in a closure plan for an underground mine in order to deal with hazards associated with the mine complex.

A table may be used to aid in answering this question.

**5. Tailings disposal options**

- 15 marks a) There are three common methods of raised embankment design and construction: downstream; upstream; and, centerline. Populate the following table and provide a cross-section sketch of each method showing embankment construction progression, beach location, pond location, and any other relevant features. An additional copy of the table is included at the end of the exam.

	Upstream	Centerline	Downstream
Embankment fill/construction material requirements			
Mill tailings requirements			
Suitability for water storage			
Seismic resistance			
Rising rate restrictions			
Methods for phreatic surface control			
Relative cost			
Sketch			

- 5 marks b) On the following cross-sectional sketch identify:
- i. the expected beach above water and beach below water slopes; and,
  - ii. the expected distribution of coarse and fine materials within the tailings beach and decant pond as a result of hydraulic separation (i.e. indicate horizontal and/or vertical variability of material grain size).

NOTE: The section is representative only, and is not to scale. An additional copy of the diagram is included at the end of the exam.



## 6. Dust and water issues

### Dust

- a) What are the primary human health and environmental concerns associated with dust from waste dumps and tailings impoundments? Include both metal and non-metal mining issues. Discussion should take five to ten sentences.  
5 marks
- b) Discuss two methods of dust control or dust suppression that can be used on waste dumps and tailings impoundments. For each method discuss the advantages or benefits of the method as well as any drawbacks. Four to six sentences should be sufficient for each method.  
5 marks

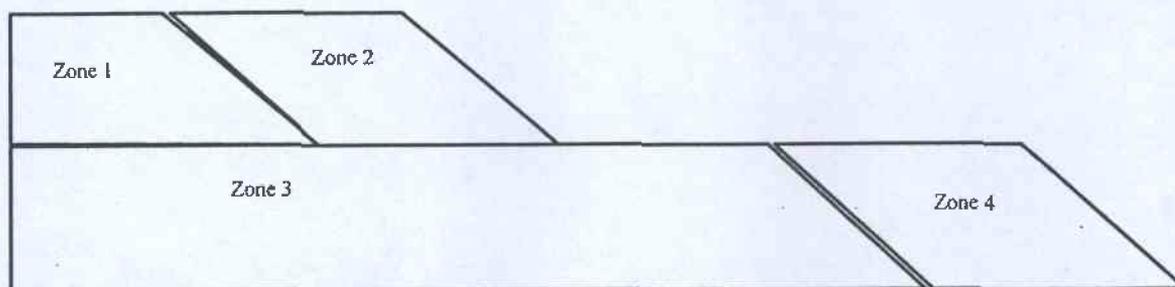
### Water Issues

- c) Sketch a basic water balance diagram for a surface impoundment tailings system showing the primary inflow and outflow sources. Identify how input and output water volumes could be measured or estimated.  
5 marks
- d) Discuss the use of TWO of the following techniques for seepage control from tailings embankments:  
5 marks
- Collector ditch
  - Cutoff trench
  - Slurry wall

For each method discuss the design considerations and criteria, the advantages or benefits of the method, and any drawbacks. Cost and material suitability should be considered. Four to six sentences should be sufficient for each method.

**Question 3. Acid rock drainage**

NPR Value(s)	Potential for ARD	Interpretation
	Likely	Likely acid generating unless sulphides are non-reactive.
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	Non-acid generating	Not potentially acid generating unless there is significant preferential exposure of sulphides or extremely reactive sulphides in combination with insufficiently reactive NP.



**Question 5. Tailings disposal options**



	Upstream	Centerline	Downstream
Embankment fill/construction material requirements			
Mill tailings requirements			
Suitability for water storage			
Seismic resistance			
Rising rate restrictions			
Methods for phreatic surface control			
Relative cost			
Sketch (Please use your exam booklet if more space is required)			