ECHO BAY MINES

Lupin Operation
9818 International Airport
Edmonton, AB T5J 2T2
Tel: (780) 890-7000
Fax: (780) 890-8814

July 16, 2001

Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU X0B 1J0

Attn: Mr. Philippe di Pizzo
Executive Director

Re: **Amendment to Security Deposit for Licence for Lupin**

Dear Mr. di Pizzo:

In Bill Danyluk's letter to you, dated May 16, 2001, requesting an amendment to the security deposit required for Lupin, Mr. Danyluk referred to a research program being developed in affiliation with the University of Alberta to look at alternate reclamation options for Lupin's tailings (page 4, last paragraph).

Attached is a proposal title *Proposal to Study Alternate Approaches to Cover Lupin Mine Tailings*, which was recently submitted by David Sego and Kevin Biggar of the University of Alberta. Echo Bay Mines has asked Dr. Sego to discuss his proposal at the upcoming public hearing in Kugluktuk on August 9, 2001.

Sincerely,

Hugh Ducasse
Manager, Loss Control & Environmental Affairs

cc: Bill Danyluk

Proposal to Study

Alternate Approaches to Cover Lupin Mine Tailings

Submitted
to
C.M. Tansey, P.Eng.
Chief Mine Engineer Lupin
ECHO BAY MINES Ltd.

By

D.C. Sego and K.W. Biggar
Department of Civil & Environmental Engineering
University of Alberta
Edmonton, Alberta
T6G 2G7

Telephone: (780) 492-2059
Telefax: (780) 492-8198
Email: dcsego@civil.ualberta.ca

Research Objective

The proposed research will evaluate the use of a rock cover that allows for air convection to promote and maintain permafrost in mine tailings. Conventional evaluation for cover thickness is based on conductive thermal transfer to establish the material thickness required to prevent thaw from penetrating into the underlying tailings. A field study to be carried out at the Echo Bay's Lupin Mine will be used to determine the minimum required thickness of a placed open-work rock cover that will enhance convective winter cooling but minimize convective warming during the summer due to air density differences. The research findings have the potential of improving the design of covers for mine tailings in Canada's North while offering substantial savings associated with the required placement thickness of the cover. In addition the open-work rock cover offers a robust solution to any potential impacts on the permafrost stability in the mine tailings due to future climate change.

Background

Echo Bay's Lupin Mine is located on the western shore of Contwoyto Lake in the Northwest Territories. It is located 80 km south of the Arctic Circle on the barren lands and is 400 km northeast of Yellowknife. The mine site is underlain by permafrost and it is located in Canada's continuous permafrost region. Figure 1 is a location map for the Lupin Mine.

Construction of the mine began in 1980 with first mill production in April 1982 (Wilson 1990). Initial production was 860 tonnes per day with a mine life of 8 year but additional reserves were discovered following start up and production was increased to 1750 tonnes per day (Wilson 1990). Mining of present reserves is expected to be complete by 2007 using a production of 1900 tonnes per day.

The mill circuit consists of crushing and grinding, alkaline per-aeration, cyanidation and aeration to leach the gold from the ground ore, separation of leached ore from the pregnant solution, precipitation of gold from the solution using zinc dust followed by smelting of the gold precipitate in a bullion furnace. Annual tailings production is approximately 850,000 m^3 consisting of 175,000 m^3 of solids and 675,000 m^3 of water. The tailings not presently used for the mine backfill operation is pumped to the tailings impoundment for storage and later discharge of the environmental safe release water (Wilson 1990).

Figure 2 illustrates the tailings pond area that is divided into a primary settling pond and a secondary release water polishing area prior to safe release into the environment. Safe containment within the tailings pond was constructed using frozen core dam techniques for the outer dams while internal dams were constructed to facilitate optimum water clarification via settling of solids, natural degradation of cyanide and precipitation of arsenic using ferric sulphate that is mixed into the process water prior to transfer from the clarification to water polishing pond. Wilson (1990) provides detailed information on the release of water that meets all requirements of the Water Licence issued by the Northwest

Territories Water Board under the Northern Inland Waters Act. Ongoing production has resulted in infilling of the tailings facility with tailings that have settled and dewatered.

