Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

Wetlands Treatment Study

Hall Beach, Nunavut

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TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

Dillon Consulting Limited (Dillon) was retained by Indian and Northern Affairs Canada (INAC) for the provision of logistics support, compilation of results and preparation of the report for a wetlands study in Hall Beach, Nunavut. The study methodology was determined by INAC personnel and sampling was conducted by the Hamlet of Hall Beach personnel. This report documents the results of the study.

1.1 Objectives

The objective of this study was to determine what effect(s) seasonal changes have on the ability of wetlands to remove biological oxygen demand, suspended solids, nutrients and fecal coliform bacteria from municipal wastewater.

1.2 Scope

The wetland studied and sampled in this report is in Hall Beach, NU, and is used for the treatment of municipal sewage. Results will be compared to previous studies, namely "Sewage Treatment Using Tundra Wetlands" (Dillon, 1998). All sampling was conducted by Hamlet of Hall Beach personnel, under the instructions of Mr. Michael Roy, Qikiqtani Regional Coordinator for Water Resources with INAC. Dillon was retained to compile the results in a report.

2.0 BACKGROUND INFORMATION

The treatment and disposal of municipal sewage is an essential service that must be provided in every community. The overall objective of treating sewage is to protect the health of the public and the receiving environment.

Many of the communities in the Northwest Territories and Nunavut are presently using lagoon-based systems for the storage and treatment of sewage. However, recent fiscal restraint, together with the technical challenges associated with the development of lagoon-based systems has prompted the Government of the Northwest Territories and Nunavut to consider alternative technologies. The use of natural "wetland" systems (including components such as tundra open ponds, emergent grasses, fens or bogs) has been identified as a promising alternative.

To date, the majority of the natural wetland treatment systems in the Northwest Territories and Nunavut area have not been engineered, but have been established as a consequence of discharging raw sewage into one location over time. Monitoring of these systems has suggested that they are meeting the overall objectives of sewage treatment. In addition, natural "wetlands" in the north generally have nutrient deficiencies and consequently there are limited concerns related to eutrophication. Discharge from wetlands into small ponds is the exception. It can result in eutrophication, and may be a concern if the ponds are fish-bearing. The controlled discharge of sewage to northern, nutrient deficient wetlands generally acts to enrich the vegetation by providing essential nutrients for growth. The results of studies carried out by Dubuc *et. al.* (1986) at Fontanges in the James Bay area, Lakshman (1983) at Humboldt, Saskatchewan and Reid Crowther (1990) at Yellowknife, NT, confirm the observations that wetlands in the north have the potential to act as an efficient method of sewage treatment.

Composition

The physical, chemical and biological characteristics of sewage are referred to as its composition. The composition of sewage generated in a given community is highly dependent on the type of waste delivery/sewage collection services and the ratio of residential to commercial/industrial input.

Water delivery and sewage collection in Hall Beach is by truck. The ratio of residential to commercial/industrial input is very high. Sewage composition is generally domestic in nature. The untreated wastewater was not sampled during this study. The following table presents "typical" values expected to be similar to the sewage generated in Hall Beach.

Table 1: Typical Untreated Trucked Domestic Wastewater Characteristics[1]

Parameter	Concentration (mg/L)
Biological Oxygen Demand (BOD_5)	400
Fecal coliforms (FC)[2]	$1.5x10^7$ CFU/100mL
Total Phosphorus (TP)	15
Ammonia nitrogen	50
Nitrate and Nitrite	0
Total Suspended Solids (TSS)	350

2.1 Environment

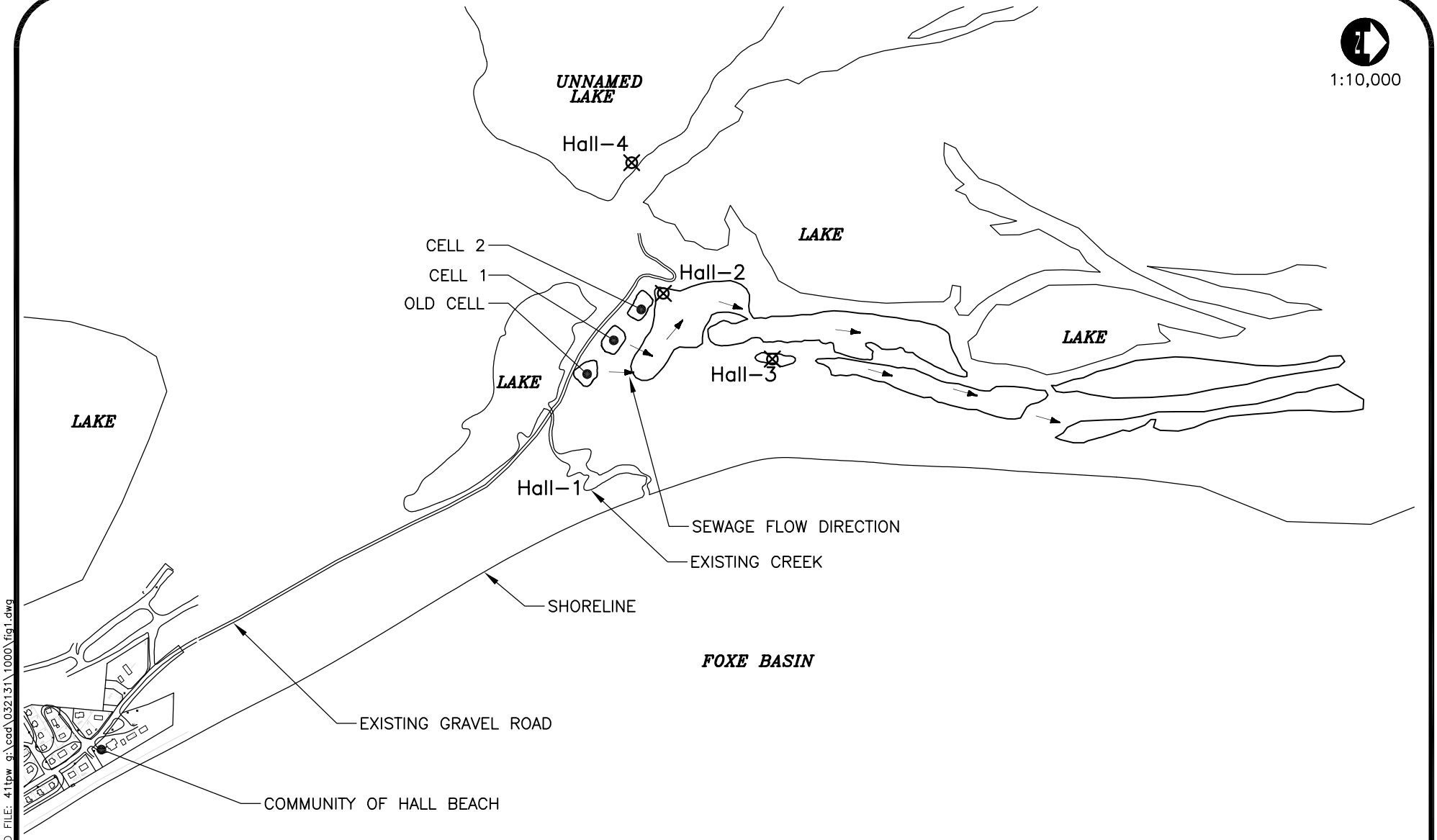
Location

The Community of Hall Beach is located in the west area of Baffin Island, northeast of Melville Peninsula on the western side of Foxe Basin. The geographical setting is latitude 65°45' and longitude 81°15'. The sewage lagoons are located approximately 1.0 km north of the community itself. A site location plan is presented in Figure 1 and a plan of the wetlands is presented in Figure 2.

Climate

Average climate data for the community of Hall Beach was obtained from Environment Canada, for the period between 1971 and 2000. Hall Beach has a daily mean temperature of -14.1°C over the entire year. The annual average depth of precipitation is 216.7 mm, composed of 102.3 mm of rain and 124.0 mm of snow. Hall Beach is located in a zone of continuous permafrost. July mean high and low temperatures are 9.4°C and 2.8°C. January mean highs and lows are -27.8°C and -35.7°C. Winds are generally from the northwest and annually average 21.3 km/hr.

[1] Source: Wastewater Engineering Treatment/Disposal/Reuse, Metcalf and Eddy, 1991, 3rd Edition
[2] Source: Value reported by Dillon (1998) in report entitled "Sewage Treatment Using Tundra Wetlands".



