

Hamlet of Tuktoyaktuk

Sewage Treatment Facility Operation and Maintenance Manual for Existing Landfill Site

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1. INTRODUCTION

The proper operation and maintenance of Hamlet of Tuktoyaktuk's sewage treatment facility are important components of its overall municipal waste management system. It is universally recognized that inappropriate operation and maintenance (O & M) of a sewage treatment facility may cause the lagoon site to become a source of potential public health hazards and adverse environmental impacts.

1.1 Objective of Tuktoyaktuk's Sewage Treatment Facility O&M Manual

The primary objective of the Hamlet of Tuktoyaktuk's sewage treatment facility O & M manual is to assist the lagoon site staff in the proper operation and maintenance of the site, to apply appropriate technology and procedures to treat and dispose of its municipal sanitary sewage in a manner to minimize the potential public health and environmental hazards from the site, and acceptable to Northwest Territories Water Board. However, the application of appropriate technology depends upon the geology, terrain and climate of the area, as well as the technical and financial capabilities of this Hamlet. In the case of Hamlet of Tuktoyaktuk the appropriate technology is a "natural retention lagoon with a seasonal discharge."

The following general requirements to minimize the potential public health and environmental (water pollution) hazards are addressed in this O & M manual:

1. To minimize environmental nuisances that can interfere with community life and development;
2. To minimize the possibility of polluting surface waters through retention and controlled discharge; and
3. To minimize public health impact through retention and controlled discharge.

1.2 Sewage Treatment Facility Site Description

The Hamlet of Tuktoyaktuk's sanitary sewage treatment facility retention site is a natural lake, 5.9 ha in area that has been modified with perimeter structures to provide a retention structure. The lagoon provides a 365-days retention period to treat the Hamlet's sanitary sewage.

The site is located approximately 5.8 km south of the Hamlet Office and approximately 3.9 km south of the Airport Terminal Building. The site is also 1.5 km southwest of the Reindeer Point Subdivision (**Figure 1. Facility Locations**).

The area surrounding the lagoon site is influenced by winds primarily from a northwesterly direction, and tides of 30 to 60 cm. The sewage lagoon is discharged in the early fall of each year to a saltwater inlet. The lagoon is 3.0 km southeast from the open-ocean and approximately 6.5 km from the ocean by way of the inlet, which varies in depth from 1 to 4 m

The lagoon is required to meet the following effluent standards:

BOD ₅	120 mg/L
Total Suspended Solids	180 mg/L
Oil and Grease	5 mg/L
Faecal Coliforms	1x10 ⁴ CFU/100ml
pH	6 to 9

The sewage collection services within the community are contracted to a private contractor who operates vacuum trucks seven days a week.

The sewage treatment facility is estimated to have a capacity to serve a population of 1,900 depending upon the level of commercial and industrial activity that occurs in the future.

1.3 Sewage Treatment Facility - Treatment Processes

The treatment process that best describes the Tuktoyaktuk sewage treatment facility is classified as a facultative lagoon (See **Figure 2. Sewage Treatment Schematic**). A facultative lagoon does not contain any supplemental aeration to provide treatment but relies on wind and algae to provide the necessary oxygen for treatment. A facultative lagoon possesses an aerobic zone near the surface of the lagoon which contains excess dissolved oxygen for biological processes; an anoxic zone which contains little oxygen near the middle depth of the lagoon; and an anaerobic zone which contains no oxygen near the bottom of the lagoon.

Disinfection of the treated wastewater is provided by the sun. The sun provides heat and ultraviolet radiation to disinfect the wastewater contained in the lagoon. The amount of disinfection will depend on how clear the water being treated is.

The term retention refers to how long the impoundment structure retains the water before being discharged. The Tuktoyaktuk lagoon has a retention period of 365 days prior to discharge into the Arctic Ocean. The retention provides the necessary time required for the biological processes to occur, particularly during the long, warm, sunny days of the short Arctic summer. The biological processes may function to some degree at low temperatures and without sunlight; however, the processes that treatment the sewage become very, very slow. During the summer the biological processes thrive with the sun, wind and long days.

1.4 Information Sources

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

1. Water License N7L3-0714 (Renewal) for the Incorporated Hamlet of Tuktoyaktuk Northwest Territories (Effective April 23, 2010 and expiring November 20, 2013).
2. Guidelines for the Planning, Design, Operation and Maintenance of Wastewater Sewage Lagoons in the Northwest Territories - Volume I: Planning and Design / Volume II: Operation and Maintenance, Department of Municipal and Community Affairs, and Government of the Northwest Territories, 1988.

