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July 18, 2006

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

Dillon Consulting Limited

Government of Nunavut

Sewage Treatment Alternatives for the Hamlet of Cape Dorset, Nunavut

August 2003-08-08

Our File: 03-1943

Submitted by:

Dillon Consulting Limited
#2450, 101 – 6th Avenue SW
Calgary, Alberta T2P 3P4

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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

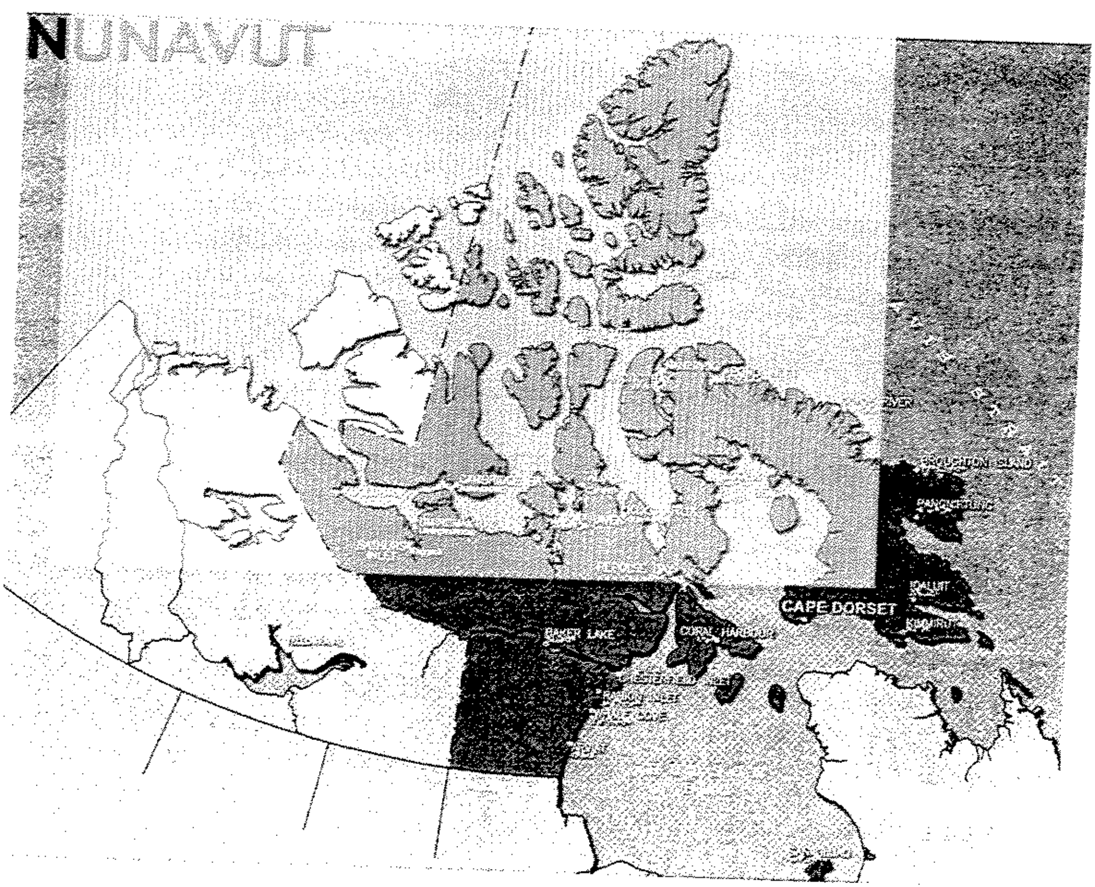
1.1 Purpose

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.

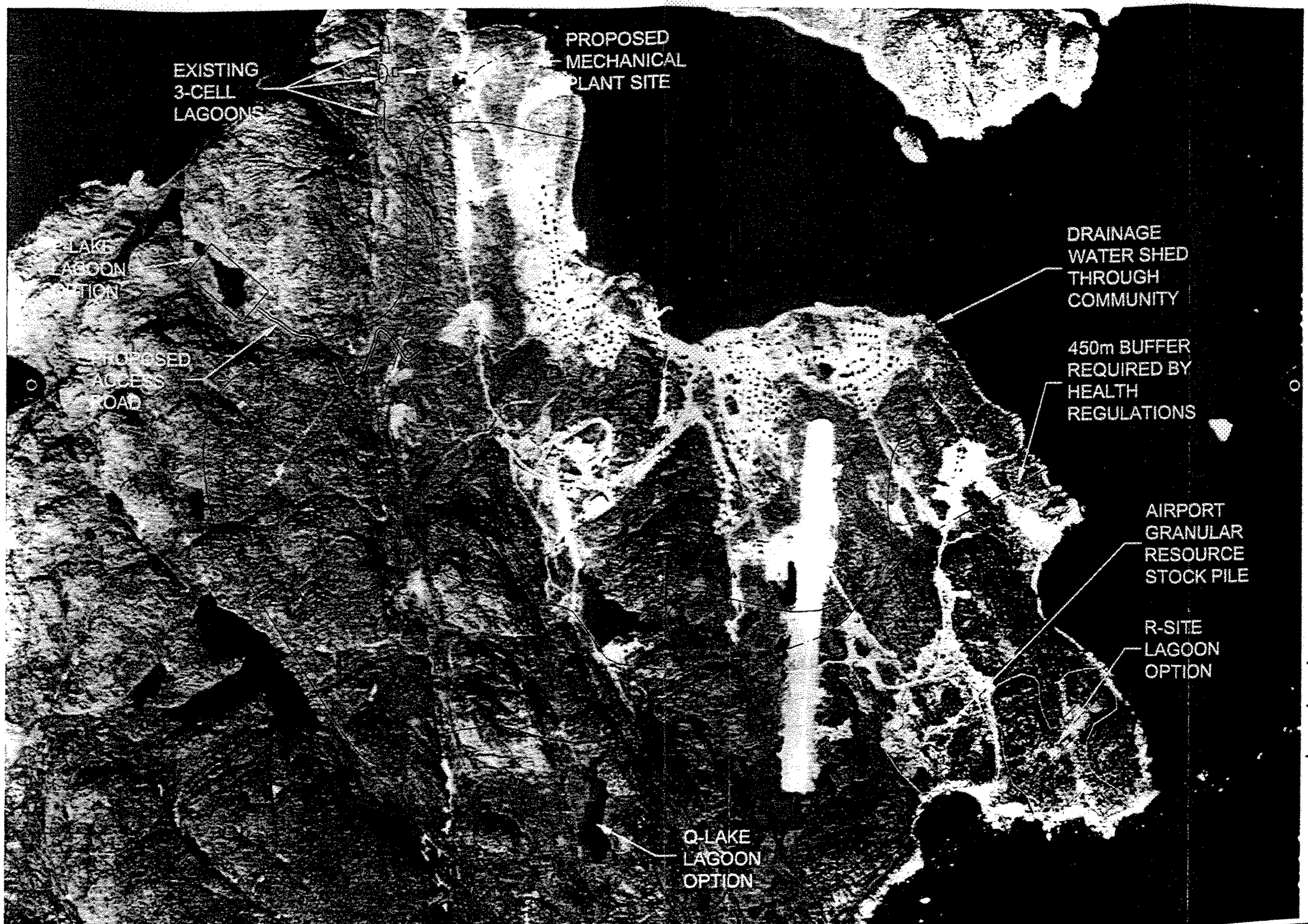
The lagoon berms are constructed mainly of fine-grained material from local sources. It is understood that the berms were originally designed so that sewage would ex-filtrate (seep) through the lower berm of Cell #1 and then flow overland approximately 150 m to the remaining two cells. The combination 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.



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LEGEND

450m BUFFER

DRAINAGE WATER SHED

COMMUNUTY

MAJOR LAND

SIGNIFICANT

DILLON CONSULTING

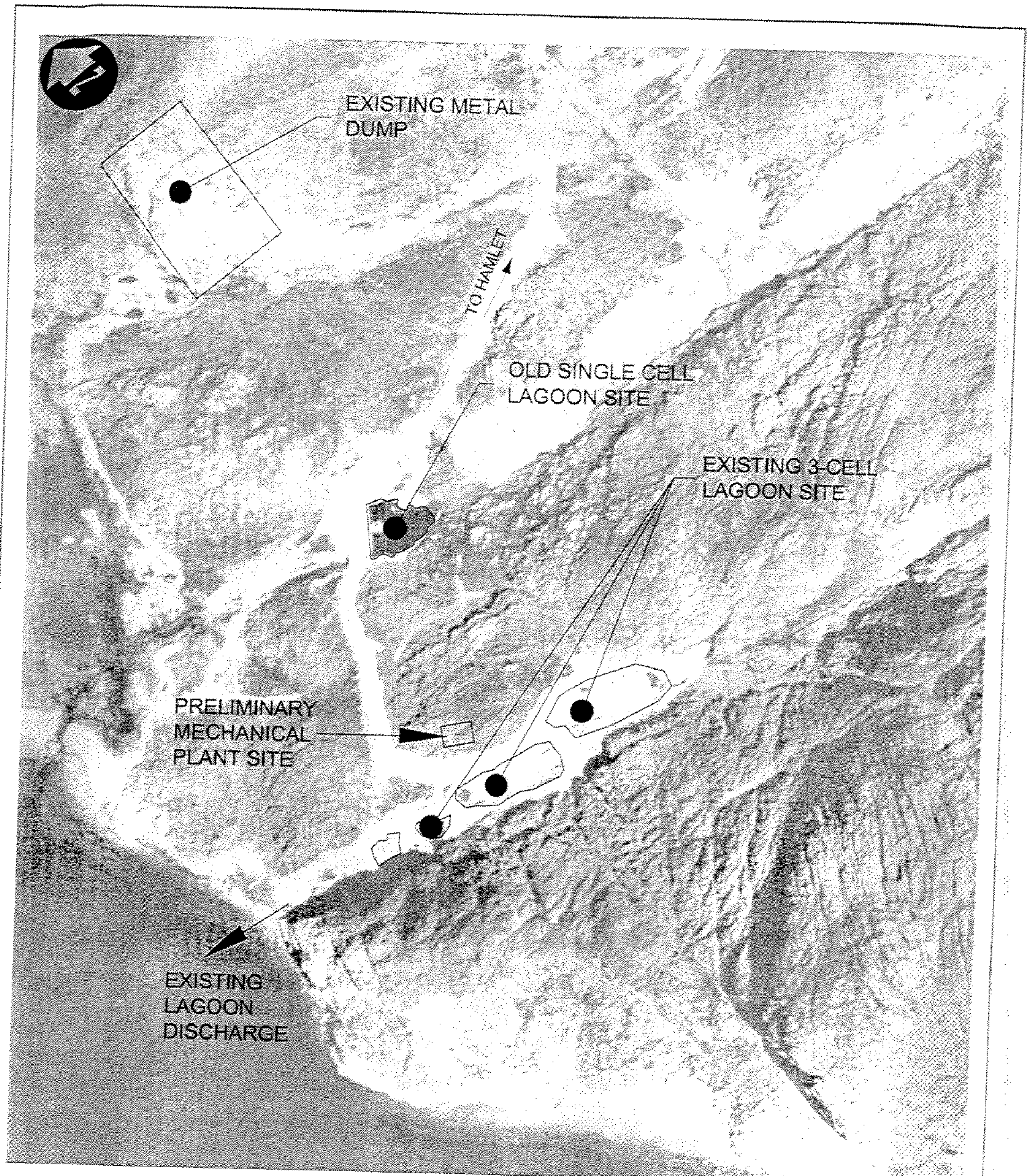
PROJECT

CAPE DORSET SEWAGE MANAGEMENT REVIEW

CAPE DORSET, NUNAVUT

TITLE

AREA PLAN



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DILLON CONSULTING

PROJECT: CAPE DORSET SEWAGE MANAGEMENT REIVEW
CAPE DORSET, NUNAVUT

PROJECT NUMBER: 031943-1000

DATE: JULY 2003

TITLE: EXISTING SEWAGE LAGOON SITE

FIGURE NUMBER: 3

The lack of capacity has been most evident in winter. During Dillon's April 2003 site visit the lower 2 cells appeared to be full with sewage running over the ice with little or no retention time prior to discharge to Telik Inlet.

Breaches to the containment berms have been caused by spring runoff from Malik Mountain flooding the lower 2 cells. The fine-grained material used in the berm construction is susceptible to erosion. In addition, the berms do not appear to have any rock armour protection, as recommended by Dillon in 2001. The gradient of the valley floor is relatively steep and the resulting flow volumes and velocities have led to historical breaches to the berm in Cells #2 and #3. A diversion ditch was constructed in 2002 but it appears that substantial runoff still enters the lower 2 cells. Photographs of the lagoons and the breached cells are included in Appendix C.

3.2 History of Treatment Options

The decision to proceed with a mechanical treatment plant was made after previous studies and community consultations failed to identify a suitable location for a new sewage lagoon. In March 2001 Dillon Consulting Limited was retained by the GN to conduct a planning study with the goal of identifying the most viable sewage treatment option. The following briefly highlights the options considered and the recommendations at the time of the report:

Expand Existing Lagoons: This option had the highest estimated capital cost. The work would involve modifications to the existing lagoons and excavation in rock to expand the total capacity to approximately 70,000 m3. This option was not considered further due to the high cost relative to the other options. An additional 25,000 to 30,000 m3 of excavation would be required to achieve required volumes for an annual storage lagoon in the year 2024. The feasibility of expansion to this extent is unknown based on currently available information.

Site R Lagoon Option: The report concluded that the Site R lagoon was the most viable option. Site R is located near the airport granular resource stockpile, and the terrain is suitable for a sewage lagoon. This option was rejected in the summer of 2002 due to concerns over the proximity to the airport runway and the increased bird strike hazard.

The remaining two options were for mechanical treatment. These two systems would have similar requirements including an access road, lot grading, building enclosure, process equipment, and building services.

Macerator and Deep Water Discharge: The macerator is a mechanical plant option that reduces the particle size of the sewage to remove floating material and takes the sewage away from the shoreline via a deep water discharge. Deep water discharge consists of a pipe leading from the plant along the ocean floor to a point of deep water where the sewage is discharged through diffusers. This option had the lowest estimated capital cost but was not considered further due to concerns over the future regulatory acceptance of deep water discharges. A similar system is in operation in Rankin Inlet. Design and operational problems, combined with expressed regulatory concerns with deep water discharge led to a decision by GN not to further pursue this option for Cape Dorset.

Primary Treatment Mechanical Plant: This option considered enhanced primary treatment with a mechanical "Proteus" type system. Effluent quality would be similar to a lagoon. Experience in the community of Fort Simpson has shown the cost of implementing this system is essentially equivalent to that for a standard/conventional secondary sewage treatment plant. As a result, GN subsequently decided to focus on conventional systems when evaluating mechanical treatment options.

Regulatory pressure for a long term solution intensified during 2002. Two additional lagoon sites were suggested by community representatives, these were as follows:

Q – Lake Lagoon Option: Q – Lake is small water body located east of the community. The lake was used as an emergency water supply in the winter of 2001/2002 and therefore this option was dropped from further consideration at the request of the community.

P – Lake Lagoon Option: P –Lake is located south of the community. Development of this site requires approximately 1 km of new access road with steep grades and large quantities of rock excavation. This option was *initially* rejected due to concerns over high development costs.

By the summer 2002 the GN advised regulators of the decision to proceed with a secondary mechanical treatment plant for Cape Dorset. The plant was to be similar in scope to the mechanical plant being constructed in Pangnirtung. In early 2003, Dillon commenced detailed design of the mechanical plant for Cape Dorset. Process equipment vendors submitted price quotations which ranged from $835,686 to $1,877,300. The vendors proposed to use Sequencing Batch Reactor (SBR) technology, and operating costs were estimated to range from $135,000 to $150,000 per year.

Due to concerns over operating costs and long term funding, the GN subsequently requested that Dillon re-visit the P-Lake lagoon option. Preliminary site surveys were undertaken for the plant and a portion the lagoon access road. The lagoon and the mechanical plant options were compared on the basis of life cycle cost in a letter report to the GN dated 7 May 2003. The report stated that the life cost of the lagoon was marginally lower. At this stage the GN requested this further study to confirm which of the two treatment options (mechanical plant or lagoon) is better suited for Cape Dorset.

While this work was ongoing the GN was experiencing delays in the final commissioning and start-up of the new Rotating Biological Contractor (RBC) mechanical plant in Pangnirtung. It is understood that the delays were related to finalizing the connection details between the sewage truck and the plant.

3.3 Regulatory Background

The following is a summary of recent regulatory activities, inspections, and permits related to sewage treatment at the 3-cell lagoon system in Cape Dorset:

- **Indian and Northern Affairs Canada (INAC)** - conducted a site inspection in September 2000. At the time of the inspection Cell #1 (the upper cell) was full and the Hamlet had reverted to using the old sewage lagoon. The lower cells were breached. The inspector recommended the Hamlet consider alternate lagoon locations or treatment technologies as a long term solution. The inspector noted that the community did not have a water licence and was therefore in contravention of the regulations.

- **Department of Health and Social Services** (GN) - conducted a site inspection in February 2001. At the time of the inspection the Hamlet was using the old sewage lagoon, which was discharging under the road and then to Telik Inlet. The inspector described the situation as "inadequate". Recommendations were made similar to those by the INAC inspector.

- **Environment Canada** - issued a Directive under *The Fisheries Act* to the GN and the Hamlet dated March 2002. The directive identified raw sewage into Telik Inlet as a "serious and imminent danger" to fish bearing waters, and required that the Hamlet take immediate remedial steps. In August 2002 the GN replied to the EC Directive. The letter addressed repairs and mitigation to the existing lagoon cells, the expected treatment effectiveness, and a long term sewage treatment strategy that was to include construction of a mechanical sewage treatment plant.

- **Nunavut Water Board** – In April 2001 the Hamlet made application for a water licence from the Nunavut Water Board. The licence application included the operation of the water supply system, the solid waste disposal site, and the sewage treatment facility. The Hamlet was granted Water Licence NWB3CAPO207 in September 2002. Key effluent criteria established for discharge of treated sewage to Telik Inlet are 120 mg/l BOD_5 and 180 mg/L Total Suspended Solids. An amendment to the water licence will be required in the event a new sewage treatment facility is adopted.

Regulatory background letters are included in Appendix D.

4.0 Option No. 1: Mechanical Treatment Plant

4.1 Mechanical Plant Description

Mechanical plants are commonly used to treat municipal sewage in southern Canada. In northern Canada sewage lagoons are far more common, however mechanical plants have been installed at certain mine sites, and in the community of Pangnirtung, as previously mentioned. In the context of this report "mechanical plant" refers to a pre-manufactured process package which is installed in a building constructed on site.

Currently the most common types of package treatment plants are Rotating Biological Contractors (RBC's), Extended Aeration (EA), and Sequencing Batch Reactors (SBR's). Of these the RBC and the SBR are considered the most suitable for Cape Dorset due to their smaller overall footprint compared to the EA process. A few of the advantages and disadvantages of mechanical treatment plants are as follows:

Advantages

- Relatively small footprint for treatment
- Can meet and exceed existing water licence
- Effluent quality can be improved with process changes

Disadvantages

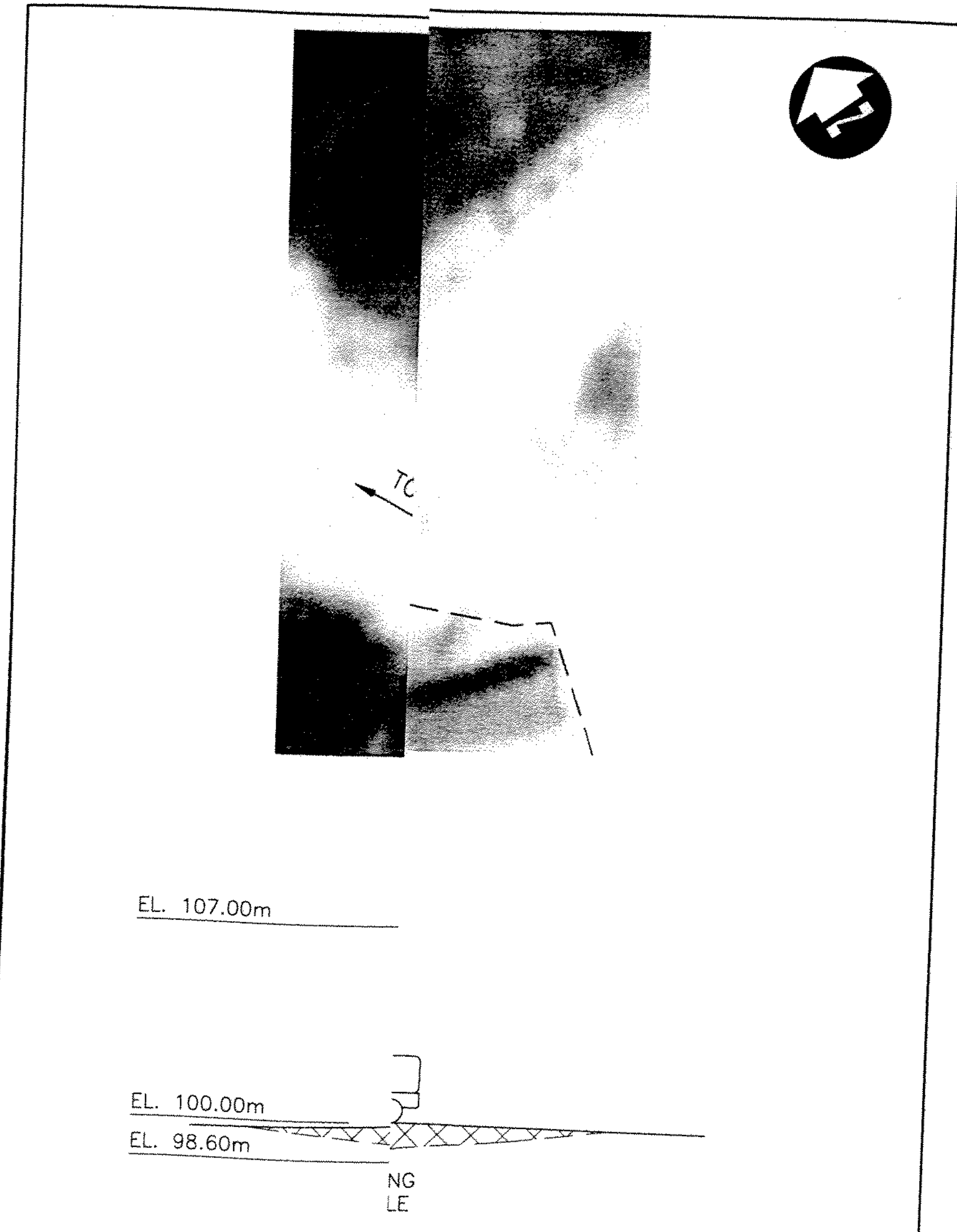
- Higher energy consumption
- Trained operator required

System Components

- Access road and site grading
- Building enclosure
- Process equipment
- Domestic building services
- Sewage effluent discharge
- Sludge discharge / disposal

The preferred location for the mechanical plant is near the existing 3-Cell lagoons. A preliminary site has been identified opposite Cell #1, north of the access road. The building pad would be constructed on bedrock and therefore it will be preferable if all the process tanks are above ground. A concept building plan and section view are shown in Figure No 4.

The treated effluent would be pumped below the access road in a heat traced pipe. The effluent would discharge to Telik Inlet via the existing lagoon drainage swale. Stabilized sludge from the plant would be discharged to the existing lagoons for long term storage. The new facility would also require Nunavut Power Corporation service, involving a service extension of approximately 800 m.



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PROJECT	PROJECT NUMBER 03–1943
	DATE JULY 2003
TITLE	FIGURE NUMBER ~~5~~ 4

4.2 Mechanical Plant Design Basis

The design basis for the mechanical treatment plant was summarized in a concept brief and in the equipment specification in March 2003. The documents were circulated to the GN and to selected equipment vendors. Copies of these documents are included in Appendix E.

A twenty year design horizon was used for the hydraulic and process treatment design. The hydraulic capacity is 265 m^3/ day, based on treating the daily sewage in 2024. Effluent criteria for the plant was set at 20 mg/L BOD_5 and 20 mg/L TSS.. These criteria are more stringent than the current requirements in the Water Board Licence, however are readily achievable using this type of treatment process.

A process diagram for a typical mechanical sewage treatment plant is shown in Figure No. 5. The major process components specific to Cape Dorset are as follows:

Raw Sewage Handling

Truck delivery of raw sewage occurs 5 days per week. The raw sewage would be stored in holding tanks located inside the building enclosure. The holding tank volume would accommodate 1.5 truck loads, or 15 m^3.

Primary Screening

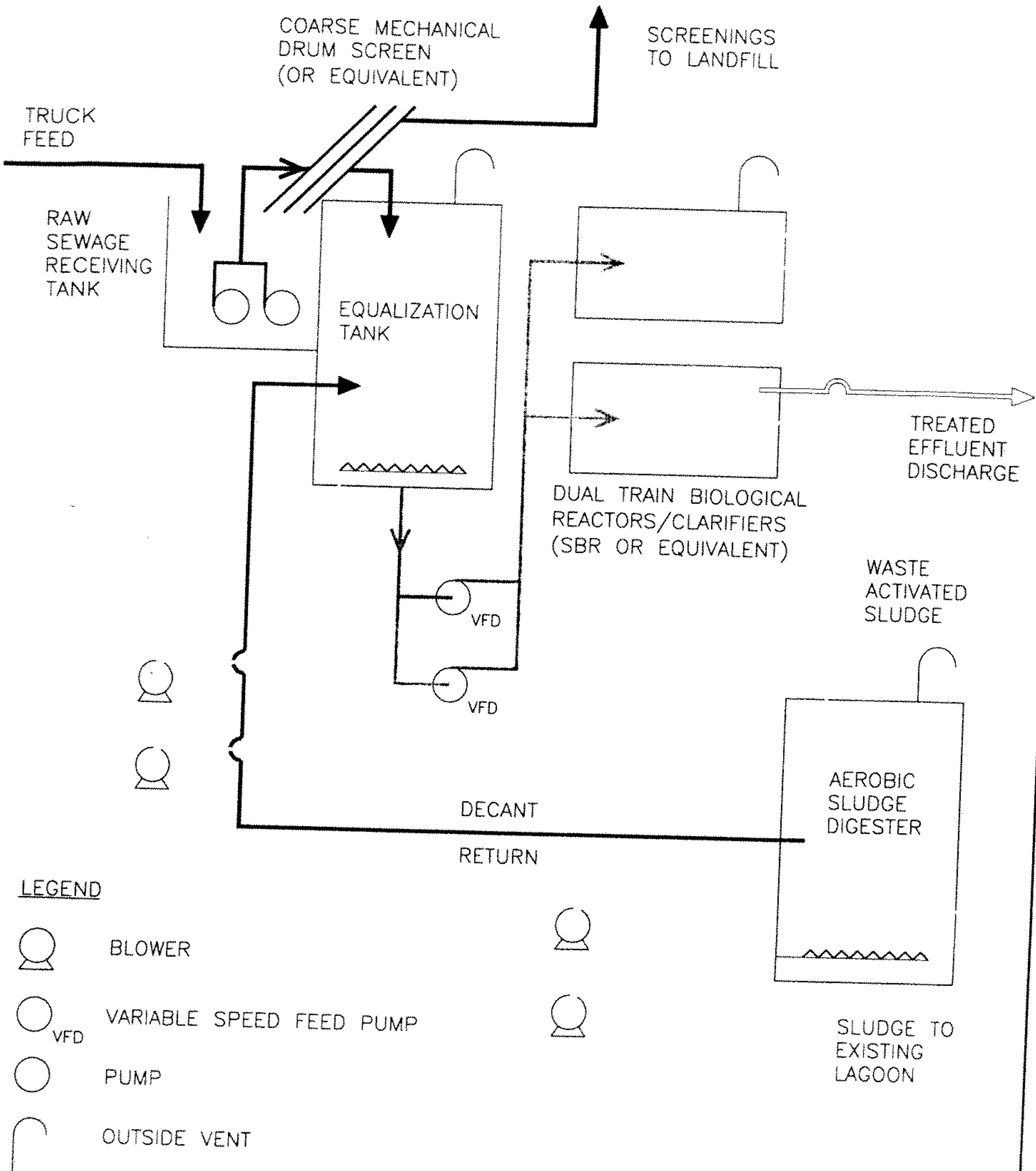
Primary screening is required to remove debris and larger solids from the sewage. An automated rotating drum screen with 12.5 mm (1/2") openings was selected as the design basis. Compacted solids would be automatically bagged and hauled to the existing solid waste landfill.

Flow Equalization

Flow equalization (EQ) is required to provide buffer storage and a well mixed sewage prior to entering the biological treatment unit. A minimum of 24 hours hydraulic capacity was selected for this tank during pre-design. Sewage would be pumped from the EQ tank to the biological reactors.

Biological Treatment

A dual train biological reactor system is required to provide appropriate redundancy and process flexibility, with each reactor capable of treating the daily design flow. Reactor sizes, internal components, and control logic vary from vendor to vendor.



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DILLON CONSULTING	PROJECT CAPE DORSET SEWAGE MANAGEMENT REIVEW CAPE DORSET, NUNAVUT	PROJECT NUMBER 031943-1000
		DATE JULY 2003
	TITLE SBR MECHANICAL PLANT BLOCK DIAGRAM	FIGURE NUMBER \# 5

Sludge Handling

A continuously aerated aerobic digester is required to stabilize sewage sludge prior to disposal. Liquid decant from the digester is returned to the flow equalization tank for further treatment. Sludge is pumped from the bottom of the digester for disposal. Cell #1 of the 3-cell lagoon was selected as an appropriate disposal site for digested sludge.

4.3 Supplier's Proposals

Dillon invited proposals from qualified suppliers of package mechanical sewage treatment plants. The invitation was structured such that the supplier was free to recommend the process technology.

Dillon invited and received quotations from APD Engineering and Constructors Ltd., Perma Engineered Sales, and Sanitherm Engineering Ltd. All three suppliers indicated they could meet the required effluent criteria using Sequencing Batch Reactor (SBR) treatment systems. The supplier's proposed floor layouts and process diagrams are included in Appendix F. The use of SBR based treatment processes is consistent with the stated preference of GN to date that use of an SBR would allow for a performance comparison to the recently installed Rotating Biological Contactor (RBC) based treatment process installed in Pangnirtung.

Concern has been recently raised by the GN over the estimated Operating Costs for a mechanical sewage treatment plant. Given this concern, the GN may wish to further consider the selection of an SBR based treatment process over that of an RBC based treatment process. 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 long-term cost savings.

Key elements of the supplier's submissions are as follows:

1) APD Engineering and Constructors Limited

APD is a Calgary-based firm representing US Filter Jet Tech SBR systems. APD has relevant project experience in the Western Canada and the US but none in the NWT or Nunavut. The APD proposal is for an SBR system with a total of five tanks - two equalization tanks and three SBR tanks. The aluminum tanks are all the same size (3.5 m wide X 15 m long X 5 m high) for a volume of 247 m^3 each. The tanks breakdown into upper and lower pieces for shipment.

The raw sewage would be manually screened, requiring frequent removal of solids by the Hamlet (Dillon specified an automated drum or similar screen in the specifications). The two receiving tanks would be above ground in accordance with the specifications. No estimate of operating costs was provided.

APD did *not* include aeration of the equalization tanks, an aerobic digester, a full description of the electrical and controls, or an estimate of operating costs, as required by Dillon. Due to these submission deficiencies APD was not given consideration for this project.

2) Perma Engineered Sales / FWS

Perma Engineered Sales of Winnipeg proposed an SBR system with a total of six rectangular tanks; one raw sewage (15 m^3), one equalization tank (100 m^3), two reactors (270 m^3 each), and two aerobic digesters (115 m^3 each). In this proposal the raw sewage receiving tank would be installed below ground, and this raises the issue of blasting during construction.

Advantages:

- Pre-installed electrical conduits, piping and fittings
- Opportunity for lower building height due to lower tank heights

Disadvantages:

- Highest overall capital cost
- Unconventional process logic. The plant would run high rate between Monday and Friday and low-rate / stand-by on the weekend. This may cause problems with process stability.
- Below ground receiving tank may require blasting.

