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June 5, 2003
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Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU
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Attention: Ms. Dionne Filiatrault, P.Eng.,
Senior Technical Advisor

Dear Dionne:

Nanisivik Mine - Phase II
Environmental Site Assessment (ESA) Report, Emergency Response Plan (ERP) Report, and Human Health and Ecological Risk Assessment (HHERA) Report - Final Comments

On May 19, 2003 Canzinco submitted documents which contain replies to the queries and questions raised during the technical meeting held in Iqaluit on March 28, 2003, and submitted by various respondents for the following three documents:

- Phase II Environmental Site Assessment (ESA) for the Nanisivik Mine, as prepared by Gartner Lee Limited for Canzinco Ltd. and issued on January 30, 2003. The Phase II ESA report was submitted as per Section G, Item 13 of the Water License NWB1NAN0208.

- Emergency Response Plan (ERP) prepared by Nanisivik Mine/Canzinco Ltd. and issued on February 28, 2003. The ERP report was submitted as per Section E, Item 1 of the Water License NWB1NAN0208.

- Human Health and Ecological Risk Assessment (HHERA), as prepared by Jacques Whitford Environment Limited For Canzinco Ltd., and issued on January 30, 2003. The HHERA report was submitted as per Section G, Item 14 of the Water License NWB1NAN0208.

The following recommendations summarize our reviews of Canzinco's May 19, 2003 reply to Acres/ Dillon queries and questions submitted to the Nunavut Water Board (NWB) on March 21, 2003, as well as reviews by other respondents, including EBA Engineering Consultants (EBA)/BC Research Inc. on behalf of DIAND, Government of Nunavut (GN), Amec Earth and Environmental Limited (Amec) on behalf of Nunavut Tunngavik Incorporated (NTI), Environmental Canada (EC) and Canada - Fisheries and Oceans (DFO).

1. Phase II ESA Report

One of the main concerns raised during the technical meeting in Iqaluit and after the final comments provided by Canzinco is the use of 1985 soil data as background levels. In their report dated May 16, 2003 Gartner Lee Limited (GLL) provided a response which related to the applicability of the 1985 soil data as "background". It is understood that the 1985 soil data was one of the earliest comprehensive baseline environmental data gathering studies in the area, which provide sufficient information on background data. GLL indicated that the effects of mining activities during the nine-year mine operation prior to the 1985 report were considered to be negligible with the exception of the concentrated mining activities areas, townsite and loading dock area.

However, in view of the concerns brought up by the various parties, the fact that the mine has been in operation more than 9 years prior to the 1985 study, and the potential impact of the background data on the selection process to determine the SQRO values at Nanisivik, we recommend that Canzinco shall revisit one more time the issue of the 1985 background soil data, for use in the screening process of the HHERA report. A comprehensive analysis, including potential use of other background data such as 1975 BC Research Inc. report or other must be explored and strong rationale shall be developed to justify to use of the 1985 background data. Alternatively, the use of surrogate background data, other data prior to 1985 (if available and the data were comprehensive enough to use), or creation of new background data from a nearby sitting, etc. must be discussed in greater detail. Pending to this detail analysis, justifications to use 1985 background data will need to be accepted by the various parties, prior to the final approval of the ESA II document.

For the remaining issues and their final comments by Canzinco, we recommend that they are accepted and to be included in the final ESA document. Rather then modifying the entire document, we recommend that only the Executive Summary and the Table of Contents be updated as necessary, while any additional supporting information be attached at the end of the main report.

The conditions which are required for the final acceptance of the ESA II document are:

(a) The Executive Summary be revised to include statements that address the issues which were raised from various parties during the reviews and the technical meeting in Iqaluit. Specifically, it should include brief statements, rationale, and sufficient justifications about the following:
- the use of 1985 background soil data
- marine environment sediments issues
- field methodology, sampling , lab. testing and QA/QC
- surface water quality objectives
- acid rock drainage (ARD) evaluations, including mine roads assessment
- landfill content issues raised in Phase I ESA report
- removal of all hydrocarbon contaminated soils
- concerns of other contaminants used in mining operations, including PCB, ammonia (nitrogen compound), xanthate, etc.
- follow-up programs prior to the final remediation phase of the Closure and Reclamation Plan, including the upcoming 2003 summer investigation program.

