Trow

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Telephone: (613) 225-9940
Facsimile: (613) 225-7337
E-mail: ottawa@trow.com
Web Site: www.trow.com

Reference: OTCD00019055A

August 5, 2008

Mr. Bhabesh Roy, M.A.Sc., P.Eng.
Municipal Planning Engineer
Community Government Services
Baffin Region, Government of Nunavut
P.O. Box 379, Pond Inlet X0A 0S0

via facsimile:
(867) 899-7328

Response to Comments
Clyde River Sewage Lagoon, Nunavut

Dear Mr Roy:

We have received and reviewed the comments received from the regulatory agencies on the Clyde River Sewage Lagoon submission and offer the following.

Comments were received from the Department of the Environment, Indian and Northern Affairs Canada, and BGC Engineering Inc. The following tables summarize the comments and provide our corresponding response.

Comments from the Department of the Environment

	Comment	Response
1.	The DOE suggest the sampling frequency be once at the onset of decant, once during the decant period and once at the end of decant, totalling three sampling events.	Trow agrees with the benefit of the additional sampling and recommends the Government of Nunavut adopts a three sampling program.
2.	An Operation and Maintenance Manual related to the routine operation and maintenance procedures for the two sewage lagoons should be provided for review.	An outline of the Operation and Maintenance Manual structure with a description of what information will be provided in each section is attached. A complete Operation and Maintenance Manual will be provided prior to the commissioning of the system.

Comments from the Department of the Environment (Continued)

	Comment	Response
3.	Page 19 of the Design Brief – "*New Sewage and Rehabilitation of New Sewage Lagoon for the Hamlet of Clyde River*" states that the effluent quality will guide when the lagoon needs to be desludged. The DOE requests more information on the rate of sludge accumulation and frequency desludging be provided.	A calculation of the rate of sludge accumulation is attached.
4.	Page 19 of the report referenced above stated that the sludge has to be tested prior to disposal. However, it is unclear disposal standard proponent intends to comply with. DOE requests more information regarding standards to be provided.	Prior to discharge the sludge should be tested against any criteria from the solid waste facility. This will probably include hydrocarbons and heavy metals to determine if the disposal may cause leachate problems.
5.	Sludge is suggested to be disposed of in a separated cell at the municipal solid waste site. More information should be provided on sludge disposal procedures, how and when (time of year) will sludge removal occur, where will the community sewage go when the lagoons are being desludged, will 1 lagoon be desludged while the other is in operation. Details on logistics, practicalities and maintenance procedures are required.	One lagoon will be taken out of service after a complete decanting process has occurred. Normally this will be late summer or early fall. The second lagoon will be used during the desludging program as the primary sewage discharge point for the Hamlet.
6.	Page 15 of the Design Brief "*New Sewage and Rehabilitation of New Sewage Lagoon for the Hamlet of Clyde River*" indicated decant to start mid to late August and end around mid to late September. As proposed, the sewage treatment facility relies on wetlands treatment. DOE recommends the decant start no later than mid August as there may be limited plant growth and biological treatment available in late September.	Trow concurs with the recommendation and will amend operation schedule in the O&M manual.

Comments from Indian and Northern Affairs Canada

	Comment	Response
1.	The GN – CG&S should notify the Nunavut Water Board what activities and undertakings are proposed to allow rehabilitation of the Hamlet's existing sewage lagoon cell and construction of the new sewage lagoon cell. The submitted licence and amended application consists of a report, drawing and recommendations prepared by the consultant and retained by GN – CG&S. The GN – CG&S does not specify which recommendations of its consultants and staff would be implemented to upgrade the Hamlet's waste water treatment facility.	GN – CGS has accepted option 4 of the consultant's recommendations.
2.	The GN – CG&S should provide an Operations and Maintenance Plan specific to the Hamlet's waste water treatment and solid waste disposal facility. This is a requirement of Part F – Item 1 in the 3BM-CLY0308 licence.	An outline of the Operation and Maintenance Manual structure for the waste water treatment facility, with a description of what information will be provided in each section is attached. A complete Operation and Maintenance Manual will be provided prior to the commissioning of the system. The solid waste disposal facility is not included with this submission
3.	The GN – CG&S should provide a quality control plan for the collection and analysis of water quality samples.	Issues related to the water license are not included in this submission.
4.	The 3BM-CLY0308 licence will expire on September 15, 2008. The licencee should submit a licence renewal application as soon as possible.	GN – CGS has requested an amendment on behalf of the Hamlet, since this is a long process the GN request for a new license for a 4 year period.