3) Sanitherm Engineering Limited

Sanitherm Engineering in Vancouver submitted a proposal based on an SBR. Their proposal calls for six circular tanks, including two receiving / screened sewage (15 m^3 each), one equalization (530 m^3), two SBR's (326 m^3 each), and one digester (197 m^3). The total requested floor space to house the package plant is 580 m^2, including an 11 m X 7 m allowance for mechanical / electrical, generator room, and washroom.

Advantages:

- Technically complete proposal
- Lowest capital cost of all submissions
- Recent Arctic experience (Pangnirtung)

Disadvantages:

- Tall tanks increase overall building height
- Larger floor area than other submissions

4.4 Capital and Operating Costs

4.4.1 Capital Cost

The original suppliers bids for the process equipment are shown in Table 2. These quotes have formally expired however they are still useful for cost estimating purposes.

Table 2 Equipment Pre-Selection Quotations

Item	APD Engg	Perma/FWS	Sanitherm
Tankage	$837,000.00	$945,100.00	$334,367.00
Major Equipment	$265,000.00	$343,700.00	$271,150.00
Ancillary Equipment	$183,000.00	$473,900.00	$91,019.00
Start-Up and Training	$18,975.00	$97,900.00	$44,000.00
Other	$92,000.00	$16,700.00	$95,140.00
Total	**$1,395,975.00**	**$1,877,300.00**	**$835,676.00**

The low bidder was Sanitherm. APD was dropped from consideration and discussions were held with the remaining suppliers to confirm their design assumptions and prices.

Other major capital costs were estimated as follows:

- Building Structural costs were estimated based on $3000 per square meter of floor space. In addition, concrete foundation costs were estimated based on a 200 mm thick slab @ $2000 per cubic meter.
- Building Mechanical / Electrical: The starting point for these costs was the $970,000 contract for the mechanical and electrical at Pangnirtung. This amount was increased to account for the larger building size for Cape Dorset.
- Nunavut Power Line: The new electrical service for the mechanical plant (NU Power) has an estimated cost of $80,000, based on a service length of 800 m.

The total estimated capital cost for mechanical plant option ranges from $5.6 million (Sanitherm SBR) to $6.1 million (Perma SBR) including engineering and contingencies.

The cost calculations are provided in Appendix G.

4.4.2 Operating Costs

Operating and maintenance (O + M) costs for a mechanical treatment plant are significantly higher than for a sewage lagoon of comparable capacity. Estimating O + M costs for a mechanical plant is complicated because of a lack of operating cost history available for a mechanical plant in NU. Limited O + M data is readily available for SBR's in more southern North American locations, however and conversions must be made to account for differences in power and maintenance costs.

Possible approaches to estimating O + M are as follows:

- **Unit Rate Approach**: in this approach the total annual O + M costs are divided by the annual sewage volume treated to arrive at a unit cost per cubic meter.
- **Itemized Cost Approach**: In this approach operating costs are broken down into power, labor, heating, etc. and added to arrive at the annual cost. This approach was used in Dillon's previous estimates to the GN in May 2003.
- **% of Capital Cost Approach**: In this approach historical O + M costs are divided by the original capital cost to arrive at annual O + M cost as a % of capital cost.

Dillon's May 2003 O + M estimates were prepared using power consumption costs provided by the equipment suppliers. Due to large variations in the annual power costs submitted by the suppliers, Dillon initiated discussions with the suppliers in order to explain the variation, and to attempt to identify which of the two estimates was more realistic. The suppliers resubmitted their power cost estimates, and the revised cost for the Sanitherm plant was one half the original. To these plant power costs Dillon added operator labor, building heat and light, and miscellaneous provisions for items such as testing. The resulting O + M costs ranged from $135,000 to $150,000 per year. Sewage haulage costs are not included.

For this report, we reviewed limited published data for SBR's operating in the US (see Appendix H). The published data indicate that average annual O + M costs were in the range of 9.5 to 10% of the plant capital cost. For Cape Dorset we have assumed O + M costs based on 8.0% of the initial capital cost, after considering the low end estimates from the suppliers and the higher end estimates from the published data. The resulting O + M costs range from about $255,000 to $280,000 per year. It was assumed that these costs would be incurred with the plant operating at full capacity of 265 m^3/day. This is not the case in earlier years and the O + M costs were therefore pro-rated based on the average plant flow in any given year. Calculations are provided in Appendix G.

4.4.3 Equipment Service Life

The design expected life (service life) for the building, pumps, and tanks and piping was established in the concept brief. The design expected life was defined as the *"the practical maximum expected life of a facility assuming no premature failure, destruction, or obsolescence"* and ranged from 20 years for pumps to 30 years for tanks and piping.

The service life of process equipment is heavily dependent on the implementation of the maintenance program. Experience has shown that in small plants equipment maintenance is lacking and this can lead to premature failure. Dillon contacted an SBR supplier and a plant operations firm in order to identify the typical service life that can be expected assuming proper maintenance. The following summarizes these discussions:

- **IPEC Drum Screen**: 20 -25 year service
- **Pumps**: 5 – 10 years service life – heavily dependent of inspection and occasional cleaning. In remote communities it is often more economical to replace smaller pumps (<7.5 HP) than repair. Consideration should be given to providing shelf spares for all pumps in this category.
- **Blowers**: 10-15 years typical service life, with many cases of over 20 years with reasonable maintenance.
- **Diffusers**: 10 years typical service life. Equipment cost is minimal.
- **Floating Decanter**: 20 years typical service life.
- **Tanks and Pipes**: 50+ years for stainless steel or glass fused-to-steel tanks, assuming they are not frozen or otherwise abused.

The above list shows that the majority of the replacement costs will be incurred at some time during the twenty year horizon. By 20-30 years the building electrical, mechanical and structural components will also need upgrades. No cost estimates were attempted for this work as the degree of confidence would be extremely very low.

5.0 Option No 2: P-Lake Sewage Lagoon

5.1 Introduction

The terrain in the Cape Dorset area is rocky and hilly, and this makes finding a suitable lagoon site very challenging. This also explains why the existing lagoon is located in a valley with little opportunity for expansion – there was simply no other obvious location for the lagoon.

Besides the existing lagoon, three other lagoon sites have been considered in previous studies. One of these (**Site R**) was rejected due to the proximity to the airport and the increased risk of bird strikes. The second alternative was **Q Lake**, a small lake located east of the community. This option was rejected after the community water line froze and the lake was used as an emergency water supply.

The third option was **P-Lake**, which is located on Malik Mountain south of the community. This option requires an access road with steep grades and rock excavation. P-Lake was previously rejected on the basis of high development costs.

The GN requested that Dillon re-examine the P-Lake lagoon option and compare the costs to that of a mechanical treatment plant. This work was completed in May 2003 and it was concluded that the long term costs were about the same as for a mechanical plant. For this current report the cost estimates for the lagoon and the access road have been further refined. The revised total cost for this option is approximately \$6.8 million, which is \$650,000 higher than the previous estimate. Site information remains extremely limited for this option and therefore the degree of confidence in the cost estimates is lower than for the mechanical plant option.

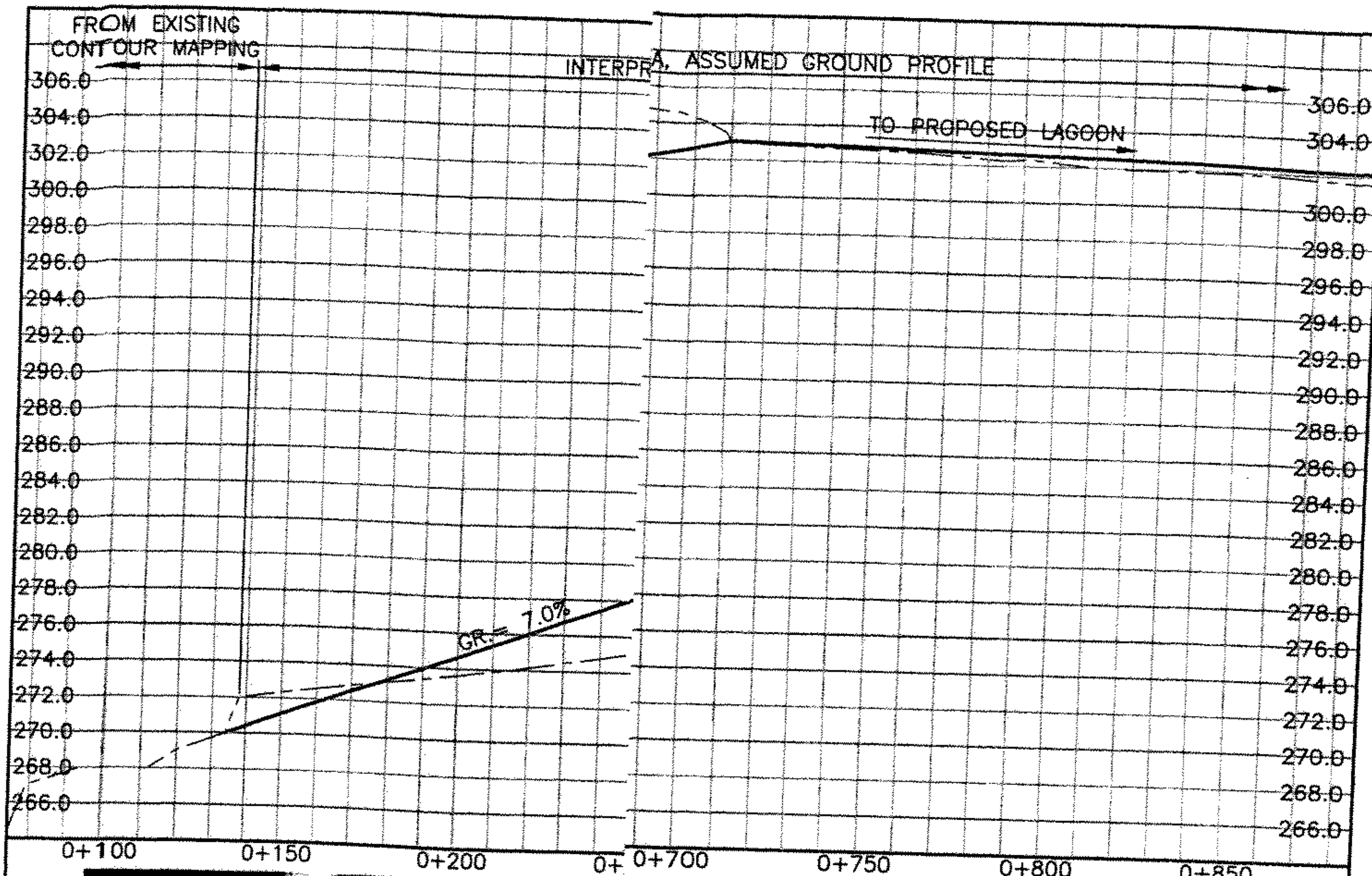
Further details are provided in the sections that follow.

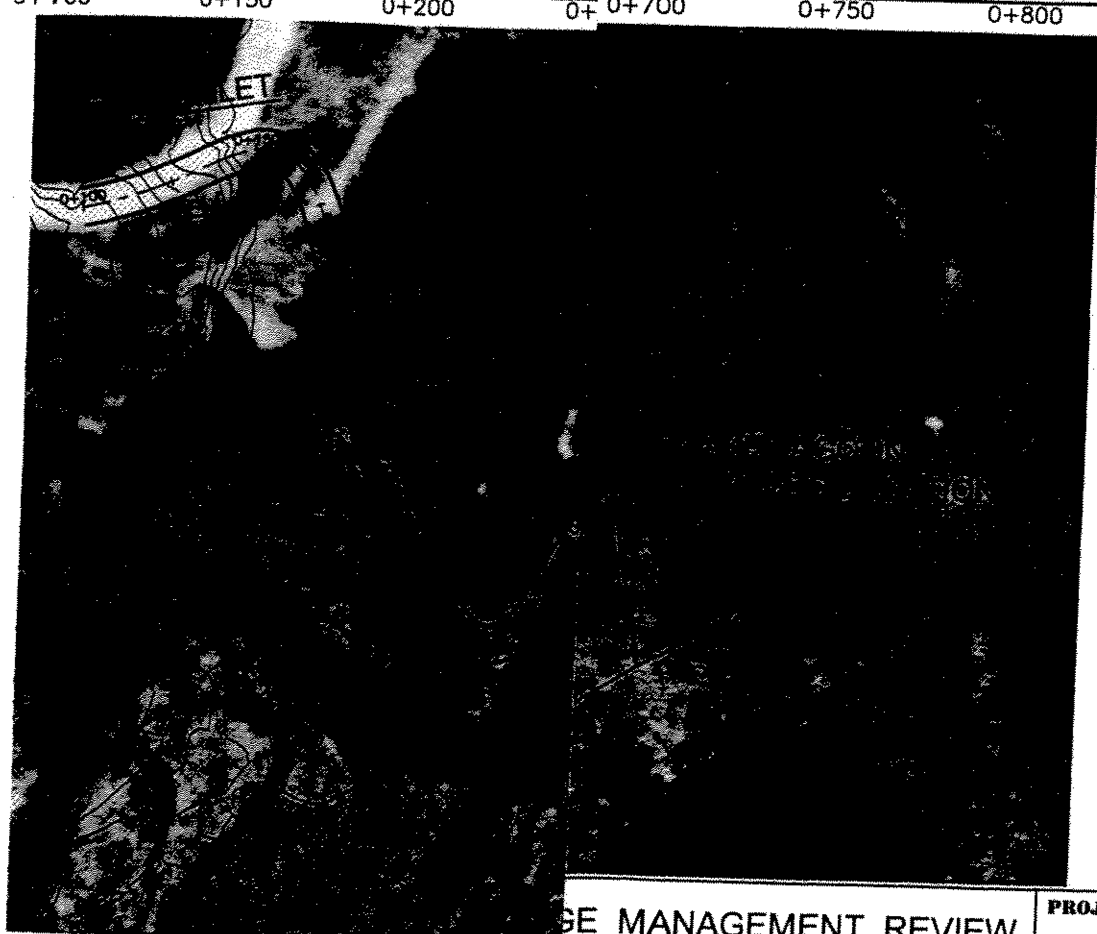
5.2 Design Basis

Access Road

A site inspection and survey of the preliminary access road route was carried out in April 2003 by Dillon and GN personnel. In order to access the lagoon location a steep rock face must be traversed. The lagoon site is located on an elevated plateau south west of the Hamlet. Access would be partially provided along an existing road but a new road 850 m in length and with an elevation change of approximately 33 m would need to be constructed. The preliminary plan and profile are shown in Figure No. 6. Winter photographs of the route are in Appendix I. The profile consists of interpreted data from existing contour mapping, survey data and photographs. Before construction of this option could begin a more in depth survey, route selection, and geotechnical (surface geology) investigation would need to be performed.

The access road costs were estimated based on \$100/m^3 for rock excavation and \$40/m^3 for fill. In fill sections the road width was assumed to be 10 m in fill with 3H:1V side slopes. In cut the width was assumed to be 16 m with 0.5H:1V side slopes. Cut and fill volumes are 12,000 m^3 and





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S ROAD CONCEPT	FIG. NO. 6

43,000 m^3 respectively. The total road cost is assumed the blasted material is suitable for fill. If this is not the case, fill material will have to be crushed on site at an additional cost of approximately $500,000.

Sewage Lagoon

The sewage lagoon was sized based on hydraulic loading criteria to provide annual storage in the year 2024 of 97,000 m^3. Lagoon storage could be provided in a 1, 2, or 3 cell configuration, depending on existing ground conditions at the site. The lagoon configuration can only be determined after a full site survey and geotechnical investigation. For the purposes of this report a 2 –cell configuration was assumed with a liquid depth of 2.0 m and on overall berm height of 3.3m. Each cell would have inside dimensions of 214 m X 110 m. The lagoon area was assumed to be fenced to prevent wildlife intrusion and for general site safety. Volumetric and cost calculations are provided in Appendix J.

5.3 Capital and Operating Costs

In May 2003 Dillon completed capital and operating cost estimates for the access road and the sewage lagoon. The total capital cost for the access road and the lagoon was $4.5 million, as shown in Table 3. For this report the previous costs estimates were revisited in order to confirm the design assumptions and refine the costs wherever possible. The most significant change since the previous estimates is the capital cost estimate for the lagoon, which has increased from $1.1 million to $1.9 million. The increase is due to the larger lagoon volume assumed for this report (97,000 m^3 vs. 88,000 m^3), and the inclusion of rough costs for site preparation and inlet and outlet controls. With these revisions the total estimated capital cost is $5.1 million (excluding engineering and contingency), as shown in Table 3. It must be emphasized that these are preliminary costs completed in the absence of any site specific data in the vicinity of the proposed lagoon.

The total estimated capital cost for this option (including engineering and contingency) is $6.9 million.

Operating costs were based on 2% of the lagoon construction cost, or $38,000 per year. This accounts for minor maintenance, fence repairs, etc. The cost does not account for sludge removal, which may be required in the long term. Sewage haulage costs are not included either.

Table 3 P-Lake Lagoon Capital and Operating Costs

Item	May 2003 Estimate	Current Estimate	Comment
Access Road	$3,400,000	$3,200,000	Earthworks volumes refined slightly
Sewage Lagoon	$1,100,000	$1,900,000	Capacity increased to 97,000 m3. Higher misc costs.
Total Capital Cost	**$4,500,000**	**$5,100,000**	
Engineering @ 10%	$450,000.00	$510,000.00	
Geotechnical @ 2%	$90,000.00	-	Geotech now assumed to be included in Engineering
Contingency @ 25%	$1,125,000.00	$1,275,000.00	
Total	**$6,165,000**	**$6,885,000**	
O + M @ 2.0% of Lagoon	$22,000	$40,000	

6.0 Analysis of Options

6.1 Life Cycle Cost Analysis

A life cycle cost analysis was undertaken for the mechanical plant and the lagoon options. Net Present Value or Life Cycle Cost considers both Capital and Operating Costs by estimating the total cost in current day dollars of a facility over a given time period. For the purposes of this study, the planning period selected is 20 years. The determination of current day dollars for future outlays is a function of inflation and future interest rates (referred to as discounted rates). Given the uncertainty in predicting future rates, often estimates are made at a variety of discount rates in order to provide a range of costs. The results of the life cycle cost analysis for the two long-term sewage management options for Cape Dorset are shown in Table 4.

The life cycle costs are shown in Table 4 below.

Table 4 Net Present Value Analysis

Option	Capital Cost	Op. & Maint.	20 Year Life Cycle Cost @ 2% Discount	20 Year Life Cycle Cost @ 4% Discount	20 Year Life Cycle Cost @ 8% Discount
Mechanical Plant	$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 above table shows that the P-Lake lagoon is the more economical option.

As highlighted in Table 4, the life cycle cost analysis favours the lagoon option, however the overall margin of difference is relatively small given uncertainty in the mechanical plant operating cost and the lagoon capital cost. For example a sensitivity analysis shows that if the capital cost of the lagoon increases by 21%, the net present value (NPV) over twenty years is the same as the mechanical plant (at 4%). Given that the lagoon cost estimate is +/- 40% the sensitivity analysis highlights that the estimated life cycle costs for the two options are roughly the same when considering uncertainty.

6.2 Other Evaluation Criteria

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 first step in the matrix analysis is to determine the criteria to be evaluated and the relative "weighting" for each. Based on our review of the previous studies, the regulatory and community history, and contacts with GN personnel over the past 1-2 years, the following seven evaluation criteria are proposed for initial consideration.

Operating and Maintenance Cost (O + M)

Operating and Maintenance Costs represent a perpetual outlay of direct dollars throughout the life expectancy of any facility or other infrastructure. O + M costs are often presented as a percentage of capital dollars that are required on an annual basis. Operating costs are estimated to range from a low of **2%** for lagoons to a high of **8%** for a pre-engineered secondary level treatment plant.

The GN has recently indicated that O + M Costs are a key concern given the limited dollars available in any given year to address a large number of priorities across the Nunavut Territory. Given this expressed concern, and the likelihood that O + M represent a greater fiscal challenge than capital expenditures, a higher weighting has been assigned to Operating Costs than for Capital Cost.

Operating Costs have been assigned a weighting of 25%.

Operating and Maintenance Cost Uncertainty

Uncertainty in the estimated Operating and Maintenance Costs are due to a lack of operating history for mechanical treatment plants in Nunavut. This is particularly true of the Sequencing Batch Reactor (SBR) process. In contrast, there are many lagoon systems installed across Nunavut and thus there exists little uncertainty in Operating Costs for these type of systems. In comparison, the Operating Costs for a lagoon are negligible to that of a mechanical sewage treatment plant. This criteria has been established to acknowledge uncertainty as a factor that may influence ultimate costs to Operate and Maintain the sewage management system.

Operation and Maintenance Cost uncertainty was assigned a value of 30% for a mechanical treatment plant and 10% for a lagoon. The mechanical plant uncertainty is subjectively assigned based on the difference between the current estimates for Operation and Maintenance Costs ($260,000) compared to the original supplier estimates. A 10% uncertainty in lagoon costs reflects the increased confidence in the estimate.

Operating and Maintenance Cost Uncertainty has been assigned a weighting of 15%.

Capital Cost

Capital cost is a quantitative criteria which can be used to compare the "up front" costs of each option. A slightly lower relative rating has been assigned to Capital Costs in comparison to the

Operating Costs. To date, the GN has not expressed concerns in the ability to secure the funding necessary for the construction of a mechanical sewage treatment plant at the existing 3-cell lagoon site. In selecting weighting criteria, an assumption has been made that funding would be also be available for the more Capital Cost intensive option of the P-Lake Lagoon. Negating uncertainties in cost estimating, the P-Lake Lagoon carries an approximately 20% higher Capital Cost than the mechanical sewage treatment plant.

Capital Cost has been assigned a weighting of 20%.

Capital Cost Uncertainty

Recent and relevant experience with the construction of a similar facility in Pangnirtung combined with detailed cost estimates obtained through a site specific pre-selection process have provided a cost estimate for a mechanical treatment plant that is considered more accurate than that for the P Lake Lagoon Option. Uncertainties that may influence the Capital Cost estimate for P-Lake Lagoon are primarily related to an absence of data related to site topography, lake bathymetry, and surficial geology information required for road and lagoon design. For planning purposes, it is reasonable to expect Capital Costs for the mechanical treatment plant to carry an accuracy of +/- 10% whereas the P Lake Lagoon may be +/- 40%.

This criteria has been established to acknowledge uncertainty as a factor that may influence ultimate costs to implement the sewage management system.

Capital Cost Uncertainty has been assigned a weighting of 10%.

Regulatory Environment

Regulatory uncertainty considers both immediate and future regulatory requirements. Immediate requirements represent the ability to, and cost implications of, obtaining the necessary approvals to implement the selected long-term sewage management option. Future needs are more obscure as they represent potential changes in the regulatory environment that may have an impact on the requirements surrounding the management of sewage. At this point in time, Dillon is unaware of imminent regulatory changes that may impact Cape Dorset.

In order to implement the long-term sewage management option in Cape Dorset, approvals are required from the Nunavut Water Board (NWB) with input from a variety of other stakeholders. Depending on the selected management option, approvals from other regulatory bodies may also be required. Interaction with the NWB and other project stakeholders commenced in the spring of 2003 with the distribution of the Concept Brief and the identification of a mechanical treatment plant as the preferred option.

The ability to obtain the necessary regulatory approvals for a mechanical treatment plant at the existing site is considered of low risk. The NWB and other stakeholders have been provided information about the treatment process and proposed discharge quality. In using the existing treatment site to implement a mechanical treatment plant, no new potential impacts on the natural environment will occur. For the P-Lake lagoon option, there is a requirement to build a new road and convert an existing water body to a sewage lagoon. It is expected that the time required to implement the sewage lagoon option will take longer than that for a mechanical treatment plant. Sufficient baseline information has not yet been collected on the natural environment to fully identify potential environmental impacts that may result from implementing this option. For example, it is not yet known if P-Lake is considered fish habitat under the definition of the Fisheries Act. With an absence of site specific information, the regulatory uncertainty for the P-Lake lagoon option is greater than that for a mechanical treatment plant.

In selecting a sewage management option, consideration should also be given to the ability to adapt to potential regulatory change. Changes most likely to impact sewage management operations would be the adoption by regulatory authorities of more stringent effluent discharge criteria. Although an annual storage facultative lagoon that discharges to a non-sensitive aquatic environment can generally meet existing regulatory expectations (as indicated by the current Water License for Cape Dorset), its' performance cannot be readily improved should more stringent criteria be adopted at some time in the future. In comparison, the discharge quality from a secondary level mechanical treatment plant is inherently superior to that of a facultative lagoon. In addition, the effluent quality from a mechanical treatment plant can generally be improved through process adjustments and if necessary through the addition of additional process units to address specific parameters of concern.

In short, should Cape Dorset be subject to changes in regulatory requirements during the course of the 20 year planning period, the cost to adapt to these changes is potentially of greater significance with a lagoon in place. There is also more uncertainty associated with the implementation of the P-Lake Lagoon option as compare to a mechanical treatment plant.

Regulatory Environment has been assigned a weighting of 10%.

Process Uncertainty

Once a new sewage management facility is commissioned, it must be operated using local personnel. The complexity of a mechanical sewage treatment plant is such that significant training is required for process operation. Local maintenance support (mechanical, electrical) as well as third party process support is also necessary and represents an added cost, especially in a remote northern setting. In contrast, a facultative lagoon requires little operator training and third party support once designed and constructed.

Consideration should be given to the local capacity required to support sewage management. Improper operation and/or management of any sewage management facility has the potential to increase liabilities for the GN. Due to the complexity of process, a lack of experience, and high training requirements, the mechanical treatment plant carries with it higher uncertainty in having the facility operational and effective 100% of the time.

Process Uncertainty has been assigned a weighting of 10%.

Community Acceptance

Formal community consultation has not been a component of this particular study. However, the community has been an active stakeholder in the sewage management planning process for Cape Dorset. Several potential lagoon sighting options were identified by the community. In response to input from the community, several potential lagoon sites were dropped for further consideration by the GN. For example, Q-Lake was dropped from further consideration due to concern from the community that the lake was a suitable and proven back-up potable water source in the event of an emergency.

Community acceptance for a given plan may be driven by a variety of issues and concerns including:

- Time required for implementation
- Familiarity with the type of facility proposed
- Complexity of the treatment process
- Proximity of the facility to Community
- Aesthetics
- Potential environmental impacts (real or perceived)

Consideration should be given to how the community may respond to the implementation of a given option in the decision making process. A sound management solution has a decreased chance of success if not embraced by the community. The suggested weighting of 10% has been assigned to this subjective consideration. The mechanical treatment plant option has been scored higher on the basis that the community was involved in the preliminary decision to move forward with that option.

Community Acceptance has been assigned a weighting of 10%.

6.3 Option and Criteria Analysis

The second step in the matrix evaluation process is to determine the extent to which each option satisfies each of the selected considerations. The purpose of this section is to present the results of the matrix table.

Quantitative and qualitative approaches were used in determining the points awarded to each of the two options depending on the consideration. Quantitative approaches to scoring could be used for cost based considerations whereas the more subjective considerations of Regulatory Environment, Process Uncertainty, and Community Acceptance were scored qualitatively.

Quantitative scoring was completed as illustrated by the example calculation for Operation and Maintenance (O&M) Cost:

Mechanical Plant O + M	=	$260,000
Lagoon O + M	=	$ 40,000
Total O + M		$300,000
Mechanical Plant Ratio	=	$260,000/ $300,000 = 87%
Mechanical Plant Points	=	(100%-87%) * Points Available
	=	(13%)*25 Points
	=	3.25 Points (say 3 Points)

Lagoon Points = Points Remaining = 25-3 = 22 Points.

The same calculation method was used for the three other cost criteria, however the Operation and Maintenance and Capital Cost Uncertainties are subjective to the extent of assigning confidence levels.

The results are summarized in Table 5.

Table 5 Option and Criteria Analysis

Criteria	Potential Points	Mechanical Plant	P Lake Lagoon	Comments
O + M Costs	25	3	22	Combined O + M cost = $300,000. Mechanical Treatment Plant represents 87% of the Combined O + M.
O + M Uncertainty	15	4	11	Combined Uncertainty is 40%. Mechanical Treatment Plant represent 75% of the Combined Uncertainty.
Capital Cost	20	11	9	Combined Capital Cost $12.5 million. Mechanical Treatment Plant represents 45% of the Combined Capital Cost.
Capital Cost Uncertainty	10	8	2	Combined Uncertainty is 50%. Mechanical Treatment Plant represents 20% of Combined Uncertainty.
Regulatory Environment	10	8	2	Subjective Assessment that regulatory issues are fewer with a mechanical plant
Process Uncertainty	10	2	8	Subjective Assessment that technology and training issues are fewer with a lagoon
Community Acceptance	10	7	3	Subjective Assessment that community will favour a mechanical plant over a sewage lagoon.
TOTAL	**100**	**43**	**57**	

<u>The option with the highest overall score is the P-Lake Lagoon.</u>

7.0 Conclusions

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 to be 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 for Cape Dorset suggest an SBR to have approximately 30% higher power consumption than that for a comparable RBC based system.

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 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.

REFERENCES AND RELATED STUDIES

1. Dillon Consulting Limited, "*Sewage Facility Planning Study*", Cape Dorset, Nunavut. March 2001.

2. Cold Regions Nomograph, American Society for Civil Engineering.

3. Environmental Engineering, Peavey/Rowe/Tchobanoglous.

4. US Environmental Protection Agency Wastewater Technology Fact Sheet – Package Plants.

Appendix A
Terms of Reference

Indian and Northern Affairs Canada   Affaires Indiennes et du Nord Canada

MUNICIPAL WATER USE INSPECTION FORM

Date: 2000/09/05   Licensee Rep. (Name/Title): Dan Holmes / Director, Municipal Operations

Licensee: Municipality of Cape Dorset   Licence No.: unlicenced

WATER SUPPLY

Source(s): Tee Lake / Dead Dog Lake   Quantity used: not inspected

Owner:/Operator: Hamlet

Indicate: A - Acceptable U - Unacceptable NA - Not Applicable NI - Not Inspected

Intake Facilities: NI   Storage Structure: A   Treatment Systems: A   Chemical Storage: A

Flow Meas. Device: NI   Convey. Lines: NI   Pumping Stations: A

Comments: Alternate water source periodically utilized due to recurring freeze-ups of the old intake line. Sections of intake line recently replaced. No concerns noted with well-kept truckfill station. Chlorination in use.

WASTE DISPOSAL

Sewage: Sewage Treatment System (Prim./Sec/Ter.): primary; discharge overland to ocean

Natural Water Body: Continuous Discharge (land or water):

Seasonal Discharge: x   Wetlands Treatment: very limited   Trench:

Solid Waste: Owner/Operator: Hamlet

Landfill: Burn & Landfill: x   Other:

Indicate: A - Acceptable U - Unacceptable NA - Not Applicable NI - Not Inspected

Discharge Quality: sampled   Decant Structure: NA   Erosion: U

Discharge Meas. Device: none   Dyke Inspection: NA   Seepages: A

Dams, Dykes: U   Freeboard: NA   Spills: none reported

Construction: NA   O&M Plan: NA   A&R Plan: NA

Periods of Discharge: A   Effluent Discharge Rate: not measured

Comments: Extensive spring runoff washed out the lower cell of the new sewage disposal facility. Upper cell and old sewage lagoon utilized alternatively, until full. Sewage effluent at both facilities flowing downslope without much prior retention time. Unfenced solid waste disposal facility appears regularly burned, and is well compacted and covered. Concerns noted with the quantity of observed, and potential, runoff flowing through the site. The toe of the bulky metal wastes disposal site lies under the high tide mark. No form of containment provided for hazardous materials. Waste oil is adequately stored and disposed of at the Hamlet garage (furnace).