The Lupin Mine in anticipation of closure upon completion of mining is interested in examining reclamation options for their tailings pond. The present reclamation proposal is to cap the exposed tailings with locally available esker material. The reclamation plan is based on the gradual aggradation of permafrost through out the full depth of tailings due to extreme climatic conditions at the site (Geocon, 1993). The development of permafrost throughout the tailings depth is proposed to minimize the potential to develop acid mine drainage from the tailings in the future. The capped and frozen tailings will minimize the inflow of both water and oxygen to the tailings and thus prevent the initiation of acid mine drainage (Geocon, 1993). The esker cap is to prevent thaw during the summer from penetrating to and into the underlying frozen tailings. This will ensure that all tailings once frozen in place remain frozen.

Trial esker cover have been constructed to 0.5m and 1m thickness on portions of the tailing surface. Temperatures have been measured beneath these two covers and indicate that thaw has penetrated to about 1.75m below the cover surface. This would indicate the present use of the esker material would require at least 1.75m thickness of cover to prevent thaw from penetrating into the underlying tailings. It has been suggested that a cover of up to 2m thick may be required. These cover thickness have a substantial cost implication for reclamation prior to abandonment of this tailings facility.

This research proposal is to examine an alternate approach to selection of material for and construction of the cover that incorporates the concept of convective heat transfer to promote more rapid freezing of the tailings while preventing summer thaw. The approach results in substantial decrease of the thaw penetration into the cover compared to that due to conductive heat transfer within a well-graded material (Goering 1998). The basic concept is that rather than use a well-graded granular material from the esker one uses a poorly graded open-work rock or gravel. This material in contrast with the well-graded esker material has a high air permeability that will allow for the circulation of air into and through its void spaces. The air movement allows for the set up of circulation cells within the void space that causes faster cooling of the cover during the winter and much reduced warming during the summer. Figure 3 illustrates the basic concept of the winter circulation caused by the density difference of the cold air compared to that of warmer air (Goering 1998). The cold air sinks to the base of the fill causing the warmer less dense air to rise and remove heat from within and below the fill. This allows for more rapid cooling of the fill and it promotes freezing of the underlying material.

In the summer the warm air does not set up the same circulation pattern because the warm air at the surface of the cover is less dense than the cooler air within the void space in the cover. The cold air that has settled into the fill remains at its base and slows the penetration of thaw through the cover. This research project will test this hypothesis and undertake field measurement to determine the minimum thickness of poorly graded open-work material required to protect the underlying tailings from thawing.

Research Program

An open-work rock cap and an esker cap of varying thickness on the tailings will be constructed and instrumented. Measurements of temperature profile from thermistor strings placed through the constructed covers and into the underlying tailings will be monitored over a 3-year period to evaluate freeze back in the winter, and subsequent warming in the summer for 3 years. Based on the data collected and its evaluation, recommendations can be made as to the effectiveness of the method, the optimal thickness, and the costs associated with the alternative cover design. In addition, access tubes will be installed for neutron probe determination of water content profiles through the covers at various times during the field experiment.

An additional component includes constructing a second open-work rock cover during the winter. This method of construction can take advantage of year-round construction activity as the open work rock will be obtained by drilling and blasting in a near by rock quarry. Winter placement has the advantage of covering the tailings when they are already frozen. This has the potential to both enhance freeze back of the tailings, and allows for placement of the rock directly on a firmer material.

Figure 4 presents a schematic diagram of the test embankment set up. Two embankments will be constructed during the summer of 2001. One will be constructed using the esker material and the second will be constructed out of blast rock or mine waste that will be quarried adjacent to the mine site. Later in 2001 and early 2002, the third embankment will be constructed out of blast rock or mine waste on top of frozen tailings. Each embankment will be constructed to the same dimensions to remove the embankment size other than thickness from the test program.

A detailed thermal analytical evaluation of the as placed test embankments will be carried out using the Geoslope International Ltd TempW software that can analyze thermal conduction with input of the as measured surface climatic data. The open work rock cap will be analyzed using the convective heat transfer model described by Goering and Kumar (1996). The results from these separate analytical methods will be compared to each other and the field data compiled during the project.

Benefits of the Research

The data from the research will allow for evaluation of the best locally available material for use in constructing the cover. Presently the esker material can only be excavated during the summer since downward thawing of the in-situ frozen esker is required to allow for easy of excavation. Operationally the blast rock can be excavated year round. The blast rock can also be obtained near the tailings pond while the esker material must be trucked for about 7 km to the tailings impoundment. Use of the blast rock will result in reduced costs associated with transport of the cover material and the potential for year round placement.

