BGC ENGINEERING INC.
AN APPLIED EARTH SCIENCES COMPANY

NANISIVIK MINE, A DIVISION OF CANZINCO LTD.

2003 GEOTECHNICAL INSPECTION OF WASTE CONTAINMENT DIKES

NANISIVIK MINE, NUNAVUT

FINAL

PROJECT NO.: 0255-008-05
DATE: OCTOBER 28, 2003

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Project No. 0255-008
September 28, 2003

Mr. Bob Carreau
Nanisivik Mine, a Division of CanZinco Ltd.
Box 225
Nanisivik, Nunavut
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Re: 2003 Geotechnical Inspection of Waste Containment Dikes
Nanisivik Mine, Nunavut

Dear Bob:

Please find attached our final report on the Annual Geotechnical Inspection program undertaken at Nanisivik Mine. The inspection visit was undertaken between August 30 and September 1, 2003. This report includes your comments that were previously forwarded to BGC.

If there are any questions or comments regarding this report, please contact the undersigned at your convenience.

Yours truly,
BGC ENGINEERING INC.
per:

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer
(direct line 403/250-5185 ext. 101)

Enclosure: Final Report

GWF/sf

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LIMITATIONS OF REPORT

BGC Engineering Inc. (BGC) prepared this report for Nanisivik Mine, a division of CanZinco Ltd. The material in it reflects the judgement of BGC staff in light of the information available to BGC at the time of report preparation. Any use that a Third Party makes of this report, or any reliance on decisions to be based on it, are the responsibility of such Third Parties. BGC Engineering Inc. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

As a mutual protection to our client, the public, and ourselves, all reports and drawings are submitted for the confidential information of our client for a specific project and authorization for use and/or publication of data, statements, conclusions or abstracts from or regarding our reports and drawings is reserved pending our written approval.

1.0 INTRODUCTION

Nanisivik Mine is wholly owned and operated by CanZinco Ltd., which is a division of Breakwater Resources Ltd. Nanisivik Mine is located on the Borden Peninsula on northern Baffin Island, just south of Strathcona Sound, as shown on Figure 1.

The mine operates under Nunavut Water Board License NWB1NAN0208, dated October 1, 2002 which entitles the Licensee to use water and dispose of waste associated with the closure and reclamation of the mine. Part H, Item 6 of the License states:

> An inspection of the earthworks, the geological regime, and the hydrological regime of the West Twin Disposal Area, East Adit Treatment Facility, and fuel containment berms shall be carried out annually during the summer by a Geotechnical Engineer. The Geotechnical Engineer's report shall be submitted to the Board within sixty (60) days of the inspection, with a covering letter from the Licensee outlining an implementation plan to respond to the Engineer's recommendations.

In fulfillment of this requirement, Mr. Bob Carreau, Manager Environmental Affairs for Breakwater Resources Ltd., requested that Mr. G. Ferris, P.Eng., of BGC Engineering Inc. (BGC), conduct such an inspection visit. This report provides a summary of the dike conditions observed and resulting recommendations and maintenance issues.

Containment structures that were inspected included the following:

- West Twin Dike, the associated Test Cell Area Dike and the polishing pond decant structure,
- East Twin Lake diversion dike and channel,
- East Adit Treatment Facility dikes (treatment pond and retention pond),
- Dump Ponds (mill and upper ponds),
- Day Tank Farm spill containment berm, and
- Tank Farm spill containment berm.

All pre-1998 site investigation work, geotechnical design and construction monitoring of the West Twin and East Audit containment structures was carried out by Terratech, a division of SNC Inc. and Mr. Frank Tordon, P.Eng. Initial design work relating to the East Twin diversion dike and channel and the dump containment ponds was provided by Kilborn Engineering Ltd. Golder Associates Ltd. prepared the annual inspection reports for the waste containment dikes in 1998 and 1999, while BGC provided the annual inspection reports for 2000 through 2002. These other reports should be reviewed in combination with this current report for the sake of consistency regarding performance and maintenance issues.

2.0 CLIMATIC INFORMATION

Climatic data has been collected by Environment Canada since 1976 at the Nanisivik Airport, which is located approximately 10 km south of the West Twin Lakes Tailings and approximately 250 m higher in elevation. The recorded climate data were analysed in Golder (1998) to provide a basis for deriving the existing climate parameters such as precipitation, air temperatures and lake evaporation at the project site. The following list is a summary of the main climatic parameters based on the data available in 1998:

- The mean annual air temperature was –15.2°C.
- The mean annual precipitation totals 240 mm.
- The 24 hour Probable Maximum Precipitation (PMP) value was estimated to range from 140 to 210 mm.
- The mean annual lake evaporation value, as measured at the Nanisivik site, was approximately 200 mm.

Figure 2 illustrates the long-term mean monthly temperature values (Nanisivik Airport) versus the monthly values for 2001, 2002 and a portion of 2003. Values for 2002/2003 indicated that, in general, the temperature was about average, with some months being 2-5 °C different from the average (both higher and lower).

Figure 3 shows the long-term monthly total precipitation values as compared to the monthly values recorded in 2001, 2002 and a portion of 2003. In July and August of 2002, the amount of precipitation was about double the average value and in May 2003, the amount of precipitation was nearly three times the average.

Site specific evaporation studies for the Nanisivik tailings basin were performed by Mr. Bob Reid, who is a hydrologist with Indian and Northern Affairs Canada (INAC), Water Resources Branch, in Yellowknife. The estimated evaporation rate for Nanisivik amounted to 142 mm for 2002 (personal communication with Mr. Reid), as compared to the mean value of 187 mm.

3.0 MINE OPERATIONAL DESCRIPTION

3.1 Mine Production and Reserves

Nanisivik Mine began mining in 1976, initially at 550,000 tonnes per year, increasing to 685,000 tonnes per year in 1982. Table 1 provides a summary of the major mine production and waste statistics over the last several years:

Table 1 Summary of Mine Production and Tailings Statistics

Parameter	1999	2000	2001	Until September 2002
Total ore mined (tonnes)	791,100	891,875	859,120	573,527
Total tailings reporting to WTDA (tonnes)	688,100	697,769	668,582	425,213

Nanisivik Mine completed all mining activities on September 30, 2002. As such, no additional storage capacity (and resultant dike raise) was required within the West Twin Disposal Area (WTDA). The WTDA will be closed and reclaimed according to the Reclamation and Closure Plan (which is subject to regulatory approval).

3.2 West Twin Disposal Area Operation

The WTDA is comprised of an upper, solids retention pond, named the Surface Cell and a lower, water retention pond, called the Reservoir, as shown on Figure 4. The Surface Cell and the Reservoir are separated by an earthen dike, called the West Twin Dike. This dike is constructed of frozen compacted shale and settled tailings. Excess water from the Surface Cell is transferred to the Reservoir by pumping system. The Reservoir and a final polishing pond are separated by a causeway and stop log structure. The sop log structure controls the water level in the polishing pond. Water from the polishing pond is then discharged to Twin Lakes Creek at the decant structure located at the outlet from the pond.

During operations, tailings were deposited into the Surface Cell along the perimeter to promote stratification of sediments and to clarify waters returning to the decant/siphon pipe. Advancement of additional discharge points was determined by the overall height of the deposited tailings and the ability to return clear water to the decant well. Excess water was then siphoned or pumped into the Reservoir from where it was reclaimed for use in the mill. Occasionally tailings were discharged directly into the Reservoir. Golder (1998) provides an assessment of the freeboard requirements for the West Twin Dike.

Due to the extraction of potable water from East Twin Lake, it is a requirement of the water licence that the Reservoir (formerly, West Twin Lake) elevation remain lower than the East Twin Lake level. Table 2 presents a summary of the tailings tonnages discharged, the water volumes reclaimed and the resultant lake level for the past 12 months:

Table 2 Tailings Tonnages and Water Levels for Past 12 Months

Month	Tailings Discharged (tonnes)	Water Volume Reclaimed from Reservoir (m^3)	Month End Reservoir Elevation (m)
Jul.'02		97,700	371.02
Aug.'02		86,409	371.05
Sep.'02		99,295	371.07
Oct.'02		0	371.07
Nov. '02		0	371.07
Dec. '02		0	371.07
Jan. '03		0	371.07
Feb. '03		0	371.07
Mar. '03		0	371.07
Apr. '03		0	371.07
May '03		0	371.07
Jun. '03		0	371.29

Excess water from the WTDA is discharged to the environment between July and September of each year, with annual quantities typically ranging from 200,000 to 400,000 m^3. In 2003, approximately 375,000 m^3 of water was discharged between July 8 and September 30.

When the mine was operating, a 2 m high lift was added annually to the West Twin Dike, using compacted and frozen shale rockfill. The dike was raised in an upstream manner. Golder (1999a) provides a detailed description and relevant cross-sections for this construction technique. No annual raising of the dike has been undertaken since 1998.

Prior to closure, the water collection location for the siphon/pump system in the Surface Cell was filled in using tailings and thereby removed the deep water location that had been maintained during operations. Two smaller water ponds were maintained within the Surface Cell, both parallel to the surface of the dike. The pond closer to the dike is about 3 m deep and the pond further from the dike is about 2 m deep. The estimated pond level during the inspection was about 2 m below the crest of the dike.

In 2001, as recommended in Golder (1999b), a 2 m high shale dike was constructed around the Test Cell Area at the toe of the West Twin Dike, on top of the existing tailings causeways situated within the Reservoir. The construction of the first lift of this solids retention dike was undertaken from April to June, 2000 and involved the placement of approximately 16,400 m^3 of shale material. The second lift of the Test Cell Area dike was constructed from March until May 2001 and involved the placement of approximately 25,000 m^3 of shale material.

3.3 East Adit Treatment Facility Operation

The East Adit treatment facility is comprised of a treatment pond and a retention pond, both of which employ earthen dikes to retain surface water flow. Figure 5 shows a plan and section view of the treatment pond basin while Figure 6 shows the retention pond. Water retained in this area is runoff water from the surrounding drainage basin, where the water quality is affected and/or impacted by exposed mine workings and natural sulphide outcrops.

Both dikes are shale rockfill structures mixed with a combination of one or more of the following: regional talus, glacial till, marine clay and/or bentonitic clay. Slope angles on these dikes vary from the angle of repose (~1.25H:1V) to approximately 2H:1V.

The treatment pond level is controlled by a two pump system used to treat water and pump water to the retention pond. Lime is added to the pumped water via a screw feeder from a one tonne lime hopper. Natural agitation from the pump discharge mixes the lime and water before they're transferred to the retention pond through the second pumping stage.

Retention pond level control is achieved with a gravity siphon/decant system. The siphon line is charged using a small gasoline-powered portable pump. When the metal levels in the pond water have fallen to acceptable discharge levels within the pond, the siphon is started. Once the line is charged with water, the gravity/siphon system will maintain water flow until either the siphon is broken or until effluent quality at the discharge becomes unacceptable and decanting is halted.

4.0 INSPECTION CONDITIONS

Mr. Gerry Ferris, P.Eng, conducted the site inspection on portions of the following three days:

- Saturday, August 30,
- Sunday, August 31, and
- Monday, September 1, 2003.