FUEL STORAGE

Owner/Operator:

Indicate: A - Acceptable U - Unacceptable NA - Not Applicable NI - Not Inspected

Berms & Liners: Water within Berms: Evidence of Leaks:

Drainage Pipes: Pump Station & Catchment Berm:

Pipeline Condition: Not Applicable: x   Condition of Tanks:

SURVEILLANCE NETWORK PROGRAM (SNP)

Samples Collected   Hamlet: none

INAC: metal dump leachate, dump leachate, discharge from new sewage lagoon

Signs Posted   SNP: not applicable   Warning: none

Records & Reporting: not applicable

Geotechnical Inspection: none required; although may be warranted due to recurring erosion problems

Non-Compliance of Act or Licence: Community is unlicenced.

Philippe Lavallée

Inspector's Name

Inspector's Signature

figure 1. Chute and first cell of the new sewage disposal facility; 2000/09/05.

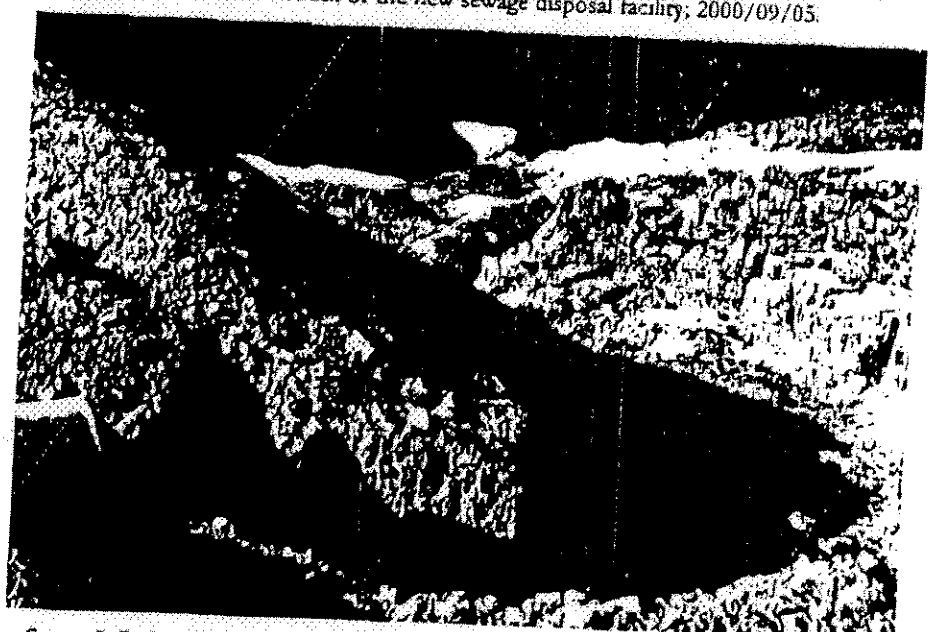

figure 2. Path of discharge from the first cell of the new sewage disposal site; 2000/09/05.

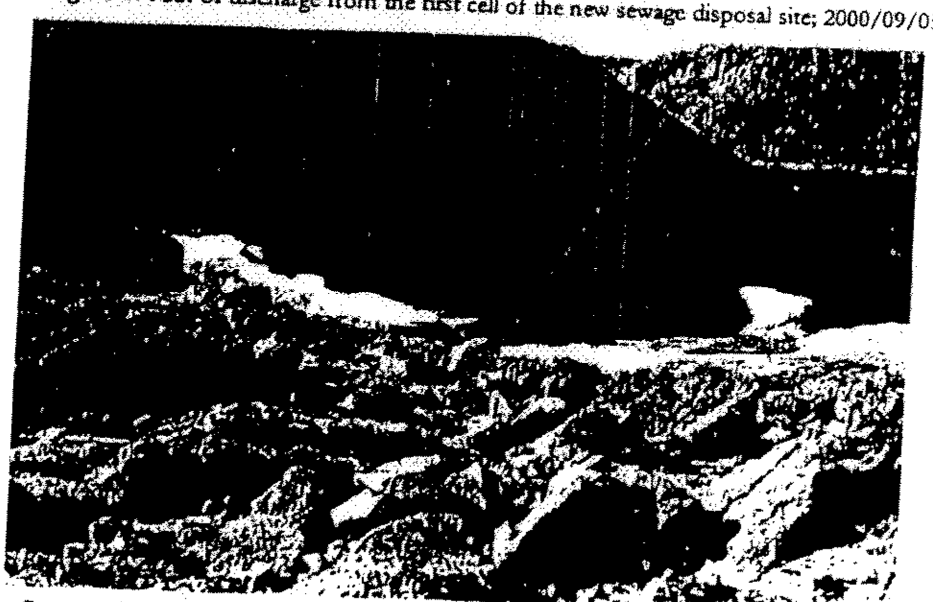

figure 3. Breached berms, new sewage disposal facility; 2000/09/05.

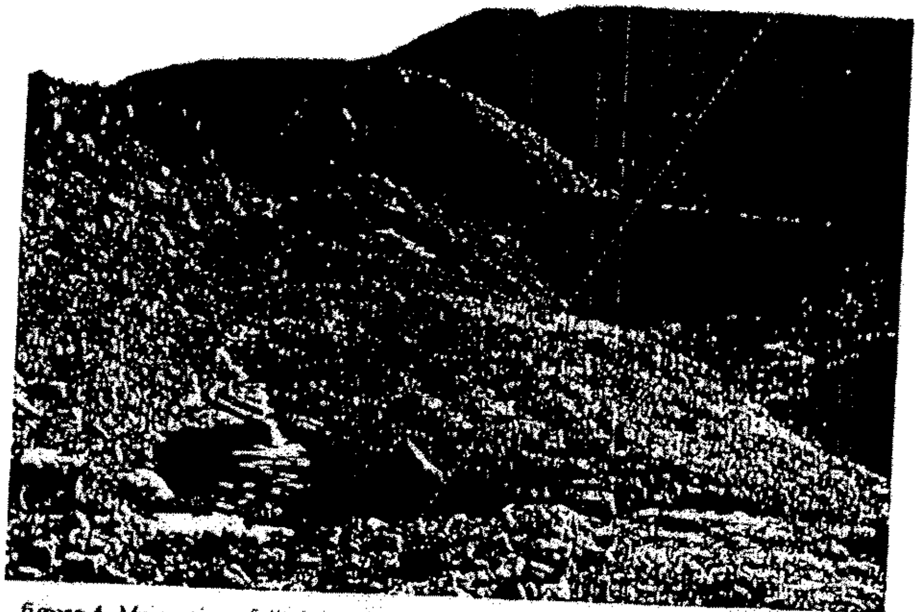

figure 4. Main veins of discharge from the first cell and the dump; 2000/09/05.

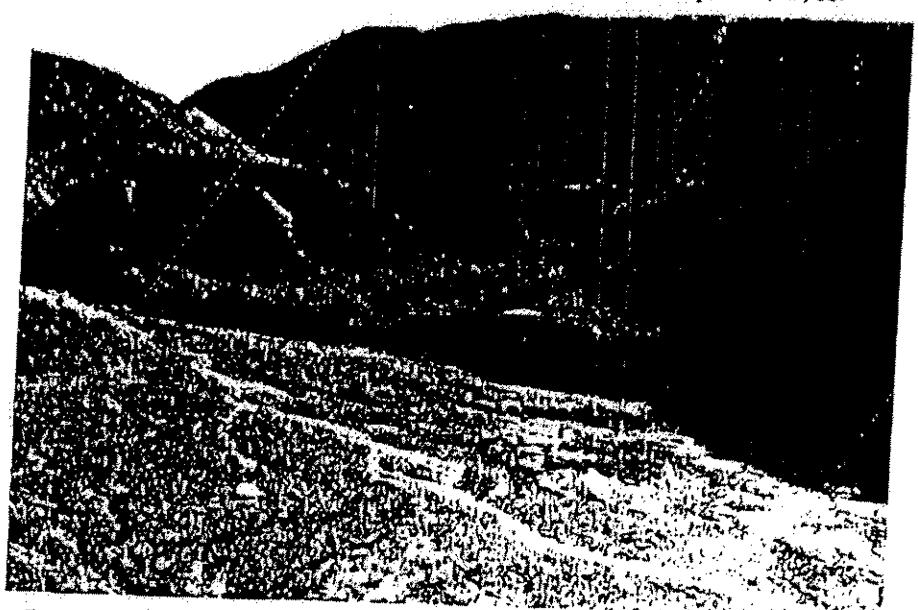

figure 5. Second cell of the new sewage disposal facility; 2000/09/05.

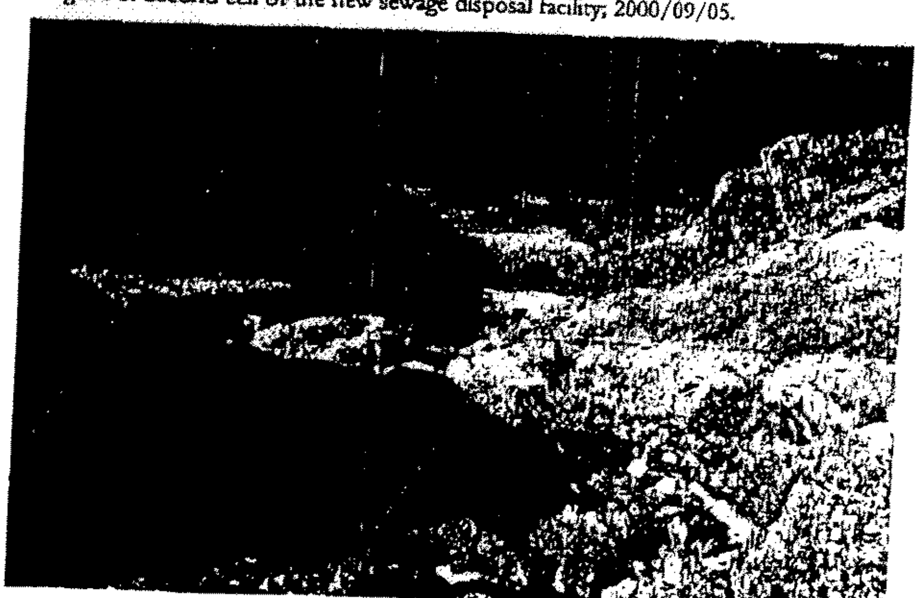

figure 6. Path of discharge from the new sewage disposal facility; 2000/09/05.

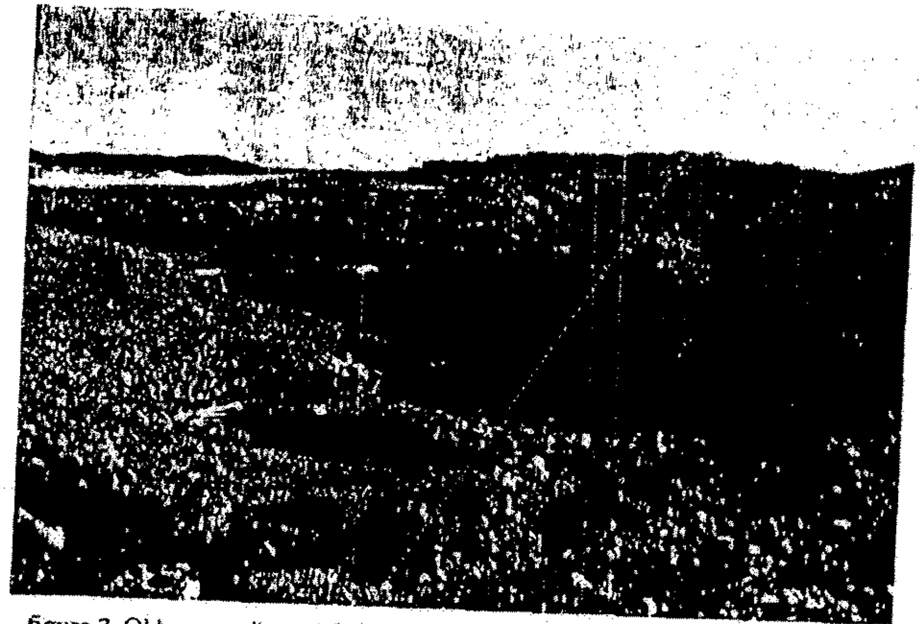

figure 7. Old sewage disposal facility; 2000/09/05.

figure 8. Path of discharge from the old sewage disposal facility; 2000/09/05.

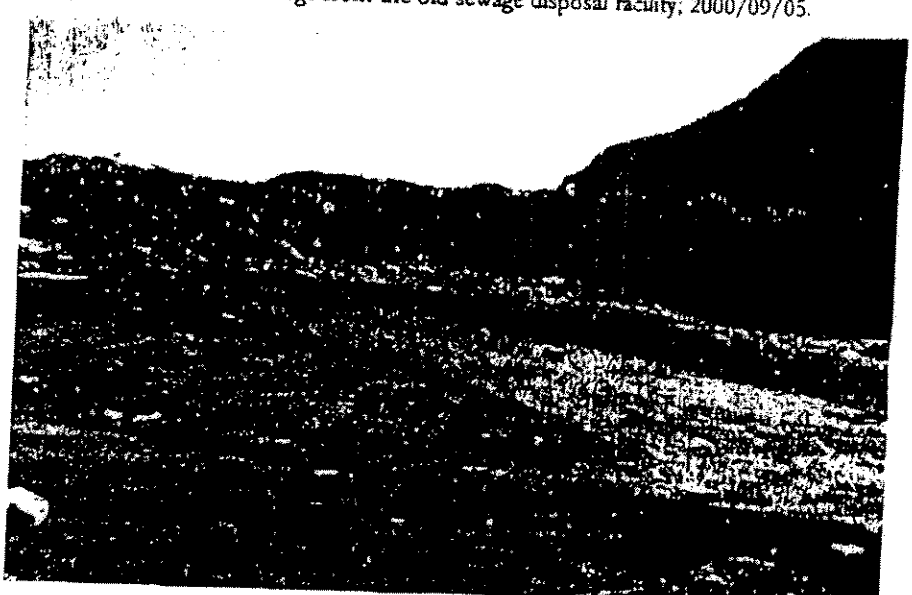

figure 9. Solid waste disposal facility; 2000/09/05.

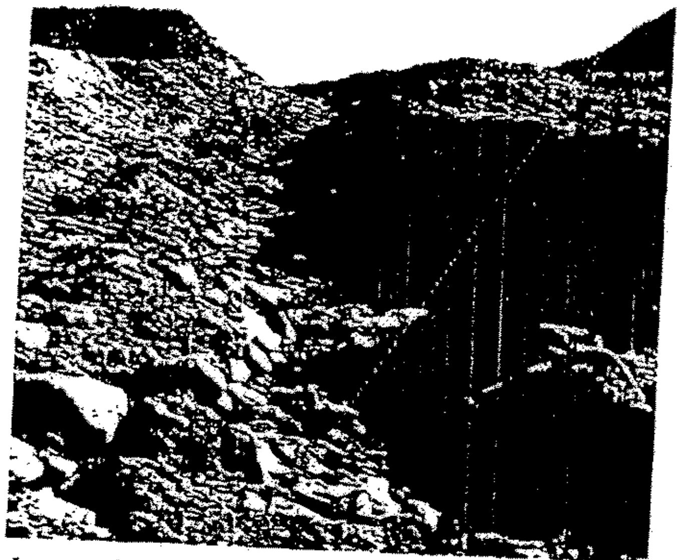

figure 10. Leachate from the solid waste disposal facility; 2000/09/05.

figure 11. Bulky metal wastes disposal facility; 2000/09/05.

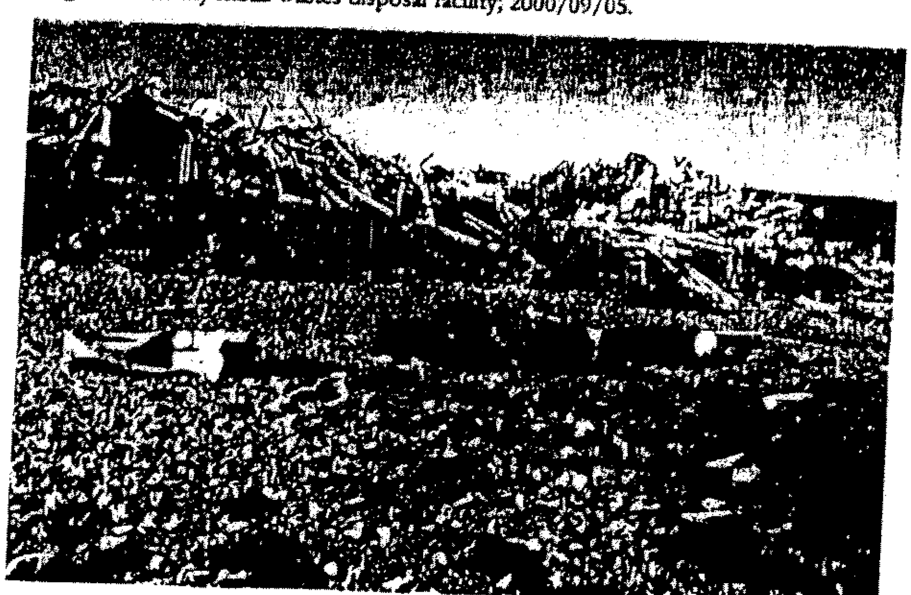

figure 12. Bulky metal wastes disposal facility; 2000/09/05.

TAIGA ENVIRONMENTAL LABORATORY
Dept. Indian Affairs & Northern Development
4601-52 nd Ave., Box 1500
Yellowknife, NT. X1A 2R3
Tel. (867) 669-2788
Fax: (867) 669-2718

To: NUNAVUT
Operations Directorate, DIAND
BOX 100
IQALUIT X0A 0H0
Att'n: Philippe Lavallee

LAB# 201981

SAMPLE INFORMATION

Our Lab#: 201981
Your Sample ID: Lagoon
Sample Matrix: discharge

PROJECT:

Collection:
Location: Cape Dorset
Date: 9/05/00
By: Philippe Lavallee

Received Date: 9/7/00
Report Date: 11-Oct-00
Approved By: W. [signature]

- SAMPLE ANALYSIS REPORT -

Lab#	Test	Result	Units	Detection Limit	Analysis Date	Analytical Method
201981						
	Tot-Suspended-Solids	15	mg/L	3	9/21/2000	EC10406
	NO3-N+NO2-N	0.015	mg/L	0.008	9/29/2000	07110
	Ammonia-N	35.7	mg/L	0.005	9/13/2000	EC7557
	T-Phosphorous	2.73	mg/L	0.004	9/12/2000	EC15411
	Bio-Oxy-Demand	34	mg/L	2	9/07/2000	08208
	Faecal_Coliform	90000	CFU/dL	1	9/08/2000	036014

Field Data (00/09/05) lagoon
Temperature: 9.5 °C
Conductivity: 703 μS
pH: 8.0 Time: 11:39

··IGA ENVIRONMENTAL LABORATORY
Dept. Indian Affairs & Northern Development
4601-52 nd Ave., Box 1500
Yellowknife, NT. X1A 2R3
Tel. (867) 669-2788
Fax: (867) 669-2718

To: NUNAVUT
Operations Directorate, DIAND
BOX 100

IQALUIT X0A 0H0
Att'n: Philippe Lavallee

LAB# 201980

SAMPLE INFORMATION

Our Lab#: 201980
Your Sample ID: Dump
Sample Matrix: leachate

PROJECT:

Collection:
Location: Cape Dorset
Date: 9/05/00
By: Philippe Lavallee

Received Date: 9/7/00
Report Date: 11-Oct-00
Approved By:

- SAMPLE ANALYSIS REPORT -

Lab#	Test	Result	Units	Detection Limit	Analysis Date	Analytical Method
201980						
	Calcium	25.3	mg/L	0.05	9/09/2000	EC20003
	Magnesium	8.67	mg/L	0.01	9/09/2000	012102
	Sodium	61.3	mg/L	0.02	9/10/2000	011102
	Potassium	5.54	mg/L	0.03	9/10/2000	EC19102
	Sulphate	39	mg/L	3	9/27/2000	016306
	Tot-Suspended-Solids	21	mg/L	3	9/21/2000	EC10406
	NO3-N+NO2-N	0.716	mg/L	0.008	9/29/2000	07110
	Ammonia-N	0.185	mg/L	0.005	9/13/2000	EC7557
	T-Phosphorous	0.177	mg/L	0.004	9/12/2000	EC15411

Field Data (00/09/05) dump
Temperature: 6.5 °C
Conductivity: 524 μS
pH: 8.4
Time: 11:15

~~IGA ENVIRONMENTAL LABORATORY
Dept. Indian Affairs & Northern Development
4601-52 nd Ave., Box 1500
Yellowknife, NT. X1A 2R3
Tel. (867) 669-2788
Fax: (867) 669-2718

To: NUNAVUT
Operations Directorate, DIAND
BOX 100

IQALUIT X0A 0H0

Att'n: Philippe Lavallee

LAB# 201979

SAMPLE INFORMATION

Our Lab#: 201979
Your Sample ID: Metal Dump
Sample Matrix: leachate

PROJECT:

RECEIVED 2 OCT 2000 D.I.A.N.D.

Collection:
Location: Cape Dorset
Date: 9/05/00
By: Philippe Lavallee

Received Date: 9/7/00
Report Date: 29-Sep-00
Approved By: W Tead

- SAMPLE ANALYSIS REPORT -

Lab#	Test		Result	Units	Detection Limit	Analysis Date	Analytical Method
201979							
	Tot-Suspended-Solids		10	mg/L	3	9/21/2000	EC10406
	Ammonia-N	<	0.005	mg/L	0.005	9/13/2000	EC7557
	T-Phosphorous		0.035	mg/L	0.004	9/12/2000	EC15411
	Total Arsenic(w)-GFAA	<	1	ug/L	1	9/18/2000	GFAA
	Tot-Cadmium(ICP-MS)	<	0.3	ug/L	.3	8/09/2000	ICP-MS
	Tot-Cobalt(ICP-MS)	<	1	ug/L	1	8/09/2000	ICP-MS
	Tot-Chromium(ICP-MS)		3	ug/L	3	8/09/2000	ICP-MS
	✓ Tot-Copper(ICP/MS)		3	ug/L	2	8/09/2000	ICP-MS
	Tot-Iron(AA)		1.75	mg/L	0.03	9/12/2000	ICP-MS
	Tot-Manganese(ICP-MS)		16	ug/L	1	8/09/2000	ICP-MS
	Tot-Nickel(ICP-MS)		2	ug/L	1	8/09/2000	ICP-MS
	✓ Tot-Lead(ICP-MS)		1	ug/L	1	8/09/2000	ICP-MS
	✓ Tot-Zinc(ICP-MS)	<	10	ug/L	10	8/09/2000	ICP-MS
	✓ Tot-Mercury(water)	<	0.01	ug/L	0.01	9/08/2000	080314

Field Data (00/09/05) metal dump
Temperature: 9.0 °C
Conductivity: 353 uS

N.W.T. SPILL REPORT

Oil, Gas, Hazardous Chemicals or other Materials

24-Hour Report Line
Phone (403) 920-8130
Fax (403) 873-6924

A Report date and time: May 26, 2000 15:00

B Date and time of spill (if known): May 26 2000 08:50

C Original report / Update no. — Spill number: 00-130

E Location and map coordinates (if known) and direction (if moving): RCMP & Hamlet of Cape Dorset

F Product(s) spilled and estimated quantities: P50 Fuel oil 800 - 1000 litres

G Cause of spill: Valve on fuel tank snapped off

H Is spill terminated? Yes / No

I If spill is continuing, give estimated rate: Nil

J Is further spillage possible? Yes / No

K Extent of contaminated area: 20m²

L Factors affecting spill or recovery (weather conditions, terrain, snow cover, etc.): Snow is level

M Containment (natural depressions, dykes, etc.): yes

N Action, if any, taken or proposed to contain, recover, clean up or dispose of product(s) and contaminated materials:
immediate action was taken Snow is being removed to dump for destruction by Fire Front end loader is being used to remove snow.

O Do you require assistance? Yes / No

P Possible hazards to persons, property, or environment, eg.: fire, drinking water, fish or wildlife: NO

Q Comments and/or recommendations:
Spill is larger than originally assumed Area of contamination is the same as original report.

FOR SPILL LINE USE ONLY
Lead Agency: GN
Spill significance:
Lead Agency contact and time:
Robert Reid, MAY 26/00 14:18

Is lead agency change required?

COPY

INTERNAL
PC
LA Mar 13/01
...
Copy
Dist'n: March/13/01
cc: dfo

Reported by: David Whitewolf	Position, Employer, Location: Wildlife Officer	Telephone: 867-897-8932
Reported to: spill line	Position, Employer, Location: Sustainable Development Govt of Nunavut	Telephone: 867-897 975-5955

NWT 1746 (6/91)

Spill Report Fax

Dial Group #001

Nunavut

Date: March 9, 2001

To: **Baffin Regional Superintendent**-Department of Sustainable Development-Pond Inlet

Lands Manager-Department of Community Government, Housing & Transportation-Kugluktuk

Environmental Health Officer-Department of Health & Social Services-Iqaluit

Nunavut Emergency Services

Nunavut Water Board

Assistant Fire Marshal-Department of Community Government, Housing & Transportation-Cape Dorset

Hamlet of Cape Dorset

Wildlife Officer-Cape Dorset Area Office

From: Environmental Protection Division
Department of Sustainable Development-HQ
Government of Nunavut
P.O. Box 1000, Station 1195
Iqaluit, NU
X0A 0H0

Tel (867) 975-5900
Fax (867) 975-5980

Pages: 2, Including Cover

Comments:
Spill Report 00-130

APR-29-03 13:32 FROM: ID:867 360 6369 PAGE 14/15

8678736924 AAL STATN/SPILL LINE 561 P01/01 AUG 11 '00 17:49

8678736924 AAL STATN/SPILL LINE 984 P01 MAY 26 '00 13:01

N.W.T. SPILL REPORT

(Oil, Gas, Hazardous Chemicals or Other Materials)

24-Hour Report Line
Phone (403) 920-8130
Fax (403) 873-6924

A. Report date and time: August 11 2000 ~~15:50~~ 1713

B. Date and time of spill (if known): August 11, 2000

C. Original report / Update no. — Spill number: 00-222

D. Location and map coordinates (if known) and direction (if moving): Above high water mark on beach in front of Cape Dorset

E. Party responsible for spill: Parr Family owners of Peterhead boat

F. Product(s) spilled and estimated quantities (provide metric values if possible): 450 diesel Fuel

G. Cause of spill: Old Peterhead boat Fuel tank ruptured

H. Is spill terminated? yes / no

I. If spill is continuing, give estimated rate:

J. Is further spillage possible? yes / no

K. Extent of contaminated area (in square metres if possible): 5 m²

L. Factors affecting spill or recovery (weather conditions, terrain, snow cover, etc.): nil

M. Containment (natural depression, dykes, etc.): Sand

N. Action, if any, taken or proposed to contain, recover, clean up or dispose of product(s) and contaminated materials: Remaining Fuel in tank pumped out, will remove contaminated sand

O. Do you require assistance? no / yes, describe

P. Possible hazards to persons, property, or environment, eg. fire, drinking water, fish or wildlife:

Q. Comments and/or recommendations:

Rob Eno advised of blank spaces above, he will follow up and request that reporting officer fill these out.
YG. - Spill Line.

FOR SPILL LINE USE ONLY

Lead Agency:

Spill significance:

Lead Agency contact and time:

Is this file now closed?

Nunavut Water Board
[illegible] 2001
Public Registry

[illegible]
2
Mon [illegible]
[illegible]
Read
Nov 25/13/01
info
Nirb

Reported by	Position, Employer, Location	Telephone
David White WO II	Dept of Sustainable Development	867-897-8932
Reported to: Y GREEN	OPERATOR SPILL LINE	(867) 920-8130.

NWT 1746/0495

Spill Report Fax

Dial Group #001

Nunavut

Date: March 9, 2001

To: **Baffin Regional Superintendent**-Department of Sustainable Development-Pond Inlet

Lands Manager-Department of Community Government, Housing & Transportation-Kugluktuk

Environmental Health Officer-Department of Health & Social Services-Iqaluit

Nunavut Emergency Services

Nunavut Water Board

Assistant Fire Marshal-Department of Community Government, Housing & Transportation-Cape Dorset

Hamlet of Cape Dorset

Wildlife Officer-Cape Dorset Area Office

From: Environmental Protection Division
Department of Sustainable Development-HQ
Government of Nunavut
P.O. Box 1000, Station 1195
Iqaluit, NU
X0A 0H0

Tel (867) 975-5900
Fax (867) 975-5980

Pages: 2, Including Cover

Comments:
Spill Report 00-222

09-02 THU 11:55 AM CG&T FAX:8679795811 PAGE 1

Derek Chubb — 02-0397

1000

Clifford Haney

FAX TRANSMISSION

Community Government & Transportation
GOVERNMENT OF NUNAVUT
David Parker, Snr. Municipal Planning Engineer
Community Development Division
P.O. BOX 1000, Station 700
IQALUIT, NT, X0A 0H0
PHONE: (867) 975-5311 Fax: (867) 979-5811

TO:	DILLON CONSULTING Y-K	DATE:	MAY 09/02
Att'n	PETER MOORE	No. Of Pages: 6 (Including cover sheet)	
FAX NO.:	(867) 873-3328		
		Reply By:	

Reference: CAPE DORSET E.C INSPECTORS DIRECTION

MESSAGE

Peter,

Here is Inspector's Direction

I have a copy of our response

to him.

Will review it briefly with you

on Friday when you arrive

Please try and "work up" something

that we can have to assist us

when we meet with him

Thanks Dave

IF YOU HAVE NOT RECEIVED ALL THE PAGES, PLEASE CALL THE NUMBER LISTED ABOVE

PA

INSPECTOR'S DIRECTION

Environment Canada
Environmental Protection
Prairie and Northern Region
Iqaluit District Office
P.O. Box 1870
Iqaluit, Nunavut X0A 0H0

PROTECTED

File: 2002-002

25 March 2002

WITHOUT PREJUDICE

TO: **The Hamlet of Cape Dorset**

AND TO: **The Nunavut Territorial Government**

RE: ***FISHERIES ACT* INSPECTOR'S DIRECTION**

This letter constitutes an Inspector's Direction to the Hamlet of Cape Dorset and to the Nunavut Territorial Government, under subsection 38(6) of the Fisheries Act, R.S.C. 1985, c. F-14, as amended and relates to the serious and imminent danger of the deposit of raw sewage into water frequented by fish, to wit: Tellik Inlet; contrary to subsection 36(3) of the Fisheries Act, R.S.C. 1985, c. F-14, as amended.

REASONABLE GROUNDS FOR BELIEF

I, Wade Comin, an Inspector designated by the Minister of Fisheries and Oceans pursuant to subsection 38(1) of the Fisheries Act, R.S.C. 1985, c. F-14, as amended have reasonable grounds to believe:

1. That there is out of the normal course of events a serious and imminent danger of a deposit of a deleterious substance by reason of any condition, that is, raw sewage, in water frequented by fish, that is, Tellik Inlet, that damage or danger to fish habitat or fish or the use by man of fish may reasonably be expected to result therefrom; and that immediate action is necessary to carry out reasonable measures consistent

with safety and with the conservation of fish and fish habitat to prevent such a deposit or to counteract, mitigate or remedy any adverse effects that may reasonably be expected to result from such a danger.

2. That the Hamlet of Cape Dorset and the Nunavut Territorial Government owns the deleterious substance or has the charge, management or control thereof, or has caused or contributed to the causation of a deposit of the deleterious substance or danger thereof.

3. That reasonable measures consistent with safety and with the conservation of fish and fish habitat to prevent any occurrence or to counteract, mitigate or remedy any adverse effects that result or may reasonably be expected to result therefrom have not been taken by the Hamlet of Cape Dorset or the Nunavut Territorial Government as required by subsection 38(5) of the Fisheries Act, R. S. C. 1985, c. F-14, as amended.

4. That on 25 March 2002, I was told by Mr. Arthur Stewart, the Senior Administrative Officer for the Hamlet of Cape Dorset that the Hamlet of Cape Dorset is responsible for the operation, maintenance and repair of the sewage lagoon in the Hamlet of Cape Dorset, Nunavut and therefore responsible for the structural integrity of the berm surrounding the sewage lagoon.

5. That on 25 March 2002, I was told by Mr. Arthur Stewart, the Senior Administrative Officer for the Hamlet of Cape Dorset that the Nunavut Territorial Government owns or has control of the land where the Hamlet of Cape Dorset sewage lagoon is located.

