FINAL REPORT

SNOWDRIFT ASSESSMENT
PROPOSED WASTEWATER LAGOON
ARCTIC BAY, NUNAVUT

Project Number: 08-1032A **April 14, 2008**

SUBMITTED TO: **Mr. Steven Burden**
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Project Manager: Godfrey Holder, B.Sc.
Project Director: Bill F. Waechter, C.E.T.

1. INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained by Trow Associates Inc. to conduct a snowdrift assessment for the proposed Wastewater Lagoon in Arctic Bay, Nunavut. The purpose of this assessment was to qualitatively review the potential for undue snowdrift activity at the proposed lagoon site and on its access road that could potentially have a significant affect on the lagoon's use and access. Where the potential for adverse snowdrifting conditions is anticipated, recommendations have been provided.

2. METHODOLOGY

The review focussed on the proposed wastewater lagoon layout and access road location with respect to prevailing winds, as these design aspects have the greatest impact on snowdrift conditions. An assessment of the local terrain was a critical part of the site review. RWDI has previous snowdrift control site experience in Arctic Bay. Hamlet representatives were also contacted in this assessment to discuss their experience with wind and snowdrift conditions in the vicinity of the existing sewage lagoon and along the access road.

The following information was used to conduct the reviews:

- Design drawings received by RWDI on January 15, 2008 (Refer to Appendix A);
- Google Earth™ information regarding the surroundings (i.e., 3D terrain model);
- An assessment of the prevailing winds in the Arctic Bay region;
- RWDI's previous experience with prior visits to Arctic Bay; and,
- Our engineering judgement.

3. WIND AND WEATHER ANALYSIS

The topography in this area of Baffin Island is relatively complex. Therefore, there are no data from a single weather station in this region that can provide an accurate picture of the prevailing winds expected at the proposed wastewater lagoon site. Image 1 shows the relative position of wind data sources in relation to the proposed lagoon site. There are three choices of wind data locations: Nanisivik Airport, which is located on an exposed plateau 16 km to the east-southeast of the lagoon site; an airport that was previously located in Arctic Bay (2 km west-southwest); and, finally the Community Airstrip (4 km south-southeast) on the road to the Nanisivik Airport.

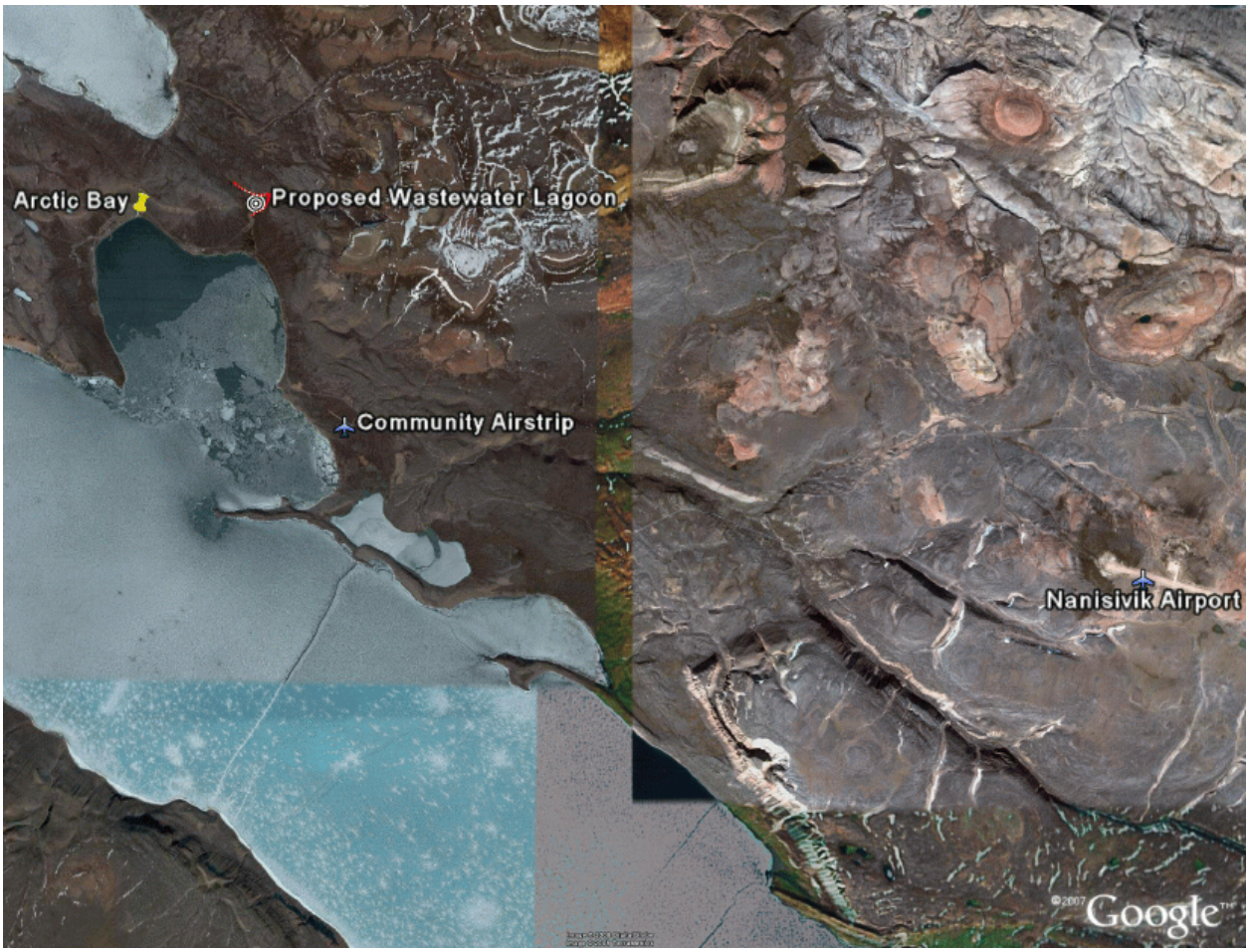


Image 1: Aerial Location Plan - Proposed Wastewater Lagoon and Surroundings
Photo Credit: Google Earth™

Wind data recorded at the Nanisivik Airport provides a good indication of the overall prevailing wind patterns in this region. The airport is located on a plateau (642 m elevation) that is well exposed in all directions and is away from any significant wind flow influences associated with

land form. Environment Canada wind data recorded at the Nanisivik Airport for the period of 1977 through 2002 were analysed to determine the wind directions that occur on an annual basis. These data are presented in Figure 1 and indicate that wind from the southeast direction occurs most frequently, at 13% of the time. Wind from the south-southeast and west are the next most frequently occurring directions, followed by northerly directions.