Each of the embankments was inspected on foot. Pertinent observations concerning both the condition and seepage were recorded by photograph and Dictaphone. In general, the crest and upstream slope of a given dike or embankment were inspected first, followed by inspection of the downstream slope by walking along the toe. The transcribed Dictaphone notes and photographs constitute the field record (the Field Memo is kept on file at BGC) and provides the basis for this formal report.

At the time of the inspection, no tailings were being deposited, and none had been deposited since September 2002. Excess water from the Surface Cell was being pumped to the lower Reservoir. Additionally, water was being discharged from the polishing pond through the valves at the decant structure. The pond level in the Surface Cell was about 386 m (about 2 m below the level of the dike crest).

After completion of the site inspection tour, a memo (attached in Appendix 1) was left with Mr. Murray Markle summarizing the conditions observed and the resulting recommendations.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the inspection for each of the structures are presented on the following pages in standardised format, complemented by a selection of site photographs (Figures 7 to 18). Refer to Figure 1 for the location of each structure.

The inspection confirmed that the West Twin Dike appears in satisfactory condition. Some minor cracking and settled areas were noted on the downstream slope (consistent with the previous years inspection). Some other minor cracks were noted on the crest edge, near the dogleg curve towards the north abutment. Monitoring of these cracks should be included in the regular inspections conducted by site personnel.

Following closure of mine operations, BGC has conducted two phases of investigation of the Surface Cell and Reservoir. The field investigations were undertaken in September 2002 and May 2003. The focus of the investigation in the Surface Cell and the Reservoir area has been on characterizing the talik. An interim report summarizing the results to-date was presented to CanZinco. Based on the interim results, a third phase of the investigation took place at the site in September 2003. The September 2003 program included installation of additional thermistors and thermocouples to supplement existing information, fill data gaps and to better characterize the geothermal regime. These investigations have confirmed the presence and the approximate size of the talik. In addition, the September 2003 investigation included the installation of piezometers to monitor the water pressures in the talik.

The existence of the talik is relevant to the long-term stability of the dike and this aspect is being reviewed by BGC as part of closure planning. In the interim, dissipation of any excess pore pressures generated by freezeback of the talik needs to be monitored to ensure they can be properly dissipated and do not adversely affect dike stability. Monitoring of the pressure will be conducted via vibrating wire piezometers (installed Sept 2003). Dissipation of pore pressure from the talik can be allowed to occur naturally by retaining water at depths of greater than 3 metres on the Surface Cell to prevent surface freezing of subaqueous tailings (i.e. allowing pressure to dissipate "up" through unfrozen regions). Alternatively, a contingency of drilling "pressure relief wells" through to the talik zone could be used to respond to excess pressures if measured in the regular instrument monitoring. The monitoring program and contingency plan has been reviewed with CanZinco. Modelling and assessment of both the freezeback progress and related pore pressures on the upstream side of the dike are currently underway and will be used to direct closure actions. Several assessment and design reports for closure will be submitted to the CanZinco for furtherance to the NWB as part of the approval process for Reclamation and Closure.

BGC (2000a) provided a qualitative risk assessment regarding the stability of the West Twin Dike. Numerous failure modes and stability issues were reviewed and the relative risks were assessed. BGC (2000a) notes that additional analytical and investigative work was recommended, the results of the recommended work was presented in a follow-up analytical report (BGC 2000b). In addition, this reference provides a list of ten design criteria and constraints, relative to the operation and closure of the West Twin Dike. Of these ten design criteria, three were related to closure (the others related to ongoing operations) and remain relevant. These criteria, included below, form a key component of the closure planning currently underway:

1. In closure, the tailings should be covered using suitable materials to ensure thermal and physical stability,
2. No pond should be maintained in the Surface Cell area.
3. A spillway should be designed to transfer any surface water the reports to surface cell to the reservoir.

Additional investigative and analytical work, relative to the stability of the West Twin Dike, was provided in BGC (2000b). Both the static and seismic stability of the dike were evaluated for the assumptions made within that report. Recommendations for further testing work were provided in this report and have been investigated as part of the three phase investigation performed in 2002 and 2003. Following completion of the investigation of May 2003 the stability analysis of the dike was reassessed (BGC 2003). The re-assessment was undertaken to include the talik location and measured pressures (the water pressure was artesian within the talik). The analysis results highlighted the importance of the pressure within the talik on the overall stability of the dike and lead to the recommendation that additional monitoring capability be installed within the talik (undertaken in September 2003). The analysis indicated that under the measured conditions, the dike had adequate factors of safety.

The Test Cell Dike was only recently constructed in 2000 and 2001 and numerous surficial edge cracks are still visible. Thermocouple and thermistor monitoring to date indicate that a talik exists at depth under the Test Cell Dike. It should be noted that no stability assessment for this dike has been undertaken to date but should be as part of the closure design process. The Test Cell Dike does not provide retention of tailings, but acts as a toe berm on the tailings placed within the Test Cell.

Some erosion has occurred directly adjacent to the concrete decant structure (at the polishing pond outlet) and repairs (including rip rap) are required.

The East Twin Dike and diversion channel require repairs to erosion and sloughing and some rip rap also needs to be placed.

The cracks and undulating nature of the upstream side of the East Adit Retention Pond Dike requires grading to re-establish proper drainage. In addition, the geocomposite liner (GCL) on the upstream side appears to have been disturbed by wind and rehabilitation of the liner is required.

The East Adit treatment pond experienced an overtopping event in August 2003 and although repairs have been undertaken by site personnel, some additional repairs are also recommended.

The two tank farm berms and the two dump pond berms are in good condition. Some minor repairs and backfilling are recommended in the attached tables.

All remedial measures undertaken by site staff should be documented within the inspection file for review prior to the next geotechnical inspection.

WEST TWIN DIKE

LOCATION: Approximate middle of West Twin Lake, separating the upper Surface Cell from the lower Reservoir.

FUNCTION: Provides tailings solids (and some decant water) retention in the Surface Cell, allowing for relatively flat deposition of solids behind the dike. Excess pond water decanted over dike into Reservoir, the elevation of which must be lower than East Twin Lake (potable water source).

LENGTH: ~ 900 m

MAX HEIGHT: ~ 17 m above downstream Reservoir level.

AS-BUILT ELEVATION: ~ 388 m

CREST WIDTH AND CONDITION: Wide, well travelled crest now apparent (Figure 7). One longitudinal and three transverse cracks noted at the crest edge where the dike crest curves into a dogleg near the north abutment. One sinkhole was noted at the crest edge near the only remaining benched section of the dike face. Generally, the crest appears to be properly sloped to prevent ponding of any surface water. At two separate locations (about 20 m long each), the appearance of rutting is beginning to be evident in the surface.

UPSTREAM SLOPE: A 30 to 40 m wide levelling lift of shale has been placed on the upstream side of the crest, hence not possible to observe the upstream side of the dike (Figure 7). A new Test Cell (built prior to the 2002 inspection), approximately 30 by 35 m, has been constructed on the upstream side. Water level during inspection date estimated at approximately 386 m.

BACKSLOPE: The dike was previously constructed by placing a number of two metre high lifts, which formed an approx. overall slope of 3.5 to 3.7H:1V. The majority of the downstream face (except for a width of approximately 65 m) has been backfilled with shale, now forming a single, consistent slope angle (Figure 8). A number of minor oblique and transverse cracks were noted in the shale backfill, along with some minor settled areas (Figure 8). A small erosional gully still exists at bottom of toe at right abutment (Figure 9).

WEST TWIN DIKE CONTINUED

SEEPAGE:

There was no evidence of seepage occurring at the toe (Figure 9). Some seepage was observed at the north abutment on top of the access road. This seepage appears to be created by the small surface pond (created from surface snow melt) formed on the upstream side of the access road berm.

WATER CONVEYANCE METHOD:

Two 20 cm diameter pipes placed on the downstream slope. Pumping was underway during the site visit.

INSTRUMENTATION:

Appendix 2 provides the results for 24 different thermocouple cables, 8 different thermistors and 5 different monitoring wells that were monitored in 2002/2003. Figure A2-1 shows the locations of the instruments and Table A2-1 provides a tabular summary of the results. Both long-term plots for various nodes and trumpet curves versus depth are provided.

The newly installed thermistors located within the Reservoir indicate thawed conditions at depth, these instruments were installed to define the talik. Of the 19 thermocouple cables and two themistors installed in the dike, TC33 (below 16 m depth), TC35 (below 10 m depth) and BGC03-33 (below 17 m depth) are showing thawed conditions at depth. These warm temperatures in the dike appear related to the talik on the upstream side of the dike.

WEST TWIN DIKE CONTINUED

COMMENTARY ON TALIK ZONE:

Given the existence of a talik (thawed zone in permafrost) on the upstream side of the dike and the measured artesian pressures in the talik, and noting that tailings are now deposited through this area, it is imperative that potential excess pore pressures generated during freezeback of the area are dissipated appropriately and monitored to confirm the response throughout freezeback. Dissipation can be accomplished naturally by maintaining a pond of water (greater than 3 m depth) through the winter over top of the talik area. Alternatively, drainage of any excess pore pressures near the upstream side may be achieved via drilling and pumping from the talik zone. The pore pressure monitoring instruments were installed in September 2003.

Installation of the final closure cover on the talik area should not be undertaken until an assessment of the talik extent and freeze back scenarios have been completed.

MAINTENANCE RECOMMENDATIONS:

Grade over the settled areas and cracks on the downstream face of the dike and monitor. Backfill the small erosional gulley located at the toe. Grade over and monitor the cracks in the crest near the north abutment dogleg and crest surface. Report any anomalous visual observations to BGC.

The vibrating wire piezometers should be read weekly throughout the winter to monitor pressure changes in the talik. The following thermocouples/thermistors should be read weekly from mid-May to mid-August and at least monthly for all other months: TC12, TC13A, TC14, TC16, TC16A, TC28, TC29. TC31, TC32, TC33, TC34, BGC02-03, BGC03-07, BGC03-10, BGC03-11, BGC03-13, BGC03-15, BGC03-20, BGC03-21, BGC03-33 and BGC03-34. All other thermocouples/thermistors within the dike should be read at least monthly.

Thermocouple data should be input and plotted as soon as practical after collection. Currently, data is collected by site staff and is then forwarded to BGC for plotting and interpretation. In addition, monitoring of the frost gauges and slope monitoring pins should also be undertaken from May until October. Vigilant monitoring of the subsurface thermal regime and visual behaviour of the dike is required.

The instrumentation monitoring needs to be complemented by weekly inspection by site staff. These inspections need to be documented in a log book or file so that changes in conditions can be easily noted. If so required, BGC can prepare a dam inspection form to be used by site staff. In addition, BGC can prepare a dam inspection training seminar for site staff (if requested). This seminar has been presented at several other mines currently in care and maintenance or closure status, where the existing site staff do not have formal dam safety training.

