RESOLUTE BAY, NWT
WATER AND SEWER FACILITIES INVESTIGATION

FINAL REPORT

Prepared for:

Government of the Northwest Territories
Public Works and Services

Prepared by:

UMA Engineering Ltd.
Engineers, Planners & Surveyors
3541 MacDonald Drive
Yellowknife, NWT
X1A 2P8

January 1996
1315-172-00-02

R95-154

UMA ENGINEERING LTD.

THIRD PARTY DISCLAIMER

This report has been prepared by UMA Engineering Ltd. ("UMA") for the benefit of the client to whom it is addressed. Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by the client, its officers and employees and others having legitimate business relations with the client. UMA denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents without the express written consent of UMA and the client.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF SYMBOLS AND ABBREVIATIONS

BTU/hr./sq.ft./°F	-	British Thermal Units per hour per square foot per degree Fahrenheit
°C	-	degrees Centigrade
cu.m./yr.	-	cubic metres per year
d/yr.	-	days per year
°F	-	degrees Fahrenheit
ft.	-	feet
HP	-	horsepower
hr.	-	hour
hr./d	-	hours per day
hr./yr.	-	hours per year
km	-	kilometre
kPa	-	kilopascal(s)
kw	-	kilowatt(s)
L	-	litre(s)
Lpcd	-	litres per capita per day
L/day	-	litres per day
L/hr.	-	litres per hour
L/min.	-	litres per minute
L/sec.	-	litres per second
m	-	metre
mm	-	millimetre
min.	-	minute(s)
m^3	-	cubic metre
m^3/yr.	-	cubic metres per year
mph	-	miles per hour
m/s	-	metres per second
mg/L	-	milligrams per litre
min./day	-	minutes per day
m^3/d/year	-	cubic metres per capita per year
psi	-	pounds per square inch
USGPM	-	US Gallons per minute
W	-	watt(s)
yr.	-	year

1.0 EXECUTIVE SUMMARY

This report, prepared for the Government of the NWT, evaluates the existing water and sewer systems in Resolute Bay which includes the Char Lake Pumphouse, the Water Supply Main, the Signal Hill Reservoir and Treatment Plant, the piped Water Distribution System, the piped Sewage Collection System, building services, the Sewage Comminution/Outfall System and all related appurtenances. This evaluation includes life cycle cost estimates for the existing system and potential alternate systems and recommendations for future upgrades and/or conversions.

The existing Char Lake Pumphouse and Signal Hill facility are well maintained and are in generally good condition. The Water Supply Main, piped Water Distribution and Sewage Collection Systems and Sewage Comminution/Outfall Systems are showing signs of deterioration and an increased frequency of line breaks and freeze ups which has greatly decreased the reliability of the water and sewer systems. However, these systems are expected to be capable of remaining in service for the next 20 year life cycle with increased O&M requirements. The O&M requirements include the potential for the replacement of some major system components although no major components were identified in the assessment process as requiring immediate replacement. A list of recommended upgrades for the existing system, complete with cost estimates, are presented in the report.

The existing system has more than sufficient capacity for the projected 20 year population of 251 persons for Resolute Bay. The system was designed for a population of 900 to 1,500 persons which were expected to immigrate to the community. This immigration did not occur, therefore the facilities still have excess capacity.

Options which are available to supply water to and remove sewage from the community include both piped systems, similar to the existing, or trucked systems. The piped option can be further broken down into; leaving the system as is, partial system upgrade, total system replacement with buried mains, and total system replacement with an above ground utilidor. Except for leaving the system as is, each piped system option includes a continuous discharge lagoon with submerged outfall for sewage treatment. The trucked option can also be broken down into having the Char Lake Pumphouse as the truckfill station versus having the Signal Hill Facility as the truckfill station and building a new truck garage versus using existing garage space. Each trucked system option includes a storage lagoon with shore discharge for sewage treatment.

