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Attn: Paul Smith
Manager, Water Management

EBA Project 1740015.002

Government of Nunavut
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PO. Box 1100, Stn 1150
Iqaluit, Nunavut, X0A 0H0
Attn: Bernie MacIsaacs
Senior Advisor, Minerals, Oil and Gas Division

Gentlemen;

Subject: July-02 Water Board Hearings, Nanisivik Mine Closure

We attended public hearings of the Nunavut Water Board in Arctic Bay concerning renewal of the water license for the Nanisivik Mine on July 22 to 24, 2002. The hearings were specifically related to mine closure planning. The purpose of our presence was to provide technical (environmental and engineering) support for interventions prepared by both Indian and Northern Affairs Canada (DIAND) and Government of Nunavut (GN) and to respond to comments or questions pertaining to the report EBA prepared following our review of documents describing the mine closure plan. This letter provides you with some observations, impressions and comments from our participation at the hearings.

We found the experience from last week valuable as it provided an opportunity to meet informally many of the technical staff working for the mine. There was a brief site visit to the mine infrastructure that provided at least an appreciation of the magnitude of the terrain restoration challenges. We want our participation in this process to be constructive; contributing our past arctic mine reclamation experience to the common goal of a practical and effective plan for restoration of the mine site prior to abandonment. Our sense is that we share these goals with the mine staff and their consultants as well as with DIAND and the GN.

It is clear that the accelerated schedule for mine closure has compressed the time frame normally required for preparation of a comprehensive closure plan. The plan produced by the mine and their consultants prior to the public hearings has data gaps and is generally recognized as incomplete. Some interveners have described it as a "concept level plan". The mine provided an update on their approach to eight components of the plan that they identified as the principal public awareness issues during a three hour presentation. They also described the work plan and

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progress on the Phase II Environmental Site Assessment (ESA), currently underway at the mine site.

In this letter, we focus on what we consider are the principal technical considerations that were discussed at the hearing. For the most part, these are the components of the overall closure plan where there has not been a written commitment to close data gaps, analyses deficiencies and documentation that is currently lacking. Our purpose here is to present our views of several activities that we consider particularly important to completion of those components of the plan.

1. THE TAILINGS SYSTEM CLOSURE PLAN

A The Surface Cell

The West Twin Lakes tailings containment system is the largest and most visible of all site facilities that require restoration. There is a perception among the residents of Arctic Bay that this facility poses the greatest risk of post-closure pollution by uncontrolled discharge of contaminated water or by wind-blown dust. It is also the closest facility to the Hamlet of Arctic Bay and the residents have observed its operation and performance over the 20 years of mine operation. A number of residents spoke directly to this issue and expressed their skepticism regarding the ability of permafrost to protect future generations of Inuit who will harvest country food that may drink the water in the reservoir or creek downstream from the facility. The local residents also want assurances that construction associated with reclamation of this facility is completed to a high standard.

There have been a number of studies completed over the years focusing on the design of an engineered soil cover that will be placed over the exposed surface cell tailings. The closure plan documentation leaves the reader with the clear impression that the tailings within this cell are currently in a permafrost condition; therefore, the purpose of the cover is to ensure that permafrost is sustained over the long term. The existing pore water (or pore ice) within the tailings is known to be rich in metals thus it is important to ensure that the water phase will be locked up in the tailings mass as ice in perpetuity.

We agree with the objective and are confident that permafrost can be an effective containment system at this site; however, the mine has not yet demonstrated that they have a clear understanding of either the physical or thermal conditions within the overall tailings mass below the surface cell. This data gap has resulted in assumptions regarding post-closure performance of the system that cannot be supported at the present time by existing site data.

The mine has focused on the cover design and has completed very useful work in this area over the past decade. We support the general approach to cover design and its placement as described in the documentation. Cover materials and thickness have been developed to contain the active layer within the cover for long-term mean annual air temperature conditions then a thickness

increment has been added to accommodate summer thaw following a projected warming trend for 100 years. We would like further assurances that the cover thickness is also sufficient for the warmest year on record at Nanisivik and for a particularly warm year with an annual exceedance probability of 1/100 (100 year return period) air temperature.

We have interpreted that the design cover thickness of 1.25 m proposed is the minimum that will initially be placed over any tailings and that the mine recognizes that they will have to repair those areas that may have been disrupted by settlement or frost effects during ensuing summers following closure until stability is achieved. With this understanding and confirmation of geothermal performance in warm years, we are comfortable with the general approach adopted for design and placement of the soil cover.

The tailings were deposited below the water cover in West Twin Lake for the first 14 years of mine operations. The tailings pond was divided into two components, identified as the surface cell and reservoir, some 12 years ago and most deposition since that time was directed to the surface cell. The elevation of the tailings surface increased behind a shale dyke that was raised periodically using an upstream construction method (built over frozen tailings). Summer deposition into this surface cell has been by conventional beaching with particular efforts made to spread the tailings thinly so they would freeze during the winter following their deposition. Winter deposition was into a pond behind the dyke in order to limit ice formation. Water that accumulated in the pond was directed to a decant structure where it was pumped into the lower reservoir. When we visited the site on July 22,2002 approximately 50 percent of the surface cell had a water cover on it.

