APPENDIX-E

REVISED O&M MANUAL OF THE P-LAKE SEWAGE LAGOON, 2010

Comparison of the Revised O&M Manual of 2010 versus 2007
P Lake Sewage Lagoon: Cape Dorset

Revised O&M Manual 2010	Original O&M manual 2007
This is a revised O&M manual of May 2010 which is based on the manual updated by Dillon Consulting Ltd in Sep.3, 2009 from their Basic document of November 9, 2007.	The original manual was presented by Dillon consulting Ltd in November 9,2007.
Item 2.1.1 has been revised adding Appendix-A in page 4. Page #6 has been changed with an as built drawing showing exact locations of the thermistors.This drawing has been signed and stamped by the Engineer of Dillon.	The original document missed appendix-A in page # 4. This was not the as -built shown thermistors locations in page # 6 because at that time thermistor issues were not discussed and considered.
Item 3.4.1, Basic Operation, page #8 : CAP-3 is changed to CAP-4 and CAP-4 is changed to CAP-5. Table 3 and 4 are added. Also item 3.4.3 is revised at page 10.	Item 3.4.1, Page 8 : table 3 is there but its contents are different . Item 3.4.3 not acceptable.
Item3.4.4.page 10: Fecal Coliforms, FC $1.5*10^4$ FCU/100mL which the consultant has considered in their design. The consultant feels their design value should stand. The write up of the entire item has been revised.	Item 3.4.4, is not acceptable.
Item 3.4.4 page 14, second to last paragraph: first two years of operation.	Item 3.4.4, Page 12: one year of operation.
3.4.5: Monitoring wells were constructed in June, 2011 Item 3.4.5: Ground Monitoring wells is added. Item3.4.6: Sludge monitoring plan is revised. Item 3.4.7: Geothermal Monitoring is revised.	This was not an issue at that time when the document was prepared. Therefore this item was not there. Ground Monititoring wells were not there. Item 3.4.5 sludge management plan was not acceptable. Item 3.4.5 Geothermal monitoring Plan was not acceptable.
3.4.7: This is a new item developed once License was issued in March 7,2008. Thermistors were constructed and GPS coordinates have been	In this initial document, this information was not there because it was not an issue.

established and shown in item 3.4.7. page 16 in table 7.	
As-built drawings were signed by Dillon in 2009 is included in page 17. Also item 3.4.9 of page 19 is revised.	Item, 3.4.8 of page 14: Record keeping and reporting were not acceptable.
Item 4.0: Spill Contingency Plan is entirely revised.	Item 4.0 page 6 was not acceptable.
Item 5.0: Response organization: Added new chapter.	This was not included.
Item 6: Added new Chapter	This was not included.
Item 7: Resource inventory: Added new Chapter	This was not included.
As built drawings: Only one drawing shows thermistor locations has been changed.	All the as-built drawing except site plan are correct and unchanged as per Dillon Consulting Ltd.
Addition of new O&M manual for Monitoring Wells	This was not an issue and not included in the original manual.

COMMUNITY GOVERNMENT SERVICES
GOVERNMENT OF NUNAVUT

OPERATION AND MAINTENANCE MANUAL
SEWAGE TREATMENT SYSTEM

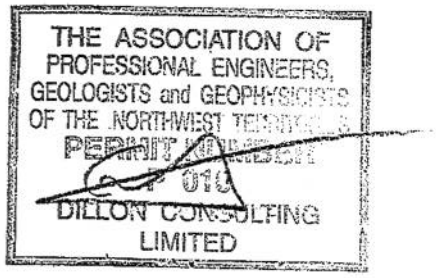
REVISED MAY, 2010

HAMLET OF CAPE DORSET

Operation and Maintenance Manual, Sewage Treatment System

Hamlet of Cape Dorset

Sept 3, 2009



Operation and Maintenance Manual, Sewage Treatment System - Hamlet of Cape Dorset

Government of Nunavut, Department of Community and Government Services

05-4319-5000

Gary Strong - Project Manager

Submitted by

Dillon Consulting Limited

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1 INTRODUCTION

1.1 Purpose

The purpose of this manual is to establish standard operation and maintenance protocol for the management of the sewage treatment system for Hamlet of Cape Dorset. Information presented in this manual has been developed based on the document "Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities." This document fulfils Parts B, D, F and H of the Water License 3BM-CAP0810. The Water License is included in **Appendix B** of the Manual.