Life cycle cost estimates are prepared for each option previously described. For the piped system, the option with the lowest life cycle cost is leaving the system as is. The option with the second lowest life cycle cost is a partial system upgrade. The life cycle costs do not include the cost of thawing a major freeze up in the system due to the difficulty in predicting the frequency of occurrence and an average repair cost. However, the occurrence of a major freeze up, and therefore an extended interruption in service, is more likely with the option of leaving the system as is than with any other option. For the trucked system options, the option with the lowest life cycle cost is Char Lake as the truckfill station and using existing garage space.

All options are evaluated against weighted criteria to determine which option best meets the needs for the users (community) and owner (GNWT) of the system. The evaluation criteria is divided into "must" and "want" criteria, with the corresponding weights for the "want" criteria selected by UMA and reviewed by the GNWT. The "must" and "want" criteria evaluate the servicing options using criteria which is important to the users and owner of the system, including system reliability, life cycle costs, acceptance by community, operation and maintenance requirements, environmental impact, potential for contamination, local employment, system capacity, adaptability and expandibility.

Once the options are evaluated against the "must" and weighted "want" selection criteria, the two highest scoring options and their total weighted scores are as follows:

1. Trucked system with Char Lake Pumphouse as truckfill station, existing space and storage lagoon with shore discharge 499

2. Trucked system with Char Lake Pumphouse as truckfill station, construct a new truck garage and storage lagoon with shore discharge 496

It is therefore recommended that the existing piped system in Resolute Bay be converted to a trucked system using a converted Char Lake Pumphouse for a truckfill facility, existing garage space for storing the trucks and a storage lagoon with shore discharge for sewage treatment, in accordance with the highest scoring option. The advantages and disadvantages of the recommended trucked system versus the piped system options are as follows:

Advantages

- Higher reliability in the harsh climate of Resolute Bay as evidenced in other Northwest Territories communities and the frequent line breaks in Resolute Bay.
- Increased flexibility for new development including random or planned development phasing without the restrictions imposed by the extension of piped services.
- Significantly lower lot development cost.
- More long term employment opportunities for the local residents.
- Lower risk of contamination of the water supply due to the elimination of system bleeders.
- Less complex operation and maintenance requirements.
- Lower risk of extended interruptions in service which can occur with line breaks which result in pipeline freeze ups.
- Stored water immediately available in each house during the interruptions in the trucked services, while setting up a temporary supply is required with piped services.
- Avoids the need for an appeal to the Department of Health regarding their ruling on sewage discharge because a sewage lagoon will be required which should then meet their treatment requirements.

Disadvantages

- Viewed by local residents as an undesirable option.
- Interruption of trucking services during winter storms are possible.
- Living space in houses is reduced by water storage tank.
- Water consumers must be conscious of water consumption and remaining water in tank.
- Higher life cycle cost than leaving the piped system as-is or the piped system with a partial upgrade (provided the occurrence and severity of line breaks or freeze ups with the piped system does not increase).

In order to have a transition from a piped to a trucked system which does not interrupt the water supply to the residents, the transition should be staged as follows:

Stage 1

- Assess conversion requirements including decommissioning and provisions for operating two systems at reduced loading.
- Prepare and submit plans to authorities for approval.

Stage 2

- Construct lagoon (and access road, if required).
- Construct truckfill system at Char Lake.

Stage 3

- Purchase water and sewer trucks.
- Train operators.

Stage 4

- Conversion of houses (starting at identified trouble areas in existing piped system).
- Phase in water delivery and sewage pumphouse as houses are converted.

Stage 5

- Decommission supply main to Signal Hill, Signal Hill Facility, piped Water Distribution and Sewage Collection Systems, Sewage Comminution Building and Sewage Outfall.

The implementation of the trucked system can be phased over a number of years to extend the initial capital requirements of the conversion. Each of the stages listed above can be completed over a number of years, if required, but the order of the stages should remain as listed. An economic assessment of phasing options indicates there are costs associated with phasing the conversion over a number of years, however, there are significant benefits to both the community and GNWT as a result of phasing which are identified in this report.

