

Hamlet of Cambridge Bay Lagoon Operations and Maintenance Manual

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1.0 INTRODUCTION

The proper operation and maintenance of Hamlet of Cambridge Bay's sewage lagoon system are important components of its sewage waste management system. It is recognized that inappropriate operation and maintenance (O&M) of a sewage waste system may result to a source of potential public health hazards and adverse environmental impacts.

This O&M Manual is intended to provide a standard for the sewage lagoon site staff in the proper operation and maintenance of the site and to make the site O&M acceptable to the Nunavut Water Board (NWB).

1.1 Objective of the Sewage Lagoon

The primary objective of the Hamlet of Cambridge Bay's sewage lagoon system is to apply appropriate technology and procedures to treat and dispose off its sanitary sewage. The application of appropriate technology depends upon the geology, terrain and climate of the area, as well as the technical and financial capabilities of the Hamlet. In the case of Hamlet of Cambridge Bay the appropriate technology is an "engineered retention lagoon" with a continuous exfiltration discharge to a natural wetland.

The following general requirements for minimizing water pollution, health and environmental hazards are addressed in this O&M manual:

1. To minimize aesthetic nuisances that can interfere with community life and development,
2. To minimize the possibility of polluting surface and ground waters through retention, controlled discharge and wetland treatment, and
3. To minimize occurrence of disease carrying bacteria, vegetation and odours.

1.2 Sewage Lagoon Site Description

The Hamlet of Cambridge Bay, the gateway to the Kitikmeot region, is geographically situated on the Dease Strait between the Queen Maud Gulf and the Coronation Gulf in the North West Passage, at 69°07' N latitude and 105°03' W longitude. It is the largest community in the Kitikmeot Region and acts as the regional center and transportation hub. Environment Canada records that the average precipitation is 69.6 mm of rain and 82.1 cm of snow, and that the average temperature for January is -32.8°C and July is 8.4°C.

The existing sewage lagoon system of the Hamlet begins at a truck discharge point into the primary cell, located approximately 1.0 km east of the community (**Error! Reference source not found.**). The current system consists of several natural ponds connected in series (Pond 1, Pond 2, Pond 3, Pond 4, Pond 5 and Pond 6) (**Error! Reference source not found.**). The final receiving water is the ocean in an inlet of the Cambridge Bay. The total capacity of the lagoon is estimated at 72,000 m³.

The landfill site is located in close proximity to the main lagoon, and metal dump boundary overlaps this lagoon. However, a detailed design report has been submitted to reengineer the Hamlet's solid waste system. This would separate the metal dump from the lagoon by a berm. Runoff from the solid waste dump would be directed to a detention pond for initial treatment, which would then be pumped into the sewage lagoon.

Currently, sewage is collected in 9,000 litre trucks and are discharged into the lagoon system each day (see **Photos 1-4**). Based on water consumption data, the community's annual discharge is estimated as 70,080 m³/year (192 m³/day). Sampling results indicate that most of the sewage treatment occurs in Pond 1.

1.3 Sewage Treatment System Operation & Performance

The sewage treatment and disposal system operates under the following water licence parameters:

• Effluent Faecal Coliforms	10 ⁶ CFU/100 mL
• Effluent BOD ₅	100 mg/L
• Effluent Total Suspended Solids	120 mg/L
• Effluent pH	6 to 9
• Effluent Oil and Grease	no visible sheen

The sewage collection service is operated by the Community and operates seven days a week. The performance of the sewage lagoon system follows the characteristics for an aerobic lagoon based upon the available values.

The 72,000 cubic metre estimated volume of the lagoon provides enough capacity for a hydraulic retention time of 375 days based on current sewage production.

The Detailed Design Report by Earth Tech specifies future plans to increase the hydraulic retention time and to increase the treatment capability of Cambridge Bay's sewage lagoon.