1.5 Contact List

Primary and emergency contacts for issues concerning the Tuktoyaktuk Lagoon are:

Board: Northwest Territories Water Board
Box 2531
INUVIK, NT X0E 0T0

Executive Director
Mardy Semmler
(867) 678-8609
semmlerm@nwtwb.com

Science and Regulatory Coordinator
Bijaya Adhikari
(867) 678-8610
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Box 1500, 4601 – 52nd Avenue
YELLOWKNIFE, NT X1A 1L4
(867) 765-6645

Inspector; Philippe Thibert-Leduc, Water Resource Officer
Environment and Natural Resources
Government of the Northwest Territories
PO Box 2749
INUVIK, NT X0E 0T0
Tel: (867) 678-6676
Cell: (867) 678-0623
Fax: (867) 678-6699
Philippe_Thibert-Leduc@gov.nt.ca

Hamlet of Tuktoyaktuk: Senior Administration Officer: (867) 977-2286

Northwest Territories Spill Line: (867) 920-8130

2. LAGOON OPERATIONAL REQUIREMENTS

The Hamlet of Tuktoyaktuk's sewage treatment facility operational requirements will be those activities that must be done on a regular basis (daily, weekly, or yearly) to operate and maintain the lagoon.

The operation of the Hamlet of Tuktoyaktuk's sewage treatment facility has been divided into seven types of activities:

1. Normal Operation (daily);
2. Safety (daily);
3. Checking (weekly);
4. Sampling (yearly);
5. Reporting (yearly);
6. Record Keeping (daily/weekly); and
7. Review (yearly).

2.1 Normal Operation of Sewage Treatment Facility

The Hamlet of Tuktoyaktuk's sewage treatment facility system has four main components (See **Figure 3. Facility Organization** and **Figure 4. Facility Components**):

1. The inlet structure;
2. Retention pond;
3. Berm structure; and
4. Discharge stream.

The normal operation of the sewage treatment facility involves observing the inlet structure on a daily basis for any unusual situations. Observations should also be made of the lagoon surface and berm structures. Observations of any material floating and what the material may be should be taken if these are present.

An entry should be recorded every day on the Daily Operation Observations Record to either indicate that the operation is normal; whether something abnormal was observed; and whether any corrective steps had to be taken. If abnormal observations were noted, provide adequate details of the observations in the notes.

2.2 Annual Discharge of Sewage Treatment Facility

The Tuktoyuktuk lagoon has sufficient capacity to provide a 365 day retention period before requiring discharge. Annually, the lagoon should be discharged by pumping treated effluent over the lagoon berm (See **Figure 5. Discharge Activity**). Effluent discharge should be done in the early fall before freeze up in order to provide the maximum treatment of the sewage.

Before starting the discharge, all sampling should be completed, analyzed and reported to the facility Inspector. Normally sampling is completed about two (2) weeks before the planned discharge to make sure that the lagoon can meet its effluent requirements. Sampling methods are described in Section 2.6 Sampling.

If the sampling shows that the lagoon contents meet the effluent requirements of the water license, then all notifications required should be given to the Inspector and public and lagoon discharge can begin.

If the sampling shows that the effluent will not meet the requirements of the water license, then the lagoon can be held longer to try to get additional treatment before discharging. If it looks like the effluent requirements will not be met before freeze up, an Emergency Lagoon Discharge from the Water Board should be requested from the Water Board to allow a discharge to take place. Document all request and responses and keep these with the lagoon records for review if required.

Ten (10) days before the annual discharge, the Inspector should be contacted to provide notice them of the intent to discharge. In addition, an appropriate notice will be given to the public and any other impacted party to advise them of the release of wastewater effluent from the sewage treatment facility.

2.3 Emergency Lagoon Discharge

Periodically an emergency discharge may be required in the event of capacity related issues or when adequate treatment cannot be obtained.

Capacity related issues will arise when higher volumes of sewage are placed in the lagoon than anticipated and a discharge is required before 365 days have passed. This reduces the amount of time available for treatment processes and results in partially treated wastewater being discharged before it has a chance to meet the required effluent limits.

If the level of the lagoon approaches the 1 m freeboard and it becomes clear that an early discharge will be required, the Inspector should be notified and a request for an Emergency Lagoon Discharge should be made. The freeboard may be reduced if approval is obtained from a Geotechnical Engineer.

