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July 18, 2006

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Joe Murdock,
Coordinator of Technical Services
Nunavut Water Board,
Gjoa Haven, Nunavut

Subject: **Cape Dorset P – Lake Sewage Lagoon Water License Amendment. Response to Intervener**

Dear Mr. Murdock,

We provide this letter on behalf of the Hamlet of Cape Dorset. In response to your letter dated July 6, 2006, requesting for further information, not limited to treatment technologies, such as financial implication, Operation & maintenance aspect and other issues, regarding sewage treatment in the community, please find enclosed a report titled: *Sewage Treatment Alternatives for the Hamlet of Cape Dorset, Nunavut", dated August 2003.* As you will note page 26 of the report, under Table 5- Options and Criteria Analysis, the option of P lake lagoon was appraised to be the most favourable option.

As you may realize, in addition to the finding of the study report referred above, the decision of P Lake as the preferred option of sewage treatment for the community was based on the interest of the Hamlet of Cape Dorset and community in general and also experiences of GN in wastewater treatment in the various communities in Nunavut. Motion from the council of Hamlet of Cape Dorset and documentation of public consultation, identifying P Lake as the preferred option have already been provided to NWB through previous submission.

Trusting this meets your requirement, we thank you in advance for you co-operation on the issue.

Sincerely,

DILLON CONSULTING LIMITED

Gary Strong, P. Eng

Project Manager

CC: Art Stewart, Hamlet of Cape Dorset
Bhabesh Roy/Anjan Joshi, Dept of CGS, GN, Pond Inlet

Enclosed: Sewage Treatment Alternatives for the Hamlet of Cape Dorset, Nunavut
Dated August 2003 by Dillon Consulting Limited, Calgary

Government of Nunavut

Sewage Treatment Alternatives for the Hamlet of Cape Dorset, Nunavut

August 2003-08-08

Our File: 03-1943

Submitted by:

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Executive Summary

Dillon Consulting Limited (Dillon) was retained by the Department of Community Government and Transportation (CG&T), Government of Nunavut (GN) to help facilitate the decision making process for the selection of a long-term sewage treatment option for the Community of Cape Dorset.

To aid the GN in the decision making process, this report, entitled "Sewage Treatment Alternatives for the Hamlet of Cape Dorset Nunavut", has been prepared. The purpose of this report is primarily to integrate the body of knowledge gained to date with respect to the long term planning for sewage management in Cape Dorset into one cohesive document. Much work has been completed to date as part of the planning process; this report brings the work together into a decision making support document. More specifically, the GN has asked Dillon to compare the option of the "P Lake Lagoon" to the installation of a pre-engineered secondary level treatment plant at the existing lagoon site.

The need for a long term sewage management strategy for Cape Dorset stems from ongoing difficulties with berm integrity and volumetric storage capacity of the current lagoon structures. For the past several years, breaches to the berm structures have occurred each spring. In the most recent efforts to address this issue, work was completed in 2002 to repair and reinforce the existing berm structures, enable overflow of the lower two lagoon cells (installation of culverts), and redirect surface water flows away from the lagoons. Upgrades were not completely effective as one of the berms breached again in the spring of 2003. Even in the absence of issues related to berm integrity, the volumetric capacity of the current lagoons still remains an immediate issue. Current standards of practice for facultative lagoon systems in cold weather climates typically incorporate a lagoon storage capacity of at least one year. Current estimates suggest that the current lagoon system has a volumetric capacity of 30,000 m^3 equating to a retention time of approximately 190 days on an incorrect assumption that there are no other inflows (run-off and direct precipitation). With a projected average annual 2.4 % increase in population over a standard planning horizon of 20 years, capacity issues will perpetuate over time.

The current 3-cell lagoon is located approximately 1 kilometre southwest from the Hamlet boundary. It was constructed in the mid 1990's and is located within a natural valley with drainage to the Telik Inlet of the Arctic Ocean. The lagoon cells are constructed in a terraced formation with sewage flowing from one cell to the next. Although designed to exfiltrate, culverts have since been installed within the upper portion of each berm to accommodate overflow conditions and reduce the risk of berm failure. At the current time, the rate of inflow to the lagoon system (sewage and natural run-off) exceeds the rate of exfiltration. Due to the location of the lagoon system, natural run-off further exasperates the issue of volumetric capacity required for the purposes of sewage treatment.