If the research establishes that the blast rock can be placed year round this may also reduce costs especially if the majority of the cover material can be placed prior to mine closure in 2007. This will result in less additional costs associated with maintaining the camp only for placement of the cover material.

Additional environmental benefit is gained by use of the blast rock versus the esker material. The esker material is excavated from some of the best wildlife habitat in the Arctic. Eskers are used for dens by small animals and as travel corridor during the winter because they generally are wind sweep of snow making travel easier.

References:

Geocon, 1994. Preventing of AMD by Disposing of Reactive Tailings in Permafrost. MEND Program Report, December 1993, 98p.

Goering D.J., 1998. Experimental Investigation of Air Convection Embankments for Permafrost – Resistant Roadway Design. **PERMAFROST** Proceeding of 7th International Permafrost Conference, June 23-27, 1998. Yellowknife, Canada, pp319-326.

Goering, D.J. and Kumar, P. 1996. Winter-time Convection in Open-Graded Embankments. Cold Regions Science and Technology.**24**: 57-74.

Wilson, H.R., 1990. Tailings Management in the Canadian Arctic- Echo Bay's Lupin Mine. Society for Mining, Metallurgy and Exportation Inc. GOLDTech 4, Reno Nevada- September, 10-12, 1990, Preprint No. 90-416

Budget for Lupin Cover Evaluation 2001, 2002 and 203

This budget is prepared using the NSERC guidelines and it is planned that after review and agreement with the scope of work by the Lupin Mine to submit it as a NSERC Collaborative Grant. The funding formula used by NSERC is to match 1 to 1 the company's contribution to the research costs. The company's contribution can consist of 1 to 1 cash to in kind support for the project.

As and example the cash requirement of say $78,000 can be arrived at as follows:

Lupin Mine contributes $26,000 in cash and $26,000 of in kind made up of construction of test embankments, travel to and from site and accommodation. This then generates a contribution of $52,000 in cash from NSERC. Thus there is $78,000 in cash to support the work in addition to the $26,000 of in kind (which can consist of placing the test embankments?).

Using the above example it would cost Lupin $26,000 in cash to support this 3 year project that would support at least one graduate student to completion of his/her degree.

Item	**Cost**
Technician time for construction, instrumentation assembly and installation, etc.	$4,000.00
Instrumentation (see attached quotation	$27,289.82
Research Assistant or graduate student to oversee construction of pad, installation of instrumentation, process data, do modelling, draft report etc. ($15,000/yr)	$45,000.00
Flights to site	$0
Accommodation	$0
Secretarial Support for report generation, copying, etc.	$1,000.00
Subtotal	**$77,289.82**
University overhead @ 0% on NSERC Grants	0
TOTAL	**$77,289.82**

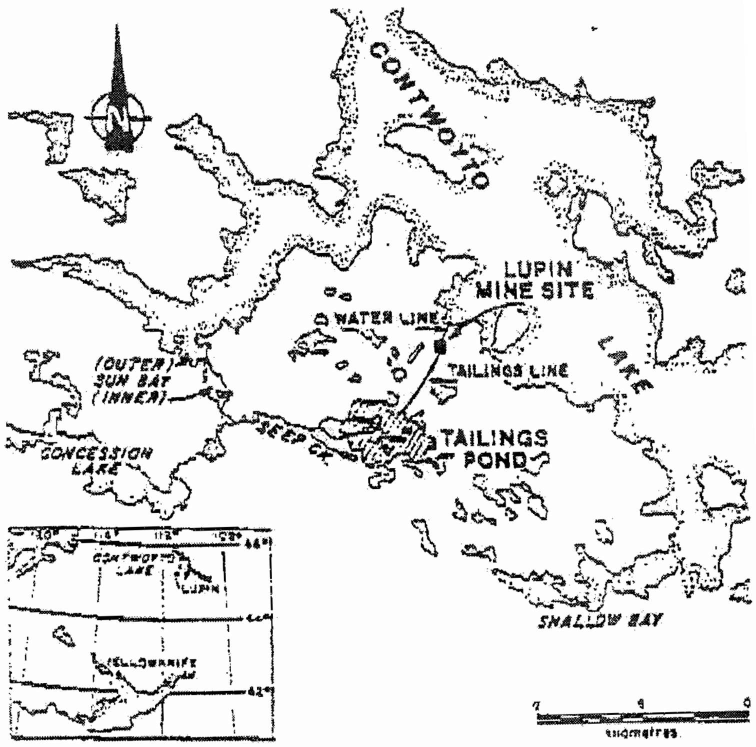


Figure 1 Location Map for Lupin Mine (Wilson 1990).

