Site Investigations Report for the Sewage Disposal System In the Hamlet of Baker Lake, NU

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The Government of Nunavut

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1.0 Introduction

1.1 Background

Baker Lake, or Qamanittuaq, is the only community situated inland in Nunavut, at the huge widening at the mouth of the Thelon River on the Northwest side of Baker Lake. It is the geographic centre of Canada, and the geographical settings are latitude of 64° 81' N and longitude of 96° 03' W. The community is about 230 air km northwest of Rankin Inlet and 940 air km east of Yellowknife.

Based on the projections by Nunavut Bureau of Statistics, the population in Baker Lake in 2004 was 1594.

The ground in the community slopes up from the lake towards a few rocky ridges located about 2 km inland. Permafrost conditions are prevalent. The maximum of the active layer is approximately 1.5m. Vegetations are typical arctic tundra and consist of mosses, lichens, and grasses.

Baker Lake receives an average of 15.6 cm of rainfall and 130.7 cm of snowfall per year. Mean annual precipitation totals 23.8 cm.

The mean high and low temperature in July are 16.0 and 6.0 °C, while in January the mean high and low temperature are -29.5 and -36.4 °C respectively.

Winds are generally from the north with annual average speed of 23.0 km/h.

1.2 The purposes of the site investigations

The purposes of the site investigations are

- To inspect the sewage disposal system on site and evaluate its treatment effectiveness;

- To sample at the appropriate locations in the sewage disposal area for further chemical and biological analysis to establish the final effluent meet relevant federal and territorial water quality guidelines' requirements;
- To provide appropriate suggestions and solutions for the issues to be considered;

2.0 Site investigations and findings, test results reports, and discussions

Totally three site investigations were made from June to September in 2005 by the author and accompanied by the foreman in the Hamlet.

The Hamlet is applying for the water license from Nunavut Water Board and hasn't received formal approved water license. Considering this, the sample locations and the required tests were selected referring to the NWB water license requirements (for other communities) as well as relevant CCME water quality guidelines for the protection of aquatic life (fresh water). During each visit, totally four samples were collected from the sewage disposal system: three samples were from the three ponds in the sewage disposal area, the last was collected at the final discharge point at the Baker Lake. The current solid waste disposal facilities were close to the second pond (P2), hence the sample from P2 was used to represent the effluent (leachate) of the solid waste disposal facilities. Specific sampling locations were indicated in Appendix-1.

The required tests for sewage samples included pH, BOD, TSS, oil and grease, total Phenols, Fecal Coliforms, metals, ammonia nitrogen, nitrite and nitrate nitrogen, sulphate, conductivity, etc.

2.1 Sewage disposal system

The sewage disposal system in the Hamlet of Baker Lake is located in the natural valley about 1.5 km north of the community and is composed of three ponds in series extending from west to east. The ponds are separated by areas of natural wetlands. The sewage disposal area is confined to the north, south and west by rock ridges. At the end of third pond, the effluent turns south and proceeds down to Baker Lake.

The truck-collected sewage was dumped to the bermed pond on the road side (Figure-1). The sewage was found to seep from this bermed pond. This bermed pond may partially be regarded as a primary treatment, for large particles in the sewage may settle or be screened.

The effluent from the dumping pond flowed over the slope area and down to the first pond (P1). The slope area between the dumping pond and P1 was covered by a thick layer of slime (Figure-3).

Effluent from the first pond flowed through a defined channel to the second pond while the effluent from the second pond proceeded over a large area of wetland with abundant vegetation plants to the third pond, P3 or Landing Lake, as was locally called (Figure-3, 4). The effluent from the P3 flowed by gravity through a defined sloping gravel ditch, and finally was discharged at Baker Lake (Figure-5, 6).

From visual inspection, the water in P1 and P2 appeared to be turbid and green in color due to algae boom (Figure-7). This was probably due to the combined functions of the rich organics and nutrients (nitrogen, phosphorous, etc.) in the water as well as the long daylight in the summer. However, the effluent from P2, after flowing over the area of

wetland with abundant vegetation plants, became significantly clear when it entered the Landing Lake (P3). No smell could be smelted.

The test result reports (Appendix-2) established that all the tested items with the final discharged effluent from the sewage disposal system met the requirements by CCME quality guidelines for the protection of aquatic life (fresh), and also met the requirements proposed by NWB for other similar facilities. This indicated that the current sewage disposal system was effective in disposing organics and up-taking the nutrients in the sewage.