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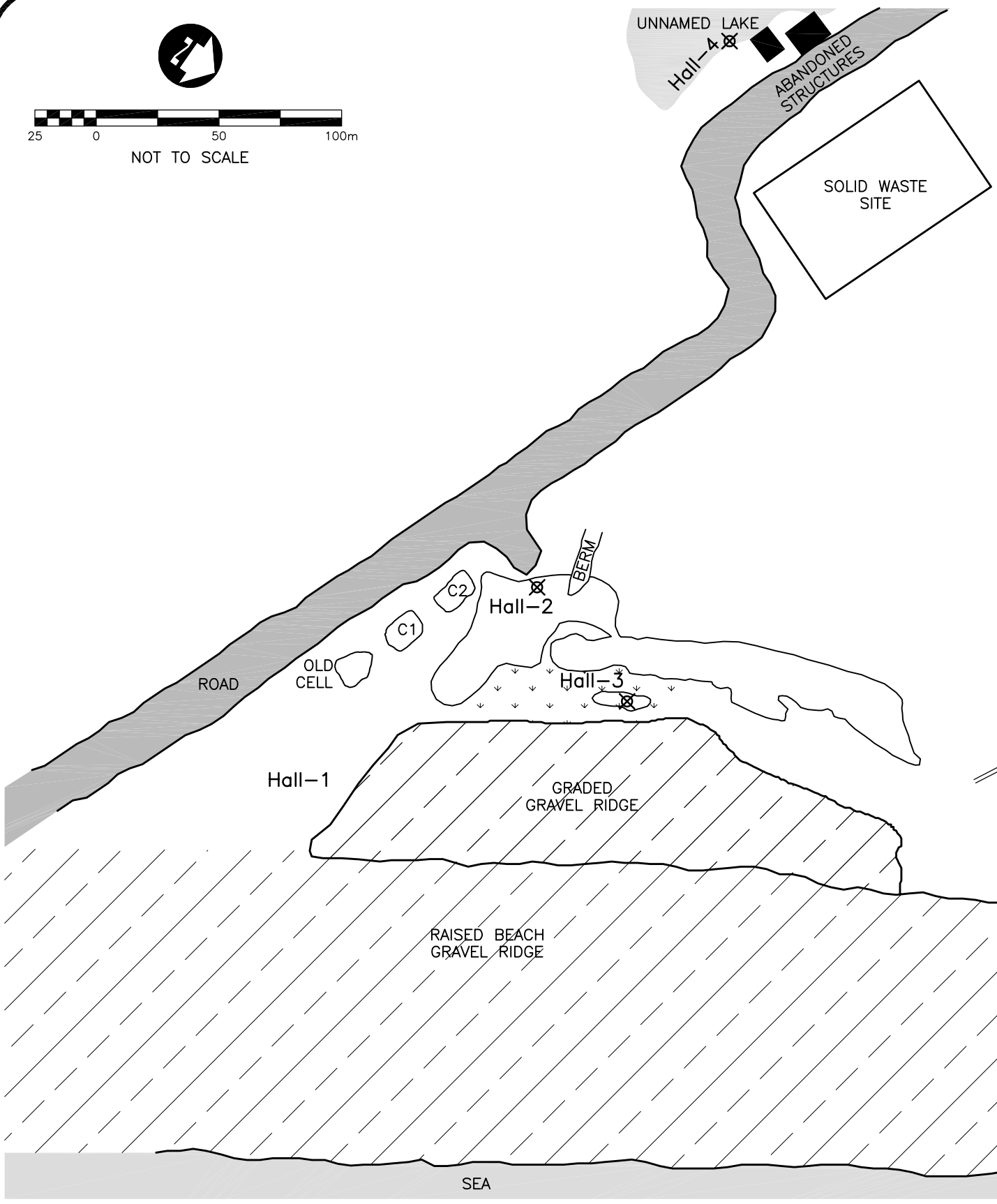
DILLON CONSULTING

PROJECT	WETLANDS SEWAGE TREATMENT STUDY HALL BEACH
TITLE	SITE LOCATION PLAN
PROJECT NUMBER	03–2131–1000
DATE	NOVEMBER 2003
FIGURE NUMBER	FIGURE 1



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DILLON CONSULTING

PROJECT
WETLANDS SEWAGE TREATMENT STUDY
HALL BEACH

TITLE
WETLANDS SITE PLAN

PROJECT NUMBER
03–2131–1000

DATE
NOVEMBER 2003

FIGURE NUMBER
FIGURE 2

Topography, Geology and Soils

Hall Beach is surrounded by low-relief topography of raised beaches, ponds and shallow lakes. Marine sands and gravels cover most of the community landscape, with fines in the depressions. The town site is situated on an elongated raised beach, oriented to the north-west. It is bordered on the east by the sea and on the west by an elongated shallow water pond, 45 ha in area. Hall Beach is located within the zone of continuous permafrost.

The lagoons are situated on level ground, which slopes gradually (0.7% slope) east toward the Foxe Basin. The lagoons have an approximate total surface area of 0.4 ha.

Hydrogeology

The natural hydrology in the immediate vicinity of the lagoons consists of various lakes, ponds and small creeks. The wetlands are located to the north and northeast and small creeks are located to the east and southeast of the existing lagoons. There is no outlet to the lagoons, water seeps through the gravelly soil and berms, entering the wetlands area. The flow of the creeks and seepage from the lagoons becomes braided as it discharges into Foxe Basin. There is no single outlet point, water seeps through the gravel raised beaches, to reach the ocean. Representative photographs are presented in Appendix C.

Vegetation

Characteristic vegetation found within the region encompassing Hall Beach include grasses, mosses and lichens growing on a thin organic layer, 0.3 m in thickness or less. More specifically, the wetland ponding areas are mainly covered with grasses (*eriphorum spp*.).

3.0 TREATMENT REQUIREMENTS

3.1 Nunavut Water Board

The Nunavut Water Board issues general guidelines for the discharge of domestic wastewater. Tables 1 and 2 summarize the guidelines that relate to Hall Beach (i.e. discharge to the ocean, with a flow of <150 Lcd). Communities are also required to have a water license which states the site-specific discharge requirements for their system. These requirements are presented in Section 3.2.

Table 2: Summary of Nunavut Water Board Guidelines

Wastewater Flow (Lcd) and Season	Parameter	Unit	Marine Mixing Condition	
			Open Coastline	Bay or Fjord
<150 Lcd Summer	BOD_5	mg/L	360	100
	TSS	mg/L	300	120
	F. Coli	CFU/dL	(a)	(a)
<150 Lcd Winter	BOD_5	mg/L	360	100
	TSS	mg/L	300	120
	F. coli	CFU/100dL	(a)	(a)

(a) In case of an open, well flushed marine bay or fjord, bacteriological standards will be of concern only where the discharge might affect a fishery (including shellfish harvesting) or water contact recreation.

Table 3: Summary of Other Parameters that May Be of Interest

Parameter (all values shown are total)	Marine Maximum Concentration (↘g/L)
Arsenic	125
Cadmium	12
Chromium (trivalent)	5600
Residual Chlorine	20

3.2 Hall Beach Water License

Specific discharge requirements for the Hamlet of Hall Beach are set out in the community's water license, issued in April of 2003, by the Nunavut Water Board. A copy of the license is available in Appendix A. The license criteria are summarized in the following Table:

Table 4: Summary of Water License Requirements

Parameter	**Maximum Average Concentration**
Fecal coliforms	1×10^6 CFU/dL
BOD_5	120 mg/L
Total Suspended Solids	180 mg/L
Oil and grease	No visible sheen
pH	Between 6 and 9

4.0 DATA COLLECTION AND ANALYSIS

4.1 Sampling Procedures

Samples were collected by Hamlet personnel. Detailed instructions were provided by Mr. Michael Roy, of INAC. A copy of these instructions is available in Appendix B.

Samples were collected weekly, on Wednesday mornings. The cooler containing the samples was shipped to Accutest Laboratories Ltd. in Ottawa for analysis. With no delays, the samples were to arrive in Ottawa Wednesday evening, and be delivered to the lab Thursday morning, meeting the 24-hour time limit between sampling and analysis. Due to weather conditions, and other unforeseen circumstances, some disruptions occurred, and as a result, some data is missing.

Sample locations were chosen by the Hamlet personnel prior to the first sampling event, based on the written instructions provided by Mr. Roy. Hall-2 was located approximately 20 m from the lagoons (Photo 4). Hall-3 was located approximately 75 m from Hall-2, but not directly downstream. It was located in a separate seepage pond, outside of the main wetlands treatment area (Photo 6). As such, the results obtained may not be representative of the treatment occurring, since Hall-3 is not located in the main flow path of the wetlands. The entire wetlands treatment area is estimated to be 600 m in length, so Hall-2 and Hall-3 are taken at linear fractions of 0.03 and 0.16, respectively, of the entire length. It is estimated that the results obtained from the Hall-3 location would be overstated for this distance downstream, as Hall-3 was not located in the main flow path of the wetlands and any flow reaching that location would have seeped through the gravelly soil. The control, Hall-4, is taken from an unnamed lake, across the road, and approximately 350-400 m from the lagoons.

All samples were analyzed for the following parameters:

- 5-day Biological Oxygen Demand (BOD_5)
- Fecal coliforms (FC)
- Total Suspended Solids (TSS)
- Total phosphorous (TP)
- Ammonia-nitrogen
- Nitrate and nitrite

4.2 Flow Calculations

Hydrogeology has a direct influence on the concentrations measured during this study. To remove the influence of hydraulic loads, water quality data was converted to a mass basis by multiplying measured concentrations (after background levels had been subtracted), by the total estimated flow rate at the time of sampling. As a mass, the water quality data is directly comparable.

Percent removal versus linear distance was used as a direct way to compare the treatment performance in previous studies (Dillon, 1998). A similar approach was taken with this study, to facilitate comparison.

The total estimated flow has two components, namely sewage and water. These flows are both a function of location and time. The following section explains how these flows were estimated for the Hall Beach wetlands.