1.4 Reference Information

The preparation of this O&M Manual is based upon the following information sources:

1. "Water License NWB3CAM0207" for the Hamlet of Cambridge Bay, NU (effective September 1, 2002 and expiring on August 31, 2007), and "Amendment 1 to Water License" (effective February 16, 2005 and expiring on August 31, 2007).
2. "Guidelines for the Planning, Design, Operation and Maintenance of Wastewater Lagoon Systems in the Northwest Territories - Volume I: Planning and Design and Volume II: Operation and Maintenance", Department of Municipal and Community Affairs, Government of the Northwest Territories, November 1988
3. "Cambridge Bay Municipal Sewage Lagoon and Waste Facilities Assessment", IEG, Department of Community and Government Services, Government of Nunavut, October 2005.
4. "Hamlet of Cambridge Bay, Background Report for Water Licence Renewal". Earth Tech Canada, August 2007.

2.0 SEWAGE LAGOON SYSTEM OPERATIONAL REQUIREMENTS

The operational requirements will be defined as those activities which must be done on a regular basis; daily, weekly, monthly or yearly.

The operations of the Hamlet of Cambridge Bay's sewage lagoon system have been divided into eight (8) types of activities:

1. Normal Operation (daily)
2. Safety (daily)
3. Checking (weekly)
4. Sampling (May/June to August/September)
5. Reporting (monthly)
6. Record Keeping (daily/weekly/monthly/yearly)
7. Review (yearly)
8. Other Special Activities.

2.1 Normal Operation of Sewage Lagoon System

The Hamlet's sewage lagoon system consists of six main ponds connected in series. The truck discharge point and the outfall to Cambridge Bay should also be considered components of the system.

The normal operational check of the sewage lagoon system involves observing the truck discharge point and the primary lagoon on daily basis for any unusual situations. Observations should also be made of the lagoon surface, noting if there is material floating and what the material may be.

An entry should be recorded every day on the Daily Inspection Record to either indicate that the operation is normal, or that something abnormal was observed and corrective steps had to be taken.

2.2 Safety of Sewage Lagoon System

The sewage lagoon system operator(s) must make sure that all aspects of municipal sanitary sewage management are conducted safely.

General public and unimportant access to the lagoon site should be prevented. This includes all forms of recreation activities. Possible contamination or infection from pathogenic microorganisms exists with every contact with the sanitary sewage.

Equipment and any other structures should be kept clean. This reduces problems with footing and also makes it less likely that equipment will be damaged or broken by debris.

After work, before eating, and at other convenient times, the lagoon system operator(s) should wash their hands thoroughly.

Caution should be used when working with sanitary sewage. If an operator is splashed accidentally with sewage, the area should be promptly washed with plenty of water. All cuts and skin abrasions should be treated immediately to prevent any infection.

Normal preventative health care vaccinations should be kept up to date by all those working on the sewage lagoon system. Check with a physician as to the recommended vaccinations (usually includes typhoid and paratyphoid).

Operators and personnel should remain attentive and aware of any potential health and safety hazards, such as tripping hazards like debris or ice. When possible, hazards should be removed. Care should especially be taken when obtaining samples and gloves (nitrile, not latex) must be worn.

2.3 Checking of Sewage Lagoon System

On a once-a-week basis, all main components of the sewage lagoon system should be checked and adjusted if necessary. The purpose of the detailed checking is to notice things that may lead to problems later. The conditions and date checked should be recorded.

2.3.1 Inlet Structures

The truck discharge point, primary lagoon and surrounding area should be examined for blockages or other operational problems.

2.3.2 Sewage Lagoon Level

During open water periods, the water level in the lagoons should be observed and recorded.

2.3.3 Sewage Lagoon Bank Condition

All visible parts of the lagoon bank should be observed and the condition be noted.

2.3.4 Sewage Colour

The variations in the colour of sewage can be an important indicator of a sewage lagoon system performance. This may only be possible during open water periods. The following list provides frequently observed sewage colours and indications:

- *Dark Green* – Good. High pH and high dissolved oxygen (DO).
- *Dull Green to Yellow* – Not very good. pH dropping, DO dropping, and blue-green algae are becoming established.
- *Grey to Black* – Very bad. Lagoon anaerobic.
- *Tan to Brown* – Okay if caused by a type of algae bloom. Not good if due to silt or bank erosion.
- *Red or Pink* – Indicates presence of sulphur bacteria (anaerobic conditions) or presence of red algae (aerobic conditions).

