March 20, 1999

Mr. Philippe di Pizzo, Executive Director

Nunavut Water Board

P.O. Box 119

Gjoa Haven, N.W.T. X0E 1J0

RE: LUPIN MINE
REVIEW OF A & R PLAN AND RECLAMATION COST ESTIMATE

Dear Philippe,

INTRODUCTION

As requested, I have prepared this review of the Interim Abandonment and Restoration (A & R) plan and supporting documentation for the Lupin Mine. The mine is owned by Echo Bay Mines Ltd. It is understood that this review may be considered by the Nunavut Water Board in discussions with the company regarding ongoing A & R planning and security requirements for reclamation liabilities.

OBJECTIVES

The objectives of this review include:

- reviewing the A & R Plan to assess if it is conceptually viable and that the proposed reclamation measures are reasonable,
- reviewing the estimated cost of carrying out the reclamation work (assuming that the work were to be conducted on behalf of the government), and,
- identifying any requirements for studies, design work or reclamation trials that may be necessary in order to successfully complete the reclamation work.

INFORMATION SOURCES

The following information was examined in preparing this review of the reclamation cost.

- Initial Environmental Evaluation For The Lupin Gold Project, Contwoyto Lake, N.W.T., Feb. 1980,
- Abandonment and Restoration Plan, Water Licence N7L2-0925, Lupin Operations, January 1996,
- Letter from N.W.T. Water Board to Echo Bay Mines, Re: Interim Abandonment and Resortation Plan, April 4, 1996
- Letter from Fisheries and Oceans to Echo Bay Mines, Re: Interim Abandonment and Resortation Plan, March 7, 1996
- Land Lease 76 E/14-I-9 for Lupin Mine, Nov. 1997,
- Closure Cost Estimate and Scoping of Mine Closure Issues, Lupin Mine, N.W.T., by Golder Associates Ltd. and PCL Constructors Northern Inc., Dec. 1997,
- Echo Bay Mines Ltd. internal memorandum, re: Review of Lupin Closure Cost Estimate, Dec. 11, 1998,
- 1998 Annual Report, Echo Bay Mines Ltd. Lupin Gold Mine, Mar. 1999,
- Echo Bay Mines Ltd. Lupin Gold Mine, Renewal Water Licence Application, July 1999, and Supplementary Information, Oct. 1999,
- 1999 Geotechnical Inspection of the Tailings Containment Perimeter Embankments, Lupin Mine, Golder Associates Ltd., Oct. 1999,
- Screening Decision Report, Nunavut Impact Review Board, Re: Water Licence Renewal Lupin Mines, Nov. 1999,
- 24 color photographs showing an assortment of views of the Lupin Mine site, (date & photographer not identified).

I have not inspected the Lupin Mine site.

SITE DESCRIPTION

The mine is located on west side of Contwoyto Lake, approximately 400 km north east of Yellowknife. Access is by winter road or airplane.

Mining has been conducted by underground methods. Due to permafrost extending up to 400 m deep in this area there is no groundwater inflow to the mine. The crown pillar has

been mined. It is understood that the waste rocks are all acid consuming. Waste rock production is limited with most rock being used for backfill. However, waste rock has been used in the past for road construction.

The ore and tailings are potentially acid generating. Arsenopyrite, chalcopyrite and pyrrhotite are present in the ore and tailings. The tailings are disposed of in a number of cells located about six kilometres from the mine. The cells are defined by topographic features and eight dams. These dams range up to 600 m in length and 8 m above the original ground. This facility will not provide a water cover over all of the tailings to prevent acid generation. Initial reclamation, consisting of placement of a granular cover to establish permafrost in the tailings, of cells 1 and 2 has been conducted.

Infrastructure consists of the mill complex including the maintenance areas, headframe and hoist house, powerhouse and fuel tank farm, freshwater pump-house, warehouse, airstrip and offices. In addition, the residential complies consists of accommodations, kitchen and recreation centre. There also a number of quarries associated with the mine development.

A & R PLAN

Lupin Mine has submitted an Interim A & R Plan which describes the proposed activities to be carried out before and after the mine closes.

The reclamation plan involves sealing or backfilling the openings to the underground workings, covering exposed tailings acid generating with local granular material, and removal of buildings and equipment. It is expected that it will take three years to complete the reclamation work due to the time required to construct the cover on the tailings. In general, the A & R plan appears to be reasonably complete and the proposed reclamation measures are acceptable. Some aspects require further development as described below.