CONCLUSIONS:

The dike is in satisfactory condition with no current evidence of seepage at the toe of the dike. The talik located on the upstream side will need to be monitored during freezeback and its existence and changes over time will have implications for stability of the embankment.

TEST CELL DIKE

LOCATION:	Situated on the eastern and southern boundaries of Test Cell, at the toe of the West Twin Dike.
FUNCTION:	Provides tailings solids retention at the toe of the West Twin Dike. Excess pond water is pumped into the Reservoir.
LENGTH:	~ 700 m.
MAX HEIGHT:	~ 4 m above Reservoir level.
AS-BUILT ELEVATION:	~ 375.5 m
CREST WIDTH AND CONDITION:	4 to 4.5 m; constructed of saturated shale. Longitudinal edge cracking noted on the upper crest and previous lifts as well (Figure 10). Two minor sinkholes noted on the crest.
UPSTREAM SLOPE:	Sitting at angle of repose; some cracking visible along the crest edge.
BACKSLOPE:	Sitting at angle of repose with a setback at the bottom lift. Some cracking and settlement noted within a 0.8 m wide zone along the outer edge.
SEEPAGE:	No evidence of seepage occurring along the toe.
WATER CONVEYANCE METHOD:	Two pipes used to pump excess water in the cell over into the Reservoir.
INSTRUMENTATION:	Appendix 2 provides the results for TC36, BGC02-09 and BGC03-22 located in the Test Cell Dike. Temperatures warmer than zero occur at depths greater than 4 m.
MAINTENANCE RECOMMENDATIONS:	Grade over the two sinkholes on the crest and monitor for any additional settlement. Cracking on the crest of the dike should be graded to prevent inflow of water into the current cracks.
CONCLUSIONS:	The dike is in satisfactory condition.

POLISHING POND DECANT STRUCTURE

LOCATION:

Eastern end (outlet) of the polishing pond, just adjacent to the East Twin diversion channel.

FUNCTION:

Along with the associated low retention dike, the decant structure provides retention of a polishing pond (for water clarification) before discharge into Twin Lakes Creek.

Decant structure consists of a steel gate situated within a concrete structure. Five valves have been welded to the gate to allow for the conveyance of water through the gate, rather than below or above the gate.

OBSERVATIONS AND COMMENTARY:

Substantial erosion has occurred in a portion of the retention dike, directly adjacent to the concrete walls of the decant structure. The dike structure must be properly repaired and appropriately sized rip rap should be placed to prevent any further erosion. In addition, the discharge capacity of the current valve arrangement should be reviewed in detail. It is felt that the discharge capacity from this system is too low with respect to the size of flood events that may occur in the WTDA area. Consideration should be given to removing the current steel gate/valve arrangement and returning to a stop-log system which would allow greater volumes of water to be moved (thus allowing for the management of flood events).

EAST TWIN DIVERSION DIKE & CHANNEL

LOCATION:	East end outflow of East Twin Lake.
FUNCTION:	Dike deflects lake outfall channel from previous drainage course (connecting the two lakes) and combines the flow with the West Twin discharge (the polishing pond) further downstream, in the previous drainage course of Twin Lakes Creek.
LENGTH:	Dike is ~ 15 m
MAX HEIGHT:	~ 0.5 to 1.5 m above adjacent ground level
AS-BUILT ELEVATION:	~ 374 m
DIKE CREST WIDTH AND CONDITION:	5 m; composed of Twin Lakes sand, gravel and cobbles. Significant proportions of the upstream side have been eroded and extensive cracking has resulted (Figure 12).
SEEPAGE:	No evidence of seepage.
DIVERSION CHANNEL CONDITION:	Channel is excavated through native sand, gravel and cobbles. Erosion of the channel insides is on-going with a resultant slough noted on the outside of the curve (Figure 12). As previously noted, both sides of the embankment used to extend the diversion channel outward (between the two discharge channels) have experienced cracking related to edge settlement.
MAINTENANCE RECOMMENDATIONS:	The erosion and the sloughing of both the channel and the dike should be repaired and some appropriately sized rip rap placed to prevent future erosion.
CONCLUSIONS:	Pending repair of the erosion and the cracking, the dike and diversion channel appear in satisfactory condition.

EAST ADIT TREATMENT POND DIKE

LOCATION: Dike and associated pond located approximately 50 m lower than East Adit, which is situated 3 km east of the mill. Treatment pond is east of retention pond.

FUNCTION: Collects runoff water which flows from East Adit exposed mine workings and natural sulphide outcrops. Water collected on the upstream side of the access road berm is conveyed to the pond through a culvert at the southwest abutment of the dike. Lime is added to this pond water for pH adjustment before transfer to retention pond by pump.

LENGTH: ~ 30 m

MAX HEIGHT: ~ 5 m above downstream toe.

AS-BUILT ELEVATION: ~ 238 m

CREST WIDTH AND CONDITION: 4 to 5 m; shale fill covers the crest. Dike core is comprised of till mixed with bentonite. Cracking evident on crest (Figure 13) with some edge cracking on the downstream side. Repairs (additional fill placement in the affected areas) were undertaken on the north abutment due to overtopping this past summer.

RIPRAP: Angular rockfill from segregation of crest fill; placed at the angle of repose; minor cracks noted at the waterline.

BACKSLOPE: Approx. 1.5H:1V; no signs of erosion noted.

SEEPAGE: No evidence of seepage currently. Anecdotal evidence indicates seepage occurs when the pond level was overtopping the dam; seepage was related to internal overtopping of the core. This seepage was evidenced by multiple erosion paths downstream of the dam, leading from the toe of the dam.

WATER CONVEYANCE METHOD: Two 150 mm diameter steel pipes previously installed through dike would not pass extreme flood event. Need to ensure that crest does not erode in the future.

MAINTENANCE RECOMMENDATIONS: Repair (grading) of the cracks on the crest and downstream side of the dike should be performed. Additional fill placement and grading

should be performed at the north abutment to complete repairs following the overtopping. Provide a contingency plan regarding the prevention of crest overtopping due to extreme flood event. This could consist of upgrading the current spillway pipes to handle a greater volume of water or ensuring that the pumps operate to maintain a lower water level (such as having available a portable generator to run pumps if the electricity supply is interrupted).

CONCLUSIONS: The dike is in satisfactory condition with no evidence of any seepage, when the water level in the pond is maintained below the core elevation of the dike.

EAST ADIT RETENTION POND DIKE

LOCATION:	West of treatment pond, below East Adit area.
FUNCTION:	Retains treated runoff water before final discharge to the environment.
LENGTH:	northern portion ~ 120 m and western portion ~ 60 m
MAX HEIGHT:	~ 2 to 3 m above immediate downstream toe elevation
AS-BUILT ELEVATION:	~ 239 m
CREST WIDTH AND CONDITION:	4 to 5 m; constructed of shale material. Condition is relatively good except for some edge cracking on the upstream and downstream side.
UPSTREAM SLOPE:	Some minor cracking and settlement occurred in the recently placed shale rockfill (Figure 14). The edge laps in the geocomposite liner (GCL) on the upstream side has been disturbed (Figure 14), due to no soil cover and to high winds in the area. It also appears that the GCL, installed to assist with seepage prevention out of the pond, has not been installed as high as the current high water mark.
BACKSLOPE:	Approx. 1.5H:1V; somewhat armoured with cobbles and boulders; no evidence of cracking. Talus slope located adjacent to the downstream side of this dam.
SEEPAGE:	No visual evidence of seepage at current time, but any potential seepage would likely disappear into the downstream talus slope.
WATER CONVEYANCE METHOD:	Gravity siphon decant pipe.
MAINTENANCE RECOMMENDATIONS:	Some grading of the cracks and settled areas on the upstream slope should be undertaken to establish positive drainage.

Given the noted disturbance to the GCL, it is recommended that rehabilitation of the entire liner on the upstream side be undertaken. The liner needs to be installed according to the manufacturers' specification, including the provision of powdered bentonite in lap joints and the need for sufficient depth of soil cover. The GCL panels also need to be installed above the level of the current high water mark.

CONCLUSIONS:

Given the disturbance to the GCL, rehabilitation of this liner will be required in order to retain water within the pond. Quality control and construction inspection should be provided to ensure the GCL is installed properly. Following that, careful observations regarding seepage after liner rehabilitation should be made since majority of the foundation is comprised of talus rockfill.

TANK FARM SPILL CONTAINMENT BERM

LOCATION:	Adjacent to loading dock at Strathcona Sound, just west of Concentrate Storage Building.
FUNCTION:	Provides contingency storage for fuels should tanks leak or spill occur.
MAX HEIGHT:	~ 5 to 6 m above downstream toe level for the northern berm
AS-BUILT ELEVATION:	~ 16 m
CREST WIDTH AND CONDITION:	1 to 3 m; composed of sand and gravel. Small longitudinal cracks noted on western berm (Figure 15). Condition is generally good (Figure 15). A lift was placed prior to the 2002 geotechnical inspection on a portion of the berm crest, situated on the north berm.
BACKSLOPE:	Approx. 1.5H:1V to almost 2H:1V; somewhat armoured with cobbles and boulders; no evidence of cracking.
SEEPAGE:	No evidence of seepage.
MAINTENANCE RECOMMENDATIONS:	Liner is exposed at several locations and should be covered over. Repair liner before backfilling. Provide as-built survey information, including location of the internal liner (GCL), for the new lift placed on the berm crest.
CONCLUSIONS:	The berm is in satisfactory condition.

DAY TANK FARM SPILL CONTAINMENT BERM

LOCATION:	Situated just uphill from Industrial Complex, approximately 30 m away.
FUNCTION:	Provides contingency storage for fuels should day tanks leak or spill occur.
MAX HEIGHT:	~ 4 m above downstream toe level for the western berm
AS-BUILT ELEVATION:	~ 258 m
CREST WIDTH AND CONDITION:	2 m; composed of sand and gravel over top of granular shale material. Condition is good (Figure 16).
BACKSLOPE:	Approx. 1.5H:1V to 1.75H:1V; somewhat armoured with gravel and cobbles.
SEEPAGE:	No evidence of seepage.
MAINTENANCE RECOMMENDATIONS:	Backfill liner to prevent further damage from occurring.
CONCLUSIONS:	The berm is in satisfactory condition.

MILL DUMP POND CONTAINMENT BERM

LOCATION:	Immediately south of the mill, adjacent to creek.
FUNCTION:	During operation, it allowed the tailings line to be drained.
MAX HEIGHT:	~ 3.5 m above downstream toe level.
AS-BUILT ELEVATION:	~ 278 m
CREST WIDTH AND CONDITION:	2.5 to 3 m; comprised of sand and gravel. During a recent large flood event, a portion of the dike was undercut due to erosion. Other than this noted corner, the condition is good with some undulations in the surface (Figure 17).
BACKSLOPE:	Approx. 1.5H:1V; toe recently armoured with angular boulders; no evidence of cracking, except at the eroded corner adjacent to Twin Lakes creek.
SEEPAGE:	No evidence of seepage.
MAINTENANCE RECOMMENDATIONS:	Liner is wrinkled but appears to hold water. Cuts observed should be repaired. The erosion noted should be backfilled to provide support for the liner and rip rap installed to ensure protection from future storm events.
CONCLUSIONS:	The berm and the exposed liner appear in satisfactory condition, following repairs to the eroded portion of the dike.

