APPENDIX I
HYDROLOGICAL STUDIES – NANISIVIK MINE

Golder 2004b – Extended Hydrological Study
Golder 2004c– Addendum to Extended Hydrological Study
Golder 2004d – Water Balance Assessment – Nanisivik Mine Closure

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REPORT ON

EXTENDED HYDROLOGICAL STUDY
NANISIVIK MINE

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EXECUTIVE SUMMARY

This report presents the results of the hydrological analysis for Nanisivik Mine. The scope of work for the hydrological analysis was defined at the project meeting in Toronto on December 19, 2002.

The Nanisivik Mine water management system analysed in this study includes the Surface Cell, the Reservoir (West Twin Lake), the Polishing Pond, and East Twin Lake. The total drainage area covered by the hydrological study is approximately 37.6 km^2, which consists of approximately 3.0 km^2 of the Reservoir (West Twin Lake) watershed and 34.6 km^2 of the East Twin Lake watershed. The East Twin Lake drainage, therefore, has a predominant impact on the overall hydrological performance of the water management system.

Peak flows, velocities, and water levels were calculated for a 100-year, 500-year, and a PMP design events. Three scenarios of the post-closure water management system configuration were analysed:

<u>Scenario 1</u>

- The East Twin Lake outflow is diverted back into the Reservoir (i.e., existing diversion structures are removed and the original, natural drainage conditions are restored).
- The design water level in the Reservoir is 369 m.
- The Reservoir and the Polishing Pond are connected with a 30 m wide channel.

<u>Scenario 2</u>

- The East Twin Lake outflow continues to be diverted away from the Reservoir. The confluence of the East Twin Lake effluent and the tailings basin effluent is downstream of the Polishing Pond.
- The design water level in Reservoir is 369 m.
- The Reservoir and the Polishing Pond are connected with a 30 m wide channel.

<u>Scenario 3</u>

- The East Twin Lake outflow continues to be diverted away from the Reservoir. The confluence of the East Twin Lake effluent and the tailings basin effluent is downstream of the Polishing Pond (as in Scenario 2).
- The design water level in Reservoir is 372 m. Therefore, a water retaining structure is required.
- The outflow from the Reservoir is via a 6 m wide spillway.

Study Conclusions

- If the East Twin Lake outflow is directed into the Reservoir (Scenario 1), the estimated peak velocities at the Reservoir inlet range from 1.3 m/s (for a 100-year storm event) to 2.2 m/s (for a PMP event). Scour of tailings is likely to take place at the inlet to the Reservoirs. In addition, the water level fluctuations in the Reservoir are likely to be higher than those when the East Twin Lake drainage is diverted away from the Reservoir. This might result in the undesirable tailings thaw and freeze cycles.

- From the hydrological perspective, there is no benefit of setting the Reservoir operating water level at 372 m (Scenario 3). Also, maintaining this level in the Reservoir would require a dam and a spillway, which would have to be maintained.

- From the hydrological perspective, the preferred water management system configuration is Scenario 2: East Twin Lake drainage continues to be diverted away from the Reservoir, the Reservoir water level is 369 m, and the water retaining structures between the Reservoir and the Polishing Pond are removed. The Reservoir and the Polishing Pond are connected with a natural, wide (approximately 30 m) channel.

- The peak velocity at the outlet from the Polishing Pond (after the confluence of the East Twin Lake effluent and the Polishing Pond effluent) is estimated to be approximately 1.5 m/s regardless of the system configuration.

- A water cover of 200 mm or greater would be sufficient to keep the tailings submerged.

Study Recommendations

- It is recommended that the existing diversion of the East Twin Lake outflow away from the Reservoir be preserved.

- It is recommended that the existing East Twin Lake diversion system (diversion berms and ditches) be inspected and surveyed.

- It is recommended that the flow capacity of the diversion system (flow depths and velocities) be evaluated with respect to PMP flows after closure.

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1.0 INTRODUCTION

1.1 Background

Nanisivik Mine, located on the Borden Peninsula of Baffin Island in the Nunavut Territory, is a base metal mine that has been in production for over twenty years. The mine operates under the Nunavut Water Board License (NWB1NAN9702 dated July 31, 1997).

Nanisivik Mine is in the process of submission of the Closure and Restoration Plan to the Nunavut Water Board. As part of the plan preparation, Golder Associates has been retained by Breakwater Resources to provide hydrological support.

In February 2002, Golder carried out a hydrological study for the Nanisivik Mine Preliminary Spillway Design (Golder, 2002A). That study addressed design rainfall and snowmelt conditions and the preliminary hydraulic design for the proposed spillway from the Surface Cell.

One of the recommendations of the study was that an hydrological study be carried out to for the entire tailings water management system, which includes the Surface Cell, Reservoir, East Twin Lake, the Polishing Pond with the decant station, and the Twin Lakes Creek. This hydrological study was recommended so that the preliminary design of the required decant structures for West Twin Lake for closure could be undertaken. The work program and the cost estimate for that study were presented in the letter dated July 19, 2002 from Golder to Breakwater (Golder, 2002B).

The hydrological study was authorised by Breakwater Resources on August 12, 2002. On August 16, 2002, Alex Gordine of Golder and Jim Cassie of BGC Engineering had a project meeting in Calgary, where they went over the available information and discussed the project requirements. At that meeting Alex Gordine prepared a memo with a list of the required data for the hydrological study.

It is understood that, over time, the project requirements and priorities have changed. On December 19, 2002, there was a project meeting at the downtown Toronto office of Breakwater Resources Ltd. The purpose of the meeting was to review the scope of hydrological investigations for the Nanisivik Mine closure study, and to define the immediate hydrological needs. Present at the meeting were Bob Carreau of Breakwater Resources Ltd, Jim Cassie of BGC Engineering Limited (Calgary), Ken Bocking and Alex Gordine of Golder (Mississauga), and Eric Denholm of Gartner Lee (Yellowknife). Alex Gordine distributed the meeting notes to the participants in the e-mail on January 6, 2003. This report presents the results of the hydrological analysis as per the scope of work defined at the meeting in Toronto.

1.2 Objectives and Scope of Work

The following scope of hydrological investigations was agreed upon at the meeting in Toronto:

1.2.1 Parameters of Interest

- Flow velocity at three locations: at the inlet of East Twin Lake drainage into the Reservoir; at the outlet from the Polishing Pond; at the confluence of the East Twin Lake and Reservoir flows.
- Peak water level at the Reservoir.
- The amount of drawdown expected in the flooded tailings area under drought conditions. As a simplified worst case scenario, we will assume zero runoff, zero seepage losses, and consider evaporation only.

1.2.2 Design Conditions

- The existing flow control structures are not to be considered. It is assumed that the culverts and stop logs will be removed from Reservoir outlet and there will be no decant structure from the Polishing Pond.
- The outlet from the system will be at the present Reservoir outlet. Channel cross-sections are to be estimated from the topographic map, and this cross-section is to be used as the reservoir outlet control section.
- Two scenarios of East Twin Lake drainage: "existing" (flow continues to be diverted from West Twin Lake) and the "pre-development" (no flow diversion, East Twin Lake flows into West Twin Lake).
- Two scenarios of spillway invert elevation from Reservoir: 369 m and 372 m.
- Design storm events: PMP, 500 yr, and 100 yr.