2.4 Sewage Sampling

The purpose of taking samples and carrying out tests on them is to obtain information on how well the sewage lagoon system performs. There are six important parts to the process of sampling. These are:

1. Taking the sample at the time called for,
2. Taking the sample in a properly cleaned container,
3. Careful collection of the sample from the correct location and performing any necessary field tests called for at that time,
4. Careful and correct labeling of the sample container and filling out a record sheet,
5. Where performing tests on-site, use of proper testing procedures, and

6. Shipping of the sample in properly packaged containers and expeditiously so that it arrives to the laboratory with minimum delay.

2.4.1 Sample Frequency

Samples should be taken on a monthly basis during warmer months, May to August, inclusive.

2.4.2 Sample Parameters

Samples will be taken and analyzed for fecal coliforms, BOD₅, total suspended solids, oil and grease and pH.

2.4.3 Sample Locations

Samples are required to be taken from the following locations (**Figure 3**):

1. At the sewage lagoon pond "lagoon",
2. At the outlet of the pond adjacent to the metal disposal site "pond", and
3. At the ocean discharge point "outlet".

Occasionally, other samples may be required as required by the conditions of the Water License.

2.4.4 Sample Collection

Normally, sampling will be done at one of the above specified locations, using two bottles; one sterile bottle for fecal coliforms and other bottle for the remaining parameters. The sample will be collected by dipping a sample bottle into the flow stream after rinsing the bottle with the flowing water for two (2) or three (3) times. This type of sample is referred to as a grab sample.

2.4.5 Sample Containers

Sewage samples will be collected in plastic bottles provided by a laboratory. If the samples are to be used for bacteria determination then sterilized bottles must be used. These must be handled carefully so that the sample is not contaminated.

2.4.6 Field Tests

Normally, the only field (on-site) test is pH. The equipment for this is a pH litmus paper kit (with instructions included).

2.5 Reporting

Sample results will be reported to the NWB as required and will be included in the annual reports.

2.6 Recordkeeping

Record keeping is necessary to have information on the state of the lagoon system at a specific time and details on any unusual operation or occurrence. The use of accurate records is very important for the Hamlet, the NWB and its supporting agencies, and engineers that may need to work on the lagoon system.

The records must be detailed enough to allow evaluation of performance and to track the development of problems. The records also give a good check on completed and required tasks.

The records kept on four (4) different forms will be set up so that they are useful and accessible to all that need to use them:

- Form 1 – Daily Inspection Record
- Form 2 – Weekly Systems Check Record
- Form 3 – Monthly Sampling Record
- Form 4 – Yearly Review Record.

2.7 Review

A summary of the operations, sampling and performance of the sewage lagoon system will be prepared once a year. This annual report will allow for an operational management review by the Hamlet of Cambridge Bay and will be submitted to the Water Board.

2.8 Other Special Activities

Other special activities may form part of the operational requirements of the Hamlet's sewage lagoon system. For example, the addition of chemicals to enhance biological activity may be considered as a special activity. Special activities must be approved by the Nunavut Water Board. WHMIS (Workplace Hazardous Material Information System) guidelines must be followed in the use of all chemicals.

3.0 MAINTENANCE REQUIREMENTS

3.1 Inlet Structures

The inlet structures enable the lagoon to function properly. These structures require attention to make sure that they operate properly and do not experience or cause erosion.

The most important aspect of maintenance of these structures is that they must not freeze in a way that inhibits their operation. Another problem is sludge deposition near the inlet structure, which have to be cleared manually or mechanically at regular intervals.

The sewage lagoon system has a free-fall truck discharge system. The operator must be aware of the following locations for potential problems:

1. The support structure holding the pipe,
2. The foundation and wall of the support structure,
3. Potential for ice build-up, and
4. Potential for ice-related damage.

The wood support structure should also be inspected for deterioration and related problems which may weaken the inlet structure.

3.2 Sewage Lagoon Banks

There are five (5) main functions of sewage lagoon banks:

1. To form part of a storage container (retention) of the sewage for treatment;
2. To form access to the parts of the sewage lagoon system,
3. To allow variation in sewage levels due to changes in sewage volume,
4. To provide 'freeboard' for the lagoon, and
5. To provide a 'filtering' discharge media of the lagoon effluent during the summer and fall months (usually May through August).