2.0 INTRODUCTION

2.1 OBJECTIVE

This report, prepared for the Government of the NWT, evaluates the existing water and sewer systems in Resolute Bay, NWT which includes the Char Lake Pumphouse, the Water Supply Main, the Signal Hill Reservoir and Treatment Plant, the piped Water Distribution System, the piped Sewage Collection System, the Sewage Comminution/ Outfall System and all related appurtenances. The evaluation of these systems include the following:

.1 Assessment of the condition of the existing water and sewer facilities and compliance with applicable codes, regulations and bylaws.

.2 Provide life cycle expectations, including both capital and annual O&M cost estimates, for the existing facilities.

.3 Provide recommendations, schematic options and Class "D" cost estimates for upgrading the existing Utilidor System and the existing Sewage Treatment Facility.

.4 Provide Class "D" estimates for the conversion of the existing utilidor system to a trucked system.

.5 Provide a recommendation as to the whether a Utilidor or Trucked System is the most suitable for Resolute Bay. The recommendation is to be based upon cost analysis (Class "D" estimates), annual maintenance costs, job creation, reliability, etc.

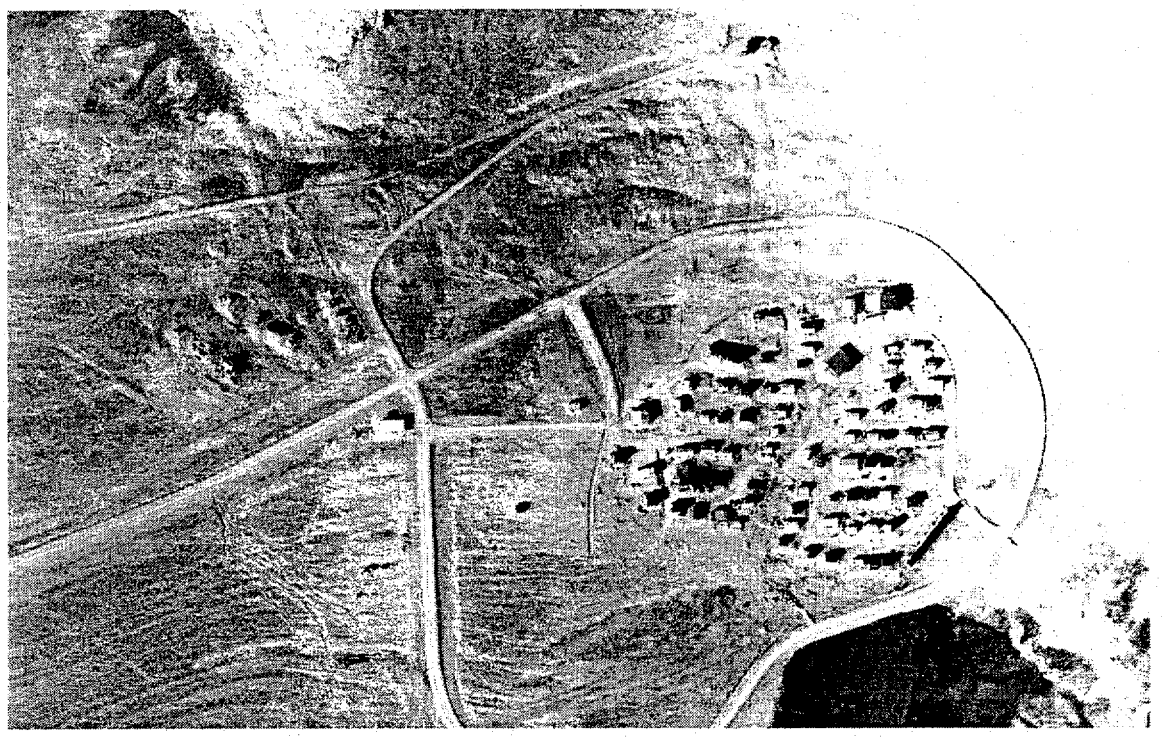
2.2 COMMUNITY INFORMATION

Resolute Bay is situated on the south shore of Cornwallis Island approximately 900 km north of the Arctic Circle and well within the continuous permafrost zone. It is about 1,660 air km northeast of Yellowknife and about 1,550 air km northwest of Iqaluit.