Covering the acid generating tailings is the most significant element of the A & R plan. The objective is to provide a cover which results in the establishment of permafrost in the potentially acid generating material. Some temperature monitoring data of the cover on the tailings in Cell 1 are presented in the July 1999 Water Licence application. The data show that freezing conditions have been maintained since late 1995 at a depth of 1.75 m. However, in an area where more granular material was placed the active layer extended to nearly 2m.

A cover thickness of 2 m is probably acceptable assuming the following two conditions are addressed:

1. the proposed cover material will have a grain size distribution which is not coarser than that which was used where the active layer was restricted to 1.75 m, and,
2. it can be demonstrated through modelling that unusually warm winters (such as 1999/2000) or the effects of global warming will not result in thawing of the tailings.

As the cells are covered any remaining supernatant which is not acceptable for discharge should be removed and treated.

Minor structural problems are noted in the 1999 geotechnical assessment with seven of the eight tailings dams. These problems include; erosion gullies, settlement depressions and tension cracks. In order to ensure long-term stability, these problems should be corrected. Additional material is required on the dams to address these issues.

Placement of non-salvageable equipment in the underground mine is proposed for waste disposal. Before this material is placed underground all hazardous materials (fuels, batteries and oils) should be removed from the equipment. Furthermore, it appears that there may be a problem with either the total storage capacity in the mine or the ability to effectively use the available space. Allowance for on-land burial of some demolition

waste, either over the mill foundations or over the crown pillar area, should be provided in the reclamation cost estimate.

The A & R plan states that there is contaminated soil associated with the air strip and fuel storage and handling. An audit of hydrocarbon contaminated soil should be conducted. The Government of Northwest Territory document: Guideline for Contaminated Site Remediation, (Feb. 1998), should be reviewed before preparing detailed plans for management of contaminated soil. Contaminated soils could be remediated on site. However, it could take many years due to the short summer season.

Efforts to re-establish vegetation where practical and where it previously existed should be planned.

OUTSTANDING REQUIREMENTS FOR STUDIES & RESEARCH

There are a number of studies and research requirements which must be conducted in order to prepare a final A & R plan. These include:

- Thermal evaluation of cover performance and demonstration of sufficient quantity of esker material with a suitable grain size distribution,
- Evaluation of revegetation strategy and anticipated effort,
- Inventory of equipment to be disposed of in the underground mine,
- Assessment of post-closure drainage water quality from the site.

RECLAMATION COST ESTIMATE

All of the comments presented here regarding reclamation costs are based on the assumption that Lupin Mine does not carry out the reclamation work and it becomes necessary for the government and land owners to hire contractors to reclaim the site. This approach is consistent with other assessments of reclamation costs for mining projects in Nunavut made on behalf of the government.

A cost estimate has been provided by Lupin Mine, initially by Golder Associates Limited (GAL) in association with PCL Contractors (PCL) in 1997, and subsequently revised by Lupin Mine staff in 1998. The GAL/PCL estimate appears to be based upon a detailed assessment of closure requirements and quantities of work for the various reclamation activities. Considering that the mine operations ceased in January 1998 it is assumed that the quantities of work, for those items addressed in the estimate, are essentially unchanged.

The there is considerable detail in the GAL/PCL estimate. In addition, the most costly element, the tailings cover, is supported by unit costs derived from previous contract work on the site and more recently by monitoring which demonstrates its effectiveness. Consequently, it is believed that there is little merit in repeating their work here. Therefore, the approach taken in conducting this review of closure costs is to evaluate the GAL/PCL estimate with respect to:

- general review of the unit costs and quantities of work,
- the cost for those items which were not included in the GAL/PCL estimate (as identified by the estimators),
- any adjustments to reflect the cost of work should it be necessary for the government to carry out the reclamation plan,
- any other omissions in the scope of work.

This evaluation is based on the assumption of no revenue to offset the cost of reclamation.

The unit costs in the GAL/PCL estimate for demolition of buildings and concrete removal appear to be reasonable. The unit costs in that estimate for remediation of contaminated soil are very low. The unit costs for earth work appear to be reasonable and are supported by previous contractor work at the site.

A spreadsheet which presents the estimated cost of reclamation, should it be necessary for the government to carry out the work is attached as Table 1. Key elements of the spreadsheet include the following features.