To assist personnel that operate the sewage lagoon with proper operation and maintenance procedures, the following requirements are further addressed in this O&M manual:

1. Proper operation and maintenance procedures for the sewage treatment system to provide effective treatment and operation of the facility;
2. Monitoring program description;
3. Appropriate methods and procedures for wastewater sampling, and;
4. A spill contingency plan.

1.2 Site Setting

The Hamlet of Cape Dorset is located on Dorset Island, near the southwest tip of Baffin Island at 64° 14' north latitude and 76°32' west longitude. Situated in the Qikiqtaaluk Region of Nunavut, the community is approximately 402 air km southwest of the city of Iqaluit (see **Figure 1** on the following page).

Located in the continuous permafrost zone, Cape Dorset has a climate which consists of short cool summers and long cold winters. Annual snowfall and rainfall are approximately 118 cm and 15 cm, respectively. The typical temperature range for January is between a low of about -29°C and a high of about -23°C whereas in July, the temperatures range between a low of 3°C to a high of about 7°C. Usually, freeze up occurs during the month of November but it may happen as early as October or even September. In some years, early freeze up may thaw again before final freeze up occurs. Spring thaw typically takes place during the month of July, but the time frame can vary as much as freeze up. During spring runoff, the community experiences mild flooding.

The community is situated between two valleys of the Kingnait range of hills. Topography consists of areas of moss surrounded by rock outcrops, bedrock and steep cliffs.