As directed by the Inspector, additional wastewater samples may need to be collected and analyzed before an Emergency Lagoon Discharge is authorized. Once the Emergency Lagoon Discharge has been approved, the lagoon can be pumped out. During the discharge, follow any sampling instructions provided by the Inspector.

Any Emergency Lagoon Discharges should be requested as soon as possible if it becomes apparent that effluent requirements cannot be met. All responsible authorities should be notified, including the public if instructed to do so.

During the discharge, measures should be taken to control the erosion at the discharge area.

2.4 Safety of Lagoon

It is important that the operator must ensure that all aspects of wastewater management are conducted in a safe manner. Wastewater contains a number of organisms that can potentially cause a person to become sick if they come in contact with the sewage.

General public and unimportant access to the lagoon site should be prevented. This includes all forms of recreation activities. This is to ensure no possible contamination or infection of the public, with no protective awareness, from pathogenic microorganisms.

The equipment, structures, and discharge pumping work areas should be kept clean. This reduces problems with footing and also makes it less likely that equipment will be damaged or broken by debris. Many injuries in the workplace are due to slipping or tripping.

All people should wear safety boots, gloves, face shields and other personal protective clothing or equipment when handling or working around sewage. This will reduce the chance of getting splashed in the event of a hose leak or rupture during effluent discharge. After work, before eating, and at other convenient times, wash your hands thoroughly.

Caution should be used when working with wastewater. If you get splashed accidentally with sanitary sewage, wash promptly with plenty of water. Treat all cuts and skin abrasions immediately to prevent any infection. Have appropriate access to life rings or personal floatation devices when working around open water.

All those working on the wastewater system should keep normal preventative health care vaccinations up to date. Check with a physician as to the recommended inoculations (usually includes typhoid and paratyphoid).

All operators should be given appropriate safety training prior to working around the lagoon.

2.5 Sewage Treatment Facility Checking

Once a week, all main components of the sewage treatment facility system should be inspected for damage or operational difficulties. The purpose of the detailed checking is to spot things that may lead to problems later and to record the conditions of the date checked. If problems are noted, make all necessary adjustments as soon as is possible to prevent further damage or operational restrictions.

It is anticipated that the storm surges, which influence the shoreline erosion at the landfill, may not be a serious concern for the lagoon because the lagoon is located over 6 kilometers inland from the ocean by a shallow channel.

Access Road and Truck Turnaround Area: Access roads and truck turn around areas should be checked for damage and repaired as soon as possible. This may require the placement of material that fills and repairs the road surface and prevents trucks from getting stuck.

Inlet Structure: The inlet structures and surrounding area should be examined for blockages, erosion, ice build-up, or other operational problems. Erosion may occur in the discharge area due to the pumping activities. Erosion protection should be placed before and during discharge if required. Any observed erosion should be recorded in operational logs and repaired as soon as is practical.

Retention Pond Wastewater Level: During open water periods, the water level should be observed and recorded. A freeboard on 1.0 m should be provided between the water level and the top of the berm at its lowest point.

Berm Condition: All visible parts of the lagoon berm should be observed and the condition noted. Any cracking, slumping, seepage or other visible damage should be recorded.

Wastewater Colour: The variations in colour can be an important indicator of lagoon performance. This may only be possible during open water periods.

Sewage Treatment Facility Colours and Indications:

Colour	Indication
Dark Green	Good High pH High dissolved oxygen (DO).
Dull Green to Yellow	Not very good pH dropping DO dropping 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	Presence of purple sulphur bacteria (anaerobic conditions) or presence of red algae (aerobic conditions).

If the colour of the lagoon is grey, black, yellow or other colours that indicate poor operation, the appropriate notifications should be given to the Inspector, Board and MACA Regional Office.

2.6 Sampling

The purpose of taking samples and carrying out tests on them is to obtain information on how well the lagoon is performing throughout the summer months and whether the lagoon contents can meet effluent requirements. Keep analytical results to document and provide support to reports.

There are six important parts to the process of sampling. These are:

1. Taking the sample at the time called for;
2. Using a properly cleaned container for the sample to be taken;
3. Careful collection of the sample from the correct location and doing 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. Use of proper testing procedures, where tests can be performed on site; and
6. Shipping of the sample in proper containers and expeditiously so that it arrives on time for the testing.

Sample Frequency: Four Samples will be taken on an annual basis prior to discharge or "decant" of the lagoon. These samples must be submitted to the Inspector in order to obtain approval for decant of the lagoon.

Sample Parameters: Samples will be taken and analyzed for pH, fecal coliforms, suspended solids, BOD₅, and Oil and Grease.

