Hamlet of Kugaaruk, NU Sewage Treatment Facility Operation and Maintenance Manual

Hamlet of Kugaaruk

October 27, 2010

Sewage Treatment Facility – Operation and Maintenance Manual

Community & Government Services, Government of Nunavut

05-4755

Gary Strong – Project Manager

Submitted by
Dillon Consulting Limited

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(In reply, please refer to)
Our File: 05-4755

October 27, 2010

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Attention: Sean Joseph, Technical Advisor

Re: Letter Dated February 22, 2010 Regarding Approval for the Hamlet of Kugaaruk Sewage Treatment Facility Operation and Maintenance Manual

Dear Mr. Joseph:

Please find enclosed a revised Operation and Maintenance Manual for the Hamlet of Kugaaruk Sewage Treatment Facility. The revisions included in the Operation and Maintenance Manual are in response to the comments received in the letter from the Nunavut Water Board dated February 22, 2010. This Operation and Maintenance Manual for the Hamlet of Kugaaruk Sewage Treatment Facility was prepared on behalf of Community & Government Services, Government of Nunavut.

Listed below are the comments that were provided by the Nunavut Water Board and the corresponding sections of the revised Operation and Maintenance Manual that address these comments:

1) Provide detailed procedures with respect to addressing service disruptions *Please refer to Section 4.2 – Contingency Planning*

2) Identify remedial actions to handle sludge containing excessive levels of contaminants and sludge forming extremely thick blankets. *Please refer to Section 3.3.2 – Storage, Treatment, and Disposal of Sludge*

3) Provide relevant method to sample sludge and perform sludge-depth measurements. *Please refer to Section 3.3.3 – Methods for Performing Sludge Depth Measurements*

4) Update historical information to include

a. The dimensions of the new sewage treatment facility;
b. The date it was constructed;
c. The date the new facility was commissioned;

Please refer to Section 1.2 – Site Setting and Appendix D – Record Drawings

5) Provide methods of controlling access, besides the use of large boulders, and methods for managing insects and weeds. *Please refer to Section 3.11 – Site Access Control; and, Section 3.6 – Managing Insects and Weeds.*

6) Provide actual contact numbers for the names of the persons responsible for operating and maintaining the facility. *Please refer to Section 3.12 – Contact Numbers.*

7) Provide measures to address unfavourable operating conditions like extreme short-circuiting/stagnation and excessive odour. *Please refer to Section 3.7 – Measures to Prevent Short-Circuiting and Section 3.8 – Measures to Prevent Stagnation and Excessive Odour.*

8) Update site description to include a map depicting the following features:
   a. Location of the facility;
   b. Size of the facility;
   c. Topography;
   d. Water bodies and flow direction;
   e. Buildings, roads, and other infrastructure; and
   f. Environmentally sensitive areas.

   Please refer to Appendix D – Record Drawings and Appendix E – Map of Sewage Treatment and Solid Waste Facilities.

We hope this meets your requirements at this time. Should you have any questions or concerns regarding this submission, please contact me at your convenience, by email at gstrong@dillon.ca or by telephone at (867) 920-4555.

Yours truly,

Dillon Consulting Limited

Gary Strong, P.Eng.

GS/encl.

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1 INTRODUCTION

1.1 Purpose

The purpose of this manual is to assist the Hamlet of Kugaaruk personnel with the operation and maintenance of their newly constructed sewage treatment facility. The manual has been developed according to the requirements of the Nunavut Water Board and is based on the *Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities in the Northwest Territories* (Duong and Kent, 1996).

1.2 Site Setting

The Hamlet of Kugaaruk is located 68.52° north latitude and 89.9° west longitude in central Nunavut. This places Kugaaruk along the east coast of Pelly Bay, which is roughly nine hundred and sixty kilometers (960 km) west of the capital of Iqaluit.

The annual snowfall in Kugaaruk is approximately 125 cm and the annual rainfall is approximately 11 cm. In January the daily mean temperature is approximately -33^0C while in July the daily mean temperature is approximately 6^0C. Freeze up usually occurs during the month of November but may happen as early as September or October while spring thaw usually happens around late May.

Prior to construction of the new sewage lagoon, the Hamlet was using a two cell sewage lagoon system and wetland area to treat sewage. The lagoon was placed by the community over an old MSW site at some point in the past 20 years. Berms were uncompacted, porous material laid over fractured granite bedrock. The lagoon has experienced a number of breaches and over-toppings throughout the years. In addition, the lagoon was severely under-capacity for the current population. As the effluent had not been fully treated, it did not meet the required environmental standards. Even though extra local material was periodically added to the upper berm to prevent seepage, exfiltration from the berm remained at unacceptable environmental levels.

Construction of the new sewage lagoon was completed in 2008 and was commissioned in September 2009.

The new system is similar to the old system; however, it has been upgraded to meet the Hamlet needs for the next 20 years. The new facility consists of an upper and a lower berm and will also incorporate the use of the adjacent wetland area as a means of secondary treatment of the effluent. The new lagoon has been built exactly where the old lagoon used to be. Please refer to Figure 1-1 for the site location.

**Image taken from Google Earth Pro, July 2008*

Figure 1-1. Site Map of Sewage Lagoon and Solid Waste Facilities

2 BACKGROUND

2.1 Design Data

The following sections describe the data used in the design of the sewage lagoon.

2.1.1 Population Projections

The new sewage treatment facility was designed for a 20 year operational period (2008 – 2028). To size the lagoon, sewage generation rates were determined using population projections obtained from the Nunavut Bureau of Statistics and Statistics Canada. Predicted population values until the year 2020 were provided by the Nunavut Bureau of Statistics. Population values beyond 2020 were predicted using the same growth rate as previous years (20 persons per year), and using a percentage growth rate (2.6%) as illustrated in Figure 2.1 The population for 2028 was predicted to be 1127 persons.