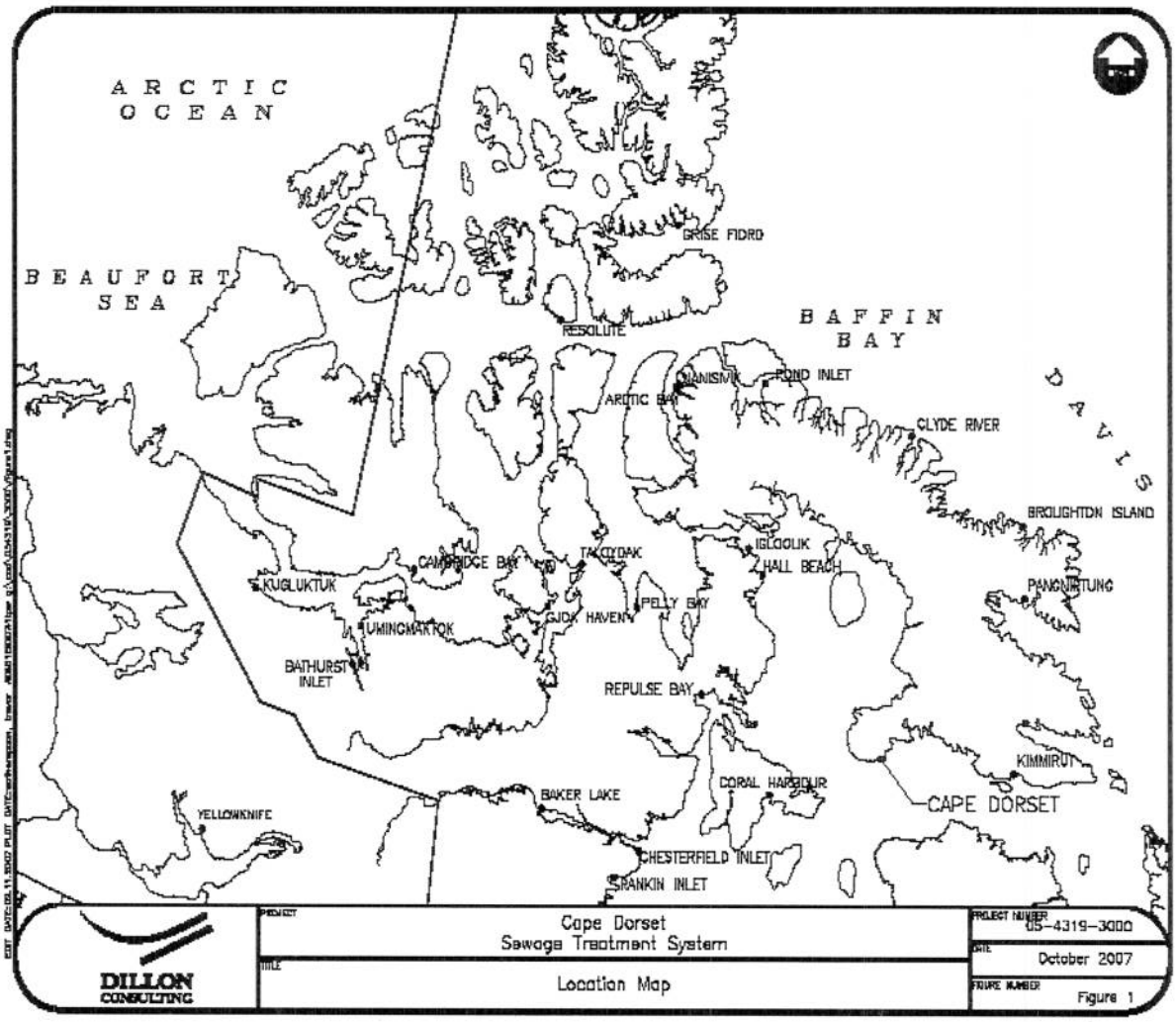


Figure 1: Map of Nunavut

The community uses trucked services for both water delivery and sewage collection. Wastewater is treated using a constructed retention cell treatment system that is located approximately 800 m southwest from the center of the community. **Figure 2** (on page 5) shows the location of the new sewage treatment facility in relation to the community and existing plant.

1.3 Population Projection

Presently, the population of Cape Dorset is approximately 1,236 people (Statistics Canada, 2006). **Table 1** shows the population growth for the Hamlet over the lifetime of the plant projected by Nunavut Bureau of Statistics.

Table 1: Population Projections for Cape Dorset

Year	2000	2006	2011	2016	2021	2026
Population	1,213	1,382	1,536	1,692	1,848	2,002

Source: Nunavut Bureau of Statistics.

A population of 2,002 people was used for the design horizon of the facility.

1.4 Contact List

The Hamlet of Cape Dorset has a Maintenance Management Operation System (MMOS) already in place. Regular maintenance will be conducted as outlined in this manual whereas specific work orders for sewage treatment facility and system will be passed through to the MMOS. A list of the individuals that are responsible for the operation and maintenance of the sewage treatment and waste disposal system are as follows:

Senior Administrative Officer	(867) 897-8943
Municipal Works Foreman	(867) 897-8943

2 BACKGROUND

2.1 General

2.1.1 Sewage Treatment Facility

The facility incorporates a constructed lagoon as the treatment system. Lagoon cell was designed with a 365 day hydraulic retention for storage and treatment. As shown in **Figure 3** on page 6, it has a rectangular shape with approximate dimensions of 170 m and 192 m, distances calculated from inner berms. With an operating liquid level of 3.5 m and 1.0 m freeboard, the lagoon cell has an overall, constructed volume capacity of 96,100 m^3.

Wastewater is stored in the lagoon cell during the entire year. During the spring and summer, natural biological and physical processes will occur, treating the sewage. In early to mid autumn, the sewage effluent is discharged into P Lake (with a capacity of 11,650 m^3), prior to freeze up. Further filtration and treatment will occur as the wastewater flows from P Lake into a small wetland area and down over a cliff and then through a mossy area, approximately 370 m in length, before draining into Telik Inlet.

The sewage lagoon can be considered a water retaining structure. The classification of the berms (dams) that comprise the lagoon is considered to have a very low consequence category. In the event of a dam failure there is no expected loss of life, and there are no economic/financial consequences other than to the owner's facilities. This classification is used to determine the operation and maintenance procedures for the berms and structures.

Record drawings of the sewage treatment system can be found in **Appendix A**.

2.1.2 Sewage Collection and Transport

All municipal wastewater of the community is collected and transported to the sewage lagoon by vacuum trucks. The sewage collection service operates 7 days a week. With three trucks operating, about 15 to 20 trips are made to the sewage lagoon per day.

