# CanZinco Ltd.
# Nanisivik Mine
# Closure and Reclamation Plan

## Volume 2 of 2
## Supporting Documents

A. 2001 Environmental Site Assessment and Proposal for Phase 2 ESA, Gartner Lee Limited, February 28, 2002.
B. Reclamation Cover Design for Nanisivik Mine West Twin Disposal Area Surface Cell, Gartner Lee Limited, March 08, 2002.
C. Pseudostatic Analysis for Seismic Stability of West Twin Lake Dyke, Closure Planning for Nanisivik Mine, NU, BGC Engineering Inc., February 5, 2002.
D. Report on Hydrological Study Nanisivik Spillway Design, Golder Associates Ltd., February 2002.
E. Preliminary Design of the West Twin Dike Spillway for Closure, Nanisivik Mine, NU, BGC Engineering Inc., February 28, 2002.

***Prepared for:***

**CanZinco Ltd.**

***Prepared by:***

**Gartner Lee Limited**

**February 2002**

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AN APPLIED EARTH SCIENCES COMPANY
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# PROJECT MEMORANDUM

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| **To:** | **Gartner Lee Ltd.** | **Fax No.:** | **867/873-4453** |
| **Attention:** | **Mr. Eric Denholm** | **CC:** | |
| **From:** | **Geoff Claypool (Ext. 104)** | **Date:** | **Feb. 5, 2002** |
| | **Jim Cassie (Ext. 103)** | | |
| **Subject:** | **Pseudostatic Analysis for Seismic Stability of West Twin Lake Dyke Closure Planning for Nanisivik Mine, NU** | | |
| **No. of Pages (including this page): 4+2=6** | | **Project No:** | **0168-015-01** |

## 1.0 BACKGOUND

In 2000, BGC Engineering Inc. (BGC) undertook slope stability modelling of the West Twin Dyke located at the Nanisivik Mine, following a risk assessment that is summarized in BGC 2000a. Within the analytical work undertaken, referenced as BGC 2000b, three potential models were formulated and assessed to bound a potential solution regarding the frozen shale dyke:

- "rigid-block" sliding along the base of the dyke;
- "conventional" slope stability analyses assuming dry (representative of frozen conditions); and
- creep failure related to potential massive ice lenses.

The conventional stability analysis completed for this study included both static and seismic (pseudo-static) analyses. The seismic coefficient used for the pseudo-static analysis, 0.05g, was determined from the seismic zonation provided in the Building Code of Canada. It should be noted that seismic hazard information provided by the Pacific Geoscience Centre (Geologic Survey of Canada) indicated that, for the Nanisivik Mine site, the 1 in 476 year return seismic event is 0.076g and the 1 in 1000 year return event is 0.099g.

BGC 2000b concluded that the West Twin Dyke met the required Factors of Safety (as outlined in CDA 1999) for both static and the specified seismic conditions of 0.05g, based on the assumed frictional values provided in the report. It should be noted that five recommendations

for additional work were provided within that report. The purpose of these tasks was to reduce the uncertainty regarding assumptions made within the analyses.

As part of closure planning for Nanisivik Mine, it became necessary to further investigate the long-term stability of the dyke under potentially more extreme seismic conditions. As a result, it was decided that additional stability analyses would need to be conducted. This project memorandum describes the additional analyses and summarises the results.

It should be noted that CDA 1999 states that:

> *"Dams shall be designed and evaluated to withstand ground motions associated with the Maximum Design Earthquake (MDE), without release to the reservoir. Selection of the MDE for a dam shall be based on the consequences of failure."*

It should be noted that no assessment of the MDE has been made within this present assessment. Generally though, more extreme seismic events are to be evaluated for the closure phase versus the operational phase of a mine.

## 2.0 STABILITY ANALYSIS

The stability analysis conducted for this study was completed in order to determine what seismic loading conditions are required for failure of the West Twin Dyke to occur. The analysis was conducted assuming the dyke has frozen and hence, dry (no pore pressures existing within the dyke). For this analysis, the effective friction angle of the tailings was varied over the same range considered in BGC 2000b, 23° to 33°.

