

# HBT AGRA Limited

Engineering & Environmental Services

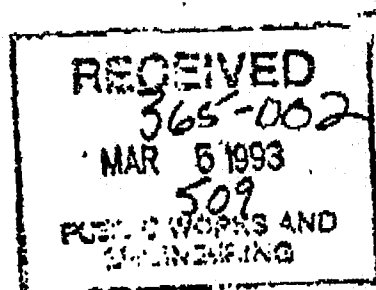
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March 4, 1993

The City of Yellowknife  
P.O. Box 580  
Yellowknife, NWT  
X1A 2N4

Attention: Mr. Dan Levert, P.Eng., LL.B.  
Director of Public Works



YK District  
WB

Dear Sir:

Re: Guidelines for Developing Terms of Reference -  
Arsenic Disposal: Giant Mine

HBT AGRA Limited (HBT) has been requested by the City of Yellowknife to review proposed guidelines developed by the Technical Advisory Committee (TAC) for the purpose of the guidelines is to assist the Royal Oak Mines Inc. in developing Terms of Reference (TOR) to address the disposal of arsenic wastes underground at the Giant Gold Mine.

It is HBT's opinion that the originally stated objectives may be perhaps too focused and could be used by Royal Oak to restrict their TOR. HBT presents for consideration by the Technical Advisory Committee a modified set of objectives with suggestions for achieving those objectives. These objectives are attached to this letter.

A review of the abandonment document submitted by Royal Oak Mines Inc. (February 1992) has identified several important issues that may be of concern to the TAC. Our comments with respect to these issues are contained in a separate letter.



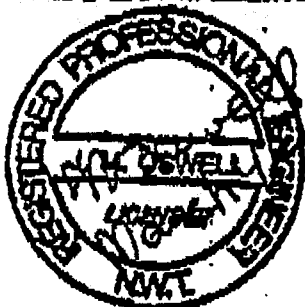
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- 2 -

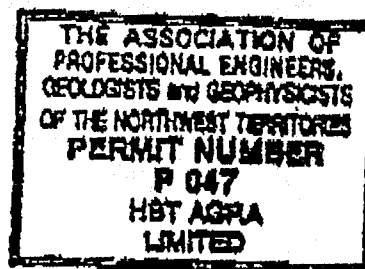
We trust this information is sufficient for your present needs. If you have any questions or require additional assistance, please contact our office.

Yours truly,

HBT AGRA Limited



J.M. Oswell, P.Eng.  
Project Engineer



Reviewed by:

Andrzej Slawinski, Ph.D., P.Geol.  
Principal Hydrogeologist

attachment

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- 3 -

**OBJECTIVES FOR A STUDY SUPPORTING A WATER LICENCE WITH  
RESPECT TO THE DISPOSAL OF ARSENIC IN THE UNDERGROUND STOPES  
OF THE GIANT MINE, YELLOWKNIFE, NWT**

It is understood that arsenic waste storage in the underground workings has been reviewed by a Federal CPEA Task Force (1977) and that a permanent underground disposal of these wastes by Royal Oak Mines Inc. is now being considered. An application for the water licence should be supported by a study that would address the potential for negative impacts of the stored wastes on the environment and human population in the short and long term perspectives.

Since the permafrost is an important controlling factor for groundwater flow, the thermal regime and its evolution should be addressed, including the scenario of global warming.

It is believed that the major components of the study should include the following:

1. An assessment of leachate generation should be made, and the concentration of arsenic, heavy metals and leachate acidity evaluated.
2. An appropriate mass transport (solute) model should be developed, and the leachate plume migration in both the transient, and steady-state mode evaluated.
3. A risk assessment should be carried out in order to evaluate the risk presented by this disposal method to the local population and environment. The risk assessment results may form the basis for the decision making process leading to the issuance of a water licence.
4. A monitoring program should be developed and presented, with any corrective or remedial measures identified in the event that the monitoring data is less favourable than predicted.

To achieve the above objectives, it is recommended that the following tasks be undertaken:

1. Establishment of a comprehensive 3D geological model which would include all underground facilities (stopes, shafts, adits, caverns, etc.). Formation characteristics and bulkhead construction records would have to be reviewed and evaluated as part of this task. In addition, the physico-chemical stability of the wastes as they would relate to waste-rock-water interaction should be assessed.

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- 4 -

2. Define the present geothermal regime in a 3D model all around the mine workings, extending well beyond the limits of underground workings.
3. Establish a 3D numerical model of heat transfer, and demonstrate how the permafrost will change with time, in the short, intermediate and long term. Consider the effects of remedial measures or interventions.
4. Based on the defined geological setting, formation characteristics and permafrost distribution, a hydrogeological 3D numerical model should be established and the short, intermediate and long term hydrogeological regimes simulated.

TOTAL