2.0 SPILLWAY HYDROLOGICAL ANALYSIS

2.1 Hydrological Modelling

Hydrological models mimic physical processes in the watershed, and simulate the response of the watershed to the rainfall and snowmelt input. The GAWSER model (Guelph All-Weather Sequential Event Runoff model) was used for the hydrological simulation of the Nanisivik Mine tailings basin. This model is widely used in Canada for various types of hydrological analyses.

The objective of the hydrological modelling was to simulate peak flows, water levels, and velocities at various points along the flow path.

2.2 Modelling Approach

2.2.1 Surface Drainage Conditions

The surface drainage system at the Nanisivik Mine under the post-closure conditions will consist of the following main components (Figure 1):

- The Surface Cell – the main deposition area for the tailings solids. The drainage area is approximately 1.27 km^2.
- The Reservoir (West Twin Lake) – currently receives syphoned tailings water from the Surface Cell. After closure, the Reservoir will receive spillway overflow from the Surface Cell. The total drainage area is approximately 3.0 km^2, which includes the Surface Cell sub-basin (1.27 km^2, as mentioned above).
- The Polishing Pond – currently receives overflow from Reservoir through the stop log structure. At closure, the stop log structure will be eliminated. Drainage options from the Reservoir to the Polishing Pond are discussed later in the text. The Polishing Pond drainage area is approximately equal to that of the Reservoir (3 km^2). The pond surface area is approximately 0.017 km^2, considerably smaller than the contributing watershed.
- East Twin Lake – currently a source of potable water supply. The drainage area is approximately 34.6 km^2. The lake surface area is approximately 0.18 km^2 (approximately 0.5% of the drainage area).

In summary, the total drainage area covered by the hydrological study is approximately 37.6 km^2, which consists of approximately 3.0 km^2 of the Reservoir (West Twin Lake) watershed and 34.6 km^2 of the East Twin Lake watershed. The East Twin Lake drainage, therefore, has a predominant impact on the overall hydrological performance of the water management system.

2.2.2 Watershed Representation and Assumptions

- The Surface Cell watershed representation was that developed in the previous hydrological investigation (Golder, 2002A).

- East Twin Lake is significantly smaller than the contributing watershed (approximately 0.5% of the area, as mentioned above). The attenuation effect of such a small lake on the flood flow was assumed to be negligible. Consequently, the surface runoff from the East Twin Lake watershed was assumed to contribute directly to Reservoir (Scenario 1) or confluence with the Polishing Pond effluent (Scenarios 2 and 3).

- Similarly to East Twin Lake, the Polishing Pond is significantly smaller than the contributing watershed (especially if the East Twin Lake effluent is directed into Reservoir). Consequently, the flood attenuation in the Polishing Pond was considered to be negligible, and the flood routing through the Polishing Pond was not carried out.

It was assumed that the ground in the watershed has low permeability. (This is an appropriate assumption for permafrost). Therefore, the soil properties were selected to represent small losses of precipitation and high runoff.

2.2.3 Design Precipitation Events

The analysis was carried out for the daily PMP event (140 mm), daily 500-year rainfall event (51 mm), and daily 100-year rainfall event (41 mm).

2.2.4 Simulated Scenarios

As mentioned above, three scenarios of the post-closure tailings basin configuration were considered:

Scenario 1

- The East Twin Lake outflow is diverted back into Reservoir (i.e., the original, pre-development drainage conditions are restored).

- The design water level in the Reservoir is 369 m.

- The Reservoir and the Polishing Pond are connected with a 30 m wide channel.

Scenario 2

- The existing drainage pattern, whereby the East Twin Lake outflow is diverted away from the Reservoir, is preserved. In other words, East Twin Lake does not contribute flow to the Reservoir; the confluence of the East Twin Lake effluent and the tailings basin effluent is downstream of the Polishing Pond.

- The design water level in Reservoir is 369 m.

- The Reservoir and the Polishing Pond are connected with a 30 m wide channel.

Scenario 3

- The existing drainage pattern, whereby the East Twin Lake outflow is diverted away from the Reservoir, is preserved (as in Scenario 2).

- The design water level in Reservoir is 372 m. Therefore, a water retaining structure is required.

- The outflow from the Reservoir will be through an assumed 6 m wide spillway.

2.2.5 Flow Velocities

The peak flow velocities were estimated at two locations: the East Twin Lake inlet to the Reservoir (Scenario 1) and at the outflow from the Polishing Pond.

The peak flow velocities were calculated as averages by dividing the calculated peak flow rate by the flow cross-section area. The flow cross-section areas were calculated as a product of the flow width and the average flow depth.

The flow widths was measured from the map. The width of the outflow channel from the Reservoir was estimated to be 30 m; the width of the East Twin Lake outflow channel into reservoir was estimated to be 43 m. The flow depths were estimated using Manning's equation.

2.3 Modelling Results

The results of the hydraulic analysis are summarized in Table 1. The following observations could be made from Table 1:

- The peak flow rate from the East Twin Lake watershed is approximately four times higher than that from the West Twin Lake (Reservoir) watershed. For example, the estimated PMP flood from the East Twin Lake watershed is approximately 52 m^3/s, while that from the West Twin Lake watershed is approximately 11 m^3/s. Therefore, diversion of the East Twin Lake outflow into or away from the Reservoir has a significant impact on the flow conditions in the tailings basin.

- The peak water level in the Reservoir depends on the water management system configuration.

  - If the East Twin Lake drainage is directed into Reservoir and the flow control from the Reservoir to Polishing Pond is eliminated (i.e. if 30 m wide channel connects the Reservoir and the Polishing Pond), the PMP peak level in the reservoir is estimated to be 1.1 m (Scenario 1).

- If the East Twin Lake continues to be directed away from the Reservoir and the flow control from the Reservoir to Polishing Pond is eliminated (i.e. a 30 m wide channel connects the Reservoir and the Polishing Pond), then the estimated PMP peak water level in the Reservoir is 0.2 m (Scenario 2).

- If the East Twin Lake continues to be directed away from the Reservoir, but the water level in the Reservoir is maintained high, at 372 m, using a dam with a spillway (a 6 m wide channel was assumed), then the estimated PMP peak water level in the Reservoir is 0.5 m (Scenario 3).

- If the East Twin Lake effluent is directed into reservoir (Scenario 1), the estimated flow velocities at the inlet to the Reservoir range approximately from 1.3 m/s (for a 100-year storm event) to 2.2 m/s (for a PMP event). It is likely that such velocities may cause scouring of any tailings currently in that location.

- The peak velocity at the outlet from the Polishing Pond (after the confluence of the East Twin Lake effluent and the Polishing Pond effluent) is estimated to be approximately 1.5 m/s, regardless of the system configuration.

3.0 WATER COVER OVER TAILINGS

It is understood that the Nanisivik Mine tailings should be submerged to prevent their exposure to air and oxidation. The water cover over tailings is subject to seasonal fluctuations. Therefore, it is necessary to estimate the range of the water level fluctuations and to provide sufficient water cover to keep the tailings always submerged.

In principle, the water level can decline seasonally due to evaporation, infiltration through tailings, and seepage through the dam. Because any exposed tailings and dam cores at Nanisivik will be permanently frozen, it is assumed that the infiltration and seepage losses are negligible. Therefore, evaporation is the main mechanism of water loss from the tailings basin.

Evaporation from the Nanisivik tailings basin has been evaluated and reported previously (Golder, 1998 with reference to Reid, 1996). The estimated mean monthly lake evaporation values reported in the above studies are reproduced in Table 2. Also provided in Table 2 are mean monthly precipitation values.