Sample Locations: Samples are normally required to be taken at the effluent discharge area (SNP 0714-2 – See **Figure 3. Facility Organization**). Occasionally, other samples may be collected as required by the conditions of the Water License.

Sample Collection: Normally, you will be required to collect all of the samples at the specified location above in supplied bottles; normally two bottles – one sterile bottle for fecal coliforms and the other bottle for the remaining parameters. This type of sampling is referred to as a grab sample as it is collected at one time from a specific location. The grab samples are collected by dipping a sample collector or the bottle into the flow stream. The samples should preferably be collected by rinsing sample bottles with the sample wastewater for a couple of times prior to final sample collection.

To take a representative effluent sample during the discharge, at a minimum a grab sample should be collected at the beginning, middle and end of the discharge. The grab samples are mixed in a clean bucket and the combined sample is placed in the sample jar and submitted for analysis.

Sample Containers: The sample containers can affect the sample test results. The type of material it is made of and the way it was cleaned are the most important factors. Most lagoon samples are collected in plastic bottles that have been well washed and rinsed about six times. If the samples are to be used for bacteria determination, then special sterilized bottles must be used. These must be handled carefully so that the sample is not contaminated.

Field Tests: Normally, the only test you may be required to carry out on the lagoon site is pH. The equipment for this is a pH litmus paper kit (with instructions included).

2.7 Sample Reporting

An annual report on the sample parameters will be submitted to Northwest Territories Water Board.

2.8 Record Keeping and Reporting

Record keeping and reporting is necessary to have information on what has happened. The use of accurate records reports is very important for the Hamlet, NWT Water Board and its supporting agencies, and to engineers that may need to work on the sewage treatment facility.

The records and reports must be detailed enough to allow evaluation of performance and to track the development of problems. The records and reports also give a good check on completed tasks, and those left to complete. The records and reports for the Tuktoyaktuk sewage treatment facility include:

1. Daily Inspections and Weekly Systems Checks Record prepared by Hamlet staff (See **Appendix A**);
2. Annual Sampling Report prepared by water sample testing laboratory; and
3. Annual Water License Report prepared by the Hamlet staff.

2.9 Review

A compilation of the sewage treatment facility operations and sampling of the lagoon will be prepared once a year as a summary of the operation and performance for the purpose of submitting an annual report to NWT Water Board and for the purpose of an operation management review by the Hamlet Administration.

3. LAGOON MAINTENANCE REQUIREMENTS

3.1 Lagoon Inlet Structures

The inlet structures enable the sewage treatment facility to function properly (See **Figure 4. Facility Components**). In addition, these structures require considerable attention to ensure that they operate properly and do not experience or cause any erosion.

The most important aspect of maintenance of inlet structures is that they must not freeze in a way that inhibits their operation. Another important problem is caused by sludge deposition near the inlet structure, which has to be cleared manually or by machinery at regular intervals, on need-basis.

The lagoon has a free fall wastewater discharge. The sewage treatment facility operator must be aware of the following locations of potential problems:

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

The metal support structure should also be inspected for corrosion and related problems that may weaken the support structure.

3.2 Lagoon Discharge Stream

The discharge stream is a pump and pipe over the berm (See **Figure 4. Facility Components; Figure 5. Discharge Activity**). The pump and piping are used on an annual basis; therefore maintenance is required in advance of the annual discharge and as required during the discharge.

3.3 Lagoon Berms

There are four main functions of lagoon berms:

1. To form part of a storage container for retention of the wastewater for treatment;
2. To form access to parts of the lagoon;
3. To allow variation in wastewater levels due to wastewater volume changes; and
4. To provide "freeboard".

The objective of the berm inspection is to make sure excessive leakage does not occur. Erosion of dikes is mainly caused by wave action and surface runoff. Regular monitoring and maintenance are required to control berm erosion.

Surface runoff must be prevented from entering the lagoon through diversion ditches around the berms. The ditches must be properly maintained to prevent blockage of drainage.

3.4 Odour Problems, Weed and Insect Control

Odour Problem: Under normal operating conditions, the lagoon will not cause serious odor problems. However, at certain times, severe odors may occur. The lagoon is located at a significant distance from the nearest house; therefore, odor problems would not normally be a concern.

The most troublesome conditions are:

1. Lagoon and storage lagoons in the period following ice break-up;
2. At the end of an extensive period of cloud cover (in 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.

The operator of the lagoon has limited opportunities to do anything about these conditions.

For Item 1. This problem will normally be of short duration; 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.