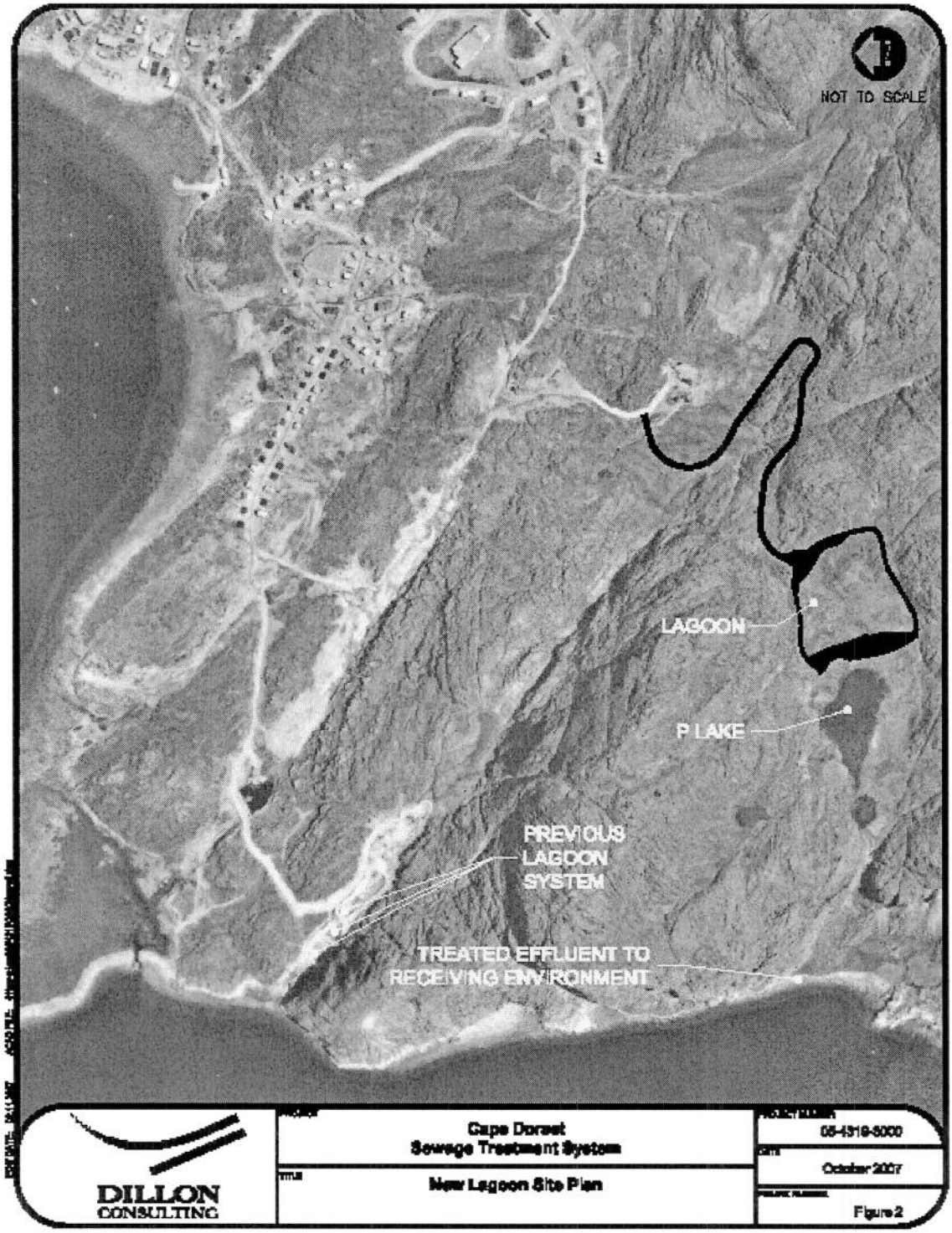
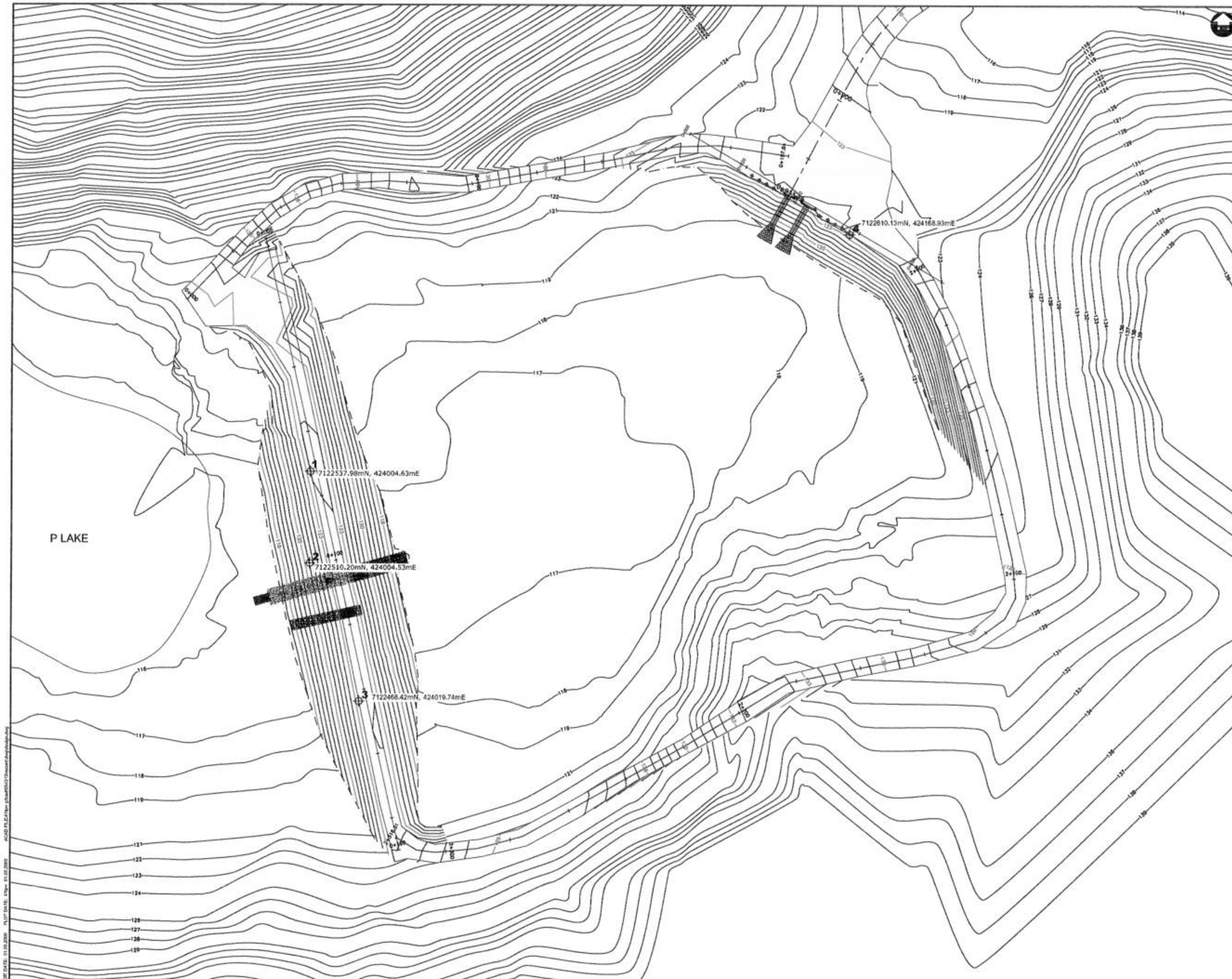