As can be seen from Table 2, the estimated total mean annual evaporation at Nanisivik is approximately 200 mm. The evaporation takes place from June through September. The maximum mean monthly evaporation of approximately 100 mm/month takes place in July. It is understood that monthly and annual evaporation rates fluctuate, and in any given month or year the actual evaporation could be greater than those reported in Table 2. Typically, the variability of evaporation is fairly small (less than the variability of precipitation or runoff).

The mean annual precipitation exceeds the mean annual evaporation by approximately 40 mm/year. In June and July the total mean evaporation exceeds precipitation by approximately 90 mm (Table 2).

Assuming zero runoff and zero precipitation during the period of four months, from June through September, the total water losses due to evaporation are estimated to be 200 mm. The assumption of zero precipitation and runoff is conservative; it offsets the effect of possible evaporation fluctuations. Therefore, it would be sufficient to provide a 200 mm water cover on top of tailings to prevent them from exposure to air and oxidation. Deeper cover (say 300 mm) would provide an extra factor of safety for keeping the tailings submerged should droughts occur in several successive years.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

- If the East Twin Lake outflow is directed into the Reservoir (Scenario 1), the estimated peak velocities at the Reservoir inlet would range from 1.3 m/s (for a 100-year storm event) to 2.2 m/s (for a PMP event). These velocities would be sufficient to cause scour of any tailings currently located at the inlet to the Reservoir. In addition, the water level fluctuations in the Reservoir would likely be higher than under current conditions (i.e. with the East Twin Lake drainage diverted away from the Reservoir). Higher water level fluctuations could expand the zone of active freezing and thawing of tailings on the margins of the Reservoir.

- From the hydrological perspective, there is no benefit in setting the Reservoir operating water level at 372 m (Scenario 3). Also, it is understood that maintaining this level in the Reservoir would require a dam and a spillway, which would then have to be maintained.

- From the hydrological perspective, the preferred water management system configuration is Scenario 2: East Twin Lake drainage continues to be diverted away from the Reservoir, the Reservoir water level is 369 m, and the water retaining structures between the Reservoir and the Polishing Pond are removed. The Reservoir and the Polishing Pond would then be connected with a natural, wide (approximately 30 m) channel.

- The peak velocity at the outlet from the Polishing Pond (after the confluence of the East Twin Lake effluent and the Polishing Pond effluent) is estimated to be approximately 1.5 m/s regardless of the system configuration.

- A water cover of 200 mm or greater would be sufficient to keep the tailings submerged.

4.2 Recommendations

- It is recommended that the existing diversion of the East Twin Lake outflow away from the Reservoir be preserved.

- It is recommended that the existing East Twin Lake diversion system (diversion berms and ditches) be inspected and surveyed.

- It is recommended that the flow capacity of the diversion system (flow depths and velocities) should be evaluated with respect to PMP flows after closure.

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Golder, 2002B. Letter to Breakwater Resources Ltd, Re. *Extended Hydrological Study, Nanisivik Mine*. Reference No. P21-1293. July 19, 2002

Golder, 1998. Report on *1998 Geotechnical Inspection of Waste Containment Dykes, Nanisivik Mine. Baffin Island, N.W.T.* Reference No. 982-2432-5100. October 1998.

Reid, 1996. *Evaporation Studies at Mine Tailings Ponds in the Northwest Territories, Canada.* Proceedings of the Hydro-Ecology Workshop on the Arctic Environment Strategy, Canadian Geophysical Union, May 5-10, 1996, Banff, Alberta, pp115-134.

Tables

TABLE 1
SUMMARY OF NANISIVIK MINE HYDROLOGICAL ANALYSIS

	Channel Width	
Channel from Reservoir	30	m
Channel from ETL to Reservoir	43	m

ETL drains into Reservoir, then the total flow is routed through the outflow channel

Reservoir Level	East Twin Lake Diversion	Precipitation Event	Inflow to Reservoir: From WTL	Inflow to Reservoir: From ETL	Diverted Flow from ETL: Flow Depth from ETL	Diverted Flow from ETL: Peak Vel from ETL	Outflow from Reservoir: Peak Flow	Outflow from Reservoir: Peak Level	Outflow from Reservoir: Peak Depth	Outflow from Reservoir: Peak Velocity	Flow After Polishing Pond: Peak Flow
m			m^3/s	m^3/s	m	m/s	m^3/s	m	m	m/s	m^3/s
369	removed	PMP	11.0	50.2	0.5	2.2	51.7	370.1	1.1	1.6	51.7
		500 yr Chicago	4.1	17.0	0.3	1.4	17.0	369.4	0.4	1.5	17.0
		100 yr Chicago	3.3	13.2	0.2	1.3	13.2	369.3	0.3	1.5	13.2

ETL By-passes Reservoir, then confluences with the Reservoir Outflow

Reservoir Level	East Twin Lake Diversion	Precip	Inflow to Reservoir: From WTL	Inflow to Reservoir: From ETL	Diverted Flow from ETL: Flow Depth from ETL	Diverted Flow from ETL: Peak Vel from ETL	Outflow from Reservoir: Peak Flow	Outflow from Reservoir: Peak Level	Outflow from Reservoir: Peak Depth	Outflow from Reservoir: Peak Velocity	Flow After Polishing Pond: Peak Flow
m			m^3/s	m^3/s	m	m/s	m^3/s	m	m	m/s	
369	maintained	PMP	11.0	NA	NA	NA	8.0	369.2	0.18	1.5	54.9
		500 yr Chicago	4.1	NA	NA	NA	2.9	369.1	0.06	1.6	18.6
		100 yr Chicago	3.3	NA	NA	NA	2.3	369.1	0.05	1.5	14.4

Note: for WL=369 m outflow from Reservoir is a channel, 30 m (100 ft) wide; for WL=372 m, outflow from Reservoir is a spillway (assume 6 m wide)

Reservoir Level	East Twin Lake Diversion	Precip	Inflow to Reservoir: From WTL	Inflow to Reservoir: From ETL	Diverted Flow from ETL: Flow Depth from ETL	Diverted Flow from ETL: Peak Vel from ETL	Outflow from Reservoir: Peak Flow	Outflow from Reservoir: Peak Level	Outflow from Reservoir: Peak Depth	Outflow from Reservoir: Peak Velocity	Flow After Polishing Pond: Peak Flow
m			m^3/s	m^3/s	m	m/s	m^3/s	m	m	m/s	
372	maintained	PMP	11.0	NA			3.4	372.5	0.5	0.2	53.4
		500 yr Chicago	4.1	NA			1.1	372.2	0.17	0.2	18.0
		100 yr Chicago	3.3	NA			0.8	372.1	0.14	0.2	14.0