Historical wind data recorded at the Arctic Bay Airport (Figure 2) for the period of 1953 through 1976 by Environment Canada were analysed to determine the wind directions that would most often be associated with drifting snow. These data were recorded when an airstrip was located at the southwest edge of town (≈5 m elevation). The following meteorological conditions were assessed for the winter months (November through April):

- winds greater than 15 km/h;
- winds greater than 15 km/h with snowfall; and,
- blowing snow events.

The movement of drifting snow at low wind speeds is negligible. A threshold wind speed of 15 km/h was therefore used to determine the predominant winds that could be associated with snow movement on and around the study site. The 15 km/h wind speed is measured at the weather station's anemometer, which is typically located on a mast approximately 10m above the ground. Winter winds with blowing snow represent higher wind speeds often associated with storm events and significant drifting.

The first analysis of the winter winds greater than 15 km/h (see upper left wind rose in Figure 2) indicates that wind blowing from north, northwest and south sectors occurs most frequently. The second analysis considered winds greater than 15 km/ with snowfall (see upper right wind rose in Figure 2). From these data the south and west winds are most prevalent. The third analysis considered blowing snow events (see lower wind rose in Figure 2), which indicates that south, northwest and north winds are prevalent. It is likely, however, that the tall, steep hill that nearly surrounds the town influenced the data that were also based on a limited set of observations.

Wind data for the Community Airstrip, that exists along the road to Nanisivik, are based on a one-year monitoring program conducted by RWDI for the Government of Nunavut. The data (see Figure 3) indicate that wind from the east, east-southeast and northwest are most prevalent throughout the year. These data are not necessarily indicative of long term conditions; however, they are useful as a reference given the proximity to the proposed lagoon site.

As mentioned earlier, no single weather recording site has data that are directly applicable to the study site. However, collectively all the data indicate a trend of prevailing winds blowing from the southeast, east, northwest, and north. The local terrain around the proposed lagoon site will influence the relative importance of each of these directions in terms of snowdrift conditions. A Hamlet representative indicated that in his experience the northwest and southeast directions occur most often in the area, which agrees with the regional trend.

Environment Canada Normals (1971 to 2000) indicates an annual average snowfall of 173 cm for Nanisivik. Natural Resources Canada, Atlas of Canada (http://atlas.nrcan.gc.ca/site/english/index.html), reports a snowfall of 72cm for Arctic Bay. There is a significant difference between the two values, which in part would be attributed to the difference in elevation between the two locations. Precise snowfall data are not as critical as is understanding how the site and its surroundings can influence snow movement.

4. ASSESSMENT RESULTS AND RECOMMENDATIONS

For reference, the project drawings and information provided by Trow Associates Inc for use in this assessment are included in Appendix A. Two possible routes for the access road were presented in the reference material and both routes have been considered. The Public Works Supervisor (Joeli Qamanirq - SAO) for the Hamlet of Arctic Bay was contacted to discuss his experience with snowdrift conditions on the road between the Hamlet and the existing wastewater lagoon. Joeli indicated that snowdrifting is generally not an issue along the route to the existing wastewater lagoon, which includes a portion of the main road that heads to the Nanisivik Airport, and also the connecting side road to the existing wastewater lagoon.

The proposed wastewater lagoon is located approximately 700 m north-northwest of the existing lagoon. The lagoon site is located on a northeast facing hillside in a shallow depression (valley) that runs towards Victor Bay, an inlet situated 2 km to the northwest. It is our understanding that the ice surface in this inlet is relatively smooth, which would allow the wind to readily blow fallen snow towards the proposed lagoon site for northwest winds. Approximately 4 km to the southeast is King George V Mountain, which will alter wind flows approaching from southerly directions. The terrain in the immediate vicinity of the proposed wastewater lagoon is somewhat rolling, with intermittent steep slopes, drainage channels, etc. in the area. Details of the topography along the proposed access road are unknown. The first proposed routing of the access road considered in this assessment, from the existing lagoon to the proposed site, is approximated in Image 2.

Image 2: Proposed Access Road Between Existing and Proposed Lagoons
Photo Credit: Google Earth™

As the proposed access road is located in a hilly area, portions of the road will be positioned on the downwind and down slope side of a hill, or the road may be cut into a hillside. Snow will drift into the road cut (see Image 3), and where possible this construction method should be avoided. Ideally the road surface should be elevated above the immediate surroundings as high as practical, bearing in mind safety for truck drivers when roads are slippery or when visibility is limited due to weather. An elevated road surface would notably increase the granular fill requirements for the project

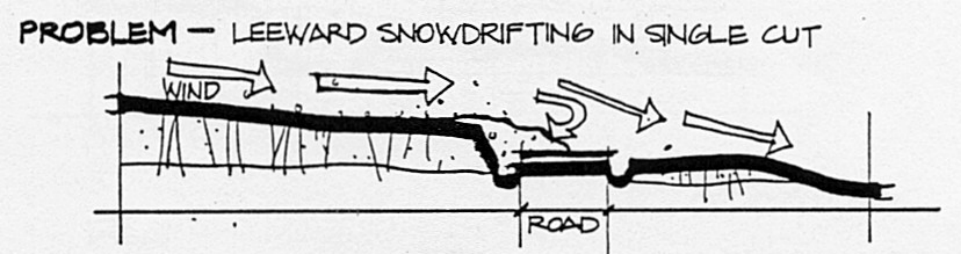


Image 3: Problematic Snowdrift Conditions for Road Cut Into Hillside

Images 4, 5 and 6 are views of the study area, using a Google Earth™ 3D terrain model, to illustrate areas of potential concern for the access road location. The low elevation views denote portions of the access road that are hidden from view for key wind directions. In a simplistic sense, nearby portions of the road that cannot be seen could potentially be wind sheltered by the terrain, and thus more prone to snowdrift formation. This use of the 3D model is not a comprehensive analysis of drift potential for the road, but instead it provides visuals to highlight the potential for snowdrift problems on the access road, as indicated in Image 3.