Comments from BGC

Page	BGC Comment	Response
3	Moisture content of soil samples	We agree that the moisture contents are somewhat lower than would been expected. It is possible that some of the moisture may have been lost during transportation. This has been addressed in the revised Geotechnical Report.
3	Salinity of 20 PPT is likely conservative and is likely lower, in the order of 4 PPT.	Salinity measurements were not determined. However, in our opinion, this fact does not substantially affect the assessment of stability of slopes. BGC has also indicated that the salinity is expected to 4 ppt or less. Therefore, the soils at the site can be classified as of low to negligible salinity with minimal impact on freezing point.
3	No distinction between natural soils and fill material	Distinction has be made between the fill and natural soil on the boreholes logs for boreholes drilled in the existing berm and is included in the revised geotechnical report.
4	BGC expects subsurface soils to be saline.	This comment is inconsistent with BGC comment on Page 3. Regardless, it is of little importance because the design is based on conservative salinity values.
4	No description of surficial geology	Description of surficial geology has been provided in the geotechnical report.
4	No boreholes drilled west of existing lagoon	At the time of the geotechnical investigation, construction of the new lagoon on the south side of the existing lagoon was envisaged and boreholes were drilled accordingly. During the evolution of the design, the new lagoon was also extended west of the existing lagoon. This has been addressed in the revised geotechnical report.
4	Borehole logs provided little information considering limiting penetration depths	Limitation of the drilling equipment prevented deeper investigations. The choice of drilling method available in the community must be balanced against economics and quality of data. While an air track drill rig could likely drill deeper boreholes, the quality of geotechnical information is much lower than the drilling method employed for the investigation. In our opinion, the depth investigated is sufficient since the ice content in the soil generally decreases with depth and the depth investigated exceeds the depth to which undesirable soil conditions would be expected. This has been addressed in the revised geotechnical report.

Comments from BGC (Continued)

Page	BGC Comment	Response
5	Geotechnical design of the original lagoon facility	The Thurber report was made available to Trow as reference material. The Thurber investigation comprised excavating four test pits on the site to 0.7 m to 1.0 m depth, which was within the active layer at the time of the investigation. The only tests undertaken by Thurber were moisture contents. Slope stability analyses were not undertaken by Thurber. In our opinion, the Trow investigation and analyses has been much more detailed and comprehensive in comparison to the Thurber study. The Thurber report is included as an Appendix to the revised geotechnical report
6	Calculated active layer is about 0.5 m versus measured active layer of about 1.5 m.	BGC inferred the measured active layer by SPT penetration. This might not be reliable. Active layer in disturbed soils may be highly variable depending on moisture content (drier soils will "exhibit" deeper active layers). The consultants believes an active layer of 0.5 m is consistent with undisturbed terrain at this latitude. Clearly local variations should be expected.
6	Thermistor depth of 2 m below containment berm is too shallow.	Subsequent to the submission of the preliminary design and through consultation with the GN, the thermistor casings are designed to a depth of 5 metre below the containment berm. Nevertheless, if monitoring of the thermal performance of the containment berms indicates that thawing is shown to extend below the bottom of the monitoring thermistors, then new, deeper thermistor cables can be installed at a later date with no loss of information or data interpretation. Such an approach has been used successfully on other projects.
6	Cost of installing thermosyphons	The Consultants do not support the implied suggestion that it would be cheaper, and therefore preferred, to install thermosyphons as part of the initial construction. Unless performance monitoring indicates a need for this mitigation, which may not be required for 10 more years, if at all, it is recommended that thermosyphon installation be deferred until shown to be actually needed.