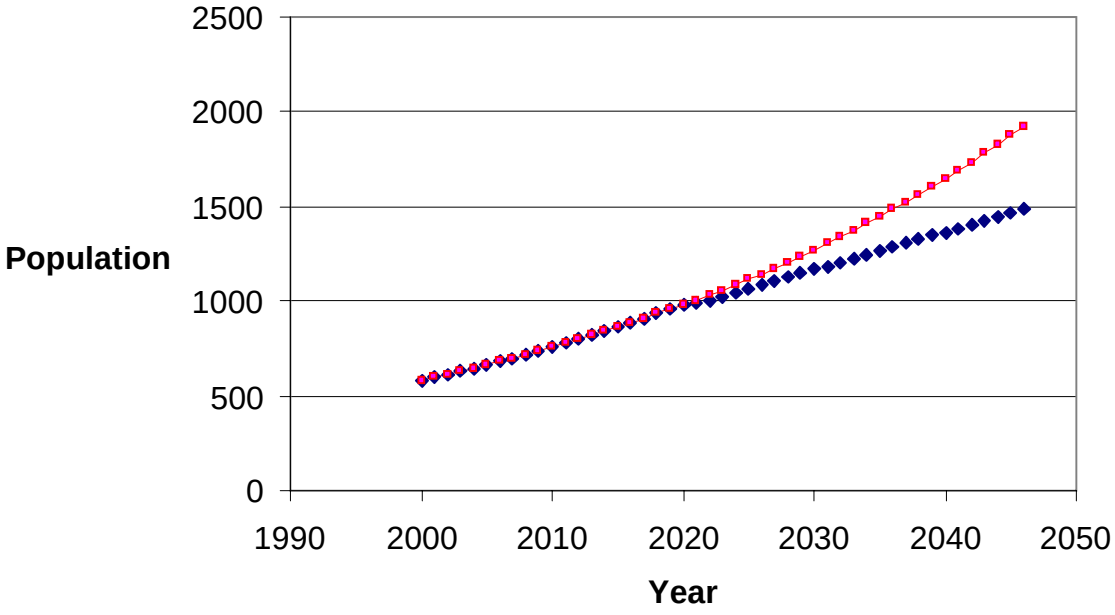

Figure 2-1. Population Projections for the Hamlet of Kugaaruk, NU

*Note: Data prior 2021 was provided by Nunavut Bureau of Statistics and data proceeding 2021 was predicted. Dark blue data points indicate data calculated using a growth rate of 20 persons per year. Red data points indicate data calculated using a percentage growth rate of 2.6%.

2.1.2 Sewage Generation Rates

Sewage generation rates for Northern communities can be calculated by using the following formula (Department of Municipal and Community Affairs, Government of the Northwest Territories):

$$Water\ Usage\ (l/c/d) = 90\ l/c/d \times (1.0 + 0.00023 \times population)$$

Based on this information, the lagoon was designed to treat 46,600 m^3 of sewage per year. Table 2.1 shows the calculated sewage generation for years 2008 – 2028.

Table 2.1. Predicted Sewage Generation 2008 - 2028

Year	Population	MACA Predicted Sewage Production (L)	MACA Predicted Sewage Production (m3)
2008	719	27,525,000	27,525
2009	737	28,314,000	28,314
2010	756	29,153,000	29,153
2011	779	30,175,000	30,175
2012	802	31,205,000	31,205
2013	823	32,153,000	32,153
2014	844	33,107,000	33,107
2015	867	34,160,000	34,160
2016	889	35,175,000	35,175
2017	911	36,197,000	36,197
2018	934	37,273,000	37,273
2019	957	38,357,000	38,357
2020	979	39,402,000	39,402
2021	987	39,780,000	39,780
2022	1007	40,736,000	40,736
2023	1027	41,698,000	41,698
2024	1047	42,665,000	42,665
2025	1067	43,639,000	43,639
2026	1087	44,619,000	44,619
2027	1107	45,605,000	45,605
2028	1127	46,597,000	46,597

2.2 Sewage Collection, Treatment and Disposal

In the past, the sewage lagoon had operated as an exfiltration lagoon with sewage being trucked to the lagoon 5 days per week. Sewage discharged to the lagoon received treatment within the lagoon (physical and biological), and effluent would filter through the north wall.

3 OPERATIONAL AND MAINTENANCE PROCEDURES

3.1 Sewage Lagoon and Wetland System

Sewage collection will be carried out in the same manner as in previous years. Collected sewage will be discharged into the lagoon via the effluent discharge flume. Any effluent spilling onto the truck turn around pad must be cleaned up to prevent accumulation of ice during the winter. Effluent from the lagoon will be discharged once per year from July to October, weather dependent.

Discharge of effluent will take place as soon as the stored effluent has thawed. The valve in the discharge pipe will be opened and effluent will flow from the main lagoon to the smaller holding cell. Once the holding cell has filled, the valve will be throttled back to maintain a discharge flow such that effluent steadily but slowly runs over the top of the secondary cell's rip-rap berm and enters the wetland for secondary treatment. This flow will be regulated so that the wetland is not overwhelmed by any large volume of effluent, and the flow can continue this slow rate throughout the growing season. Treated effluent from the wetland will discharge into the ocean. As the ocean is the final destination, it is imperative that the effluent sampling monitoring program be completed every year to ensure that the lagoon and wetland are providing adequate treatment.

3.2 Yearly Operation and Maintenance

Operation of the lagoon has been broken down into two sections; operation during the winter months and operation during the summer months. The following dates are estimates as operational changeovers are weather dependent and may occur earlier or later than the anticipated dates.

3.2.1 Operation from Freeze-up to Break-up

Operation of the lagoon during this time is for winter operations. Changeover to winter operations should occur when effluent in the lagoon begins to freeze. Sewage will be collected using the Hamlet's vacuum truck and will be discharged into the lagoon via the sewage discharge flume. Any sewage spilled onto the truck turn around pad must be cleaned up immediately to prevent the accumulation of ice. Also, any accumulation of ice on the discharge flume should be cleared away to keep the flume clean and free of blockages.

3.2.2 Operation from Break-up to Freeze-up

Operation of the lagoon during this time is for summer operations. Changeover to summer operations should occur when stored effluent in the lagoon has thawed. Sewage will be collected and discharged into the lagoon as described for winter operations. The lagoon will also be decanted during this time. As soon as the stored effluent has thawed, the valve in the discharge pipe is to be opened. This will allow effluent to decant from the main lagoon into the smaller holding cell and then into the wetland for secondary treatment. If problems are encountered with the valve, a trash pump will be used to decant the lagoon into the secondary cell at the same rate as described in Section 3.1. Prior to decanting any effluent into the wetland treatment area, the Hamlet must provide notice to an INAC Inspector at least 10 days before decanting occurs. Once the decantation period is over (approximately late September/early October), the valve will be closed and sewage will be stored in the lagoon during the winter months.

During summer operations, implementation of the Lagoon and Wetland Monitoring Program will begin. It is the Hamlet's responsibility to ensure that this program is carried out each summer to remain in compliance with the Hamlet's water licence. Please refer to Section 3.3 for further details.

As well, according to the Hamlet's water licence, the Hamlet must have the lagoon inspected by a Geotechnical Engineer in either July or August of each year. The Hamlet must first consult with the Government of Nunavut for a listing and how to properly retain the services of a Geotechnical Engineer. The Geotechnical Engineer's report must be submitted to the Nunavut Water Board within 60 days of the inspection and include a copy of the Hamlet's plan to implement any recommendations suggested in the report.

3.3 Sewage Sludge Management Plan

3.3.1 Characterization of Sludge

Collected sewage will mostly come from residential buildings in the Hamlet as there are no industrial or commercial sources. The sludge will generally be a mixture of fecal matter, organic and inorganic material. However, contaminants such as heavy metals, solvents and petroleum products may enter the lagoon due to municipal activities.

3.3.2 Storage, Treatment and Disposal of Sludge

During the treatment process, heavier solids in the lagoon liquid will sink to the bottom of the lagoon and collect over time as a sludge blanket. If the depth of the sludge blanket becomes thick enough to decrease the volume of the lagoon cell significantly or contaminant concentrations become too high, the sludge must be collected from the lagoon and treated according to CCME standards.

