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PROJECT MEMORANDUM

To:	**Indian and Northern Affairs Canada**	**Fax No.:**	**Via e-mail**
Attention:	**Mr. Carl McLean, Manager Land Administration Operations**	**CC:**	**Dionne Filiatrault, NWB**
From:	**Holger Hartmaier (Ext. 113)**	**Date:**	**December 30, 2003**
Subject:	**Polaris Mine- Request for Changes to Soil Disposal Approvals**		
No. of Pages (including this page): 6 Pages		**Project No:**	**0131-013-01**

As requested in your e-mail message dated December 22, 2003, this memorandum summarizes BGC's comments regarding the request by Teck Cominco to dispose of metals contaminated soils in Little Red Dog Quarry Landfill (LRDQL) and to dispose of the remaining hydrocarbon contaminated soils underground.

1.0 Background

Since the start of reclamation in late 2002, Teck Cominco has undertaken remediation of soils contaminated by metals and hydrocarbons at various locations around the Polaris mine site. Initial estimates of the volumes of contaminated soils were based on environmental site assessment studies done by Gartner Lee Limited (GLL) in 1999 and 2000. The Polaris Mine Decommissioning and Reclamation Plan dated March 2001 ("Closure Plan") stated that there was 92,350 m^3 of metals contaminated soils, of which 20,000 m^3 were co-contaminated with hydrocarbons, and 36,700 m^3 of hydrocarbon contaminated soils. These soils were placed into the underground workings of the mine, with protocols as approved by DIAND/NWB under the overall Closure Plan.

As reclamation work began, the volume of contaminated soils requiring disposal increased. The issue of volumes of contaminated soil versus available underground storage space has been the subject of concern in several previous instances as summarized in a letter from Teck Cominco dated September 16, 2003 and comments provided by BGC on that letter dated September 24, 2003.

BGC pointed out in the September 24, 2003 commentary that there was some confusion regarding the calculation of the available volumes of void space underground and the volumes of soil that remained to be disposed.

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Since October, Teck Cominco has undertaken additional drilling, sampling and a detailed review of the analytical data to prepare a more accurate estimate of the volume of soils remaining to be disposed.

In the current assessment, Teck Cominco estimate an additional 91,100 m^3 of metals contaminated soils and 102,400 m^3 of hydrocarbon contaminated soils remain to be disposed. These volumes include a 20% swell factor in addition to the in-place volume, plus another 10% contingency for unexpected materials. As of November 30, 2003, Teck Cominco estimate there is 168,000 m^3 of space available underground. Teck Cominco has assumed that 75% of the available volume can be utilized, leaving 126,000 m^3 of storage space available.

Teck Cominco have requested permission to dispose of the metals contaminated soils in the LRDQ so that the remaining underground storage space can be used for disposal of the hydrocarbon contaminated soils.

It should be noted by DIAND and NWB that the volume of metals contaminated soils that now remain to be disposed of is approximately equivalent to the original estimate based on the environmental site assessment done prior to closure and the volume of remaining hydrocarbon contaminated soils is almost 3 times the original estimate. This is in addition to the volumes of contaminated soils already disposed of underground. This indicates that the environmental site assessment has seriously underestimated the volumes of contaminated soils that required remediation. This is not to say that the site assessment was deficient in any way, since some areas would have been inaccessible for assessment, such as the mill barge and product storage area foundations. In hindsight, knowing that the underground disposal option provided only a finite volume of void space for disposal, it would have been prudent to reserve the underground space for hydrocarbon contaminated soils only. Some of the other options considered by Teck Cominco could have been implemented to deal with the metals contaminated soils, if this was recognized at an earlier stage in the project.

We are now faced with dealing with an even greater volume of soil than was originally anticipated and the preferred disposal option is close to its capacity. The solution proposed by Teck Cominco, as discussed below, is now the only option left in view of the circumstances at the site.

2.0 Comments on Proposed Plan

2.1 Disposal of Hydrocarbon Contaminated Soils Underground

Disposal of hydrocarbon contaminated soils underground has been previously approved by DIAND/NWB, as long as the following protocols are followed:

- No free phase hydrocarbons will be disposed of in the mine.
- All hydrocarbon contaminated soils must be placed in areas of the mine where long term rock temperatures (including effects of global warming) will be maintained at less than -4° C, and are not influenced by seasonal temperature fluctuations.
- The mine floors are wetted to seal potential rock fractures, prior to placing soil.

- A wetted earth plug, which shall be allowed to freeze, will be constructed to further isolate the hydrocarbon contaminated soils disposal area from the rest of the underground mine workings.