In the early 1970's, it was decided to relocate the existing settlement from the beach area south of Resolute Lake (South Camp) to a new site across the bay, near the beach and to the south of Signal Hill. At this time, government and private sector employment was anticipated for Resolute Bay which was expected to create a population of 900 in the mid 1970's and a population of 1,500 by the mid 1990's.

The proposed employment opportunities did not materialize, therefore the population of Resolute, which is classified as a settlement, has remained relatively stable and is presently at approximately 181 (Statistics, 1994).

FIGURE 2-1
RESOLUTE BAY TOWNSITE



2.3 EXISTING SYSTEM

The new townsite is served by a shallow buried insulated piped water and gravity sewer system with insulated concrete access vaults. This is commonly referred to as a "utilidor" system. This system was designed for a first stage population of approximately 900, with a fully developed townsite population of approximately 1,500. However, the current population is 181 and, as a result, system flows have been considerably below design rates requiring system and operational modifications for freeze protection.

The source of water for the townsite is Char Lake located approximately 1.5 km west of the townsite. Water is pumped through a 150 mm diameter insulated shallow buried electrically heat traced water supply line to the water treatment and storage facility located to the north of the townsite on the side of Signal Hill. The elevation of the storage facility is sufficient to provide gravity pressure to the townsite distribution system by the connecting trunk/water circulation mains.

The sewage discharge from the townsite is presently untreated except for dilution by system "bleeders" and comminution prior to discharge into the bay. The outfall pipe is located at the shore of the bay at the high tide water edge.

The emergency heat tracing throughout the utilidor system was abandoned in 1984/85 because of deterioration due to access vault water infiltration. Potable water is presently bled through the sewage system at five access vaults to provide minimum flow requirements and prevent freezing of the sewage system.

One of the higher water use facilities, the row housing unit, was taken out of service during the winter of 1981.

Pyrotenax heat tracing cable was installed in the pipeline from the Char Lake pumphouse to the Signal Hill water treatment plant in 1993 to replace the faulty Thermon Econotrace heat tracing cable which was originally installed in the line.

At present there is a total of approximately 60 buildings connected to the utilidor system. There are also a few buildings, including all buildings in South Camp, the Renewable Resources home and some perimeter lots, with trucked services. Water for these buildings is obtained from a truckfill connection at the Signal Hill Water Treatment Plant and the sewage is discharged at the shore of Resolute Bay near the outfall of the communitor station.

Buildings located near the airport in Resolute Bay also have trucked water and sewer services with water supply/sewage disposal facilities separate from the facilities for the Hamlet residents. The airport water and sewer systems are not within the scope of this report.

2.4 WATER CONSUMPTION

According to the Water Licence Inspection Reports for 1993 and 1994 (NAP, 1993 and DIAND, 1994), approximately 48,000 m^3 water was pumped from Char Lake each year for 1993 and 1994. According to Hamlet water meter documents (Hamlet, 1994), the community used 9,597 m^3 water from April 1993 to March 1994. Therefore, of the 48,000 m^3/yr. pumped from Char Lake, approximately 38,400 m^3/yr. is lost from the system through leakage or bleeding directly to the sewer.

Using the Water Licence water quantities and a population of 181 persons, the average total demand for Resolute Bay is 730 Lpcd. Using the Hamlet's quantity records, the average consumption demand is 145 Lpcd.

For a community with a population of 181 and piped water and sewer systems, GNWT guidelines (MACA, 1986) set a "design" water consumption rate at 225 LPCD. Table 2-1 provides population and water demand projections for three demand rates, including current demand rates without system losses and GNWT design rates for piped and trucked services.