Prior to the construction of the current 3-cell lagoon system, a single cell lagoon located approximately 600 m south west from the community was used for the treatment of sewage. Discharge from this lagoon is also to the Arctic Ocean. Different to that of the 3-cell lagoon the physical barrier of a land tidal bridge does not exist between the discharge point of the old lagoon and the community. The former sewage lagoon has a smaller capacity than that of the 3-

cell lagoon. Available information suggests that expansion of this lagoon is not likely possible nor feasible given its relatively close proximity to the community.

The berm failures and the winter overflows from the 3-cell lagoon were recurring problems which permitted raw sewage to enter Telik Inlet with little prior retention time. The Hamlet was forced on a number of occasions to revert to using the old single cell lagoon which suffered from the same problem. In 2001 the Hamlet made application for a water licence from the Nunavut Water Board. The water licence (#NWB3CAPO207) was granted in September 2002. The water licence sets out criteria for the performance of the 3-cell lagoon.

In March 2002 Environment Canada (EC) issued an Inspector's Directive under the Fisheries Act that identified the release of untreated sewage into Telik Inlet as "*a serious and imminent danger*" to waters frequented by fish. The directive further identified raw sewage as "a deleterious substance". In August 2002 the GN responded to the directive and advised Environment Canada that repairs to the lagoons were being undertaken, that the capacity shortfall with the 3-cell lagoon would remain, and that a decision had been made to implement a mechanical treatment plant. The plant was to be operational by early 2004, however this timeframe is no longer realistic. Therefore, one of the keys issues facing the GN is the need to comply with the EC directive and at the same time implement a long term treatment solution.

In the year 2001 planning studies were first initiated to address issues related to the 3-cell lagoon by reviewing potentially viable options for the long-term management of sewage. At the time considerations included the expansion of the existing 3-cell lagoon, new lagoon sites, primary physical treatment with deep water or shoreline discharge, and pre-engineered secondary level biological treatment plants. The results of this work identified the construction of a new sewage lagoon in an area east of the community previously used for granular resource extraction as potentially the most cost effective alternative (referred to as Site R). The next most cost effective approach was to construct a primary level treatment plant (macerator) with deep water discharge at the existing 3-cell lagoon site. Although identified, these planning studies did not assess other considerations that could influence the selection by the GN of the preferred solution.

Subsequent to the completion of the 2001 report, Site R was determined by GN and the community as no longer feasible on the basis that the proximity to the airport runway would cause an increased bird strike hazard and as such may not meet regulatory approval. Direction was also given from the GN that installation of a macerator with deep water discharge was no longer considered a feasible option on the basis of recent negative experience with the implementation of this technology in the Community of Rankin Inlet, Nunavut.

Also identified subsequent to the 2001 studies were two other potential lagoon sites not originally considered in the 2001 reports. These lagoon sites were identified as Sites P and Q and were later dismissed from further consideration:

- Site P is a small lake and is located south of the community at the top of a steep rock face. Given its location, Site P was considered at the time as too capital cost intensive to be considered further.

- Site Q is a small lake south east from the community. While this option was under consideration, the community was forced to use the lake as an emergency back-up potable water source. For this reason, the community stated that the Q Lake site was not an alternative for consideration.

Facultative lagoon systems have been widely used throughout the Northwest Territories and Nunavut for the treatment of municipal sewage waste. These systems generally have the advantage of being a proven technology that is able to meet current regulatory expectations, has limited operation and maintenance costs, and is relatively simple to operate. That being said, local topography often plays a deciding role in the ability to site a lagoon system in some communities. Cape Dorset is one of these communities that the local topography provides a challenge to site a lagoon.

Given lagoon sighting difficulties, the GN and the Community came to the consensus in July 2002 that a pre-engineered secondary level treatment plant installed at the existing site would replace the current 3-cell lagoon facility as the preferred strategy for long-term sewage management. To that end, equipment pre-selection and engineering design activities commenced in the Spring 2003 after a Design Concept Brief was prepared and submitted to appropriate regulatory authorities and other project stakeholders for information. In submitting the Design Concept Brief, the GN committed to installation of a mechanical plant at the existing lagoon site with the plant to be operational by early 2004.