3.3.3 Methods for Performing Sludge Depth Measurements

According to the National Guide to Sustainable Municipal Infrastructure (2004), sludge depth measurements should be performed each year to determine the depth of sludge and rate of sludge accumulation within the lagoon. This will help Hamlet staff to plan and prepare for lagoon desludging operations. There are a number of methods available for measuring the depth of the sludge blanket, however one of the more economical tools is called a Sludge Judge®. The Sludge Judge® is a clear plastic tube with a check valve on the bottom and measured increment markings on the tube. It comes in 5-foot sections that can be screwed together as necessary. The number of sections required for sampling will be dependent on the depth of the water level in the lagoon.

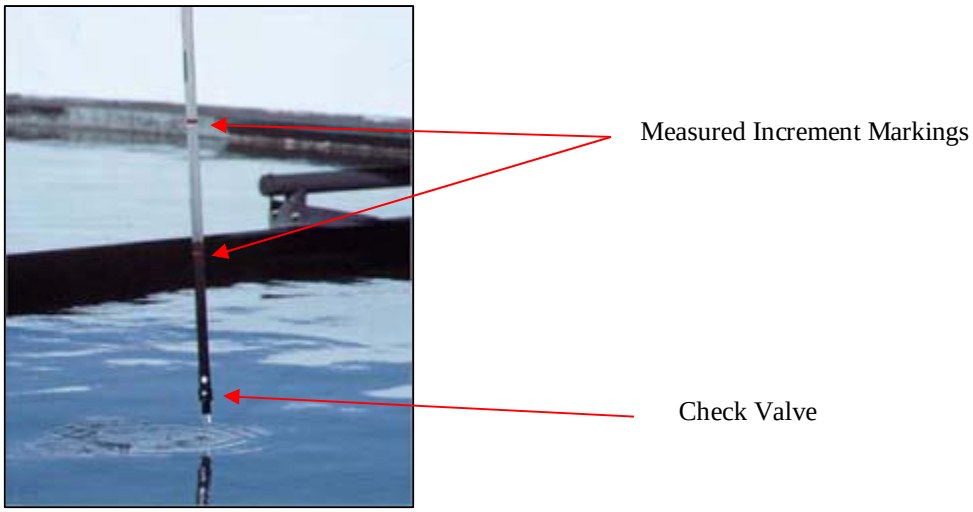

Figure 3-1. Photo of Sludge Judge®

Source: http://www.geneq.com/catalog/en/sludge_judge.htm
Retrieved March 29, 2010

Sludge depth measurements should be taken based on a grid format, and should be taken in the same locations each year. Based on the document *Sludge Survey Methods for Anaerobic Lagoons* (Westerman, Shaffer & Rice, 2008), 6 depths measurements per acre is sufficient. Based on the bottom surface measurements of the lagoon in Kugaaruk, the estimated bottom surface area of the lagoon is 1.37 acres. Therefore 8 depth sampling locations are required. Please refer to the figure below for the site map showing where each depth measurement should be taken. According to Westerman *et al.*(2008), sampling locations on-site should be marked by survey flags or landmarks (sewage truck discharge chute, boulders, outlet pipe, etc.). Hamlet staff can place markers on the side of the lagoon to indicate sampling point locations at intersecting junctures.

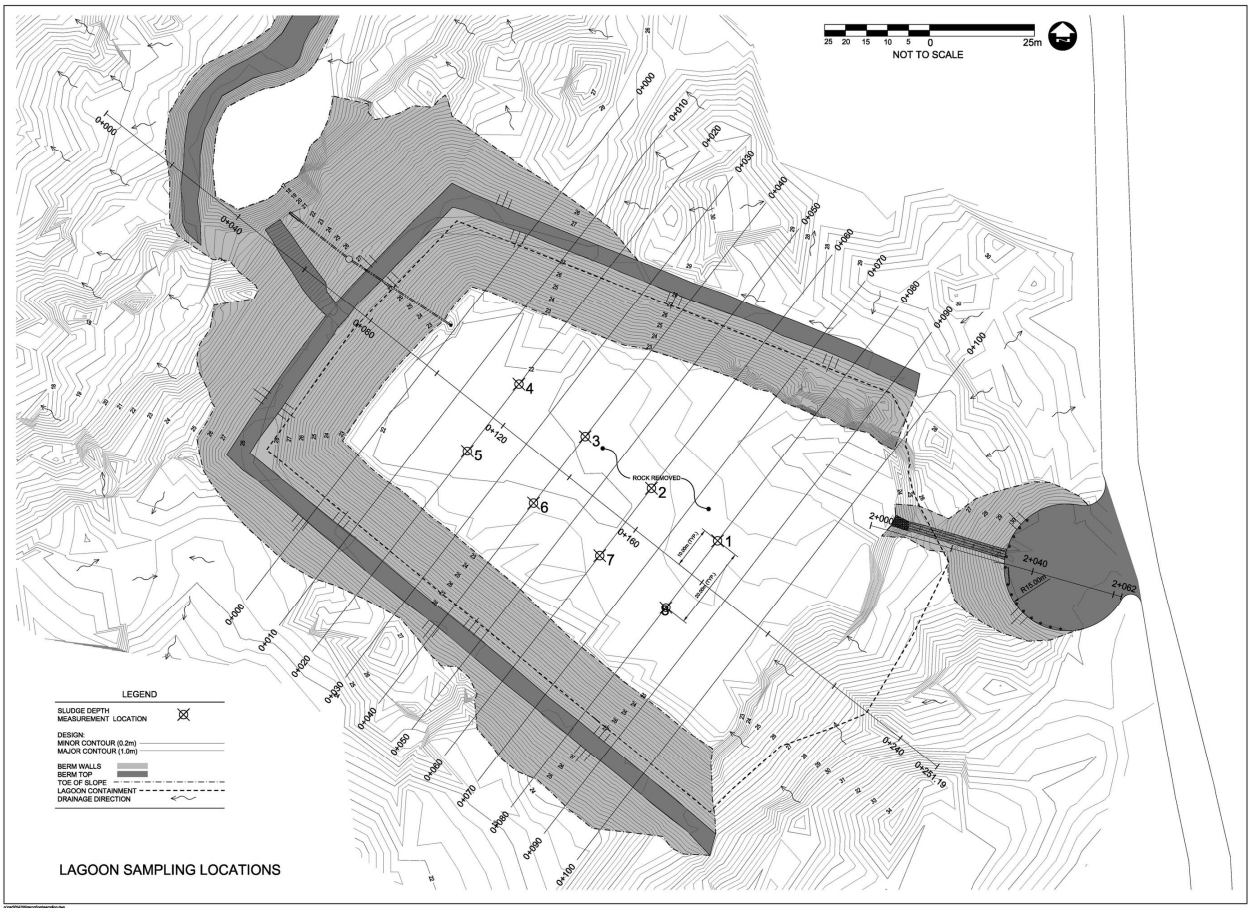

Figure 3-2. Locations for Sludge Depth Measurements and Sampling

To prepare for sludge depth measuring, the follow items must first be obtained:

- A boat (a flat bottom boat should be used as they are more stable than a canoe or V-bottom boat, Westerman *et al.*, 2008)
- Appropriate floatation devices for each sampling team member
- Sludge Judge® or a similar measuring device (ensure that the check valve is operating properly)
- Measuring rod to measure total depth from top of water level to bottom of the lagoon
- Appropriate Personal Protective Equipment (PPE) such as latex or nitrile gloves, CSA certified rubber boots, coveralls, safety goggles, etc.
- Notebook and pen to record measurements

Choose to take depth measurements during the summer, after the lagoon has completely thawed. Take measurements on a calm day when weather conditions (wind, rain, etc.) will not interfere with the process. According to Westerman *et al.* (2008), always have a team of three people to take measurements. One person will stay on shore to monitor and act as a rescuer should the need arise. The other two team members will be in the boat, one person will help to anchor the boat and record depth measurements while the second person uses the Sludge Judge® and measuring rod to obtain the measurements. All team

members, including those on the shore, are to wear appropriate floatation devices (Westerman *et al.*, 2008).