4.2.1 Sewage Flow Calculations

Based on previous reports (Dillon, 1998), it has been estimated that, on average, the sewage ice pack that forms on top of the lagoons takes approximately four weeks to completely melt. The ice pack represents an accumulation of eight months of sewage. Based on these observations, the estimated sewage component of the flow on a seasonal basis in Hall Beach is as follows:

June: Eight months of accumulated sewage flow, discharged equally throughout the month, plus the average daily rate of sewage generated by the community

July, August, September: The average daily rate of sewage generated by the community.

October through May: Sewage accumulated in the ice pack. Sewage flow through the wetlands is zero.

For this study in Hall Beach, sampling began in July and ended in September. The effect of the ice pack melt will not be considered in this report. In addition, it will be assumed that the flow out of the lagoon, by exfiltration, will equal the rate of flow of wastewater into the lagoon, by the sewage collection trucks. The flow rate from the lagoons to the wetlands was not calculated as part of this study.

Sewage generation rates are not routinely kept by the Hamlet of Hall Beach. For the purposes of this study, these will be estimated based on literature values. Experience has shown that the volume of sewage generated by a community is equal to the rate of water consumption (MACA, 1988). The Department of Municipal and Community Affairs (MACA) has shown that the water consumption/sewage generation for trucked water delivery and sewage pump-out collection systems, is estimated by the following equation:

$$\text{Per Capita Water Use} = \text{Residential Rate} \times [\,(1.0) + (0.00023)\,\text{Population}]$$

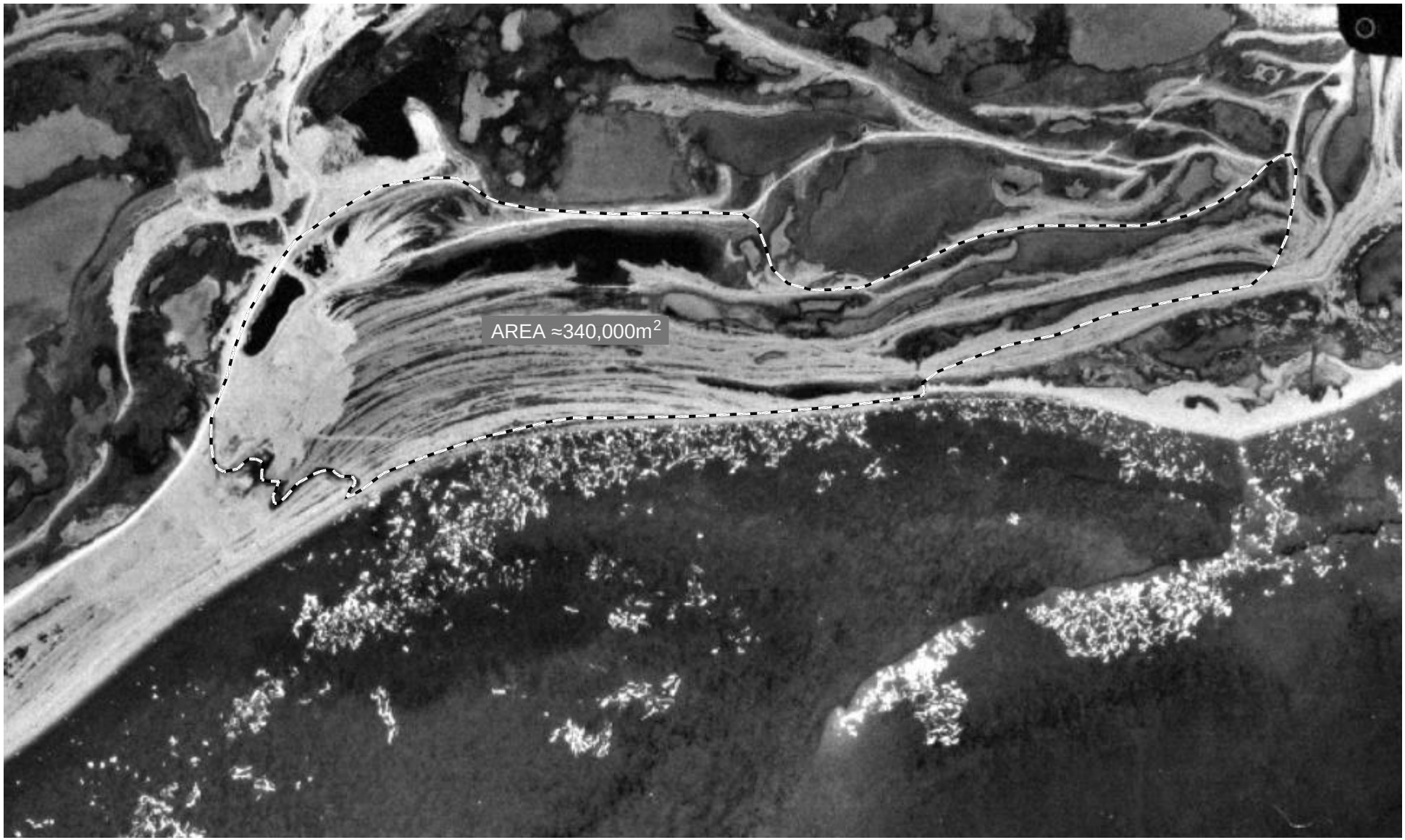
The residential rate, for trucked water delivery and sewage pumpout collection has been estimated to be 90 L/c.d (MACA, 1988). The most recent population statistics, available from the Nunavut Bureau of Statistics, indicate that in 2003, the projected population of Hall Beach is 696 (based on 1999 population estimates). Using the formula above, the daily per capita sewage generation rate is calculated to be 104 L/day. For the community of Hall Beach in 2003, the daily sewage generation rate is 72,000 L/day.

4.2.2 Precipitation Calculations

In the absence of detailed site specific hydrology studies, a desktop approach was taken in this study to estimate the contributing water flow to the natural wetlands systems. Available information for this task was limited to aerial photographs and climatic data for Hall Beach.

The catchment area of the wetlands was estimated from aerial photographs. This area was estimated to be 34 ha. This is illustrated in Figure 2.

Climatic data, for the months of this study, was available from Environment Canada and is summarized on the following table:



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DILLON CONSULTING

PROJECT	WETLANDS SEWAGE TREATMENT STUDY HALL BEACH
TITLE	CONTAINMENT AREA (FROM 1997 AIR PHOTO)
PROJECT NUMBER	03-2131-1000
DATE	NOVEMBER 2003
FIGURE NUMBER	FIGURE 3

Table 5: Summary of Climate Data

Parameter	July	August	September
Temperature			
Daily mean (2003)	8.4 °C	4.8 °C	0.6 °C
Daily mean (climate normal)	6.1 °C	4.7 °C	-0.3 °C
Precipitation			
Total (2003)	23.5 mm	117.5 mm	75 mm
Total (climate normal)	28.4 mm	44.6 mm	30.1 mm

From the above table, it is apparent that Hall Beach experienced a warmer than average July, an average August, and a warmer than average September. The warmer weather would have a positive effect on the growing season, and therefore the potential effectiveness of the biological and physical treatment within the wetland. Except for the month of July that received slightly less precipitation than normal, Hall Beach experienced a wet summer, with significantly more precipitation than usual. The additional precipitation would affect the concentrations in the wetlands through dilution. By converting concentrations (mg/L) to mass equivalents (kg/d), this effect is eliminated.

To determine estimates of run-off eligible to drain through the wetlands, monthly streamflow and climate data was examined. Unfortunately no data was available in the vicinity of Hall Beach. Streamflow data was taken from the Water Survey of Canada's Marcil Creek Station, near Nanisivik, NU and from the Kirchoffer River Station, at Coral Harbour, NU. Hall Beach is located approximately midway between Nanisivik and Coral Harbour.

Upon examination of the data from these two stations, annual run-off was determined to be at least 50% of the annual precipitation. Most of the run-off occurred during the months of June and July, and typically declined rapidly to relatively low flows in August and September. The wetland at Hall Beach has a much smaller catchment area (34 ha in comparison to 13900 ha and 316000 ha, for Marcil Creek and Kirchoffer River, respectively), however similar trends can be applied to the smaller basin. Unit run-off rates based on the data from these stations were assumed to be representative of the relative distribution of run-off at Hall Beach. These estimates were then prorated to account for the lower precipitation depths locally recorded at Hall Beach. (Hall Beach received approximately 15% lower precipitation compared to other regional stations.)

To account for the unusually wet summer in Hall Beach in 2003, the additional run-off volume resulting from the higher rains, together with the increased subsurface soilwater conditions, were conservatively assumed to yield a run-off coefficient of at least 0.5. As such, run-off was calculated by the addition of typical run-off conditions (based on gauged unit rates) with the assumed additional run-off brought on by the well-above average precipitation conditions. These are summarized in Table 6.

To calculate the flow through the wetlands, a linear model was employed. The wetland was assumed to be a linear stream, through the catchment area. The sewage portion of the total flow was assumed constant all the way through the wetland. Flow resulting from run-off was assumed to increase linearly, proportional to the distance downstream. At the start of the wetland, the total flow was assumed to be equal to the sewage flow. At the outlet of the wetland, the total flow was assumed equal to the sewage flow plus 100% of the run-off. At various distances along the wetland, the total flow was equal to the sewage flow plus the fraction of run-off, corresponding to the distance downstream.

