

National Exams May 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.  
No 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 five 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  
10 marks  
total
- a) Subaqueous tailings disposal to fresh water lakes is allowable in Canada.
  - b) Mineral and mining rights fall under federal jurisdiction.
  - c) Federal environmental approval is required for most mining projects in Canada.
  - d) Mine sites in Canada are not allowed to discharge effluent to the environment.
  - e) Progressive reclamation is a requirement under the Mining Act, or equivalent legislation, in your Province.

Define ONLY FIVE of the following terms. One to two sentences should be 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
  - Standard Proctor Compaction Test
  - Darcy’s Law
  - Subsidence
  - Freeboard
  - Probable maximum flood

## 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 material with respect to acid rock drainage potential.
- Your answer should include a description of the test method, 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. Acid rock drainage-Neutralization and treatment

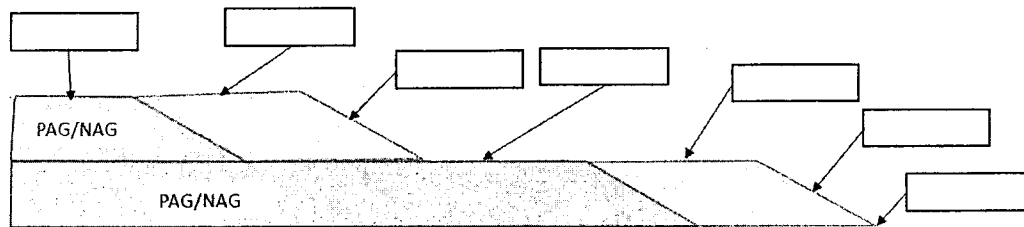
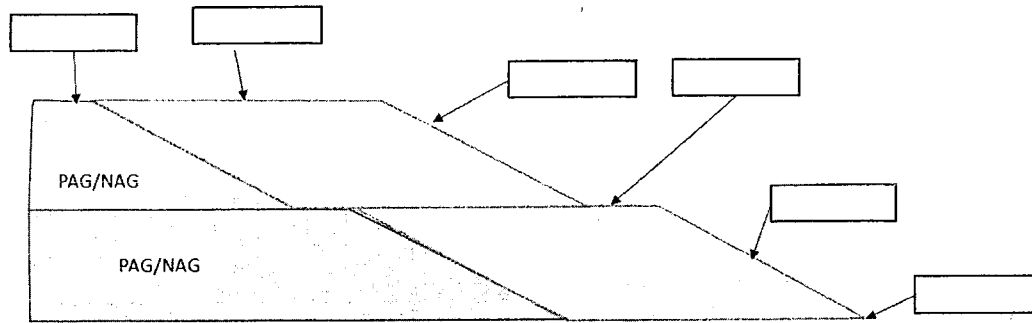
- 9 marks a) Provide a detailed description of the conventional active treatment of ARD impacted mine water using a water treatment plant.

Your description should include an overview of the method, including the 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.

Discussion should take approximately eight to ten sentences.

- 6marks b) The figures below represent a generic sample waste rock encapsulation strategy. Identify the location of potentially acid generating materials (PAG), potentially acid neutralizing or non-acid generating materials (NAG), and the dump cover requirements by populating the empty boxes.

A copy of this figure is included at the end of the exam paper for mark-up and submission with your exam booklet.



- 5 marks c) List five active or passive methods used in the prevention of ARD not discussed in a) or b) above.

#### 4. 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 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 marks b) Briefly discuss the benefits and issues associated with subaqueous tailings disposal in natural water bodies (lakes or oceans). Your discussion should include both technical and social issues and/or benefits.

Discussion should take five to ten sentences.

#### 5. Effluents and emissions

- 12 marks a) What are the primary environmental health concerns associated with the following substances:
- Polycyclic aromatic hydrocarbons
  - Mercury
  - Lead
  - Cyanide

Discussion should take three to five sentences each and include typical air and waterborne transmission mechanisms, human health effects and identification of the minerals most commonly associated with the substance.

- 8 marks b) Excluding water spraying, discuss one method of dust control used for open pit haul roads and one method used for active waste dumps or active 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.

**6. Failure modes and water issues**

- a) Tailings dam failures can have catastrophic results on the environment, communities, corporate finances and social perceptions of mining. Describe FOUR of the following failure modes. Include a description of typical causes and the physical failure process for each.