- A summary of the reclamation cost estimate as prepared by GAL/PCL in 1997.
- An adjustment of the 1997 estimate for work already completed.
- An adjustment of the 1997 estimate for not having to cover Cell 4 as tailings have not been placed in this area.
- An adjustment of the 1997 estimate for the effects of inflation up to 2000.
- Addition of a cost item for removal of hazardous materials from the underground mine and for off-site disposal of hazardous materials removed from equipment, buildings and fuel storage tanks.
- The unit cost for management of petroleum contaminated soils is low at only $\$9.14/m^3$. On-site bio-remediation of contaminated soils may cost up to $\$50/m^3$. In addition, there may be other contaminated soil on the site. Allowance for an additional 5000 m^3 of contaminated soil associated with the tank farm and fuel handling should included in the reclamation cost estimate. The amount allowed for in the GAL/PCL estimate is deducted from the adjusted amount to avoid double counting.
- Addition of a cost allowance for decontamination of pipes and tanks in the mill.
- Addition of a cost allowance for covering demolition waste over the mill foundations or backfilled stopes.
- Addition of a cost item for treating the tailings pond supernatant prior to placing the granular cover.
- Addition of a cost item for a quantity of rip rap to stabilize the tailings dykes.
- Allowance for revegetation of the area impacted by the Lupin Mine development.
- Winter road costs were not included in the GAL/PCL estimate. It is assumed here that the winter road would be required for a full winter for one of the reclamation years and that it would be used on a limited basis for two years. Limited basis use means

opening the road and maintaining it for a brief period, say 6 weeks for transportation of fuel and equipment to the site.

- Addition of a cost allowance for shipment of fuel to the site.
- Airfare costs for personnel movement are included in the estimate. However, occasional movement of equipment by air could be required as the nature of site activities change. This estimate is based on establishing the winter road in each of the three years for the reclamation work. Therefore, it is assumed that, if required, the cost for using the Hercules aircraft, or lessor equivalent, would be covered under the contingency cost.
- Addition of a cost allowance for mobilization and demobilization plus winter stand-by of contractors equipment.
- Post-closure monitoring should be conducted. It is assumed that monitoring in each of five years would be carried out over a ten year period.
- Allowance for engineering and reclamation studies at 1.5 % of the reclamation cost is included. Engineering work is expected to include: geotechnical studies, vegetation mixtures, audit and investigation of hazardous materials and contaminated soil,
- Allowance of a contingency at 10% of the project total is included. This rate is lower than the 15% rate suggested by Lupin Mine in the 1995 estimate (ref. GAL/PCL report page 12). The 10% contingency reflects the fact that that detailed engineering has been carried out using site specific data and incorporating the results of reclamation efforts to date.

Based on the review of the reclamation cost estimate prepared by GAL/PCL in 1997 and adjustment for inflation and omitted items, it is estimated that the government's cost for reclamation of the Lupin Mine would be $44.6 million. This amount includes a 10% contingency.

A revised reclamation cost estimate is presented in the Echo Bay Mines Ltd. memo of Dec. 11, 1998. In that estimate it is suggested that the total closure cost may be in the range of $18.9 million. It is based on the assumption that the work is carried out by the company and the tailings cover thickness is 1.75 m. If the work were conducted by the company, to the extent which is practical, that estimate is probably optimistic even for the company. The suggestion of a thinner cover for the tailings may not be acceptable and the estimate does not include the additional reclamation items described above. Furthermore, in the event that it became necessary for the government to conduct the work, then the government would employ contractors and the costs for contractor profit and equipment charges would apply.

CONCLUSIONS

The Interim A & R plan for the Lupin Mine has been reviewed. The preceding comments are based on the A & R plan and supporting information, as no site inspection has been conducted. Review of additional information and/or a site inspection may result in different conclusions.

Irrespective of any comments presented here, Lupin Mine still has the responsibility for achieving the objectives of the A & R plan and leaving the site in an environmentally acceptable condition. The comments presented here are not recommendations for specific reclamation activities.

In general, the A & R plan presents a reasonable approach for management of the potential impacts which may arise after closure of the mine. Further work is required to demonstrate that the plan will be effective.

In the event that Echo Bay Mines Ltd. is unable or unwilling to carry out the reclamation of the Lupin Mine, then it is estimated that the cost to the government to carry out the

necessary work will be $44.6 million. Revenue from the use of the winter road by others could reduce this cost.

I trust that this report addresses your requirements for reclamation review of the A & R plan for the Lupin Mine. Please contact me if you have any questions.

Yours truly,
Brodie Consulting Ltd.

M. J. Brodie, P. Eng.