The following Table summarizes the flow information. Average flows were calculated on a monthly basis, to be used with the corresponding sampling events in each month. The ranges shown provide an indication of error associated with the calculations. Middle values were chosen, as indicated, for the subsequent calculations.

Table 6: Summary of Flow Data

	July				**August**				**September**			
	Inlet	Hall-2	Hall-3	Outlet	Inlet	Hall-2	Hall-3	Outlet	Inlet	Hall-2	Hall-3	Outlet
Fraction downstream	0	0.03	0.16	1	0	0.03	0.16	1	0	0.03	0.16	1
Flow (m^3/day)												
Sewage	72	72	72	72	72	72	72	72	72	72	72	72
Run-off Range	0	21-33	112-120	700-750	0	6-20	32-104	200-650	0	3-11	16-56	100-350
Middle value*	-	22	116	720	-	12	64	400	-	6	32	200
Total Range	72	93-95	184-192	772-822	72	78-92	104-176	272-722	72	75-83	88-128	172-422
Total*	72	94	188	792	72	84	136	472	72	78	104	272

*These values were used for subsequent calculations

5.0 DATA INTERPRETATION

5.1 Site Specific

The following sections present the results obtained during the study, by individual parameter. The results from both sample locations are presented (Hall-2 and Hall-3). A summary of the raw analytical data is available in Appendix D. Averages were calculated on a monthly basis, i.e. the July average is comprised of all samples taken in July. Treatment is compared to typical trucked sewage values (listed in Table 1), as no site specific studies were completed. This introduces another uncertainty into the report, however it provide a means of comparing the percent removal at Hall-2 and Hall-3.

5.1.1 Background Concentrations

The following table summarizes the background concentrations reported at Hall-4. Analytical data from the lab is presented in Appendix D. These average concentrations were subtracted from the averages calculated for July, August and September, for each individual parameter.

Table 7: Summary of Background Concentrations

Parameter	Units	Method detection level	July Average	August Average	September Average
BOD_5	mg/L	1	ND	ND	2
Fecal coliforms	CFU/100mL	-	ND	3.3	0.5
Total phosphorus	mg/L	0.01	0.017	0.033	0.015
Ammonia nitrogen	mg/L	0.02	0.013	0.017	0.035
Nitrate + Nitrite	mg/L	0.10	ND	ND	ND
Total suspended solids	mg/L	2	1.3	5.3	3.5

5.1.2 5-day Biological Oxygen Demand

The following Table summarizes the BOD_5 results.

Table 8: Summary of BOD_5 Removal

	Units	Sample Location		
		Inlet	Hall-2	Hall-3
Distance Downstream	m	0	20	95
Fraction Downstream		0	0.03	0.16
July				
Average Concentration	mg/L	400	46	15
Mass Equivalent*	kg/d	28.8	4.3	2.8
Percent Removal	%	0	85	90
August				
Average Concentration	mg/L	400	49	11
Mass Equivalent*	kg/d	28.8	4.1	1.5
Percent Removal	%	0	86	95
September				
Average Concentration	mg/L	400	99	8
Mass Equivalent*	kg/d	28.8	7.7	0.83
Percent Removal	%	0	73	97

*Mass Equivalent = Concentration x Total Flow (taken from Table 6)

The following can be observed from the above table:

- Treatment performance measured on a percent removal basis increases with distance (up to 0.16 of the way downstream to the outlet, based on this data)
- At Hall-2, the months of July, August and September have corresponding percent removals of 85%, 86% and 73%.
- At Hall-3, the months of July, August and September have corresponding percent removals of 90%, 95% and 97%.
- The average temperatures for the sampling period in July, August and September were 9.1°C, 4.8°C and 2.9°C (Environment Canada).
- BOD_5 concentrations are below the limit stated in the Hall Beach water license (120 mg/L)
- The overall average percent removals during the summer months at Hall-2 and Hall-3 were 81% and 94% respectively
- The overall percent removal, for the entire length of the wetlands, cannot be calculated with this data.

5.1.3 Fecal Coliforms (FC)

The following Table summarizes the FC results.

Table 9: Summary of FC Removal

	Units	Sample Location		
		Inlet	Hall-2	Hall-3
Distance Downstream	m	0	20	95
Fraction Downstream		0	0.03	0.16
July				
Average Concentration	CFU/100mL	$1.5x10^{7}$	37	ND
Mass Equivalent*	CFU/d	$1.1x10^{13}$	$3.5x10^{7}$	0
Percent Removal	%	0	100.0	100.0
August				
Average Concentration	CFU/100mL	$1.5x10^{7}$	57	10
Mass Equivalent*	CFU/d	$1.1x10^{13}$	$4.8x10^{7}$	$1.4x10^{7}$
Percent Removal	%	0	100.0	100.0
September				
Average Concentration	CFU/100mL	$1.5x10^{7}$	ND	30
Mass Equivalent*	CFU/d	$1.1x10^{13}$	0	$3.1x10^{7}$
Percent Removal	%	0	100.0	100.0

*Mass Equivalent = Concentration x Total Flow (taken from Table 6)

The following can be observed from the previous table:

- Treatment performance measured on a percent removal basis increases with distance, however most treatment appears to occur in the lagoon or in the early stages of the wetlands (prior to Hall-2). At Hall-2, virtually 100% of the FC had been removed.
- At Hall-2, each month had an average percent removal of 100.0%.
- At Hall-3, each month had an average percent removal of 100.0%.
- The average temperatures for the sampling period in July, August and September were 9.1°C, 4.8°C and 2.9°C (Environment Canada).
- FC concentrations are below the limit stated in the Hall Beach water license ($1x10^{6}$ CFU/100mL)

5.1.4 Total Phosphorus (TP)

The following Table summarizes the TP results.

Table 10: Summary of TP Removal

	Units	Sample Location		
		Inlet	Hall-2	Hall-3
Distance Downstream	m	0	20	95
Fraction Downstream		0	0.03	0.16
July				
Average Concentration	mg/L	15	2.51	3.25
Mass Equivalent*	kg/d	1.1	0.24	0.61
Percent Removal	%	0	78	45
August				
Average Concentration	mg/L	15	2.44	3.68
Mass Equivalent*	kg/d	1.1	0.20	0.50
Percent Removal	%	0	82	55
September				
Average Concentration	mg/L	15	2.88	3.05
Mass Equivalent*	kg/d	1.1	0.22	0.32
Percent Removal	%	0	80	71

*Mass Equivalent = Concentration x Total Flow (taken from Table 6)

The following can be observed from the above table:

- Treatment performance measured on a percent removal basis appears to decrease with distance (up to 0.16 of the way downstream to the outlet, based on this data). The largest increase occurred in July, and the smallest increase occurred in September.
- At Hall-2, the months of July, August and September have corresponding percent removals of 78%, 82% and 80%.
- At Hall-3, the months of July, August and September have corresponding percent removals of 45%, 55% and 71%.
- The average temperatures for the sampling period in July, August and September were 9.1°C, 4.8°C and 2.9°C (Environment Canada).
- The overall average percent removals during the summer months at Hall-2 and Hall-3 were 80% and 57% respectively
- The overall percent removal, for the entire length of the wetland, cannot be calculated with this data.

5.1.5 Ammonia Nitrogen

The following Table summarizes the ammonia nitrogen results.

Table 11: Summary of Ammonia Nitrogen Removal

	Units	Sample Location		
		Inlet	Hall-2	Hall-3
Distance Downstream	m	0	20	95
Fraction Downstream		0	0.03	0.16
July				
Average Concentration	mg/L	50	20.3	16.2
Mass Equivalent*	kg/d	3.6	1.9	3.0
Percent Removal	%	0	47	17
August				
Average Concentration	mg/L	50	4.0	23.0
Mass Equivalent*	kg/d	3.6	0.34	3.1
Percent Removal	%	0	91	14
September				
Average Concentration	mg/L	50	1.1	19.1
Mass Equivalent*	kg/d	3.6	0.089	2.0
Percent Removal	%	0	98	44

*Mass Equivalent = Concentration x Total Flow (taken from Table 6)

The following can be observed from the above table:

- All months showed an increase in ammonia nitrogen mass equivalent. This may be due to seasonal die-off of vegetation in the cooler months. Heavier rains during this period may have also contributed, by washing more plant debris into the wetlands, or stirring up settled debris.
- At Hall-2, the months of July, August and September have corresponding percent removals of 47%, 91% and 98%.
- At Hall-3, the months of July, August and September have corresponding percent removals of 17%, 14% and 44%.
- The average temperatures for the sampling period in July, August and September were 9.1°C, 4.8°C and 2.9°C (Environment Canada).
- The overall average percent removals during the summer months at Hall-2 and Hall-3 were 79% and 25% respectively
- The overall percent removal cannot be calculated with this data.

5.1.6 Nitrate + Nitrite

The following Table summarizes the nitrate/nitrite results.