Comments from BGC (Continued)

Page	BGC Comment	Response
7	Use of permeable soils does not fully explain observed seepage; if so seepage should have been reported all around the perimeter of the existing facility.	We disagree with this comment since potential seepage of a berm is a function of the berm material and its degree of compaction. The berm would be more permeable in areas where the soil was not adequately compacted. However, we agree that increased solar radiant heating over the south facing downstream berm slope may also have contributed to the spatial variations in permafrost distribution. Any comments on seepage from the existing facility is speculative because the Consultants were not provided with construction records and related documents. This is address in the revised geotechnical report.
7	No geothermal analysis was performed for rehabilitation of the existing lagoon.	Whilst the BGC comments is correct, given the similarities in construction materials of the existing containment structure and the geothermal material properties assumed in the geotechnical modeling of the proposed structure, one could extrapolate the results of the geotechnical modeling for the proposed structure to the existing structure. For example, if new fill were to be placed over and adjacent to the existing berm, re-freezing of these materials could be expected to occur by the middle of the following winter, all else being equal.
8	Soil stability analyses used friction angle of 27° to 32° for the mineral soil and cohesion of 100 to 125 kPa for ice. More sensitivity analyses are necessary.	The inside and outside slopes of the berm were re-analysed assuming a crest width of 4 m and soil stratigraphy sloping parallel to the ground surface instead of being horizontal. The inside slope was analysed for completely submerged case and for completely submerged case with seismic loading. The outside slope was analysed for steady state seepage conditions. The results are presented in Figures 2 to 4. Factors of safety were compared to those presented in the report and the results have been summarized below. There is only a marginal decrease in the factor of safety assuming soil stratigraphy parallel to the ground surface instead of being horizontal.

Slope	Slope Inclination	Condition	Factor of Safety Horizontal Soil Stratigraphy	Factor of Safety Sloping Soil Stratigraphy
Inside	3.5H:1V	Completely submerged	2.42	2.31 (Fig. 2)
		Completed submerged with seismic loading	1.15	1.11 (Fig. 3)
Outside	2.75H:1V	Steady state seepage	1.59	1.58 (Fig. 4)

Comments from BGC (Continued)

Page	BGC Comment	Response
8	There is disconnect between the geotechnical and geothermal analyses	The disconnect between the geotechnical and geothermal analyses is intentional. The geotechnical (slope stability) analysis was based on unfrozen or weakened thawed soil. The unfrozen or thawed conditions are expected to be the worse conditions expected. The geothermal modeling has shown that the significant portions of the containment structure is frozen for long periods of the year, which would imply increased stability.
8	Representativeness of the foundation conditions of design cross section is highly questionable.	In our opinion, a conservative soil stratigraphy has been used in the stability analysis. The sensitivity of the stability analyses will be tested for the case where the top of the ice layer follows the slope of the ground surface.
8	Slope stability should consider thaw consolidation at the interface of the ice layer and overlying soil.	Thaw consolidation, as proposed by Morgenstern and Nixon (1971), representing a mechanism to induce excess pore water pressures and therefore negatively impact slope stability is not considered a viable mechanism in this case. The soils are assumed to be predominately fine sands or gravels or silty gravels. The corresponding coefficient of consolidation would be sufficiently high as to preclude the development of excess pore water pressures during the thawing process. Furthermore, the rate of thawing at depth is likely to be sufficiently slow to mitigate excess pore water development.

Comments from BGC (Continued)