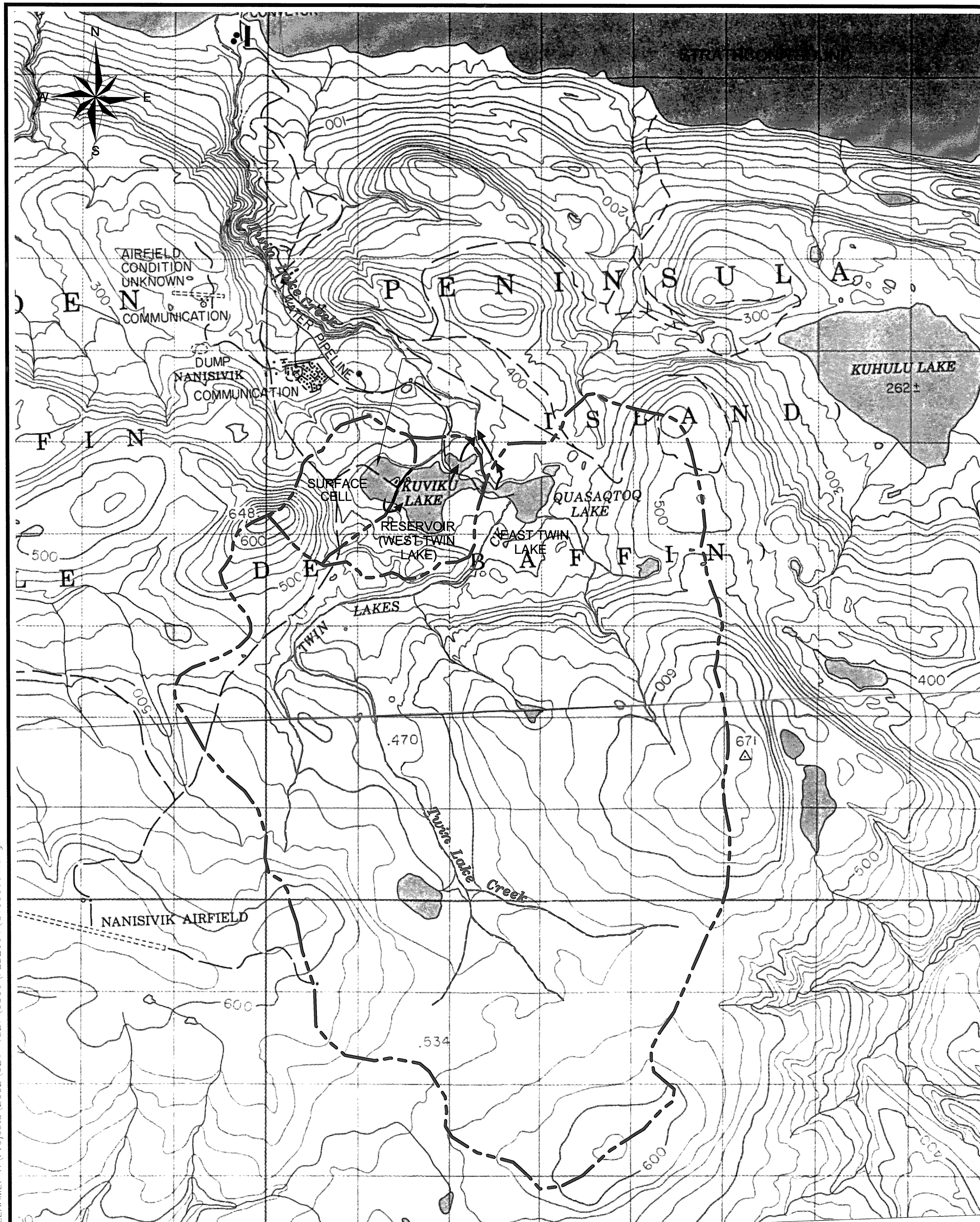
Notes
removed ETL outflow is redirected back to Reservoir (i.e. change of the existing drainage conditions and return to the pre-development conditions)
maintained The existing ETL outflow drainage is preserved (i.e. ETL by-passes Reservoir)
NA not applicable

TABLE 2
MEAN MONTHLY PRECIPITATION AND LAKE EVAPORATION

Month	Total Precipitation mm	Lake Evaporation mm
Jan	8	0
Feb	4	0
Mar	7	0
Apr	10	0
May	18	0
Jun	24	51
Jul	36	101
Aug	41	31
Sep	42	20
Oct	32	0
Nov	14	0
Dec	8	0
Total	242	203

Notes
1) Precipitation data are based on the Nanisivik Station record for the period from 1977 through 1997
2) Distribution of monthly lake evaporation was derived based on mean monthly air temperature
3) Data source: Golder, 1998

Figures



INFERRED WATERSHED BOUNDARIES
NANISIVIK MINE

FIGURE 1

LEGEND

INFERRED WATERSHED BOUNDARIES

SURFACE WATER FLOW DIRECTION

DRAINAGE AREAS

EAST TWIN LAKE	34.6 sq.km.
RESERVOIR (WEST TWIN LAKE)	3.0 sq.km.
SURFACE CELL	1.27 sq.km.

REFERENCE

ENERGY, MINES AND RESOURCES, MAP SHEETS 48 C/1 AND 48 B/16, 1986, SCALE 1 : 50,000.

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SCALE 1:50000 KM

DATE: FEBRUARY, 2004

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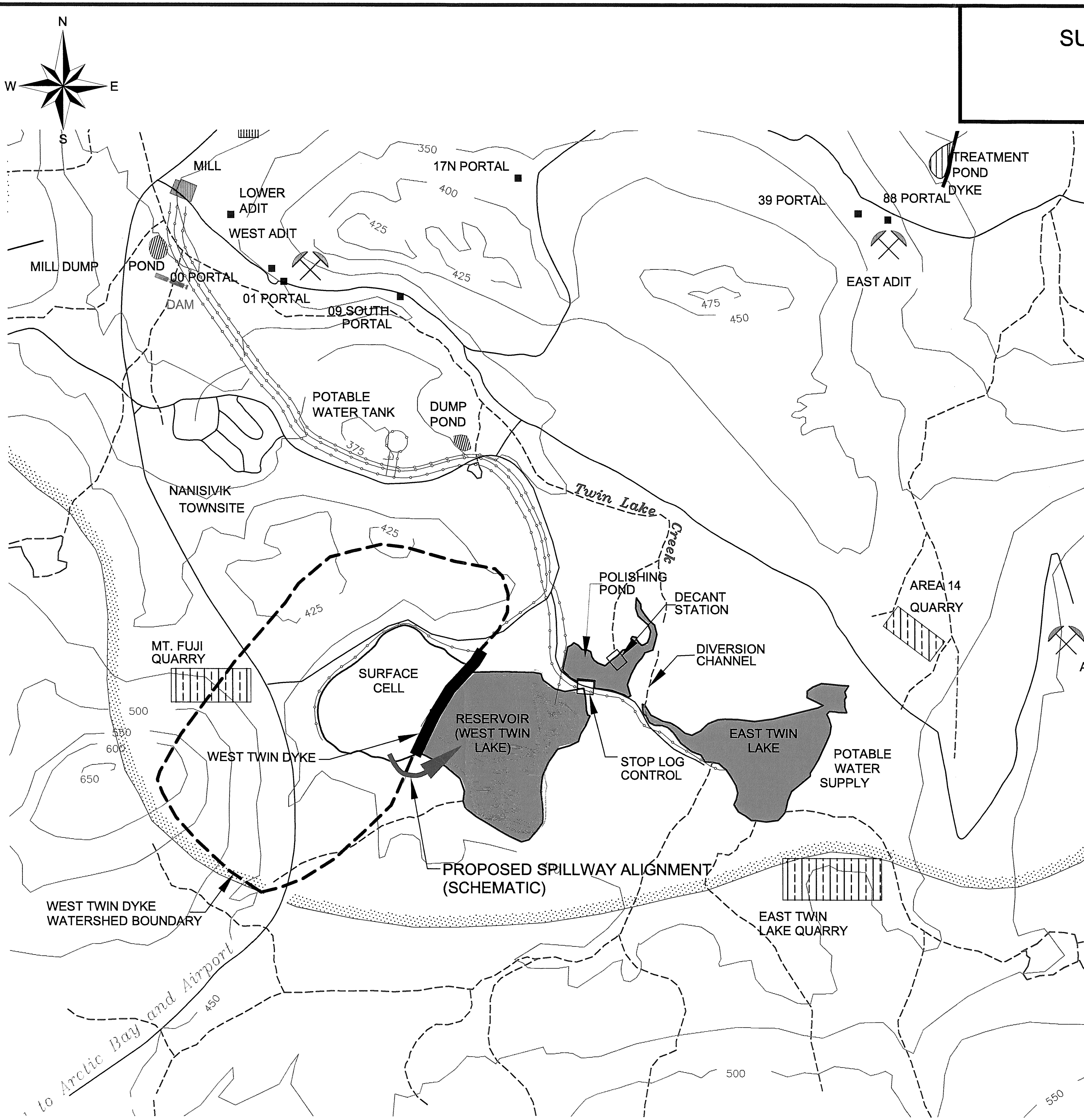
SURFACE WATER MANAGEMENT PLAN
NANISIVIK MINE TAILINGS AREA