In the September 16, 2003 letter from Teck Cominco, it was stated that in January 2003 there was 154,200 m^3 of storage space available for metals contaminated soils and 40,000 m^3 of storage space for hydrocarbon contaminated soils. The mine had the capacity to store additional contaminated soils, but these areas would require extra work (i.e. increased cost) to utilize and in some cases, their availability would also depend on confirming the safety of working in these areas due to ground conditions. Subsequently, additional unexpected areas of hydrocarbon contaminated soils were identified in the Fuel Bladder and dock area. Teck Cominco then identified additional storage areas on the 820 level, the 790 level and the 760 level for storage of contaminated soils. Presumably these areas are now becoming filled, but it is not clear exactly where all the soils are going. Some of these spaces have been filled with metals contaminated soil and some with hydrocarbon contaminated soils.

BGC recommends that Teck Cominco be asked what proportion (if any) of the 168,000 m^3 of currently estimated available underground space requires additional work before it can be safely used for disposal of the remaining hydrocarbon contaminated soils, and what additional cost this would be to the mine closure budget. As a follow-up, to this request, Teck Cominco should be prepared to provide a contingency plan for dealing with hydrocarbon soils in case underground space becomes exhausted.

BGC also recommends that Teck Cominco be requested to provide and accurate accounting of the volumes of hydrocarbon, metals and co-contaminated soils that have now been placed underground and their locations.

2.2 Disposal of Metals Contaminated Soils in LRDQL

To date, LRDQL has been used for the disposal of demolition debris from the mill/barge complex. In 2004, the demolition debris from the accommodation complex will be added. The demolition debris likely contains a wide variety of metals, including structural steel, copper wiring and plumbing, as well as other components that contain metals such as lead and zinc. These metals can remain relatively stable and inert within a landfill, once the landfill cap is in place and permafrost has aggraded into the waste, creating conditions of low oxygen exchange and practically zero groundwater flow.

The metals contaminated soils, on the other hand, contain potentially reactive sulphide minerals, typically pyrite (iron sulphide), galena (lead sulphide) and sphalerite (zinc sulphide). The main concern is the potential for these minerals to undergo chemical reactions, resulting in generation of acidic drainage and related metals leaching. The presence of acidic conditions exposes the other manufactured metals in the demolition debris to potential leaching effects, if free movement of water and oxygen exchange is possible. This process is time-dependent as well as temperature dependent.

To avoid the potential for acid generation and metals leaching, the soils within the landfill must become frozen as quickly as possible by permafrost aggradation. The LRDQL was approved

for disposal of demolition debris on this basis and the fact that the materials in the landfill would be both chemically inert and become stabilized through natural permafrost aggradation. There is no impervious liner containing the waste placed to date. The sides of the landfill are composed of natural limestone and dolomite bedrock of the abandoned quarry, which offer a natural source of buffering for any short-term acidic drainage that may occur.

BGC agrees with Teck Cominco's assessment that placement of the metals contaminated soils into LRDQL is the best option of the ones considered, which included:

- Increasing remediation target values to reduce volume of metals contaminated soils.
- Disposal of metals contaminated soils into Garrow Lake.
- Leaving the contaminated soils in place with a cover cap.
- Developing a new landfill for disposal of metal contaminated soils.

BGC recommends that Teck Cominco undertake a risk assessment to assess the potential for oxidation and short term release of acidic drainage before permafrost aggradation occurs.

Another concern is the presence of soils that are contaminated by both metals and hydrocarbons. Teck Cominco has not provided a breakdown on this item, but it must be a condition of approval that co-contaminated soils be disposed of only in the approved underground areas.

Placement of the metals contaminated soils into the LRDQL should follow these protocols:

- The metals contaminated soils can be used as infill materials to fill in the voids of the demolition debris.
- Metals contaminated soils may be used as the lift separating lifts of demolition debris, and as general fill within LRDQL.
- The location of the metals contaminated soils within the LRDQL should satisfy the following requirements:
    - Be below the depth of the long term –4° C isotherm predicted considering the effects of global warming to minimize the potential for initiating acidic generation.
    - Along the perimeter of the LRDQL, the metals contaminated soils should be placed a minimum horizontal distance of 5 m from the rock surface. The intervening buffer distance should be filled using inert cover materials, such as shale to ensure that the sides of the landfill debris containing the metals contaminated soils are adequately encapsulated.
    - The quantities and locations of metals contaminated fill will be recorded in the daily work sheets of the contractor (as is currently done) and recorded on drawings used to record placement of debris in LRDQL. These records must be submitted in the regular reports required by the Closure Plan approvals and under the Water Licence.