Table 12: Summary of Nitrate + Nitrite Removal

	Units	Sample Location		
		Inlet	Hall-2	Hall-3
Distance Downstream	m	0	20	95
Fraction Downstream		0	0.03	0.16
July				
Average Concentration	mg/L	0	0.07	0.59
Mass Equivalent*	kg/d	0	0.066	0.11
Percent Removal	%	-	-	-
August				
Average Concentration	mg/L	0	0.14	0.50
Mass Equivalent*	kg/d	0	0.012	0.068
Percent Removal	%	-	-	-
September				
Average Concentration	mg/L	0	0.07	0.26
Mass Equivalent*	kg/d	0	0.0055	0.027
Percent Removal	%	-	-	-

*Mass Equivalent = Concentration x Total Flow (taken from Table 6)

As nitrate and nitrite are not present in raw sewage, their presence is indicative of treatment occurring. An increase of nitrate + nitrite is linked to the conversion of ammonia nitrogen. The following can be observed from the above table:

- Mass equivalents increase between sampling points, during each month. Percent increases were all greater than 100%.
- Highest nitrate/nitrite production occurs in July.
- Lowest nitrate/nitrite production occurs in September.

5.1.7 Total Suspended Solids (TSS)

The following Table summarizes the TSS results.

Table 13: Summary of Total Suspended Solids Removal

	Units	Sample Location		
		Inlet	Hall-2	Hall-3
Distance Downstream	m	0	20	95
Fraction Downstream		0	0.03	0.16
July				
Average Concentration	mg/L	350	151	18.0
Mass Equivalent*	kg/d	25	14	3.4
Percent Removal	%	0	44	86
August				
Average Concentration	mg/L	350	163	14.0
Mass Equivalent*	kg/d	25	14	1.9
Percent Removal	%	0	44	92
September				
Average Concentration	mg/L	350	299	46.5
Mass Equivalent*	kg/d	25	23	4.8
Percent Removal	%	0	8	81

*Mass Equivalent = Concentration x Total Flow (taken from Table 6)

The following can be observed from the above table:

- Treatment performance measured on a percent removal basis increases with distance (up to 0.16 of the way downstream to the outlet, based on this data)
- At Hall-2, the months of July, August and September have corresponding percent removals of 44%, 44% and 8%.
- At Hall-3, the months of July, August and September have corresponding percent removals of 86%, 92% and 81%.
- The average temperatures for the sampling period in July, August and September were 9.1°C, 4.8°C and 2.9°C (Environment Canada).
- TSS concentrations are below the limit stated in the Hall Beach water license (180 mg/L) at Hall-3.
- The overall average percent removals during the summer months at Hall-2 and Hall-3 were 32% and 86% respectively.
- The overall percent removal cannot be calculated with this data.

5.2 Data Interpretation

Due to the sampling location chosen in this study, limited conclusions can be drawn. Interpretation of the available data indicates the following:

BOD_5 and TSS were generally removed as a function of increasing distance along the wetland. Total phosphorus and ammonia nitrogen mass equivalents generally increased with distance along the wetland.

Nutrients (phosphorus, ammonia nitrogen and nitrates/nitrites) showed tendencies to increase along the wetland. This could be attributed to the die-off of vegetation, and subsequent re-release of the nutrients into the wetland system, or high amounts of run-off, experienced over the wet summer, may have carried additional plant debris into the wetland. Generally Hall-3 values were higher than Hall-2 values. The Hall-3 sampling location was located in an isolated pond adjacent to the main wetlands stream, while the Hall-2 sampling location was located in the open water. The smaller pond may be more conducive to algae growth and subsequent die-off, contributing to the higher concentrations.

Percent removal of BOD_5 was observed to be highest in August. The lowest value was obtained in September, although it was not substantially lower.

Percent removals of nutrients tended to increase through the summer months. As the main removal mechanism for nutrients is uptake by plants (nitrogen can also be converted to N_2 and released into the atmosphere), this corresponds to increased growth over the course of the summer. Warmer temperatures were experienced in September, so any seasonal die-off would have been delayed. Seasonal die-off re-releases the nutrients back into the environment, and would result in a decrease in percent removal.

Percent removal of FC was virtually 100% in all seasons, meeting discharge guidelines at the Hall-2 sample location. It would appear that FC concentrations can be greatly reduced by treatment in the lagoons, filtration as the lagoon water passes through the gravel berm, or die-off in the first portion of the wetland. Treatment of FC appears to be less influenced by the seasons.

Overall, results obtained in this study meet the discharge requirements. In fact, discharge requirements are met at the Hall-2 sampling location, indicating that the majority of treatment may be occurring in the lagoons. The wetlands appear to be used only as a polishing step, before discharge into the ocean.

It should be noted, while interpreting this data, that uncertainties exist. The catchment area was estimated using aerial photographs, run-off estimates were based on data from other locations and may not represent what is actually occurring at Hall Beach, there was a limited number of samples taken (eight sampling events in total) and Hall-3 was located outside of the main flow path. Small changes in some of the assumptions can have implications on the conclusions. Despite these uncertainties, it appears that the wetland is effective in meeting the requirements of the water license. The exact percent removal is unknown; however the magnitude seems to be sufficient.

5.3 Comparison to Other Studies

Results were compared to the Dillon study entitled "Sewage Treatment Using Tundra Wetlands" (1998). This study examined the treatment occurring in 3 different wetland systems, in Baker Lake, Repulse Bay and Chesterfield Inlet. This comparison is limited due to the fact that Hall-3 was located in an isolated pond and may not accurately reflect the treatment occurring at 0.16 of the way downstream. In addition, no sampling occurred further downstream (i.e. at the outlet), so no overall comparison can be made.

The 1998 Dillon study reported that contaminants were generally removed in the summer as a function of increasing distance along the wetland. Exceptions were TP and ammonia nitrogen, which showed some increase on several dates and locations. This was similar to the results of the Hall Beach study.

The 1998 Dillon study reported that, over the summer months (July, August and September), percent removals of BOD_5 and ammonia nitrogen were lowest at the end of the season. In some cases low percent removals were also reported in July. For BOD_5, this was similar to the Hall Beach study: the lowest percent removal occurred in September, with the second lowest occurring in July. However, for ammonia nitrogen, the highest percent removal occurred in September. As previously discussed, the sample was taken at the end of a long growing season, before the plants started to die off.

According to Dillon (1998), the linear rate of contaminant removal (mass/unit length) decreased as the distance from the sewage discharge point increased. The first portion of the wetland was most effective at removing the measured contaminants from the sewage. Not enough data was collected in the Hall Beach study to determine if this occurred. However, given that the furthest sampling point downstream (Hall-3), was only 0.16 of the distance to the outlet, and all parameters had met the discharge requirements, it is likely that this is the case in Hall Beach as well. The presence of an initial lagoon cell would have aided in meeting the discharge requirements.

Actual values obtained for percent removal of the contaminants were not compared directly between the studies. None of the wetland treatment systems studies in the 1998 Dillon report retained the discharged wastewater in a lagoon prior to discharge into the wetlands treatment area. The Baker Lake system included a holding cell for the discharged sewage, but the berm was breached at the time of the study. Contaminant concentrations would vary greatly in the early stages of treatment, rendering any direct comparison of numerical values futile. The Hall Beach study did not include a sample point at the outlet of the wetlands treatment area, thus disabling comparison of the overall treatment efficiency.

5.4 Recommendations

Based on this investigation, recommendations can be made for future work at the Hall Beach wetlands. These include the following:

- Sampling should be conducted at various locations along the wetland. Samples should be taken from near the inlet and outlet as a minimum, as well as one or two locations part way downstream. The selection of the locations of these points should be performed by someone familiar with the wetlands, and a visit to the community is required to convey this information to the personnel that will actually be sampling. Training related to taking the samples could also occur at this time, to ensure proper procedure is followed.

- If the results are to be compared to the influent (i.e. calculation of the percent removal), the influent sewage should also be sampled, directly from the trucks. Literature values for trucked sewage would not be required.

- The sampling parameters chosen for this study were adequate. Additional parameters could also include pH, volatile suspended solids (VSS) and Kjeldahl nitrogen (the total of the organic and ammonia nitrogen).

6.0 SUMMARY AND CONCLUSIONS

Dillon was retained by INAC for the provision of logistics support, compilation of results and preparation of the report for a wetlands study in Hall Beach, Nunavut. The study methodology was determined by INAC personnel and sampling was conducted by the Hamlet of Hall Beach personnel.

Many of the communities in the Northwest Territories and Nunavut are presently using lagoon-based systems for the storage and treatment of sewage. To date, the majority of these have not been engineered, but have been established as a consequence of discharging raw sewage into one location over time. Previous studies have shown that wetlands in the north have the potential to act as an efficient method of sewage treatment.

The site at Hall Beach is located approximately 1.0 km north of the community itself. The lagoons are situated on level ground, which slopes gradually east toward the Foxe Basin. The natural hydrology in the immediate vicinity of the lagoons consists of various lakes, ponds and small creeks. The wetlands are located to the north and northeast and small creeks are located to the east and southeast of the existing lagoons. There is no outlet to the lagoons, water seeps through the gravelly soil and berms, entering the wetlands area. At the end of the wetlands area, the water seeps through the gravel raised beaches, to reach the ocean.

Samples were collected weekly by Hamlet personnel, and shipped to Ottawa for analysis. Two samples from the wetland were taken, as well as a control. However, the sampling locations chosen were not representative of the entire wetlands treatment area and limited conclusions can be drawn. Samples were analyzed for BOD_5, ammonia nitrogen, nitrate and nitrite, TP, TSS and FC.