FIGURE 2



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TECHNICAL MEMORANDUM

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TO: Bob Carreau
K. Bocking, D. Ritchie, Jim Cassie

DATE: March 2, 2004

FROM: Alex Gordine

JOB NO: 03-1118-049 (4400)

EMAIL: agordine@golder.com

RE: **ADDENDUM TO THE REPORT ON EXTENDED HYDROLOGICAL STUDY, NANISIVIK MINE CLOSURE**

This Technical Memorandum provides an addendum to the Nanisivik Mine Extended Hydrological Study (Golder, 2004). It presents the simulated peak flows and water levels in the West Twin Lake (Reservoir) at the Nanisivik Tailings Management Area under the post-closure conditions. The methods of hydrological analysis are discussed in the Extended Hydrological Study (Golder, 2004), and discussion of these is not reproduced in this addendum. Only the results of the revised hydrological analysis are presented.

The normal water level in the West Twin Lake (Reservoir) was finalized at 370.2 as part of revisions to the Nanisivik Mine closure plan in late February 2004. At the same time, the decision was made to construct the spillway outlet from the Reservoir with a base width of 7.0 m. The Report on the Nanisivik Mine Extended Hydrological Study had been issued by that time using different input parameters. This addendum serves to update the previous study for the new normal water level and spillway width.

Background

In February 2004, Golder issued the Report on Extended Hydrological Study at the Nanisivik Mine. Peak flows, velocities, and water levels were calculated in the study for various design storm events. The hydrological calculations were carried out for two cases of Reservoir post-closure normal water levels: 369.0 m and 372.0 m.

The water levels of 369.0 m and 372.0 m were considered to be the minimum and maximum possible post-closure water levels, respectively. These water levels were selected based on the following considerations:

The benefit of maintaining the water level low (369.0 m) is that the water storage and the hydraulic structures left after the mine closure are small, hence pose a minimal risk. The lowest possible water level in the Reservoir is approximately 369.0 m because it is the water level in the Twin Lakes Creek, which receives the Reservoir effluent. Consequently, lower water level in the Reservoir would result in the opposite flow direction (backwater) from the West Twin Creek into the Reservoir.

The benefit of maintaining water level high (372.0 m) is that it reduces the amount of tailings to be relocated from high grounds to the deep sections of the Reservoir, or alternatively to be covered with shale. On the other hand, the higher water level would entail a greater differential head across the outlet control embankment.

We understand that the post-closure Reservoir normal water level that was ultimately recommended is 370.2 m. It was recommended based on the following considerations:

- This corresponds roughly to the West Twin Lake water level under the natural, pre-development conditions.
- This water level provides a trade-off between reducing the required amount of relocation of tailings and reducing the differential head across the outlet control embankment.

This memo presents the simulated post-closure Reservoir peak water levels based on the normal operating water level of 370.2 m.

Results of Hydrological Analysis

The results of the hydrological analysis are summarized in Table 1 (attached). The following observations could be made from Table 1:

- The simulated peak water levels in the Reservoir are 370.36 m from a 100-year storm, 370.40 m from a 500- year return storm, and 370.8 m from the PMP event.
- The peak water depths on the spillway are approximately 0.2 m for a 100-year return and 500-year return events and 0.6 m for the PMP storm event.
- The simulated peak velocities over the spillway are approximately 1.5 m/s.

REFERENCES

Golder, 2004. Golder Associates Ltd. *Report on Extended Hydrological Study. Nanisivik Mine.* Report 021-1827.

AG/dh
Attachments
Table A1 - Summary of Reservoir Flood Routing for 7 m Spillway and Normal Water Level of 370.2 m. Nanisivik Mine Closure.

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TABLE A1
SUMMARY OF RESERVOIR FLOOD ROUTING FOR 7 m SPILLWAY AND NORMAL WATER LEVEL OF 370.2 m
NANISIVIK MINE CLOSURE

Design Storm	Peak Inflow to Reservoir		Outflow from Reservoir				Flow After Polishing Pond
	From West Twin Lake	From East Twin Lake[2]	Peak Flow	Peak Level	Peak Depth	Peak Velocity	Peak Flow
	m^3/s	m^3/s	m^3/s	m	m	m/s	
PMP	11.0	NA	6.5	370.80	0.6	1.5	54.9
500 year return	4.1	NA	2.1	370.40	0.2	1.5	18.6
100 year return	3.3	NA	1.7	370.36	0.2	1.5	14.4

Notes
1. Addendum to the Extended Hydrological Study of the Nanisivik Mine (Golder, Report 021-1827, March 2004)
2. The East Twin Lake flows continue to be diverted through the Diversion Channel into East Twin Creek downstream of the Reservoir Outflow
3. Width of spillway 7 m
4. Reservoir Level 370.2 m

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REPORT ON

WATER BALANCE ASSESSMENT
NANISIVIK MINE CLOSURE

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1.0 INTRODUCTION

This report presents the results of the Nanisivik Mine water balance assessment.

The main objective of the water balance analysis was to assess the range of annual and monthly flow and water level fluctuations in the Surface Cell and the Reservoir (West Twin Lake) at the Nanisivik Mine after closure.

2.0 WATER BALANCE ASSESSMENT- DESIGN CONDITIONS

2.1 Drainage Areas

The following drainage areas were used in the water balance calculations:

- The Surface Cell drainage area: total drainage area is approximately 127 ha, which consists of 126.6 ha of the contributing watershed area and the remaining 0.4 ha area of the cell pond itself. (The Surface Cell surface area corresponds to the proposed closure cover level of 384.0 m, after the regrading and cover placement).

- The Reservoir (West Twin Lake) drainage area is approximately 173 ha, which consists of 154 ha of the contributing watershed (excluding the Surface Cell drainage area) and the remaining 19 ha of the Reservoir surface area. (The Reservoir (West Twin Lake) surface area corresponds to the proposed closure water level of 370.2 m).

- The Total Reservoir (West Twin Lake) drainage area, including the Surface Cell watershed, is 300 ha (127 ha from the Surface Cell plus 173 ha of the Reservoir drainage area).

2.2 Precipitation

Rainfall and snowmelt are the key precipitation parameters in the weather balance equation.

The total precipitation, rainfall, and snowfall, as reported in climatological publications, are not directly usable for the water balance calculations because they do not indicate when the accumulated snowfall melts and contributes to runoff. To evaluate the snowmelt, a climatic water balance, which accounts for air temperature and associated snow melt and freeze, was developed.