2.2 Vegetation in the wetlands

In the wetland area, abundant and thick vegetation was observed. In the relatively dry area, mosses and lichens were dominated, while in the swampy areas, sedge marshes and grasses were dominated (Figure-3, 4, 5, 8).

The vegetation plants within wetland can substantially increase their biomass through the absorption and assimilation of nutrients, thereby increasing ambient oxygen levels as by-product of their growth. This in turn provides the aerobic bacteria with more oxygen in decomposing organics. Hence the vegetation plants play an important role in the wetland disposal system.

2.3 Wildlife

Wildlife observed in the upland areas included sparrows, plovers, geese, mouse, as well as bugs and mosquitoes. Some ducks were seen swimming on the surface of water in all three lagoons (Figure-9). Bones of dead animals (probably caribous) were also nod. Small fishes were found in the last pond (Landing Lake). By talking to a local resident, it

was learned that there were lots of fishes in the Landing Lake (P3). No fish was found in the first two ponds.

2.4 Issues to be concerned

Discarded metal oil barrels The current solid waste disposal facilities are located on the southern slope to the second pond Some discarded trucks and metal auto parts were observed there. The landfill is about 20 meters away from the pond (Figure-9). On the east shore of the Landing Lake (P3), almost thirty discarded metal oil barrels were observed (Figure-10). This would potentially affect the quality of sewage effluent in the wetlands, especially in the melting and rainy seasons due to release of oil and grease, metals, etc. On the third site visit and sampling, it rained almost everyday. According to the third test results report, some of the metals, such as Zinc, exceeded the guidelines limit. There was close relations between these two.

On-site signage No signage was observed in the areas for the sewage / solid waste disposal areas. It is advised that appropriate signage be placed in these locations.

3.0 Summary and Conclusions

- The test result reports established that all the tested items with the final discharged effluent from the sewage disposal system met the requirements by CCME quality guidelines for the protection of aquatic life (fresh water), and also met the requirements proposed by NWB for other similar facilities. This indicated that the current sewage disposal system was effective in disposing organics and up-taking the nutrients in the sewage.
- The discarded metal oil barrels were advised to be removed from the sewage disposal area to avoid potential negative effect for the final discharged effluent quality;
- On-site signage was suggested to set up in the areas such as solid waste and sewage disposal facilities;

Acknowledgement

The Hamlet of Baker Lake office provided support for these site investigations.

Figures:

Figure-1 Sewage dumping pond

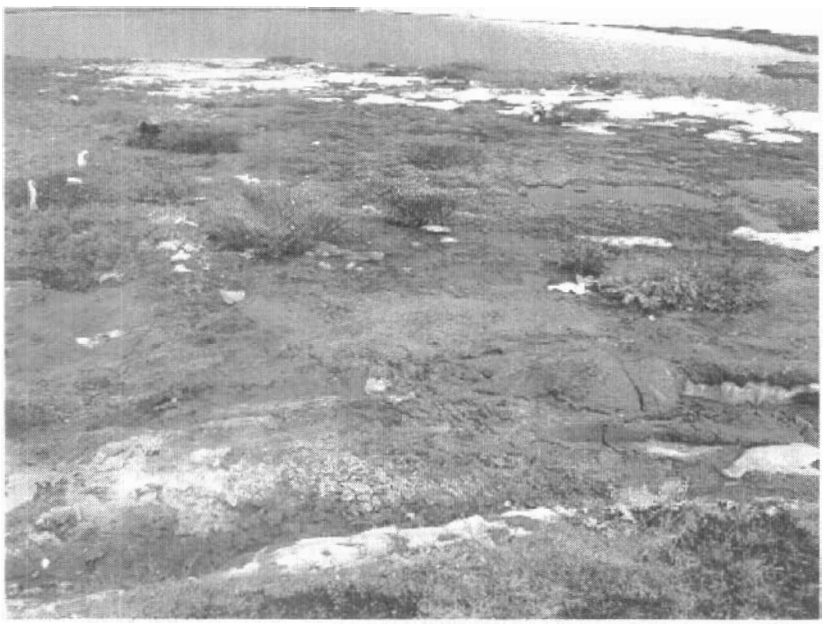

Figure-2 Slime layers on the slope after the dumping pond

Figure-3 Defined channel from pond1 to pond 2

Figure-4 Shallow water area with species of sedges between pond 2 and pond 3

Figure-5 Confined gravel ditch for effluent to Bake Lake

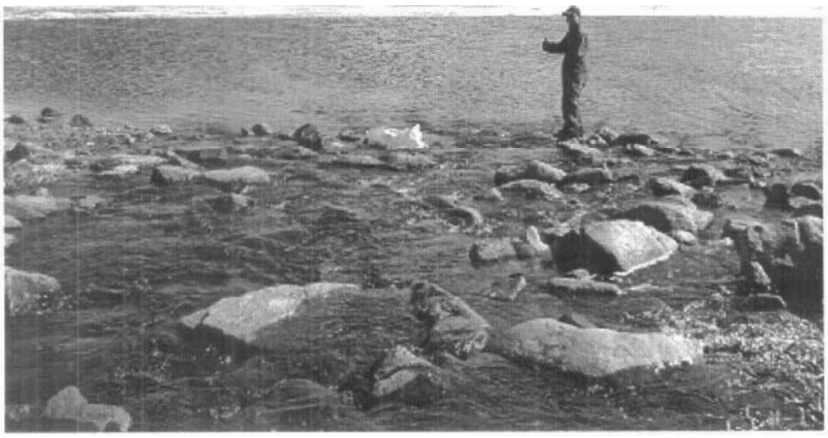

Figure-6 Final discharge point to Baker Lake

Figure-7 Algae boom in P2

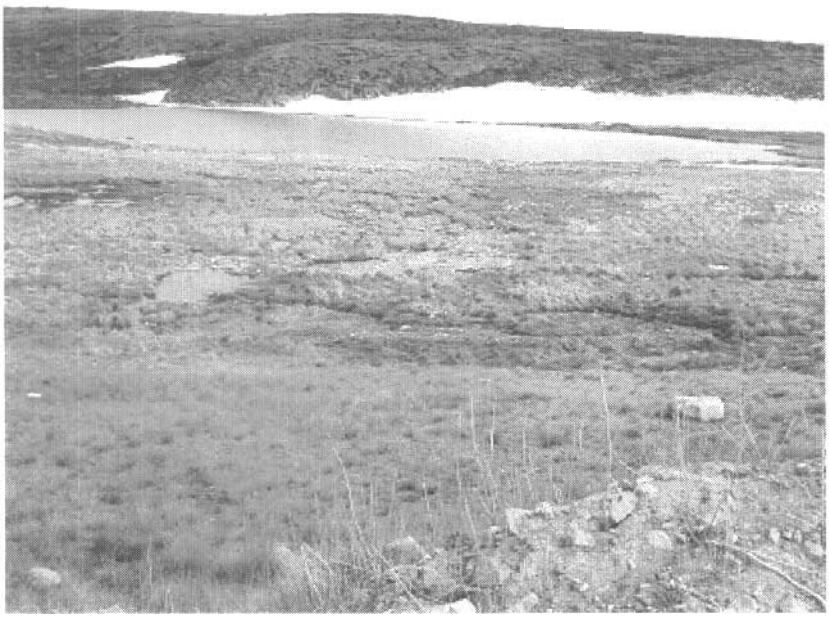

Figure-8a The vegetation plants around the P1

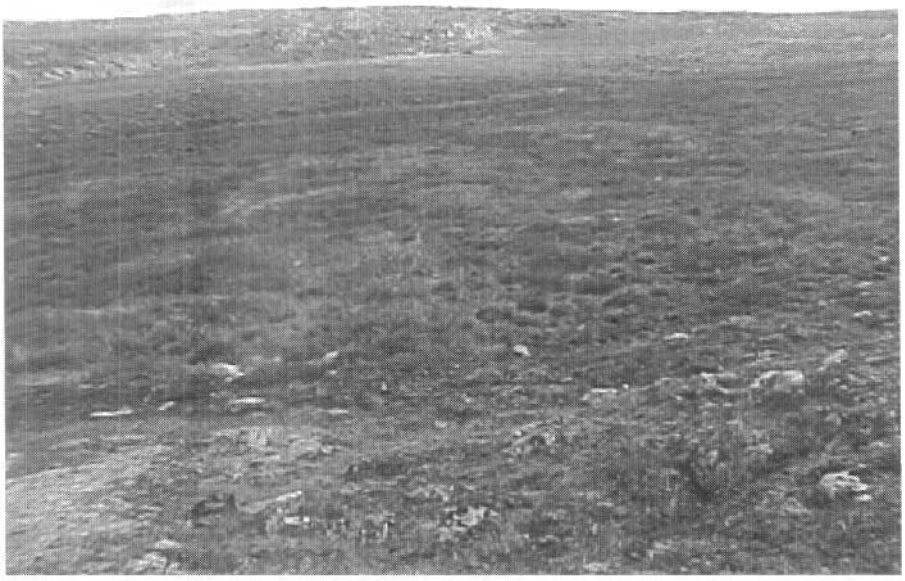

Figure-8b The vegetation plants wetland area before P3

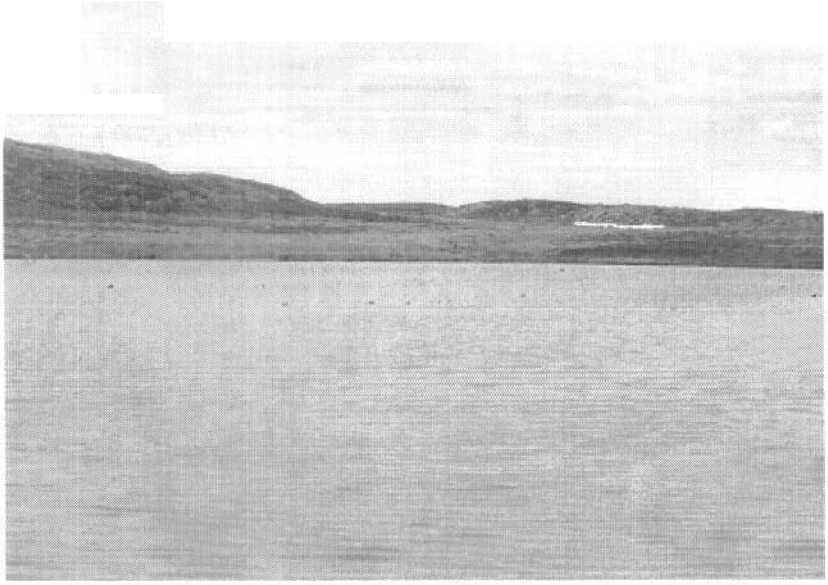

Figure-9 Wild swimming ducks in pond 1

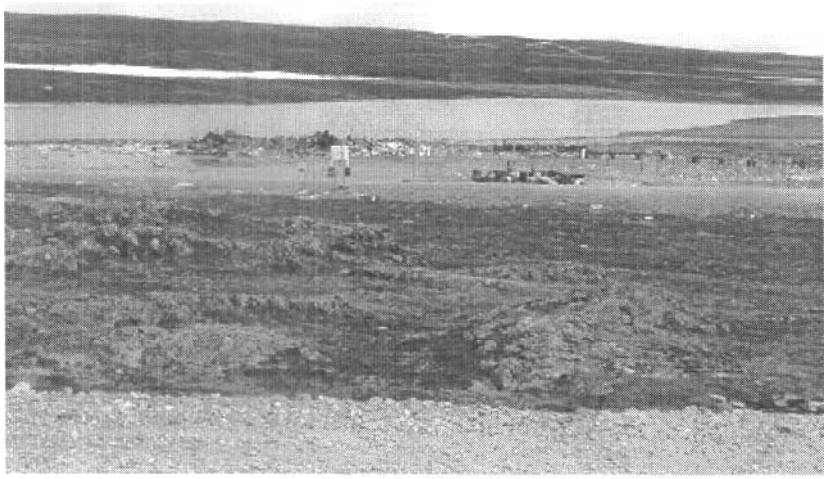

Figure-10 Landfill area beside pond 2

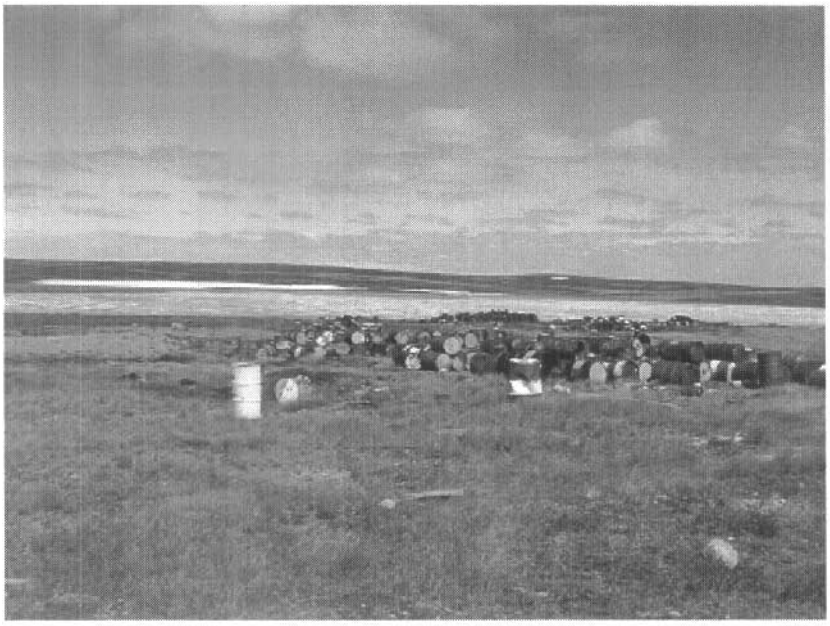

Figure-11 Garbage cans close to the pond 3

Appendix-1 Sampling Locations' Drawing

Appendix-2

Summary of Laboratory Test Results
For the Sewage Disposal System in Bake Lake, NU

C.G.S. Rankin Inlet Office, 2005