Weed Control: A number of surface weeds can develop in sewage treatment facility. The problem with these weeds is that they block out the sunlight that is needed by algae to produce dissolved oxygen. A second problem is that when the floating plants die, they begin to decompose using up oxygen which is needed by the wastewater bacteria.

The ways to control surface weeds are as follows:

1. Skimming (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 odor and insect problems.

Insect Control: Flies and mosquitoes create the most common insect problems in sewage treatment facility. Most mosquitoes breed in sheltered, calm water containing vegetation and floating materials to which the female can attach the eggs. The egg clusters are fragile and easily damaged by turbulent action caused by wind currents. Poor weed control and the accumulation of a scum layer will make insect problems worse. Puddles of water outside the lagoon will also harbour insects. Berm maintenance and the filling of potholes and puddles will reduce the opportunity for insect reproduction. In some cases, the use of insecticides may be necessary. Approval of the insecticide and the application procedure should be obtained through the supervisor.

Removal of Floating Materials: The floating materials must be removed on regular basis and whenever the weather conditions are favourable. This material should be disposed of at the landfill.

3.5 Fencing and Signs

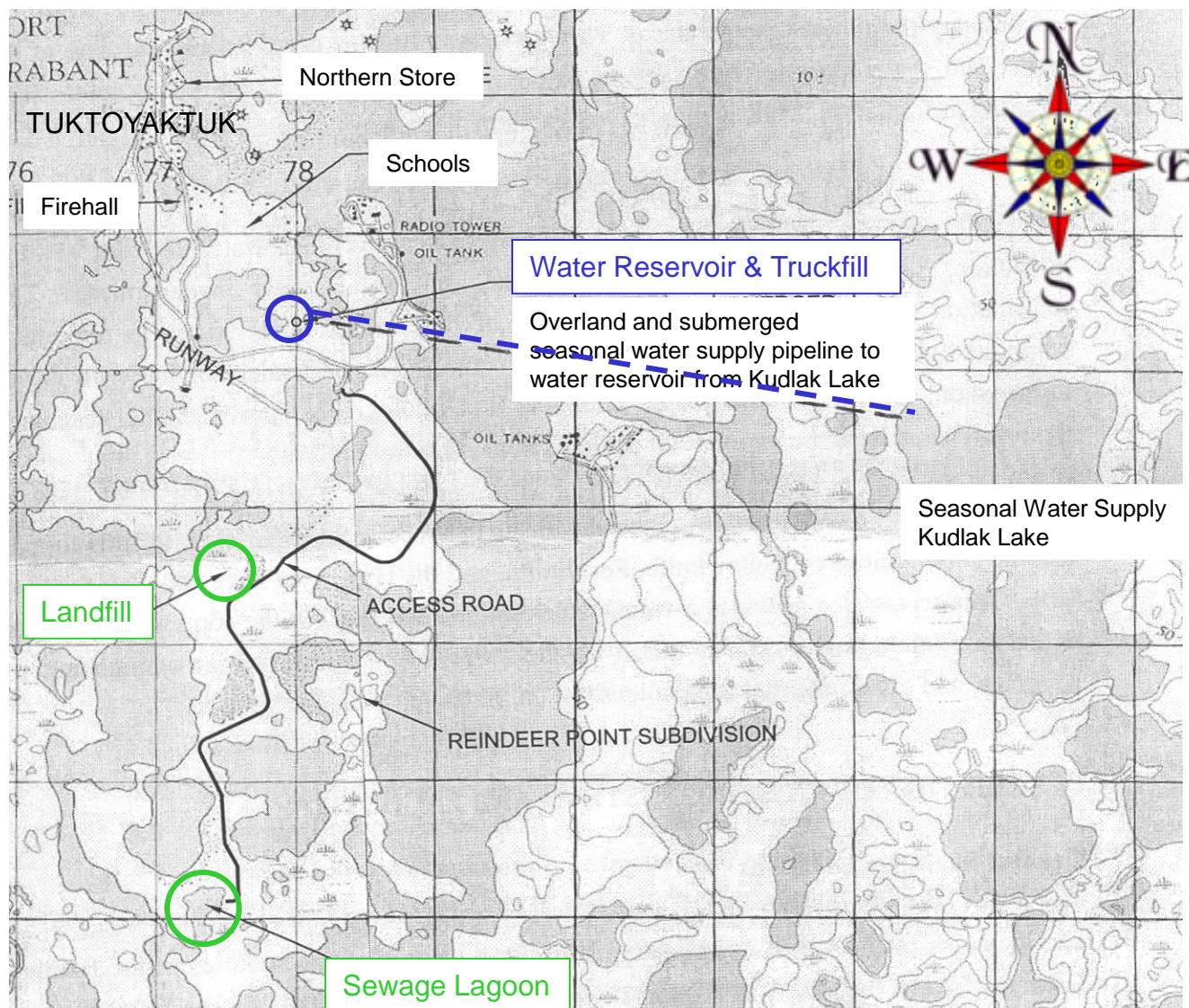
Bilingual warning signs are normally installed at regular intervals around the lagoon. Lost or damaged signs should be replaced.