To take the depth measurements, follow these steps provided by Westerman *et al.* (2008):

1. Paddle to the first sampling location. Be sure to mark down which location it is (ie. depth sampling point #1).
2. Slowly lower the Sludge Judge® into the lagoon being careful not to move the tube up and down. To determine when the tube has reached the top of the sludge layer, watch the liquid level inside the tube as it is lowered into the lagoon. When the tube has reached the sludge layer, the water level inside the tube will drop slightly.
3. As soon as the tube has reached the sludge layer, tug on the rope to secure the check valve and pull the tube up slowly.
4. Using the increment markings on the tube, measure the depth of the liquid layer (this is the layer of water that sits above the sludge layer). There should be 1 to 2 inches of sludge at the bottom of the tube, indicating that the tube did reach the sludge layer. The depth of the liquid layer in the tube is measured from the top of the sludge to the top of the liquid (Refer to Figure 3-3 below). Record the measurement.

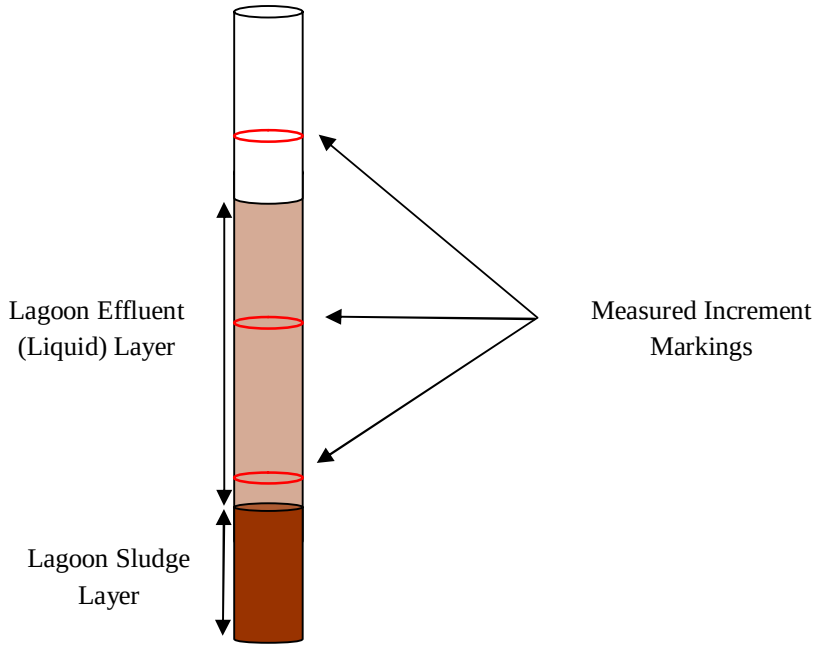

Figure 3-3. Sketch of Tube After Retrieving Lagoon Effluent Depth Measurement (Not to Scale)

5. Empty the contents of the Sludge Judge® back into the lagoon.
6. Take the measuring rod, place it in the lagoon with the zero end pointing downwards. Lower the rod all the way down until the bottom of the rod touches the lagoon floor. Read the water level

measurement. This is the total depth of the effluent plus the sludge layer (Refer to Figure 3-4 below). Record the measurement.

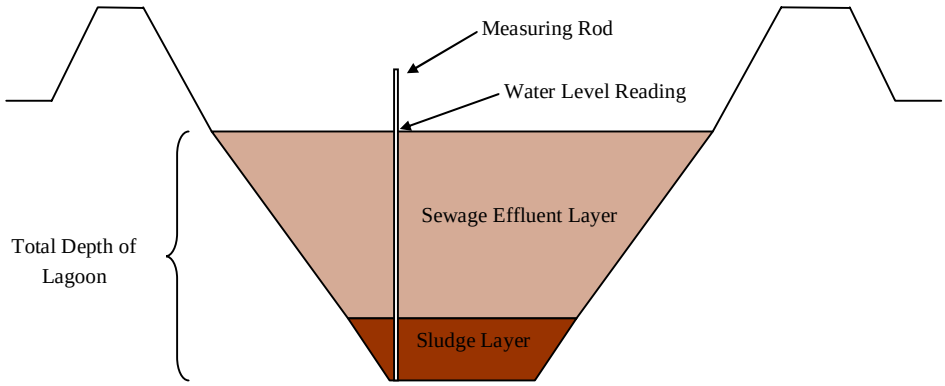

Figure 3-4. Sketch of Lagoon Cross-Section and Total Depth Measurement (Not to Scale)

7. To find the thickness of the sludge layer, subtract the depth of the liquid layer from the total depth.
8. Repeat steps 2 through 7 for the next 7 sampling locations. Be sure to record all measurements and the corresponding sample locations.

An alternative method to measure the depth of the sludge blanket is to lower the Sludge Judge® all the way to the bottom of the lagoon. Sludge and effluent will enter the tube through the check valve. When the tube is lifted out of the water, a distinct layer of sludge will be visible at the bottom of the tube. The distance from the bottom of the tube to the top of the sludge layer in the tube is the estimated thickness of the sludge blanket. Unfortunately this method can provide inaccurate results as the sludge does not enter the tube as easily as the effluent. This may cause the sludge depth measurement to be less than the actual depth of the sludge blanket (Westerman *et al.*, 2008).

When the sludge layer has become thick enough to affect the operation of the lagoon, the sludge should be removed, treated and disposed. As a guide, if the height of the sludge is thicker than 0.5m from the bottom of the lagoon floor and has reached the bottom of the decant screen structure, the sludge should be removed from the lagoon. At this point, in consultation with the Government of Nunavut, the Hamlet should retain the services of an Engineer for the design of appropriate sludge removal, treatment and disposal options. The design will need to be submitted and approved by the Nunavut Water Board prior to implementing the sludge removal process. Prior to any lagoon draining or sludge removal, an INAC inspector must be informed at least ten days in advance.

3.3.3.1 *Methods for Sampling Sludge*

Although there are no specific guidelines with regards to the frequency of sludge sampling, sampling of sludge once per year should be sufficient to monitor the contaminant concentrations. Therefore sludge samples can be collected during the sludge depth measurements.