Statements shall be brief, but explicit enough to provide finality in the Executive Summary for these major issues.

(b) All the queries from the various interested parties and the response by Canzinco Ltd., including a new section containing additional analysis on the use of 1985 background soil data, shall be considered as official submissions and part of the ESA report. It is suggested that they should all be compiled in one attachment.

2. HHERA Report

This section has been prepared by Dillon, who has been working together with Acres in reviewing the HHERA document submitted by Canzinco. The comments with respect to the HHERA issues at Nanisivik are finalized as follows.

Based on the comments prepared by Dillon, we recommend that NWB requests Canzinco to redo the analysis, incorporating the various inputs and comments made by other parties. This final round of analyses and revisions should include new input or justifications for the use of the 1985 background data. In summary, the HHERA report requires additional analysis before their recommended SQRO values be approved and adopted for Nanisivik.

We also recommend that the revision should not include or wait for any additional test results from any new proposed field program to be carried out this summer. Such additional data should only be incorporated in the remediation program at Nanisivik, unless there is new data which may critically change the SQRO values.

To bring the SQRO values and HHERA report to a final conclusion, it may be necessary (and more practical) to have conference call among the parties who are involved in the preparation of the documents and comments on the report. This may be the only solution to finalize the issues and concerns among the parties in a timely manner.

Details information from Dillon is attached to this letter.

3. ERP Report

In general, the ERP report has been considered to be complete. We recommend that NWB accepts the documents, with a following minor conditions:

- The document be updated whenever there is any change on the contact information (contact personnel and number), and list of equipments, supplies, and other logistical information which affect the execution of the emergency response.

- Ensure that the figures and appendices are included in the document. Appendix C needs to be updated as required.

We hope that the above information is adequate for your purpose. Should you have any further questions about this review report, please contact me.

Yours very truly

RAH:sep
Attach
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R. Halim , P. Eng
Senior Geotechnical Engineer

MEMO

DILLON CONSULTING

TO: Ramli, Halim
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FROM: Bryan Leece, Ulysses Klee , Dillon Consulting

DATE: June 3rd , 2003

FILE: 03-1598

SUBJECT: Peer Review Human Health and Ecological Risk Assessment for the Nanisivik Mine

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As per your request we have reviewed the response to our peer review comments on the human health and ecological risk assessments for the Nanisivik Mine, prepared by Jacques Whitford Environmental Ltd (JWEL). Our review of the JWEL responses are provided in three sections. The first addresses the JWEL responses to the ecological risk assessment (ERA). The second addresses the JWEL responses to the human health risk assessment (HHRA). And the third addresses the additional questions you raised in your e-mail of May 29, 2003.

1 Review of Responses to ERA Comments

1.1 Chemical Screening

The response provided was acceptable. It is suggested however that this information be included in the report as it represents an important element of the site remediation process and thus impacts on the scope of the risk assessment.

1.2 Selection of Valued Ecosystem Components

Disagree. The "careful consideration" of biota that are likely to be found on the site was based on the information provided in the report by Gartner Lee and this information was not reflected accurately in the risk assessment. The objective of the risk assessment is to assess the impacts of the contaminants on the ecosystem. This is not based solely on exposure. The toxicity of the metal to the animal must also be considered. It is agreed that animals with a large home range will be expected to receive a lower exposure but this needs to be quantified and compared to their respective exposure limit in order to conclude that they are not of concern. Likewise, migratory species

that use the area extensively will potentially receive unacceptable levels of exposure while on-site. This too needs to be quantified in order to address this issue in a transparent and complete manner. It is not acceptable or necessary to rely on the authors "experience or judgement" with these matters.

The question regarding the exclusion of marine wildlife was not addressed.

1.3 Applicability of OTR data to Nanisivik Mine Site.

If the authors of the risk assessment were aware that background data for the mine site area was not available then why was this data not collected as part of the assessment work? The importance of data characterizing the background soil conditions, particularly when assessing contaminants that are naturally occuring and naturally elevated, is very important. This oversight represents a significant data gap and undermines the development of SQROs. Background concentrations of metals in the soil are used in the calculation of SQROs and these soil clean-up levels should not be lower than the natural background. It is unfortunate that OTR values are the only ones available but this does not make them valid for application at a mine site in Nunavut. The authors comment does not satisfy the concern raised by the question.