The climatic water balance allows for differentiation between rainfall, snowfall, and snowmelt, which is essential for the monthly water balance assessment. A complete meteorological record is required for the climatic water balance development. Meteorological records at Nanisivik Airport and Pond Inlet Airport were analyzed to identify the suitable and representative data set for Nanisivik Mine.

2.2.1 Nanisivik Airport and Pond Inlet Airport Records

The closest meteorological station to the Nanisivik Mine i s situated in the Nanisivik Airport. Upon review and consultation with Environment Canada, however, the Nanisivik Airport records were found to be inadequate for the climatic water balance calculations because of numerous missing measurements. The long -term meteorological record suitable for the climatic water balance assessment was available at Pond Inlet Airport, which is located approximately 220 km east of the mine site.

The records from the Nanisivik Airport and Pond Inlet Airport were compared to determine whether the climatic water balance at Pond Inlet is representative of the Nanisivik Mine conditions (Table 1).

The following observations could be made from Table 1:

- The average annual total precipitation at Nanisivik (243 mm) is 58 mm greater th an that at Pond Inlet (185 mm). This fact needs to be reflected in the water balance calculations.

- The average annual temperature at the two locations is the same (-15.1°C), which is indicative of the climate similarity. The summer months, when the snowm elt occurs, appear to be colder in Nanisivik. For example, in June the average monthly temperature is 1.8°C at Pond Inlet and -0.4°C at Nanisivik. This indicates that the snowmelt at Nanisivik may occur later than at Pond Inlet.

- The amount and seasonal distribution of rainfall at the two stations are comparable. Rainfall at both locations typically take place from June through September. The rest of the year the precipitation is frozen.

2.2.2 Climatic Water Balance

The climatic water balance at the Pond Inl et Airport was provided by Environment Canada (Appendix A). The Pond Inlet Airport water balance was used as a basis to derive rainfall+snowmelt inputs at Nanisivik. The additional precipitation at Nanisivik of 58 mm/year was added to the climatic water balance based on the following assumptions:

- The excess of precipitation at Nanisivik (58 mm) occurs as snowfall.

- The accumulated snowfall melts and contributes to runoff in June (29 mm) and July (29 mm).

The resulting rainfall and snowmelt values used in the water balance calculations are listed in Table 2. As can be seen from Table 2, the snowmelt takes place in June, which makes it the wettest month. The calculated monthly snowmelt is 109 mm, and the total liquid precipitation (rainfall+snowmelt) is 12 2 mm.

The annual precipitation and the estimated rainfall+snowmelt in June were analyzed statistically, for the return periods from 10 years to 100 years. The estimated annual precipitation with a 100-year return period is 373 mm/year (Table 3). In Jun e, the estimated amount of rainfall+snowmelt with return period of 100 years was estimated to be 216 mm (Table 4).

2.3 Evaporation

2.3.1 Evaporation from Water Surface

Monthly estimates of evaporation from water surface at Nanisivik were reported in the previous studies (Golder, 2004A). Evaporation takes place during four months of the year only: June through September. The average annual evaporation is estimated to be 203 mm; the highest reported monthly evaporation of 101 mm occurs in July (Table 2).

There is no information on the statistical variability of evaporation at Nanisivik. Typically, evaporation is less variable than precipitation. For the purpose of this report, the annual and monthly evaporation rates were considered to be constant.

The open water surface occupies approximately 6% of the Reservoir (West Twin Lake) watershed. Therefore, the evaporation from water surface is a fairly small component in the water balance.

2.3.2 Evaporation from Snow and Ice

The evaporation takes place not only from the open water surface but also from the from snow and ice. The process of evaporation from snow and ice is referred to as sublimation.

For the northern regions, such as Nanisivik, where the ground is covered with snow and ice most of the year, water losses due to sublimation may be a significant component of the water balance.

There are various empirical formulae for the estimation of sublimation. Because evaporation, especially from snow and ice, is a very complex process, the empirical formulae provi de only an approximation of the real evaporation values.

Many formulae relate evaporation to the vapour pressure deficit and wind velocity. Evaporation from snow and ice at the Nanisivik Mine was estimated based on the following data and assumptions:

- Average monthly air temperatures (Table 1).
- Assumed relative humidity of 60%.
- The long-term average wind speed of 3.5 m/s (based on the Nanisivik wind speed record for 1993, 1995, 1996, and 1997).

The annual sublimation at Nanisivik of approximately 50 mm was estimated using the GGI Equation (Bogoslovsky *et* al, 1984). Due to the inherent uncertainty associated with the empirical formulae and assumptions for the sublimation calculation, this estimate was not used in the water balance calculation directly but rather was used as one of the indicators for the runoff coefficient assessment.

2.4 Runoff Coefficient

Due to the frozen ground, the runoff coefficient at Nanisivik is expected to be high. The runoff coefficient was estimated based on the following considerations:

- The average annual precipitation at Nanisivik is 243 mm; the estimated annual sublimation is approximately 50 mm. Therefore, approximately 20% of water (50mm / 243 mm) is lost from the watershed due to sublimation.

- Some evaporation, interception, and limited infiltration takes place during the open water season. These losses on annual basis are assumed to account for additional 10% of the total precipitation.

- The total annual precipitation losses, therefore, were estimated to be 30%. Consequently , the runoff coefficient was estimated to be 0.7 or 70%.

2.5 Seepage

The Nanisivik Mine is situated in the permafrost area. Consequently, for the purpose of the water balance assessment, the seepage losses through the dam are considered to be negligible.

2.6 Elevation-Discharge Curves

The elevation-discharge curves were used to calculate water levels in the Surface Cell and the Reservoir based on the calculated flows. The elevation-discharge curve for the Surface Cell was developed earlier (Golder, 2002). It w as based on the closure cover level of 384.0 m and a 6 m wide spillway from the Surface Cell. Such a wide spillway results in a relatively small range of water level fluctuations.

The elevation-discharge curve for the Reservoir (West Twin Lake) was developed based on the closure water level of 370. 2 m and a 7 m wide spillway (Golder, 2004A; Golder, 2004B). Such a wide spillway results in a relatively small range of water level fluctuations.

3.0 WATER BALANCE ASSESSMENT- RESULTS

The water balance assessment results are summarized in Tables 2, 3, 4, and 5. Of primary interest to the analysis is the flow through Reservoir (West Twin Lake), as it represents the environmental discharge from the tailings area. The following is the summary of the analysis:

Flow Fluctuations

- Most of the time (approximately seven months per year) there is no flow through the tailings area (Table 2).

- The long-term average annual flow through Reservoir (West Twin Lake) is 0.01 5 m^3/s (approximately 486,000 m^3/year). This is a conservatively high estimate. In 2001, the reported effluent discharge from the Reservoir was approximately 375,000 m^3/year (Nanisivik, 2003). In 2001 the tailings slurry was not discharged to the Reservoir, so the natural runoff was the only water decanted fro m the Reservoir.

- On a wet year with a 100-yr return period, the average annual flow through Reservoir (West Twin Lake) is estimated to be 0.024 m^3 /s (766,000 m^3/year) (Table 3). These average annual flows are based on the 12 months in a year, during some of which the water will be frozen and there will be no flow through the tailings basin.

- The highest monthly flow through Reservoir (West Twin Lake) is expected to take place in June. On average, the flow rate in June is estimated to be approximately 0.10 m^3/s. On a 100-yr return wet month, the flow rate in June is estimated to be 0. 18 m^3/s (Table 4). In other months the 100-yr return flows range from zero in November through April to 0.11 m^3/s in July (Table 5).