Referring to Image 2 for reference locations (i.e., lettered points), the section of road from 'A' to approximately 'D', is on the downwind side of a hill when considering northwesterly winds (hidden portion of road in Image 4). Similarly, the road section in the vicinity of 'D' through to the proposed lagoon site is located on a side slope that would be downwind for winds approaching from easterly directions (Image 5). For north winds (Image 6), the section of road from approximately 'D' to 'E' is obscured from view and could be drift prone. As the local terrain and exposure of the road surface to the wind will dictate the potential for snowdrifting on the proposed access road, we recommend that a field visit be undertaken to assess the proposed road location late this winter. RWDI should be included in this field visit along with key decision makers (civil, GNU, Hamlet) should there be a need to discuss mitigation (e.g., road re-alignment, tall snow fence, etc.).

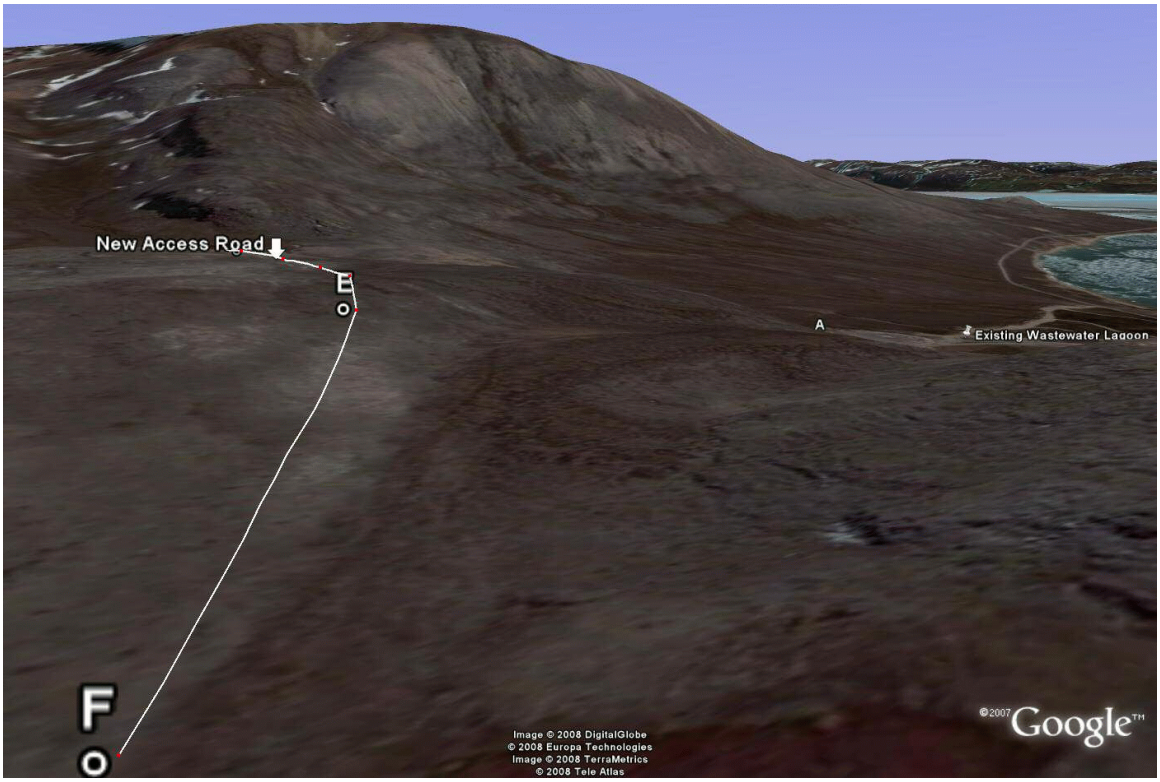


Image 4: Looking Southeast - For Northwest Winds the Potential Wind Sheltered Sections of Access Road are Hidden from View