As well, parameters to be analyzed in the sludge have not been stated in the Hamlet's water licence. Therefore, prior to initiating the sludge sampling program, the Hamlet must contact the Nunavut Water Board to determine which parameters (ie. microbiological, nutrients, physical, metals, etc.) to test for during the program.

Sludge samples should be collected as a composite sample. This means that sludge samples are taken from various points in the lagoon and mixed together before bottling and sending to a laboratory for analysis (Westerman *et al.*, 2008). To collect sludge samples, gather all items listed in Section 3.3.3 for sludge depth measurements as well as the following:

- Sample bottles
- Preservatives (if required)
- Clean 5 gallon bucket
- Cooler
- Ice packs to keep samples cool
- Chain of custody forms (also called COCs)
- Permanent marker to mark on bottles
- Pen to fill out chain of custody forms
- Packing tape
- Shipping label to send samples back to the lab
- Clean stir-stick to mix sludge samples in 5 gallon bucket (must be clean as an unclean mixer may contaminate the sample, leading to inaccurate results).
- Sealable freezer bag

Samples must be collected shortly before they are sent to the lab for analysis. For example, if the samples must be at the airport by 2:00pm, the samples should be collected that morning. Make sure that there is enough time to collect and package all samples for transport. This is important because the samples must be at the lab within 24 hours from the time they are collected, otherwise some of the samples will no longer good for analysis. Be sure to contact the airport and ask what time the samples must be there to make the flight. Contact the lab to let them know that samples will be arriving and ask if they are able to pick them up at the airport.

To collect a composite sludge sample, follow the procedure below (adapted from Westerman *et al.*, 2008):

1. Prior to beginning sampling, label the sample bottles with the date, time of collection, your name and description of sample (ie. sludge from Kugaaruk sewage lagoon).

2. After taking the sludge depth measurement using the Sludge Judge®, dip the Sludge Judge® into the lagoon to collect a sample of sludge in the tube. Pull the tube out and release the valve at the bottom to discharge sludge into the 5 gallon bucket. Be careful not to empty any of the effluent (liquid) into the bucket.
3. Continue this step until a sample of sludge has been collected from each sampling location.
4. Mix the sludge samples together in the 5 gallon bucket. Collect samples by dipping sample bottles carefully into the bucket. Do not allow any of the preservatives in the bottles to spill out of the bottle while filling it. Cap bottles and place in cooler.
5. Once all bottles have been filled, pack bottles in cooler with ice packs for shipping. Fill out chain of custody forms, place in a sealable freezer bag and place in the cooler with the samples. Close cooler and secure with packing tape and place shipping label on top of the cooler.
6. Take cooler to the airport and ship to the laboratory immediately. Some sample parameters must be analyzed within 24 hours of collection, otherwise they will be no longer good for analysis. Call the lab and give them the shipping number of the cooler.

Samples should be only of sludge and include as little effluent as possible. This is because of the desludging procedure for the lagoon. When it is time to desludge the lagoon, the lagoon effluent will first be discharged to the wetland treatment area leaving mostly sludge (Westerman *et al.*, 2008). Once the sludge is removed, it will most likely require further treatment prior to disposal. Sampling only the sludge will give a more accurate analysis of the amount of contaminants within the sludge to be treated. Results are to be reported once analysis has been completed and are to be included in the Annual Report.

3.4 Lagoon and Wetland Monitoring Program

As per the conditions set out in the Hamlet's water licence, the effluent discharged from the lagoon and wetlands must be monitored during the treatment period. The following sections describe in detail how the program must be completed.

3.4.1 Program Description

The sampling program is divided into two main parts: the lagoon and the wetland treatment area. The lagoon is the main storage and primary treatment facility for the sewage. Solids will settle to the bottom and the remaining effluent is stored until decantation occurs. The wetland area provides secondary treatment of the effluent by removing organic and inorganic materials. The water licence has set the following effluent quality standards for effluent discharged from the lagoon and wetland.

Table 3.1. Quality Standards for Effluent Discharged from Sewage Lagoon (Station PEL-3-1)

Parameter	Maximum Average Concentration
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Fecal Coliforms	$1x10^4$ CFU/100mL
Oil and Grease	No visible sheen
pH	Between 6 and 9

Table 3.2. Quality Standards for Effluent Discharged from the Wetland Treatment Area (Station PEL-4)

Parameter	Maximum Average Concentration
BOD_5	45 mg/L
Total Suspended Solids	45 mg/L
Fecal Coliforms	$1x10^4$ CFU/100mL
Oil and Grease	No visible sheen
pH	Between 6 and 9

Discharged effluent must meet these parameters. As well, the water licence has listed a number of other parameters to be tested. These parameters must meet the CCME marine standards for the Canadian Water Quality Guidelines for the Protection of Aquatic Life. A list of these parameters can be found in Section 3.3.2.

Effluent discharged from the wetland to the ocean must also demonstrate that it is not acutely toxic under the following tests:

1. Acute lethality to Rainbow Trout, *Oncorhynchus mykiss* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13);
2. Acute lethality to the crustacean, *Daphnia magna* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14).

Methodology for collecting these samples is covered in Section 3.4.1.

3.4.2 Program Schedule

Figure 3-5 below shows the locations for each sampling point for both the sewage lagoon and the wetland treatment area. A larger image can be found in Appendix A.

**Image taken from Google Earth Pro, July 2008; Pictures from Dillon Consulting Limited, July 2008.*

Figure 3-5. Sampling Locations for Sewage Lagoon and Wetland Treatment Facility

Table 3.3. GPS Coordinates for Sampling Stations

Station	Latitude	Longitude
PEL-2	68° 31' 13.66" N	89° 49' 49.25" W
PEL-3-1	68° 31' 16.74" N	89° 50' 05.68" W
PEL-3-2	68° 31' 17.91" N	89° 50' 03.19" W
PEL-4	68° 31' 21.38" N	89° 50' 16.06" W
PEL-5	5m offset from shore into ocean where PEL-4 is located	

The following table is a sampling schedule for the lagoon and wetland treatment area during the decantation period.

Table 3.4. Sampling Program Schedule

Sampling Point	Description	Parameters to be Tested		Sampling Dates
PEL-2	Discharged raw sewage from pump-out truck.	Volume of sewage discharged		Every discharge into the lagoon.
PEL-3-1	Discharge from lagoon to settlement pond.	Biochemical Oxygen Demand (BOD)	Fecal Coliforms	Beginning of July
		Total Suspended Solids	pH	
		Conductivity	Nitrate-Nitrite	
		Oil and Grease (visual)	Total Phenols	
		Magnesium	Calcium	
		Sodium	Potassium	Mid-August
		Chloride	Sulphate	
		Total Hardness	Total Alkalinity	
		Ammonia Nitrogen	Total Zinc	
		Total Cadmium	Total Iron	
		Total Cobalt	Total Manganese	End of September
		Total Chromium	Total Nickel	
		Total Copper	Total Lead	
		Total Aluminum	Total Arsenic	
		Total Mercury	Total Organic Carbon (TOC)	
PEL-3-2	Discharge from settlement pond to wetland.	Biochemical Oxygen Demand (BOD)	Fecal Coliforms	Beginning of July
		Total Suspended Solids	pH	
		Conductivity	Nitrate-Nitrite	
		Oil and Grease (visual)	Total Phenols	
		Magnesium	Calcium	
		Sodium	Potassium	Mid-August
		Chloride	Sulphate	
		Total Hardness	Total Alkalinity	
		Ammonia Nitrogen	Total Zinc	
		Total Cadmium	Total Iron	
		Total Cobalt	Total Manganese	End of September
		Total Chromium	Total Nickel	
		Total Copper	Total Lead	
		Total Aluminum	Total Arsenic	
		Total Mercury	Total Organic Carbon (TOC)	
PEL-4	Discharge from wetland to ocean.	Biochemical Oxygen Demand (BOD)	Fecal Coliforms	Beginning of July
		Total Suspended Solids	pH	
		Conductivity	Nitrate-Nitrite	