Page	BGC Comment	Response
9	BGC notes that the assumed strength of the ice of 100 to 125 kPa may be appropriate for fresh water ice, but might not be appropriate for saline ice-rich soils.	BGC have perhaps, confused the discrete layer of ice with ice-rich mineral soils. It is expected that the discrete ice layer observed in the boreholes will be essentially low saline "freshwater" ice. Such thick ice layers likely freeze with low salinity as a result of salt extrusion during the freezing process. While the mineral soil may contain salts, the thicker ice layers may be of low salinity and therefore fresh water strength values for thick ice lenses may be justified.
9	BGC questions the derivation of the design peak ground acceleration.	The National Building Code specifies the peak ground acceleration for Clyde River as 0.33. Work by Makdisi and Seed (1978) suggests that for a 8.25 magnitude earthquake, the ratio of seismic coefficient to peak ground acceleration is approximately 0.5. Hence the seismic coefficient of 0.15 was used which is approximately 0.5 the value from the NBC.
9	Slope stability analyses did not consider results of geothermal analysis.	Since the slope stability analysis used unfrozen strength parameters, the results are valid for the unfrozen or thawed cases. The stability of the berms will likely be enhanced by being frozen. Using unfrozen strength parameters is considered conservative.
9	The design has not considered the impact of thaw settlement on the integrity of the liner material.	BGC is correct that quantitative estimates of thaw settlement have not been made. Thaw settlement poses what is considered to be a relatively low level risk to the integrity of the specified liner material, and monitoring plans have been developed that would help identify a loss of liner integrity. The design of the berm envisions that it will be constructed of unfrozen materials, placed and compacted in summer. Therefore, the berm structure itself may be considered to be thaw stable. While the subgrade soils may be subject to thaw settlement, the majority (in the order of two-thirds) of the subgrade laterally underlying the berm structure is expected to remain frozen. (See Figure 4-3 of the NCI report) Only the approximate lateral one-third of the berm structure under the upstream toe of the berm may be subject to thawing and thaw settlement. The thaw settlement within the upstream one-third of the berm will not be uniform as the settlement will be a function of thaw depth (assuming constant thaw strain), with the greatest thaw settlement occurring under the toe of the berm and progressively less thaw settlement occurring beneath

Comments from BGC (Continued)

Page	BGC Comment	Response
		the upstream interior of the berm. The vertical key for the liner is proposed to be located approximately 3 m into the berm from the toe; hence the thaw depth (and thaw settlement, all else being equal) at the key location is estimated to be about one-half that at the toe (See Figure 4-3 of the NCI report). At the vertical liner key, thaw settlement that may occur will be vertical. Therefore, any settlement at this location will induce compressive strains in the vertical liner key portion, which does not pose an integrity issue to the liner. Along the inclined section of the liner under the upstream berm face, some differential settlement of the subgrade may occur. As noted above this settlement will likely be differential in nature, with the greatest settlement near the vertical liner key, with progressively less settlement inward from the vertical liner key. While this settlement (if it occurs) may induce tensile strains in the inclined liner, the anticipated progressively reducing settlement amount means that the liner may be able to accommodate the strain without rupture. The movement of the liner is envisioned to be somewhat rotational or tilting in nature. The envisioned settlement scenario is in contrast to a much more severe but improbable scenario, where the settlement is not progressively reducing with distance from the toe, but rather is of a "step change" or "guillotine", where maximum differential settlement occurs over a very short distance. It is considered that this scenario does not fit the geothermal and geotechnical conditions of the proposed design and is of low risk to occur. Notwithstanding the potential for thaw settlement to occur at the upstream toe of the containment berm, the proposed design includes the provision for both temperature and seepage monitoring. In addition, it is envisioned that visual inspections of the containment structure will be conducted as part of good operational practice. If visual, thermal or seepage observations indicate changes in the performance of the containment structure the operators should contact the designers to make these observations known and to prepare an appropriate response.

Comments from BGC (Continued)

Page	BGC Comment	Response
9	Minimum berm crest width is 4 m, but the stability analysis considered a berm crest width of 5 m.	The design crest width of the berms is 4 m. The slope stability analysis presented in the geotechnical investigation report assumed a crest width of 5 m. This discrepancy is not expected to affect computation of the slope stability unless the critical failure plane encompasses the entire 4 m or 5 m of the crest width. In order to confirm this, the inside slope of the berm was re-analysed for the completely submerged case assuming a crest width of the berm of 4 m. The results are present in Figure 1 and indicate a factor of safety of 2.42. This value is the same as that computed for a 5 m wide berm in the geotechnical investigation report.
10	Rapid drawdown analysis	The rapid drawdown analysis was undertaken since originally unlined berms were proposed. With the installation of the liner, the berms would not be subjected to rapid drawdown condition. The issue has been addressed in the revised geotechnical report.
10	Settlement program is recommended	Trow agrees that a settlement monitoring program should be undertaken. Details will be included in the design report and/or drawings, as appropriate. The issue has been addressed in the revised geotechnical report

If you have any questions or require additional information please contact Steven Burden at (613) 225-9940 extension 257.

Yours truly,

Trow Associates Inc.

Stephen A. Douglas
Senior Designer
Infrastructure Division

Steven L. Burden, P.Eng.
Senior Project Manager
Infrastructure Division