Photo Credit: Google Earth™

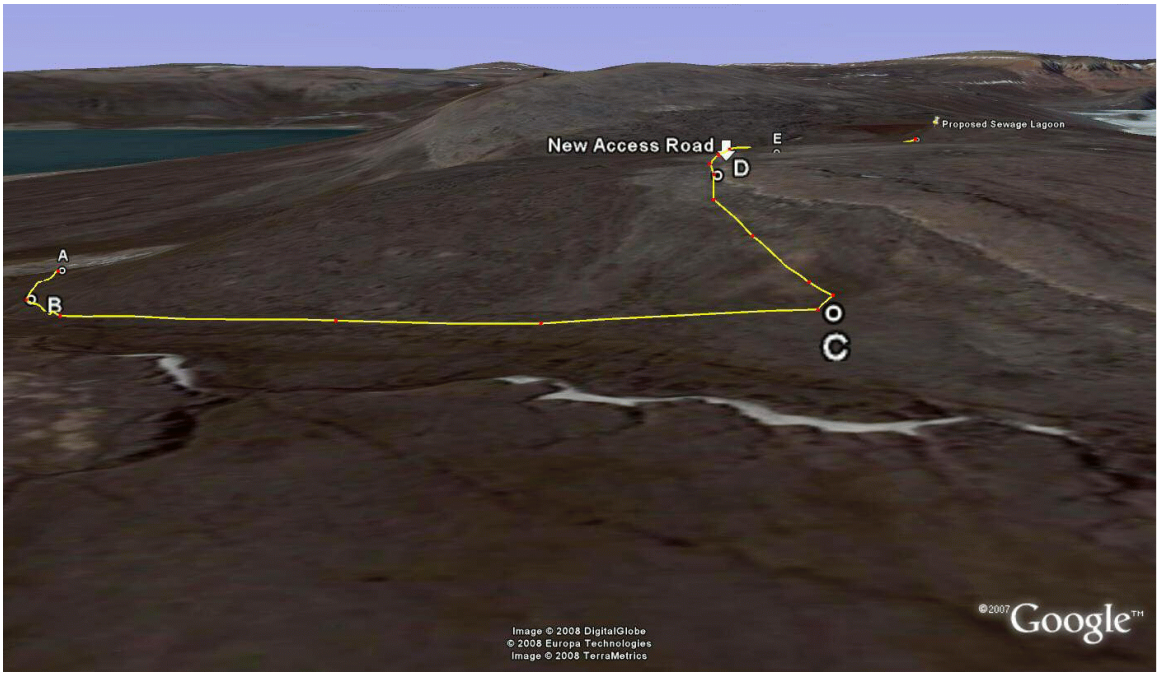


Image 5: Looking West - For East Winds the Potential Wind Sheltered Sections of Access Road are Hidden From View

Photo Credit: Google Earth™

Image 6: Looking South - For North Winds the Potential Wind Sheltered Sections of Access Road are Hidden From View *(Proposed Lagoon Site is to Right)*
Photo Credit: Google Earth™

A second route (Cross-Creek Route) for the access road was also considered in this assessment, where the initial southerly portion of the road, near the existing lagoon / landfill area, deviates from the other route by crossing over a creek, and then returns back over the creek, reconnecting to the common route. Image 7 approximates only the section of this route that differs from the first route assessed, and runs from Location A, across the creek through Location B1 and across the creek again to Location to B2, where it would join the common route through C, D, etc.

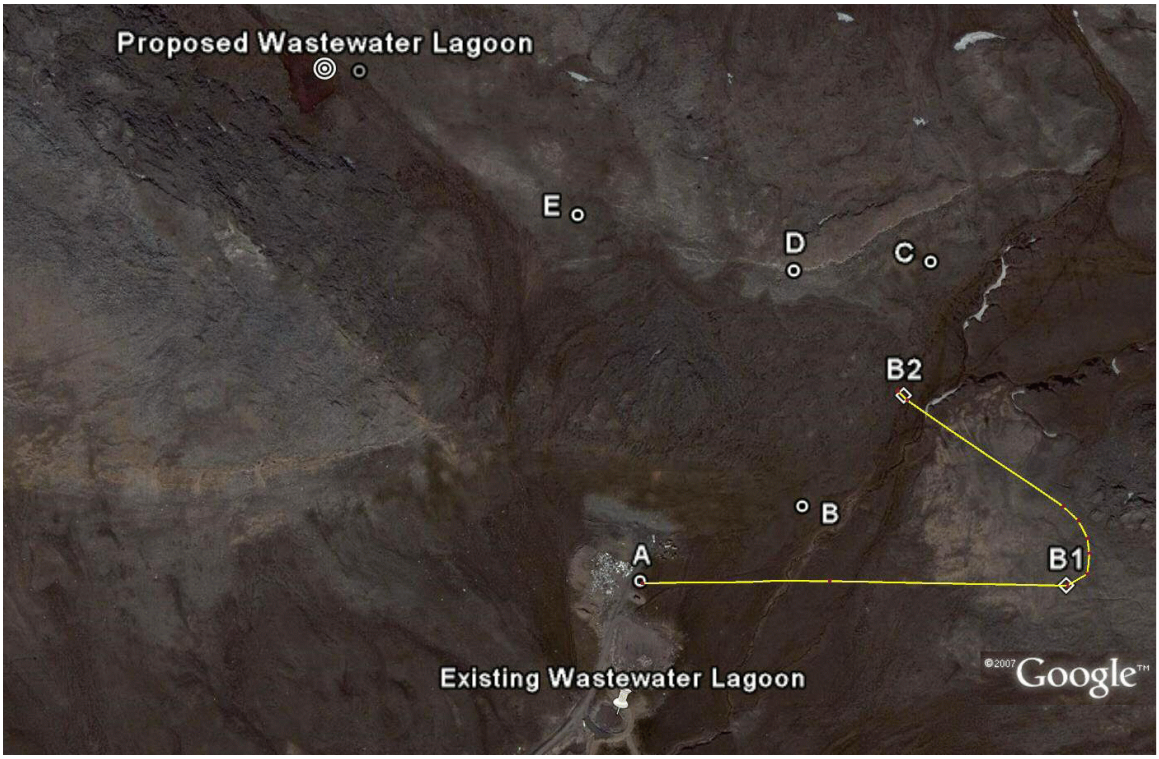


Image 7: Proposed Access Road (Cross-Creek Routing)
Southern Alternative Route (Locations A, B1, B2) Near Existing Lagoon
Photo Credit: Google Earth™