1.4 Surface versus subsurface soil

The response does not address the question. Why was 10 to 15 cm used as a designation for surface soil? Surface soil, in terms of the ecological risk assessment should be considered as that depth of soil that will provide reasonable potential for exposure to terrestrial biota. Consideration should be given to the depth of plant roots, and the presence of burrowing mammals and soil invertebrates. It is agreed, that using the top 10 to 15 cm will provide a conservative estimate of exposure but the statement "only soil samples that accurately reflect concentrations in the upper 10 to 15 cm from ground surface are relevant to potential exposures" is false. The use of "surface" and "subsurface" to describe soil above and below 30 cm is inappropriate unless the nature of the soil supports this. No information or discussion regarding this is provided in Section 3.2.1.

In addition, the actual value of the EPCs is irrelevent for the development of SQROs. More important is the relationship between the contaminated areas and the naturally occuring background, and the relationship between the concentration of contaminants in the soil and the concentration of contaminants in biota.

1.5 Copper in surface water

Copper was designated as a chemical of concern and thus the data gap is a significant deficiency. The water was screened for the other contaminants where data was available. The approach should be consistant. The surface water could represent an important contaminant source depending on the concentrations of copper present and thus should be quantified. If the authors were aware of the data gaps, then the appropriate sampling should have been initiated at the beginning of the project in order to address this. Surface water sampling is a relatively simple and inexpensive process but represents an important element of the site characterization with regards to ecological risk assessment..

1.6 Arithmetic versus geometric means

It is agreed that the geometric mean is an alternate measure of the central tendency when data is not normally distributed. It offers the advantage of being relatively imune to outliers associated with highly skewed data sets. But, it is not appropriate to take the geometric mean of log-normally distributed data after it has been log transformed (as is stated in Section 3.6). By performing the transform, the distribution will be normal and the arithmetic mean is the more appropriate measure of the central tendency. Section 3.6 should be corrected.

1.7 Omitted metals from screening process

The author did not sufficiently answer the question and conveniently omitted the relevant section. Metals such as mercury, barium, beryllium, chromium, selenium, tin and vanadium, that were omitted from the screening process, are of great interest from an ecotoxicological perspective. Why were they omitted from the screening process?

1.8 Position of Conceptual Model in the text

Response Accepted.

1.9 Stream sediment characterization

Do the soil SQROs take into consideration the potential for run-off into the stream and subsequent downstream contamination of the marine environment? This is a valid concern for the development of the SQROs and needs to be considered. Additional text in the report is required.

1.10 Site characterization focussing on ecology

The response was completely inadequate. Section 2.1 provides several sentences with reference to the physical environment and Section 4.0

discusses Community Consultation. Please provide thr requested information in the text of the report.

With regards to the selection of VECs, please refer to Comment 1.2, provided above.

1.11 Unique characteristics of Arctic ecosystems

It is agreed that knowledge gaps can be compensated for by making conservative assumptions, but knowledge of these gaps must be understood and conveyed in the report in order to ensure that the steps taken in the risk assessment are truly conservative. No information was provided regarding the unique nature of Arctic ecosystems and the wildlife that inhabit them. No adjustments were made to the exposure limits to account for hibernation strategies, or feast/famine strategies. As stated earlier, migratory species are of concern and it has to be demonstrated that the site does not contribute an unacceptable level of contaminant loading to these animals while they are on-site.

Again, the response by the author to this issue was inadequate.

1.12 Terrestrial Invertebrates

Dissagree, the statement that soil invertebrates will be rare is unfounded.

"About 2,000 species of resident terrestrial arthropods (insects, spiders, mites, and related forms) have been reported from the North American arctic, and probably about the same number of additional species are yet to be recognized or discovered. Over 550 species have been found in the high arctic Queen Elizabeth Islands."