Parameters	Units	06/ 29/ 2005				07/ 28/ 2005				08/ 31/ 2005			CCME Guidelines		NWB Requirements
		P1	P2	P3	P_{fd}	P1	P2	P3	P_{fd}	P1	P2	P_{fd}	Fresh	Marine	
BOD	mg/L	16	8	<6	<6	6	<6	<6	<6	7	<6	<6			120
TSS	mg/L	10	18	<5	<5	<5	<5	25	<5	15	6	6			180
Oil & Grease	mg/L	<1	<1	<1	<1	<1	<1	<6	<1	<1	<1	<1			Not Visible
pH		7.14	9.12	7.44	7.29	7.85	7.23	7.38	7.40	6.80	6.86	6.96	6.5~9	7.0~8.7	6~9
Fecal Coliforms	CFU/100mL	110000	23	<3	<3	<3	4	<1	<3	>200	>200	8			1×10^6
NH_4-N	mg/L	13.20	1.22	0.02	<0.01	0.05	0.11	1.62	<0.01	6.01	3.43	<0.01	4.84		
NO_3-N $+NO_2$-N	mg/L					0.02	0.06	0.27	0.04	0.77	0.69	<0.01	13	16	
Total Phenols	µg/L	<2	<2	<2	<2	<2	<2	<2	<2	2	2	<2	4.0		
Conductivity						93.2	72.3	57.9	59.3	185	226	67.9	N/A	N/A	
Arsenic	µg/L	0.7	0.7	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	0.7	<0.5	5	12..5	
Cadmium	µg/L	0.5	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.02	<0.02	<0.02	0.017	0.12	
Calcium, total	mg/L	6.8	6.4	5.1	5.1	5.4	7.7	6.7	5.3	8.5	0.68	7.5	N/A	N/A	
Chromium, total	µg/L	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	9.9	57..5	