Figure 2: Location of Sewage Treatment Facility



LEGEND

PLAN:

EXISTING:
MINOR CONTOUR (1m)
MAJOR CONTOUR (5m)
THERMISTER LOCATIONS (STANDARD GPS ACCURACY)

NOTES

UTM COORDINATES ARE IN NAD83, WGS84 ELLIPSOID, UTM ZONE 18.

RECORD DRAWING

CHANGE	DATE	DESCRIPTION	CHECK
△	05/01/09	RECORD	GS
7	10/24/07	RECORD	GS
6	12/21/06	RE-ISSUED FOR CONSTRUCTION	GS
5	09/07/06	ISSUED FOR CONSTRUCTION	GS
4	03/07/06	ISSUED FOR TENDER	GS

REVISIONS

DESIGN	DRAWN	CHECKED	DATE
GS	TPW	GS	MAY 09

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
PERMIT NUMBER P 018
DILLON CONSULTING LIMITED

REGISTERED PROFESSIONAL ENGINEER G. STRONG NWT.

Nunavut

PROJECT
P LAKE AREA
SEWAGE LAGOON SYSTEM
CAPE DORSET

TITLE
THERMISTER LOCATIONS

DILLON CONSULTING

SCALE	AS SHOWN
DILLON PROJECT NUMBER	05-4319-3000
CLIENT PROJECT NUMBER	3439
DRAWING NUMBER	114

2.2 Sewage Production

It is approximated, for smaller communities such as Cape Dorset where water distribution is provided by trucks, that the sewage generation is equal to the water consumption. Therefore, the daily and annual sewage generation rates are approximately equivalent to the water consumption rates. The following equation, proposed by MACA, gives the water consumption rate for small communities on trucked services that have a population less than 2,000 people.

$$\textit{Water Use (L/capita/day)} = 90\ \textit{L/capita/day} \times (1.0 + 0.00023 \times \textit{Population})$$

Using the estimated population projections shown in **Table 1**, the projected sewage generation rates over the facility lifetime are shown in **Table 2** below. The lagoon was constructed to hold the annual generation rate of 96,100 m^3 of wastewater.