From "The Biological Survey of Canada"

Terrestrial invertebrates represent an important element of all biologically active soils, and the Arctic is certainly no exception. Although a primary role will be as decomposers, they will likely represent a food source as well. Birds (particularly the ptarmigan) and small mammals, including the fox, will utilize this food source. The potential for these invertebrates to be significant vectors for metal bioaccumulation needs to be included as a pathway.

Direct impacts of the contaminats on soil microbes and microbial processes in the soil are also important and should be included as a VEC within the risk assessment. This is supported by the following excerpt.

From the Nordic Arctic Research Program

"The vast majority of studies of physiological adaptations in invertebrates have concerned themselves with single stress types. The Arctic environment is a sink for a large number of environmental contaminants and there is a growing body of evidence suggesting that tolerance to climatic stress may be decreased by pollution. The ecological implications of this synergism is that pollution in arctic regions may play a much more dramatic role for local extinction and the geographical distributions of species than in more benign climates. Investigation of this type of synergism will be a central element in Arctic risk assessment."

1.13 Soil to plant bioaccumulation models

Soil pH is an important modifier of both the fate/behaviour and toxicity of metals in soil. If the authors were aware of this data gap, why was it not addressed.

The paper by Efroymson et al. (2001), provides 4 equations (two that consider pH and two that do not). For zinc, the consideration of pH significantly improves the correlation (r^2 of 0.85 versus 0.32). Without pH, an r^2 of 0.32 to 0.4 hardly provides strong predicitive power. The author should refer to the graphs on page 2564 of the journal paper to get a better understanding of the "predictive powers" associated with these models.

The author should also review a paper presented by Fordham et al (1999) that provides an evaluation of bioaccumulation models. Their conclusion was that in order to estimate the contribution of dietary pathways in risk assessment, at least limited tissue data from the site should be collected. Was this considered during the conception of the risk assessment and identified as a data gap?

1.14 Exposure estimates

Although a relatively minor point, the first issue regarding the title of the section was not addressed. The title should be modified accordingly.

The deficiency may be considered insignificant to the outcome but the predicted values in Tables 7.8 to 7.11 need to be corrected to reflect contributions from background exposure. The values for the Gyrfalcon are incorrect. Again, the short sitedness of the authors in not ensuring that adequate background data was available, is not a valid excuse.

1.15 Site remediation recommendations

The reviewer does not require information to be stated "simply". It would be appreciated, however, that information, both in the RA report and the

comments, be stated accurately, clearly, concisely, and properly supported with data and/or references.

The "hotspots" either represent a risk to ecological receptors at the population/community level or they do not. Using a phrase such as "there may be some benefit" is vague and meaningless within the context of the risk assessment and the application of the SQROs. If the issues are associated with aesthetics and public perception then this needs to be made clear in the report text.

1.16 Chemical interactions

The comment provided is inadequate, irrelevant and significantly different from the position provided in Section 7.9 of the risk assessment document. The interaction of metals with regards to wildlife toxicity is not simply a function of similarities in the mode of toxic action. It is unclear what is meant by the physiological behaviour of a metal. And the fact that cadmium and lead have no known biological function while copper and zinc are essential elements is irrelevant in terms of the potential for interactions.

JWEL's statement regarding chemical mixtures included that "there is considerable uncertainty associated with the additive approach in that risk may be greatly overestimated or underestimated." This latter element is of considerable importance and requires further discussion with respect to the potential risks to wildlife and the impact on the SQROs. Is information available to support this statement (provide reference) and how does it apply to the current group of COCs under the conditions present at the mine site?

2 Review of Responses to HHRA Comments

2.1 HHRA Comment 2.1: Identification of COCs.

The original comment indicated that not all potential COCs had been considered in the HHRA. The JWEL response indicates that the HHRA focused on metals because CanZinco has indicated that soil contamination with other COCs will be remediated. Therefore, JWEL indicates that it is not necessary to include these compounds in the HHRA. The only way that this can be considered valid is if remediation is intended to mean that all other COCs will be completely removed from the site. The current responses from JWEL indicate that the intent is to bury these contaminated soil in the permafrost where they will become encapsulated, thereby eliminating exposures. While this would appear to be an adequate means of limiting or eliminating exposures, there will likely be some requirement for monitoring to ensure that the assumptions made regarding disposal are indeed correct. Provided that measures are put in place to ensure that the intended

remediation option is effective, the elimination of these COCs from the human health risk assessment is adequate. However, the explanations provided in the Response Comments should be included in the final report.