		Oil and Grease (visual)	Total Phenols	
		Magnesium	Calcium	
		Sodium	Potassium	Mid-August
		Chloride	Sulphate	
		Total Hardness	Total Alkalinity	
		Ammonia Nitrogen	Total Zinc	
		Total Cadmium	Total Iron	
		Total Cobalt	Total Manganese	End of September
		Total Chromium	Total Nickel	
		Total Copper	Total Lead	
		Total Aluminum	Total Arsenic	
		Total Mercury	Total Organic Carbon (TOC)	
		Acute lethality to Rainbow Trout, *Oncorhynchus mykiss* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13)		Mid-August
		Acute lethality to the crustacean, *Daphnia magna* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14)		
PEL-5	Ocean water 5 metres from point where effluent enters ocean.	Biochemical Oxygen Demand (BOD)	Fecal Coliforms	Beginning of July
		Total Suspended Solids	pH	
		Conductivity	Nitrate-Nitrite	
		Oil and Grease (visual)	Total Phenols	
		Magnesium	Calcium	
		Sodium	Potassium	Mid-August
		Chloride	Sulphate	
		Total Hardness	Total Alkalinity	
		Ammonia Nitrogen	Total Zinc	
		Total Cadmium	Total Iron	
		Total Cobalt	Total Manganese	End of September
		Total Chromium	Total Nickel	
		Total Copper	Total Lead	
		Total Aluminum	Total Arsenic	
		Total Mercury	Total Organic Carbon (TOC)	

All sampling, sample preservation and analysis is to be performed in accordance with methods approved by the Nunavut Water Board. All analysis must be completed in a Canadian Association of Environmental Analytical Laboratories (CAEAL) Certified Laboratory. Note that an example of one laboratory's sampling instructions is provided in Appendix B.

3.4.3 Record of Sampling Events

It is the responsibility of the Hamlet to file an Annual Report to the Nunavut Water Board no later than March 31st following the reported year. Appendix A contains samples of forms to be filled out and included in each Annual Report. The amount of water pumped from the water treatment plant to the community and the amount of sewage discharged to the lagoon must be documented monthly and annually. As well, the amount of solids removed from the sewage lagoon each year (if this has proven to be necessary due to excessive sludge accumulation) must be recorded.

3.5 Quality Assurance/Quality Control Plan for Lagoon and Wetland Monitoring Program

Section 3.4.1 to Section 3.4.3 describes the Quality Assurance/Quality Control (QA/QC) Plan for sampling of the Sewage Lagoon and Wetland Treatment Facility. This plan outlines general QA/QC procedures, however, once the Hamlet has chosen a specific laboratory to complete the sample analysis they should obtain more specific instructions on sample collection and handling from the chosen laboratory. They must also obtain a certificate from the lab stating that the lab is certified as a CAEAL Laboratory. Information in developing this plan was taken from *Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class "B" Licensees in Collecting Representative Water Samples in the Field and for Submission of a QA/QC Plan* (Department of Indian and Northern Affairs Canada, Water Resource Division and the Northwest Territories Water Board, July 1996) and *Wastewater Sampling Instructions, Kitikmeot Region* (IEG Environmental, July 2005).

3.5.1 Sample Collection

3.5.1.1 Preparing for Sample Collection

Samples are to be collected from the marked Surveillance Network Program (SNP) locations. Each location has been marked with a sign and location number as well as located with GPS coordinates. Please refer to Figure 3-5 for a map of the SNP locations and Table 3.3 for GPS coordinates. It is the responsibility of the Hamlet to maintain these markers in good condition.

Before collecting samples, follow the list of instructions below:

1. Contact the lab and ask where their lab is located. Tell them you need 5 sets (or 4 sets if the temporary sewage treatment plant is no longer in use) of sampling bottles and equipment to test the following list of parameters in Table 3.5. As well you will need travel blanks and field blanks. Travel blanks are jars of deionized water that are filled in the laboratory and travel in the coolers with the field samples to determine if there is any possible contamination from traveling and handling methods. Field blanks are also filled with deionized water, but must be filled in the field by the sampler during the sample collection process. Also ask the laboratory for an instruction sheet for collecting the samples. An example of an instruction sheet can be found in Appendix B.

Table 3.5. Parameters to be Tested During Water Sampling Program

Biochemical Oxygen Demand (BOD)
Total Suspended Solids
Conductivity
Oil and Grease (visual)
Magnesium
Sodium
Chloride
Total Hardness
Ammonia Nitrogen
Total Cadmium
Total Cobalt
Total Chromium
Total Copper
Total Aluminum
Total Mercury
Fecal Coliforms
pH
Nitrate-Nitrite
Total Phenols
Calcium
Potassium
Sulphate
Total Alkalinity
Total Zinc
Total Iron
Total Manganese
Total Nickel
Total Lead
Total Arsenic
Total Organic Carbon (TOC)

If you are sampling in Mid-August, tell them that you also need a set of sample bottles to perform a **definitive** test (this means you will need to collect approximately 40L of sample water) for the following:

Acute lethality to Rainbow Trout, *Oncorhynchus mykiss* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/13)
Acute lethality to the crustacean, *Daphnia magna* (as per Environment Canada's Environmental Protection Series Biological Test Method EPS/1/RM/14)

2. Contact the airport and find out what time the samples must be dropped off in order to make the flight to the city where you are sending them. The samples should be collected shortly before they are shipped. For example, if the samples must be at the airport by 2:00pm, the samples should be collected that morning. Make sure that you have enough time to collect and package all samples for transport. This is important because the samples must be at the lab within 24 hours from the time they are collected, otherwise they are no longer good for analysis.

3. Go to the sampling locations shown in Figure 3-5 and familiarize yourself with the area. Walk to each location so you know where each sample must be taken.

Once you have received the sampling bottles and equipment from the lab, make sure you have the following things with you before you begin collecting samples:

1. Sample bottles;
2. Preservatives;
3. Coolers that the bottles and preservatives were sent in;
4. Field blanks;
5. Chain of custody forms (also called COCs);
6. Permanent marker to mark on bottles;
7. Pen to fill out chain of custody forms;
8. Nitrile gloves;
9. Packing tape;
10. Ice packs;
11. Shipping label to send samples back to the lab.