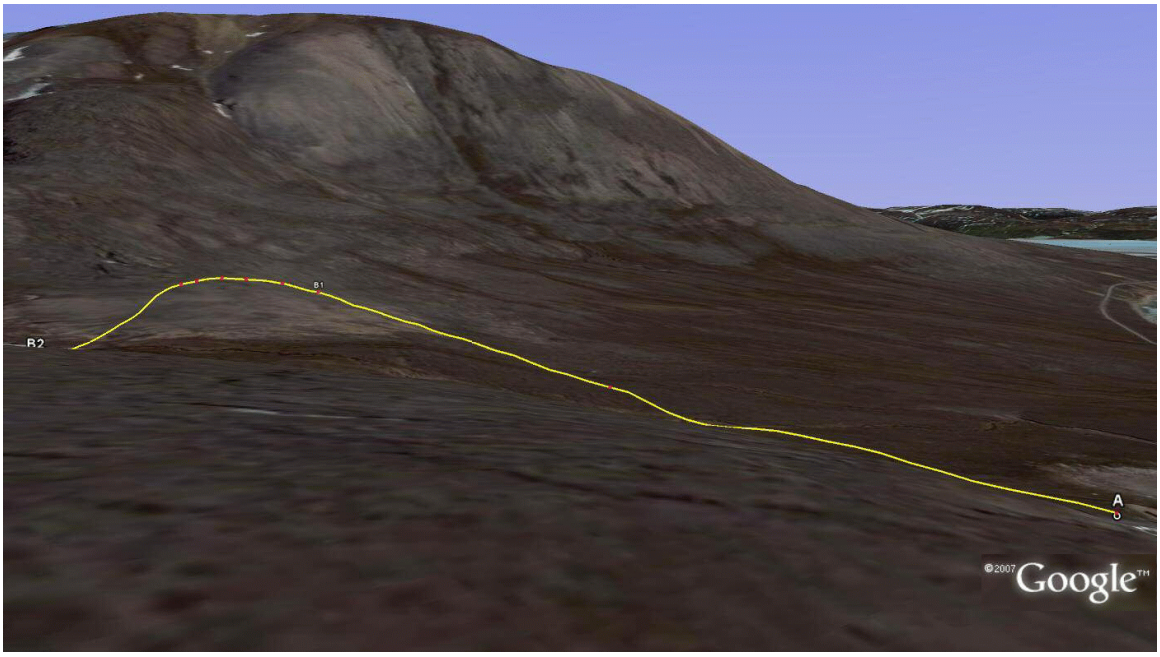


Image 8: Looking Southeast for Cross-Creek Routing - For Northwest Winds the Potential Wind Sheltered Sections of Access Road are Hidden From View
Photo Credit: Google Earth™

Images 8, 9 and 10 are views of the Cross-Creek routing, also using a Google Earth™ 3D terrain model, to illustrate areas of potential concern for this access road location. As described earlier, this visualization method is only an approximation to illustration portions of the road, which when hidden from view, would be wind sheltered and therefore potentially prone to drifting. In Images 8 and 9, most of the Cross-Creek route is visible (i.e., exposed to the wind), suggesting reduced potential for snow drifting on the road due to local terrain.

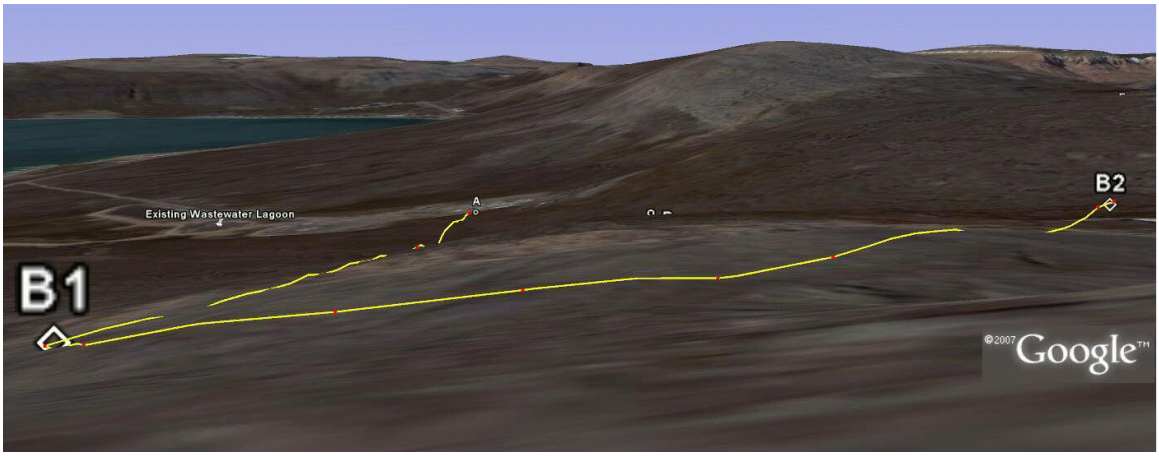


Image 9: Looking West for Cross-Creek Routing - For East Winds the Potential Wind Sheltered Sections of Access Road are Hidden From View
Photo Credit: Google Earth™

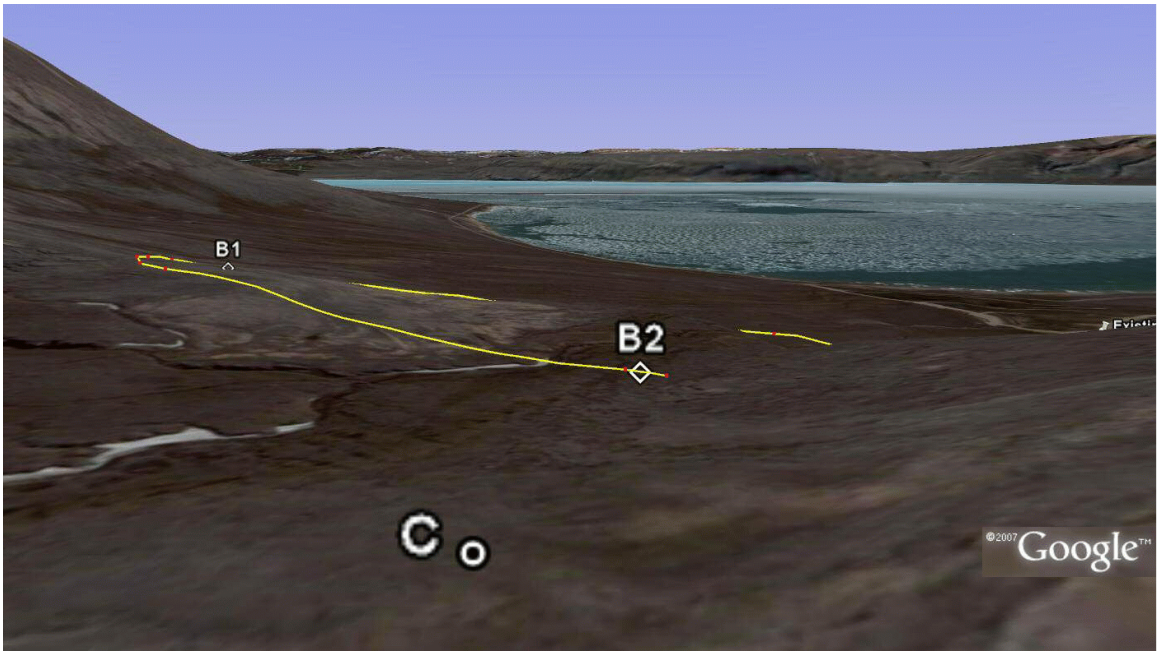


Image 10: Looking South for Cross-Creek Routing - For North Winds the Potential Wind Sheltered Sections of Access Road are Hidden From View