To remove the influence of hydraulic loads, water quality data was converted to a mass basis by multiplying measured concentrations, by the total estimated flow rate at the time of sampling. The total estimated flow has two components, namely sewage and water. Sewage flows were estimated based on per capita water rates. Run-off entering the lagoon was estimated based on monthly climate and streamflow data from nearby hydrological stations. The catchment area of the wetlands, determined by aerial photographs, was estimated as 34 ha. Total flows were estimated for July, August and September, for use with the corresponding sample results.

The results of this study indicated that BOD_5 and TSS were generally removed as a function of increasing distance along the wetland. Exceptions to this were total phosphorus and ammonia nitrogen. Nutrients (phosphorus, ammonia nitrogen and nitrates/nitrites) showed tendencies to increase along the wetland. This can be attributed to the die-off of vegetation and re-release of nutrients, or run-off entering the wetland area, while carrying plant debris.

Percent removal of BOD_5 was observed to be highest in August. The lowest value was obtained in September, although it was not substantially lower. Percent removals of nutrients tended to increase through the summer months. Warmer temperatures experience in September may have prolonged the growing season, delaying any seasonal die-off.

Percent removal of FC was virtually 100% in all seasons, meeting discharge guidelines at the Hall-2 sample location. It would appear that FC concentrations can be greatly reduced by treatment in the lagoons, filtration as the lagoon water passes through the gravel berm, or die-off in the first portion of the wetland.

7.0 REFERENCES

Dillon Consulting Limited. *Sewage Treatment Using Tundra Wetlands.* 1998.

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Appendix A

Hamlet of Hall Beach Water Licence

P.O. BOX 119
GJOA HAVEN, NU X0B 1J0
TEL: (867) 360-6338
FAX: (867) 360-6369

kNK5 wmoEp5 vtmpq
NUNAVUT WATER BOARD
NUNAVUT IMALIRIYIN KATIMAYINGI

DECISION

LICENCE NUMBER: NWB3HAL0308

This is the decision of the Nunavut Water Board (NWB) with respect to an application for a Licence dated January 9, 2003, made by:

Hamlet of Hall Beach

to allow for the use of water and disposal of waste for the Hamlet at Hall Beach , Nunavut.

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

DECISION

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

Licence Number NWB3HAL0308 be issued subject to the terms and conditions contained therein. (Motion #: 2003-07)

SIGNED this _____ day of April 2003 at Gjoa Haven, NU.

Original signed by:

_____

Philippe di Pizzo
Chief Administrative Officer

TABLE OF CONTENTS

I. INTRODUCTION

Following an application filed by the Hamlet of Hall Beach on January 9, 2003 to the Nunavut Water Board, the Board conducted an initial assessment of the Hamlet's request for a municipal water licence for water use and waste disposal activities within the Hamlet. The assessment was conducted so that the Nunavut Water Board could make a fully informed decision on the application. The application was referred for review and comments to Federal, Territorial and local organizations. Based upon the results of this initial assessment and the technical review, including consideration of any potential accidents, malfunctions, or cumulative environmental effects that the overall project might have in the area, the Board concluded that this application was complete and could go through the regulatory process.

In accordance with the *Nunavut Waters and Nunavut Surface Rights Tribunal Act* S. 55.1 and Article 13 of the *Nunavut Land Claims Agreement*, public notice of the application was posted. No public concerns were expressed, and the NWB waived the requirement to hold a public hearing for the application. Authority to approve the application was delegated to the Chief Administrative Officer pursuant to S. 13.7.5 of the *Agreemen*t. After considering and reviewing the comments submitted by interested parties, the NWB has issued licence NWB3HAL0308.

II. GENERAL CONSIDERATIONS

Term of the Licence

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

Annual Report

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

Regulated Parameters

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

Operation and Maintenance Manual (O&M)

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

Abandonment and Restoration (A&R)

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

Monitoring Program

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

Quality Assurance/Quality Control (QA/QC) Plan

The requirements to develop a QA/QC Plan imposed on the Licensee in this licence are for the purpose of ensuring the NWB that samples taken in the field as part of the Monitoring Program will maintain a high

quality, so as to accurately represent the physical and chemical nature of the samples being taken.

LICENCE NWB3HAL0308

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

HAMLET OF HALL BEACH
(Licensee)

of **HALL BEACH , NUNAVUT, X0A 0K0**
(Mailing Address)

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

Licence Number **NWB3HAL0308**

Water Management Area **NUNAVUT 06**

Location **HALL BEACH, NUNAVUT**

Purpose **WATER USE AND WASTE DISPOSAL**

Description **MUNICIPAL UNDERTAKINGS**

Quantity of Water Not to be Exceeded **35,000 CUBIC METRES ANNUALLY**

Date of Licence **April 23, 2003**

Expiry Date of Licence **MARCH 31, 2008**

Dated this ____ of April 2003 at Gjoa Haven, NU.

Original signed by:

Philippe di Pizzo
Chief Administrative Officer

PART A: SCOPE AND DEFINITIONS

1. Scope

a. This Licence allows for the use of water and the disposal of waste for municipal undertakings at the Hamlet of Hall Beach, Nunavut (68➡46'N, 81➡12'W);

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

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

2. Definitions

In this Licence: **NWB3HAL0308**

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

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

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

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

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

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

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

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

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

"Composite Sample" means a water or wastewater sample made up of a number of samples taken at regular periods over a 24 hour period;

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

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

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

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

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

"Licensee" means the holder of this Licence;

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

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

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

"Sewage Disposal Facilities" comprises the area and engineered lagoon and decant structures designed to contain sewage as described in the Application for Water Licence filed by the Applicant on January 9, 2003;

"Solid Waste Disposal Facilities" comprises the area and associated structures designed to contain solid waste (landfill site) as described in the Application for Water Licence filed by the Applicant on January 9, 2003;

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

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

"Waste Disposal Facilities" means all facilities designated for the disposal of waste, and includes the Sewage Disposal Facilities, Solid Waste Disposal Facilities, and Bagged Toilet Waste Disposal Facilities, as described in the Application for Water Licence filed by the Applicant on January 9, 2003; and

"Water Supply Facilities" comprises the area and associated intake infrastructure at Water Supply Lake, as described in the Application for Water Licence filed by the Applicant on January 9, 2003.

PART B: GENERAL CONDITIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(i) Chief Administrative Officer:

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

(ii) Inspector Contact:

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

(iii) Analyst Contact:

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

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

PART C: CONDITIONS APPLYING TO WATER USE

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

2. The annual quantity of water used for all purposes shall not exceed 35,000 cubic metres.

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

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

PART D: CONDITIONS APPLYING TO WASTE DISPOSAL

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

2. All Effluent discharged from the Sewage Disposal Facilities at "Monitoring Program" Station Number HAL-4 shall meet the following effluent quality standards:

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

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

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

5. The Sewage Disposal Facility shall be maintained and operated, to the satisfaction of an Inspector in such a manner as to prevent structural failure.

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

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

PART E: CONDITIONS APPLYING TO MODIFICATION AND CONSTRUCTION

1. The Licensee shall submit to the Board for approval design drawings stamped by a qualified engineer registered in Nunavut prior to the construction of any dams, dykes or structures intended to contain, withhold, divert or retain water or wastes.
2. The Licensee may, without written approval from the Board, carry out modifications to the Water Supply and Waste Disposal Facilities provided that such modifications are consistent with the terms of this Licence and the following requirements are met:

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

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

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

    iv. the Board has not rejected the proposed modifications.

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

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

PART F: CONDITIONS APPLYING TO OPERATION AND MAINTENANCE

1. The Licensee shall, before April 1, 2004 submit to the Board for approval, a plan for the Operation and Maintenance of the Sewage and Solid Waste Disposal Facilities in accordance with *"Guidelines for preparing an Operation and Maintenance Manual for Sewage and Solid Waste Disposal Facilities"* (October 1996).

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

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

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

    i. employ the appropriate contingency plan as provided for in the Operation and Maintenance Plan;
    ii. report the incident immediately via the 24-Hour Spill Reporting Line at (867) 920-8130 and to an Inspector; and

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

PART G: CONDITIONS APPLYING TO ABANDONMENT AND RESTORATION

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

    i. water intake facilities;

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

    iii. petroleum and chemical storage areas;

iv. any site affected by waste spills;

v. leachate prevention;

vi. an implementation schedule;

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

viii. consideration of altered drainage patterns;

ix. type and source of cover materials;

x. future area use;

xi. hazardous wastes; and

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

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

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

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

PART H: CONDITIONS APPLYING TO THE MONITORING PROGRAM

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

Station Number	Description
HAL-1	Raw Water supply prior to treatment
HAL-2	Runoff from the Solid Waste Disposal Facilities

HAL-3	Raw Sewage at Discharge point
HAL-4	Effluent discharge from the Sewage Disposal Facilities

2. The Licensee shall sample monthly at Surveillance Stations HAL-2 and HAL-4 during the months of May to August, inclusive.