The slope stability software used Janbu's non-circular method of analysis in the commercially available program SLOPE/W, under license from Geo-Slope International, Calgary, Alberta. A block specified analysis was used to ensure a number of potential failure surfaces were investigated. It is recognised that using Janbu's method of analysis may render conservative results, however given the uncertainty in the effective shear strength of the materials, use of this analysis is considered valid.

The results of the analysis are illustrated in Figure 1 for a dry (frozen) slope. The results indicate that the dyke will remain stable under seismic loading less than 0.11g, that is excess of the estimated 1 in 1000 year return event of 0.099g. Additionally, the dyke may remain stable under greater seismic loading conditions depending on the effective shear strength parameters of the frozen tailings material.

An additional analysis was completed to examine the effects of pore pressures on stability of the dyke under seismic loading conditions. This analysis assumed the potential failure mass would be partially saturated by using a pore water pressure coefficient, $r_u$, of 0.25. The results of this analysis are illustrated on Figure 2. The results indicate that the dyke will remain stable under

seismic loading less than 0.022g. Similar to the dry (frozen) analysis, the dyke may remain stable under greater seismic loading conditions, depending on the effective shear strength parameters of the tailings material.

As can be seen, the potential generation of pore pressures within the dyke and its foundation zone is of critical importance in the long-term stability of the dyke. There are three possible mechanisms that could result in thawing and pore pressure generation and these include:

1. Global warming affecting the subsurface temperatures.
2. Exothermic heat release from oxidizing sulphide minerals within the tailings material.
3. Placement and long-term storage of a deep (>2.5 m) pond of water within the Surface Cell, proximal to the West Twin Dyke.

As noted previously, no assessment of these possible mechanisms is provided in the memo herein.

## 3.0 CONCLUSIONS

A comparison of the results of this analysis with the regional seismic information provided by the Geologic Survey of Canada leads to the conclusion that the West Twin Dyke may withstand a 1 in 1000 year seismic event if it is dry (frozen). If thawing occurs for any reason, but complete drainage does not occur, the dyke may not be able withstand the 1 in 476 year event.

It should be noted that this analysis is pseudo-static and considers additional forces applied to the failure block as a result of a seismic event. No account for possible seismic induced liquefaction and resultant deformation has been made at this time. It is recognized by BGC that the tailings material is a loose, fine grained soil that could potentially be susceptible to seismic induced liquefaction given the appropriate thawing conditions. Further investigation would be required to assess this potential failure mode.

We trust the enclosed project memorandum meets your requirements at this time. Should you have any questions, please contact the undersigned at any time.