Photo Credit: Google Earth™

In Image 10, a majority of the Cross-Creek route that runs from the existing landfill area (Location A, which is hidden from view in Image 10), across the creek to Location B1 is hidden by local terrain for the north wind direction. This portion of the access road would be in a wind sheltered area, due to the local terrain, and therefore an increased potential for the terrain to cause snowdrifts on the road is predicted. Increasing the height of the road surface above that of the local terrain, as described earlier, can be considered to reduce the potential for significant drifting on the road.

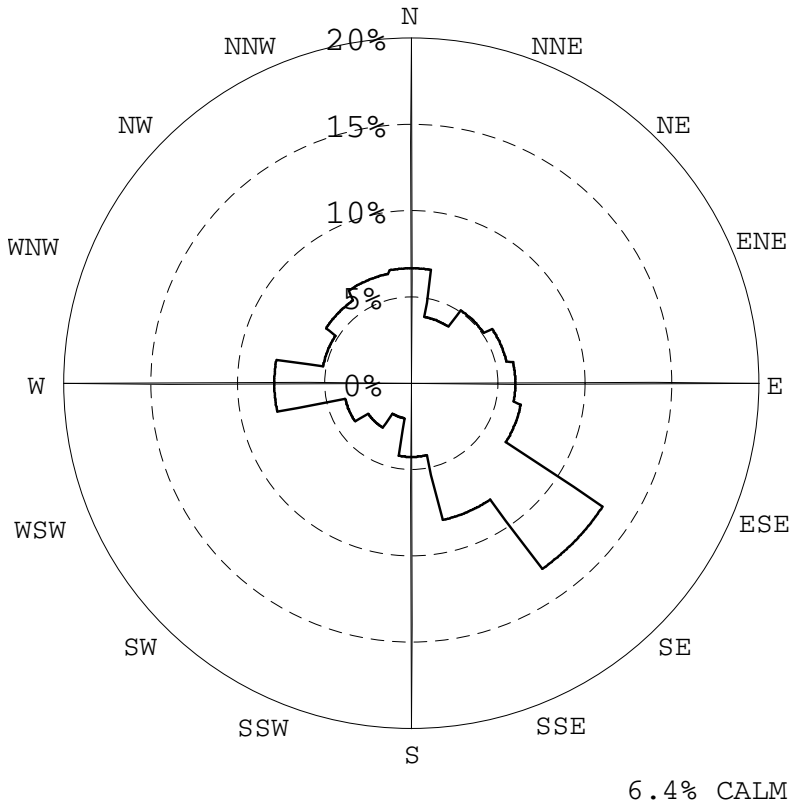
Through this approximation method of assessing the proposed access road routing, the Cross-Creek route appears to have better wind exposure, thus reduced snowdrift potential, and would be preferred over the routing on the west side of the creek. As recommended previously, a field assessment should be undertaken to assess the snowdrift potential for this route.

5. CONCLUSIONS

The proposed wastewater lagoon is located in an area where the existing snowdrift conditions are not well understood, as it is beyond existing developed area of the Hamlet's waste treatment facilities. The proposed lagoon design does not include details that are significantly different from other wastewater lagoons, thus snowdrift conditions influenced by the design would not be unusual at this site. The proposed access road will travel along hillsides and in potentially wind sheltered areas where snowdrifting could create access problems. The likelihood of drifting problems increase where the road is cut into a hill side.

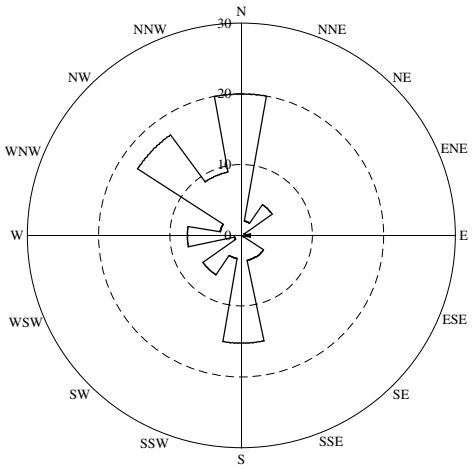
Overall, the Cross-Creek route of the southern portion of the access road appears better exposed to the wind, and therefore is expected to be less drift prone due to the local terrain. We recommend that the proposed route of all sections of the access road be assessed in the field during the latter part of this winter, to determine if it may be located in areas that are inherently drift prone due to the local terrain. During this field visit, mitigation measures, such as realignment of specific sections of the road, the use of a snow fence, etc. could also be discussed. The project's civil engineer and the Hamlet Foreman should be included in this routing assessment, along with a representative from RWDI.