Copper	µg/L	38	8	2	3	2	2	6	2	9	5	3	2~4		
Iron	µg/L	580	500	490	460	240	420	520	230	0.88	0.68	0.16	300		
Lead	µg/L	9.9	2.3	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5	0.7	<0.5	1~7		
Magnesium	mg/L	1.63	1.44	1.02	1.01	1.07	1.24	1.27	1.02	1.77	2.88	1.33	N/A		
Mercury	µg/L										0.0038	0.0016	0.03	0.016	
Nickel	µg/L	76	13	<2	<2	<2	<2	<2	<2	<2	2	<2	25~150		
Potassium	mg/L	4.2	2.6	1.0	1.0	1.1	1.1	2.0	1.0	2.8	2.7	1.1			
Sodium	mg/L	17.4	11.0	3.92	3.88	4.42	4.82	8.96	4.12	14.3	14.8	4.30	N/A	N/A	
Sulphate	µg/L									12	25	9		N/A	
Zinc	µg/L	170	60	20	30	<10	10	10	10	20	20	40	30		

·· P1 and P3: samples collected in P1 and P3; P2: the landfill leachate; P_{fd}: the final effluent discharged at the Baker Lake;

* Comments for the test results: all the tested items with the final effluent meet the requirements by CCME quality guidelines for the protection of aquatic life (fresh), and also meet the requirements by NWB for other similar hamlets; In the third test results report, the contents of Zinc exceeded the guideline limit.