The community of Pangnirtung is in a situation similar to that of Cape Dorset in that a pre-engineered secondary level sewage treatment plant was recently selected by GN as the long term sewage management strategy. Originally scheduled for commissioning in the spring of 2003, recent delays have negatively impacted the schedule. The plant is now expected to be fully operational at some time during the summer of 2003.

Through the course of constructing the sewage treatment plant in Pangnirtung and planning for the construction of an equivalent system in Cape Dorset, the GN decided it appropriate to revisit the original decision not to construct a lagoon at P Lake on the basis of cost. This re-evaluation was prompted by concerns with the pre-engineered treatment systems over escalating estimates for Operation and Maintenance costs, a gained understanding of operator training and community capacity requirements, and the limited acceptance by the community of a new technology. Direct cost comparisons of the P Lake Lagoon Option and a Sequencing Batch Reactor (SBR) mechanical treatment plant were first completed in May 2003.

Capital and operating and maintenance costs were refined for this report. Compared to the original cost estimates in May 2003, the most significant cost adjustments for this report are as follows:

- Mechanical Plant capital cost increased by 17%
- Mechanical Plant O + M cost increased by 73%
- Lagoon capital cost increased by 12%

Refinements were made through the incorporation of most recent site data, further discussions with equipment suppliers, and a review of relevant and readily available literature.

In order to consider the total cost in current day dollars, a net present value/life cycle cost analysis was completed assuming a twenty year time period. The life cycle analysis was completed over a range of discount rates to account for the uncertainty in predicting future rates.

Option	Capital Cost	O + M Cost	2% Discount	4% Discount	8% Discount
Mechanical Plant (SBR)	$5,600,000	$260,000	$9,700,000	$9,000,000	$8,000,000
P - Lake Lagoon	$6,900,000	$40,000	$7,500,000	$7,400,000	$7,300,000

The analysis suggests, based on current assumptions, that the P-Lake lagoon option has a lower life cycle cost compared to the Mechanical Treatment Plant option.

As a decision making document, the purpose of this report is to not only provide updated cost estimates, but to introduce some of the other potentially influencing factors that GN may want to consider. Examples of these potential considerations include cost uncertainty, regulatory environment, process uncertainty, and community acceptance. The GN may determine that there are additional factors that should also be considered.

In order for the GN to make an informed decision in selecting a preferred long-term solution for sewage management specific to the situation in Cape Dorset, a weight-of-evidence approach is recommended. To assist in this regard, a matrix has been developed that allows the weighting of the various considerations based on GN priority. The weightings are split between the two options on a proportional basis. Both objective and subjective approaches are used in determining the points split, as shown in the matrix table. A comparison of Total Score identifies a preferred solution using this approach and based on the assumptions made in assigning weights and scores.

Criteria	Potential Points	Mechanical Plant	P Lake Lagoon
O + M Costs	25	3	22
O + M Uncertainty	15	4	11
Capital Cost	20	11	9
Capital Cost Uncertainty	10	8	2
Regulatory Environment	10	8	2
Process Uncertainty	10	2	8
Community Acceptance	10	7	3
TOTAL	**100**	**43**	**57**

For the purpose of this report, Dillon has established inputs into a weight of evidence approach that is representative of our perspective and best understanding of the key issues. Input is required from the GN to refine weightings, scores, and the list of considerations/factors most reflective of current and/or anticipated government policy, priorities, perception, and understanding of the specific situation in the community of Cape Dorset.

Using this weight of evidence approach with the considerations, weights, and relative quantitative and qualitative scores, the P Lake Lagoon is shown to result in a higher total score. Operation and Maintenance Cost considerations were shown to have the greatest influence on the outcome and reflects GN concerns over long-term fiscal commitments required as part of the installation of a mechanical treatment plant. Other considerations favour the installation of a mechanical treatment plant, however, higher relative scores were outweighed by those points awarded from Operation and Maintenance costs.