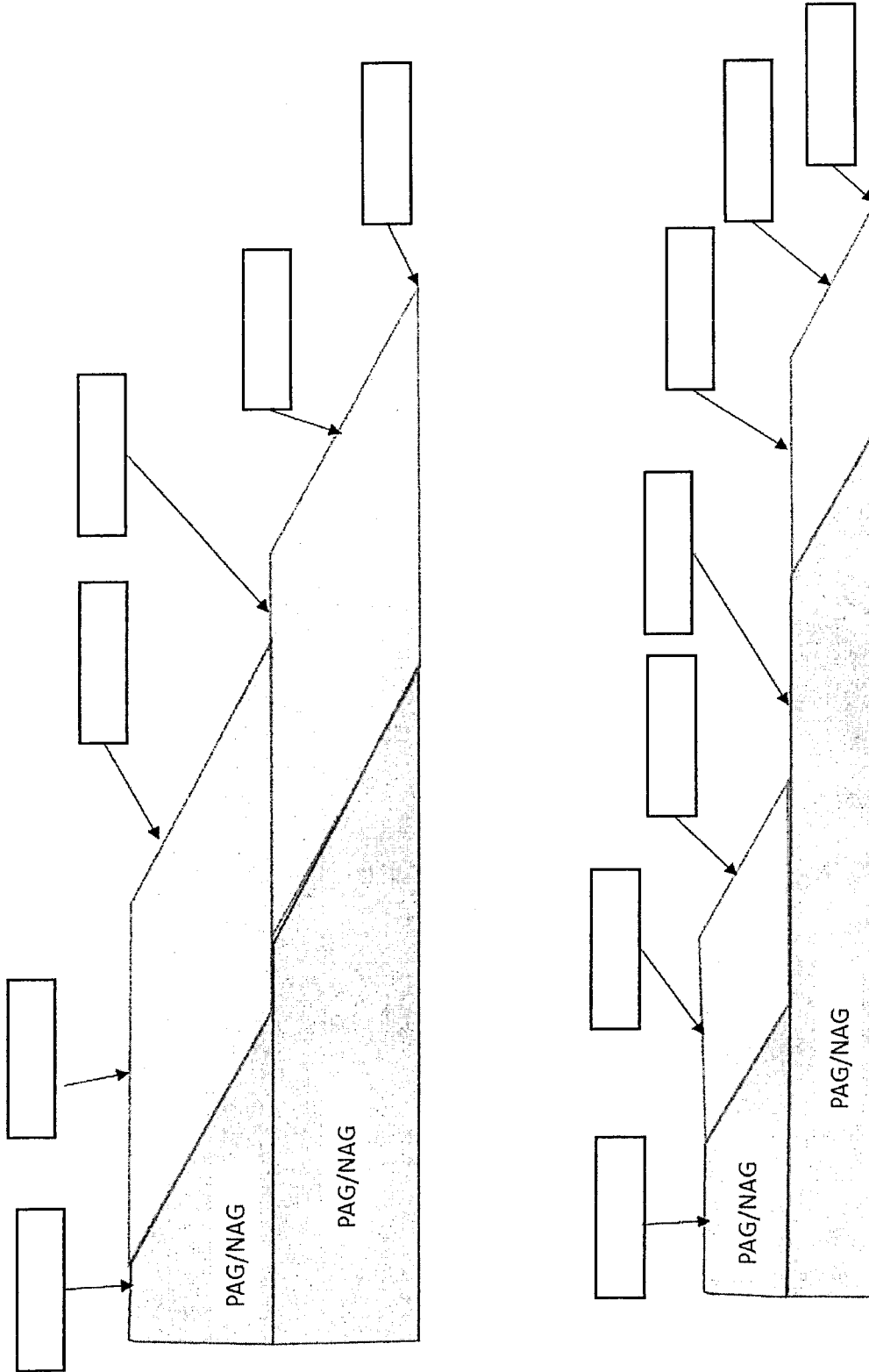
Select FOUR of:

- 10 marks
- Erosion
  - Foundation Failure
  - Liquefaction
  - Overtopping
  - Piping
  - Rotational Sliding

Four to six sentences should be sufficient for each mode and the use of diagrams is encouraged in describing the physical failure process.

- b) 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.
- 10 marks

Question 3



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			