UPPER DUMP POND CONTAINMENT BERM

LOCATION:	Approximately 2 km uphill from mill along tailings line.
FUNCTION:	During mine operation, it allowed the tailings line to be drained.
MAX HEIGHT:	~ 2 to 3 m above downstream toe level.
AS-BUILT ELEVATION:	~ 350 m
CREST WIDTH AND CONDITION:	3 to 4 m; comprised of sand and gravel. Condition is good; no cracking evident (Figure 18).
BACKSLOPE:	Approx. 1.5H:1V; no evidence of cracking.
SEEPAGE:	No evidence of seepage on two exposed sides.
MAINTENANCE RECOMMENDATIONS:	No maintenance required at the current time.
CONCLUSIONS:	The liner and the berm appear in satisfactory condition.

6.0 CLOSURE

This report provides a performance assessment of numerous waste containment dikes and berms at the Nanisivik Mine, based on a one-time visual observation and a review of monitoring instrumentation for some of the dikes. As noted earlier, the existence of a talik in the Surface Cell has implications for stability of the West Twin Dike. Additional assessment and monitoring requirements will be summarized in reports forthcoming under separate cover. These additional reports should be reviewed in conjunction with the information provided herein, when the reports become available.

We trust the above meets your present requirements. Thank you for allowing BGC to be of service, once again, to Nanisivik Mine. If you have any questions or require additional details, please contact the undersigned.

Respectfully submitted,
BGC ENGINEERING INC.

REGISTERED PROFESSIONAL ENGINEER
J. W. CASSIE
LICENSEE
N.W.T.

Gerry Ferris, M.Sc., P.Eng.
Geotechnical Engineer

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Specialist Geotechnical Engineer

PERMIT TO PRACTICE
BGC ENGINEERING INC.
03-OCT-28
PERMIT NUMBER: P 285
The Association of Professional Engineers, Geologists and Geophysicists of the Northwest Territories

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BGC Engineering Inc. 2000b. Analytical Modelling Results, Nanisivik Mine, Nunavut. Report submitted to Nanisivik Mine, a Division of CanZinco Ltd., Project No 0255-001-02, November 2000.

BGC Engineering Inc. 2003 Preliminary Results for WTL tailings based on 2003 Drilling and Instrumentation Program at Nanisivik Mine. Memo submitted to Nanisivik Mine, a Division of CanZinco Ltd. June 2003.

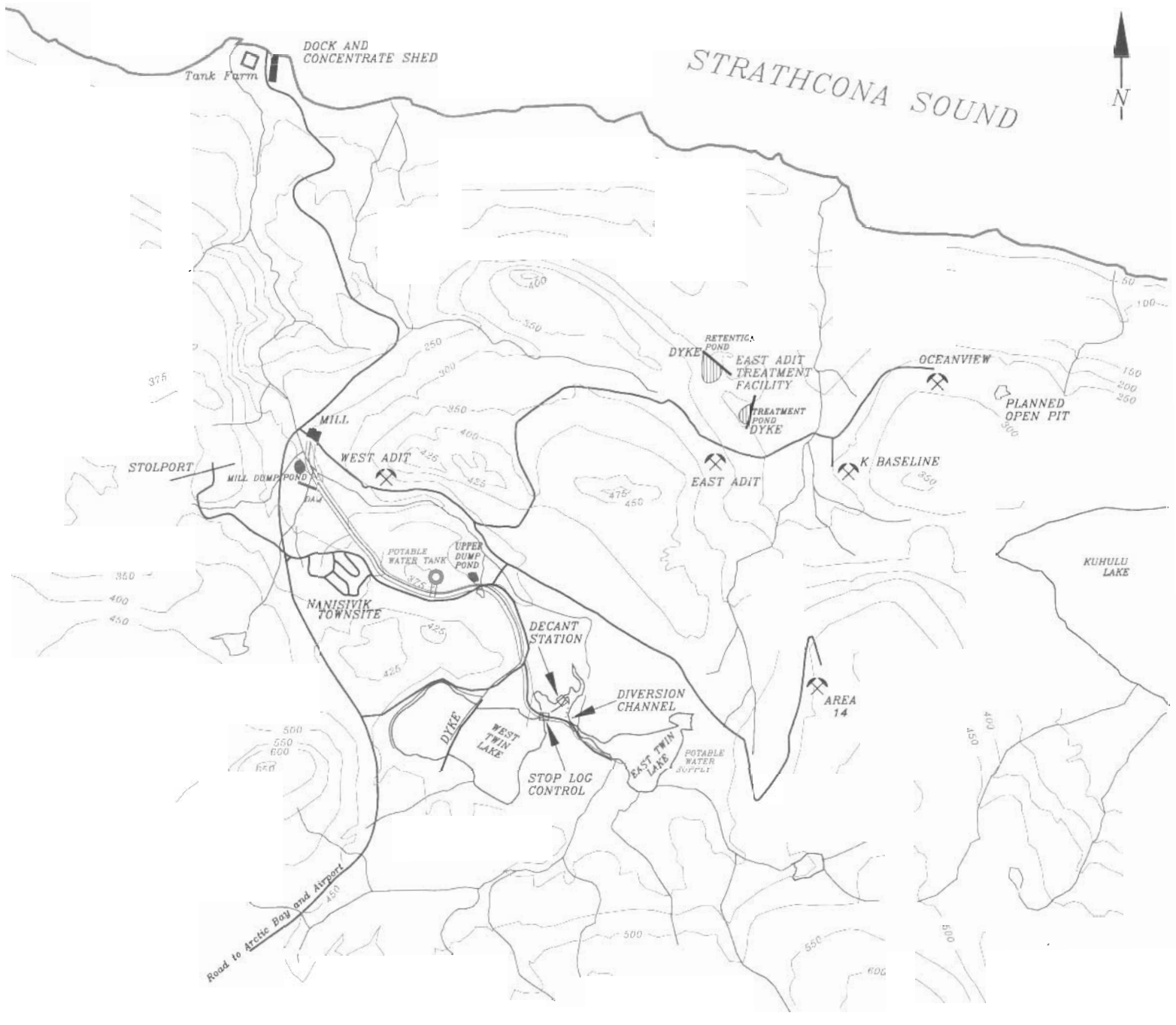
Gartner Lee Ltd. 2002. Nanisivik Mine, Closure and Reclamation Plan. Report submitted to CanZinco Ltd., February, 2002, two volumes.

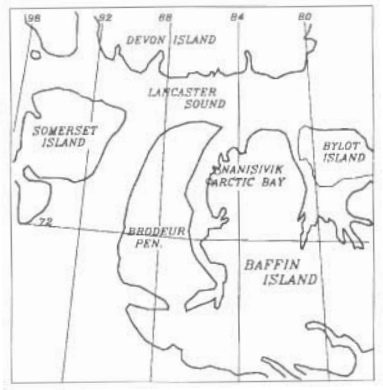
Golder Associates Ltd. 1998. 1998 Geotechnical Inspection of Waste Containment Dykes, Nanisivik Mine, Baffin Island, NWT. Report submitted to Nanisivik Mine, a Division of CanZinco Ltd., Project No.: 982-2432.5100, October, 1998, 27 pages plus figures.

Golder Associates Ltd. 1999a. 1999 Geotechnical Inspection of Waste Containment Dykes, Nanisivik Mine, Baffin Island, Nunavut. Report submitted to Nanisivik Mine, a Division of CanZinco Ltd., Project No.: 992-2411.5100, October, 1999, 25 pages plus figures and appendix.

Golder Associates Ltd. 1999b. Geotechnical Data Review and Stability Assessment of West Twin Dyke, Nanisivik Mine, Baffin Island, Nunavut. Report submitted to Nanisivik Mine, a Division of CanZinco Ltd., Project No.: 992-2411.5200, October, 1999, 36 pages plus figures and appendices.

FIGURES





LEGEND

- Surface Opening To Sulphide Deposits
- Stream Drainage
- Topographic Contour
- Roads
- Tailings Disposal Line
- Reclaim Water Line
- Potable Water Line

CLIENT:

Nanisivik Mine, a Division of CanZinco Ltd.

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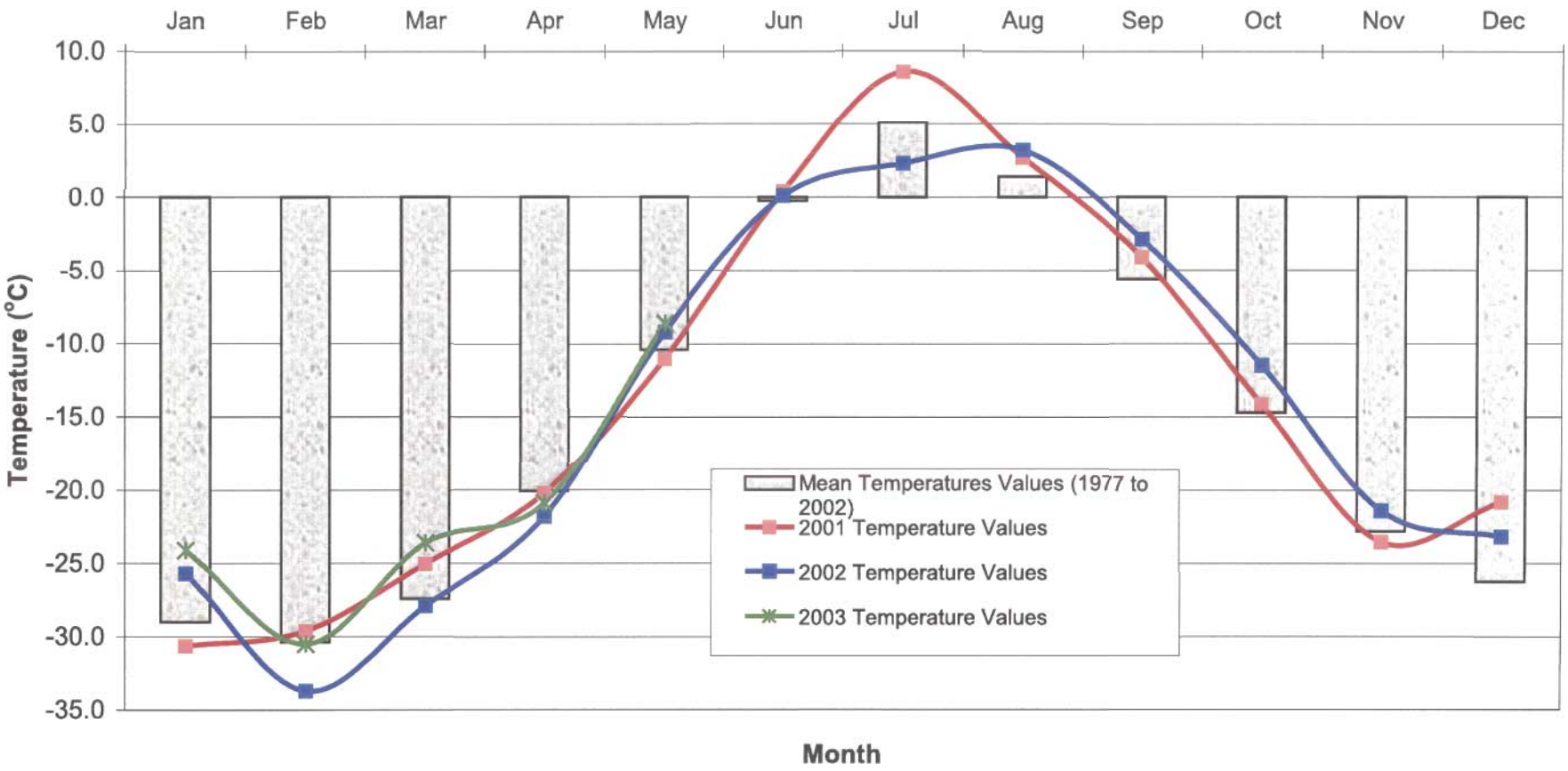
PROJECT
Annual Inspection of Waste Containment Dikes

