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Attention: Mr. Bruce Donald

Subject: Response to DFO-FHM Comments
Garrow Lake Dam Decommissioning
Polaris Mine Operations, Nunavut

1.0 INTRODUCTION

This letter addresses comments received by Teck Cominco Metals Ltd. (TCML) from the Department of Fisheries and Oceans – Fish Habitat Management (DFO-FHM) in a letter dated October 26, 2001 pertaining to the Garrow Lake Dam Decommissioning report submitted by EBA Engineering Consultants Ltd. (EBA) to TCML in March 2001.

It is EBA's understanding that decommissioning of Garrow Lake Dam has been scheduled during 2004. The lake elevation will gradually be reduced between now and then by discharging water using the siphon system during open water season.

2.0 DFO-FHM COMMENTS

The DFO-FHM letter of October 26, 2001 includes comments from three parties: Mr. Bruce Fallis, Messrs. Rick Gervais and Chris Katopodis, and Mr. Dennis Wright.

A summary of the comments is presented below:

- A cost-benefit analysis should be provided to compare the partial and complete dam removal options.
- Integrity of the remaining portion of the dam after drilling and blasting needs to be addressed.
- Timing of the dam decommissioning is critical to its success.
- Erosion of the now-thawed shoreline of Garrow Lake and the potential increase in total and/or dissolved solids (TSS/TDS) in run-off needs to be addressed.

3.0 EBA RESPONSES

3.1 Cost-Benefit Analysis

Two options were presented in the EBA report; partial dam removal and complete removal. Partial removal was the preferred option and the design was developed on this basis. The following expands on the complete dam removal and presents a cost-benefit analysis of the two options.

3.1.1 Complete Dam Removal

Complete removal of the dam is a viable option to its decommissioning. This option removes the entire dam structure, allowing Garrow Creek to flow through its historic channel.

The core material used to construct the dam (processed, saturated limestone and shale) will have to be removed from the key trench under the dam core. This material will thaw in the summer months and slump towards or into Garrow Creek unless replaced or covered with stable granular material.

Complete removal of the core and key trench will entail exhaustive blasting of the frozen material. The loose surface materials (shell and rip rap) will require removal prior to drilling and blasting. The estimated volume of the shell and rip rap material is 21,100 m^3. Some of this material could be stockpiled for remediation use at the dam site and the balance hauled to Little Red Dog Pit for disposal.

The drilling and blasting of the frozen portion of the dam can proceed following removal of the shell and rip rap. The volume of the frozen shell and core material is estimated to be 27,900 m^3. This in-place volume will have to be excavated and hauled to the Little Red Dog Pit for disposal.

Blasting of the core will affect the natural ground to some degree. The native permafrost may experience some minor cracking; however, this is not deemed as problematic because the permafrost will naturally "heal" itself by freezing water that infiltrates the cracks.

Placement of fill material will be required in the channel and in the excavated key trench under the core. The volume of fill to be placed is estimated to be 1500 m^3. A small thickness of shell material should be left in place over the remaining dam footprint to cover the disturbed dam footprint.

Table 1 provides the estimated cost for complete removal of the dam. Unit costs have been based on historical northern earthworks, but the actual costs will be a function of the overall decommissioning plan and contract strategy. It does not include any costs for remediation of erosion channels near the dam as this cost is common to all decommissioning options. The complete dam removal would be accomplished at the cost of nearly $1,250,000.

Table 1
Estimate Decommissioning Costs for
Complete Removal of Garrow Lake Dam

Item	Unit	Unit Cost	Estimated Quantity	Amount
Excavate rip rap material	m^3	$ 5.00	3,300	$16,500
Haul excess rip rap to Little Red Dog Pit (8 km)	m^3	$12.00 (1)	1,800	$21,600
Excavate unfrozen shell material	m^3	$ 5.00	17,800 (2)	$89,000
Haul unfrozen shell to Little Red Dog Pit (8 km)	m^3	$12.00 (1)	17,800	$213,600
Drill and blast frozen shell and core material	m^3	$15.00	27,900 (2)	$418,500
Excavate blasted shell and core material	m^3	$ 5.00	27,900	$139,500
Haul blasted shell and core to Little Red Dog Pit (8 km)	m^3	$12.00 (1)	27,900	$334,800
Place rip rap in creek channel and key trench	m^3	$10.00	1,500	$15,000
			Total	$1,248,500

(1) Based on a rate of $1.50 per m^3-km and an 8 km haul distance
(2) 50% of the shell material volume is estimated to require drill and blast excavation; the actual percentage will vary with degree of material saturation and temperature at the time of excavation.