6. That on 24 March 2002, I inspected the area located adjacent to the Hamlet Cape Dorset sewage lagoon which follows a course that at a distance of approximately 100 meters empties directly into Tellik Inlet and as of 24 March 2002 no work or undertaking has been done to prevent the deposit of the deleterious substance or the serious and imminent danger therefrom. From visual observations raw sewage is entering Tellik Inlet.

7. That based upon conversations with Mr. Mathew Jaw, Mayor of the Hamlet of Cape Dorset and information received by me from the Department of Fisheries and Oceans, I am aware that Tellik Inlet is a body of water frequented by fish.

8. That I am aware from personal knowledge that raw sewage constitutes a deleterious substance as defined under section 34 of the Fisheries Act, R. S. C 1985, c. F-14, as amended.

.../2

MEASURES TO BE TAKEN BY THE HAMLET OF CAPE DORSET AND THE NUNAVUT TERRITORIAL GOVERNMENT

Under the authority given to me pursuant to subsection 38(6) of the Fisheries Act, R.S.C. 1985, c. F-14, as amended I do hereby direct the Hamlet of Cape Dorset and the Nunavut Territorial Government to take or cause to be taken, as soon as possible in the circumstances, all reasonable measures consistent with the safety and the conservation of fish and fish habitat to prevent the deposit of aforementioned deleterious substance in water frequented by fish, and to counteract, mitigate or remedy any adverse effects that result or may be expected to result therefrom, including:

1) Taking action, upon receipt of this Direction, to prevent any deposit of a deleterious substance and to prevent any run off and further seepage from entering water frequented by fish.

2) **Advising Environment Canada in writing of the measures that have been taken to prevent the deposit of the deleterious substance in water frequented by fish on or before September 31, 2002.**

3) Monitoring the sewage lagoon until such time that the risk of depositing the deleterious substance in water frequented by fish from this incident is eliminated.

THE LAW

Subsection 36(3) of the Fisheries Act, R. S. C. 1985, c. F-14, as amended. provides that no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water, except in accordance with prescribed Regulations.

Failure to take reasonable measures as required by subsection 38(5) of the Fisheries Act, R. S. C. 1985, c. F-14, as amended and failure to comply with an inspector's direction issued under subsection 38(6) of the Fisheries Act, R. S. C. 1985, c. F-14, as amended are offences under paragraphs 40(3)(e) and 40(3)(f) of the Fisheries Act, R. S. C. 1985, c. F-14, as amended .

Paragraph 40(3) provides that everyone who...

(e) fails to take any reasonable measures that he is required to take under subsection 38(5) or fails to take such measures in the required manner;

../3

and,

(f) fails to comply with the whole or any part of a direction of an inspector under subsection 36(6),

is guilty of an offence punishable on summary conviction and liable, for a first offence, to a fine not exceeding two hundred thousand dollars, and for any subsequent offence, to a fine not exceeding two hundred thousand dollars or to a term of imprisonment for a term not exceeding six months, or to both.

Paragraph 78.1 provides that where any contravention of this Act or the regulations is committed or continued on more than one day, it constitutes a separate offence for each day on which the contravention is committed or continued.

CONCLUSION

Please be advised that this Inspector's Direction is **WITHOUT PREJUDICE** to any further course of action that Environment Canada or any other enforcement agencies may take with respect to these alleged violations of subsection 36(3) of the Fisheries Act, R. S. C. 1985, c. F-14, as amended or any other Act, including prosecution.

I wish to further advise **the Hamlet of Cape Dorset and the Nunavut Territorial Government**, that Environment Canada will be conducting further inspections of the site to verify compliance with this Inspector's Direction.

If you have any questions or require clarification, please contact the undersigned at (867) 975-4644.

Wade Comin
Fisheries Act Inspector

cc: Arthur A. Stewart
Senior Administrative Officer
Hamlet of Cape Dorset
P.O. Box 30
Cape Dorset, Nunavut
XOA OCO

[illegible]
Acting Director
Community Development Division
Community Government and Transportation
Nunavut Territorial Government
P.O. Box 800
Iqaluit, Nunavut
XOA OHO

Mathew Jaw
Mayor
Hamlet of Cape Dorset
P.O. Box 30
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Peter Blackall - Regional Director
Environmental Protection - Prairie and Northern Region, Environment Canada

John Walsh
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Laura Johnston - Manager, Northern Division
Environmental Protection - Prairie and Northern Region, Environment Canada

Craig Broome - Head of Enforcement, Northern Division
Environmental Protection - Prairie and Northern Region, Environment Canada

Renzo Benocci - Director, Enforcement Branch
Environmental Protection Service,
Environment Canada

Ginette Williams - Senior General Counsel
Environment Canada Legal Services

Guy Martin - Chief of Inspections and Investigations
Environmental Protection Service

DILLON
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August 28, 2002

Environment Canada
Environment Protection
Prairie and Northern Region
Iqaluit District Office
PO BOX 1870
Iqaluit, NU XOAOHO

RECEIVED
SEP 05 2002

Attention: Wade Comin
Fisheries Act Inspector

Fisheries Act Inspectors Directive

Dear Mr. Comin,

This letter is in response to Mr. Wade Comin's letter, dated March 25, 2002, addressed to the Government of Nunavut (GN) and the Hamlet of Cape Dorset. Dillon Consulting Limited has been retained by the GN to identify a long-term solution to the community's sewage treatment requirements, and to assist the community and the GN in the implementation of the long-term plan.

In the ***Fisheries Act Inspector'sDirection***, Mr. Comin identifies that the deposit of raw sewage into Tellik Inlet has the potential to cause "serious and imminent danger" to waters frequented by fish and will contravene Section 36(3) of the Fisheries Act. Furthermore, Mr. Comin identifies the sewage as a deleterious substance.

Several actions have been taken by the GN and the community both prior and since the issuance of the ***Fisheries Act Inspector's Direction***. Theses are in summary;

- The community has made an application for the issuance of a ***Water License*** through the Nunavut Water Board. In discussion with Mr. Jim Wall of the Nunavut Water Board, it is understood that the draft license was distributed for comments and the final license will be issued shortly after all the comments received and reviewed.
- An assessment of the existing lagoon facility has been completed to determine the expected treatment results from the existing lagoon in 2002 once the lagoon is on operation.
- The Department of Community Government and Transportation (CG&T) has identified a long-term solution to the sewage treatment issues in Cape Dorset.

The following sections discuss each of these topics.

<u>Nunavut Water Board License</u>

The community of Cape Dorset completed a ***Water License*** application in the fall of 2001 This license application included the operation of the water supply system, the solid waste disposal area, and the operation of the sewage treatment facility. The community's submission was received by the Water Board and distributed for comments in 2002. It is understood that the comment period is completed, and the Water Board is in the process of finalizing the license to be granted to the community.

Without prejudicing the authority of the Water Board to set the limits they deem appropriate; the following table shows typical discharge criteria for small communities discharging to the marine environment in past licenses and are provided in *Guidelines for the Disposal of treated Municipal Wastewater in the Northwest Territories (1992)*.

Table A
Discharge Criteria

Parameter	Criteria
BOD mg/L	120
PH	6 to 9
Ammonia mg/L	Not regulated
SS mg/L	180
Fecal Coliform CFU per dL	Not regulated in marine environment

On the granting of the Water License, the actual compliance parameters will be reviewed, however for the purposes of discussion, the above parameters will be assumed for discharge criteria.

Assessment of the Existing Sewage Lagoon

The existing lagoon's effective working configuration consists of an operating Cell 1, and 2 non operating cells 2 & 3. Cell 1consists of 8,208 m^3 of storage that is available in the spring after the lagoon is drawn down. Cell 1 will receive trucked sewage on a continuous, daily basis (6 days per week). The lagoon effluent percolates through the 'down gradient' west berm of the Cell 1 and flows along the surface of approximately 150 metres of sandy material to ultimately discharge to the marine environment west of the tidal land bridge and away from the community. The discharge from Cell 1 is through the non functioning Cells 2 & 3. Cell 1 dimensions are 30m by 120m and has an approximate surface area of 0.36 ha (1 acre).

Design parameters are as follows;

- The 2002 population (Mar '01 Dillon Report) is 1,268.
- The sewage generation rate is 53,800 m^3 /yr (Mar '01 Dillon Report), or 147 m^3/d.
- No raw sewage characterization data is available.
- To estimate loading, typical domestic organic load rates are assumed to be 0.17 lbs BOD/c/d.
- Average BOD concentration, based on 90 L/cd (gross 116 L/cd) generation rate is estimated to be 665 mg/L.
- Average SS concentration, based on 90 L/cd (gross 116 L/cd) generation rate is estimated to be 1,000 mg/L.
- Average Fecal concentrations in the raw sewage to be in the 1x10E7 to 1x10 E8 level. /100ml

Lagoon Cell 1 loadings are;

- The average hydraulic retention time is 42 days.
- The average organic loading is 215 lbs BOD/ac/d (0 97.7 kg/d).

Based on the above the treatment processes provided with this system are primary treatment by sedimentation in the lagoon and filtration through the granular berm and in the down gradient surface flow. Some secondary treatment through surface oxygen absorption will also occur.

Literature values for treatment expectations are as follows:

Through primary treatment:	BOD removal 25 to **40%** (as particulate BOD) SS removal 40 to **70%**
Filtration allowance through berm	BOD removal 90 to 95% (as particulate BOD) BOD in rapid sand filtration process 60 to 85% SS removal **85** to 95%

In addition there will be some oxidation of the soluble portion of BOD with surface oxygen absorption. Allow **25%** BOD reduction after the primary treatment and prior to the filtration through the berm. Estimated probable fecal concentration by typical decontamination factors for various processes a 50% removal rate in a sedimentation process is a typical result. An effluent result of 5x10E3 to 1x10E4 at the discharge point of the lagoon would be expected. Further reduction of the fecal count would occur in the surface flow area prior to discharging to the marine environment.

A further daily die away of 50 to 75% after it exits through the granular berm is expected. We understand that the sample point for the lagoon will be near water's edge. It will be important to be to define a sampling point down stream from the point where it migrates through the berm, and as close to the marine environment as practical.

Treatment expectations from Cell 1 (using the bold percentages from above treatment ranges) are;

- BOD reduction from 665 to **120 mg/L** (ref. marine discharge criteria 120 mg/L BOD)
- SS reduction from 1000 to **45mg/L** (ref. marine discharge criteria 180 mg/L SS)
- F.Coli reducted to from 10E8 to 10E4 (no ref. discharge criteria)

This is considered to be a conservative estimate of the net treatment. This can be predicted to be achieved based on typical treatment processes described above. Monitoring by the community is expected to be part of the license requirements. If as a result of the monitoring program additional BOD reduction is deemed necessary because the degree of treatment does not achieve these expectations during the summer of 2002, then additional BOD treatment could be achieved by the addition of surface aerators. It is not considered to be necessary to contemplate installing aerators at this time.

The regulators have raised concern with the lagoon's downstream wall stability. It is understood that CG&T indent to undertake capital works to protect this berm from erosion in the summer of 2002. Further that these capital works will enable the lagoon to operate through the winter months. This work includes the following;

- Redirection of the overland flow of spring run-off water away from the toe of the berm walls to prevent erosion of the walls of Cell 2 and 3
- Reconstruction of Cells 2 and 3 down stream walls and the installation of an over flow channel
- Installation of an overflow channel in Cell 1

It is understood that this work is currently underway, and expected to be completed in the coming weeks.

Mr. Comin
August 28, 2002
Page 4

Long Term Sewage Treatment Facility

In March 2001, CG&T retained Dillon Consulting Limited, to conduct a planning study with the goal of that study being to identify a long term solution to the Community of Cape Dorset's sewage treatment requirements. Several options for technologies and alternative locations were reviewed. The results of the study, and subsequent meeting with the community representatives indicate that there are 4 potential options. These are:

Q Lake Lagoon Option– a small lake located to the north east of the community. Initially identified as a potential location for a lagoon. However, in the winter of 2001/2002, the community's water supply pipeline froze, and Q Lake was used as the emergency back-up water supply source. Subsequent to the pipeline freeze up the community stated that Q Lake should not be used as a sewage lagoon facility. The development of road to Q Lake, and the site development for a lagoon at this site has a capital cost estimate of **$1,300,000.**

P-Lake Lagoon Option– a small lake located south of the community. The community identified this site as a potential location for a lagoon. The road to P-Lake would have a capital cost over $1.5 M, if in fact the road construction were possible. This road would have a constant grade of 8 to 10% over a length of approximately 1km. This type of grade over the length of the road will create unsafe conditions in the winter months. The site development costs will be nearing another $1.0M. This capital costs for this option is over $2.5 M. The option would have high operational cost for trucking the sewage along the steep road, and maintaining the steep road through out the winter months. The total capital cost estimate for this option is estimated to be **$2,500,000.**

Site R Lagoon Option– Site R is a flat area north east of the community. This site is currently used as the granular stockpile for CG&T. The site is also located at the end of the runway. The Airports Division has expressed concerns over this location and the potential for the increased bird strike hazard. The site may not meet regulatory approval because of the increased risk of bird strikes. The site development cost for this site is **$1,600,000.**

Existing Site Mechanical Plant Option - installation of a Mechanical Sewage Treatment Plant would be best at the existing lagoon site. The treated sewage effluent discharge is to the south of the tidal bridge. The proposed discharge location results in the effluent being directed away from the community. The effluent discharge location was an important issue to the community during the consultation period. This option carries with it the issue of higher operational costs and concern with hiring and training qualified operators in the community. The cost of the mechanical plant (secondary treatment such as is currently being implemented in Pangnirtung) is **$2,500,000.**

Recently, the community and the GN has come to the consensus that a mechanical plant constructed at the existing site will be the long term sewage treatment system for the community of Cape Dorset. The GN is proceeding with the initial stages of the project implementation through the development of the terms of reference and project description. This project will be completed through the public tendering process in accordance with GN tendering policy. The development of the project will have several stages. The following is an outline of the current schedule for the project implementation.

Project Schedule

Task Item	Start Date	Completion Date
Project Description		
Regulatory Consultation	May 2002	August 2003
Definition of Treatment process	May 2002	August 2002
Definition of Implementation Process	May 2002	August 2002
Development of terms of reference	September 2002	October 2002
Preliminary Design	October 2002	November 2002
Detailed Design	November 2002	January 2003
Tender Period	January 2003	February 2003
Material Order	March 2003	June 2003
Material Mobilization to Site	July 2003	September 2003
Earth Works & Site Development	July 2003	September 2003
Building Construction	September 2003	November 2003
Treatment Plant Installation	November 2003	February 2004
Testing and Start up	March 2004	April 2004
Commissioning	April 2004	May 2004

Review of the *Fisheries Act Inspectors Direction*

We feel that the community can, by properly using the existing lagoon, meet the requirements of the pending ***Water License*** prior to the date issued in this document. Specifically, the order states that the Hamlet of Cape Dorset and the Nunavut Territorial Government are to advise:

"Environment Canada in writing of the measures that have been taken to prevent the deposit of the deleterious substance in water frequented by fish on or before September 30, 2002".

After careful review of all possible long-term sewage treatment options, the GN has chosen to develop a mechanical sewage treatment facility for Cape Dorset. Unfortunately, due to logistical constraints, this system will not be operational until 2004.

The GN and the community understand and recognize the problems associated with the operations witnessed by the **Inspector** with respect to the current sewage treatment facility. Should monitoring results dictate, the GN is willing to develop short-term remedial actions for the existing operation of the lagoon to bring the effluent into the criteria set out in the pending ***Water License***. Mitigation measures, if required, will be scheduled for the summer of 2002.

The Government of Nunavut and the Hamlet of Cape Dorset wish to comply with the various stipulations addressed in Mr. Comin's order. Logistically however, it may not be possible to meet all of these requirements in the time frame indicated. At this time we request that an amendment to the ***Fisheries Act Inspectors Direction*** be added that will allow our client to meet the requirements as outlined in *the* ***Water License***. Further meeting the ***Water License*** requirements by September 2002, will be considered compliance with the ***Fisheries Act Inspectors Directions*** by Mr. Comin.

Water License

EC
FFA

The GN will commit to providing Environment Canada in September 2002 an updated schedule for proposed mechanical plant construction activities, a summary of the summer monitoring program, and a report outlining any remediation carried out on the existing lagoon system.

On behalf of the GN, the Department of Community Government and Transportation and the Hamlet of Cape Dorset, we look forward to working with Environment Canada in developing a successful sewage treatment facility that will meet all water quality criteria specified in the Federal *Fisheries Act*. Should you have any questions or concerns, please contact the undersigned.

Sincerely,

DILLON CONSULTING LIMITED

Gary Strong, P. Eng

Project Manager

Cc *Sameh Elsayed – GN, CG&T Cape Dorset*
Dave Parker – GN, CG&T
Doug Sitland – GN, CG&T

Nunavut

FAX TRANSMISSION

Sameh Elsayed M.A.Sc., P. Eng.
Municipal Planning Engineer
Community Government & Transportation
GOVERNMENT OF NUNAVUT
P.O.Box 330
CAPE DORSET, NU., XOA OCO
PHONE: (867) 897-3616 **FAX:** (867) 897-3633
EMAIL: selsayed@gov.nu.ca

To: **Mr. Derek Chubb**	From: **Sameh Elsayed**
Fax: 1-403-215-8889	Pages: 1 + 18
Phone: 1-403-215-8880	Date: 15/02/2003
Re: **Cape Dorset Water Licence**	CC:

☐ Urgent ☑ For Review ☐ Please Comment ☐ Please Reply ☐ Please Recycle

Comments

Hi Derek,

Following to our telephone conversation. Please find attached a copy of Cape Dorset Water Licence.

Should you have any queries, please do not hesitate to contact me.

Regards,

Sameh Elsayed

Enc.

P.O. Box 119
Gjoa Haven, NU X0B 1J0
Tel: (867) 360-6338
Fax: (867) 360-6369

NK5 wmoEp5 vtmpR
NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI

DECISION

LICENCE NUMBER: NWB3CAP0207

This is the decision of the Nunavut Water Board (NWB) with respect to an application for a Licence dated 19 April 2001, made by:

Hamlet of Cape Dorset

to allow for the use of water and disposal of waste for the Hamlet at Cape Dorset, Nunavut.

With respect to this application, the NWB gave notice to the public that the Hamlet had filed an application for a water licence.

DECISION

After having been satisfied that the application was exempt from the requirement for screening by the Nunavut Impact Review Board in accordance with S. 12.3.2 of the *Nunavut Land Claim Agreement* (NLCA), the NWB decided that the application could go through the regulatory process. After reviewing the submission of the Applicant and written comments expressed by interested parties, the NWB, having given due regard to the facts and circumstances, the merits of the submissions made to it and to the purpose, scope and intent of the *Nunavut Land Claims Agreement* and of the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* (NWNSRTA), decided to waive the requirement to hold a public hearing and furthermore to delegate its authority to approve the application to the Chief Administrative Officer pursuant to S. 49(a) of the NWNSRTA and determined that:

Licence Number NWB3CAP0207 be issued subject to the terms and conditions contained therein. (Motion #: 2002-11)

SIGNED this _______ day of September, 2002 at Gjoa Haven, NU.

____
Philippe di Pizzo
Chief Administrative Officer

TABLE OF CONTENTS

I. INTRODUCTION

Following an application filed by the Hamlet of Cape Dorset on April 19, 2001 to the Nunavut Water Board, the Board conducted an initial assessment of the Hamlet's request for a municipal water licence for water use and waste disposal activities within the Hamlet. The assessment was conducted so that the Nunavut Water Board could make a fully informed decision on the application. The application was referred for review and comments to Federal, Territorial and local organizations. Based upon the results of this initial assessment and the technical review, including consideration of any potential accidents, malfunctions, or cumulative environmental effects that the overall project might have in the area, the Board concluded that this application was complete and could go through the regulatory process

In accordance with the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* S. 55.1 and Article 13 of the *Nunavut Land Claims Agreement*, public notice of the application was posted. No public concerns were expressed, and the NWB waived the requirement to hold a public hearing for the application. Authority to approve the application was delegated to the Chief Administrative Officer pursuant to S. 13 7.5 of the *Agreement*. After considering and reviewing the comments submitted by interested parties, the NWB has issued licence NWB3CAP0207.

II. GENERAL CONSIDERATIONS

Term of the Licence

In accordance with the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* S. 45, the NWB may issue a licence for a term not exceeding twenty-five years. The NWB believes that a term of five years is appropriate Because this is the first licence issued to the Hamlet by the Nunavut Water Board, a 5-year licence will allow enough time for the Hamlet to establish a consistent compliance record. The 5-year licence will allow the Licensee to properly carry out the terms and conditions of the licence and to ensure that sufficient time is given to permit the Licensee to develop, submit, and implement the plans required under the licence to the satisfaction of the NWB.

Annual Report

The requirements imposed on the Licensee in this licence are for the purpose of ensuring that the NWB has an accurate annual update of municipal activities during a calendar year. This information is maintained on the public registry and is available to any interested parties upon request. Refer to attached standard form for completing Annual Report (see Attachment 1).

Regulated Parameters

Effluent quality criteria imposed in this Licence are consistent with the *Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories* (Northwest Territories Water Board; 1992), and follow advice received from both the Department of Indian and Northern Affairs and Environment Canada.

Operation and Maintenance Manual (O&M) SEPT. 1, 2003 Pg 11 PART F (1)

The purpose of an Operation and Maintenance Manual is to assist Hamlet staff in the proper operation and maintenance of their waste disposal facilities. The manual should demonstrate to the Nunavut Water Board that the Hamlet is capable of operating and maintaining all waste disposal sites adequately. The Plan should be completed using the *Guidelines for the Preparation of an Operations and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories* (Duong and Kent, 1996; see Attachment II). MICHAEL WILL SEND THIS.

Abandonment and Restoration (A&R)

To ensure that all future abandoned facilities are reclaimed in an appropriate manner, the NWB has imposed the requirement for the submission of Abandonment and Restoration Plans. These plans should be submitted when the Licensee files preliminary design drawings for the construction of new facilities to replace existing ones.

Surveillance Network Program PART D ITEM 2 Pg. 9

The Surveillance Network Program (SNP) is a monitoring program established to collect data on water quality to assess the effectiveness of treatment for protection of public health and to assess potential impacts to the environment associated with the municipal facilities. As this is the first Municipal Water Licence issued to the Hamlet by the Board, minimum requirements have been imposed, but additional sampling may be required by an Inspector.

Quality Assurance/Quality Control (QA/QC) Plan

The requirements to develop a QA/QC Plan imposed on the Licensee in this licence are for the purpose of ensuring the NWB that samples taken in the field as part of the SNP will maintain a high quality, so as to accurately represent the physical and chemical nature of the samples being taken

LICENCE NWB3CAP0207

Pursuant to the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* and the *Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in Right of Canada*, the Nunavut Water Board, hereinafter referred to as the Board, hereby grants to

HAMLET OF CAPE DORSET
(Licensee)

of CAPE DORSET, NUNAVUT, X0A 0C0
(Mailing Address)

hereinafter called the Licensee, the right to alter, divert or otherwise use water for a period subject to restrictions and conditions contained within this licence:

Licence Number	NWB3CAP0207
Water Management Area	NUNAVUT 05
Location	CAPE DORSET, NUNAVUT
Purpose	WATER USE AND WASTE DISPOSAL
Description	MUNICIPAL UNDERTAKINGS
Quantity of Water Not to be Exceeded	70,000 CUBIC METRES ANNUALLY
Date of Licence	SEPTEMBER 1, 2002
Expiry Date of Licence	AUGUST 31, 2007

Dated this ____ of September 2002 at Gjoa Haven, NU.

Philippe di Pizzo
Chief Administrative Officer

PART A: SCOPE AND DEFINITIONS

1. **Scope**

a This Licence allows for the use of water and the disposal of waste for municipal undertakings at the Hamlet of Cape Dorset, Nunavut (64°14'N, 76°32'W).

b. This Licence is issued subject to the conditions contained herein with respect to the taking of water and the depositing of waste of any type in any waters or in any place under any conditions where such waste or any other waste that results from the deposits of such waste may enter any waters. Whenever new Regulations are made or existing Regulations are amended by the Governor in Council under the *Nunavut Waters and Nunavut Surface Rights Tribunal Act*, or other statutes imposing more stringent conditions relating to the quantity or type of waste that may be so deposited or under which any such waste may be so deposited, this Licence shall be deemed, upon promulgation of such Regulations, to be subject to such requirements; and:

* c. Compliance with the terms and conditions of this Licence does not absolve the Licensee from responsibility for compliance with the requirements of all applicable Federal, Territorial and Municipal legislation.

2. **Definitions**

In this Licence, **NWB3CAP0207**

* "**Act**" means the *Nunavut Waters and Nunavut Surface Rights Tribunal Act;* Committee

"**Amendment**" means a change to original terms and conditions of this licence requiring correction, addition or deletion of specific terms and conditions of the licence; modifications inconsistent with the terms of the set terms and conditions of the Licence;

"**Analyst**" means an Analyst designated by the Minister under Section 85 (1) of the *Act*;

"**Appurtenant undertaking**" means an undertaking in relation to which a use of waters or a deposit of waste is permitted by a licence issued by the Board;

* "**Average Concentration**" means the arithmetic mean of the last four consecutive analytical results for contained in composite or grab samples collected from the Waste Facility's final discharge point;

"**Average Concentration For Faecal Coliforms**" means the geometric mean of the last four consecutive analytical results for faecal coliforms contained in composite or grab samples collected from the Waste Facility's final discharge point;

"**Board**" means the Nunavut Water Board established under the *Nunavut Land Claims Agreement*;

"**Chief Administrative Officer**" means the Executive Director of the Nunavut Water Board;

"**Commercial Waste Water**" means water and associated waste generated by the operation of a commercial enterprise, but does not include toilet wastes or greywater;

"**Effluent**" means treated or untreated liquid waste material that is discharged into the environment from a structure such as a settling pond or a treatment plant;

"**Freeboard**" means the vertical distance between water line and crest on a dam or dyke's upstream slope;

"**Grab Sample**" means a single water or wastewater sample taken at a time and place representative of the total discharge;

"**Greywater**" means all liquid wastes from showers, baths, sinks, kitchens and domestic washing facilities, but does not include toilet wastes,

"**Inspector**" means an Inspector designated by the Minister under Section 85 (1) of the *Act*;

"**Licensee**" means the holder of this Licence;

"**Modification**" means an alteration to a physical work that introduces new structure or eliminates an existing structure and does not alter the purpose or function of the work, but does not include an expansion, and changes to the operating system that are consistent with the terms of this Licence and do not require amendment;

"**Nunavut Land Claims Agreement**" (NLCA) means the "Agreement Between the Inuit of the Nunavut Settlement Area and Her Majesty the Queen in right of Canada," including its preamble and schedules, and any amendments to that agreement made pursuant to it;

"**Sewage**" means all toilet wastes and greywater.

"**Sewage Disposal Facilities**" comprises the area and engineered lagoon and decant structures designed to contain sewage as described in the Application for Water Licence filed by the Applicant on April 19, 2001;

"**Solid Waste Disposal Facilities**" comprises the area and associated structures designed to contain solid waste (landfill site) as described in the Application for Water Licence filed by the Applicant on April 19, 2001,

"**Surveillance Network Program**" means a monitoring program established to collect data on surface water and groundwater quality to assess impacts to the environment of an appurtenant undertaking.

"**Toilet Wastes**" means all human excreta and associated products, but does not include greywater;

"**Waste**" means, as defined in S.4 of the *Act*, any substance that, by itself or in combination with other substances found in water, would have the effect of altering the quality of any water to which the substance is added to an extent that is detrimental to its use by people or by any animal, fish or plant, or any water that would have that effect because of the quantity or concentration of the substances contained in it or because it has been treated or changed, by heat or other means;

"**Waste Disposal Facilities**" means all facilities designated for the disposal of waste, and includes the Sewage Disposal Facilities, Solid Waste Disposal Facilities, and Bagged Toilet Waste Disposal Facilities, as described in the Application for Water Licence filed by the Applicant on April 19, 2001, and;

"**Water Supply Facilities**" comprises the area and associated intake infrastructure at Tee Lake, as described in the Application for Water Licence filed by the Applicant on April 19, 2001

PART B: GENERAL CONDITIONS

1. The Licensee shall file an Annual Report with the Board not later than March 31st of the year following the calendar year reported which shall contain the following information:

   i. tabular summaries of all data generated under the "Surveillance Network Program";

   ii. the monthly and annual quantities in cubic metres of fresh water obtained from all sources;

   iii. the monthly and annual quantities in cubic metres of each and all waste discharged;

   iv. a summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures and facilities;

v. a list of unauthorized discharges and summary of follow-up action taken

vi. a summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year;

vii. a summary of any studies, reports and plans (e.g., Operation and Maintenance, Abandonment and Restoration, QA/QC) requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned;

viii. any other details on water use or waste disposal requested by the Board by November 1st of the year being reported; and

2. The Licensee shall comply with the "Surveillance Network Program" described in this Licence, and any amendments to the "Surveillance Network Program" as may be made from time to time, pursuant to the conditions of this Licence.

3. The "Surveillance Network Program" and compliance dates specified in the Licence may be modified at the discretion of the Board.

4. Meters, devices or other such methods used for measuring the volumes of water used and waste discharged shall be installed, operated and maintained by the Licensee to the satisfaction of an Inspector.

5. The Licensee shall, within ninety (90) days after the first visit of the Inspector, post the necessary signs, where possible, to identify the stations of the "Surveillance Network Program." All signage postings shall be in the Official Languages of Nunavut, and shall be located and maintained to the satisfaction of an Inspector.

* 6. The Licensee shall immediately report to the 24-Hour Spill Report Line (867-920-8130) any spills of Waste, which are reported to or observed by the Licensee, within the municipal boundaries or in the areas of the Water Supply or Waste Disposal Facilities

* 7. The Licensee shall ensure a copy of this Licence is maintained at the municipal office and at the site of operation at all times. Any communication with respect to this Licence shall be made in writing to the attention of:

(i) **Chief Administrative Officer:**

Executive Director
Nunavut Water Board
P. O Box 119
Gjoa Haven, NU X0B 1J0
Telephone: (867) 360-6338
Fax: (867) 360-6369

ii) **Inspector Contact:**

Water Resources Officer
Nunavut District, Nunavut Region
P.O. Box 100
Iqaluit, NU X0A 0H0
Telephone: (867) 975-4298
Fax: (867) 979-6445

(iii) **Analyst Contact**

Taiga Laboratories
Department of Indian and Northern Affairs
4601 - 52 Avenue, P.O. Box 1500
Yellowknife, NT X1A 2R3
Telephone (867) 669-2781
Fax: (867) 669-2718

8. The Licensee shall submit one paper copy and one electronic copy of all reports, studies, and plans to the Board. Reports or studies submitted to the Board by the Licensee shall include a detailed executive summary in Inuktitut.

PART C: CONDITIONS APPLYING TO WATER USE

1. The Licensee shall obtain all fresh water from Tee Lake using the Water Supply Facilities or as otherwise approved by the Board.

2. The annual quantity of water used for all purposes shall not exceed 70,000 cubic metres.

3. The Licensee shall maintain the Water Supply Facilities to the satisfaction of the Inspector.

4. The water intake hose used on the water pumps shall be equipped with a screen with a mesh size sufficient to ensure no entrainment of fish.

PART D: CONDITIONS APPLYING TO WASTE DISPOSAL

1. The Licensee shall direct all Sewage to the Sewage Disposal Facilities or as otherwise approved by the Board.

2. All Effluent discharged from the Sewage Disposal Facilities at "Surveillance Network Program" Station Number CAP-3 shall meet the following effluent quality standards:

Parameter	Maximum Average Concentration
Faecal Coliforms	1×10^{6} CFU/dl
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Oil and grease	No visible sheen
pH	between 6 and 9

3. A Freeboard limit of 1.0 metre, or as recommended by a qualified geotechnical engineer and as approved by the Board, shall be maintained at all dykes and earthfill structures associated with the Sewage Disposal Facilities.