FIGURES

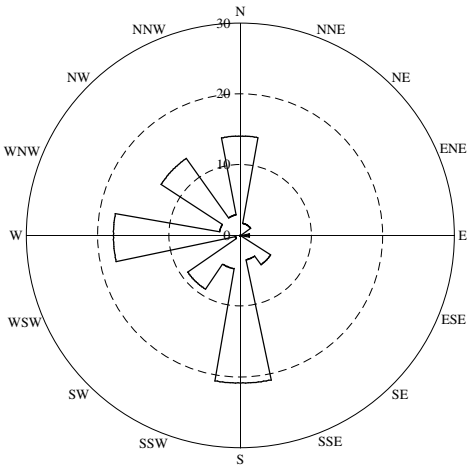


ANNUAL WINDS

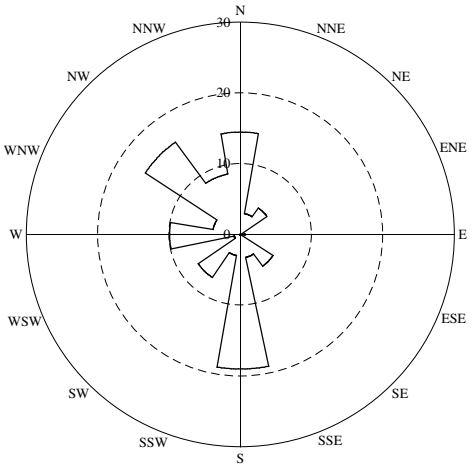
Directional Distribution (%) of Winds (Blowing From) **Nanisivik Airport, NU (1977 - 2002)**	Figure No. **1**	RWDI
Wastewater Lagoon - Arctic Bay, NU Project # 08-1032A	Date: Feb. 15, 2008	



Winter Winds > 15 km/h

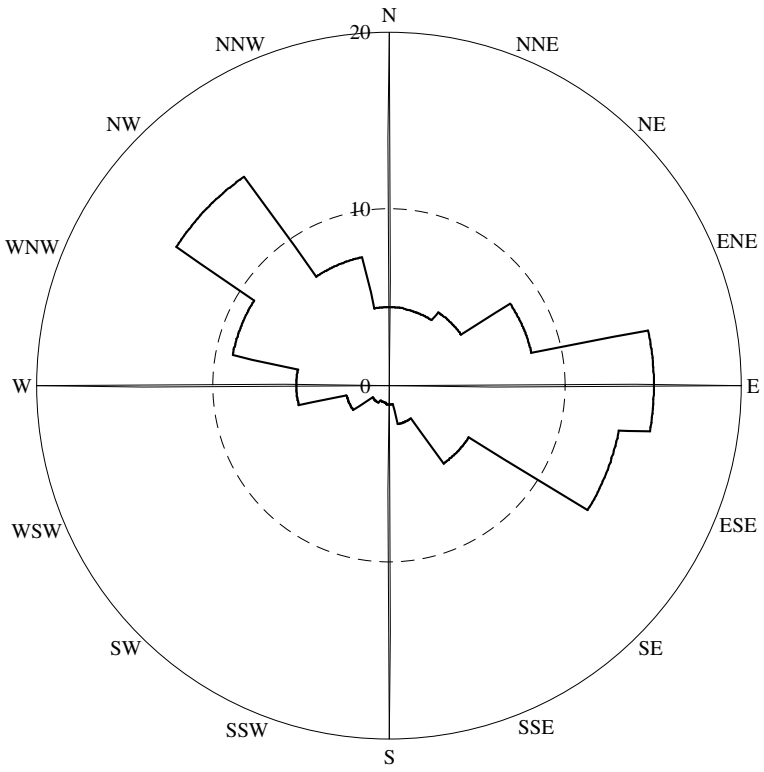


Winter Winds > 15 km/h with Snowfall



Blowing Snow Events

Directional Distribution of Winds Affecting Drifting Snow **Arctic Bay Airport, NU (1953 - 1976)**	Figure No. **2**	RWDI
Wastewater Lagoon - Arctic Bay, NU Project # 08-1023A	Date: Feb. 15, 2008	



(September 1997 to November 1998)

Directional Distribution of Annual Winds **Arctic Bay Aerodrome, NU (Sept. 1997 - Nov. 1998)**	Figure No. **3**	RWDI
Wastewater Lagoon - Arctic Bay, NU Project # 08-1023A	Date: Feb. 15, 2008	

APPENDIX A

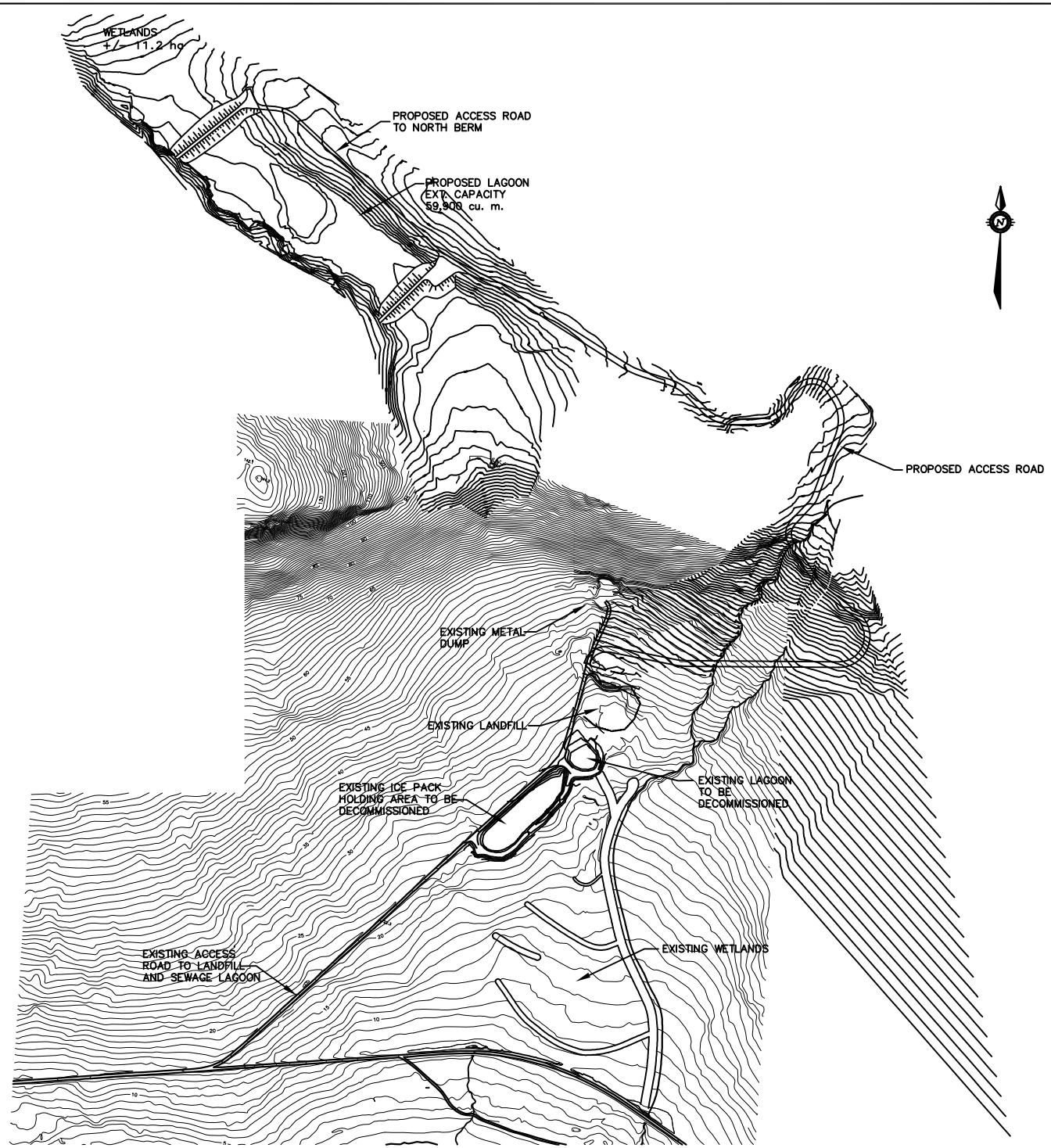
Trow Associates Inc.
154 Colonnade Road South, Ottawa, Ontario K2E 7J5
Tel: (613) 225-9940
Fax: (613) 225-7337