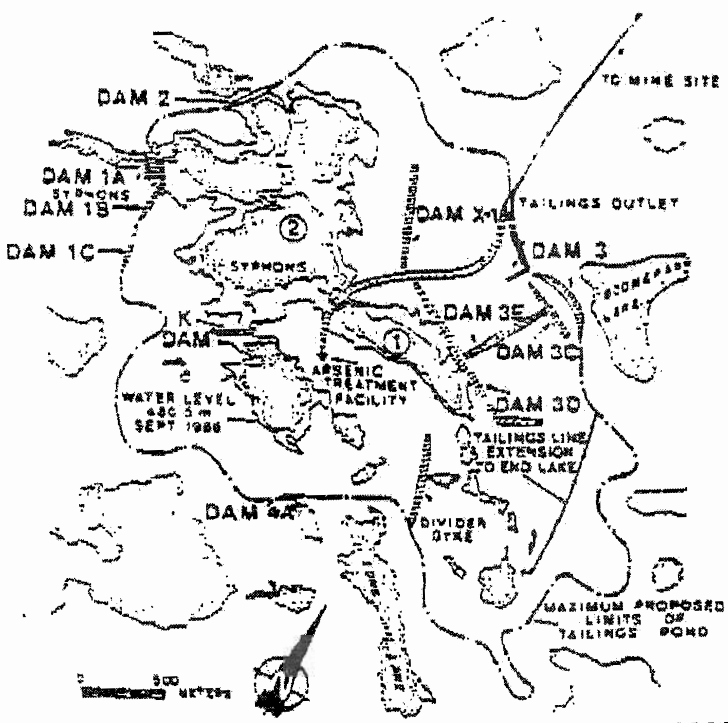


Figure 2 Tailings Impoundment Area 1988 (Wilson 1990)

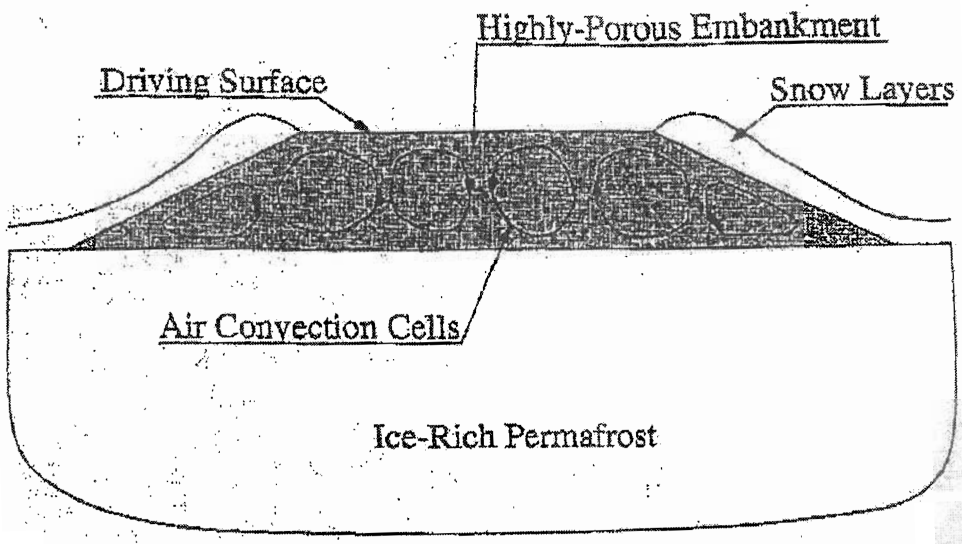


Figure 3 Pattern of air circulation in an embankment (Goering 1998)