3. The Licensee shall analyze samples collected at Station Number HAL-2 and HAL-4 for the following parameters:

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

4. The Licensee shall measure and record in cubic metres the monthly and annual quantities of water pumped from Monitoring Program Station Number HAL-1 for all purposes;

5. The Licensee shall measure and record in cubic metres the monthly and annual quantities of raw sewage discharged at Monitoring Program Station Number HAL-3 for all purposes

6. Additional sampling and analysis may be requested by an Inspector;

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

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

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

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

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

12. Modifications to the Monitoring Program may be made only upon written approval of the Chief Administrative Officer.

Appendix B

Sampling Instructions

Sampling Instructions: DIAND Hall Beach Wetland Study

Mr. Qammanik, here is a more detailed, step by step instructions, on how to collect the samples for the wetland study.

1. On Tuesday afternoon or evening, take one of the coolers provided by Accutest labs. Verify that is has all of the required bottles (9 in total - six 500 ml bottles and three 200 ml bottles with preservatives). You should also have three pairs of sampling gloves, and a "chain of custody" sheet to be filled out. If the cooler has everything that is required, take the ice packs from the cooler and place them in a freezer to freeze them overnight.

2. Sampling should begin on Wednesday at approximately 13:00 (1:00 PM) The objective is for the samples to make it on the First Air flight to Iqaluit, then Ottawa, on Wednesday. The First Air flight leaves Hall Beach at 15:20 (3:20 PM). If more time is needed, start earlier. However, sampling should not begin earlier than 12:00 (noon) on Wednesday.

3. Take the ices packs out of the freezer, put them back in your cooler, and bring the cooler (with ice packs) to sample.

4 First sample the "control" sample, which should be a nearby stream, upstream/upslope from the wetland and sewage lagoon. It should be located at least 50 m away from the sewage lagoon and wetland, and should be in a place that will not be affected by sewage effluent. Once the control sampling location is chosen, it should remain the same for the entire summer.

   When sampling, you should be wearing sampling gloves. You will have 3 bottles to fill for the sample (two 500 ml bottles, and one 200 ml bottle with preservatives).

   For the two 500 ml bottles, you must do a normal "grab sample." That means you must rinse the bottle 3 times, then fill it. That is, fill the bottle with the water to be sampled, then dump it, and repeat two more times. After dumping it the third time, fill it, then seal the bottle with the cap.

   For the 200 ml bottle - the smaller one with the sodium thiosulfate preservative already in the bottle, it's a "grab sample without rinsing." In this case, you simply fill the bottle once and close the cap. DO NOT dump the contents to rinse it. (If you did, you would dump out the preservative already in the bottle). When closing the bottle, be careful not to touch to top of the open bottle - you should only be touching the cap of the bottle.

   On all three bottles, be sure to clearly label the sample ID as "HB-CON" (for Hall Beach CONtrol).

   Throw out the used sampling gloves (you are not to use the same gloves again).

5. The second sample should be at the end of the wetland, where the water leaves the

wetland area and the sewage effluent is suppose to be treated.

Again, you should be wearing new sampling gloves for this site (do not use sampling gloves that you have already used for a previous sampling).

Sampling proceeds exactly the same as at the control site. The only difference is that once done, you should label all 3 bottles "HB-OUT" (for Hall Beach, OUTflow) as their sample ID.

6. Go to the last sampling site, where the sewage effluent from the sewage lagoon enters the wetland area. Sampling is once more identical to the previous two sites. The three bottles should be labelled "HB-INF" (for Hall Beach INFlow) as their sample ID. At this point, you should be using the last pair of sampling gloves.

7. Pack sample bottles carefully in the cooler. Fill out the "chain of custody record" sheet that is in the cooler. This sheet essentially tells the lab what samples you are sending them, and what to analyze the samples for. See the next page for an example of a filled out sheet; you only have to fill the sheet the same way as the example provided, except that you will have to add the name of who took the samples ("Sampled By:") and when ("Date/Time"). Those areas are marked by a circled star (like this:) on the example.

8. Tape the cooler shut with packing tape. Also tape a copy of the cooler label provided with these instructions on the top of the cooler. This label gives the address of Accutest Laboratories, tells First-Air cargo to call the lab and hold for pick-up, and to keep the samples refrigerated.

9. Ship the samples on First Air cargo for the Wednesday 15:20 flight leaving Hall Beach. The cooler is to be shipped priority, and charged to the Department of Indian Affairs and Northern Development (DIAND)'s First Air account #**48032**. The cooler is to be shipped to:

    Accutest Laboratories Ltd.
    146 Colonnade Rd., Unit 8
    Ottawa, ON K2E 7Y1
    ph: (613) 727-5692, fax: (613) 727-5222

    Inform First Air that they are to call Accutest Laboratories immediately upon the cooler's arrival in Ottawa, that it is to be held for pick, and that it is to be kept refrigerated (4 C).

10. If you have any questions, please do not hesitate to contact either Stephanie Joyce of Dillon Consulting in Yellowknife at (867) 920-4555 or Michelle McChristie of DIAND in Iqaluit at (867) 975-4550.

LABEL FOR COOLER

From: **Municipality of Hall Beach, on behalf of:**
Michelle McChristie
Manager of Water Resources,
Department of Indian Affairs
and Northern Development (DIAND)
P.O. Box 100, Iqaluit, NU, X0A 0HO
Ph: (867) 975-4550, Fax (867) 975-4276

Ship to: **Robert Walker**
Accutest Laboratories Ltd.
146 Colonnade Rd., Unit 8
Ottawa, ON, K2e 7Y1
Ph: (613) 727-5692, Fax: (613) 727-5222

Quotation Number: 230338

-Time-Sensitive: - Priority Shipment to Ottawa.
- Please call Accutest Laboratories immediately upon arrival in Ottawa.
- Hold for Pick-Up
- Keep Refrigerated (4°C), but do not Freeze
- Contains Water Samples (note: NO hazardous or dangerous goods, safe for shipping)

Sampling Instructions

Re: INAC Hall Beach - Sewage Effluent - Quotation 230338

For each set of samples you will have to fill up the following bottles:

Bottle	Parameters	Sampling	Storage Instructions
2 x 500 mL plastic bottles	General Chemistry	Grab	Keep cool
200 mL plastic bacteria bottle with sodium thiosulphate preserv.	Faecal Coliforms	Grab, no rinsing. Be careful not to touch open top of sterile bottle.	Keep cool. Arrange shipping so that laboratory receives sample within 24 hours (48 hours max) from the time of sampling

You will be supplied with a chain-of-custody form. Please complete it with as much detail as possible, and return it with the samples. Please indicate Accutest's quotation number in all correspondence and sample submissions.

Pack the sample bottles carefully. Place cold freezer packs in the cooler with the samples and ship to Accutest as soon as possible. If there is any delay, the samples should be kept cool (4°C). Seal the coolers with packing tape prior to shipment.

To order more sampling supplies, or if you have questions with sampling or shipping protocol, please call Accutest at **1-888-271-8378**.

CHAIN OF CUSTODY RECORD

ACCUTEST LABORATORIES LTD.

☐ 146 Colonnade Rd., Unit 8
Ottawa, ON K2E 7Y1
Ph: (613) 727-5692 Fax: (613) 727-5222

☐ 608 Norris Court
Kingston, ON K7P 2R9
Ph: (613) 634-9307 Fax: (613) 634-9308

LAB USE ONLY
Report Number: ______________

Company Name:	Address:		☐ Fax Results to: ______________
Report Attention:	City/Prov:	Postal Code:	☐ E-mail Results to: ______________
Phone: Waterworks #:	Project #	* Quotation #	☐ Copy of Results to: ______________

Invoice to:
(if different from above)

____

____

SAMPLE ANALYSIS REQUIRED

⇦ Indicate: F=Filtered or P=Preserved

Sample ID	Date/Time Collected	Sample Matrix	C=Comp. G=Grab	Number of Containers	Service Required ** R=Rush S=Standard										Laboratory Identification	CRITERIA REQUIRED * (i.e. MOE GUCSO, CCME, PWQO, ODWS, Québec) MOE Reg. #: ______ Other: ______ MOE Reportable ?
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐
																Yes ☐ No ☐

Sampled By:	Date/Time:	Shipped Via:	Waybill #:	Comments
Relinquished By:	Date/Time:	Received By:	Date/Time:	
Relinquished By:	Date/Time:	Received By Lab:	Date/Time:	

*** Indicates a required field. If not complete, analysis will proceed only on verification of missing information.** **** There may be a surcharge applied to "Rush" service. Please check with lab.**

Appendix C

Site Photographs

Photograph 1
Cell 1

Photograph 2
Cell 2.

Photograph 3
Looking back at Cell 2.

Photograph 4
Hall-2 Sample Location.

Photograph 5
Looking north from gravel peninsula.

Photograph 6
Hall-3 Sample Location.

Photograph 7
Looking through the narrows, by Hall-3.

Photograph 8
Looking north from gravel peninsula.

Photograph 9
Raised beaches at outlet.