2.2 HHRA Comment 2.2: Use of Bioavailability Factors.

The original comment related to the inappropriate use of bioavailability factors to adjust exposure estimates without the corresponding adjustment of the toxicity reference values (TRVs). The response provided by JWEL indicates that bioavailability factor (AF) for soil has been set to be the same value that was used for game. This seems to indicate that the revised report has applied a bioavailability factor of 100% to all components. If this is indeed what was done, then the issue has been appropriately addressed. However, the current response provided by JWEL is confused and difficult to follow. If a factor of 100% has been used, this should be clearly stated.

2.3 HHRA Comment 2.3: Soil Ingestion Factors for Toddlers.

The JWEL response to this comment appears to have addressed the original concern. However, the data have not been reviewed in detail to determine if appropriate exposure averaging factors have been applied in the adjusted calculations.

2.4 HHRA Comment 2.4: Apportionment of Soil Ingestion Rates.

The initial comment was directed at the fact that exposures to metals in indoor dust were being treated as background exposures. By definition, background exposures are not related to site sources. This clearly is not the case for metals in Nanisivik, where the levels of metals in indoor dust will be driven by the levels of metals in outdoor soil and dust. Thus, both indoor and outdoor dust exposures must be considered in the development of the SSTLs for metals in soil.

The JWEL authors are correct in indicating that apportionment of intake between outdoor and indoor soil/dust in a common practice in risk assessment. However, inclusion of these types of considerations in a risk assessment requires substantial scientific justification to support the apportionment selections. None of this justification was provided in the original report and has not been provided in the current response document. In the absence of this justification, it is possible to say that the approach used in the report is valid, but it is not possible to state that the assumptions used as values in the approach are sound. Until such justification is provided, it is not possible to fully evaluate the SQROs developed in the HHERA.

2.5 HHRA Comment 2.5: Receptor Parameters.

Drinking Water Consumption Rates:

The drinking water consumption rates used by JWEL are inadequate. JWEL indicates that a drinking water ingestion rate of 0.2 L/day was used as indicated by Health Canada. The rationale for using this lower value rather than the standard 0.8 L/day is based on the fact that the upper limit includes the consumption of drinking water as part of food and reconstituted drinks. This suggests that the use of the upper limit would result in some level of double counting of exposure. However, the are a couple of problems with this.

Firstly; for the toddler, the Health Canada estimates of the intake of foods/drinks that may contain tap water account for approximately 173 grams/day (0.173 L/day) which is short of the 0.8 L/day cited by Health Canada as a recommended daily intake. Therefore, using 0.2L/day and assuming that the remainder is accounted for by the use of tap water in food preparation results in an daily intake of approximately 0.4L/day which is only 50% of the recommended value.

Secondly; The current report classifies food intakes as a non-site or background source. Using this approach effectively limits the estimated intakes to a total tap water exposure of 0.2 L/day. It is reasonable to assume that local drinking water will be used for cooking and preparing other drinks in the homes in this community. Therefore, excluding these intakes from tap water under estimates the exposure to metals in drinking water. If as the authors suggest, that drinking water accounts for less than 5% in the current assessment (based on an estimated daily intake of 0.2 L/day) this would rise to somewhat less than 20% if proper drinking water ingestion rates had been used.

Receptor Body Weights:

The response provided by JWEL is adequate. However, the fact that the values selected for use in the assessment are less conservative than those typically used in a standard risk assessment should be acknowledged and the effect that this lack of conservatism will have on the overall conclusions should be properly addressed.

Receptor Inhalation Rates:

The response provided by JWEL is adequate. However, if these values are to be used, it will be necessary to adjust the inhalation toxicity values to account for the differences in inhalation rates between the assumptions used in the development of the values and the inhalation rates used in the report.

2.6 HHRA Comment 2.6: Review of Calculations

Bioavailability Factor for Lead in Drinking Water

If, as the authors suggest, a bioavailability factor is not used, then reference to its use should be removed from the text of the report.