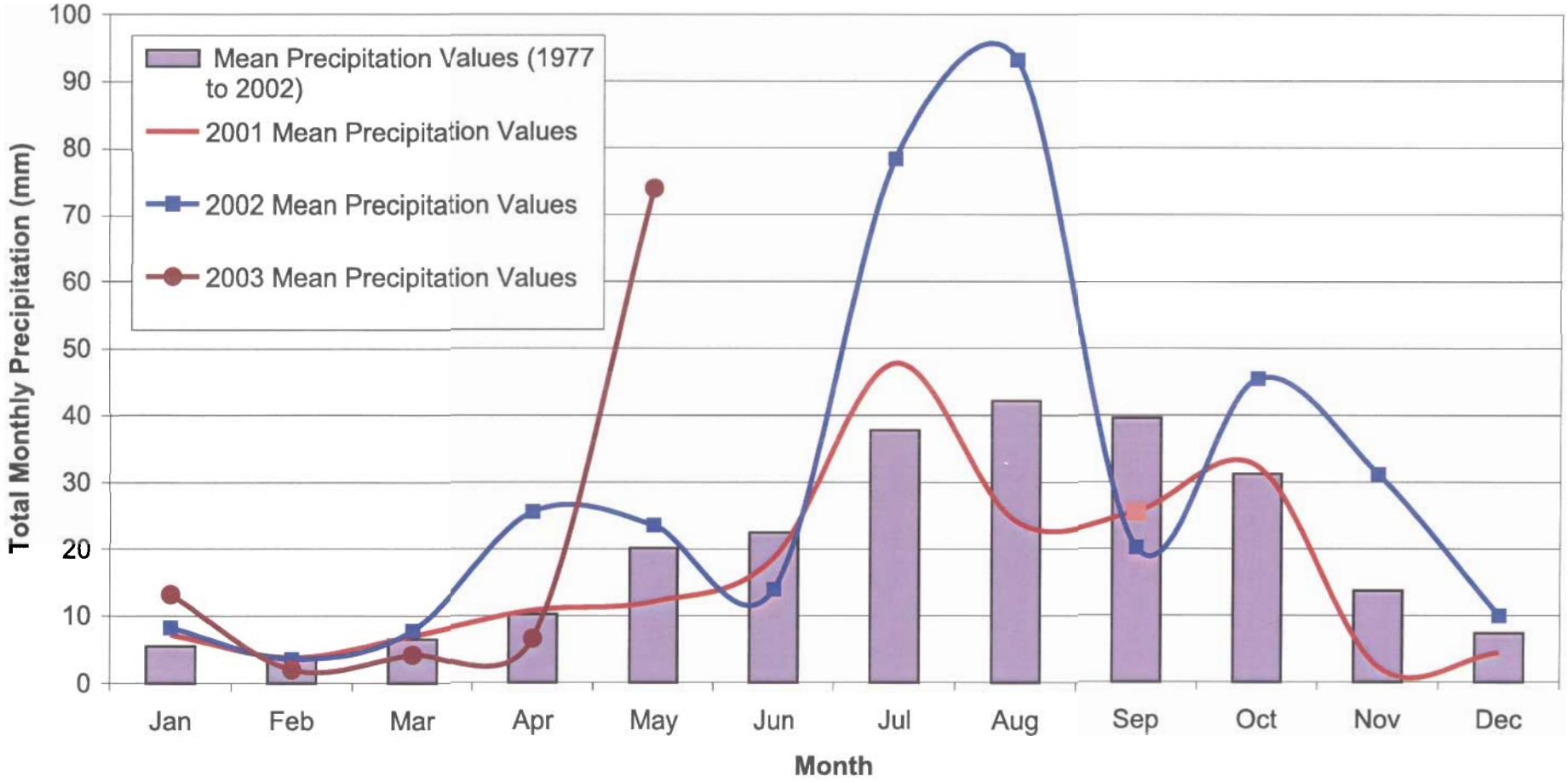
TITLE
Nanisivik Mine: Water and Tailings Handling Facilities

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 1	0

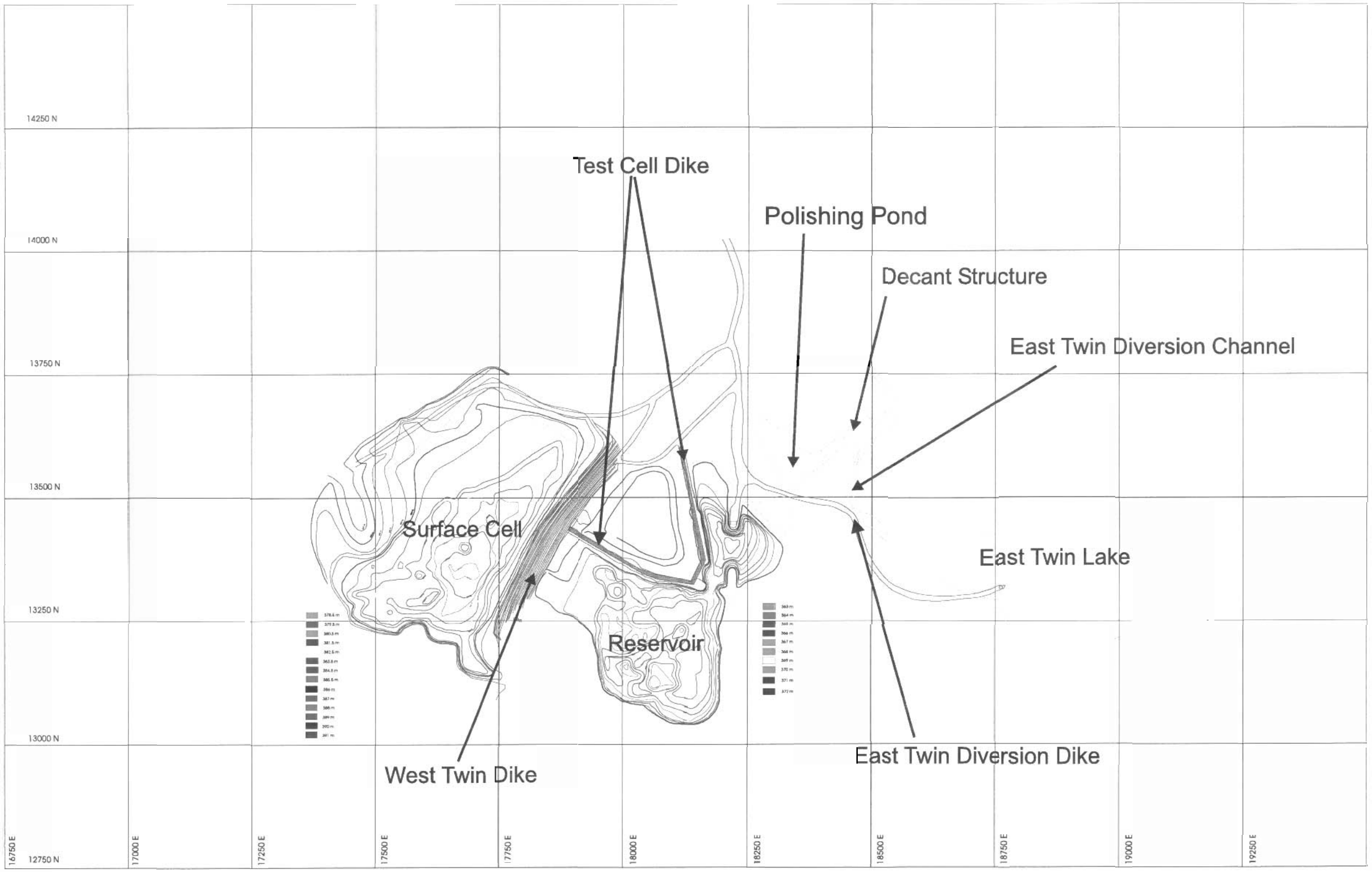
BGC Engineering Inc.
AN APPLIED EARTH SCIENCES COMPANY
Calgary Alberta
Phone: (403) 250-5185



DATE: OCT 2003	DRAWN SLF	BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY Calgary, Alberta Phone: (403) 250-5185	PROJECT Annual Inspection of Waste Containment Dikes		
REFERENCED DRAWING DESCRIPTION			TITLE Comparison of Mean Monthly Temperature Data		
CLIENT **Nanisivik Mine, a Division of CanZinco Ltd.**			PROJECT No. 0255-008-05	DWG. No. Figure 2	REV. 0



DATE: Oct 2003	DRAWN SLF	BGC ENGINEERING INC. AN APPLIED EARTH SCIENCES COMPANY Calgary, Alberta Phone: (403) 250-5185	PROJECT Annual Inspection of Waste Containment Dikes
REFERENCED DRAWING DESCRIPTION			TITLE Comparison of Mean Monthly Precipitation Data
CLIENT **Nanisivik Mine, a Division of CanZinco Ltd.**		PROJECT No. 0255-008-05	DWG. No. Figure 3 / REV. 0



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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
Components of West Twin Disposal Area