4. The Licensee shall advise an Inspector at least ten (10) days prior to initiating any decant of the sewage lagoon.

5. The sewage lagoon shall be maintained and operated in such a manner as to prevent structural failure.

6. The Licensee shall maintain the Sewage Disposal Facilities to the satisfaction of an Inspector.

7. The Licensee shall dispose of and contain all solid wastes at the Solid Waste Disposal Facilities or as otherwise approved by the Board.

8. The Licensee shall implement measures to ensure hazardous materials and/or leachate from the Solid Waste Disposal Facility does not enter water.

PART E: CONDITIONS APPLYING TO MODIFICATION AND CONSTRUCTION

* 1. The Licensee shall submit to the Board for approval design drawings stamped by a qualified engineer registered in the Nunavut prior to the construction of any dams, dykes or structures intended to contain, withhold, divert or retain water or wastes.

2. The Licensee may, without written approval from the Board, carry out modifications to the Water Supply and Waste Disposal Facilities provided that such modifications are consistent with the terms of this Licence and the following requirements are met:

   i) the Licensee has notified the Board in writing of such proposed modifications at least sixty (60) days prior to beginning the modifications;

   ii. said modifications do not place the Licensee in contravention of the Licence or the *Act*,

   iii. the Board has not, during the sixty (60) days following notification of the proposed modifications, informed the Licensee that review of the proposal will require more than sixty (60) days; and

   iv. the Board has not rejected the proposed modifications.

3. Modifications for which all of the conditions referred to in Part E, Item 1, have not been met may be carried out only with written approval from the Board.

4. The Licensee shall provide as built plans/drawings of the modifications referred to in this Licence within ninety (90) days of completion of the modifications.

PART F: CONDITIONS APPLYING TO OPERATION AND MAINTENANCE

1. The Licensee shall, before September 1, 2003 submit to the Board for approval, a plan for the Operation and Maintenance of the Sewage and Solid Waste Disposal Facilities in accordance with *"Guidelines for preparing an Operation and Maintenance Manual for Sewage and solid Waste Disposal Facilities"* (October 1996).

2. The Licensee shall implement the Plan specified in Part F, Item 1 as and when approved by the Board.

3. The Licensee shall revise the Plan referred to in Part F, Item 1, if not acceptable to the Board. The revised Plan shall be submitted to the Board for approval within thirty (30) days of notification of the Board decision.

4. If, during the period of this Licence, an unauthorized discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:

   i. employ the appropriate contingency plan as provided for in the Operation and Maintenance Plan;

   ii. report the incident immediately via the 24-Hour Spill Reporting Line at (867) 920-8130 and to an Inspector; and

   iii. submit to an Inspector a detailed report on each occurrence not later than thirty (30) days after initially reporting the event.

PART G: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION

1. The Licensee shall submit to the Board for approval an Abandonment and Restoration Plan at least six (6) months prior to abandoning any facilities and the construction of new facilities to replace existing ones. The Plan shall include, but not be limited to where applicable:

   i. water intake facilities;

   ii. the water treatment and waste disposal sites and facilities;

   iii. petroleum and chemical storage areas;

   iv. any site affected by waste spills;

   v. leachate prevention;

   vi. an implementation schedule;

   vii. maps delineating all disturbed areas, and site facilities;

   viii. consideration of altered drainage patterns;

ix. type and source of cover materials;

x. future area use;

xi. hazardous wastes; and

xii. a proposal identifying measures by which restoration costs will be financed by the Licensee upon abandonment.

2. The Licensee shall implement the plan specified in Part G, Item 1 as and when approved by the Board.

3. The Licensee shall revise the Plan referred to in Part G, Item 1 if not approved. The revised Plan shall be submitted to the Board for approval within thirty (30) days of receiving notification of the Board's decision.

4. The Licensee shall complete the restoration work within the time schedule specified in the Plan, or as subsequently revised and approved by the Board.

PART H: CONDITIONS APPLYING TO THE SURVEILLANCE NETWORK PROGRAM

1. The Licensee shall maintain Surveillance Stations at the following locations:

Station Number	Description
* CAP-1	Raw Water supply prior to treatment T LAKE
* CAP-2	Runoff from the Solid Waste Disposal Facilities
* CAP-3	Effluent discharge from the Sewage Disposal Facilities

2. * The Licensee shall sample monthly at Surveillance Stations CAP-2 and CAP-3 during the months of May to August, inclusive.

CONTACT LAB - WHAT BOTTLES ARE NEEDED

??

* TA
TAGA LAB IN YK

3 The Licensee shall analyze samples collected at Station Number CAP-2 and CAP-3 for the following parameters:

BOD
pH
Total Suspended Solids
Nitrate-Nitrite
Total Phenols
Sodium
Magnesium
Total Arsenic
Total Copper
Total Iron
Total Mercury
Total Zinc
Faecal Coliforms
Conductivity
Ammonia Nitrogen
Oil and Grease (visual)
Sulphate
Potassium
Calcium
Total Cadmium
Total Chromium
Total Lead
Total Nickel

23 [illegible]

4 Additional sampling and analysis may be requested by an Inspector;

5. The Licensee shall conform to the Quality Assurance/Quality Control (QA/QC) Plan which shall be provided to the Licensee by the NWB within 60 days of the issuance of this licence;

* 6. All sampling, sample preservation and analyses shall be conducted in accordance with methods prescribed in the current edition of *Standard Methods for the Examination of Water and Wastewater*, or by such other methods approved by the Board;

* 7. All analyses shall be performed in a Canadian Association of Environmental Analytical Laboratories (CAEAL) Certified Laboratory, or as otherwise approved by an Analyst; [illegible]

* 8. The Licensee shall measure and record in cubic metres the monthly and annual quantities of water pumped from Surveillance Network Program Station Number CAP-1 for all purposes;

9. The Licensee shall measure and record the annual quantities of sewage solids removed from the Sewage Disposal Facility;

10. The Licensee shall, unless otherwise requested by an Inspector, include all of the data and information required by the "Surveillance Network Program" in the Licensee's Annual Report, as required *per* Part B, Item 1; and

11. Modifications to the Surveillance Network Program may be made only upon written approval of the Chief Administrative Officer.

ANNUAL REPORT FOR THE HAMLET OF CAPE DORSET

YEAR BEING REPORTED:__________

The following information is compiled pursuant to the requirements of Part B, Item 1 of Water Licence NWB3CAP0207 issued to the Hamlet of Cape Dorset.

i)- iii) tabular summaries of all data generated under the "Surveillance Network Program"; monthly and annual quantities in cubic metres of freshwater obtained from all sources; monthly and annual quantities in cubic metres of each and all wastes discharged;

Attached Laboratory results for SNP station CAP-2 and CAP-3

Month Reported	Quantity of Water Obtained from all sources	Quantity of Sewage Waste Discharged
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		
ANNUAL TOTAL		

ANNUAL REPORT
FOR THE HAMLET OF CAPE DORSET

Please indicate volumes in cubic metres - 1 cubic meter equals 1000 litres

iv) a summary of modifications and/or major maintenance work carried out on the Water Supply and Waste Disposal Facilities, including all associated structures and facilities;

v) a list of unauthorized discharges and summary of follow-up action taken;

vi) a summary of any abandonment and restoration work completed during the year and an outline of any work anticipated for the next year;

vii) a summary of any studies requested by the Board that relate to waste disposal, water use or reclamation, and a brief description of any future studies planned;

Part F. Item 1: Operation and Maintenance Manual

Part G, Item 1: Abandonment and Restoration Plan

ANNUAL REPORT FOR THE HAMLET OF CAPE DORSET

viii) any other details on water use or waste disposal requested by the Board by November 1st of the year being reported; and

ix) updates or revisions to the approved Operation and Maintenance Plans.

ADDITIONAL INFORMATION THAT THE HAMLET DEEMS USEFUL:

FOLLOW-UP REGARDING INSPECTION/COMPLIANCE CONCERNS:

Nunavut

Sameh Elsayed, P. Eng., M.A.Sc.
Regional Municipal Planning Engineer
Community Government & Transportation
GOVERNMENT OF NUNAVUT
P.O.Box 330
CAPE DORSET, NU., XOA OCO
PHONE: (867) 897-3616 FAX: (867) 897-3633
EMAIL: selsayed@gov.nu.ca

March 6, 2003

Environment Canada
Environmental Protection Branch
Suite 301, 5204 - 50th Avenue
Yellowknife, Northwest Territories
Canada X1A 1E2

Attention: Mr. Craig Broome
Head of Enforcement, Northern Division

Re: The Hamlet of Cape Dorset
Long Term Sewage Management Plan

In March 2002, Environment Canada raised concerns regarding the management of sewage in the Hamlet of Cape Dorset (Community) through the issuance of a Directive outlining specific measures to be taken to prevent the release of a deleterious substance to the Telik Inlet. Concerns stemmed from the use of a former lagoon for the deposition of sewage during a period in which two (2) cells of the existing lagoon were rendered inoperable due to a breach in the water retaining berms. Environment Canada was concerned that the former lagoon was of insufficient capacity to provide adequate treatment and, at the time of the inspection, work was not underway to repair breached berms of the current lagoons.

A letter was sent to EC, dated August 28, 2002 in response to the Directive issued to the Hamlet of Cape Dorset (Hamlet) and the Government of Nunavut (GN). The purpose of the letter was to advise EC that work was in fact proceeding to alleviate concerns over the management of the sewage, including:

- Reconstruction and reinforcement of the sewage lagoon berms that had been breached.
- The construction of drainage ditches to redirect surface water flow around the lagoon cells in an attempt to reduce the likelihood for erosion/breach, and
- The development of a long-term sewage management plan.

The referenced construction work was completed in the summer of 2002 and with the redirection of sewage to the three-cell lagoon: these steps in themselves met the intent of the Directive issued by EC. A site inspection was completed by Mr. Wade Comin, who was the EC inspector at the time. Mr. Comin did not raise any concerns with the work completed by GN.

Currently, all sewage generated by the Community is being directed to the three-cell lagoon. GN and the Hamlet are confident that the work completed in 2002 will ensure that the integrity of the lagoon berms is maintained during spring melt and throughout the open water season. However,

Where the risk !!

Appendix E
Concept Brief and Equipment Specification

Cape Dorset Mechanical Sewage Treatment Plant

Concept Design Brief - Draft

February, 2003

Our File: 02-0397-6000

Submitted by:

Dillon Consulting Limited

Cape Dorset
Mechanical Sewage Treatment Plant
Concept Design Brief

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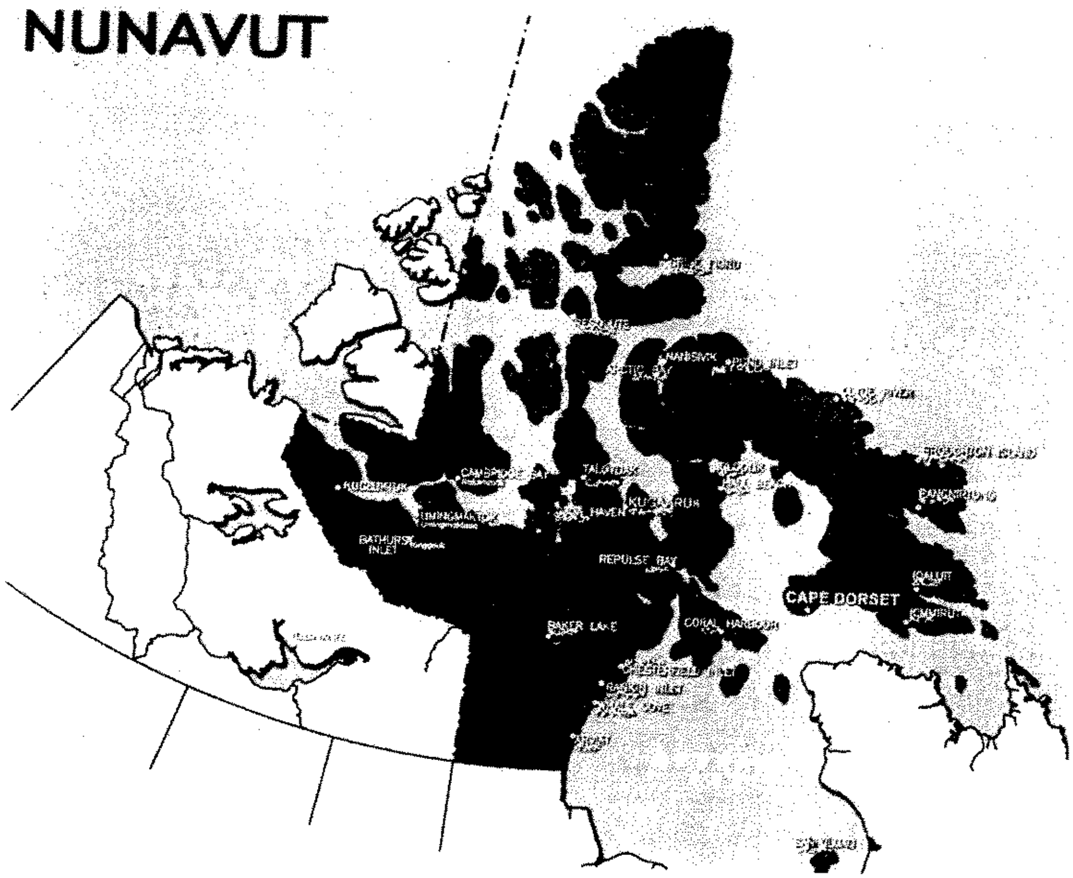
1.0 Background

General

The community of Cape Dorset is located on an island off of the coast of the Foxe Peninsula in the south-west corner of Baffin Island, Nunavut. Sewage treatment for this community of approximately 1,400 people consists of a three-cell, tiered facultative lagoon system located as shown in **Figure 1**. Sewage is transported by truck on a continuous, daily basis (week days) to a lagoon facility for treatment.



The existing sewage treatment facility was constructed in the mid 1990's. It is constructed in a sloping valley with eventual ocean discharge. In response to ongoing difficulties with the integrity of the lagoon structures and with eventual treatment capacity limitations anticipated to result from population growth, the Government of Nunavut (GN) has completed studies[1,2] to determine the best long-term strategy for municipal sewage treatment for the community. The selected strategy is one in which a pre-engineered, prefabricated mechanical treatment process installed at the existing site replaces the existing lagoon facility.

[1] Cape Dorset Sewage Facility Planning Study, March 2001
[2] Evaluation of Treatment Alternatives????

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DILLON CONSULTING

PROJECT
MECHANICAL SEWAGE TREATMENT PLANT
CAPE DORSET, NUNAVUT

PROJECT NUMBER
02-0397

TITLE
EXISTING LAGOON SITE

DATE
FEB 03

FIGURE NUMBER

Purpose of Concept Brief

The purpose of this Concept Brief is to document background information to support:

- Regulatory review and approval of the long term sewage management plan. The Design Concept Brief forms part of the application package by the GN to the Nunavut Water Board in request of modifications to the existing License NWB3CAPO207.
- Pre-selection of the sewage treatment process equipment through a request for competitive quotations from qualified suppliers. Pre-selection of process equipment is necessary given the limited window of opportunity that exists to meet the sea-lift schedules for the summer of 2003.
- The design of the sewage treatment facility in its entirety including site works, building infrastructure, as well as process and ancillary equipment, by establishing a design basis.

More specifically, sections of this Concept Brief describe;

- The design requirements based on location, population estimates, and sewage generation rates
- The design criteria and assumptions
- System descriptions
- Facility descriptions
- Implementation schedules and strategies

2.0 Regulatory Framework

The Hamlet of Cape Dorset was issued License NWB3CAPO207 from the Nunavut Water Board in September 2002. A copy of this License is attached in **Appendix A** for reference. With respect to the treatment of sewage, the License defines the facility as follows:

> **"Sewage Disposal Facilities"** comprises the area and engineered lagoon and decant structures designed to contain sewage as described in the Application for Water License filed by the Applicant on April 19, 2001.

The proposed change in the "Sewage Disposal Facilities" to that of a mechanical treatment plant results in a need to change the current License. In seeking changes, it must be recognized that:

- Criteria have been set for discharge to the receiving environment (Telik Inlet) under the current License.
- A standard, secondary level mechanical treatment plant has the inherent capability of producing a higher quality effluent than that from a lagoon process. Discharge from the mechanical treatment plant will more than satisfy the requirements of the current License.
- The mechanical treatment plant is proposed for installation at the site of the current "Sewage Disposal Facilities". Effluent from the facility will discharge to the same general location as that of the lagoon facility.

This Concept Brief is complimentary to an Application that will be submitted to the NWB in request for changes to the current License. Requested changes will be limited to describing a different process by which the discharge criteria to the receiving environment are met.

The GN is unaware of any other specific licenses or permits that are required for the operation of the sewage disposal facilities.

3.0 System Design Standards

Design Criteria

The design criteria for a mechanical treatment plant will be completed in accordance with the parameters set out by the GN, "Water and Sewage Facilities Capital Programs". These are as follows:

Table 3-1 Design Horizons

Facility	Design Horizon (Years)	Design Economic Life (Years)	Design Expected Life (Years)
Building	20	20	40
Pumps	10	20	20
Tanks and Pipes	20	20	30

Where the:

- Design horizon is the period used to establish capacity requirements for a facility.
- Design economic life is the period used in the economic analysis to establish the present value (or equivalent capital cost) of a facility.
- Design expected life is the practical maximum expected life of a facility assuming no premature failure, destruction or obsolescence.

Design Standards

The following is a list of the design standards to be used in the development of the water supply system. These are derived from the GNWT "General Terms of Reference for Water and Sanitation" (GTR), and the "National Building Code" (NBC), and "Capital Standards Criteria, September 1993," MACA.

Table 3-2 Sewage Generation Rates

Sewage Generation Rates		Reference
Domestic	90 litres per capita per day	MACA
Commercial	0.00023 x population	MACA
Total Generation per Capita	90 x (1.0 + 0.00023 x pop.)	MACA
Discount Rates	4%, 8% and 12%	MACA

Table 3-3 Environmental Conditions

Environmental Conditions	
Design Minimum Temp.	-40°C [1]
Degree Days (Below 18°C)	9946 [2]
Snow Load SS SR	4.2 kPa[1] 0.2 kPa [1]
Wind Pressures	1.10 kPa [1]

1. National Building Code of Canada 1995 Appendix C, Data for Nottingham Island, p 497.
2. Canadian Climate Normals for Cape Dorset (1971-2000). Environment Canada website.

Design Parameters

The following are items that have been identified as overriding design parameters for the facility:

- The facility must be simple to operate and maintain by local forces with limited equipment, and parts and materials that are available locally.
- Reliability of the facility is extremely important.
- The facility must be efficient and cost effective.
- All major components must be capable of recovering from a frozen condition, in an operable state, if there is any possibility of freezing.
- Provisions of spares for all equipment is required, particularly components that have bulbs, fuses, relays, timers, etc.
- Standard on-site testing equipment, such as a microscope, weighing scale, settling jars, etc. are to be a requirement of the construction contract.
- Standby power shall be provided (as necessary)
- Fuel storage at the treatment facility must provide for spill containment (if applicable).
- Treated sewage discharged from the facility must be metered.
- Provision for an alarm system which indicates loss of power and low building temperature, is required.

4.0 Community Information

Sewage Characteristic Calculations

The sewage treatment system design horizon is indicated in the previous section. Based on an implementation year of 2004, the 20 year design horizon is set at 2024. Using current population projections from the Bureau of statistics for the years 2004 through 2021 and extrapolated values to 2024, the following table summarizes the estimated sewage generation volumes as well as organic and solids loadings.

Organic and solids loadings are based on 'typical' characteristics for raw sewage generated from a truck delivery system. Calculations are provided in **Appendix B**. Site specific analytical data is not available for the community of Cape Dorset.

Table 4-1 Design Sewage Generation Values

	2004	2014	2024
Population	1327	1632	2012
Sewage Generation per capita (litre)	117.5	123.8	131.6
Organic Load (BOD_5) per capita (kg)	0.074	0.074	0.074
Solids Load (Total Suspended Solids) per capita (kg)	0.111	0.111	0.111
Average Day Sewage (m^3)	156	202	265
Average Day BOD_5	98	121	149
Average Day TSS	147	181	223

5.0 Treatment Process

In a process sense, there are five (5) major units that together make up the sewage treatment facility. These major process units are: raw sewage handling, primary screening, flow equalization, biological treatment and sludge handling.

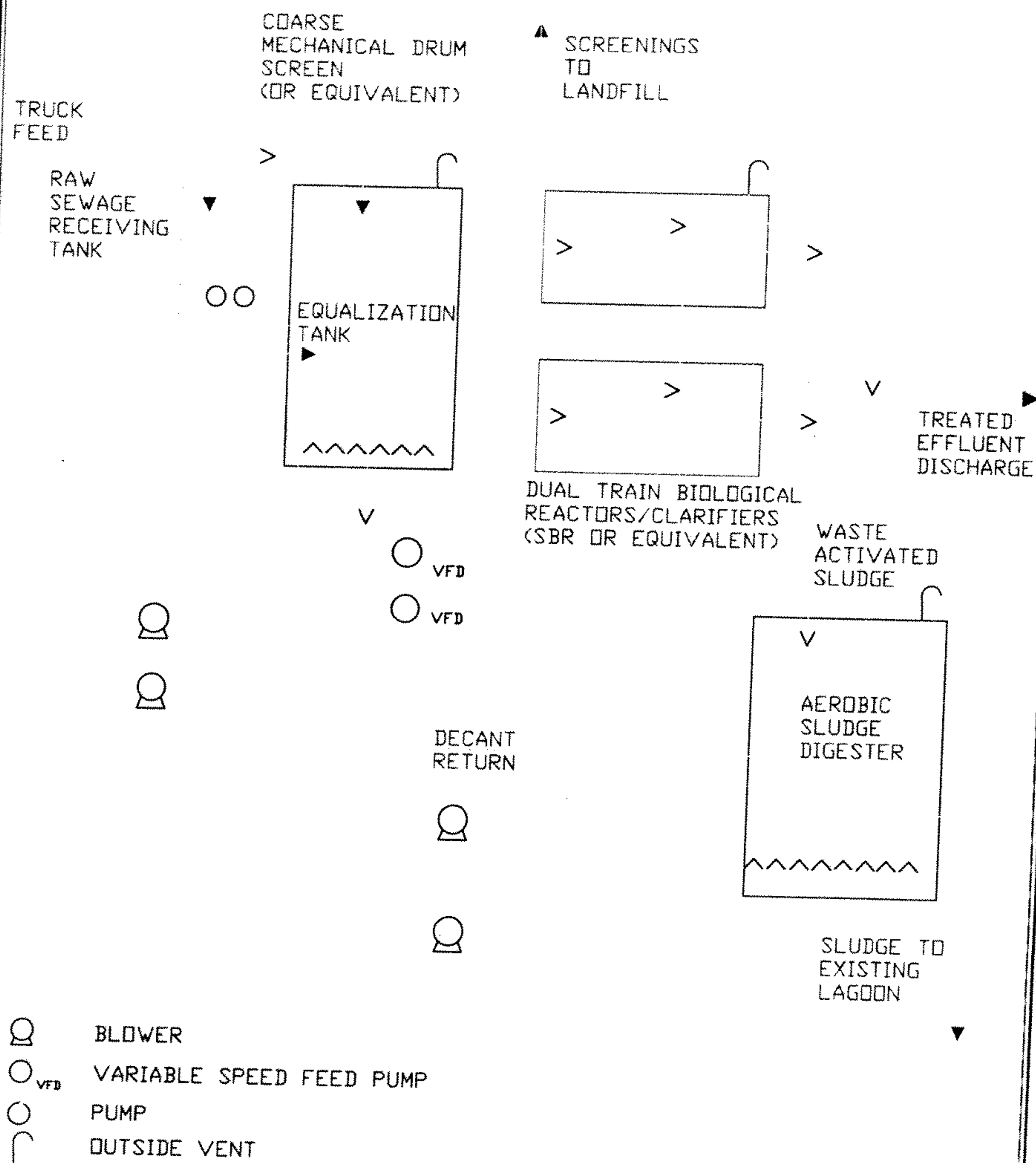
Different manufacturers and suppliers commonly offer various alternatives for the equipment/materials that together make up a pre-engineered and prefabricated sewage treatment process consisting of these major units. Accordingly, the GN will be seeking the recommendations of qualified equipment manufacturers/suppliers during a planned competitive pre-selection quotation contract process for the key process units. **Table 5.1** summarizes the preliminary design basis for each of the key process units. At the present time, the GN is working on the basis that the heart of the treatment plant, the biological process unit, is that of a Sequencing Batch Reactor (SBR). In comparing the applicable technologies of extended aeration activated sludge (EA), rotating biological contactors (RBC), and sequencing batch reactors (SBR), the GN has identified an SBR as the currently preferred process for the following reasons:

- All units can meet applicable discharge criteria
- An SBR provides an opportunity to compare/contrast performance with a fixed-film (RBC comparable) process of similar size installed in Nunavut
- In direct comparison to the EA process, the SBR is likely simpler from an operator's perspective. An SBR is also likely to have a smaller footprint then an EA.

The scope of the pre-engineered process can be described as "The design and supply (FOB Montreal) of all materials and equipment required to process sewage from the point of delivery to the point of discharge and meet stipulated treatment criteria. Materials and equipment will include, but not be limited to:

- All tanks and in-tank equipment (pumps, diffusers, piping, etc.)
- All interconnecting piping between tanks
- Ancillary equipment including all blowers and pumps
- Process controls:
    - Metering equipment
    - In-tank level controls
    - Integrated central control panel with remote monitoring capability

Due to its location, the pre-engineered sewage treatment process must be enclosed within a heated building. The design basis for the building is provided in Section 6.



DILLON CONSULTING	TITLE: CONCEPTUAL BLOCK DIAGRAM	PROJECT NO. 02-0397
	SITE: CAPE DORSET SEWAGE TREATMENT PLANT	SCALE: N/A
		DATE: FEB. 2003
	CLIENT: GOVERNMENT OF NUNAVUT	FIGURE NO. 5.1

Table 5-1 Preliminary Design Brief

Process Unit	Design Basis
Raw Sewage Handling	• Trucked delivery to treatment plant 5 days per week • Capacity of largest sewage truck 10 m^3 • Gravity discharge from truck to treatment plant receiving tank • Capacity of receiving tank minimum 150% of largest tank • Receiving tank enclosed and vented to outdoors
Primary Screening	• Pumped for controlled throughput • Coarse rotating drum screen or equivalent • Automatic solids removal and recovery • Solids recovery suitable for direct disposal to landfill • Nominal 12mm openings for coarse solids removal
Flow Equalization	• Single, continuously aerated tank • Tank enclosed and vented to outdoors • Coarse bubble aeration through fixed diffusers • Minimum hydraulic capacity 24 hours

Biological Treatment	• 100% redundant dual train reactors
	• Each reactor sized to accommodate 100% normal flow during upset events or maintenance (1 tank out of service)
	• Direct piped discharge to receiving environment
	• Sized for guaranteed discharge quality at 20 year design flows not exceeding:
	  o 20 mg/l Total Suspended Solids
	  o 20 mg/l BOD_5

Sludge Handling	• Single, continuously aerated tank • Coarse bubble aeration through fixed diffusers • Minimum 40% reduction in volatile solids at 20 year design flows • Solids retention time sized to meet volatile solids reduction criteria • Variable level decant returned to flow equalization • Thickened sludge discharge to existing ex-filtration lagoon
Ancillary Equipment	
Pumps and Blowers	• 100% redundancy for all units

6.0 Facility Requirements

The facility will require the items listed in Table 6.1.

Table 6-1 Facility Design Brief

Facility Unit	Design Basis
Truck Turnaround	• Hook-up to transfer sewage from trucks to facility • Prevent sewage from freezing inside the hook-up pipe after transfer completed
Screenings Discharge	• Collect for landfill disposal
Treated Effluent Discharge	• Discharged to Tellik Inlet via existing drainage swale • Freeze protected pipe to allow year round operation
Sludge Discharge	• Pumped discharge to existing lagoon • Freeze protected to allow year round operation
Building Shell	• Concrete pad, insulated metal cladding shell • Electrical/Mechanical Room • Office • Separate bathroom • Enough space to house all process equipment • Prime power supplied by Nunavut Power • Building heat provided by boiler system • Backup power through use of diesel electric generators to run boiler and blowers

7.0 Implementation Strategy

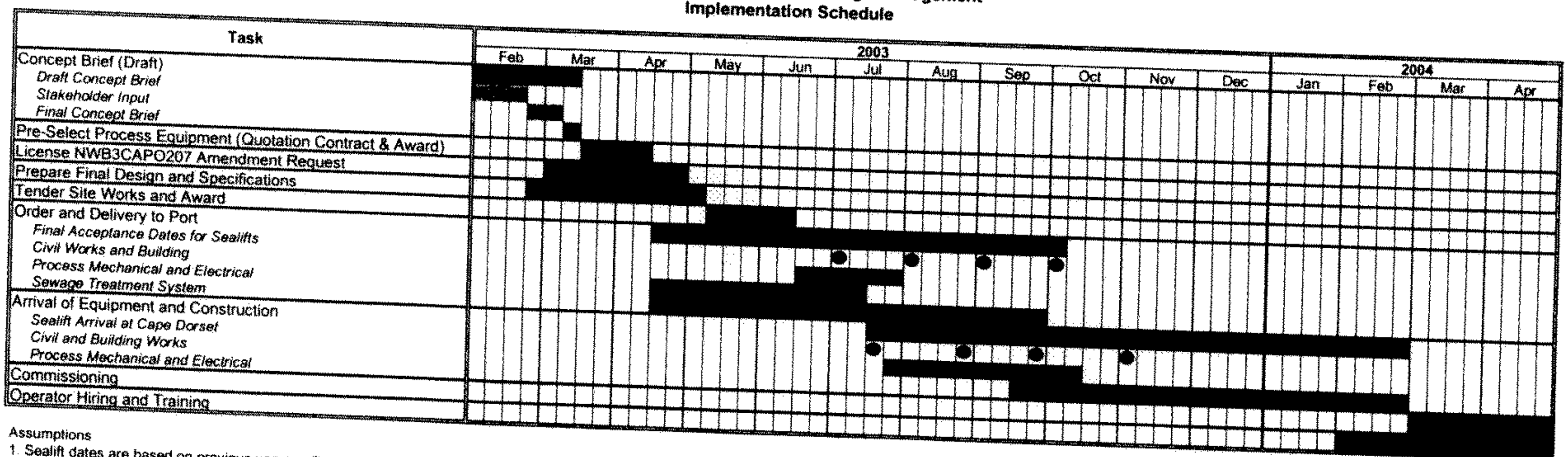
The proposed implementation schedule for this project is shown in **Table 7.1**. Given that the delivery of the process mechanical and electrical equipment is the time critical component to meet a spring 2004 start-up date, two contracts are planned for this project. One contract will be for supply of the pre-engineered, prefabricated process equipment to site and other contract would be for construction of the facility and installation of equipment.

As shown in Table 7.1, the award of the process equipment contract is tentatively scheduled for mid April with the award of the construction contract tentatively scheduled for mid June. This should provide the suppliers adequate time (18-22 weeks) to construct and deliver the process components to the port in Montreal to meet one of the four sealifts travelling to Cape Dorset. Although the sealift schedule has not yet been finalized for 2003, in previous years the first sealift has had scheduled arrival in the middle of June, with the last sealift scheduled for arrival at the beginning of November. The award of the construction contract in mid June will allow the contractor 2-6 weeks to gather equipment and supplies for delivery to the site by sealift.

The site grading and construction of the sewage treatment plant building shell must be finished before the middle of October. This enables the building to have heat and electricity connections before winter. The process equipment will be installed within the building during the winter months with commissioning occurring in the spring 2004.

This project can be completed by spring 2004 but is dependent upon the timing of the delivery of equipment and the sealift schedule. Unforeseen delays could potentially prolong the completion of the project to the following year.

Table 7.1
Cape Dorset - Long Term Sewage Management
Implementation Schedule



Assumptions
1. Sealift dates are based on previous years sailing schedules for NEAS and N3. 2003 schedule not available until May 2003
2. Some equipment for civil works arrives on first sealift
3. Process equipment must arrive on last sealift but could arrive on previous lifts
4. Process equipment will not be installed until after building is completed
5. Building must be completed and heated before middle of October

PART 1 - GENERAL

1.1 Description

.1 Design, supply, commission, and operator training for a complete sewage package plant to treat domestic, municipal wastewater for a truck delivery system in Cape Dorset, Nunavut as outlined in this specification and the attached Concept Brief.