Once you have gathered everything, determine which day you will collect the samples. Be sure to check the flight schedule for that day and call the lab to ask if they are able to pick up the samples at the airport when they arrive.

3.5.1.2 Instructions for Sample Collection

Follow these instructions to collect samples from the sewage lagoon and wetland treatment facility:

1. Place ice packs in freezer the night before sampling.
2. In the morning, place ice packs and other equipment into coolers and load into vehicle. Make sure that the travel blanks and field blanks are in the cooler as well.
3. Drive to site and park in a safe spot away from traffic. DO NOT park on the truck turn around pad for the sewage lagoon.
4. Take coolers and equipment to sample location PEL-5. As this location is 5m from the shore into the ocean, make sure to leave cooler and bottles on the shore.
5. Put on a pair of nitrile gloves.
6. Fill the field blanks with deionized water.

7. Take out bottles needed to sample at this location and place beside the cooler. DO NOT OPEN THE BOTTLES.
8. Select the bottles NOT requiring or containing preservatives and put aside.
9. Take the bottles requiring or containing preservatives and sample these first.
10. Please note that some bottles MUST be rinsed and some bottles MUST NOT be rinsed. Please refer to the water sampling instructions provided by the laboratory that sent the sample bottles to determine if the bottle requires rinsing. If rinsing is required, discard rinse water downstream and away from the sampling location. Rinse the bottle three times. If the bottle must not be rinsed, carefully unscrew the cover and place bottle slowly into the water open end up and slightly tilted to allow water to slowly fill the bottle. If the bottle contains preservatives already, be sure not to tip or overfill the bottle as the preservatives will be washed out. Fill as directed by the water sampling instructions provided by the laboratory that sent the sample bottles. To add preservatives (if not already in the bottle) refer to the water sampling instructions provided by the laboratory that sent the sample bottles to determine which preservative to add to the sample. Carefully pour contents into the sample bottle. Screw the cover on tightly and mix by gently tipping the bottle back and forth.
11. Label the bottle with the sampling location number (PEL-5), your name, date, time of collection and preservative added. Make sure to use a waterproof/permanent marker to label the bottles. Place filled sample jar in cooler.
12. Continue until all preserved samples have been taken.
13. Now fill the bottles not requiring preservatives. Refer to the water sampling instructions provided by the laboratory that sent the sample bottles to determine which bottles need to be rinsed.
14. Fill bottle as directed in the water sampling instructions provided by the laboratory that sent the sample bottles and screw cover on tightly. Label and place in cooler.
15. Continue until the rest of the bottles have been filled.
16. Take off nitrile gloves and dispose in garbage bag.
17. Collect cooler and move to sampling location PEL-4. Repeat steps 5 to 16.
18. If you are sampling during mid-August, collect samples for the acute lethality tests for Rainbow Trout and *Daphnia magna* using the supplied jugs. Unscrew the cap of the first jug and dip into the water, slowly filling the jug. Rinse the bottle three times and then fill. Screw the cap back on, label and place in the cooler. Repeat for the second jug. Be sure to properly label with the date, time and sampler's name. Keep cool, but make sure that the samples do not freeze.
19. Collect cooler and move to sampling location PEL-3-2. Repeat steps 5 to 16.
20. If necessary collect cooler and move to sampling location PEL-3-1. Repeat steps 5 to 16.
21. Once all samples have been collected and labeled, pack into coolers tightly with ice packs to limit movement during shipping.
22. Fill out the chain of custody form. An example of a filled out form can be found in Appendix C.
23. Place form in a sealable freezer bag, seal and put in the cooler with samples. Tape up the cooler with packing tape. Tape shipping label to top of cooler and bring to the airport.
24. Fill out the shipping forms for sending the cooler to the lab and check that the plane will be on time.
25. Call the lab and tell them that the samples are on the way and give them the flight information.

As part of QA/QC testing, a second set of samples should be taken from one of the sampling points. This means filling two sets of sampling bottles from the same location. This second set of samples is to verify that sample results are accurate and that sampling methods are consistent. The second set of samples should be taken from a different sampling point during each sampling period. For example, for the early July sampling period two sets of samples may be taken from PEL-5. For the mid-August sampling, two sets of samples may be taken from PEL-4. During the late September sampling, two sets of samples may be taken from PEL-3-2.

3.5.2 Lab Analysis

Once the lab has received the samples, they will begin processing them. A report stating all results as well as the detection limits will be produced and sent to the Hamlet Office. The report will also state any problems that may have occurred during analysis of the samples.

3.6 Managing Insects and Weeds

3.6.1 Insect Management

In order to discourage attracting insects, the wetland surrounding the lagoon will be inspected regularly for areas of ponding water. Hamlet staff must cover up any puddles or potholes by filling them with soil (Municipal and Community Affairs, Small Wastewater Treatment Systems Operator Student Manual). Weeds growing in and around the lagoon surface may also attract insects. For information about weed management, please refer to Section 3.6.2.

3.6.2 Weed Management

Weeds growing in and around the lagoon may cause a number of problems such attracting unwanted insects, causing excessive odours, and impeding photosynthesis. Surface weeds block sunlight from entering the lagoon that is required for photosynthesis to occur. Photosynthesis is the reaction that provides energy for algae and that in turn allows algae to provide oxygen to bacteria in the lagoon. Bacteria require oxygen in order to break down wastes within the lagoon (Municipal and Community Affairs, Small Wastewater Treatment Systems Operator Student Manual). Wastes that are not breaking down may result in excessive odour.

Weeds/plants on the surface and edges of the lagoon must be removed promptly. Hamlet staff should skim weeds off the top of the lagoon and trim them at them edges. Any weeds that have been removed must be buried in the landfill immediately to prevent odours and insects.

3.7 Measures to Prevent Short-Circuiting

The lagoon is a rectangular shape where sewage is dumped in at one short end of the rectangle (the end furthest from the outfall) and discharged from the other short end (at the outfall). Sewage effluent is therefore forced to pass through the longer length of the lagoon. As long as effluent is discharged in and out in these locations, short-circuiting should be minimized (Municipal and Community Affairs, Small

Wastewater Treatment Systems Operator Student Manual). However, should a break or breach of the lagoon berm occur, effluent may discharge from the breach potentially causing a short-circuiting effect. The Department of Community and Government Services (CGS), Government of Nunavut, has committed to conducting an annual inspection of the lagoon by a Geotechnical Engineer. This should help to identify problems with the berm structure and alert CGS to areas of the berm that need to be repaired prior to formation of a breach in the berm.

3.8 Measures to Prevent Stagnation and Excessive Odour

According to the Hamlet's water licence, the lagoon is to be discharged over the period of July to October. Continuous flow provided by the lengthy discharge period should help to prevent stagnation of effluent in the lagoon. If stagnation does become a problem, the Hamlet (in consultation with Community and Government Services, Government of Nunavut) may want to consider a mechanical option such as installation of an aeration pump to aerate the lagoon.