Water Level Fluctuations

- The seasonal water level fluctuations in the Surface Cell and the Reservoir (West Twin Lake) will be limited to a few centimetres because of the small contributing drainage areas, low precipitation, and large spillways. The calculated water levels are reported to a single decimal place in Tables 2, 3, 4, and 5 to illustrate that for practical purposes the monthly water levels in the Surface Cell and in the reservoir (West Twin Lake) could be considered to be constant.

- A summary of simulated water levels corresponding to the extreme rainfall events is presented in Table 6. As can be seen from Table 6, the peak water level corresponding to the PMP storm event was estimated to be 384.7 m (a depth of 0.7 m on the spillway) in the Surface Cell and 370.8 m (a depth of 0.6 m on the spillway) in the Reservoir (West Twin Lake).

- The water level decline under the drought conditions had been evaluated in the previous study. The max water decline under extremely dry conditions was estimated to be 200 mm (Golder, 2004). Consequently, the water level in the Reservoir may fluctuate within 0.8 m, from 370.0 m under extremely dry conditions to 370. 8 under the PMP event conditions. The reported water levels do not account for waves (discussed under separate cover).

4.0 CLOSURE

We trust this report meets your requirements. If you have any questions, please do not hesitate to contact the undersigned.

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TABLES

TABLE 1
Comparison of Climatic Conditions at Nanisivik and Pond Inlet

Month	Total Precipitation, mm		Rainfall, mm		Temperature, °C	
	Nanisivik	Pond Inlet	Nanisivik	Pond Inlet	Nanisivik	Pond Inlet
Jan	8	6	0.0	0.0	-29.2	-32.4
Feb	4	3	0.0	0.0	-30.3	-34.1
Mar	7	8	0.0	0.0	-27.8	-30.3
Apr	10	9	0.0	0.0	-20.0	-22.1
May	17	9	0.0	0.2	-10.7	-9.9
Jun	24	14	7.0	11.7	-0.4	1.8
Jul	35	32	27.5	30.5	4.9	6.0
Aug	41	33	22.5	32.9	1.5	4.2
Sep	44	24	4.4	8.4	-5.6	-1.4
Oct	31	24	0.0	1.3	-14.9	-11.4
Nov	16	16	0.0	0.4	-22.7	-22.4
Dec	7	7	0.0	0.0	-26.6	-28.7
Annual	243	185	61.5	85.4	-15.1	-15.1

Data sources:

1. Environment Canada, Canadian Climate Normals, Nanisivik Airport
2. Environment Canada, Climatic Water Balance, Pond Inlet Airport

TABLE 2
Surface Cell and Reservoir (West Twin Lake) Monthly Water Balance - Average Conditions
Nanisivik Mine Water Balance Assessment - Closure Conditions

Month	Average Monthly Climatic Data				Surface Cell		Reservoir (West Twin Lake)	
					Surface Area (ha):	0.4	Surface Area (ha):	16
					Contrib. Watershed (ha)[5]:	126.6	Contrib. Watershed (ha)[5]:	157
	Precipitation[1]			Evaporation[2]	Average Monthly Flow Through Surface Cell[4]	Average Monthly Water Level in Surface Cell	Average Monthly Flow Through Reservoir	Average Monthly Water Level in Reservoir
	Rain	Melt	Total					
	mm	mm	mm	mm	m^3/s	m	m^3/s	m
January	0	0	0	0	0.00	384.0	0.00	370.2
February	0	0	0	0	0.00	384.0	0.00	370.2
March	0	0	0	0	0.00	384.0	0.00	370.2
April	0	0	0	0	0.00	384.0	0.00	370.2
May	1	7	8	0	0.00	384.0	0.01	370.2
June	13	109	122	51	0.04	384.0	0.10	370.2
July	32	29	61	101	0.02	384.0	0.04	370.2
August	32	0	32	31	0.01	384.0	0.02	370.2
September	15	1	16	20	0.01	384.0	0.01	370.2
October	2	1	3	0	0.00	384.0	0.00	370.2
November	0	0	0	0	0.00	384.0	0.00	370.2
December	0	0	0	0	0.00	384.0	0.00	370.2
Annual	95	148	243	203	0.007	384.0	0.015	370.2

Notes:

1. Data source: Environment Canada, Climatic Water Balance for Pond Inlet Airport for the period from 1976 through 1993. Total snowmelt in June and July has been increased by 29 mm in each month to account for the fact that, based on the Canadian Climate Normals, annual precipitation at Nanisivik (242.5 mm) is higher than that at Pond Inlet (185 mm) by 58 mm.
2. Data source: Golder, 1998. *Geotechnical Inspection of Waste Containment Dykes. Nanisivik Mine.* Baffin Island. Report 982-2432-5100
3. Monthly flow attenuation in Surface Cell considered to be negligible, monthly inflow is equal to monthly outflow
4. Runoff coefficient 0.7
5. Contrib Watershed areas of Surface Cell and Reservoir do not include water surfaces. Reservoir watershed area does not include Surface Cell. Total Surface Cell drainage area is 127 ha. Total Reservoir drainage area is 300 ha

TABLE 3
Surface Cell and Reservoir (West Twin Lake) Annual Water Balance
Nanisivik Mine Water Balance Assessment - Closure Conditions

Return Period	Annual Climatic Data		Surface Cell		Reservoir	
			Surface Area (ha):	0.4	Surface Area (ha):	19
			Contrib. Watershed (ha)[4]:	126.6	Contrib. Watershed (ha)[4]:	154
	Total Precipitation (rain + snowmelt)[1]	Evaporation[2]	Average Annual Flow Through Surface Cell[3]	Average Annual Water Level in Surface Cell	Average Annual Flow Through Reservoir[3]	Average Annual Water Level in Reservoir
years	mm	mm	m^3/s	m	m^3/s	m
2 (average)	243	203	0.007	384.0	0.015	370.2
10	314	203	0.009	384.0	0.020	370.2
20	334	203	0.009	384.0	0.022	370.2
25	340	203	0.010	384.0	0.022	370.2
50	357	203	0.010	384.0	0.023	370.2
100	372	203	0.010	384.0	0.024	370.2

Notes:
1. Annual total precipitation calculated using Normal Probability Distribuition
2. Annual evaporation is assumed to be constant under various precipitation conditions.
3. Assumed runoff coefficient 0.7

4. Contrib Watershed areas of Surface Cell and Reservoir do not include water surfaces. Reservoir watershed area does not include the Surface Cell drainage basin. Total Surface Cell drainage area is 127 ha. The total drainage area of the Reservoir is 300 ha

TABLE 4
Surface Cell and Reservoir (West Twin Lake) Wet Month Water Balance (June)
Nanisivik Mine Water Balance Assessment - Closure Conditions

Return Period	Climatic Data in June		Surface Cell		Reservoir	
			Surface Area (ha):	0.4	Surface Area (ha):	19
			Contrib. Watershed (ha)[5]:	126.6	Contrib. Watershed (ha)[4]:	154
	Total Precipitation (rain + snowmelt)[1]	Evaporation[2]	Average Monthly Flow Through Surface Cell[3]	Average Monthly Water Level in Surface Cell	Average Monthly Flow Through Reservoir[3]	Average Monthly Water Level in Reservoir
years	mm	mm	m^3/s	m	m^3/s	m
2 (average)	122	51	0.04	384.0	0.10	370.2
10	174	51	0.06	384.0	0.14	370.2
20	188	51	0.06	384.0	0.15	370.2
25	192	51	0.07	384.0	0.16	370.2
50	205	51	0.07	384.0	0.17	370.2
100	216	51	0.07	384.0	0.18	370.2