As stated previously, the scope of this report is to specifically compare the options of the P Lake Lagoon to a pre-engineered sewage treatment plant located at the current lagoon site. Accordingly, analysis of these two options was completed in such a manner to assist the GN in the selection of a long-term sewage management solution. In considering its options, the GN is reminded of other alternatives that were rejected in the absence of this formal approach. For example, it would appear that lagoon Site Q was rejected primarily on the basis of community acceptance in the absence of cost considerations. Should Site Q in fact be technically feasible, integration of this option into the matrix table would likely result in a higher score than the P-Lake Lagoon option.

Should the P-Lake Lagoon remain the preferred option after refinement of the presented matrix based on GN input, a baseline data collection program should be completed during the summer/fall of 2003 field data to further characterize field conditions along the road right-of-way and proposed P-Lake Lagoon site. Field data needed to be collected includes, but is not limited to topography, lake bathymetry, soils/surface geology, hydrology, and fish habitat. The scope of the data collection program should be supportive of confirming technical feasibility and infrastructure design.

Should the GN conclude however that the P-Lake Lagoon or other lagoon options are not feasible and/or preferred further consideration of alternate mechanical treatment plant technologies may be warranted for the specific purpose of looking at potential reductions in Operating and Maintenance Costs. The installation of an SBR provides an opportunity for direct comparison to the Rotating Biological Contactor (RBC) based technology recently constructed in Pangnirtung. However, preliminary estimates suggest that an SBR will have approximately 30% to 50% higher power consumption rates than a comparable RBC based system, and therefore an RBC presents an opportunity for significant savings over the long term.

On the assumption that collected field data supports implementation of the P-Lake Lagoon option, the following schedule is proposed:

- Site Investigations — by October 2003
- Regulatory Approvals — by February 2004
- Design – Tender – Award — by May 2004
- Road and Lagoon Construction — 2004/2005

The proposed schedule reflects the reality that the access road to the P-Lake site is a major civil works undertaking for a community the size of Cape Dorset. In the interim period before the new lagoon system is commissioned, GN will need to continue to operate and maintain the existing 3-cell lagoon. Existing issues related to capacity and berm integrity will need to be managed to the extent reasonable. With approximately 2 years required to construct a new sewage lagoon at P-Lake, regulatory issues associated with the existing system are likely to remain a challenge for the GN.