Excessive odour may result from one of the following (Municipal and Community Affairs, Small Wastewater Treatment Systems Operator Student Manual):

- Shortly after the spring melt;
- During periods of extensive cloud cover;
- Stagnation
- Excessive presence of weeds in and around the lagoon
- Presence of sludge mats, floating scum or algae mats on the surface of the lagoon.

Discharging the lagoon over the July to October period, should help prevent stagnation of effluent in the lagoon and reduce excessive odour resulting from the spring melt. As well, natural wind on the surface of the lagoon should act to aerate the lagoon and prevent stagnation. Any mats and/or scum that accumulate on the surface of the lagoon must be promptly broken up and dispersed by Hamlet staff. For weed management methods please refer to Section 3.6.2.

3.9 Site Records

Copies of records pertaining to operation and maintenance of the sewage lagoon should be kept at both the Hamlet Office and the Hamlet's Maintenance Garage. Information that must be included in these records are (*Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solid Waste Facilities in the Northwest Territories*, Duong and Kent, 1996):

- Volumes of any effluent discharged to the environment through an accidental spill;
- Sewage volume collected (both monthly and annually);
- Details of any maintenance undertaken at site;
- Record sheets;

- Copies of annual reports submitted to the NWB;
- Copy of the Hamlet's water licence;
- Copies of all manuals pertaining to the operation and maintenance of the Sewage Lagoon and Wetland Treatment Facility (i.e. Operation and Maintenance Manual, QA/QC Plan, Spill Contingency Plan, Abandonment and Restoration Plan, Sludge Management Plan); and
- Copies of spill reports and related regulations.

3.10 Safety Procedures

The following safety procedures should be obeyed in order to minimize health risks to personnel working in and around the wastewater and solid waste facilities:

- Equipment is to be kept clean;
- Wear protective clothing such as gloves and boots at all times;
- Work clothes must be kept in a designated change room and employees are to change into them when they arrive for work. Work clothes must NOT be worn home. The Hamlet's PW&S Maintenance Garage should be equipped with laundry facilities to wash work coveralls onsite;
- Hands to be washed frequently; as a minimum before eating and after work; and
- Personnel should receive appropriate vaccinations and ensure they are kept up-to-date. Please contact the Department of Health for a list of the appropriate vaccinations.

3.11 Site Access Control

Currently, there are a number of large boulders placed at the entrance to the top of the berm walls to prevent residents from driving ATVs and snowmobiles along the top of the berm. As well, in order to prevent sewage trucks from backing up too far over the edge of the lagoon, bollards are placed along the edge of the truck turn around pad.

To further limit public access to the site, the Hamlet has investigated the possibility of installing a fence around the lagoon. However, as installing fencing would require drilling into bedrock and damaging the wetland the Hamlet has decided not to go ahead with this option. Therefore, at this time, no further action will be taken to control site access.

3.12 Contact Numbers

Contacts of those responsible for overseeing the operation and maintenance of the lagoon are as follows:

Contact Name	Office Contact Number	24 hr Contact Number
Andre Larabie (SAO)	(867) 769-6281	(867) 769-7277
Chris Mann (ASAO)	(867) 769-6281	(867) 769-7006
Gaetan Apsaktaun, Public Works Foreman	(867) 769-6131	not available

4 EMERGENCY RESPONSE

The Hamlet must be able to respond efficiently and effectively to all possible emergencies that may be encountered in the operation of the Hamlet's facilities. These include, but are not limited to fuel, chemical and wastewater spills as well as fires. Due to the nature of the Hamlet's facilities, burning or spillage of unknown or hazardous materials may occur. Only personnel who are properly trained to deal with these situations should respond to such emergencies.

Personnel must familiarize themselves with the emergency preparedness plans before an accident or emergency occurs. Copies of these plans must be kept in all sewage and solid waste disposal vehicles as well as in all common work areas. The following sections list contact numbers and outline procedures to follow in the event of an emergency.

4.1 Emergency Contact Numbers

The following is a list of contact numbers in the case of an emergency:

Fire Department:	(867) 769-7222
RCMP Detachment:	(867) 769-1111
24 Hour Spill Response Line:	(867) 920-8130

4.2 Contingency Planning

In the case of a service disruption, caused by a breach in the sewage lagoon berm, the Hamlet should follow the emergency measures listed below:

- Notify the Municipal Supervisor and the SAO;
- Report the spill to the NT-NU Spill Line (867) 920-8130;
- Contain or divert the spill where possible (consult with the Hamlet of Kugaaruk Spill Contingency Plan for appropriate containment measures); and
- Consult with regulatory personnel on next steps.

The Department of Community and Government Services (CGS), Government of Nunavut, has committed to conducting an annual inspection of the lagoon by a Geotechnical Engineer. This should help to identify problems with the berm structure and alert CGS to areas of the berm that require repairs.

In the event that the lagoon is not accessible by road and the sewage trucks are not able to discharge sewage to the lagoon, the following procedures should be implemented:

- Notify the Municipal Supervisor and the SAO;
- Notify the public and implement water use restrictions on the community; and
- Consult with regulatory personnel on next steps.

4.3 Spill Contingency Plan

A spill contingency plan has been created for activities associated with Hamlet operations including the water treatment plant, sewage lagoon, solid waste facility and storage and handling of hazardous materials. A copy of the plan may be found in the Hamlet office and the PW&S Maintenance Garage. Hamlet personnel must familiarize themselves with the plan in order to respond quickly and effectively in the event of a spill.

4.4 Fire Response Plan

The Hamlet Fire Department is responsible for creating a contingency plan to deal with fires in the Hamlet. As burning of waste may produce harmful gases, special precautions should be taken when responding to fires in and around the solid waste facility. In the event of an uncontrolled fire in the Hamlet, the following steps should be taken:

- Immediately evacuate the area and go to the Hamlet's meeting place;
- Keep everyone including Hamlet personnel up-wind from the source; and
- Contact the Hamlet Fire Department at (867) 769-7222.

5 REFERENCES

1. Department of Indian and Northern Affairs Canada, Water Resources Division & The Northwest Territories Water Board. (1996). *Quality Assurance (QA) and Quality Control (QC) Guidelines for use by Class "B" Licensees in Collecting Representative Water Samples in the Field and for Submission of a QA/QC Plan*.

2. Department of Municipal and Community Affairs, Government of the Northwest Territories. *Small Wastewater Treatment Systems Operator – Student Manual*. Yellowknife: Municipal and Community Affairs, Government of the Northwest Territories.

3. Dillon Consulting Limited. (2006). *Sewage and Solid Waste Sites, Kugaaruk, NU, Phase II Pre-Design Report*. Prepared for Public Works & Services, Government of Nunavut.

4. Duong, D. and R. Kent. (1996). *Guidelines for the Preparation of an Operation and Maintenance Manual for Sewage and Solids Waste Disposal Facilities in the Northwest Territories*. Produced for MACA.

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11. Westerman, P. W., Shaffer, K. A., and Rice, J. M. (2008). *Sludge Survey Methods for Anaerobic Lagoons*. Retrieved March 29, 2010 from http://www.bae.ncsu.edu/programs/extension/manure/sludge-survey/sludge_survey.pdf

APPENDIX A

Sewage Lagoon Treatment Facility Annual Report Forms