3.6 Maintenance of Access Road

The access road was designed to be an all-weather road. Maintenance takes three basic forms: road shaping and smoothing, roadway filling, and snow removal. These activities follow normal community procedures.

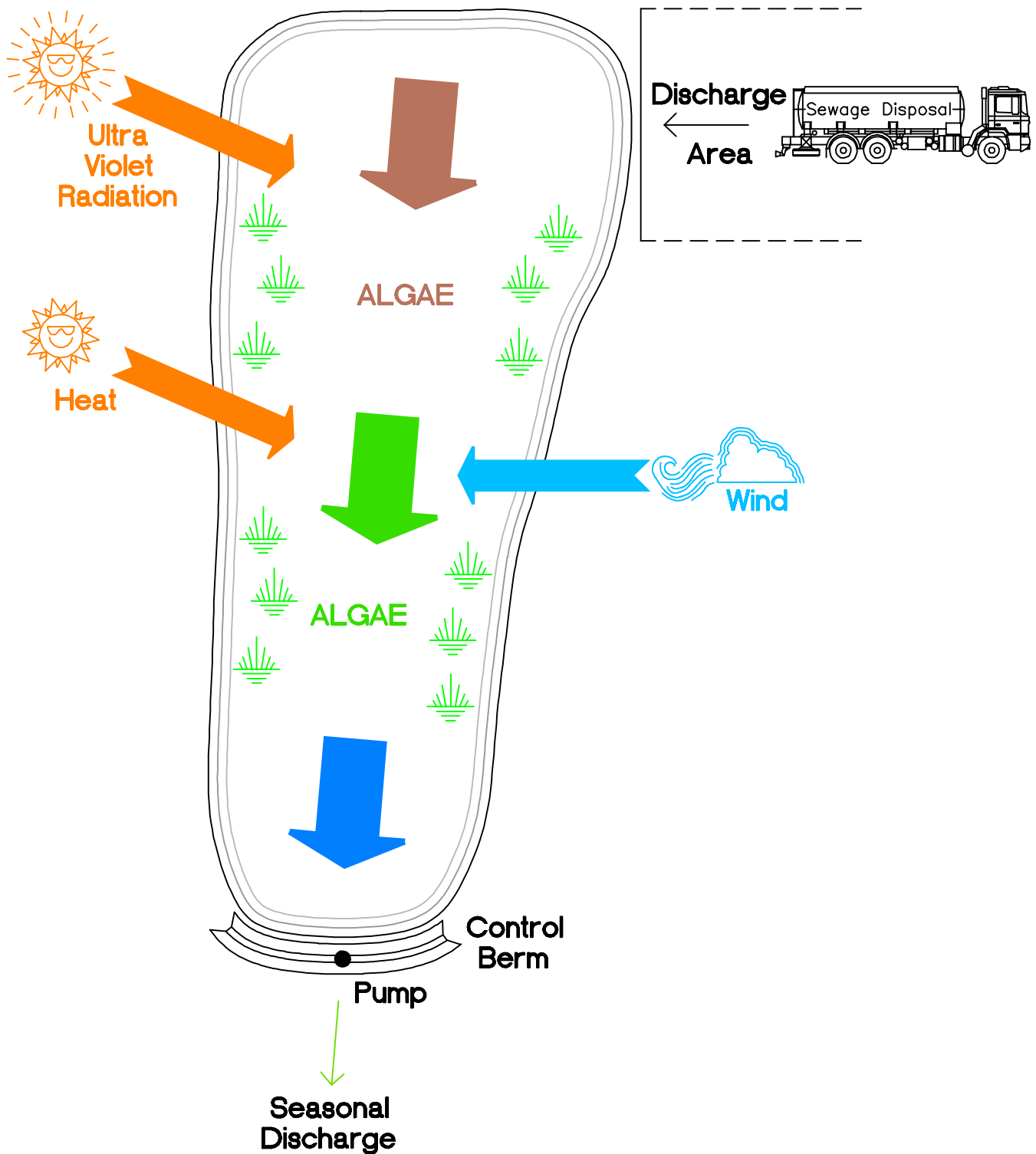
3.7 Surface Runoff Management

Drainage ditches and culverts near the sewage treatment facility should be checked, particularly in the early spring, to ensure that they are not blocked by ice. Any blockages should be cleared immediately to avoid surface runoff from entering the lagoon.