1.2 Evaluation of Proposals

.1 The proposals will be evaluated based on:

.1 Quality of design and construction of facility.

.2 Similar experience in remote, northern operations.

.3 Capital cost.

.4 Estimated annual operation and maintenance costs.

.5 Ease of operation and maintenance.

.6 Building footprint needed to house entire proposed system. Typical building construction is in the order of $2,500/m^2.

.2

1.3 Schedule

.1 The following final acceptance dates of sealift departures for Cape Dorset from Montreal are based on previous years' sailing dates. The 2003 schedule will be published sometime in April or May.

.1 First week of July

.2 First week of August

.3 First week of September

.4 First week of October

.2 All equipment must be in the port of Montreal and packaged in a form acceptable for shipment before the last final acceptance date.

.3 It is the successful tenderer's responsibility to confirm acceptance and sailing dates with the sealift companies (N3 and NEAS).

1.4 Scope

.1 The successful tenderer will be required to design and supply, FOB Montreal:

.1 Headworks, units.

.2 Sewage treatment facility and clarifier (if required).

.3 Sludge treatment units.

.4 All electrical, mechanical, instrumentation and controls for above units in accordance with the requirements of this specification and suitable for integration with other building controls.

.5 All interconnecting piping.

.6 Certification that the installation is to manufacturer's requirements and commission the facility.

.7 Training of the operators and preparation of operation and maintenance manuals.

.8 Warranty treatment process performance.

.2 Equipment shall be supplied to port of Montreal and packaged suitable for sealift delivery to Cape Dorset.

.3 The successful tenderer will enter into a subcontractual agreement with the successful General Contractor. Terms and conditions for general contractor are available upon request. It is recommended that tenderers review these documents prior to bidding.

1.5 Payment

.1 Payment is subject to terms and conditions of the general's contract as stated in Government of Nunavut Construction Contract April 2000 Terms of Payment and Government of Nunavut Construction Contract March 2001 General Conditions.

.2

1.6 Work by Others

.1 Piping up to headworks.

.2 Outfall piping and pumping.

.3 Site grading.

.4 Installation of equipment, piping and interconnecting wiring.

.5 Construction and supply of building.

.6 Supply and installation of domestic water tank, water piping, heating equipment and other building appurtenances.

.7 Extension of telephone and electricity to facility including system back-ups as required.

.8 Standby diesel electric generator.

1.7 Information to Accompany Proposal

.1 Statement of qualifications including company profile, arctic experience and similar package plant projects.

.2 Detailed description of the proposed treatment process and demonstration of suitability of design.

.3 Process diagram for treatment process.

.4 Conceptual drawings of the works proposed in sufficient detail to permit an adequate evaluation as specified in Section 1.2.

.5 Provide specifications and descriptions of the various major equipment components.

.6 Description of process control and instrumentation system, including schematics and P&IDs.

.7 Hydraulic calculations.

.8 Detailed equipment schedule.

.9 Capital cost will include all items necessary to design, supply, commission and provide operator training of complete sewage treatment plant as specified. Capital cost will be broken down in proposal by:

.1 Tankage

.2 Major Equipment

.3 Ancillary Equipment (panels, motor starters, instrumentation, piping, valves).

.4 Start-up commissioning and operator training. Assume 14 days on-site over 2 trips.

.5 Other (Commission, Operator Training, OPS Manual, etc.).

.10 Expected annual power requirements and annual operating costs. Annual costs will be based on assumed values of $0.3896/kwhr for power and $0.842/L for diesel.

.11 Expected sludge production.

.12 Labour requirements and level of training required for operators.

1.8 Design Criteria

.1 The 20 year design flows, based on typical characteristics for raw sewage generated from a truck delivery system, are as follows:

.1 Average Day Sewage = 265 m^3

.2 Average Day BOD_5 = 149 kg

.3 Average Day Total Suspended Solids = 223 kg

.2 The current flows are estimated below:

.1 Average Day Sewage = 156 m^3

.2 Average Day BOD_5 = 98 kg

.3 Average Day Total Suspended Solids = 147 kg

.3 The treatment plant shall produce an effluent not exceeding the following limits:

.1 BOD_5 = 20 mg/L

.2 Total Suspended Solids = 20 mg/L

.4 Truck delivery of sewage is 5 days/week.

.5 Plant is to operate 7 days/week.

1.9 Design Drawings Specifications and Shop Drawings

.1 Following award of contract, submit four (4) comprehensive sets of detailed design drawings and technical specifications at a mutually agreeable schedule.

.2 All design drawings shall be stamped by a professional engineer registered or licensed to practice in Nunavut.

.3 Changes to design drawings and/or Specifications shall be reviewed by the Engineer.

.4 Submit six (6) copies of the Shop Drawings for review by the Engineer prior to fabrication. Required shop drawings to be identified by Engineer after award of contract.

1.10 Operation and Maintenance Manuals

.1 The manual specified under this contract shall cover all processes associated with this specification but shall be incorporated as a section within the facility's operation and maintenance manual.

.2 Submit, a minimum of three weeks prior to commissioning, five (5) copies of the treatment plant operation and maintenance manuals.

.3 Operation and Maintenance manual submissions are to conform to the current edition of "Specifications for Operations and Maintenance Manuals", Department of Public Works and Services, Government of Nunavut and any requirements stipulated by regulating authorities (Nunavut Water Board, etc.).

.4 Provider for the following for incorporation into the plant O&M manual by the General Contractor.

.1 Names and addresses of the subcontractors and contractors.

.2 Complete list of the names, addresses and telephone numbers of equipment suppliers and local representatives from whom parts may be purchased and who can effect repair or maintenance on equipment.

.3 Copies of warranties and guarantees.

.4 Copies of approvals, certificates and similar documents for governing authorities.

.5 A final reviewed copy of all shop drawings and product data sheets.

.6 Plant start-up.

.7 Process operation, control and troubleshooting requirements.

.8 Maintenance requirements.

.5 If, during the review of the manuals, revisions are required, manuals will be returned with details of the required revisions. Revise and resubmit manuals for further review.

.6 Submission of the manuals is a condition precedent to issuing the Certificate of Substantial Performance.

1.11 <u>Manufacturer's Inspection and Certificate Equipment Systems</u>

.1 Have factory-trained service representative at the site to inspect installation of each item of equipment to supervise start-up and to instruct the plant operators in the proper operation and maintenance of equipment.

.2 On completion of the installation, testing and start-up of each item of equipment, submit to the Engineer the manufacturer's certificate stating the installation of the equipment has been inspected, is installed in accordance with the instructions, has been started and adjusted as necessary, the operators have been instructed in the operation and maintenance and it is in warranty condition.

1.12 Codes and Standards

.1 Design and construction must follow best practices of the professions, manufacturers and trades involved, and meet or exceed the requirements of the:

.1 National Building Code
.2 Canadian Plumbing Code
.3 Canadian General Standards Board
.4 Canadian Standards Association
.5 American Society for Testing and Materials
.6 American Society of Mechanical Engineers
.7 American Gear Manufacturers Association
.8 Electrical and Electric Manufacturers Association of Canada
.9 Canadian Electrical Manufacturers Association
.10 National Electrical Manufacturers Association
.11 American National Standards Institute
.12 Hydraulics Institute
.13 Transportation Association of Canada

.2 In case of a conflict or discrepancy between the contract documents and the governing codes and standards, the more stringent requirements apply.

.3 Unless otherwise specified, the latest editions published by the issuing authority, current at the date of the contract document execution, shall apply.

PART 2 - PRODUCTS

2.1 Intent

.1 This section stipulates the minimum functional requirements for the design, supply and commissioning of the sewage treatment plant.

.2 It is the intent that the tenderer will incorporate the minimum required functions described in this section into a complete process design. The tenderer is required to supplement these minimum requirements as necessary to develop a fully operational facility and to design, test, commission and warranty the treatment processes.

2.2 General Design Requirements

.1 Provide equipment arrangements so that working parts are readily accessible for inspection, maintenance, repair or replacement.

.2 Design process so that, in event of freeze-up, entire system can be drained quickly and in the easiest manner possible.

.3 Do not use gaskets containing asbestos.

.4 Provide high efficiency motors. Motors 0.375 kW and above shall be 575 V/3 phase/60 Hz motors less than 0.375 kW shall be 120 V/1 phase/60 Hz. It is the responsibility of the tenderer to ensure that all equipment meets the requirements of the electrical code for installation inside of an enclosed building.

.5 **All treatment units shall be suitable for enclosure within a building and covered as required.**

.6 All tanks to be above ground and suitably designed for stand alone structure for fill and empty conditions.

.7 Provide material and equipment meeting specified performance and for which replacement parts are readily available.

2.3 Raw Sewage Handling

.1 Trucked delivery to treatment plant 5 days per week.

.2 Capacity of largest sewage truck 10 m^3.

.3 Gravity discharge from truck to treatment plant receiving tank.

.4 Receiving tank enclosed and vented to outdoors.

.5 Capacity of receiving tank minimum 150% of largest tank.

2.4 Primary Screening

.1 Pumped for controlled throughput.

.2 Coarse rotating drum screen or equivalent.

.3 Automatic solids removal and recovery.

.4 Solids recovery suitable for direct disposal to landfill.

.5 Nominal 12mm openings for coarse solids removal.

2.5 Flow Equalization

.1 Single, continuously aerated tank.

.2 Tank enclosed and vented to outdoors.

.3 Coarse bubble aeration through fixed diffusers.

2.6 Biological Treatment

.1 100% redundant dual train reactors.

.2 Each reactor sized to accommodate 100% normal flow during upset events or maintenance (1 tank out of service).

.3 Direct gravity piped discharge to receiving environment.

.4 **Sized for guaranteed discharge quality at 20 year design flows not exceeding limits specified in Section1.8.3.**

.5 Provide access to all areas of the treatment units.

.6 Configure units to facilitate cleaning and servicing.

.7 Provide aeration as required.

.8 Configure piping to minimize clogging and to facilitate cleaning and flushing.

.9 Successful tenderer shall be responsible for the supply, storage and establishment of all required plant and animal organisms used in the treatment process.

2.7 Sludge Handling

.1 Single, continuously aerated tank.

.2 Coarse bubble aeration through fixed diffusers.

.3 Minimum 40% reduction in volatile solids at 20 year design flows.

.4 Solids retention time sized to meet volatile solids reduction criteria.

.5 Variable level decant returned to flow equalization.

.6 Thickened sludge pumped discharge to existing ex-filtration lagoon either direct or via truck.

2.8 Pumps and Blowers

.1 Provide 100% standby to all rotary equipment (i.e., blowers, pumps).

.2 All units to have 100% redundancy.

.3 Blowers shall be positive displacement, belt driven with electric motor and belt guards.

.4 Blowers to run at 1800 rpm, maximum.

2.9 Flow Measurement

.1 Flow measurement to be provided on both influent and effluent streams.

.2 Flow measurement system shall have a display unit to show the instantaneous rate of flow through the sewage treatment plant in Litres per minute and the totalizer read out.

2.10 Electrical and Controls

.1 General

.1 All major equipment shall be provided with its own control panel.

.2 All control panels must have terminals for discrete digital input/outputs or analog input/outputs, as required, for connection to SCADA system by others. Contacts shall be provided for each alarm condition, operating status, elapsed time meter and ammeter, as required.

.3 interconnecting wiring of systems and controls is performed by others.

.4 All alarms shall have manual reset.

.5 Control panels shall have motor starters and H-O-A switches, as required. All switches to be 1 pole switch, common grounds not acceptable.

.6 Electrical equipment shall have local disconnect, as per Electrical Code requirements.

.7 Provide electrical sub-station, as required.

.2 Screen Panel Requirements

.1 Alarms (minimum) and classification

.1 Motor overload - low priority

.2 Screen blinding/High Level - high priority

.3 Aeration Blower Panel Requirements

.1 Automatic switchover relay(s) on overload or high temperature.

.2 Non-resetable running hour meters, one for each blower.

.3 Alarms (minimum) and classification:

.1 Motor overload - Low Priority

.2 High temperature - Medium Priority

.4 Pump Panel Requirements (if required)

.1 Automatic switchover relay(s) on overload or seal leak.

.2 Non-resetable running hour meters, one for each pump.

.3 Alternating relays.

.4 Floats for pump control, including lead on, lag on pump off.

.5 Alarms (minimum) and classification:

.1 High level - High Priority

.2 Low level - Low Priority

.3 Pump overload - Low Priority

.4 Pump seal leak - Low Priority

.5 Flow monitoring equipment shall have the output capability to send the flow signal to SCADA system in addition to local indicator.

2.11 Plant Piping

.1 Clearly identify and label all plant piping to indicate liquid and direction of flow.

.2 All piping shall be securely fastened.

.3 Plant piping shall be suitably coated galvanized steel or ductile iron.

PART 3 - EXECUTION

3.1 Start-up and Commissioning

.1 Successful tenderer shall be responsible for all start-up and commissioning requirements.

.2 Cape Dorset operator will be on-site for training.

3.2 Operation of Treatment Facility

.1 Cape Dorset will not take over the operation of the plant until satisfactory performance is achieved.

.2 Operations to be performed include:

.1 Training Cape Dorset operator.

.2 Collecting and analyzing influent and effluent samples according to Nunavut Water Board requirements, as well as any other sampling analyses to optimize treatment.

.3 Maintenance and inspection of all equipment.

.4 Logging all pertinent operating data, results and observations.

3.3 Performance

.1 **The effluent quality requirements described in Section 1.8.3 shall be considered to be adhered to if:**

.1 80% of the BOD and SS test results are equal to or less than 20 mg/L.

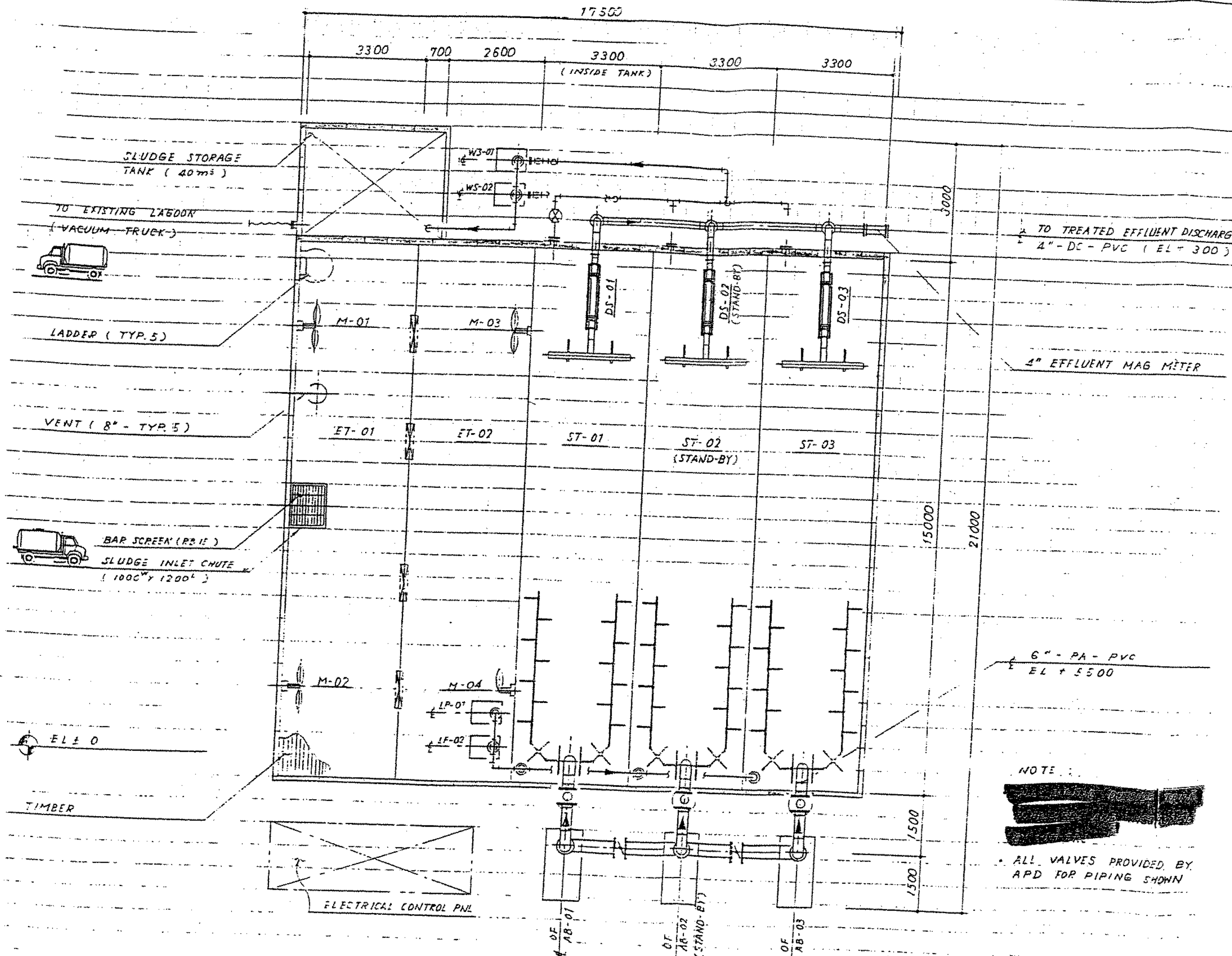
.2 No single BOD or SS test result exceed 40 mg/L each.

.3 Sampling frequency for performance requirement shall be stipulated frequency as stated in Water Licence.

.4 The Tenderer may be required to post a performance bond as part of contract negotiations.

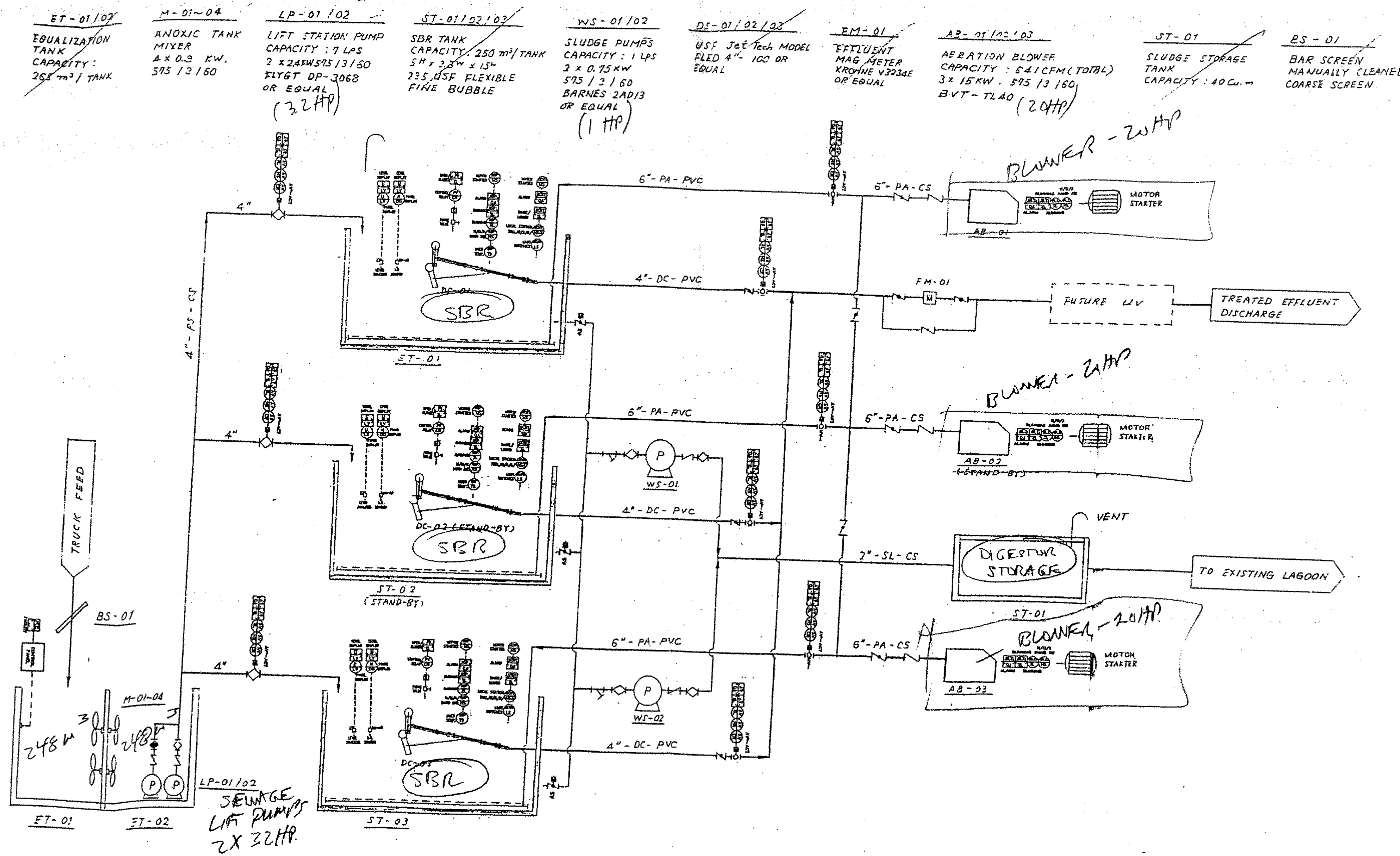
***** END OF SECTION 15000 *****

Appendix F
SBR Suppliers
Floor Layouts and Process Diagrams



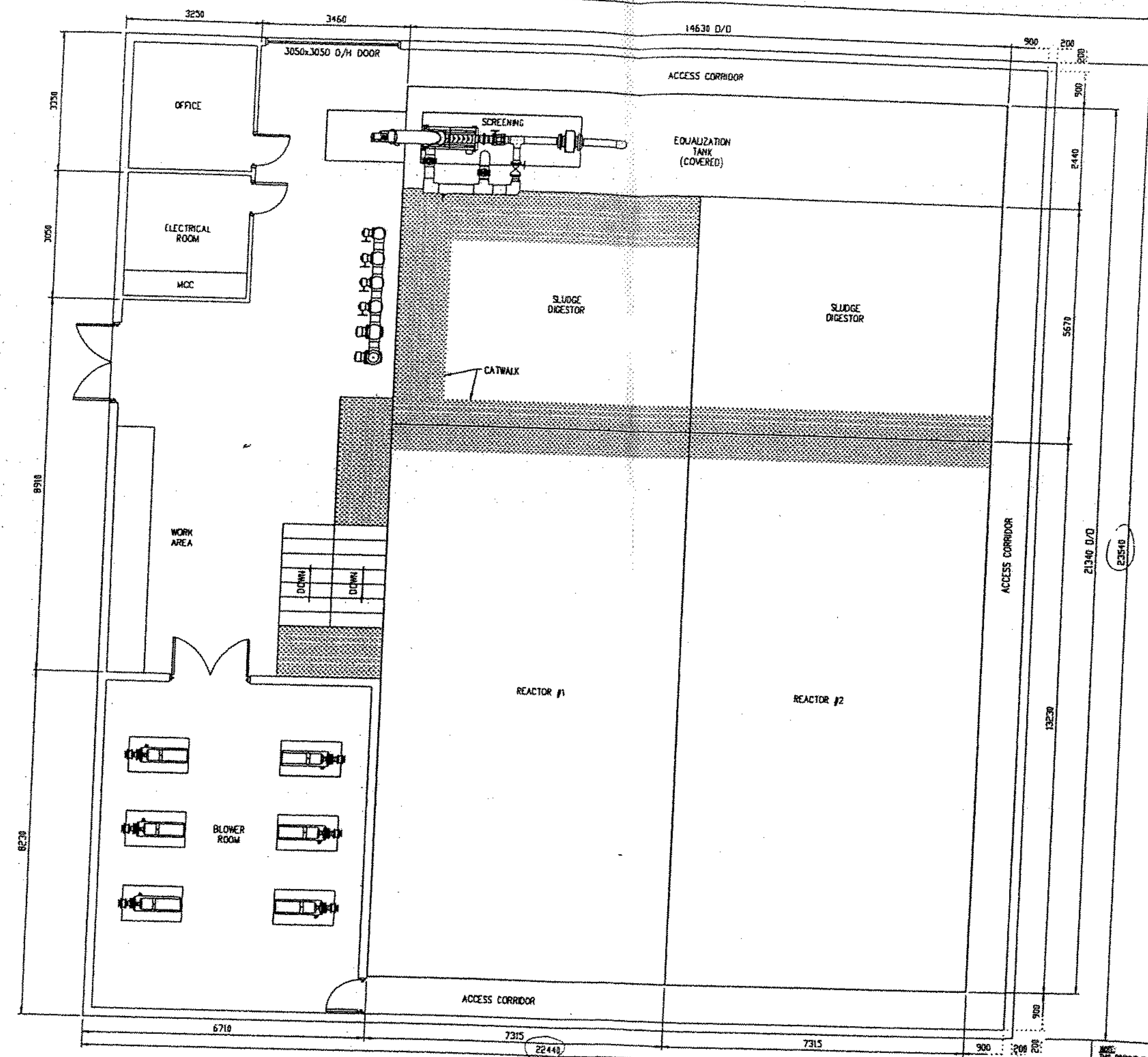
ROJECT TITLE:	NUMBER	DESCRIPTION	BY	CHK	APP
ape Dorset WWTP	Apr. 19th 2003	Proposal			
DRAWING TITLE:					

APD ENGINEERING AND CONSTRUCTORS
103, 5120 - 6TH STREET N.E.
CALGARY AB, T2K 4W5
PH: (403) 230-9257, FX: (403) 230-9262



PROJECT TITLE:	NUMBER	DESCRIPTION	BY	CHK	APP
Cape Dorset WWTP	Apr. 17th 2003	Proposal			
DRAWING TITLE:					

APD ENGINEERING AND CONSTRUCTORS
103, 5120 - 6TH STREET N.E.
CALGARY AB, T2K 4W5
PH: (403) 230-9257, FX: (403) 230-9262



A = 528 m²

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METRIC

PRELIMINARY
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CONSTRUCTION

REV	BY	DATE	DESCRIPTION			
A	MGM	04/08/2003	ISSUED FOR REVIEW			

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TITLE
SEWAGE TREATMENT PLANT – 265 M^3/D
MAIN FLOOR PLAN @ EL 100'-0"

CLIENT
THE HAMLET OF CAPE DORSET
CAPE DORSET, NUNAVUT

DRAWN BY	MGM
DATE	04/08/2003
SCALE	1:50
JOB NO.	45-03-0049
DWG NO.	G003
REV NO.	A

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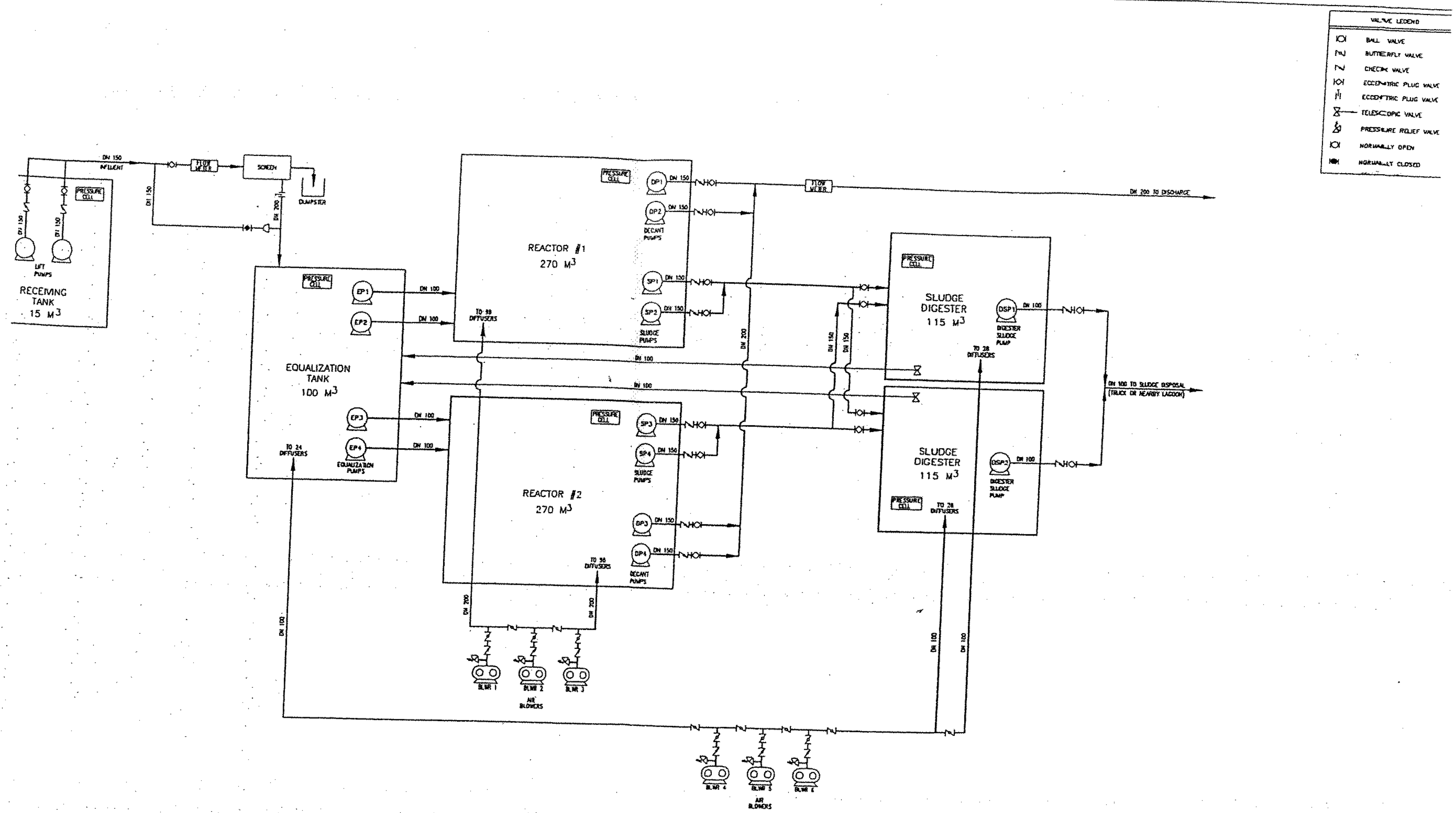

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FIELD		
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PURCHASING		

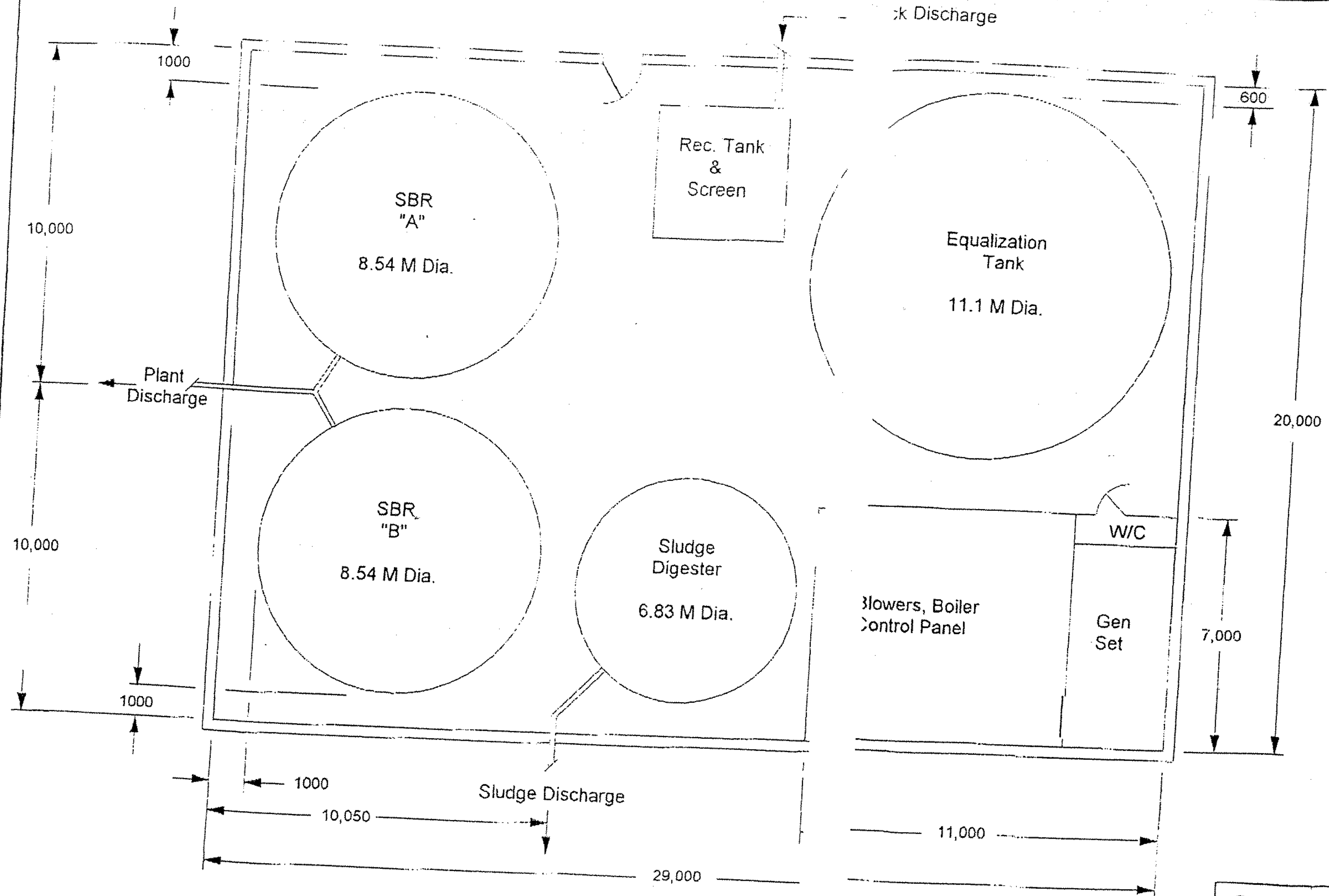
TITLE
SEWAGE TREATMENT PLANT - 265 M^3/D
PROCESS SCHEMATIC

CLIENT
THE HAMLET OF CAPE DORSET
CAPE DORSET, NUNAVUT

DRAWN BY: MCM
DATE: 04/08/2003
SCALE: NTS
JOB NO. 45-03-0049

D B I.