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 4	0

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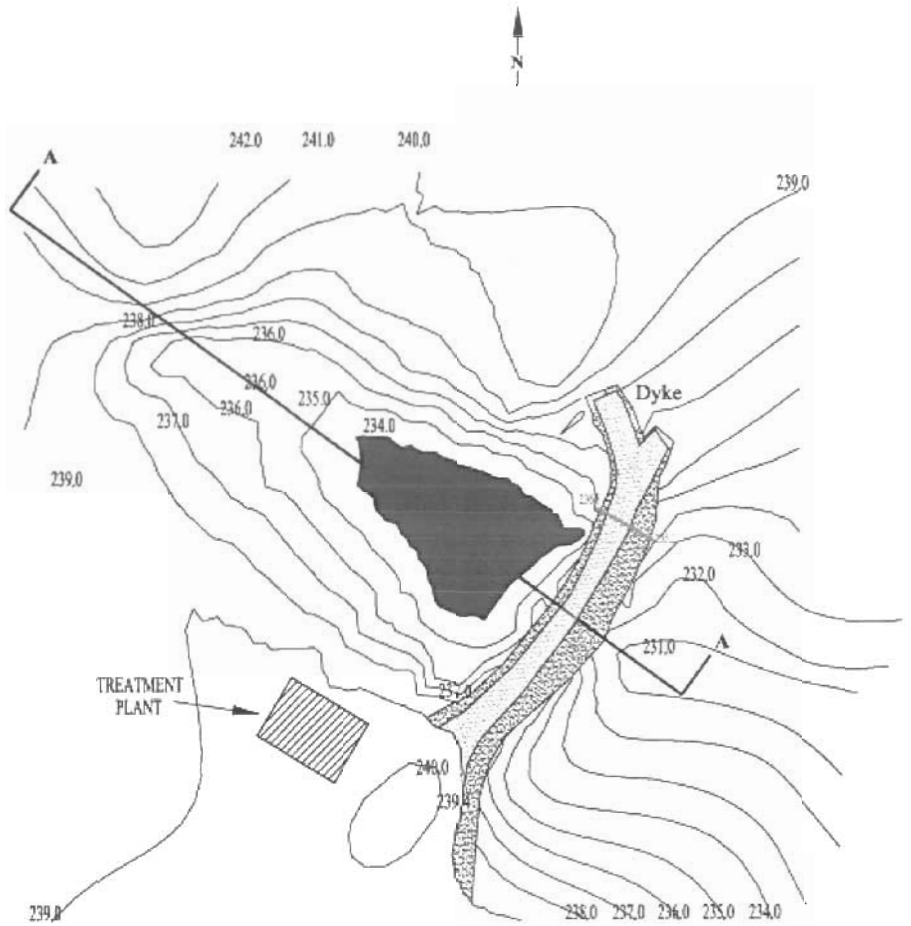

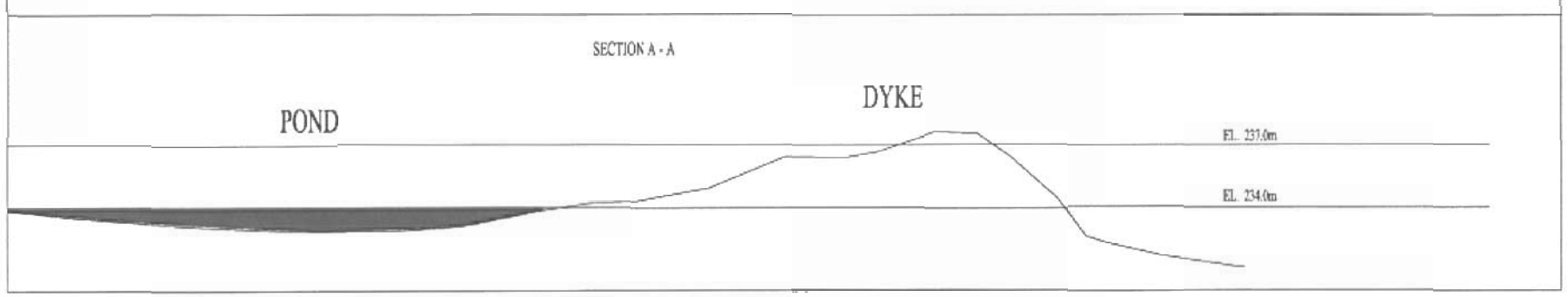

Note: Drawing file supplied by Nanisivik Mine

LEGEND

Stream Drainage

Topographic Contour

Roads

CLIENT

Nanisivik Mine, a Division of CanZinco Ltd.

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
East Adit Treatment Pond Dike - Plan & Section

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 5	0

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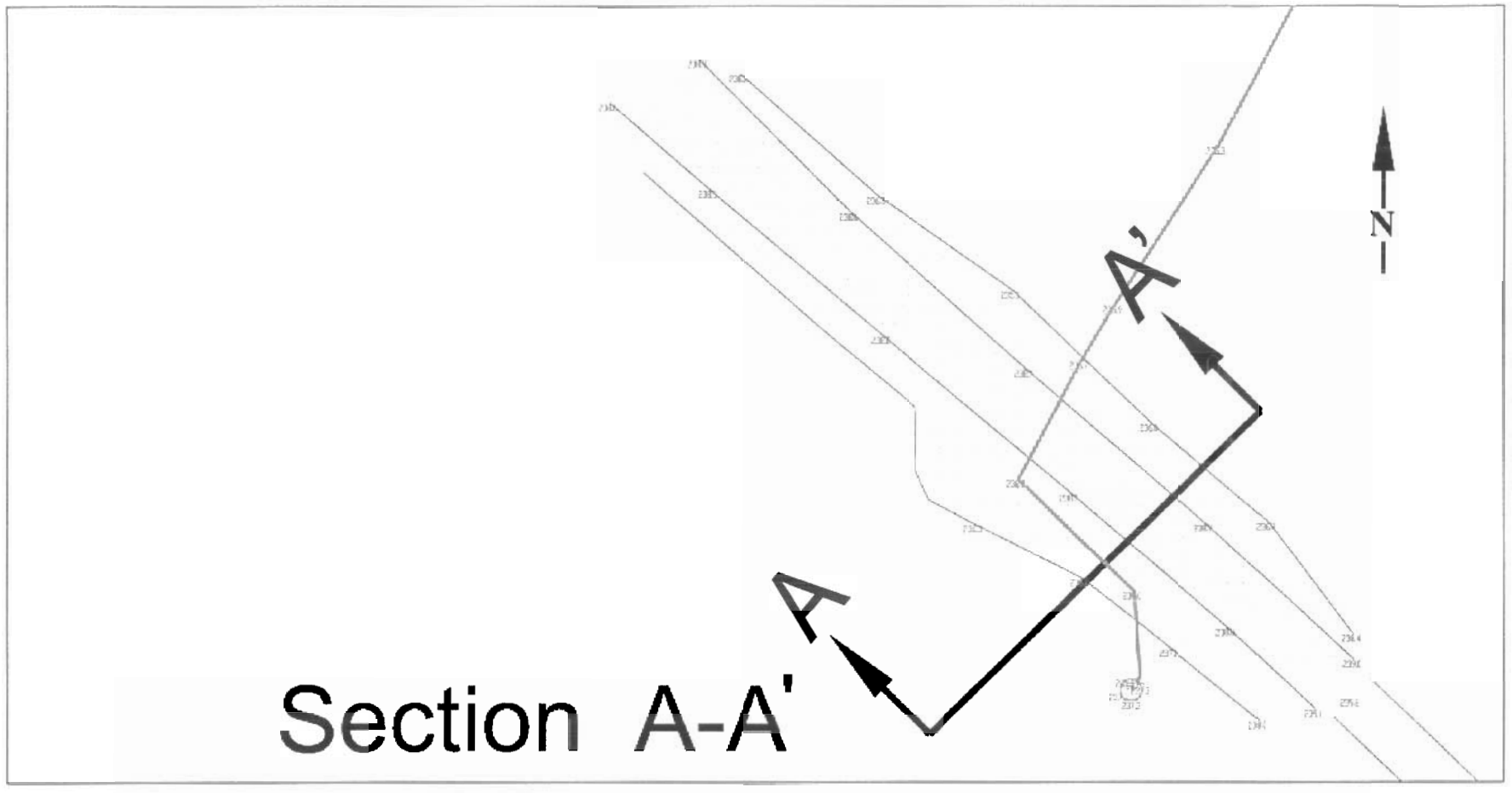
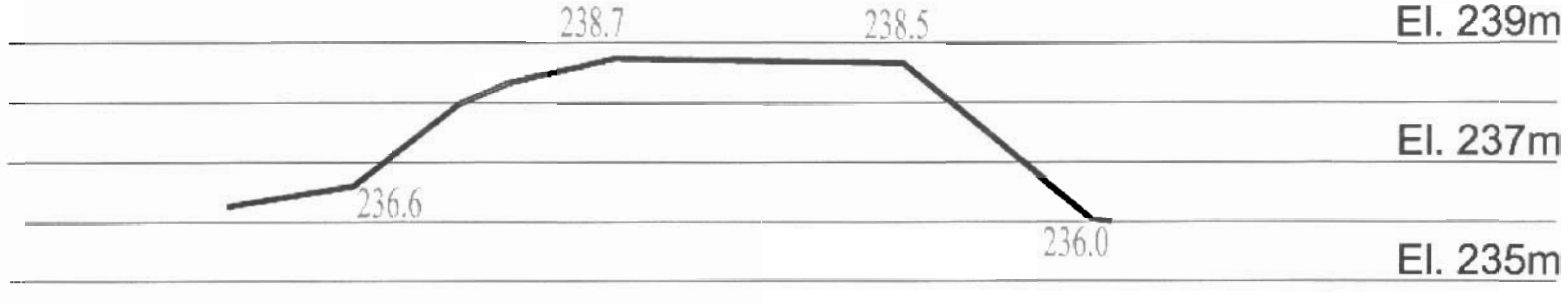


Section A-A'



Note: Drawing file supplied by Nanisivik Mine

LEGEND

Stream Drainage

Topographic Contour

Roads

CLIENT:

Nanisivik Mine, a Division of CanZinco Ltd.

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
East Adit Retention Pond Dike - Plan & Section

PROJECT No.	DWG. No.	REV.
0255-08-05	Figure 6	0

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Photo 45 shows a view of the crest looking towards the north. Some minor pot holes are evident near the north limit of the spare pipes.

Photo 59 shows a view of the upstream crest looking towards the north abutment. No signs of significant settlement or deformation.

Photo 64 shows a view of the crest of the northern portion of this dike. In general, the surface is in good condition, although some minor pot holes are evident at this location.

Photo 55 shows a sink hole located in the crest of the dike, above the portion of the dike that remains benched.

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
West Twin Dike - Crest and Upstream Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 7	0

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Photo 58 shows a view of the northern section of the downstream side of the dike. Note the smooth appearance of this slope face.