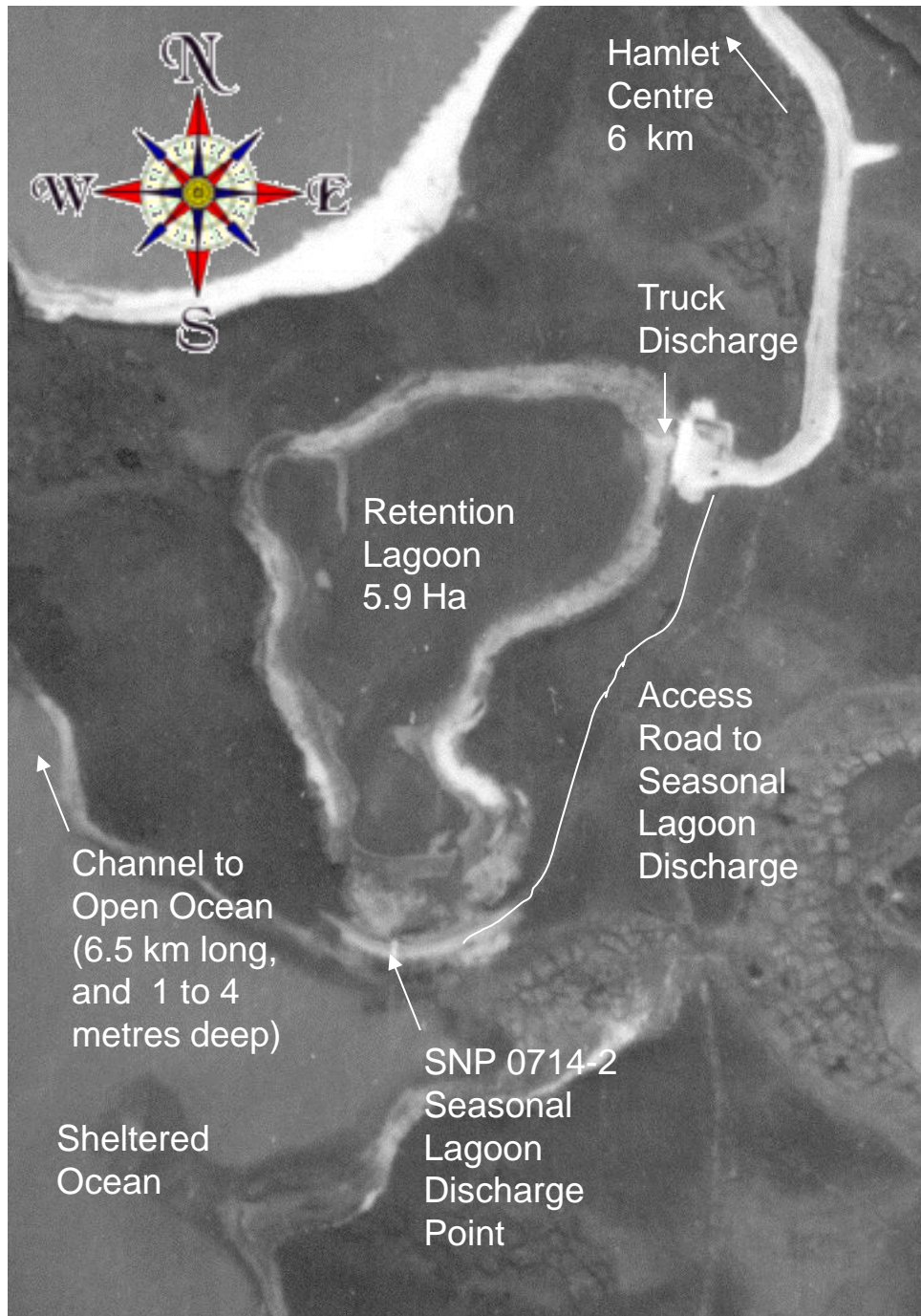
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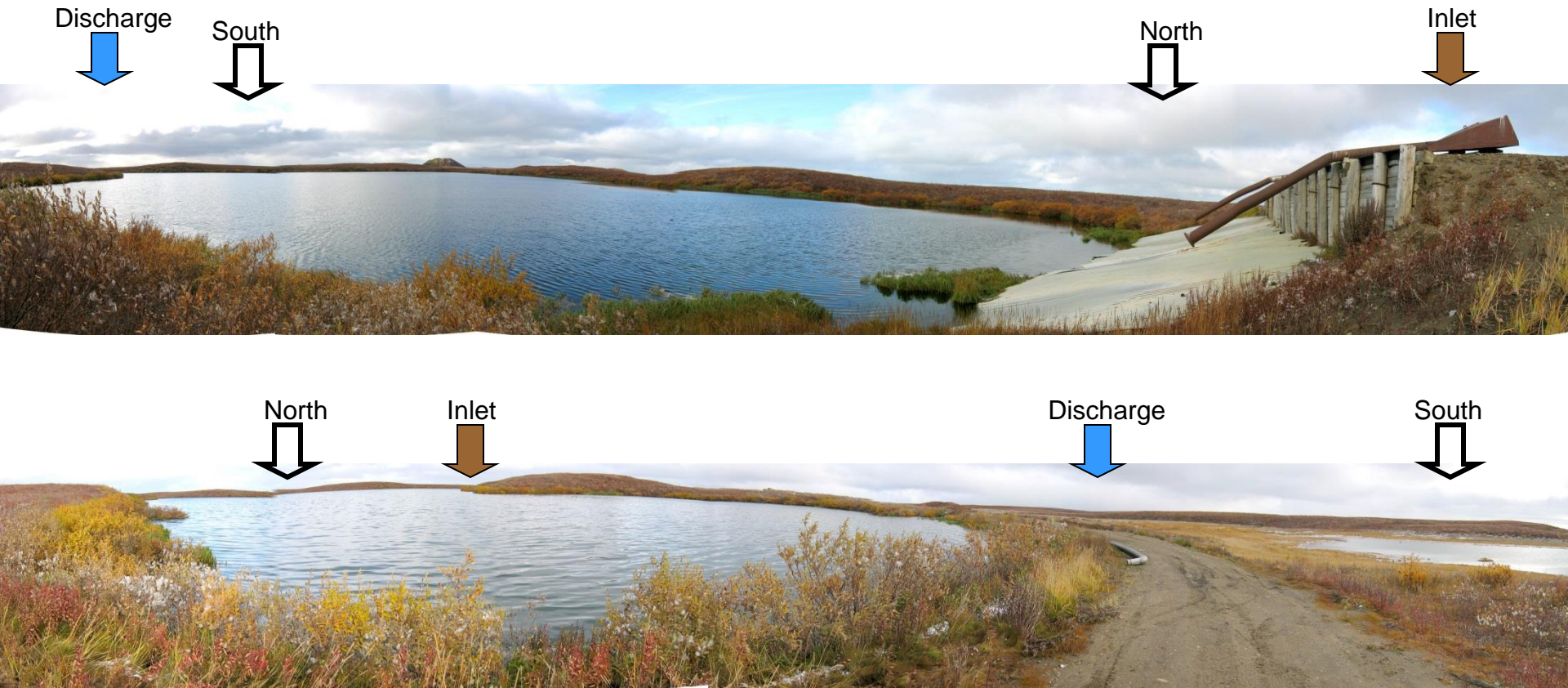
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Sewage Lagoon Operation and Maintenance Manual
SEWAGE TREATMENT SCHEMATIC



Hamlet of Tuktoyaktuk
Sewage Treatment Waste Operation and
Maintenance

Figure 3. Facility Organization



Hamlet of Tuktoyaktuk
Sewage Treatment Waste Operation and
Maintenance

Figure 4. Facility Components

Outlet of pumped
lagoon seasonal
discharge into ocean.



Photo Courtesy of IEG



Pumping system for seasonal
discharge into ocean.

Inlet of pumped lagoon
seasonal discharge into
ocean.



Hamlet of Tuktoyaktuk
Sewage Treatment Waste Operation and
Maintenance

Appendix A

Sample Record Keeping Documentation

Tuktoyaktuk Landfill Record Keeping

Daily Operation Observations for Month of _____, 20____.

Day	Lagoon Normal	Lagoon Not Normal	Observations	Action(s) required/taken if problems observed
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
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22				
23				
24				
25				
26				
27				
28				
29				
30				
31				

Weekly Inspections for Month of _____, 20____.

Week	Truck Discharge	Water Level	Berm	Water Colour	Observations
1					
2					
3					
4					
5					

Mark with a checkmark to confirm inspection.