Table 2: Projected Sewage Generation

Year	Population	Sewage Generation Rate (L/capita/day)	Annual Generation (m^3/yr)
2000	1,213	115.11	50,964
2006	1,382	118.61	59,829
2011	1,536	121.80	68,283
2016	1,692	125.02	77,213
2021	1,848	128.26	86,530
2026	2,002	131.44	96,047

Physical, chemical and biological characteristics of sewage are referred to as its composition. It is assumed that raw wastewater has a typical average concentration of 625 mg/L for BOD_5 and 900 mg/L for TSS. For domestic waste, average raw FC concentration is about 2 x 10^9 FCU per 100 mL.

3 SEWAGE DISPOSAL SYSTEM

3.1 Manual Organization

This section of the manual presents the operation and maintenance procedures that are associated with the wastewater treatment facility that designated operators assigned to the system should be aware of concerning the facility and system.

3.2 Equipment

The equipment required to operate the Cape Dorset sewage treatment system consists of three sewage collection trucks with the following capacities:

- 9,092 L (2,000 imp. gal)
- 13,025 L (2,865 imp. gal)
- 13,093 L (2,880 imp. gal)

3.3 Site Personnel

The overall responsibility of the waste disposal site as well as the overseeing of the operation and maintenance personnel is that of the Senior Administrative Officer. Day-to-day operation and maintenance of the facility is the responsibility of the Municipal Works Foreman. In addition, several other employees operate and maintain the sewage trucks on a day-to-day basis.

3.4 Operational Procedures

These procedures must be carried out frequently to ensure efficient operation of the treatment system. Daily operation procedures must/should be carried out frequently to ensure smooth operation of the treatment system.

3.4.1 Basic Operations

1. Municipal wastewater is collected from holding tanks at each residence and commercial building by sewage (vacuum) trucks.
2. Sewage (vacuum) trucks pump the wastewater out of the holding tanks and transport it to the sewage treatment area.
3. Throughout the year, the wastewater is discharged into the lagoon through the offload chute located at the truck pad. The sewage truck backs up to the lagoon (bollards are placed for safety purposes) and the valve is opened. Wastewater is discharged into the lagoon, over the splash pad.
4. The wastewater remains in the lagoon for approximately 12 months. It is naturally treated during the months of June, July, August and September.
5. Decanting occurs once a year, in late September, over a 2 week period. Refer to Section 3.4.2 for the steps to be taken during the decanting stage. The discharged effluent from the lagoon flows into P Lake and further through a small nearby wetland before entering Telik Inlet.

Nunavut Water Board (NWB) requires at least a ten (10) day notification before initiating any decanting of the lagoon.

The effluent discharged from either the 2001 Sewage Disposal Facility at sampling station CAP-4 and/or the Emergency Sewage Disposal Facility at sampling location CAP-5 must meet the following effluent quality standards prior to decant as listed in **Table 3**.

Table 3: Effluent Quality Limits for the 2001 Sewage Disposal Facility and the Emergency Sewage Disposal Facility

Parameter	Units	Maximum Average Concentration
Fecal Coliforms, FC	CFU/100 mL	1×10^4
5 Day Biological Oxygen Demand, BOD_5	mg/L	120
Total Suspended Solids, TSS	mg/L	180
Oil and Grease	-	No visible sheen
pH		6 - 9

Likewise, the effluent discharged from the 2007 Sewage Disposal Facility must meet the discharge limits listed in **Table 4**.

Table 4: Effluent Quality Limits for the 2007 Sewage Disposal Facility

Parameter	Units	Maximum Average Concentration
Fecal Coliforms, FC	CFU/100 mL	1×10^4
5 Day Biological Oxygen Demand, BOD_5	mg/L	80
Total Suspended Solids, TSS	mg/L	100
Oil and Grease	-	No visible sheen
pH		6 - 9

3.4.2 Decanting Procedure

Once the NWB has been notified and all parameters have been met at the discharge location, then the decanting procedure can begin.

The steps involved with decanting the lagoon cell are as follows:

- Open the valve at the discharge pipe.
- Monitor flow rate leaving discharge pipe during decant period.
- Monitor for erosion at the end of the discharge pipe and repair as required.
- Check daily for erosion, blockages and other problems that may occur on the upstream slope of the berm. Apply necessary procedures to fix problem to minimize downtime during decanting.
- If the discharge pipe happens to be blocked or frozen at the time of decanting, then the following options should be used:
    - Try to unblock or thaw pipe using a steamer hose. Once unfrozen, proceed with decanting. If necessary, keep applying heat to the discharge pipe to assist with the flow of material.
    - Decant lagoon using a diesel fired pump or siphon system. If a pump system is used for the decanting, then obtain a pump that will give the required flow rate to discharge the lagoon volume over the two week decant timeframe. In year 20, the required pump flow rate is 5,000 L/min.