The objective of bank inspection is to make sure erosion is not occurring from either excessive leakage or from wave action. Regular monitoring and maintenance are required to control bank erosion.

3.3 Odour Problems and Weed & Insect Control

3.3.1 Odour Problem

Under normal operating conditions, the sewage lagoon system will not cause any serious odour problems. However, at times, severe odours may occur subject to sewage quality and various environmental factors. The sewage lagoon is located a significant distance (~ 1.0 km) from the nearest house, therefore, odour is not normally considered to be a problem.

The most troublesome conditions are:

1. Sewage lagoons in the period following ice break-up,
2. At the end of an extensive period of cloud cover in the spring to fall when there is no ice cover, resulting in reduced sunlight and therefore reduced algae activity and low oxygen production, and
3. Extensive floating sludge mats.

An operator of the sewage lagoon system has limited control over these conditions. For Item 1, the problem will normally be of short duration. It is also likely to occur annually. For Item 2, 'hope' for sunshine soon. For Item 3, floating scum and algae mats need to be broken up and dispersed.

3.3.2 Lagoon Vegetation

A number of surface weeds can develop in sewage lagoons. A problem with these weeds is that they block out the sunlight which is needed by algae to produce oxygen. Another problem is that when the floating plants die, they begin to decompose and use up oxygen which is needed by the bacteria.

The ways to control surface weeds are as follows:

1. Skimming – This is often difficult and requires repeating, and
2. Use of Herbicides – Approval is required for their use.

The removed weeds should be landfilled and buried, where possible, to prevent odour and insect problems.

3.3.3 Insect Control

Flies and mosquitoes create the most common insect problems. Most mosquitoes breed in sheltered, calm water containing vegetation and floating materials to which the female can attach eggs. The egg clusters are fragile and easily damaged by turbulent action caused by wind and currents. Improper weed control and the accumulation of a scum layer will make insect problem worse.

3.4 Warning Signs

Warning signs are normally installed at regular intervals around the sewage lagoon system, usually 30 to 40 m apart. Lost or damaged signs should be replaced as soon as possible.

3.5 Maintenance of Access Road

The access road was designed to be usable year round. Maintenance takes three basic forms: road shaping and smoothing, roadway filling and snow removal. These activities follow normal Hamlet procedures.

4.0 IMPROVEMENTS

In Section 1.0, it was stated that the application of appropriate technology for the operation and maintenance of the Hamlet's sewage lagoon site is dependent upon the geology, terrain and climate of the area, as well as the technical and financial capabilities of the Hamlet.

These factors limit the pace at which improvements may be undertaken. Improvements to the operation and maintenance of a sewage lagoon system are necessary; however, sometimes these improvements are incremental.

The Hamlet is currently planning on reengineering its sewage lagoon to increase the hydraulic retention time and to better meet the future requirements of the Hamlet.