FWS
FWS CONSTRUCTION
475 Dovercourt Drive
Winnipeg, MB
TEL. 204-487-2500

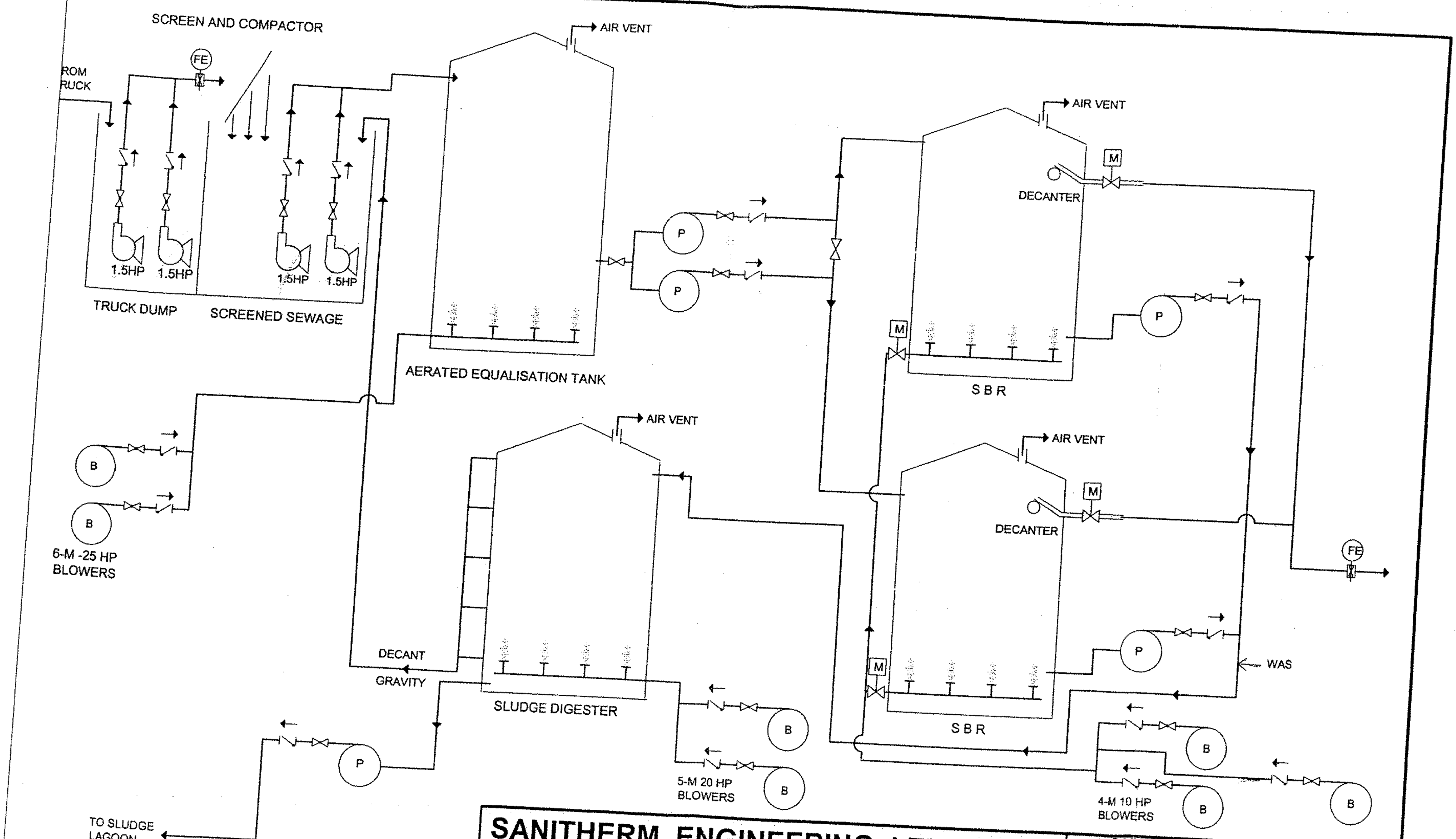


Sanitherm Engineering Limited
Suite 4 - 431 Mountain Hwy. North Vancouver, BC V7J 2L1
Tel.:(604)986-9168 Fax:(604)986-5377

Cape Dorset WWTP Floor Plan

Dillon Consulting Limited File # 02-0397-6000

D.OB	April 21, 2003	Not To Scale	SK-CDSTP001



SANITHERM ENGINEERING LTD.

431 MOUNTAIN HIGHWAY, SUITE 4, NORTH VANCOUVER, B.C. V7J 2L1, CANADA.

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FAX : (604) - 986 - 5377

E-MAIL : saneng@sanitherm.com
WEB SITE : www.sanitherm.com

PROJ. CAPE DORSET WASTEWATER TREATMENT PLANT			PROJ. NO.
TITLE PROCESS FLOW DIAGRAM			
DWG. A - 1	DATE Apr.03	SCALE N.T.S.	CHCKD.

Appendix G
Mechanical Plant Costs and NPV

Dillon Consulting Limited
Cape Dorset Sewage Options
File: 031943-1000

Option #1 - Mechanical Treatment Plant
Capital and Operating Costs

	Perma / FWS	Sanitherm -SBR		Notes
Capital Cost:				
Original Bid	$1,877,300	$835,676		
REDUCE: Adjusted Tankage	-$67,500.00			
REDUCE: Delete 1 Digester	-$129,850.00			
ADD: Elevated Walkways		$40,000.00		
ADD: Extra Blowers (~)		$15,000.00		
Total SBR Cost	**$1,679,950**	**$890,676**		
Building Footprint (m2)	530	580		
Building Envelope Cost per m^2	$3,000	$3,000		
Building Envelope Cost	$1,590,000	$1,740,000		
Foundation Volume @ 200 mm thick	106	116		
Foundation Cost @ $2000 / m3	$212,000	$232,000		
Building Mechanical / Electrical	$960,000	$1,200,000.000		Mech / Electrical Costs Based on Pang RBC + 20%
Nunavut Power Line (800 m @ $100 /m)	$80,000	$80,000		Includes Installation of SBR Plant
Total Building	**$2,842,000**	**$3,252,000**		
Total Plant and Building	**$4,521,950**	**$4,142,676**		
Engineering @ 10%	$452,195	$414,268		
Contingency @ 25%	$1,130,488	$1,035,669		
GRAND TOTAL	**$6,104,633**	**$5,592,613**		
O + M Cost @ Design Flow (8% of Capital)	$361,756	$331,414		

Note:
Costs do not include any Environmental Assessments and Permitting, Sealift, and Taxes

NPV ANALYSIS

	Perma / FWS	SBR	
Construction Year	$6,104,632.50	$5,592,612.60	
1	$218,161	$199,863	Operating Cost @ 156 m3/day
2	$223,763	$204,995	
3	$229,818	$210,543	
4	$235,720	$215,949	
5	$241,873	$221,586	
6	$248,077	$227,270	
7	$255,382	$233,962	
8	$262,544	$240,523	
9	$268,917	$246,362	
10	$275,772	$252,642	
11	$282,250	$258,577	
12	$288,780	$264,559	
13	$296,242	$271,395	
14	$303,101	$277,679	
15	$311,134	$285,038	
16	$319,243	$292,467	
17	$327,422	$299,960	
18	$339,914	$311,404	
19	$350,835	$321,409	
20	$361,756	$331,414	Operating Cost @ 265 m3/day
NPV @ 2%	**$10,638,182**	**$9,745,914**	
NPV @ 4%	**$9,810,469**	**$8,987,625**	
NPV @ 8%	**$8,699,817**	**$7,970,128**	

Dillon Consulting Limited
Cape Dorset Sewage Options
File: 031943-1000

Mechanical Plant Operating and Maint. Cost Worksheet

Background: US EPA has published O + M costs for an SBR with a daily flow of 378 m3/day. The capital cost of the plant was $1,104,500 in 1999 US $$.

Source: US EPA Wastewater Technology Fact Sheet,
Wetlands: Subsurface Flow, Table 6, Cost Comparison
SF Wetland and Conventional Wastewater Treatment

	Raw EPA O + M data			
	Daily Flow	378		m3/day
	Annual Flow	137970		m3
	Annual O + M	$106,600		1999 US $$
	Plant Cost	$1,104,500		1999 US $$
(1)	**O + M as % of Plant Cost**	**9.7%**		
	per m3	$0.77		1999 US $$

	Adjust EPA Data for Cape Dorset:			
	Daily Flow	265		m3/day
	Annual Flow	96725		m3
	Annual O+ M @ $0.77 per m3	$74,733		1999 US $$
	Say 50% of Cost is Power	$37,366		1999 US $$
	NU Power Cost / US Power Cost	3.5		
	Adjusted Power Cost	$130,782.41		1999 US $$
	Total Adjusted Cost	$168,148.81		1999 US $$
	Inflation @ 2 %/yr (1999-2005)	$185,650		
	Convert to CDN $$	$278,474.81		
(2)	As Percentage of Capital Cost	6.16%		Perma
	per m3	$2.88		CDN $$

Take Average of (1) and (2) **7.9%** **say 8%**

Dillon Consulting Limited
Cape Dorset Sewage Options
File: 031943-1000

Mechanical Plant Operating and Maint Costs
Based on 8.0% of Capital Cost.
Cost is scaled at flows less than peak flow

Perma SBR

Year	Population	Daily Sewage (m3)	Annual Sewage (m3)	O + M Unit Rate ($$/m3)	O + M Cost ($$)
2004	1327	156	56,897.00	3.74	$212,797
2005	1354	160	58,331.00	3.74	$218,161
2006	1382	164	59,829.00	3.74	$223,763
2007	1412	168	61,448.00	3.74	$229,818
2008	1441	173	63,026.00	3.74	$235,720
2009	1471	177	64,671.00	3.74	$241,873
2010	1501	182	66,330.00	3.74	$248,077
2011	1536	187	68,283.00	3.74	$255,382
2012	1570	192	70,198.00	3.74	$262,544
2013	1600	197	71,902.00	3.74	$268,917
2014	1632	202	73,735.00	3.74	$275,772
2015	1662	207	75,467.00	3.74	$282,250
2016	1692	212	77,213.00	3.74	$288,780
2017	1726	217	79,208.00	3.74	$296,242
2018	1757	222	81,042.00	3.74	$303,101
2019	1793	228	83,190.00	3.74	$311,134
2020	1829	234	85,358.00	3.74	$319,243
2021	1873	240	87,545.00	3.74	$327,422
2022	1919	249	90,885.00	3.74	$339,914
2023	1965	257	93,805.00	3.74	$350,835
2024	**2012**	**265**	**96,725.00**	**3.74**	**$361,756**
				Average	**$278,738**

Sanitherm SBR

Year	Population	Daily Sewage (m3)	Annual Sewage (m3)	O + M Unit Rate ($$/m3)	O + M Cost ($$)
2004	1327	156	56,897.00	3.43	$194,949
2005	1354	160	58,331.00	3.43	$199,863
2006	1382	164	59,829.00	3.43	$204,995
2007	1412	168	61,448.00	3.43	$210,543
2008	1441	173	63,026.00	3.43	$215,949
2009	1471	177	64,671.00	3.43	$221,586
2010	1501	182	66,330.00	3.43	$227,270
2011	1536	187	68,283.00	3.43	$233,962
2012	1570	192	70,198.00	3.43	$240,523
2013	1600	197	71,902.00	3.43	$246,362
2014	1632	202	73,735.00	3.43	$252,642
2015	1662	207	75,467.00	3.43	$258,577
2016	1692	212	77,213.00	3.43	$264,559
2017	1726	217	79,208.00	3.43	$271,395
2018	1757	222	81,042.00	3.43	$277,679
2019	1793	228	83,190.00	3.43	$285,038
2020	1829	234	85,358.00	3.43	$292,467
2021	1873	240	87,545.00	3.43	$299,960
2022	1919	249	90,885.00	3.43	$311,404
2023	1965	257	93,805.00	3.43	$321,409
2024	**2012**	**265**	**96,725.00**	**3.43**	**$331,414**
				Average	**$255,359**

Appendix H
SBR Mechanical Plant Operating Cost Data

Cost and Performance Evaluation of BNR Processes

Gerald W. Foess, Paul Steinbrecher, Kenneth Williams, and George S. Garrett

The use of biological nutrient removal (BNR) processes is expected to increase in Florida because of growing concerns about the effects of nitrogen and phosphorus on the stimulation of undesirable aquatic growth in surface waters and the potential adverse health effects of nitrates in groundwater.

In the Florida Keys, degradation and eutrophication of canal and nearshore waters led Monroe County to require all new and expanding wastewater treatment facilities to meet Advanced Wastewater Treatment (AWT) or Best Available Technology (BAT). However, the county lacked the information it needed to determine what discharge limitations could reasonably be imposed under these requirements, given the large number (nearly 300) of wastewater treatment plants with small flows and limited operational oversight. Experience had demonstrated that DEP AWT limits of 3 mg/L for nitrogen and 1 mg/L for phosphorus could be achieved by large plants, but there was no assurance or expectation that such stringent limits could be achieved by small plants. Additionally, no specific BAT standards existed.

A study was commissioned by Monroe County, with support and financial assistance from DEP, to determine BAT effluent limitations for treatment plants with permitted design capacities in the range of 2,000 to 100,000 gpd. The summary provided in this article includes a review and ranking of BNR technologies and proprietary equipment on the market with respect to costs, performance, and other factors. Information was derived from equipment suppliers, DEP and EPA databases, technical literature, and visits to operating facilities.

Small-Flow Nutrient Removal Facilities in the U. S.

Table 1 contains a nationwide list of full-scale facilities in the 2,000 to 100,000 gpd range that are designed to meet total nitrogen or phosphorus limits, as derived from DEP and EPA databases and input from 85 equipment suppliers. The most common phosphorus limit is 1.0 mg/L, ranging from 0.1 to 2.0. The most common nitrogen limit is 10 mg/L, ranging from 3 to 14. Florida has imposed the most stringent nitrogen limits on plants in this size range.

TABLE 1. U.S. WWTPs WITH NUTRIENT REMOVAL PROCESSES CAPACITY ≤ 0.1 MGD

Location	P Removal	N Removal
Arkansas	—	1
Arizona	—	1
California	—	1
Colorado	10	3
Connecticut	—	1
Florida	8	16
Indiana	3	—
Maryland	2	1
Massachusetts	—	2
Michigan	4	5
Minnesota	15	—
New Jersey	8	4
New Mexico	—	3
New York	5	12
Pennsylvania	—	11
TOTAL	55	61

Sources: U. S. EPA Permit Compliance System; FDEP WAFR database; Equipment Suppliers

Site Visits

Nutrient removal systems in the size range of 2,000 to 100,000 gpd are almost universally furnished as pre-engineered, factory- or field-assembled package systems. Approximately 25 systems available on the market were evaluated, followed by visits to 17 operating treatment plants in Florida, New York, New Jersey, and Massachusetts. The plants represented diverse technologies and covered a spectrum of sizes within the range of interest. Information was gathered on plant performance, actual operation and maintenance costs, actual capital costs, and the level of operator staffing. The collected information was subsequently used in the evaluation of alternative systems.

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Nutrient Removal Systems Evaluated

The following biological nitrogen removal systems, which were considered representative of the diverse technologies on the market and applicable to small treatment systems, were selected and evaluated.

1. MLE (2-Stage) Continuous-Flow Suspended-Growth Process
2. 4-Stage Continuous-Flow Suspended-Growth Process
3. 3-Stage Continuous-Flow Suspended-Growth Process
4. 4-Stage Sequencing Batch Reactor (SBR) Suspended-Growth Process

TABLE 2. SELECTED NUTRIENT REMOVAL SYSTEMS

System Description	Representative Suppliers	Achievable Effluent Quality BOD/TSS/TN/P' (mg/L)
1. MLE Process – continuous-flow suspended-growth process with an initial anoxic stage followed by an aerobic stage	Smith and Loveless U. S. Filter/Davco Aeration Industries Zenon Environmental The McNeil Company	10/10/10/2 (5/5/10/1 with filtration)
2. Four-Stage Process – continuous-flow suspended-growth process with alternating anoxic/aerobic/anoxic/aerobic stages	Smith and Loveless U. S. Filter/Davco Zenon Environmental The McNeil Company	10/10/6/2 (5/5/6/1 with filtration)
3. Three-Stage Process – continuous-flow suspended-growth process with alternating aerobic/anoxic/aerobic stages	Smith and Loveless U. S. Filter/Davco Zenon Environmental The McNeil Company	10/10/6/2 (5/5/6/1 with filtration)
4. SBR Suspended-Growth Process – batch process sequenced to simulate the four-stage process	Aqua-Aerobics Purestream, Inc U. S. Filter/Jet Tech Babcock International Fluidyne	10/10/8/2 (5/5/8/1 with filtration)
5. Intermittent-Cycle Process – modified SBR process with continuous influent flow but batch, four-stage, treatment process	Schreiber Corporation Austgen-Biojet Cromaglass Corporation AES	10/10/8/2 (5/5/8/1 with filtration)
6. MLE and Deep-Bed Filtration Process – Alternate 1 followed by attached-growth denitrification filter	U. S. Filter/Davco Purestream, Inc. Aeration Industries	10/5/6/1 (process includes filtration)
7. Submerged Biofilter Process – continuous-flow or intermittent-cycle process using one or more submerged media biofilters with sequential anoxic/aerobic stages	Tetra Technologies, Inc. WWSI Smith and Loveless	20/20/12/2 (5/5/12/1 with filtration)
8. RBC Process – continuous-flow process using RBCs with sequential anoxic/aerobic stages	CMS Group WWSI	20/20/12/2 5/5/12/1 (with filtration)
9. Conventional Secondary Treatment – continuous-flow activated sludge process (no enhanced nutrient removal; included for basis of comparison)	Smith and Loveless U. S. Filter/Davco Aeration Industries Zenon Environmental The McNeil Company	10/10/X/X 5/5/X/X (with filtration)

5. 4-Stage Intermittent-Cycle Suspended-Growth Process
6. MLE Process followed by Deep Bed Filtration Process
7. Submerged Biofilter Process
8. Rotating Biological Contactor (RBC) Process

In each case, the recommended method of phosphorus removal was chemical precipitation. In addition, effluent polishing filtration would be provided in each system, except System 6, which already incorporates the deep bed filtration process for nitrogen removal.

Table 2 presents a description of each system, representative equipment suppliers, and estimated achievable effluent quality. Also included for comparison is a conventional secondary treatment plant (System 9).

Two of the systems identified above (Systems 1 and 6) were determined to be potentially applicable for retrofitting nitrogen removal to existing WWTPs, and evaluated separately. These were identified as (1) System 1R—MLE (2-Stage) Continuous-Flow Suspended-Growth Process, and (2) System 2R—Deep Bed Filtration Process.

The MLE process (System 1R) can be retrofitted to an existing plant by adding an anoxic basin upstream of the existing plant, redirecting the influent flow to this basin, and adding recirculation pumping from the existing aeration basin to the new anoxic basin. Alternatively, an anoxic zone could be created within the existing aeration basin by adding a baffle wall, but that would reduce the capacity of the plant. New chemical feed facilities for phosphorus removal could also be added.

In System 2R, a deep-bed filter would be added downstream of the existing package plant, replacing any existing filtration facilities. New pumping facilities to pump secondary effluent to the deep bed filter would be required, as well as methanol feed facilities and chemical feed facilities for phosphorus removal.

Performance Comparison

As indicated in Table 2, all of the systems are generally considered capable of meeting effluent BOD and TSS concentrations similar to large plants. Achievable effluent nitrogen concentrations range from 6 to 12 mg/L, with the 4-stage and 3-stage processes and the deep-bed filtration process (Systems 2, 3, and 6, respectively) being the most effective. Chemical phosphorus removal in all of the alternative systems is expected to achieve effluent limits of 2 mg/L without filtration and 1 mg/L with filtration.

Achievable permit limits for the MLE retrofit system (System 1R) were considered comparable to the corresponding new-plant MLE system (System 1). Achievable permit limits for the deep-bed filtration retrofit system (System 2R) were also estimated to be similar to those for the corresponding new-plant system (System 6), but with a somewhat lesser N removal capability because the retrofit system did not incorporate an MLE process.

As a result of this performance assessment, DEP provided to Monroe County the following BAT limitations (annual average basis) applicable to new and expanding facilities with permitted design capacities of less than 100,000 gpd (source: DEP correspondence to Monroe County Commissioners dated May 12, 1998):

CBOD	10 mg/L
TSS	10 mg/L
N	10 mg/L
P	1 mg/L

Cost Comparison

Tables 3 and 4 compare costs for the nine new-plant and two retrofit alternatives, respectively, for five different treatment capacities. The cost summary includes the estimated construction cost, annual O&M cost, uniform annual cost, and unit cost ($/1,000 gallons). Uniform annual costs were determined using an interest rate of 6 percent for a 20-year period. The unit cost was determined by dividing the uniform annual cost by the number of 1,000 gallons of wastewater treated per year, at 80 percent capacity utilization.

Construction costs for the new-plant alternatives include all required facilities for a new plant on a new site. Filtration was included for all of the systems except the base case secondary treatment system. In general, the conventional suspended-growth nutrient removal technologies have the lowest construction costs for capacities exceeding approximately 10,000 gpd. The attached-growth processes construction costs are competitive at the smallest system sizes of 4,000 and 10,000 gpd. A generally poor correlation exists between the construction cost of alternatives and nitrogen removal performance.

TABLE 3. COSTS OF NUTRIENT REMOVAL SYSTEMS – NEW PLANTS

Cape Dorset ~70,000 gpd.

System	4,000 (gpd)	10,000 (gpd)	25,000 (gpd)	50,000 (gpd)	100,000 (gpd)
	Treatment Facility Design Capacity				
1 MLE					
Construction Cost, $	$ 261,000	$ 311,000	$ 422,000	$ 601,000	$ 874,000
Annual O&M Cost, $/yr	$ 30,400	$ 35,500	$ 49,400	$ 66,600	$ 100,100
Uniform Annual Cost, $/yr	$ 53,200	$ 62,600	$ 86,200	$ 119,000	$ 176,300
Unit Cost, $/1,000 gal	$ 61.8	$ 29.1	$ 16.0	$ 11.1	$ 8.2
2 Four-Stage					
Construction Cost, $	$ 336,000	$ 368,000	$ 475,000	$ 666,000	$ 968,000
Annual O&M Cost, $/yr	$ 52,500	$ 57,600	$ 73,800	$ 95,900	$ 132,300
Uniform Annual Cost, $/yr	$ 81,800	$ 89,700	$ 115,200	$ 154,000	$ 216,700
Unit Cost, $/1,000 gal	$ 95.0	$ 41.7	$ 21.4	$ 14.3	$ 10.1
3 Three-Stage					
Construction Cost, $	$ 291,000	$ 333,000	$ 441,000	$ 627,000	$ 913,000
Annual O&M Cost, $/yr	$ 35,900	$ 41,900	$ 56,400	$ 76,200	$ 115,900
Uniform Annual Cost, $/yr	$ 61,300	$ 70,900	$ 94,800	$ 130,900	$ 195,500
Unit Cost, $/1,000 gal	$ 71.2	$ 32.9	$ 17.6	$ 12.2	$ 9.1
4 SBR					
Construction Cost, $	$ 336,000	$ 381,000	$ 482,000	$ 697,000	$ 966,000
Annual O&M Cost, $/yr	$ 28,000	$ 34,100	$ 49,100	$ 67,600	$ 100,000
Uniform Annual Cost, $/yr	$ 57,300	$ 67,300	$ 91,100	$ 128,400	$ 184,200
Unit Cost, $/1,000 gal	$ 66.5	$ 31.3	$ 16.9	$ 11.9	$ 8.6
5 Intermittent Cycle					
Construction Cost, $	$ 229,000	$ 374,000	$ 584,000	$ 861,000	$ 1,026,000
Annual O&M Cost, $/yr	$ 28,000	$ 34,100	$ 49,100	$ 67,600	$ 100,000
Uniform Annual Cost, $/yr	$ 48,000	$ 66,700	$ 100,000	$ 142,700	$ 189,400
Unit Cost, $/1,000 gal	$ 55.7	$ 31.0	$ 18.6	$ 13.3	$ 8.8
6 MLE + Deep Bed Filtration					
Construction Cost, $	$ 308,000	$ 368,000	$ 486,000	$ 664,000	$ 958,000
Annual O&M Cost, $/yr	$ 36,900	$ 42,700	$ 58,100	$ 75,900	$ 111,400
Uniform Annual Cost, $/yr	$ 63,800	$ 74,800	$ 100,500	$ 133,800	$ 194,900
Unit Cost, $/1,000 gal	$ 74.1	$ 34.7	$ 18.7	$ 12.4	$ 9.1
7 Submerged Biofilters					
Construction Cost, $	$ 247,000	$ 296,000	$ 450,000	$ 847,000	See Note (1)
Annual O&M Cost, $/yr	$ 19,500	$ 24,400	$ 41,100	$ 60,400	See Note (1)
Uniform Annual Cost, $/yr	$ 41,000	$ 50,200	$ 80,300	$ 134,200	See Note (1)
Unit Cost, $/1,000 gal	$ 47.6	$ 23.3	$ 14.9	$ 12.5	See Note (1)
8 RBCs					
Construction Cost, $	$ 263,000	$ 342,000	$ 527,000	$ 868,000	$ 1,092,000
Annual O&M Cost, $/yr	$ 20,400	$ 25,900	$ 43,400	$ 61,500	$ 89,400
Uniform Annual Cost, $/yr	$ 43,300	$ 55,700	$ 89,300	$ 137,200	$ 184,600
Unit Cost, $/1,000 gal	$ 50.3	$ 25.9	$ 16.6	$ 12.7	$ 8.6
9 Baseline – Secondary Treatment					
Construction Cost, $	$ 183,000	$ 223,000	$ 303,000	$ 461,000	$ 671,000
Annual O&M Cost, $/yr	$ 22,000	$ 26,500	$ 39,200	$ 52,100	$ 78,000
Uniform Annual Cost, $/yr	$ 37,900	$ 45,900	$ 65,600	$ 92,300	$ 136,500
Unit Cost, $/1,000 gal	$ 44.0	$ 21.3	$ 12.2	$ 8.6	$ 6.3

Note: (1) Exceeded manufacturer's sizes

Table 4. Cost Summary for Retrofit Systems

	System	System Design Capacity 4,000 (gpd)	10,000 (gpd)	25,000 (gpd)	50,000 (gpd)	100,000 (gpd)
R1	**Anoxic Tank for MLE Upgrade**					
	Construction Cost, $	21,000	24,000	39,000	57,000	80,000
	Annual O&M Cost, $/yr	12,100	12,600	13,400	18,700	21,100
	Uniform Annual Cost, $/yr	13,900	14,700	16,800	23,700	28,100
	Present Worth, $	159,800	168,500	192,700	271,500	322,000
	Unit Cost, $/1,000 gal	16.1	6.8	3.1	2.2	1.3
R2	**Deep Bed Denitrification Filter**					
	Construction Cost, $	109,000	121,000	147,000	163,000	213,000
	Annual O&M Cost, $/yr	17,600	18,200	20,300	24,800	28,600
	Uniform Annual Cost, $/yr	27,100	28,700	33,100	39,000	47,200
	Present Worth, $	310,900	329,800	379,800	447,500	541,000
	Unit Cost, $/1,000 gal	31.5	13.3	6.1	3.6	2.2

For the retrofit alternatives, only the new facilities needed for nitrogen and phosphorus removal are included. Although the deep bed denitrification filter retrofit alternative provides somewhat better nitrogen removal percentage than the MLE retrofit alternative, it is approximately two to four times more costly, depending on capacity.

O&M costs were developed by individually considering operations labor, electricity, maintenance and repairs materials and labor, solids handling and disposal, administration labor, laboratory analytical requirements, and chemical costs. For the retrofit alternatives, only the increase in these costs associated with the addition of nitrogen and phosphorus removal facilities was estimated. Assumptions were as follows:

- Operations labor - labor at $36/hour (includes overhead), with minimum staffing per F.A.C. 62-699.310
- Electricity - $0.10/kW-hr
- Maintenance and repairs materials and labor - 3 percent of capital costs/year
- Solids handling and disposal - liquid haul at $0.17/gal
- Administrative - 5 percent of the sum of the operations labor, electricity, and maintenance and repairs costs
- Laboratory - commercial rates applied to required monitoring parameters in F.A.C.62-0699.310
- Chemical costs - alum for P removal at $1.80/lb; Symclosene (chlorine) at $2.50/lb; methanol at $0.15/lb

For the new-plant alternatives, the data show that the two attached-growth processes (Systems 7 and 8) have the lowest O&M costs, which was due to lower costs for electricity, solids handling, and laboratory analyses. These processes are also simpler to operate than suspended-growth processes. O&M costs are highest for the four-stage (System 2) and deep-bed filtration (System 6) systems because they are the most complex to operate and maintain. For the same reason, the deep-bed retrofit alternative (System 2R) has higher estimated O&M costs than the MLE retrofit system (System 1R).

On a unit cost basis, the nutrient removal systems with filtration included are approximately 20 to 40% more costly than a conventional secondary treatment system without filtration. For the two lowest new-plant capacities analyzed (4,000 and 10,000 gpd), the attached-growth processes (Systems 7 and 8) appear to have clear life-cycle and unit cost advantages over the other nutrient removal technologies. These alternatives are followed by the intermittent-cycle, MLE, and SBR systems (Systems 5, 1, and 4) in a middle cost range. The highest cost systems in this flow range are the four-stage (System 2) and denitrification filter (System 6) systems. As plant capacity increases to approximately 25,000 gpd or greater, the total cost advantage of the attached-growth systems begins to disappear. The four-stage continuous-flow process (System 2) is consistently more costly than all other technologies across all facility sizes.