Background Soil/Dust apportionment.

The original comments were intended to indicate that justification is required to support the values used. Although JWEL indicates that this issues has been addressed in previous comments, as noted above, the scientific justification necessary to support the assumptions made in this report have not been adequately provided.

Calculation of SSTLs for lead and zinc.

The JWEL response is adequate.

3 Responses to Additional Questions

In addition to addressing the JWEL responses to our original comments, we are also providing comments on the questions outlined in your e-mail of May 29, 2003. Each question is addressed below.
Our comments are intended to address the following questions, as outlined in your e-mail of May 29, 2003;

3.1 Did Canzinco properly and satisfactorily address your questions and comments?

The responses provided by CanZinco/JWEL adequately address some of the issues raised in the original review. However, as noted above, a number of outstanding issues remain to be resolved. Some of these will have an effect on the SQROs calculated for the community.

3.2 Looking at replies to queries brought forward by other peer reviewers, are there other concerns that you feel need to be addressed?

The JWEL response report provides abbreviated versions of the comments provided by reviewers. This makes it difficult to determine if all comments are adequately addressed. However, based on the present information, it would seem that the reviews have identified all of the major concerns that could have an effect on the conclusions of the report.

3.3 Do you have confidence that the revised SQRO values can be accepted and used to implement the remediation program at Nanisivik?

Based on the comments on the human health component of the HHERA related to issues such as drinking water intake estimates, an additional round of revision and review will likely be necessary before the report can be considered to be acceptable.

3.4 Do you think public health concerns brought forward by Government of Nunavut may affect the remediation objectives set by the revised SQROs for the town site?

The issues related to the selection of background concentrations may have an effect on the final SQROs developed for the community. If the background levels used in this report are high and not reflective of actual background, then the SQROs developed for the site will be higher than they would be if lower background concentrations were used.

With regard to the issues related to the carcinogenic potential of lead and the effects of metal exposures on pregnant women, the issues raised by GN should not have an effect on the SQROs developed for the community. It should be noted that the development of toxicity values by regulatory agencies incorporated considerations for sensitive members of the population such as pregnant women. The final toxicity value is based on the biological end-point that occurs at the lowest dose and therefore provides adequate protection against biological effects that only occur at higher dose levels. Thus, the investigation of metals exposures on pregnant women is unlikely to alter the conclusion of the risk assessment.

3.5 Do you believe that the revised SQRO values are reasonable: and given their background, available data and existing CCME and other guidelines, should these values be accepted for the site remediation?

Before the SQROs can be considered reasonable, we need to be confident that the concentrations of metals in the soil that are being used to represent background are truly representative and appropriate for such use. In addition, the review has identified a couple of areas where additional clarification is required to ensure that exposures and risks have not been under estimated. Until these issues are resolved, it is not possible to conclude that the SQROs are reasonable.

3.6 Are there any concerns about the complaints of using the 1985 baseline study? If it is not acceptable, what baseline, or older reading were available to compare?

As noted in previous comments, there are some legitimate concerns related to the use of the 1985 baseline study as an indicator of background. The JWEL report does not provide sufficient justification to support the use of the 1985 data. Additional clarification is required.

3.7 Do you agree with the Canzinco position that the work has been conducted in a conservative manner?

The work has been carried out using standard and customary risk assessment procedures. In general, these provide conservative estimates of risk. However, because the report is intended to be a site-specific assessment, a number of site-specific assumptions have been used. While this is appropriate and in keeping with the conservative nature of a risk assessment, a number of assumptions have been used which are not as conservative as would typically be considered in a risk assessment of this nature. For example, the drinking water ingestion rate is lower than standard and the apportionment of dust intakes between indoor and outdoor events is also less conservative than standard. While these may be satisfactory, they require more scientific justification before they can be considered to be conservative in nature.

This completes our review of the human health and ecological risk assessments for the Nansivik Should you have any additional questions, please contact Bryan Leece or Ulysses Klee at (519) 650-9833.

Sincerely

Bryan Leece, Ph.D.
Senior Toxicologist/Risk Assessment Specialist
Dillon Consulting Ltd.