It is assumed that all the waste placed into LRDQL will be contained within the former quarry volume (i.e. below the bedrock surface around the pit perimeter) This simplifies both cover design and the assumptions regarding long term encapsulation of the waste by permafrost and the buffering effects of the surrounding carbonate bedrock on potential acidic leachate before permafrost aggradation occurs. Placement of metals contaminated waste above the elevation

defined by the minimum bedrock elevation along the pit perimeter will not be permitted.

The existing Operating Protocols established by Teck Cominco for placement of fill and debris into the LRDQL will remain the same. Teck Cominco have placed pipe casings within the debris that will be used to install thermistor strings once filling of LRDQL is complete. These thermistors will monitor freezing conditions of the landfill debris until 2011, demonstrating that the landfill is remaining in a frozen state over time.

2.3 Landfill Cover Design Comments

In their letter request, Teck Cominco made reference to the final cap design on LRDQL. A 1.8 m cap thickness has been established as the design thickness for all landfills on the Polaris mine site. BGC and NWB/DIAND have approved the cap design in principal, but it is important to note that the purpose of the thermistor instrumentation is to verify the assumptions made in the thermal design of the cover. Based on the data included with the letter, the active zone in the Operational Landfill cover is up to 1.5 m thick. The individual thermistors were not labelled, but in one case, the maximum seasonal ground temperatures at a depth of 2 m were marginally below 0° C.

The final (0.6 m) layer of cover material was not placed on the Operational Landfill at the time of BGC's site visit in September 2003. Therefore, the thermistor readings should not be taken as representative of the final cover condition. The thermistor readings should be assessed to determine the long terms trends associated with permafrost aggradation and the vertical temperature profile over time to confirm, the required thickness, then additional material should be placed before earthmoving equipment is demobilized from the site.

Based on the thermistor readings, the –4° C maximum isotherm lies at a depth of at least 3-4 m below the ground surface. BGC recommends therefore, that all metals contaminated soils be placed so that they will be at least 5 m below the top of the final cover in the LRDQL.

3.0 Conclusions and Recommendations

3.1 Conclusions

BGC agrees in principal with the recommendations by Teck Cominco to retain the remaining underground void space for the disposal of hydrocarbon contaminated soils only and to place metals contaminated soils into the LRDQL, subject to the protocols outlined above.

The original environmental site assessment failed to provide a reasonably accurate estimate of the volumes of contaminated soils to be produced during the mine reclamation. As a result, disposal of contaminated soils into the underground workings was chosen as it offered a safe and convenient means of long term storage, with a considerable, though finite, margin of excess capacity.

Disposal of the remaining metals contaminated soils into LRDQL is now the only appropriate

option. If more accurate volume estimates were available earlier in the project, some of the other options considered by Teck Cominco, such as disposal into Garrow Lake may have been implemented, before decommissioning took place. These options would have provided acceptable additional contingency for dealing with the unexpected volumes of contaminated soils found later as reclamation proceeded.

3.2 Recommendations

Based on the review of the request by Teck Cominco to place metals contaminated soils into LRDQL, BGC provides the following recommendations for consideration by DIAND/NWB:

- Request Teck Cominco to provide an accurate accounting of the volumes and locations of hydrocarbon, metals and co-contaminated soils in the underground mine workings.
- Request Teck Cominco to provide information on what proportion (if any) of the remaining available underground space requires additional work before it can be safely used for disposal of hydrocarbon contaminated soils, and what additional cost this would be to the mine closure budget.
- Teck Cominco should be requested to provide a contingency plan for dealing with hydrocarbon contaminated soils in case the underground space becomes exhausted.
- Teck Cominco should undertake a risk assessment to assess the potential for short term oxidation and generation of acidic drainage and related metals leaching during the period of time it takes for permafrost to aggrade into the LRDQL.
- Teck Cominco should assess the thermistor readings in the Operational Landfill cover to confirm the design thickness of cover materials for all landfills including LRDQL so that additional fill can be placed before earthmoving equipment is demobilized from the site.

4.0 Closure

This memorandum provides comments by BGC on the request by Teck Cominco to place metals contaminated soils into LRDQL.

We trust that this information meets with your requirements at this time. Should you have any questions, or require additional information, please do not hesitate to contact me.

Yours truly,
Per
BGC Engineering Inc.

Original Signed by Holger Hartmaier

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