1.0 Introduction

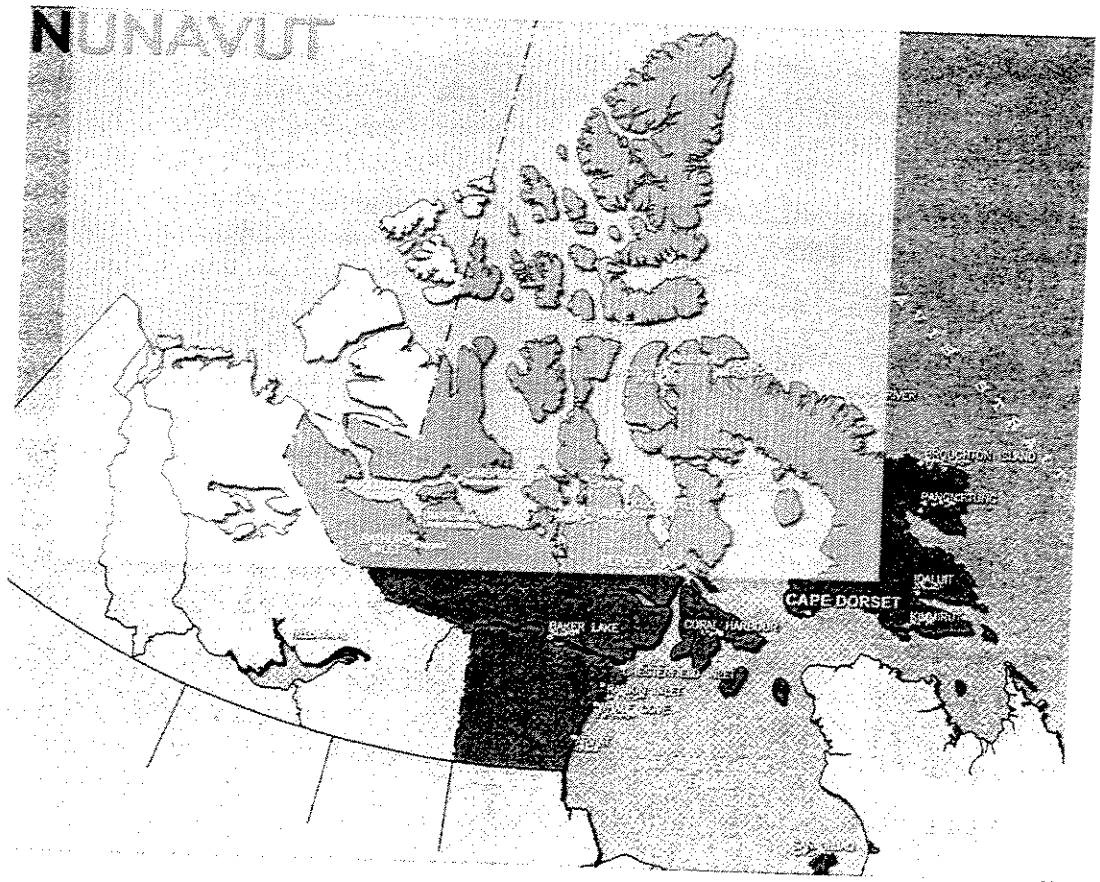
1.1 Purpose

Dillon Consulting Limited (Dillon) has been retained by the Government of Nunavut (GN) to evaluate and report on sewage treatment alternatives for the Hamlet of Cape Dorset, Nunavut. Previous studies have evaluated several sewage treatment options. By the spring 2003 two options were remaining under consideration, these being a facultative lagoon (at the P-Lake site) and a mechanical treatment plant (at the existing lagoon site). This purpose of this report is to further evaluate these options to assist the GN in the selection of a long-term sewage management plan.

1.2 Background

Cape Dorset is situated on the Foxe Peninsula on the west side of Baffin Island, as shown in Figure No. 1. The current population of the community is approximately 1300 people. Sewage originates primarily from domestic and institutional sources, as opposed to commercial or industrial sources. The sewage is collected in building holding tanks and trucked to lagoons on the outskirts of the Hamlet.

Figure 1 Community Location



Sewage is disposed of in a 3-cell sewage lagoon system which was constructed in the mid 1990's. Prior to the mid 1990's sewage was disposed of in a single cell lagoon at a distance closer to the Hamlet. The 3-cell lagoon system is constructed in a natural valley. Construction of a lagoon in a steep valley is not normal practice and highlights the difficulty of finding a suitable lagoon site in the hilly terrain around Cape Dorset.

The lagoons are constructed in a terraced formation, with sewage flowing from one cell to the next. Discharge from the final cell is to Telik Inlet on the Arctic Ocean. Telik Inlet is separated from the Hamlet by a tidal land bridge, and this outfall location is preferred over other locations closer to the community. Telik Inlet is considered a fish-bearing body of water (Environment Canada, 25 March 2002).

Given its location, the 3-cell lagoon system receives a significant volume of natural run-off in addition to sewage inputs. High spring run-off volumes/rates have on several occasions precipitated breaches in the berms of the lagoon structures. Overflows of the lagoon system as well as structural breaches contributed to the initiation of regulatory action by Environment Canada in the year 2002.

In 2001 the Hamlet made application for a water licence from the Nunavut Water Board. Water Licence NWB3CAPO207 was granted in September 2002. An amendment to the water licence will be required in the event a new sewage treatment facility is adopted.

In 2001 Dillon prepared an options report for the GN which considered four sewage treatment alternatives: expansion of the existing lagoon, a new lagoon near the airport, a macerator and deep water discharge, and a mechanical treatment plant. The options report identified the new sewage lagoon near the airport as the lowest cost option. Although identified, this report did not assess other considerations that could influence the selection by GN of the preferred solution.

Subsequent to completion of the 2001 report, and through further meetings with community representatives a decision was ultimately made by the GN to select a pre-engineered mechanical treatment plant at the 3-cell lagoon site as the preferred long term sewage management solution for Cape Dorset. Accordingly, detailed design commenced in early 2003, and quotations were received from package plant suppliers in April 2003.

More recently, the GN raised concerns over potential operating costs of a mechanical plant and as such requested that Dillon re-evaluate the P-Lake lagoon and compare it to a mechanical plant. This request led to the current study, in which the previous assumptions have been reviewed and the evaluation refined.