Water from the reservoir flows to a polishing pond where it is stored and released annually into Twin Lakes Creek, following confirmation that it meets discharge criteria set out in the water license. It is our understanding that the winter deposition pond in the surface cell has been reasonably stationary over the years and according to comments by Mr. Cassie, Geotechnical Consultant to the mine has remained about 7 m deep throughout the operations. Under this condition we would not expect permafrost to have formed within pond bottom tailings that have more than 2 to 3 m of water cover in winter.

It is our hypothesis that the surface cell is probably not completely frozen and that a substantial unfrozen zone or "talik", as it is described in permafrost terminology, is present within the deposit. The questions we posed to the mine at the hearing were intended to determine if they acknowledge the potential presence of a talik and to determine if they have a plan in place to evaluate its extent. It is our opinion that the talik could be extensive within the tailings originally placed below water level (first 14 years of deposition) and may extend into the natural lakebed sediments. Our interpretation of the response to our questions on this issue is that the mines' technical advisors do not dispute our hypothesis and they will develop, together with the mine, a plan to evaluate the current thermal regime within the surface facility.

The view expressed to us informally was that it was not practical to drill into the potentially affected zone at any time during mine operations because the ice surface on this active disposal cell is unsafe in winter. However, with closure, it will be possible to either place a cover causeway over the tailings to allow summer access or drill from the ice this winter. We strongly encourage the mine to proceed with this activity as soon as practical and to provide sufficient information to fully characterize the extent of any unfrozen zones within the tailings area and the behavior of so-called frozen tailings that are just below 0°C. A drilling program should leave behind open standpipes within the unfrozen areas for water sampling and possible future installation of piezometers plus thermistor cables for monitoring permafrost changes.

An unfrozen or partially frozen zone within the tailings has the potential to affect post-closure performance of the facility in a number of ways. The most significant of these are the following:

- Expulsion of contaminated pore water during permafrost formation by hydraulically fracturing of overlying frozen tailings and the surface cover. Contaminated water could be discharged on the surface cover or on the face of the dyke.
- Disruption of the surface cover by heave from ice lense formation within the freezing tailings,
- Increased risk of a total dyke failure during an earthquake event by liquefaction of the unfrozen zone. Although liquefaction failure was identified as a "worst case failure scenario" in the risk assessment described during the mine's presentation at the hearings, to our knowledge, this failure condition has not been analyzed.

The data collection program will need to be configured to fill data gaps that currently exist and to allow assessment of these conditions. If extensive unfrozen or partially frozen regions remain, geothermal prediction of the time to freeze sufficiently to fully immobilize the pore water will need to be undertaken.

B RESERVOIR AREA

The closure plan provides for a one-metre minimum water cover over tailings within the lower reservoir area of the disposal facility as a method of controlling acid mine drainage. The one-meter is based on research from southern regions that suggests this is sufficient to ensure bottom sediments (tailings) are not entrained by natural lake forces such as wind and waves. We expressed concerns at the hearings about the appropriateness of the proposed one metre water cover at this site and asked if winter ice formation had been considered in the assessment. The natural thickness of ice formation on lakes in this region is expected to be in the range of 1.8 to 2 m. This implies that the water cover will freeze to the bottom early each winter and there will be seasonal freezing of the ice into the tailings. This will entrain tailings in the ice (and water) at breakup. It is also possible that sporadic permafrost will form in shallow regions, further disturbing the pond bottom profile by frost heave.

It appears to us that neither of these mechanisms that could disrupt the predictions of long-term water quality in the reservoir have been evaluated. Pond bottom bathymetry and ground temperatures within the bottom sediments should be collected and evaluated. In view of these concerns and the risk of pore water expulsion from the adjacent surface cell, it is our opinion that a fresh examination of the quality of water that may be discharged from this reservoir during the period of post-closure monitoring and beyond needs to be undertaken.

C TAILINGS SYSTEM CLOSURE PLAN

It is our opinion that the mine should prepare a new and comprehensive closure plan document for this component of the mine site. The plan can draw on analyses and research completed to date but should be a stand-alone document. Much of the information already exists but there are gaps, discussed above.

The revised plan, fully supported with appropriate engineering drawings, needs to address the following topics.

- A brief description of historical operating practices, water movement and overall function of the system.
- An updated water balance for the system.
- Current site assessment including characterization of all tailings both physical properties (gradation, density, mineralogy) and thermal conditions in the surface cell, dyke and possibly the reservoir.
- A clear statement of objectives for the closure plan.
- Cover design and description of all construction activities associated with the closure plan
- Predictions of site stability and water quality with details of analyses that support the plan.
- Contingency plans for dealing with uncertainties and adverse performance during the post-closure monitoring period. These plans need to include a discussion of events that trigger their implementation.
- A monitoring plan that includes, permafrost stability, deformations of both the dyke and soil cover as well as water quality determinations.
- An appendix that constitutes a construction plan with material specifications, a quality control plan and as-built deliverables.