Respectfully submitted,
**BGC Engineering Inc.**

Geoff Claypool, B.Sc., E.I.T.(AB)
Project Engineer

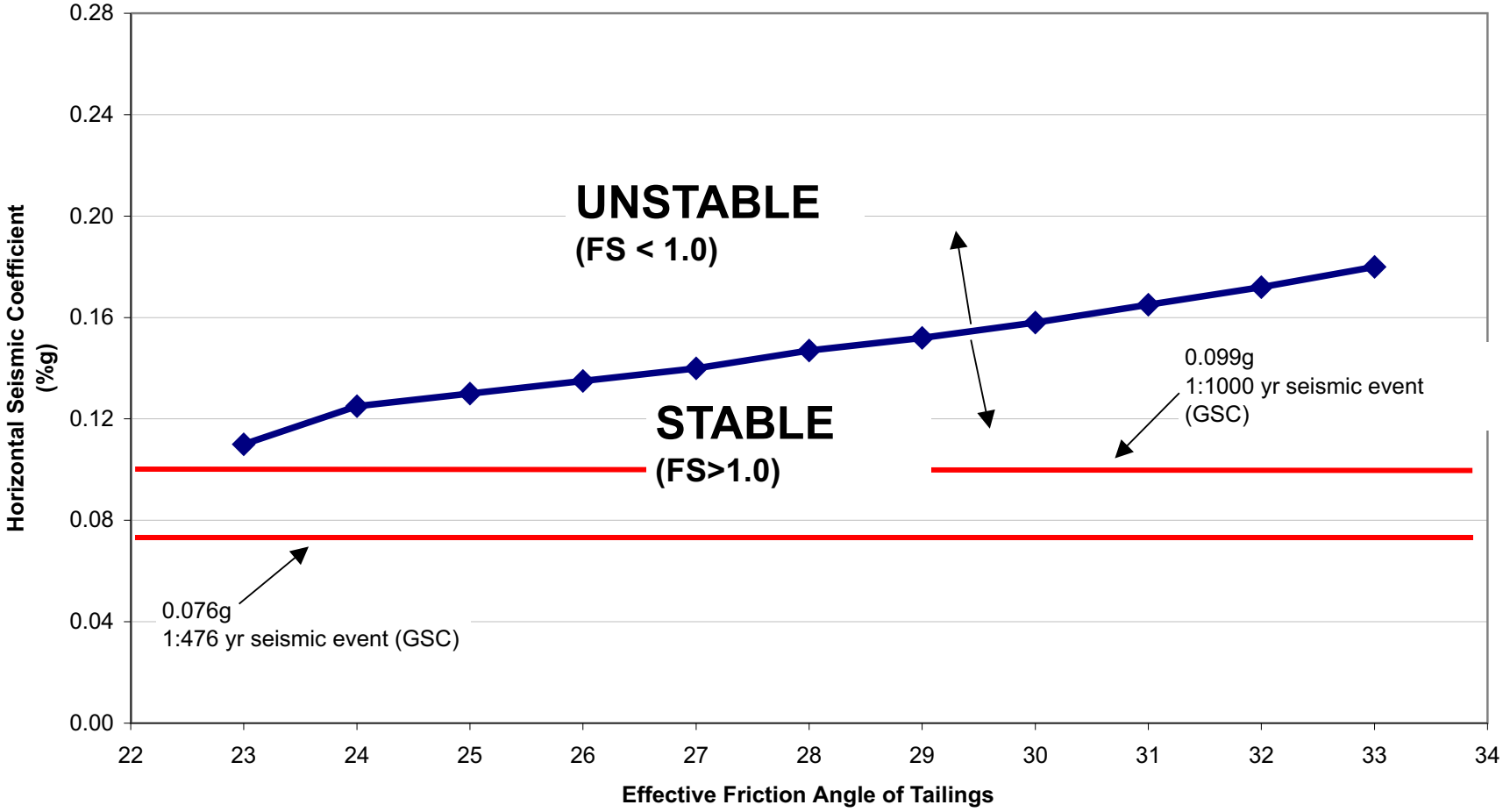
James W. Cassie, M.Sc., P.Eng.
Specialist Geotechnical Engineer

## REFERENCES

BGC Engineering Inc. 2000a. Risk Assessment of West Twin Disposal Area Dike, Nanisivik Mine, Nunavut. Project No. 0255-001. Submitted to Nanisivik Mine, a division of CanZinco Ltd., September, 2000.

BGC Engineering Inc. 2000b. Follow-up Analytical Work on West Twin Dike Stability, Nanisivik Mine, Baffin Island, Nunavut. Project No. 0255-001-02. Submitted to Nanisivik Mine, a division of CanZinco Ltd., November, 2000.

Canadian Dam Association 1999. Dam Safety Guidelines. Published by the Canadian Dam Association, twelve sections, January, 1999.