Appendix D

Summary of Raw Analytical Data

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2310947
Date: 2003-07-24
Date Submitted: 2003-07-17

Project: 01-03-0012

P.O. Number: 230338
Matrix: Sewage

								GUIDELINE		
			LAB ID:	261254	261255	261256				
			Sample Date:	2003-07-16	2003-07-16	2003-07-16				
			Sample ID:	Hall 4	Hall 3	Hall 2				
PARAMETER	**UNITS**	**MDL**						**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL		<10	<10	10					
Biochemical Oxygen Demand	mg/L	1	<1	20	28					
N-NH3 (Ammonia)	mg/L	0.02	<0.02	2.54	40					
NO2 + NO3 as N	mg/L	0.10	<0.10	0.23	<0.10					
Total Phosphorus	mg/L	0.01	0.01	3.74	2.45					
Total Suspended Solids	mg/L	2	<2	12	58					

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2311346
Date: 2003-07-31
Date Submitted: 2003-07-24

Project: 01-03-0012

P.O. Number: 230338
Matrix: Water

			LAB ID:	262364	262365	262366	262367		GUIDELINE		
			Sample Date:	2003-07-23	2003-07-23	2003-07-23	2003-07-23				
			Sample ID:	HAL 4	HAL 3	HAL 2	HAL 1				
PARAMETER	**UNITS**	**MDL**							**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL			0	<10	100					
Biochemical Oxygen Demand	mg/L	1		<1	19	59	<1				
N-NH3 (Ammonia)	mg/L	0.02		<0.02	14.1	16.0	0.16				
NO2 + NO3 as N	mg/L	0.10		<0.10	0.56	<0.10	0.95				
Total Phosphorus	mg/L	0.01		0.01	4.35	2.44	0.07				
Total Suspended Solids	mg/L	2		<2	43	165	3				

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2311778
Date: 2003-08-08
Date Submitted: 2003-08-01
Project:
P.O. Number: 230338
Matrix: Sewage

	LAB ID:	263573	263574	263575	263576		GUIDELINE		
	Sample Date:	2003-07-30	2003-07-30	2003-07-30	2003-07-30				
	Sample ID:	Hal 4	Hal 3	Hal 2	Hal1				
PARAMETER	**UNITS**	**MDL**					**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL		<10	<10	<10	10			
Biochemical Oxygen Demand	mg/L	1	<1	7	51	8			
N-NH3 (Ammonia)	mg/L	0.02	0.04	32	4.86	0.36			
NO2 + NO3 as N	mg/L	0.10	<0.10	0.98	0.21	0.18			
Total Phosphorus	mg/L	0.01	0.03	3.69	2.70	0.14			
Total Suspended Solids	mg/L	2	4	3	235	74			

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Kristina Hay
QC Coordinator

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2312255
Date: 2003-08-19
Date Submitted: 2003-08-11

Project: 01-03-0012 - Hall Beach

P.O. Number: 230338
Matrix: Sewage

			LAB ID:	265061	265062	265063	265064		**GUIDELINE**	
			Sample Date:	2003-08-06	2003-08-06	2003-08-06	2003-08-06			
			Sample ID:	Hal 4	Hal 3	Hal 2	Hal 1			
PARAMETER	**UNITS**	**MDL**							**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL			10	<10	<10					
Biochemical Oxygen Demand	mg/L	1		<1	14	59	<1				
N-NH3 (Ammonia)	mg/L	0.02		0.02	29	2.11	0.19				
NO2 + NO3 as N	mg/L	0.10		<0.10	0.80	0.18	0.38				
Total Phosphorus	mg/L	0.01		0.03	3.82	2.59	0.10				
Total Suspended Solids	mg/L	2		6	20	260	5				

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2313068
Date: 2003-09-02
Date Submitted: 2003-08-22

Project: Hall Beach

P.O. Number: 230338
Matrix: Water

			LAB ID:	267667	267668	267669	267670		**GUIDELINE**		
			Sample Date:	2003-08-20	2003-08-20	2003-08-20	2003-08-20				
			Sample ID:	Hal 4	Hal 3	Hal 2	Hal 1				
PARAMETER	**UNITS**	**MDL**							**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL			<10	30	160					
Biochemical Oxygen Demand	mg/L	1		1	9	25	1				
N-NH3 (Ammonia)	mg/L	0.02		<0.02	19.6	3.68	0.17				
NO2 + NO3 as N	mg/L	0.10		<0.10	0.40	0.11	1.65				
Total Phosphorus	mg/L	0.01		0.04	3.90	2.28	0.03				
Total Suspended Solids	mg/L	2		10	24	242	<2				

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Ewan McRobbie
Inorganic Lab Supervisor

Client: INAC - Nunavut Regional Office
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: Ms. Michelle McChristie

Report Number: 2313540
Date: 2003-09-08
Date Submitted: 2003-08-29
Project: Hall Beach
P.O. Number: 230338
Matrix: Wastewater

			LAB ID:	269138	269139	269140	269141	269142	GUIDELINE		
			Sample Date:	2003-08-27	2003-08-27	2003-08-27	2003-08-27	2003-08-27			
			Sample ID:	Hal 5	Hal 4	Hal 3	Hal 2	Hal 1			
PARAMETER	**UNITS**	**MDL**							**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL			<10	10	20					
Biochemical Oxygen Demand	mg/L	1	<1	<1	11	62	<1				
N-NH3 (Ammonia)	mg/L	0.02	<0.02	0.03	20.4	6.14	0.08				
NO2 + NO3 as N	mg/L	0.10	<0.10	<0.10	0.29	0.14	0.49				
Total Phosphorus	mg/L	0.01	0.03	0.03	3.42	2.53	0.05				
Total Suspended Solids	mg/L	2	<2	<2	14	2	6				

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Ewan McRobbie
Inorganic Lab Supervisor

Client: INAC - Nunavut Regional Office
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: Ms. Michelle McChristie

Report Number: 2313929
Date: 2003-09-15
Date Submitted: 2003-09-05
Project:
P.O. Number: 230338
Matrix: Sewage

			LAB ID:	270115	270116	270117	270118		GUIDELINE		
			Sample Date:	2003-09-03	2003-09-03	2003-09-03	2003-09-03				
			Sample ID:	Hall 4	Hall 3	Hall 2	Hall 1				
PARAMETER	**UNITS**	**MDL**							**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL			<10	10	<10	10				
Biochemical Oxygen Demand	mg/L	1		3	10	136	1				
N-NH3 (Ammonia)	mg/L	0.02		0.03	21.0	1.05	0.10				
NO2 + NO3 as N	mg/L	0.10		<0.10	0.20	0.13	0.95				
Total Phosphorus	mg/L	0.01		0.02	2.01	2.52	0.06				
Total Suspended Solids	mg/L	2		<2	46	295	2				

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL:

Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2314625
Date: 2003-09-17
Date Submitted: 2003-09-16
Project:
P.O. Number: 230338
Matrix: Water

		LAB ID:	271902	271903	271904			**GUIDELINE**		
		Sample Date:	2003-09-10	2003-09-10	2003-09-10					
		Sample ID:	Hal 4	Hal 3	Hal 2					
PARAMETER	**UNITS**	**MDL**						**TYPE**	**LIMIT**	**UNITS**
Faecal Coliforms	ct/100mL		1	50	<10					

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Krista Johns
Microbiology Analyst

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2314626
Date: 2003-09-23
Date Submitted: 2003-09-16
Project:
P.O. Number: 230338
Matrix: Water

		LAB ID:	271905	271906	271907	271908		**GUIDELINE**		
		Sample Date:	2003-09-10	2003-09-10	2003-09-10	2003-09-10				
		Sample ID:	Hal 4	Hal 3	Hal 2	Hal 1				
PARAMETER	**UNITS**	**MDL**						**TYPE**	**LIMIT**	**UNITS**
Biochemical Oxygen Demand	mg/L	1	1	9	65	<1				
N-NH3 (Ammonia)	mg/L	0.02	0.04	17.3	1.27	0.11				
NO2 + NO3 as N	mg/L	0.10	<0.10	0.32	<0.10	0.98				
Total Phosphorus	mg/L	0.01	0.01	4.11	3.26	0.06				
Total Suspended Solids	mg/L	2	7	54	310	4				

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____
Ewan McRobbie
Inorganic Lab Supervisor

ACCUTEST LABORATORIES LTD

REPORT OF ANALYSIS

Client: **INAC - Nunavut Regional Office**
P.O. Box 100
Iqaluit, NU
X0A 0H0
Attention: **Ms. Michelle McChristie**

Report Number: 2314626
Date: 2003-09-23
Date Submitted: 2003-09-16

Project:

P.O. Number: 230338
Matrix: Water

		LAB ID:	271905	271906	271907	271908		**GUIDELINE**		
		Sample Date:	2003-09-10	2003-09-10	2003-09-10	2003-09-10				
		Sample ID:	Hal 4	Hal 3	Hal 2	Hal 1				
PARAMETER	**UNITS**	**MDL**						**TYPE**	**LIMIT**	**UNITS**
Biochemical Oxygen Demand	mg/L	1	1	9	65	<1				
N-NH3 (Ammonia)	mg/L	0.02	0.04	17.3	1.27	0.11				
NO2 + NO3 as N	mg/L	0.10	<0.10	0.32	<0.10	0.98				
Total Phosphorus	mg/L	0.01	0.01	4.11	3.26	0.06				
Total Suspended Solids	mg/L	2	7	54	310	4				

MDL = Method Detection Limit INC = Incomplete AO = Aesthetic Objective OG = Operational Guideline MAC = Maximum Allowable Concentration IMAC = Interim Maximum Allowable Concentration

Comment:

APPROVAL: _____

Ewan McRobbie
Inorganic Lab Supervisor