2. UNDERGROUND DISPOSAL PLAN

Information relevant to disposal of waste underground and long term stability of the underground workings has been very limited. CanZinco addressed a number of concerns raised by EBA and others in their presentation about available storage volumes in the underground and open pits for all the materials identified for underground disposal. They have concluded that there is an excess of storage volume of about 143,000 m^3 within the mine workings. A methodology for segregation and placing the materials has not been addressed, although some effort seems to be underway in this regard.

EBA, and our sub consultant Dr. Jim Mathis P.Eng, has questioned the long-term stability of the underground workings, once the pillars are removed. A brief report dated July 4, 2002 by Guy Lauzier, included in handout materials at the hearings, partially addresses this issue. That report seems to rely on surface water infiltration and ice formation within the backfill materials for long term stability. This is puzzling as it is not clear how the material will be placed and where the water will come from. It seems doubtful to us that a placement method will be developed that will ensure that the waste will assist with mine support. These matters need further examination and clarification for us to be comfortable with this issue.

It remains our opinion that a separate plan is required for segregation and placement of underground and buried waste materials. The content of the plan should address as a minimum the following considerations.

- A simple classification system for waste designated for underground disposal based on type and future risk.
- Criteria for segregation of materials according to the classification system adopted.
- Allocation of available space, based on the premise that those materials that pose the greatest risk will be stored in the deepest portions of the workings.
- Placement methods and schedule for the various material types.
- Maps and sections that show typical or critical components of the disposal areas both before and after filling.
- An evaluation of those locations that pose the greatest risk of long-term instability. Identification of monitoring where it may be required.
- An outline of the documentation that will confirm compliance with the disposal plan and the deliverables that will be on file following closure.

3. LANDFILL REMEDIATION

There was considerable discussion at the hearings concerning the waste stream that has entered the landfill over the years of operation. The mine acknowledges that it was a practice to dispose of waste oil (crankcase oil, etc) in the landfill before an incineration plant was installed. There

was confirmation from local residents who worked at the mine that some waste oil was dumped at the landfill as late as 1985. The mine places no credence in the rumor that two thousand barrels were disposed in this way. In their view this is an over estimate by at least a factor of 10.

We spent a short time at the landfill during the site tour. The site is relatively small and is located at a divide where leachate could possibly flow into either of two watersheds. There were no detailed topographic maps provided so we can't confirm this impression. The sloping site provides a substantial gradient for liquids to exit the waste piles. There was obvious leachate discharge occurring at the toe of the dump on July 23 and a gravel containment berm placed around the toe was ponding some of the leachate. It is not clear if this discharge is collected and treated or if it just seeps under the berm during periods when the active layer is unfrozen. The leachate collection system now installed appears to us to be ineffective.

The leachate visible on July 23 was not obviously heavily contaminated with hydrocarbons. It seems unlikely to us that large quantities of hydrocarbons have been dumped at this site. We would not expect full barrels to survive burial intact nor would we expect significant containment of hydrocarbons by permafrost at the site in its current condition. The rather limited extent of disturbance to surrounding terrain seems inconsistent with disposal of large quantities of hydrocarbons. We tend to support the view of the mine personnel that waste oil disposal was not a large component of past waste streams, however, it remains the responsibility of the mine to confirm this.

Additional information on the landfill will be obtained from the Phase II ESA. It is highly probable that data from the surface sampling and test pits will indicate that more information is needed. The ultimate goal will be to determine future risk and to design a closure plan that will mitigate it. It seems unlikely to us that a simple cover that places 1.25 m of shale on the exposed sideslopes will be sufficient. At a minimum, this surface cover will need to be supplemented with an effective leachate control system. That system may take the form of an engineered shale berm (possibly including a geomembrane) around the toe of the facility. That berm will need to be keyed into the underlying natural permafrost and will have to be constructed in a manner that will contain leachate within the landfill, allowing sufficient time for saturation and complete freezeback.

In order to achieve these objectives, we encourage the mine to proceed immediately with more comprehensive site assessment by drilling and installation of standpipes and thermistors (preferably before winter freezeback sets in). The boreholes should penetrate the landfill, the underlying natural soils and terminate in bedrock. The program should provide sufficient data to prove conclusively that there is not a core within the landfill that is soaked with hydrocarbons. The data will allow development of cross sections and plans for design of a long-term leachate control system.

4. CONCLUDING COMMENTS

It is clear that the ongoing Phase II environmental assessment is a key element in advancing the mine closure plan. EBA has completed a surface soil sampling program within the Nanisivik townsite for GN. The results of that program will be available within the next week and we understand it will be provided to the mine's consultant to assist in the identification of issues associated with alternate use of the town infrastructure. In this letter, we have addressed the issues that we feel have not received sufficient attention to date in the overall abandonment and restoration documentation we have reviewed.

We have discussed with you the prospects of a technical review meeting with the mine and their consultants before the next session of public meetings. We think such a meeting would be valuable and anticipate that you will pass these comments on to the mine to give them prior knowledge where our technical concerns lie. We would be pleased to assist with organizing the meeting and if it is held in Calgary or Edmonton, you could use the conference room facilities at the local EBA office if you wish.

Yours truly

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