Figure 1 Sewage Lagoon Discharge Path

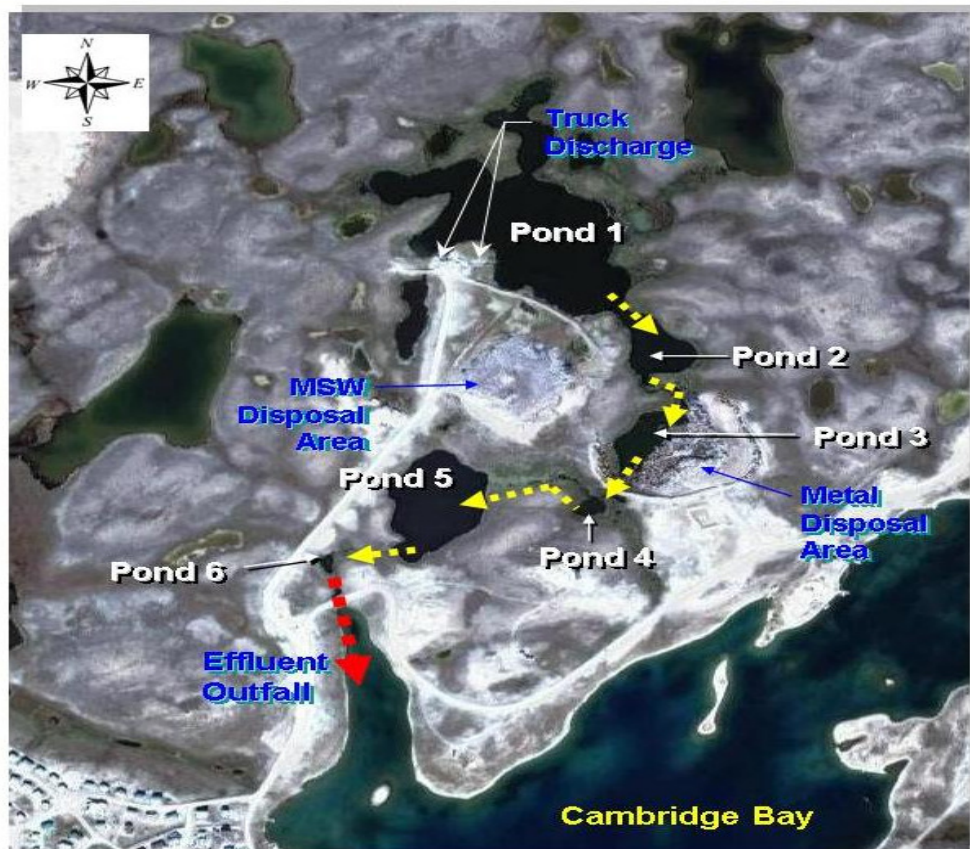


Figure 2 Sewage Lagoon Ponds 1-6

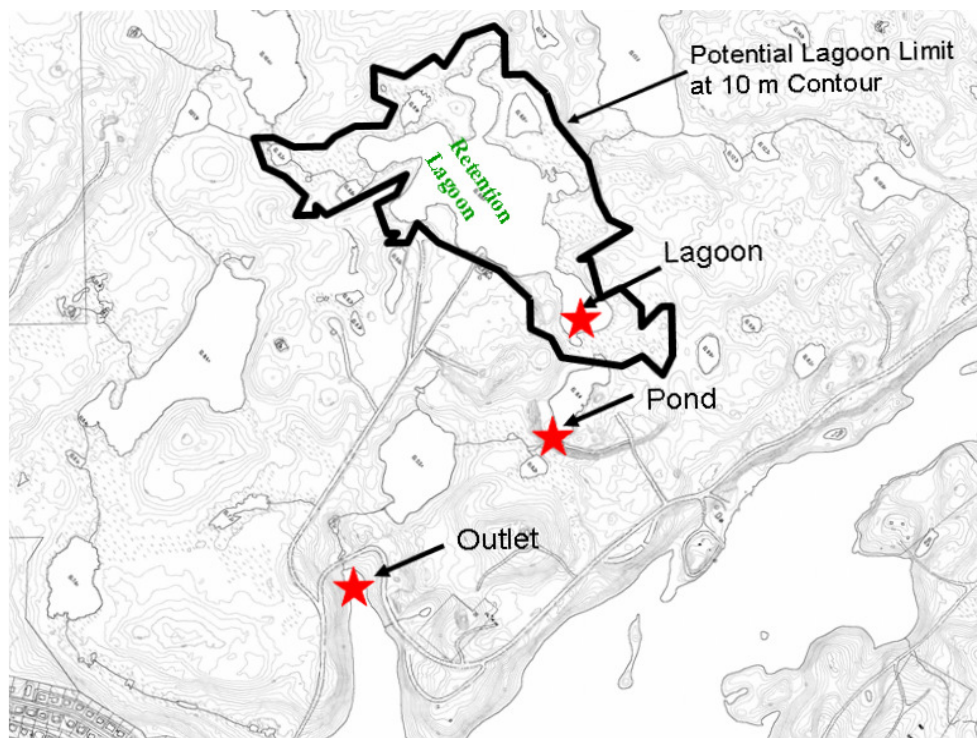


Figure 3 Sewage Lagoon Sampling Locations