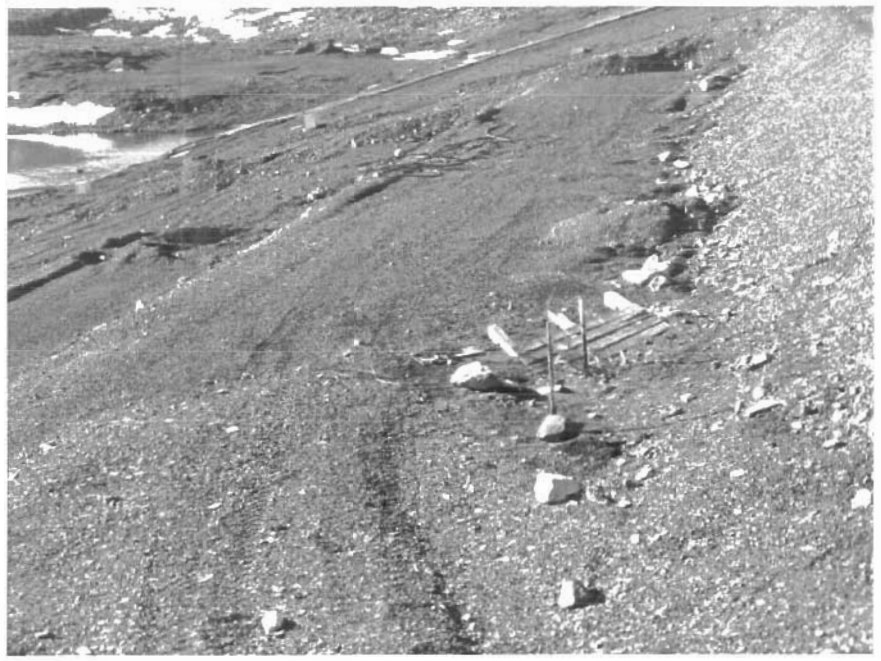

Photo 57 shows a view of the crest of two benches located just below the crest. On the level just below the crest, there is a subtle oblique crack running across the crest. On the second lower bench, there appears to be several transverse cracks.

Photo 44 shows a view of some small settled areas just behind the hard hat. These are located some 3 metres down the downstream slope from the crest elevation. This photo was taken near the water discharge lines.

Photo 35 shows a view of the contact between the dike embankment fill and the native ground rising to the right at the south abutment. There are no wet spots or signs of seeping water. Note that some settlement of the fill has occurred where it was placed to smooth the benched appearance.

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
West Twin Dike - Slope Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 8	0

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Photo 77is a view along the toe. In the mid ground can be seen the lines which discharge water from the Surface Cell into the Reservoir. In addition, the initial placement of shale covering can also be seen over some tailings at the toe .

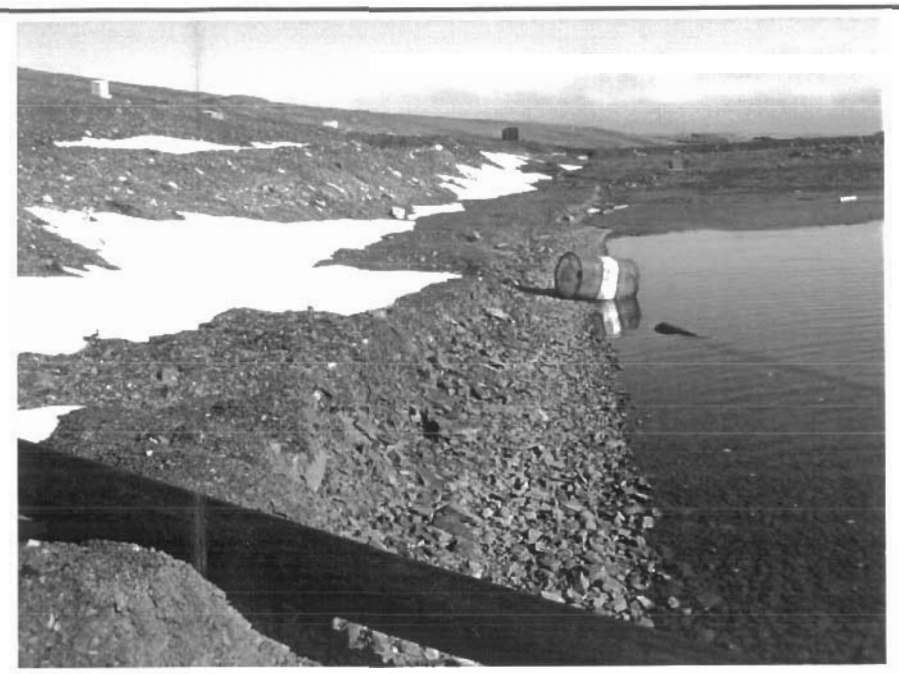

Photo 80 shows the minor erosion that is occurring at the toe of the dike. In the background of the photos some exposed tailings can be seen.

Photo 81shows a minor erosional gully situated at the toe of the dike.

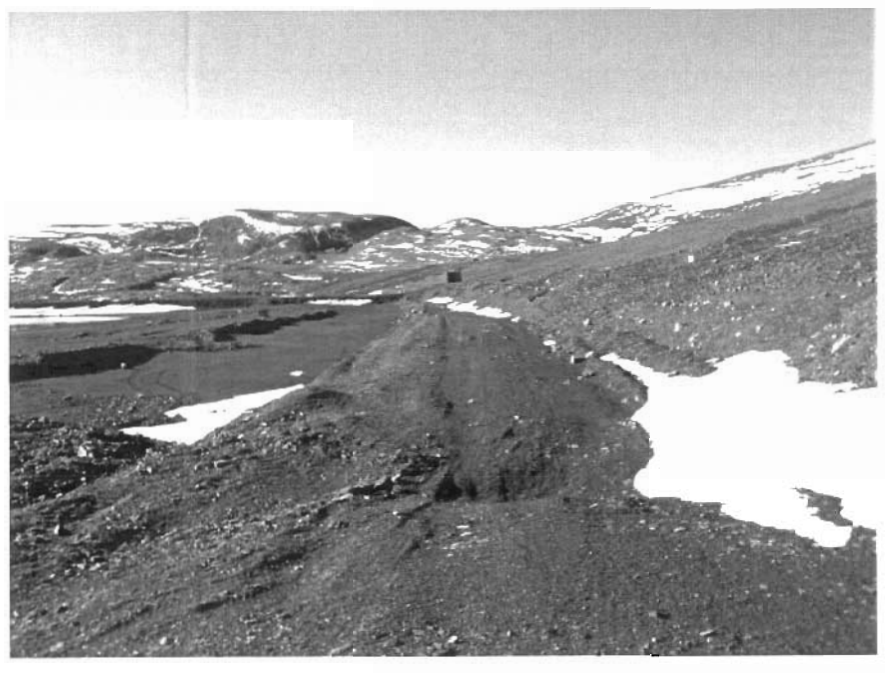

Photo 73 shows a view along the toe of the dike. There is no ponded water in this area and hence, no active erosion ongoing in this area.

CLIENT:

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
West Twin Dike - Toe Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 9	0

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Calgary Alberta Phone: (403) 250-5185

Photo 10shows a view of the Test Cell Dike, which is situated in the middle of the toe of the West Twin Dike.

Photo 90 is a view of the outside face of this dike. Cracking, and settlement can be seen on this outside edge of the crest.

Photo 104 shows a view of a small sinkhole located in the crest of the Test Cell Dike.

Photo 93 shows a view of the inside edge of the dike. This portion was the more recent fill placed to close the gap between the N-S and E-W portions of the Test Cell dikes. These cracks are the result of the oversteepended nature of the fill placed in this portion of the dike.

CLIENT:

Nanisivik Mine, a Division of CanZinco Ltd.

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
Test Cell Dike - Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 10	0

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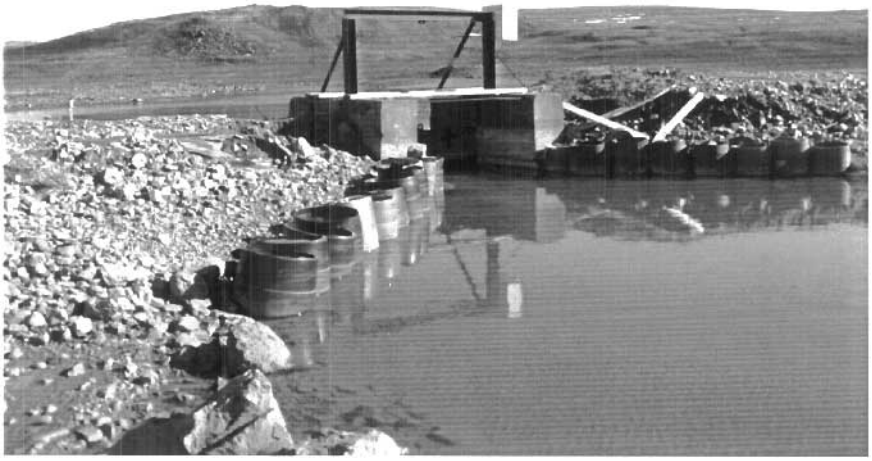

Photo 113 shows the decant spillway structure at the outlet of the polishing pond. There's a steel gate within five valves within the concrete structure that allows water to be decanted from the pond. This photo shows the erosion on the sides of wing walls of the concrete structure.

Photo 114 shows a close up view of the erosion that has occurred on the left wing wall. This needs to be repaired and then riprap should be placed on the upstream side to prevent future erosion.

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CLIENT:
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BGC Engineering Inc.
AN APPLIED EARTH SCIENCES COMPANY
Calgary, Alberta. Phone: (403) 250-5185

PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
Polishing Pond Decant Structure

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 11	0

Photo 141 shows a view of the Diversion Canal. The slope on the left hand side is sitting at the angle of repose and some sloughing has occurred where the material has been slightly oversteepened due to erosion.

Photo 144 shows a close up view of the crest of the Diversion Dike. There is cracking occurring due to erosion on this side of the dike. Hence, some repairs and riprap will be required to prevent the erosion from getting worse.

Photo 148 is a view in the downstream direction. On the left hand side of the photo can be seen some of the erosion which is sloughing the left hand slope.

Photo 139 shows a view of the Dike and the start of the diverted portion of East Twin Lake Creeks.

CLIENT:

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
East Twin Diversion Dike and Channel - Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 12	0

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Photo 182 is a view of the crest of the Treatment Pond Dike. Pipeline used to pump water for lime treatment. Note the lighter coloured fill that has been recently placed on the crest.

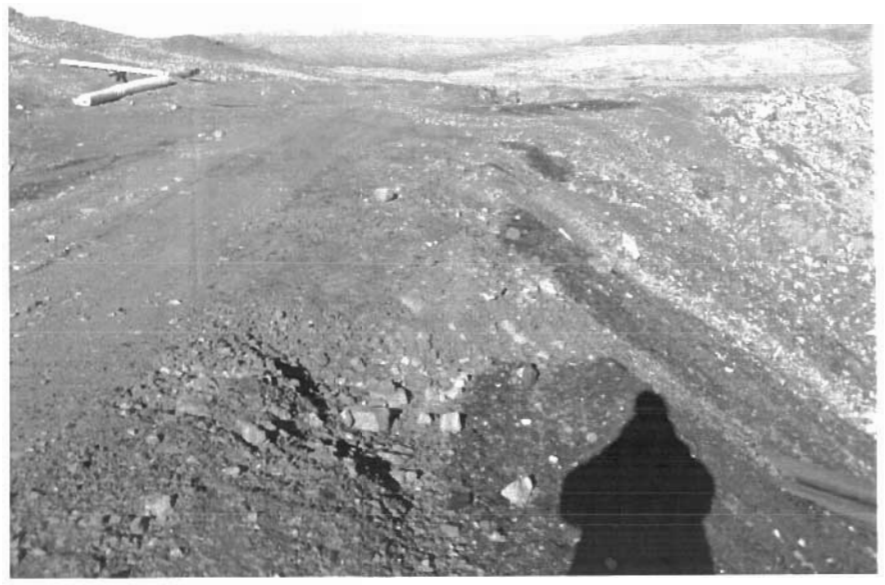

Photo 193 is a view of the fill placed at the north abutment as part of repairs taken following overtopping of this abutment.