3.1.2 Partial Dam Removal

Partial removal of the dam is detailed in EBA's March 2001 report. The concepts and discussion are presented in the report (Report #4, Volume 2 of the Polaris Decommissioning and Reclamation Plan).

Partial dam removal entails removal of the portion of the dam constructed over the historic Garrow Creek. After removal of this portion of the dam, the two remaining abutments would be sloped at 4H:1V and the exposed frozen core of the dam would be thermally protected by placing a thick layer of shell material on the slopes. The partial dam option is considered a viable option. The estimated costs for this option are presented in Table 2. The partial dam removal would be accomplished at a cost of nearly $450,000.

Table 2
Estimated Decommissioning Costs for
Partial Removal of Garrow Lake Dam

Item	Unit	Unit Cost	Estimated Quantity	Amount
Excavate rip rap material	m^3	$5.00	1,500	$7,500
Haul rip rap to Little Red Dog Pit (8 km)	m^3	$12.00 (1)	400	$4,800
Excavate unfrozen shell material	m^3	$5.00	9,100 (2)	$45,500
Haul unfrozen shell to Little Red Dog Pit (8 km)	m^3	$12.00 (1)	2,900	$34,800
Drill and blast frozen shell and core material	m^3	$15.00	8,750 (2)	$131,250
Excavate frozen shell and core material	m^3	$5.00	8,750	$43,750
Haul frozen shell and core to Little Red Dog Pit (8 km)	m^3	$12.00 (1)	8,750	$105,000
Place shell material on excavated slope of core	m^3	$10.00	6,200	$62,000
Place rip rap in creek channel	m^3	$10.00	1,100	$11,000
			Total	$445,600

(1) Based on a rate of $1.50 per m^3-km and an 8 km haul distance.
(2) 50% of the shell material volume is estimated to require drill and blast excavation; the actual percentage will vary with degree of material saturation and temperature at the time of excavation.

3.1.3 Complete vs. Partial Dam Removal

Both removal options achieve the end result of allowing natural discharge from Garrow Lake through the historic Garrow Creek. There is no difference between the two options with regard to the halocline and the concerns related to it, nor the issue of potential increased erosion and TSS.

Complete dam removal provides the following benefits over the partial dam removal option:

- eliminates risk with potential slope failure of the remaining dam abutments; and
- reduces risk of channel blocking/freezing off which could lead to large flow and erosion downstream of dam location (once the blockage releases).

The risk of slope failure of the dam abutments is low because the slopes are flat (4H:1V) and the core will remain frozen under global warming conditions. The natural ground in the area of the dam also slopes at about 4H:1V so removing the abutments will not necessarily eliminate the risk of slope failures occurring.

The 4H:1V slopes and 15 m wide channel result in a very low risk of blockage. Further, the channel will be protected from erosion by placing rip rap through the bottom of the channel as well as up the slopes of remaining abutments.

The complete dam removal option carries a cost of more than twice that of the partial removal option. Should TCML have to remobilize to site and reconstruct containment of Garrow Lake, the costs would be at least double (or more) if the complete dam is removed as part of the mine closure in 2004. There could be some difficulties in melding a new dam to the remnant abutments of the existing one, but such issues are deemed to be resolvable at limited cost that keeps the partial removal more economical.

It is under all of these considerations that the partial dam removal option is considered to be technically equivalent and economically superior to the complete dam removal option. The risk level associated with the partial dam removal is deemed to be low.

3.2 Integrity of Remaining Dam Structure Related to Blasting

The stability of the remaining dam structure is presented in EBA's report. Blasting within the central portion of the dam will have some effect on the remaining portion of the dam, as cracking of the core could result. This is not problematic because the remaining dam abutment need not be impervious. Any water that infiltrates the tiny cracks would freeze because of the cold temperatures within the core (temperatures within the core have not risen above –10˚C over the life of the dam).

The slope of the cut in the core material (frozen) would be 2H:1V. This cut will be stable if it remains frozen. A blanket of shell and/or rip rap material will be placed on the exposed core to thermally protect it. The blanket would be placed with a 4H:1V slope, such that the blanket material itself would also be stable.

The cracked portions of the frozen core are not considered to introduce unstable zones within the final dam geometry. A cracked frozen zone will be outside of the critical stability zone. In addition, the cracked frozen material would have a relatively high friction angle and not introduce a weak zone in the embankment. The frozen core will be covered with a significant amount of granular fill. The granular fill will be placed at a relatively flat slope of 4H:1V, and the thickness of it will vary. The minimum fill thickness required to keep the core frozen has been provided.