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CLIENT: **Gartner Lee Ltd.**

PROJECT: Nansivik Mine ESA

TITLE: Pseudo-static Stability Analysis - West Twin Dyke Dry, Frozen Slope (ru =0.0)

| PROJECT No. | DWG. No. | REV. |
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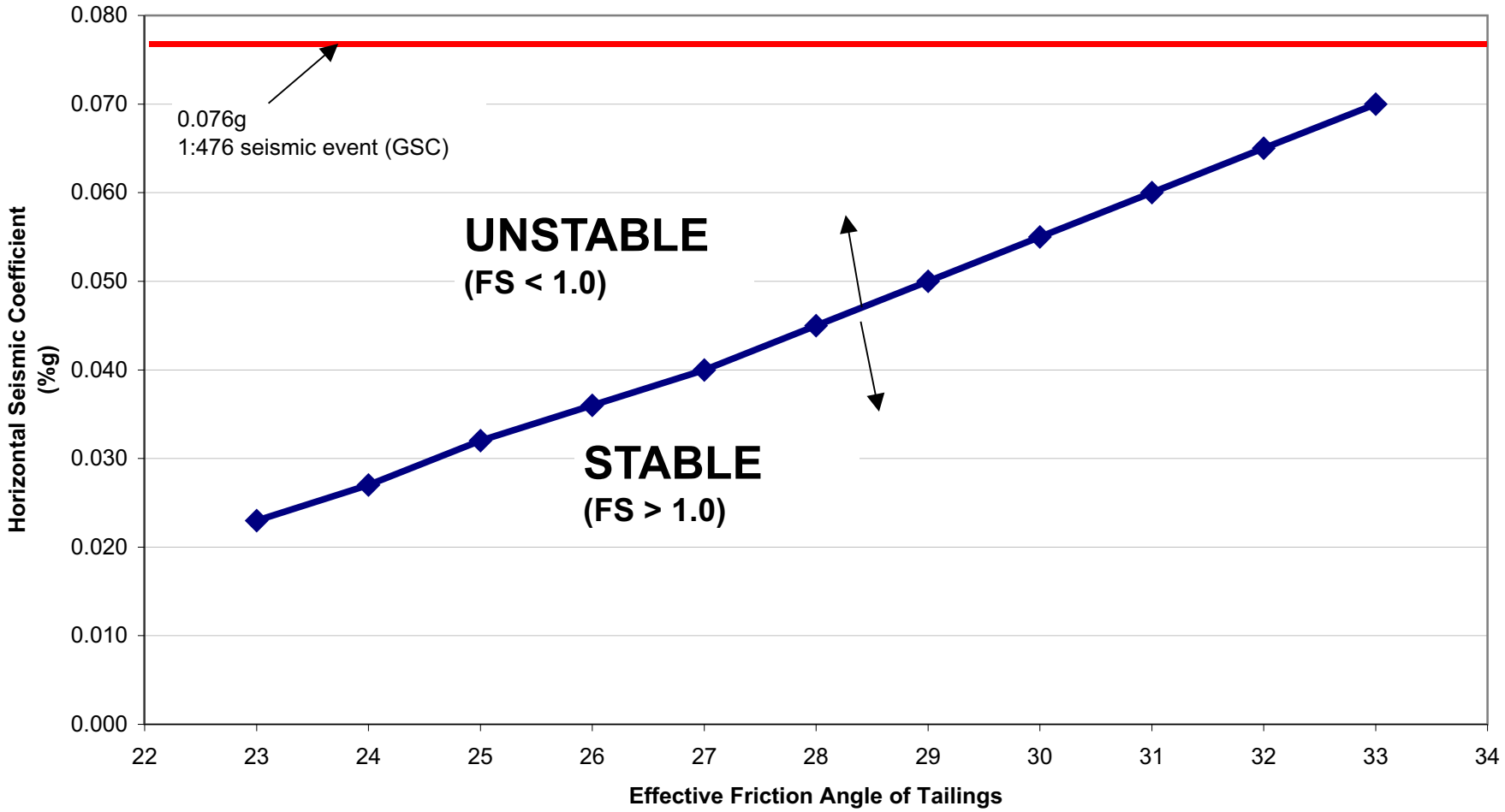
| 0168-015-01 | Figure 1 | 0 |

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CLIENT: **Gartner Lee Ltd.**

PROJECT: Nansivik Mine ESA

TITLE: Pseudo-static Stability Analysis - West Twin Dyke Thawed, Partially Saturated Slope (ru =0.25)

| PROJECT No. | DWG. No. | REV. |
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| 0168-015-01 | Figure 2 | 0 |