Photo 196 is a view of the erosion downstream from the overtopping at the north abutment.

Photo 195 is a view of the discharge pipes passing through the crest of the dike.

CLIENT:

Nanisivik Mine, a Division of CanZinco Ltd.

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
East Adit Treatment Pond Dike - Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 13	0

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Photo 202 shows a view of the upstream side of the dike. Note the multiple beach lines and the appearance of the steepened upper section of the dike face.

Photo 206 shows the undulating nature of the shale fill that was previously placed on the upstream face of the dike. Note the settlement troughs and cracking.

Photo 207 shows a view of the GCL which was previously placed on the upstream side of the dike. The top of the liner has dropped somewhat and needs to be re-installed. In the background of the photo can also be seen that some of the GCL has been caught by the wind and needs to be re-installed properly.

Photo 211shows another view the disturbed liner on the southwest dogleg of the dike.

CLIENT:

Nanisivik Mine, a Division of CanZinco Ltd.

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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
East Adit Retention Pond Dike - Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 14	0

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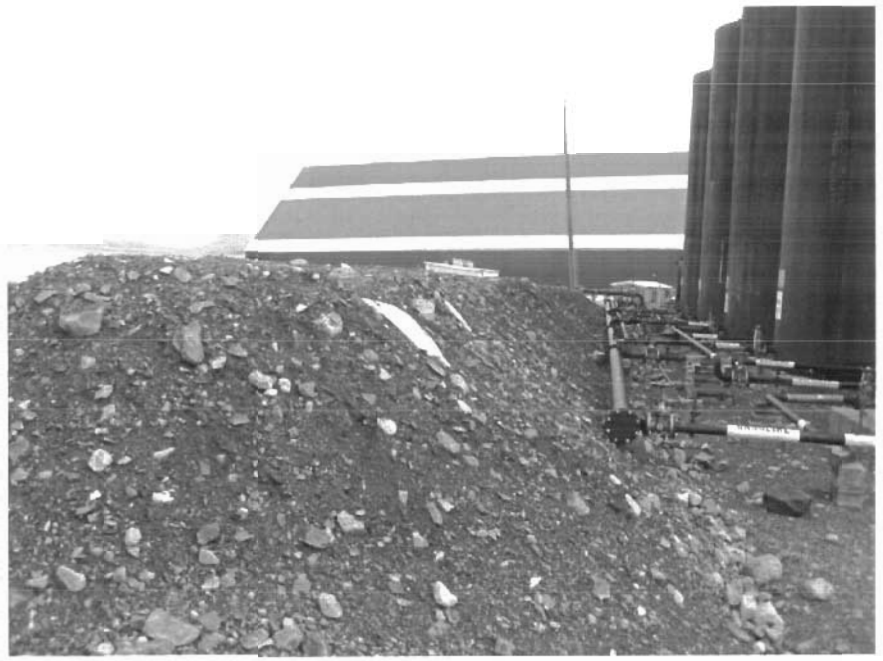

Photo 270 shows a new berm that was placed along a portion of the north berm. This new lift appears to be approximately 1.2 to 1.4 m high.

Photo 267shows the crest of the north berm. There are several locations where the liner is exposed.

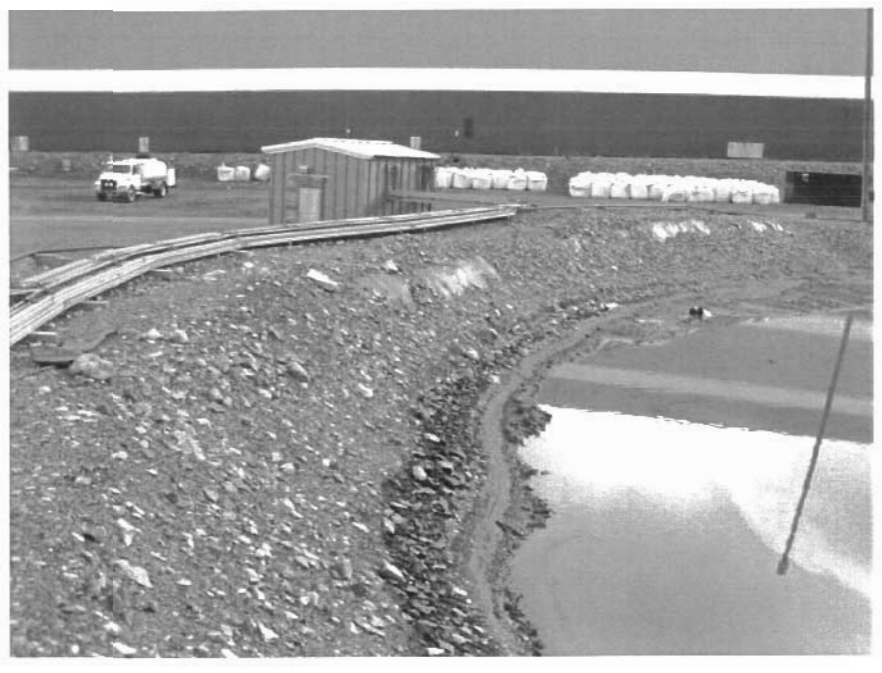

Photo 275 shows the dike crest, the retained pond and the exposed geomembrane liner (which does not appear to have any major cuts).

Photo 271 shows the sloughing of the face of the newly placed fill related to its marginal stability.

CLIENT

Nanisivik Mine, a Division of CanZinco Ltd.

REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

SCALE:	N/A
DATE:	October 2003
DRAWN:	SLF
DESIGNED:	GWF
CHECKED:	GWF
APPROVED:	JWC

PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
Tank Farm Spill Containment Berm - Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 15	0

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Photo 234 shows the east side berm. The liner is exposed in several places.

Photo 238 is a view of the exposed liner along the west berm. No cuts or tears were observed from this location.

SCALE:	N/A	DESIGNED:	GWF
DATE:	October 2003	CHECKED:	GWF
DRAWN:	SLF	APPROVED:	JWC

CLIENT:
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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
Day Tank Farm Spill Containment Berm

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 16	0

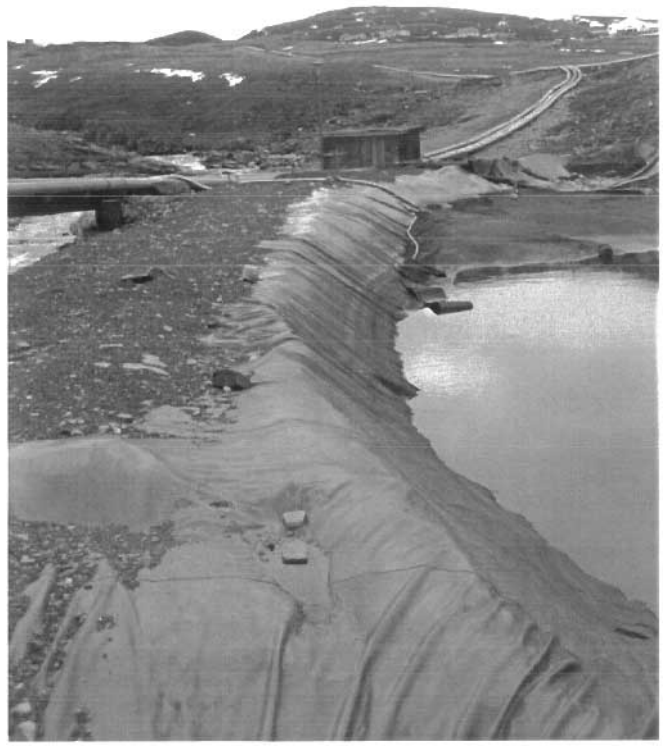

Photo 252 is a view looking towards the east or high end of the Dump Pond. The liner is wrinkled but appears to be uncut and is retaining water.

Photo 250 shows a view of the recent erosion of the bank of Twin Lake Creek. This erosion has undercut and oversteepened the embankment used to support the liner of the dump pond. This erosion needs to be repaired so that the liner maintains support.

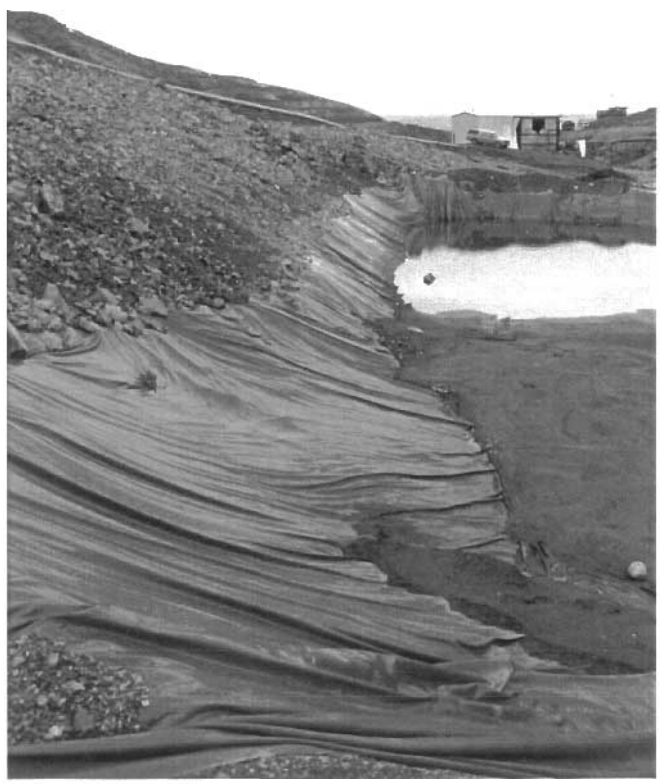

Photo 254 shows the retained pond within this Dump Pond. Two cuts in the top of the liner were observed at the crest edge.

CLIENT:

Nanisivik Mine, a Division of CanZinco Ltd.

REV.	DATE	REVISION NOTES	DRAWN	CHECKED	APPROVED
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-

SCALE:	N/A
DATE:	October 2003
DRAWN:	SLF
DESIGNED:	GWF
CHECKED:	GWF
APPROVED:	JWC

PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
Mill Dump Pond Containment Berm - Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 17	0

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Photo 154shows a view of the eastern berm of the Upper Dump Pond. The liner is quite wrinkled but some fill has been placed on top in an attempt to anchor the liner better.

Photo 157 shows a view along the top of the western berm of this dump pond. No signs of cracking of the liner were noted. No signs of berm settlements or cracking or seepage at its downstream end have been noted either.

SCALE:	N/A	DESIGNED:	GWF
DATE:	October 2003	CHECKED:	GWF
DRAWN:	SLF	APPROVED:	JWC

CLIENT:
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PROJECT
Annual Inspection of Waste Containment Dikes

TITLE
Upper Dump Pond Containment Berm - Photos

PROJECT No.	DWG. No.	REV.
0255-008-05	Figure 18	0