Sudden failure will not occur given the design slopes. The thermal modelling and stability analyses (as discussed in Volume 2, Report #4 of the Polaris Mine Decommissioning and Reclamation Plan) indicate that under global warming conditions, the core of the dam will remain frozen and stable.

3.3 Timing of the Dam Decommissioning

EBA has indicated that the work is least likely to cause erosion and/or sediment transport in the creek if completed during winter months. “Winter months” is better defined as the period where the ground and water around the dam (including the creek) are completely frozen. It is anticipated that "winter months" typically span from November through April, and possibly further into the shoulder months.

The importance of the timing of the decommissioning is the same for both the complete and partial removal options.

3.4 Shoreline Erosion

Shoreline erosion potential arises from the fact that during the mine operations, Garrow Lake rose in elevation and submerged the permafrost around its historic perimeter. Some disturbance of the submerged shoreline has likely resulted over the years due to wave erosion and surface slumping. Upon decommissioning of Garrow Lake Dam, the water level will drop and expose the now-thawed soil. Erosion potential of this soil remains constant, regardless of the dam decommissioning option.

The reservoir level has experienced fluctuations over the years due to annual discharges. Garrow Lake is gradually being lowered back to historic levels over the coming years prior to decommissioning. The performance of the shoreline and suspended solids concentrations is to be monitored over this period of time. The thawed banks of the lowered lake could potentially be unstable if the lake is drawn down too quickly. Because the lowering of the lake is scheduled over a long time period, risk of bank failure is drastically reduced.

Shoreline erosion is of concern during freshet (spring thaw or breakup), during or shortly following periods of summer precipitation and at times of high winds. The erosion around Garrow Lake will be most severe during lowering of the lake. There is likely to be less erosion following lowering of the lake, decommissioning of the dam and the return of the original lake level. Once the lake is returned to its original level the fetch distance for wave set up will be 0.5 km shorter than it is presently, and the shoreline will be at the location where it was historically. The historic shoreline will have less fine sediments than the zone above it since the historic shoreline has been subjected to erosion prior to raising the lake.

The reference to TSS issues at Kuhulu Lake was cited by DFO-FHM. Discussions with Mr. Frank Tordon, formerly of Nanisivik Mine, did not reveal any definitive conclusions that can be applied at Polaris and Garrow Lake. Mr. Tordon did indicate the Kuhulu incident may have resulted from a dam being washed away (i.e. catastrophic failure) in the 1950's, as opposed to a gradual drawdown as is planned for Garrow Lake.

Mr. Robert Carreau of Breakwater Resources Ltd. (BRL) was also contacted with regards to this incident. Mr. Carreau received the following information on the Kuhulu Lake incident from Mr. Jim Marshall, Nanisivik Mine Project Manager until 1997:

> "…A dam was built by Texas Gulf before our [BRL] involvement. The dam was built at the discharge which is on the east side to raise the level of the lake and cause it to discharge through an old creek bed at the north-east corner of the lake. The lake rose but the dam failed and washed down the current discharge route with considerable erosion. The net effect was to lower the lake level which was evident at the shallow west end."

This information verifies what Mr. Tordon recalled. The Kuhulu Lake incident was a catastrophic failure resulting in rapid drawdown of the lake and large quantities of water being rapidly discharged. The large volume of and fast velocity of the water most likely caused the vast majority of the erosion and elevated TSS levels. A similar scenario is deliberately being avoided at Garrow Lake by slowly and gradually drawing down the lake prior to removing the dam. Thus, the large water volume and high flow velocities will not be present when Garrow Lake Dam is decommissioned.

4.0 CLOSURE

The comments received from DFO-FHM in response to TCML's Mine Closure Plan submission pertaining to the decommissioning of Garrow Lake Dam have been reviewed and considered.

After reconsideration of the technical merits and potential risks associated with partial dam removal and complete dam removal options, there is little technical difference between the two. Economics suggests that the partial dam removal is preferred.

Perimeter erosion and the timing of the decommissioning are independent of the removal options. As discussed herein, the erosion around the perimeter and TSS levels during windy ambient conditions in the open water season are not expected to be significantly greater than historic levels.

We trust that the comments and potential issues raised by DFO-FHM have been satisfactorily addressed. Should you require further clarification or information, please contact EBA's office at your convenience.

Respectfully submitted,
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