Notes:
1. Monthly total precipitation (rain + snowmelt) calculated using Normal Probability Distribuition
2. Monthly evaporation is assumed to be constant under various rain conditions.
3. Assumed runoff coefficient 0.7

4. Contrib Watershed areas of Surface Cell and Reservoir do not include water surfaces. Reservoir watershed area does not include the Surface Cell drainage basin. Total Surface Cell drainage area is 127 ha. The total drainage area of the Reservoir is 300 ha

TABLE 5
Surface Cell and Reservoir (West Twin Lake) Monthly Water Balance - 100-yr Return Wet Conditions
Nanisivik Mine Water Balance Assessment - Closure Conditions

Month	Average Monthly Climatic Data				Surface Cell		Reservoir (West Twin Lake)	
					Surface Area (ha):	0.4	Surface Area (ha):	19
	Liquid Precipitation[1] (rain + snowmelt)			Evaporation[2]	Contrib. Watershed (ha)[6]:	126.6	Contrib. Watershed (ha)[6]:	154
	Mean	Standard Deviation[3]	100-year Return Wet[7]		Average Monthly Flow Through Surface Cell[5]	Average Monthly Water Level in Surface Cell	Average Monthly Flow Through Reservoir[5]	Average Monthly Water Level in Reservoir
	mm	mm	mm	mm	m^3/s	m	m^3/s	m
January	0	0	0	0	0.00	384.0	0.00	370.2
February	0	0	0	0	0.00	384.0	0.00	370.2
March	0	0	0	0	0.00	384.0	0.00	370.2
April	0	0	0	0	0.00	384.0	0.00	370.2
May	8	14	40	0	0.01	384.0	0.03	370.2
June	122.1	40	216	51	0.07	384.0	0.18	370.2
July	61.4	34	140	101	0.05	384.0	0.11	370.2
August	32	21	80	31	0.03	384.0	0.06	370.2
September	16	17	56	20	0.02	384.0	0.05	370.2
October	3	10	27	0	0.01	384.0	0.02	370.2
November	0	0	0	0	0.00	384.0	0.00	370.2
December	0	0	0	0	0.00	384.0	0.00	370.2

Notes:

1. Data source: Enviromment Canada, Climatic Water Balance for Pond Inlet Airport for the period from 1976 through 1993. Total snowmelt in June and July has been increased by 29 mm in each month to account for the fact that, based on the Canadian Climate Normals, annual precipitation at Nanisivik (242.5 mm) is higher than that at Pond Inlet (185 mm) by 58 mm.
2. Data source: Golder, 1998. *Geotechnical Inspection of Waste Containment Dykes. Nanisivik Mine.* Baffin Island. Report 982-2432-5100
3. Based on the Pond Inlet Airports records
4. Monthly flow attenuation in Surface Cell considered to be negligible, monthly inflow is equal to monthly outflow
5. Runoff coefficient 0.7
6. Contrib Watershed areas of Surface Cell and Reservoir do not include water surfaces. Reservoir watershed area does not include Surface Cell. Total Surface Cell rainage area is 127 ha. Total Reservoir drainage area is 300 ha
7. The 100-yr return monthly rain_snowmelt are estimated independently for each month. The 100-yr return values should not be added to determine the 100-yr return annual rain+snowmelt. See Table 3 for the annual rain+snowmelt statistics

Table 6
Summary of Simulated Flows and Water Levels
Nanisivik Mine Water Balance Assessment - Closure Conditions

Surface Cell								Reservoir (West Twin Lake)							
Average Monthly Conditions - Dry Month		Average Monthly Conditions - Wet Month		100-year storm		PMP		Average Monthly Conditions - Dry Month		Average Monthly Conditions - Wet Month		100-year storm		PMP	
Flow	Water Level	Flow	Water Level	Flow	Peak Water Level	Flow	Peak Water Level	Flow	Water Level	Flow	Water Level	Flow	Peak Water Level	Flow	Peak Water Level
m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m	m^3/s	m
0.00	384.0	0.04	384.0	1.4	384.3	5.2	384.7	0.0	370.2	0.10	370.2	1.70	370.4	6.50	370.8

Notes

1) The monthly values represent long-term average conditions (rain and evaporation). Under extreme conditions, the water level could decline below 384 m. The max water decline under extremely dry conditions was estimated to be 200 mm (Golder, 2004A. *Extended Hydrological Study. Nanisivik Mine*, Project 021-1827, March 2004)

2) On a dry month, the average water level is equal to the spillway invert level. On a wet month, the average water level is 1-2 cm higher than that on a dry month, which is within the data accuracy. The water levels are rounded to 0.1 m and appear to be the same during dry and wet periods.

3) The Surface Cell spillway invert: 384.0 m. The Reservoir (West Twin Lake) spillway invert: 370.2 m

APPENDIX A

CLIMATIC WATER BALANCE
POND INLET AIRPORT

CLIMATIC WATER BALANCE

Pond Inlet A, NU.			WATER BUDGET MEANS FOR THE PERIOD 1976-1993 DC20492								
LAT.	... 72.67	WATER HOLDING CAPACITY...					5 MM	HEAT INDEX...			2.18
LONG	... 78.00	LOWER ZONE..............					3 MM	A...........			0.531
DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	-31.8	6	0	0	0	0	0	0	57	2	56
28- 2	-34.2	3	0	0	0	0	0	0	61	2	59
31- 3	-30.4	8	0	0	0	0	0	0	69	2	66
30- 4	-22.4	9	0	0	0	0	0	0	78	2	75
31- 5	-9.7	9	1	7	3	3	0	3	79	3	83
30- 6	1.7	14	13	80	76	66	-10	26	0	4	97
31- 7	5.8	32	32	0	154	35	-119	0	0	0	129
31- 8	4	33	32	0	122	33	-89	0	0	0	161
30- 9	-1.6	24	15	1	20	11	-9	3	8	2	185
31-10	-11.6	24	2	1	0	0	0	3	29	2	24
30-11	-23	16	0	0	0	0	0	0	45	2	40
31-12	-28.8	7	0	0	0	0	0	0	52	2	47
AVE	-15.2 TTL	185	95	89	375	148	-227	35			

Pond Inlet A, NU.			STANDARD DEVIATIONS FOR THE PERIOD 1976-1993 DC20492								
DATE	TEMP (C)	PCPN	RAIN	MELT	PE	AE	DEF	SURP	SNOW	SOIL	ACC P
31- 1	3.7	5	0	0	0	0	0	0	24	2	21
28- 2	4.3	3	0	0	0	0	0	0	24	2	22
31- 3	2.6	5	0	0	0	0	0	0	23	2	21
30- 4	2.4	5	0	0	0	0	0	0	24	2	23
31- 5	2.5	5	1	13	7	7	0	7	31	2	24
30- 6	1.5	10	10	31	22	19	19	26	0	2	24
31- 7	1.3	17	17	0	19	18	30	0	0	0	29
31- 8	1	21	20	1	17	21	26	0	0	0	37
30- 9	1.4	16	17	2	12	10	11	8	8	2	41
31-10	3.3	18	8	3	1	1	0	10	17	3	18
30-11	3.8	11	0	0	0	0	0	0	22	3	22
31-12	3.2	5	0	0	0	0	0	0	23	3	22