For the retrofit alternatives, the annual and unit cost: operating a denitrification filter are nearly twice those retrofitting and operating an MLE system.

Ranking

Weighted rankings for the seven new treatment pla alternatives and the two plant retrofit alternatives were pr pared using five criteria that considered both cost and no cost factors associated with the ownership, operation, ar performance of small-flow nutrient removal treatment plan The criteria evaluated were unit cost, nitrogen removal pe formance, process control flexibility, ease of operation, ar land requirements. For each criterion, a relative score of (less favorable) to 5 (very favorable) was assigned to eac alternative. The raw scores for each criterion were the multiplied by a weighting factor to amplify the rankings of more important criteria relative to those of less important criteri The results are summarized in Tables 5 and 6 for the new-plant an retrofit systems, respectively.

For the new-plant alternatives, the three-stage system (Systen 3) was ranked the most favorable based on its moderate costs process control flexibility, and ease of operation. The MLE an deep-bed filtration systems (Systems 1 and 6, respectively) were ranked second and third, respectively. The SBR and intermittent cycle systems (Systems 4 and 5, respectively) were ranked in a tie for fourth. The four-stage system (System 2) was ranked fifth, while the attached-growth systems (Systems 7 and 8) were ranked in a tie for sixth.

Among the two retrofit alternatives, the MLE system (System 1R) had the best ranking, primarily due to more favorable unit costs and ease of operation. ■

Table 5. Ranking of Nutrient Removal Alternatives for New WWTPs

No.	System Alternative	Unit Cost	Nitrogen Removal	Process Control Flexibility	Ease of Operation	Land Required	Raw Score	Weighted Score	Ranking
	Weighting Factor	30%	30%	15%	15%	10%		100%	
1	MLE	4	4	3	3	3	17	3.6	2
2	Four-stage	1	5	5	2	3	16	3.2	5
3	Three-stage	3	5	4	3	3	18	3.8	1
4	SBR	3	4	3	3	4	17	3.4	4 (tie)
5	Intermittent Cycle	3	4	3	3	4	17	3.4	4 (tie)
6	MLE + Deep Bed Filtration	2	5	5	2	3	17	3.5	3
7	Submerged Biofilters	3	2	2	4	5	16	2.9	6 (tie)
8	RBC	3	2	2	4	5	16	2.9	6 (tie)
	Total Possible Points						25	5	

Note: Scores: 1 (Less Favorable) to 5 (More Favorable)

Table 6. Ranking of Retrofit Nutrient Removal Alternatives

No.	System Alternative	Unit Cost	Nitrogen Removal	Process Control Flexibility	Ease of Operation	Land Required	Raw Score	Weighted Score	Ranking
	Weighting Factor	30%	30%	15%	15%	10%		100%	
1	Anoxic Tank, MLE Upgrade	4	4	3	3	3	17	3.6	1
2	Deep-Bed Benite Filter	2	4	3	2	4	15	3.0	2
	Total Possible Points						25	5	

Note: Scores: 1 (Less Favorable) to 5 (More Favorable)

Strategies For Procurement of a 6.0 MGD Wastewater Treatment Facility

Harold E. Schmidt, Jr., J. Richard Voorhees, Jon D. Fox, and Peter A. Korelich

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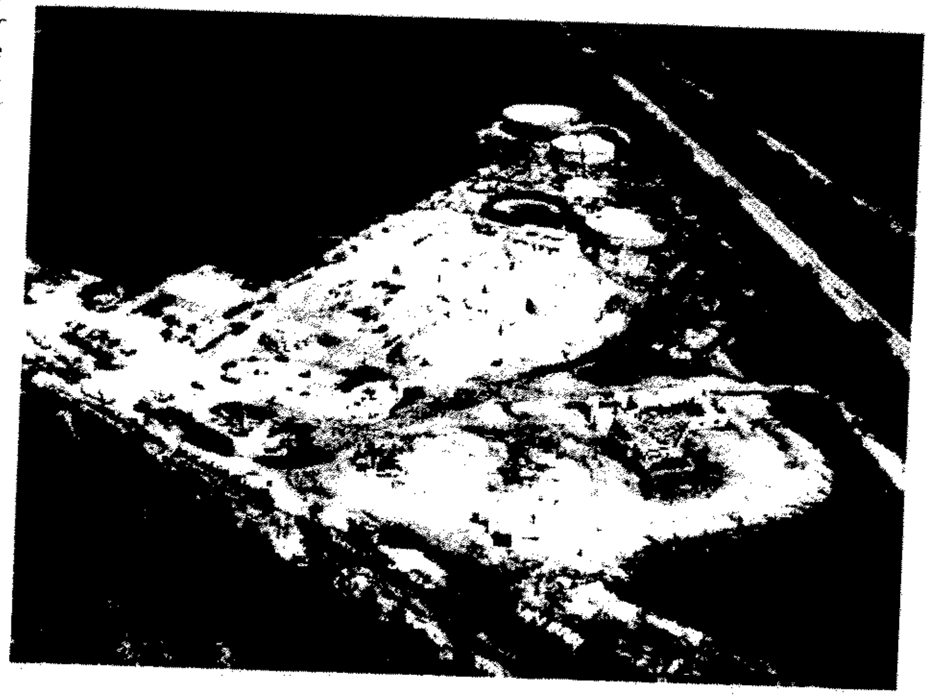
In 1980 New Smyrna Beach constructed a 4.0 MGD pure oxygen high-rate activated sludge wastewater treatment plant that discharged to the Indian River Lagoon system. To comply with House Bill 3247, *the Indian River Lagoon Act*, in 1991 the city upgraded the plant to provide advanced secondary treatment and a public access reclaimed water system. Additional expansions were necessitated by population growth in the service area.

Alternative methods of process optimization to upgrade the existing facilities included pilot testing various configurations to reduce nitrogen and phosphorus. Because of site constraints and process equipment optimization to meet the effluent criteria required by the regulatory agencies, the city decided to make various improvements to the wastewater transmission system and to construct a new 6.0 MGD treatment facility. The deadline to have the new facility on line was June 30, 1999, per an imposed Consent Order.



The improvements to the wastewater transmission system consisted of permitting and design of two wastewater pump stations, with pumping capacities of 3.0 and 15 MGD, and various improvements to existing stations. The city's engineering staff provided in-house design for 95,200 linear feet of 12-, 24-, and 30-inch diameter pipelines for raw wastewater, reclaimed water, and potable water transmission mains.

Development of the new facility consisted of site selection, ecological assessments, and resolution of various site zoning issues. Engineering service included permitting and design of a pretreatment structure, a five-stage biological nutrient removal wastewater treatment system, secondary clarifiers, continuous backwash deep bed filters, and high-level disinfection. The nutrient removal system consisting of fermentation, first anoxic, aeration, second anoxic, and reaeration basins.

The design was to provide advanced levels of treatment because of the effluent requirements for wet weather discharge into the Indian River Lagoon system and Class I reliability requirements. Also included was a Class B sludge stabilization facility consisting of sludge holding, sludge thickening, and lime stabilization.

The reclaimed water reuse system consisted of a 6.0-million-gallon substandard effluent storage tank, a 2.0-million-gallon reclaimed water storage tank, and high service pumping. The reclaimed water high service pumping facilities consisted of five vertical turbine pumps ranging in capacities from 450 to 2,000 gpm. Ancillary facilities included a new administration building, a laboratory for both wastewater and potable water, motor control centers, and other miscellaneous facilities.

The overall wastewater management program was funded using a combination of methods. It included funds from the city's mandated facility surcharges and renewal and replacement accounts), utility system revenue bonds, the State Revolving Fund, and a grant from the St. Johns River Water Management District.

Objectives

The success of a wastewater management design depends on development of a thorough and coordinated set of engineering drawings and specifications, selection of equipment, choice of contractor, and owner's commitment to proper operation. A project still may not meet all expectations because of hidden problems that enter into the project as contractors prepare the bids. Our goal was to develop a format that prevented poor quality or misapplied equipment from being included in the project, while maintaining a high level of competition between the equipment manufacturers and suppliers.

The method of procurement itself can become an impediment to a successful project. The conventional open format commonly used in the bidding of wastewater management systems generally encourages selection of only the lowest priced materials, methods of construction, and equipment. Problems sometimes develop and extend through construction and operation. For example, when the term "or equal" is added to a well-written specification, it may become vague to the reader. During the bidding process, the contractor will receive many quotes from many suppliers of the equipment named in the specifications and/or interpreted as an "equal" to the specified equipment, and thus must select the lowest priced equipment or package to be selected for the project. Therefore, little consideration is given to the equipment that best meets the requirements of the project. Most important, needs of the owner, who must operate and maintain the facilities, are ignored. Based on information from the U.S. Accounting Office, one of the most significant factors in the failure of wastewater treatment facilities to adequately meet the effluent limitations for which they were designed has been inferior process equipment.

Our experience indicated that there was no one best means of procurement and bidding format. During our initial stages, we evaluated five methods individually and in combination:

1. *Conventional open bid.* Competition is encouraged because the contractors are free to negotiate with all interested parties. However, this method also permits the contractor the opportunity to offer products that while complying with the salient requirements of the specifications and project intent may not be the exact equipment or process envisioned in the design. This process also encourages prebid packaging, post bid shopping, and may lead to the possibility of disputes during construction.
2. *Base bid.* Contractors are required to base their prices on equipment named on a fixed list. Competition tends to be discouraged, except among the named "base bid" manufacturers. Because the products and equipment in the base bid have been evaluated in the design process, fewer problems tend to arise during construction and start-up phases. Bid protests may occur because suppliers are not listed in the specifications or bid form.
3. *Base/substitute bid.* The contractor is allowed to enter equipment names and deduct amounts to the bid package. The bids can be evaluated either before or after the substitutions have been included. Similar to the base bid format, competition is limited and generally prebid packaging is discouraged. The concerns with bid protests are similar to the problems that could be encountered with the base bid process.
4. *Evaluated bid.* Equipment is selected based on total cost, life-cycle cost, or some other method of evaluation. This format maintains equipment selection with the owner and designer, provides for competition, tends to eliminate prebid packaging, and fulfills all the legal requirements for bidding of federally funded projects. Since the project is designed around a specific type of equipment, disputes are generally minimized during construction.
5. *Pre-selection of major equipment.* This method is very similar to the evaluation bid format since the engineer and owner play a critical role in selecting not only the type, but also the brands of equipment installed. The primary difference is that it does not generally permit competition, since the equipment has already been chosen prior to the bid; however, it leaves open the possibility for a fair competition during the equipment proposal process.

It was determined that a combination of methods 2 and 5 provided a number of advantages, such as:

1. Equipment selection decisions stay with the owner and engineer.
2. New and innovative processes and equipment are encouraged.
3. Pre-bid packaging and post-bid shopping are discouraged.
4. Disputes during construction are minimized.
5. The method is legal and enforceable.

A number of primary components of the wastewater facilities were evaluated during the pre-selection/evaluation process. The premise of the pre-selection process was to select the major pieces of equipment prior to bidding. With the bidding format process chosen, the contractor was still required to purchase the equipment and be responsible for its installation, as with typical construction contracts.

The process equipment that was determined to be the most important components of the wastewater treatment facilities to meet the effluent limitations contained in the Consent Agreement and was theref evaluated and pre-selected prior to bidd included the biological nutrient remo process, the method of filtration, and t instrumentation package. The primary ai of our evaluation was the biological nutrie removal wastewater treatment proce since it was the heart of the system.

A number of biological nutrient remov treatment processes were evaluated, inclu ing the Eimco 5-stage Bardenpho proces Kruger Bio-Denitpho process, Envirex Orb Simpre process, and sequential batch rea tors. Each of the process suppliers wa invited to submit proposals on technica merit and cost. The criteria for the proces evaluation, identical for all proposals, ir cluded influent and effluent characteris tics, operating conditions, and site consic erations.

Evaluations of technical proposals wer based on capital and operating costs, labo and maintenance requirements, operatin experience and reliability, the ability to mee the effluent criteria, performance guaran tees, and other miscellaneous items (e.g. odors, aerosols). Moreover, during the pro cess proposal stage of the project, we visitec a number of wastewater facilities that utilized the treatment processes to develop a subjective analysis of them.

It was determined that an Eimco 5-stage

Bardenpho facility was the biological nutrient removal treatment process that met the requirements for the UCCNSB.

The methods of filtration that were evaluated were travelling bridge and continuous backwash deep bed filters, and they were evaluated in a similar fashion to the biological nutrient removal processes. It was determined that the continuous backwash deep bed filters were the most appropriate method of filtration for this project and site.

The evaluation of the instrumentation package was more difficult because of the many suppliers available. Since the primary goal was to select a system that could efficiently operate with the selected biological nutrient removal process, one of the key evaluation criteria was experience with other biological nutrient removal processes. It was determined that the Kruger instrumentation package met all the requirements of the evaluation.

Since Kruger and Eimco are competitors in the marketing of biological nutrient removal process equipment, it was thought that integrating the Kruger instrumentation package with the Eimco equipment would be difficult. It was quite the contrary, since both organizations, along with the project team, worked effectively together to develop a successful instrumentation package that met the needs of the project.

This was the first project in the United States to successfully integrate the Eimco Bardenpho treatment technology with the Kruger controls and instrumentation system in a bidding package.

We believe that this method of pre-selection of the major process equipment enabled the city and the project team to select the most appropriate equipment for the project. It also enabled the project design team to work with the city and the various suppliers and determine what will work best for the facility. Since the project required the selection of specialized equipment, it was determined that this method of pre-selection was useful.

At the preliminary and 60-percent-final design stages, the project underwent an intensive value engineering study to identify potential savings in capital and/or operating costs. A savings of approximately $540,000 was realized.

When the design was completed the engineering drawings were forwarded to five major general contractors for a feasibility and constructability review. Additionally, the review process provided information regarding special construction techniques, alternative layouts, and other cost saving measures. The information from the five reviews was evaluated and, where possible, incorporated into the final bidding documents.

Results

The project went out for bid in September 1997. Nine bids, ranging from $16,156,705 to $18,725,000, were received. The low bid by Indian River Industrial Contractors, Inc., of Jacksonville resulted in a cost per gallon of $2.69. As of September 1998, the project is approximately 70 percent complete. It has had one change order—to add two additional filters to enable the treatment of an additional 1.0 MGD from the cooling tower of a proposed new electrical power plant that will be constructed adjacent to the project site. The $214,882 cost of the change order will be borne by the owner of the power plant. The wastewater treatment facility is currently in the process of being repermitted to treat an average daily flow of 7.0 MGD. Using the rerated flows and the additional costs from the change order, the cost per gallon was now $2.33.

The design and bidding format allowed the owner and engineer to implement a program that meets project needs, will minimizes disputes during construction, and is cost effective. Compared to recent bids from similar sized and type facilities in Florida, savings of at least $4,000,000 were realized. ■

United States
Environmental Protection
Agency

Office of Water
Washington, D.C.

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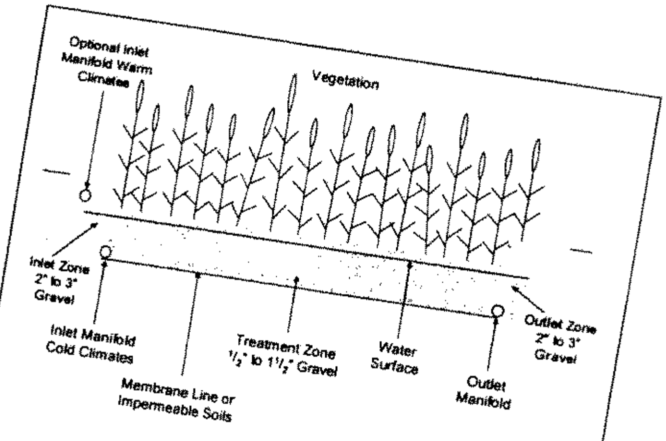
September 200

Wastewater Technology Fact Sheet
Wetlands: Subsurface Flow

DESCRIPTION

Wetland systems are typically described in terms of the position of the water surface and/or the type of vegetation grown. Most natural wetlands are free water surface systems where the water surface is exposed to the atmosphere; these include bogs (primary vegetation mosses), swamps (primary vegetation trees), and marshes (primary vegetation grasses and emergent macrophytes). A subsurface flow (SF) wetland is specifically designed for the treatment or polishing of some type of wastewater and are typically constructed as a bed or channel containing appropriate media. An example of a SF wetland is shown in Figure 1. Coarse rock, gravel, sand and other soils have all been used, but a gravel medium is most common in the U.S. and Europe. The medium is typically planted with the same types of emergent vegetation present in marshes, and the water surface is designed to remain below the top surface of the medium. The main advantages of this subsurface water level are prevention of mosquitoes and odors, and elimination of the risk of public contact with the partially treated wastewater. In contrast, the water surface in natural marshes and free water surface (FWS) constructed wetlands is exposed to the atmosphere with the attendant risk of mosquitoes and public access.



Source: Adapted from drawing by S.C. Reed, 2000.

FIGURE 1 SUBSURFACE FLOW WETLAND

The water quality improvements in natural wetlands had been observed by scientists and engineers for many years and this led to the development of constructed wetlands as an attempt to replicate the water quality and the habitat benefits of the natural wetland in a constructed ecosystem. Physical, chemical, and biochemical reactions all contribute to water quality improvement in these wetland systems. The biological reactions are believed due to the activity of microorganisms attached to the available submerged substrate surfaces. In the case of FWS wetlands these substrates are the submerged portion of the living plants, the plant litter, and the benthic soil layer. In SF wetlands the available submerged substrate includes the plant roots growing in the media, and the surfaces of the media themselves. Since the media surface area in a SF wetland can far exceed the available substrate in a FWS wetland, the microbial reaction rates in a SF wetland can be higher than a FWS wetland for most contaminants. As a result, a SF wetland can be smaller than the FWS type for the same flow rate and most effluent water quality goals.

The design goals for SF constructed wetlands are typically an exclusive commitment to treatment functions because wildlife habitat and public recreational opportunities are more li...
FWS wetlands. Th...

TABLE 5 CAPITAL AND O&M COSTS FOR 100,000 GALLONS PER DAY SF WETLAND

Item	Cost $*	
	Native Soil Liner	Plastic Membrane Liner
Land Cost	$16,000	16,000
Site Investigation	3,600	3,600
Site Clearing	6,600	6,600
Earthwork	33,000	33,000
Liner	0	66,000
Gravel Media**	142,100	142,100
Plants	5,000	5,000
Planting	6,600	6,600
Inlets/Outlets	16,600	16,600
Subtotal	$229,500	$295,500
Engineering, legal, etc.	$133,000	$171,200
Total Capital Cost	**$362,500**	**$466,700**
O & M Costs, $/yr	$6,000/yr	$6,000/yr

* June 1999 costs, ENR CCI = 6039
**12,000 cy of 0.75 in. gravel

TABLE 6 COST COMPARISON SF WETLAND AND CONVENTIONAL WASTEWATER TREATMENT

Cost Item	Process	
	Wetland	SBR
Capital Cost	$466,700	$1,104,500
O &M Cost	$6,000/yr	$106,600/yr
Total Present Worth Costs*	$530,300	$2,233,400
Cost per 1000 gallons treated**	$0.73	$3.06

*Present worth factor 10.594 based on 20 years at 7 percent interest (June 1999 costs, ENR CCI = 6039).
**Daily flow rate for 365 d/yr, for 20 yr, divided by 1000 gallons

Source: WEF, 2000.

Table 6 compares the life cycle costs for this wetland to the cost for a conventional treatment system designed for the same flow and effluent water quality. The conventional process is a sequencing batch reactor (SBR).

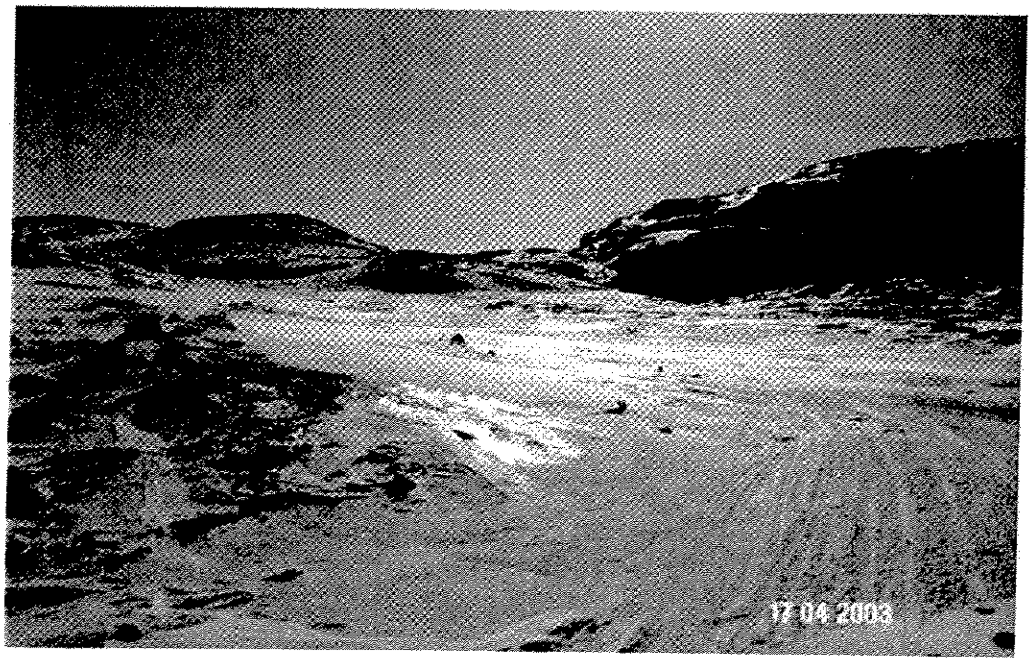
REFERENCES

Other Related Fact Sheets

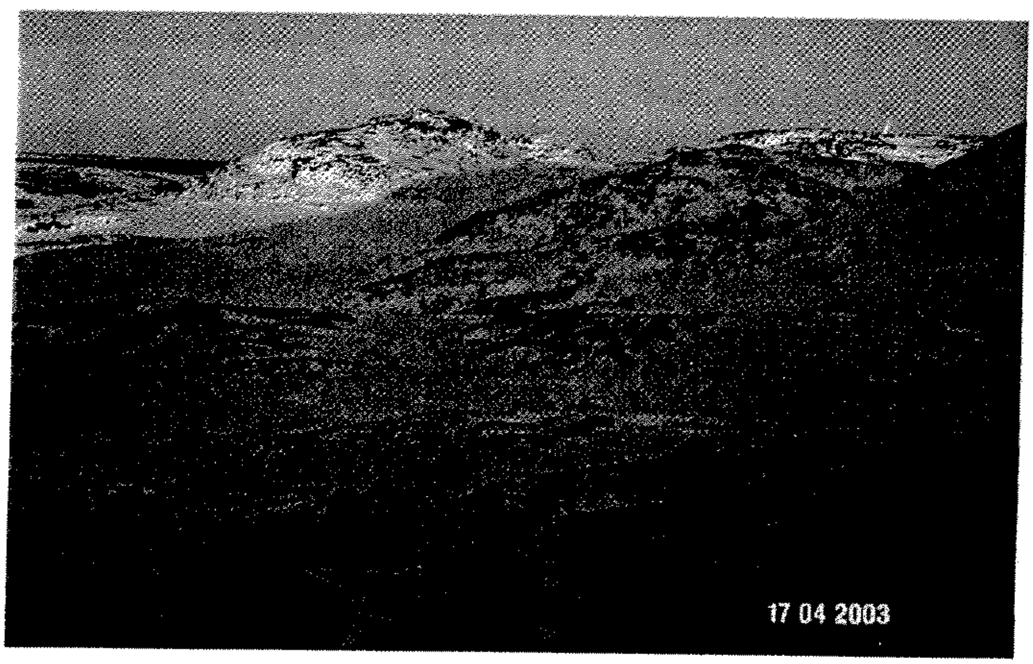
Free Water Surface Wetlands
EPA 832-F-00-024
September, 2000

Other EPA Fact Sheets can be found at the following web address:
http://www.epa.gov/owmitnet/mtbfact.htm

Appendix I
P-Lake Access Road Route Photographs



View of Existing Road Looking Toward Saddle. Wetland / Lagoon Location at Top Of Saddle.



View From Top of Saddle Looking Toward Possible Road Route.

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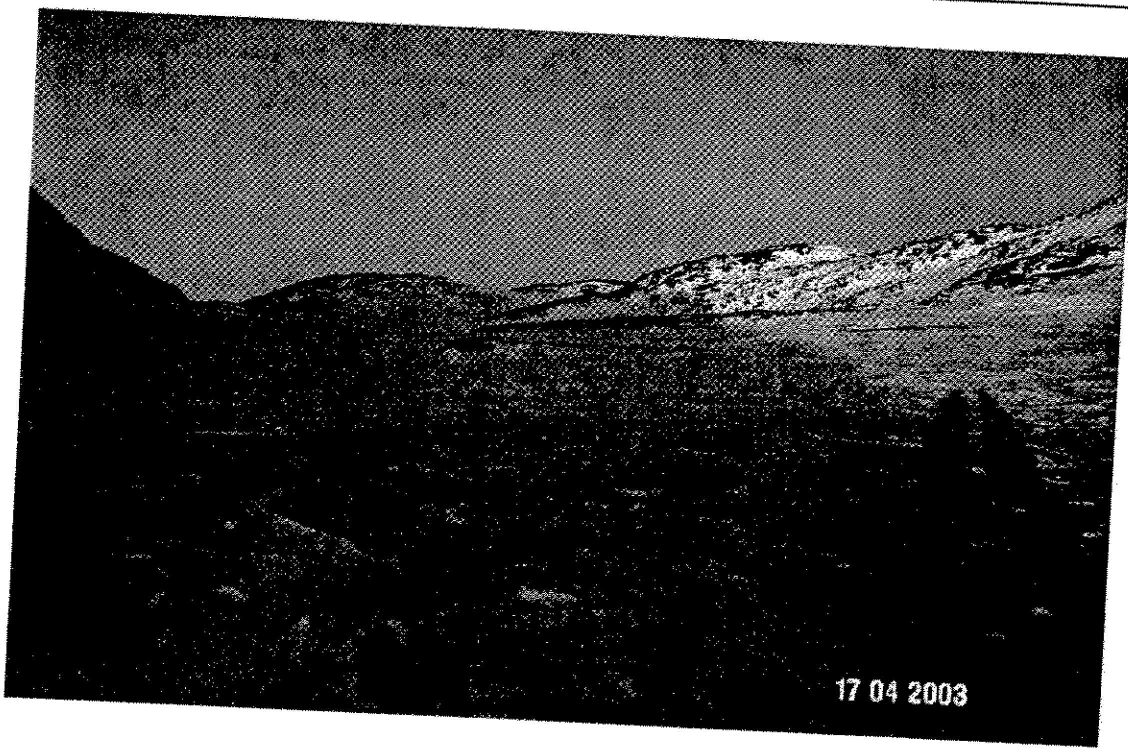
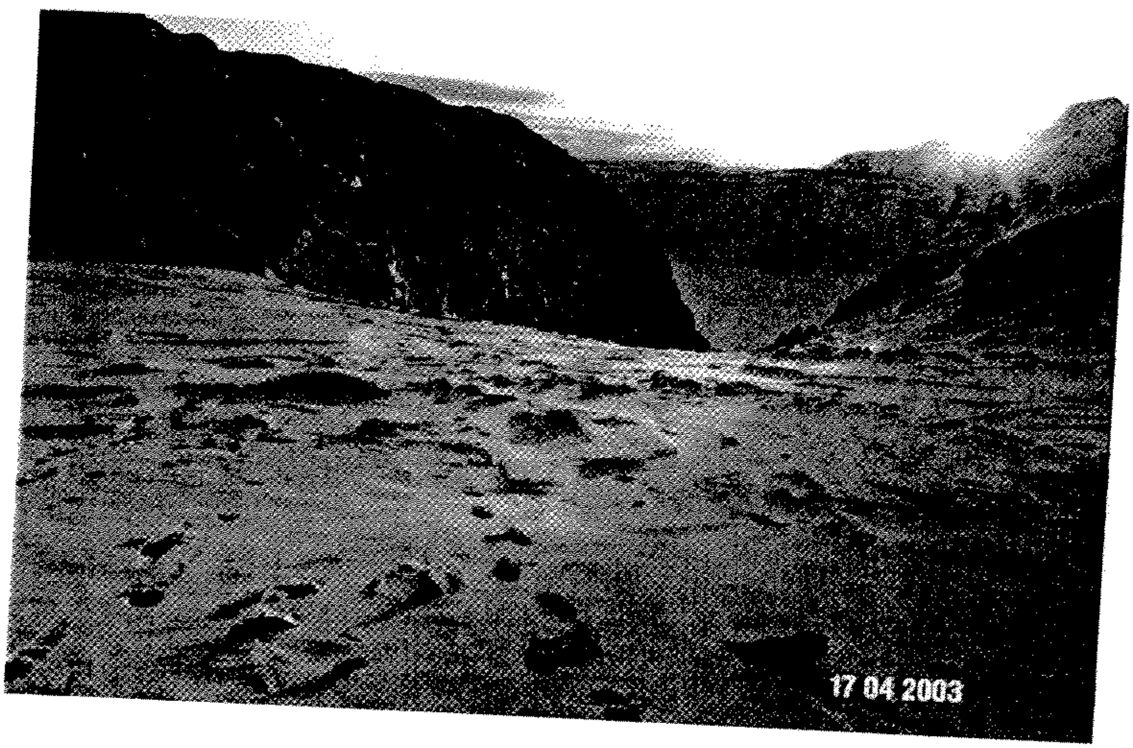
		DATE July 2003
	TITLE	FIGURE NO.



View of Wetland and Possible Lagoon Location



View of Wetland Outlet To Ocean

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		DATE July 2003
	TITLE	FIGURE NO

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Access Road Assumptions

Road Length	850	m
Excavated Road Width	16	m
Fill Road Width	10	m
Excavated Slope	0.5 H:1V	
Fill Slope	3H:1V	

Access Road	Volume (m3)	Unit Rate	Cost
Road - Cut	12,000	$100	$1,200,000
Road - Fill	43,000	$40	$1,720,000
Road Base	7,500	$40	$300,000
Total Road			**$3,220,000**
		say	$3,200,000

Lagoon Assumptions

Lagoon Constructed in Flat Ground

Total Volume (2 Cells)	96,725	m3
Cell Width	110	m
Cell Length	214	m
Berm Width	2	m
Inside Slope	2H:1V	
Outside Slope	3H:1V	
Berm Height	3.3	
Liquid Level	2.0	m
Freeboard	1.3	m

Lagoon	Quantity	Unit Rate	Cost
Earthworks (m3)	39,000	$40	$1,560,000
Site Preparation and Drainage	1	$25,000	$25,000
Fencing (m)	1100	$250	$275,000
Inlet and Outlet Controls	1	$25,000	$25,000
Total Lagoon			**$1,885,000**
		say	**$1,900,000**

Note:
Costs do not include any Environmental Assessments and Permitting, Sealift, and Taxes.
Costs do not include any geosynthetic liner.

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File: 031943-1000

P - Lake Sewage Lagoon and Access Road - NPV

Item	Cost
Access Road	$3,200,000
Sewage Lagoon	$1,900,000
Total Capital Cost	**$5,100,000.00**
Engineering and Geotechnical @ 10%	$510,000.00
Contingency @ 25%	$1,275,000.00
Total	**$6,885,000.00**
Operating Cost @ 2.0% of Lagoon Cost	$38,000
say	$40,000

Note:
Costs Do Not Include Taxes, Sewage Collection and Haulage, Road Maintenance, and Snow Clearing

NPV ANALYSIS

	Sewage Lagoon
Construction Year	$6,885,000.00
1	$40,000
2	$40,000
3	$40,000
4	$40,000
5	$40,000
6	$40,000
7	$40,000
8	$40,000
9	$40,000
10	$40,000
11	$40,000
12	$40,000
13	$40,000
14	$40,000
15	$40,000
16	$40,000
17	$40,000
18	$40,000
19	$40,000
20	$40,000
NPV @ 2%	**$7,539,057**
NPV @ 4%	**$7,428,613**
NPV @ 8%	**$7,277,726**