TABLE 2-1
RESOLUTE BAY
POPULATION AND CONSUMPTION PROJECTIONS

Study Year	Year	Population	Growth Rate**	Volume Projections (cu.m./yr.)		
				Current Rate 145 lpcd*	GNWT Piped 225 lpcd	GNWT Trucked 90 lpcd
	1991	171		9,050	14,596	5,838
	1992	174	1.0191	9,223	14,885	5,954
	1993	178	1.0191	9,399	15,181	6,072
	1994	181	1.0191	9,579	15,482	6,193
1	1995	184	1.0191	9,762	15,790	6,316
2	1996	188	1.021	9,950	16,107	6,443
3	1997	193	1.0253	10,202	16,532	6,613
4	1998	198	1.0253	10,460	16,968	6,787
5	1999	203	1.0253	10,724	17,417	6,967
6	2000	208	1.0253	10,996	17,878	7,151
7	2001	213	2.404	11,273	18,350	7,340
8	2002	216	1.0128	11,417	18,596	7,438
9	2003	218	1.0128	11,563	18,845	7,538
10	2004	221	1.0128	11,711	19,098	7,639
11	2005	224	1.0128	11,861	19,354	7,742
12	2006	227	1.0128	12,014	19,616	7,846
13	2007	230	1.0128	12,168	19,879	7,952
14	2008	233	1.0128	12,324	20,147	8,059
15	2009	236	1.0128	12,481	20,418	8,167
16	2010	239	1.0128	12,641	20,693	8,277
17	2011	242	1.0128	12,803	20,972	8,389
18	2012	245	1.0128	12,967	21,255	8,502
19	2013	248	1.0128	13,133	21,541	8,617
20	2014	251	2.0161	13,301	21,832	8,733

* These projections do not include leakage or bleeding (currently estimated at 38,400 m^3 annually).

** Rates from Statistics, 1994.

3.0 ASSESSMENT OF EXISTING SYSTEM

The condition of the existing facilities has been determined by an on site investigation of the facilities which took place between June 14 and June 18, 1994 by UMA Engineering; discussions with local DPWS Maintainer, DPWS Staff in Iqaluit and residents of Resolute Bay; and a review of the Maintenance Management System records for the facilities.

A list of the major equipment in each facility, which was prepared during the 1994 site trip, is contained in Appendix III.

3.1 CHAR LAKE PUMPHOUSE

3.1.1 Operation of Facility

The Char Lake Pumphouse, as with other components of the water and sewer systems in Resolute Bay, is operating at flow rates much less than the original design conditions due to the population in Resolute not growing as anticipated at the time of the design of the facilities. In the case of the pumphouse, this reduced flow rate has mainly affected the water supply pumps. The pumps which were installed during the construction of the facility are rated for 760 L/min. (200 USGPM). At the current consumption rate of 132,000 L/day (48,000 m^3 per year) by the community and bleeders in the distribution system, these pumps would operate 173 min./day, which is approximately three 110 min. cycles every two days (based on pump start at 12.2 ft. and pump stop at 14.7 ft. water levels in Signal Hill Reservoir). Infrequent operation during periods of low demand would result in substantial periods of no flow in the Water Supply Main which would require energizing heat trace cable to keep the water from freezing in the pipeline. Rather than operate the heat trace for extended periods of time, a less costly alternative, consisting of two smaller "jockey" pumps rated for 95 L/min. (25 USGPM) to keep constant flow in the pipe and thereby prevent freezing, was installed.

Except for the addition of the two "jockey" pumps, the operation of the facility has not been altered significantly to accommodate the reduced flow rates in the system. The pumphouse operation, which is shown schematically in Figure 3-1, is as follows:

.1 Water is drawn from Char Lake through the buried intake line into the wet well.

.2 Hot water from the boiler(s) is injected into the wet well to maintain the wet well temperature at 10°C.