

## National Exams December 2014

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.
4. Each question is of equal value (20 marks). Marks are allocated as indicated.
5. For most questions full sentence OR bullet point responses can be used. In either case clarity and organization of the answer are important.

### 1. Basic terms and knowledge

True/False. Answer each of the three questions below with a “true” or “false” in your answer booklet and provide a one to two sentence explanation of your answer. No marks will be awarded if an explanation is not provided.

/2 each

6 marks  
total

- a) Mineral and mining rights fall under federal jurisdiction in Canada.
  - b) Federal environmental approval is required for most mining projects in Canada.
  - c) Mine sites in Canada are not allowed to discharge effluent to the environment.
- d) Define THREE of the following terms. One to two sentences should be sufficient for each term. Only the first three definitions provided in the answer booklet will be marked.

/2 each

Define THREE of:

6 marks  
total

- Hazard
- Consequence
- Plasticity index
- Atterberg limits
- Darcy's Law

- e) Discuss the role of any TWO of the following laws/regulations, industry associations, or guidelines in the regulation or management mine wastes and mine closure.

Your discussion should include the activities governed by the regulations or addressed by the industry guidelines or groups, the legal or best-practice responsibilities assigned to the mine operator, and the powers held by the government, where applicable.

/4 each

Discussion of each item should take four to eight sentences.

8 marks  
total

Select any TWO of:

#### **Federal Legislation and Regulations**

- Metal Mining Effluent Regulations (MMER)

### 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

### 2. Acid rock drainage-Characterization and formation

- 8 marks a) Briefly describe either the humidity cell test OR column test approach to geochemical characterization of materials with respect to acid rock drainage potential.
- Your answer should include a description of the test method and apparatus, identification of how the results of the method are used, and identification of the advantages or limitations of the method. The answer should take approximately 6 to 8 sentences.
- 8 marks b) Describe the sulphide oxidation process. Include the 3 chemical reactions involved in the oxidation of pyrite to form acid rock drainage.
- 4 marks c) Acid-base accounting is one method used in determining the potential for acid rock drainage production. Populate the following table with respect to the potential for ARD, where  $NPR = \text{acid potential} / \text{neutralization potential}$ . Identify the ARD potential for each

Potential for ARD	Initial Screening Criteria	Interpretation
	$NPR < 1$	
	$1 < NPR < 2$	
	$NPR > 2$	

NPR criterion and provide a brief interpretation/description of the indicated potential.

### 3. Reclamation and mine closure

6 marks a) Reclamation of tailings dams may present special challenges due to difficulties in establishing load-bearing ground conditions for earth moving equipment. LIST three methods of limiting pond water collection and reducing pore water pressures in tailings impoundments.

14 marks b) Mine closure planning is required to obtain and maintain a mining license in all Canadian jurisdictions. Identify what engineering investigations need to be considered in a closure plan for an underground mine in order to address the hazards associated with the mine complex (mine entry points, mine working areas, mine gas, groundwater, etc.).

Point form or a table may be used for this question.

### 4. Tailings disposal options

5 marks a) What are the primary differences between an embankment dam and conventional gravity, arch or buttress dams?

15 marks b) There are three common methods of raised embankment design and construction: downstream; upstream; and, centerline. Populate the following table with respect to each method and provide a sketch for each. A copy of the table is included at the end of the exam for mark-up and submission or you may recreate the table in your answer booklet.

	Upstream	Centerline	Downstream
Embankment Fill/Construction			
Material Requirements			
Mill Tailings requirements			
Suitability for Water Storage			
Seismic Resistance			
Typical failure mode			
Rising Rate Restrictions			
Relative Cost			

## 5. Dust, Water and Effluent

### Dust

5 marks a) What are the primary 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, and include consideration of the relative costs. Four to six sentences should be sufficient for each method.

### Water and Effluent

5 marks 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:

- Collector ditches
- Cutoff trench
- Slurry wall

For each method discuss the implementation of the method (i.e. the design), the advantages or benefits of the method and any drawbacks. Cost and material suitability should be considered. Four to six sentences of discussion should be sufficient for each method.

## 6. Risk Assessment and Management Principles

4 marks a) Tailings dam failures can have catastrophic results on the environment, communities, corporate finances and social perceptions of mining.

Identify two leading causes of modern tailings dam failures (e.g. post 2000).

- 16 marks
- b) Describe industrial best practice with respect to tailings dam safety inspections and reporting practices. You should identify the key activities involved in dam safety inspections and the reporting requirements. Your discussion should reference industrial best practice and the minimum regulatory requirements of the province or territory in which you practice or are writing this exam. You may also wish to reference the Canadian Dam Association's *Dam Safety Guidelines*, the Mining Association of Canada's suite of publications relating to tailings facility management, or other relevant guidelines.

Question 4

	Upstream	Centerline	Downstream
Embankment Fill/Construction Material Requirements			
Mill Tailings requirements			
Suitability for Water Storage			
Seismic Resistance			
Typical Failure Mode			
Rising Rate Restrictions			
Relative Cost			