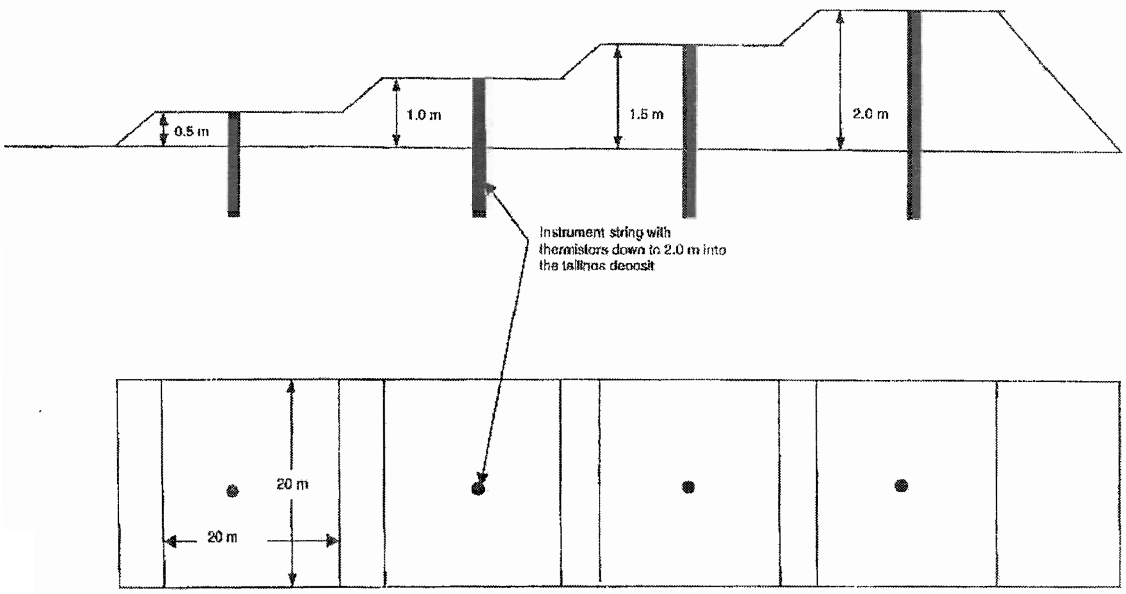


Figure 4 Schematic diagram of field test set up of cover on tailings

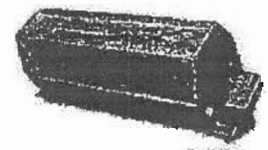
Optimum Instruments Inc.

Innovations In Communications

9413 27 Ave, Edmonton, AB, Canada, T6N 1C9
(780) 450-0591 Fax: (780) 440-2515
Optimum@optinst.com
www.optinst.com www.datadolphin.com

Gerry Cyre
University of Alberta
Edmonton, AB T6G 2G7
Phone: 492-3846
Fax: 492-0249

Sales Quotation



Quote # 101042
Contact Ken Smelquist

Date 6/5/01
Exp. Date 7/5/01

Item	Qty	Part #	Description	Price	Extend
1	4	DD-128	Data Dolphin 8 Single Ended, 24 bit Inputs and 4 General Purpose	$899.00	$3,596.00
2	30	TS-5K+-.2C	Temperature Thermistors +/- .2C 5K@25C	$18.95	$568.50
3	4	SatPhones	Satalite Data Phone 9600 Baud units	$3,899.00	$15,596.00
4	4	SP-75	75 Watt Solar Panels	$949.00	$3,796.00
5	4	SP-75B	Brackets for 75 watt Panel	$139.00	$556.00
6	4	SS-6L	Solar Controller - Morningstar 12V 6A w/TC and Low Bat. Cut Out	$109.00	$436.00
7	4	BAT-12-100AHr.	12 Volt Lead Acid 100 Ahr. Absorbed Glass Cold Temperature Charging	$239.00	$956.00
			There Box is not included as I do not know the total size		

Terms: Net 30 on approved credit. VISA or Master Card accepted.
Prices Indicated in Canadian Dollars (GST Extra)

I accept the terms and conditions of this quotation.

Signed:____________________
Name :____________ **Title:** ____________

Sub-Total	$25,504.50
Tax	$1,785.32
Total	**$27,289.82**

Delivery Instructions:
F.O.B. Optimum Instruments Inc. Facility - Edmonton, Alberta
Courier: ____________ Acct#: ____________
Must arrive by: __/__/__

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