3.4.3 Service Disruption Contingency

In the event of any disruption in the service of P-Lake Lagoon, for instance, the road to the lagoon is inaccessible, the Hamlet will use the 2001 Lagoon area as an emergency sewage treatment area until the disruption has been resolved.

The top cell of the existing three cell lagoon system (2001 Lagoon) will be maintained as the emergency sewage treatment area. During times when this cell is active, the community will record the following items;

- The date that the emergency commenced;
- The reason for the emergency;
- The date that the emergency ended;
- The number of trucks discharged to the lagoon; and,
- The volume of the sewage deposited in the lagoon.

Sewage deposited in the emergency lagoon cell will be treated until the discharge criteria are met, and then the treated sewage will be discharged to the receiving environment. It is proposed that this cell be decanted on an annual basis in October.

The Hamlet will notify INAC when the emergency lagoon is in service, and prior to the decant of the emergency lagoon.

The Senior Administrative Officer of the Hamlet of Cape Dorset will be the responsible party for the actions taken under this emergency procedure.

3.4.4 Sampling Procedures and Requirements

A key component to the operations and maintenance of the proposed sewage treatment system is a sampling program. Based on the lagoon's design, the following discharge limits are expected after the treatment stage:

Biochemical Oxygen Demand, BOD_5	45 mg/L
Total Suspended Solids, TSS	45 mg/L
Fecal Coliforms, FC	1.5×10^4 FCU/100 mL

The proposed sampling program will help to monitor the treatment while verifying compliance with regulations. As well, it will model the treatment process which with help to understand the behavior of the lagoon for future development and expansions of the system.

It is important such a sampling program be implemented by the Hamlet as a part of the annual operations for the facility. Local members of the community that operate the system are to be trained on the proper operation and procedure methods used in the sampling program. In addition, quality and safety training will also be included which will ensure that the high quality data will be obtained.

All sampling, sample preservation and analyses will be in accordance with methods described in the current edition of *Standard Methods for the Examination of Water and Wastewater*. In addition, a document has been attached in **Appendix C** of this manual that provides guidelines and procedures to follow when sampling wastewater.

To obtain meaningful results from the analysis, the following five factors are of particular importance:

- Sample collection at designated time and location;
- Correct usage of container/sample bottle for parameter being tested;
- Correct labeling of sample bottles and filling out record/field sheet;
- Correct procedure for field sampling;
- Proper and timely shipment of samples to the laboratory.

It is critical, from a quality perspective, that sample collection be performed from an area of higher concentration to an area of lower concentration of contaminants. Therefore, a sample will be collected at various locations along the system to monitor the effluent quality at various stages of treatment. Descriptions of each sampling location of the sewage treatment system for the Monitoring Program are listed in **Table 5** below and shown in **Figure 4** on page 12.

Table 5: Sampling Station Locations

Monitoring Program Station Number	Description of Monitoring Program Station
CAP-1	Raw Water Supply prior to Treatment
CAP-2	Runoff from Solid Waste Disposal Facilities
CAP-3	Influent of Wastewater to Wastewater Facilities
CAP-4	Effluent Discharge from 2001 Sewage Disposal Facilities
CAP-5	Effluent Discharge from Emergency Sewage Disposal Facilities
CAP-6	Effluent Discharge from 2007 Sewage Disposal Facilities, Final point of Control
CAP-7	Point of Influent of Wastewater to P-Lake
CAP-8	Centre of P-Lake
CAP-9	Location midway between Centre of P-Lake and Effluent discharge of P-Lake
CAP-10	Effluent discharge from P-Lake
CAP-11	Effluent discharge from Wetland area
CAP-12	Wetland Pathway at top of waterfall
CAP-13	Wetland Pathway at midway down waterfall
CAP-14	Wetland Pathway at bottom of cliff, Final Discharge Point
CAP-15	Control Point using small lake located between Lagoon and Tee Lake
CAP-16	Monitoring Well located
CAP-17	Monitoring Well No. 1 located down gradient of Sewage Disposal Facility
CAP-18	Monitoring Well No. 2 located down gradient of Sewage Disposal Facility
CAP-19	Monitoring Well located up gradient of Solid Waste Disposal Facilities
CAP-20	Monitoring Well located down gradient of Solid Waste Disposal Facilities
CAP-21	Thermistor Station
CAP-22	Thermistor Station
CAP-23	Thermistor Station
CAP-24	Thermistor Station

