

National Exams May 2011

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.

One of two calculator is permitted any Casio or Sharp approved models.
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 two to three sentence explanation of your answer.

- /2 each
10 marks
total
- Mineral and mining rights fall under federal jurisdiction.
 - Federal environmental approval is required for most mining projects in Canada.
 - Mine sites in Canada are not allowed to discharge effluent to the environment.
 - Progressive reclamation is a requirement under the Mining Act in Ontario.
 - Liquid effluent discharges from metal mining operations to water frequented by fish are allowed in certain concentrations and circumstances.

Define ONLY 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 laws/regulations or industry associations in the regulation or management of mine wastes and mine closure.

Your discussion should include the activities governed by the legislation or addressed by the industry 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 FIVE of:

Federal Legislation and Regulations

- Canadian Environmental Assessment Act
- Metal Mining Effluent Regulations (MMER)

Provincial Legislation, Regulations and Referenced Codes

- Mining Act Part VII / Mine Development and Closure Ontario Regulation 240/00
- Lakes and Rivers Improvement Act (LRIA)

Industry Associations and Voluntary Guidelines

- Mining Association of Canada – Towards Sustainable Mining Tailings Working Group
- International Council on Mining and Metals
- International Network for Acid Prevention: GARD (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.

Discussion in 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.

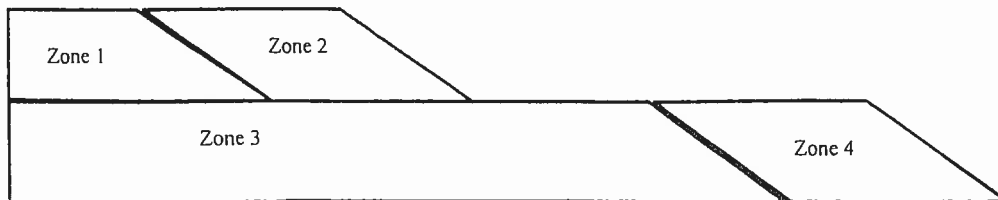
5 marks

- 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 material zones indicated on the diagram identify the material type. 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 Ontario. Identify what engineering investigations need to be considered in a closure plan for an open pit mine in order to deal with hazards associated with the mine complex.

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

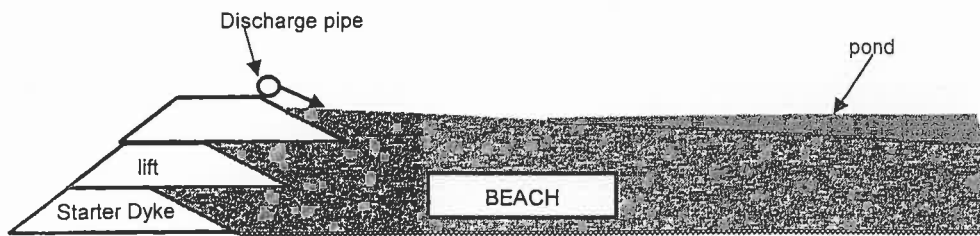
5. Tailings disposal options

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 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 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

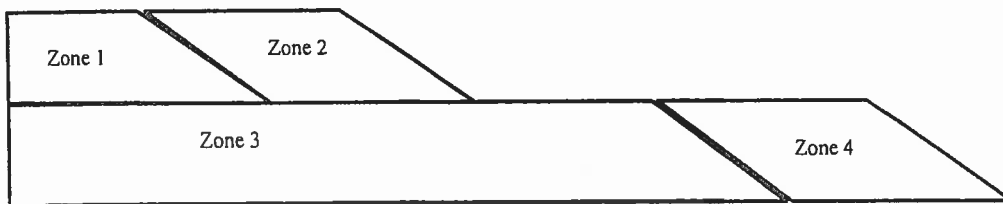
Water Issues

- 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 ditches
 - Cutoff trench
 - Slurry wall

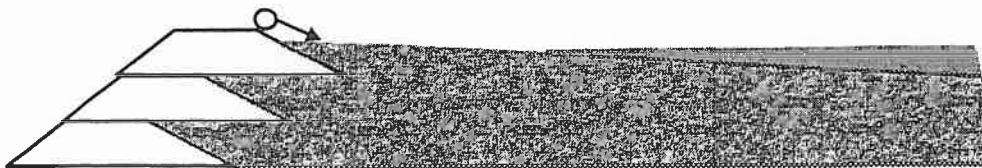
For each method discuss the implementation of the method (i.e. the design), the advantages or benefits of the method and any drawbacks. Cost and material suitability should be considered. Four to six sentences should be sufficient for each method.

Question 3. Acid rock drainage

| NPR Value(s) | Potential for ARD | Interpretation |
|--------------|---------------------|--|
| | Likely | Likely acid generating unless sulphides are non-reactive. |
| | 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. |



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) | | | |
| | | | |