GOVERNMENT OF NUNAVUT

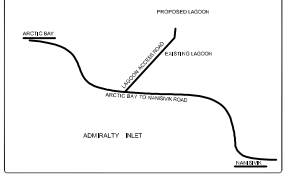
LOCATION PLAN - ARCTIC BAY SEWAGE LAGOON

DATE	SEPT 2007
SCALE	AS SHOWN
DESIGN	SAD
CHECKED	SAD
DRAWN	RG
JOB N°	OTCD00019054A

FIG 1



KEY PLAN



LEGEND

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREVIED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D

REVISIONS

HORIZONTAL

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9640
Fax:(613)225-7337

CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

ARCTIC BAY WASTEWATER LAGOON

TITLE

SITE PLAN

design by	SAD	project no.	OTC000190544
drawn by	MEB	drawing no.	SA-1
checked by	SLB		
date	15/01/2008		
scale	HORIZ 1:2500		

PROPOSED WETLANDS
AREA = ±11.2 ha

TRUCK DISCHARGE

105.0m

PROPOSED TOE OF BERM

30.0m

101.9m

4.0m

RAMP

PROPOSED TOP OF BERM

A

B

EXISTING POND
ELEVATION =96.7m

PROPOSED ACCESS ROAD TO NORTH BERM

326.0m

C

E

TRUCK DISCHARGE

PROPOSED TOE OF BERM

4.0m

30.0m

101.9m

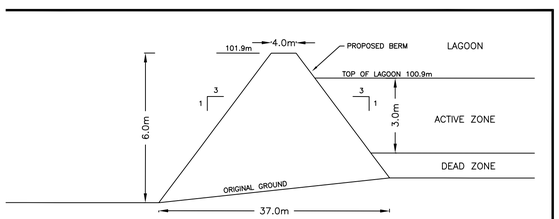
PROPOSED TOP OF BERM

93.0m

D

F

PROPOSED ACCESS ROAD TO LAGOON



PROFILE A–B
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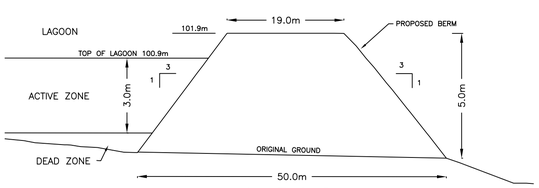

PROFILE C–D
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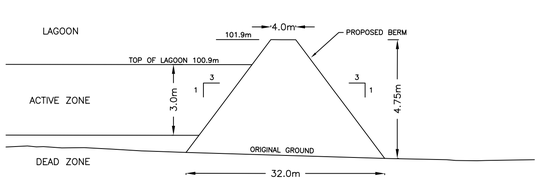
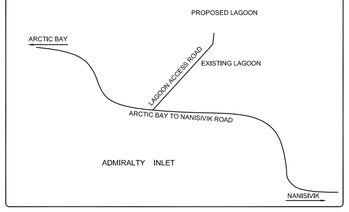


PROFILE E–F
SCALE HORZ 1:500 VERT 1:125

KEY PLAN



LEGEND

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D

REVISIONS

0 10m 20m 40m
HORIZONTAL 1:1000

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

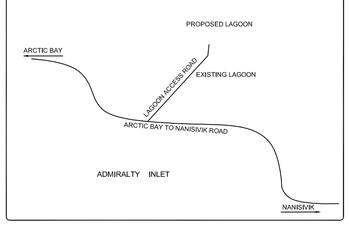
CLIENT
GOVERNMENT OF NUNAVUT

PROJECT
ARCTIC BAY WASTEWATER LAGOON

TITLE
PROPOSED LAGOON

design by	SAD	project no.	OTCD00019054A
drawn by	MEB	drawing no.	L–1
checked by	SLB		
date	15/01/2008		
scale	HORIZ 1:1000		

KEY PLAN



LEGEND

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DREIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D

R E V I S I O N S

0 10m 20m 40m

HORIZONTAL 1:1000

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CLIENT

GOVERNMENT OF NUNAVUT

PROJECT

ARCTIC BAY WASTEWATER LAGOON

TITLE

EXISTING SITE

design by	SAD	project no.	0TCD000190544
drawn by	MEB	drawing no.	ES-1
checked by	SLB		
date	15/01/2008		
scale	HORIZ 1:1000		