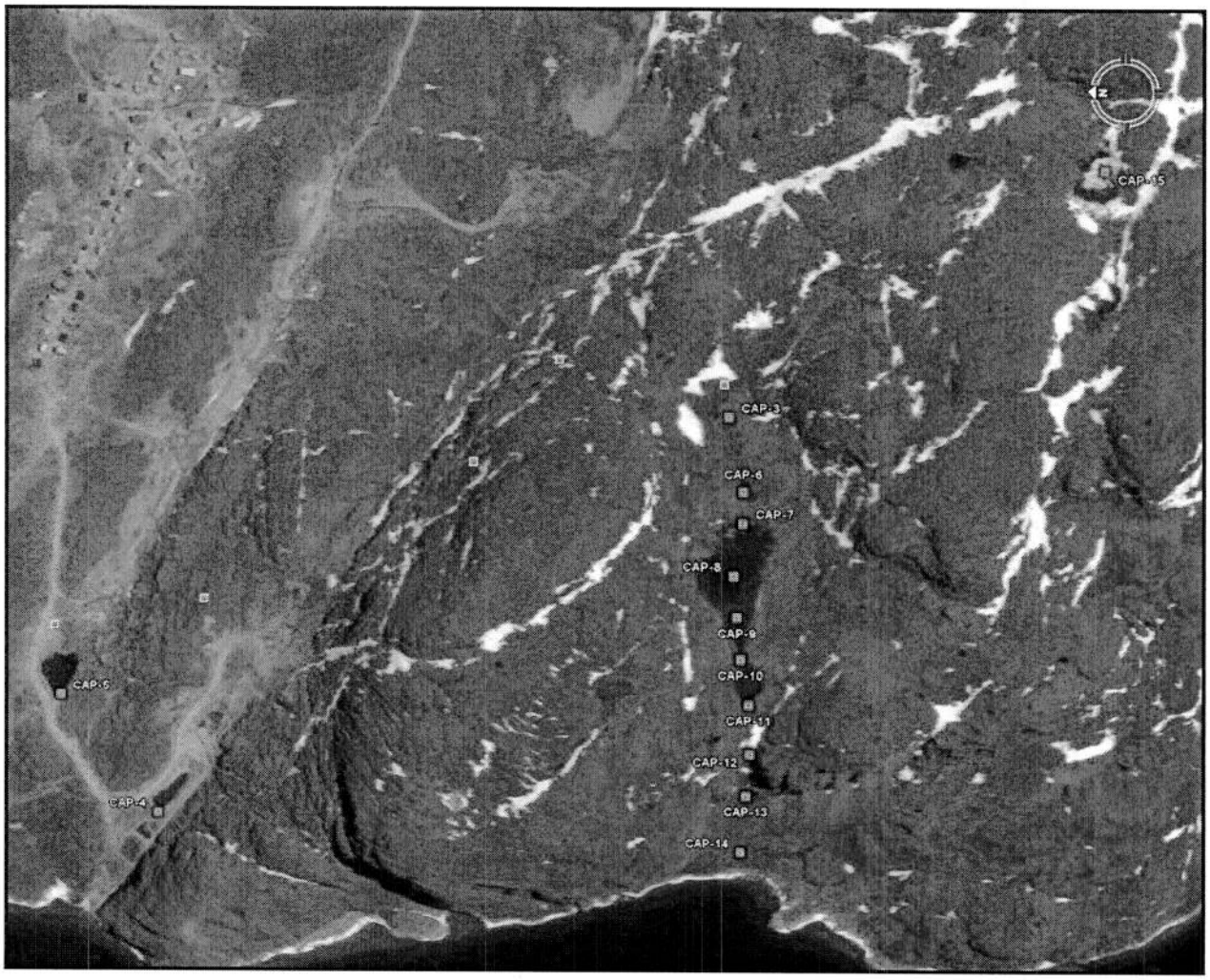


Figure 4: Sampling Locations

By obtaining samples at each of the locations proposed above, effluent treatment rates can be monitored. According to the water license, wastewater samples will be taken from locations CAP-3 to CAP-15 one (1) week prior to the proposed decant date and weekly during the course of lagoon decant. These wastewater samples will undergo the same analysis which will include the following set of parameters as listed on the following page.