1.3 Scope of Work

The Terms of Reference for this work are in Appendix A. The key tasks completed as part of this work are as summarized follows:

- Project future population and sewage volumes,
- Describe the Mechanical Treatment Plant Option,
- Describe the P Lake Sewage Lagoon Option,
- Compare capital, operating, and life cycle costs for the two primary options,
- Identify considerations other than costs that may influence decision making,
- Provide appropriate recommendations to the GN to support the selection of a long-term sewage management option.

2.0 Sewage Generation

2.1 General

The estimated current and future sewage loadings were determined based on population projections and sewage characteristics typical of truck haul systems. The detailed calculations and design assumptions are included in Appendix B. The purpose of this section is to briefly summarize the design assumptions.

2.2 Design Assumptions

The selected design horizon for planning purposes is twenty years (2004 – 2024). A 20 year planning period is considered reasonable and is typical for most studies. Population projections up to the year 2020 were obtained from the GN Bureau of Statistics, and these were extended to 2024 assuming linear extrapolation. The resulting population at the end of the design horizon is 2012 people, as shown in Table 1.

It is assumed that the sewage generated is equal to the water consumption. Water consumption was estimated using the Municipal and Community Affairs (MACA) standard rate for communities of less than 2000 residents. The resulting daily sewage volume ranges from 156 m^3/day in the year 2004 to 265 m^3/day in the year 2024. The daily sewage volume was multiplied by 365 days/year to estimate the annual sewage volume.

In lieu of any site specific data on sewage strength or other characteristics, organic mass and suspended solids mass were estimated based on typical loading criteria. The resulting BOD_5 and TSS rates are shown in Table 1.

Table 1 Population and Sewage Generation Summary

	2004	2024
Population	1327	2012
Daily Sewage – Avg. (m^3)	156	265
Annual Sewage (m^3)	56,897	96,725
Average Day BOD_5 (kg)	98	149
Average Day TSS (kg)	147	223

3.0 Background

3.1 Existing 3- Cell Lagoon

A new 3-cell sewage lagoon system was constructed in the mid 1990's in a natural valley located approximately 1 km from the Hamlet boundary. The area plan and the existing lagoon site are shown in Figures No. 2 and 3.

The lagoon berms are constructed mainly of fine-grained material from local sources. It is understood that the berms were originally designed so that sewage would ex-filtrate (seep) through the lower berm of Cell #1 and then flow overland approximately 150 m to the remaining two cells. The combination of filtration through the berms, overland flow, and retention time was designed to provide a measure of sewage treatment including pathogen reduction. Despite berm failures, effluent sampling undertaken in September 2000 downstream of Cell #3 indicated that the effluent was within regulated limits under the Water License. It is not expected that this would be the case at all times throughout the year.

The above description is applicable in the summer only, since the berms likely freeze throughout in winter and seepage is minimal. No overflow structures were incorporated as part of the original design, however culverts have since been added.

Deficiencies and Repairs

The existing lagoon system suffer from inadequate capacity, flooding during spring runoff, and breaches to containment berms. In the late winter of 2003 the Hamlet reverted to using the old single cell lagoon when sewage began to overtop the containment berms of the 3-cell lagoon. After returning to the 3-cell lagoon for a short period of time, the Hamlet again reverted to using the old single cell lagoon in the summer of 2003 due to a berm breach in Cell #3. The old single cell lagoon is undersized and the Hamlet does not currently have a permit from the Water Board for this site.

In 2001 Dillon estimated the combined capacity of the 3 cells at approximately 22,000 m3. Major repairs were undertaken by the GN in 2002, including installation of overflow culverts in the lower cells and modification to berm heights. The impact of these changes on the total lagoon capacity is unknown at present. Recent discussions with GN personnel indicate the total storage capacity may now be as high as 30,000 m3 (personal communication, Sameh Elsayed). This is still well below the current year requirement for an annual lagoon of approximately 57,000 m^3. In April 2003 Dillon completed a partial survey of the lagoon cells. The cells were ice covered at the time and it was too dangerous to work in many areas. However, the survey data that was obtained generally confirmed the volume calculations in the 2001 report.