Volume 3 - Sewage Treatment and Future System Expansion

Final Report - Revision 1

May, 1999

Nunavut Water
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Volume 3 - Sewage Treatment and Future System Expansion
Resolute Bay, NT

Public Works & Services
Government of the Northwest Territories

98-5748-01-01

Submitted by

Dillon Consulting Limited

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1.0 INTRODUCTION

1.1 General

The Hamlet of Resolute Bay is serviced by a water supply system that uses a utilidor system to deliver water to houses and commercial users, and collect the sewage from these users. The water supply and sewage disposal systems are comprised of several components, namely:

- The raw water source known as Char Lake
- The Char Lake pumphouse
- The water supply line from the Char Lake pumphouse to the Water Treatment Plant (WTP)
- The utilidor system that is comprised of the water distribution system and the sewage collection system
- The Sewage Treatment Plant
- The sewage outfall.

The above components are shown in **Figure 1.1** and will be described in more detail in the body of the report. Previous studies (UMA 1996) assessed each of the system components for condition, expected remaining life and required remedial action to be undertaken to extend the current facility life to 20 years. The results of this study indicated that in general the facility components are well maintained, and will meet the Hamlet's requirements for the next 20 years. The exception is the utilidor system that has experienced a number of failures over the past 5 to 7 years. The increase in failures is of significant concern to the utilidor maintainers and the Hamlet Council.

The GNWT, Department of Municipal and Community Affairs (MACA) owns the assets of the water and sewer systems. The Department of Public Works & Services (DPW&S) completes the operation and maintenance on the systems. The GNWT has identified the transfer of the community assets to the communities as a priority. In this vein, the GNWT intends to transfer the water and sewer system to the Hamlet of Resolute Bay. Prior to the transfer of the facilities, the systems are to be upgraded to meet the requirements of the Hamlet for the 20 year design life. Dillon was retained to review the system in this light, and develop an upgrading plan for the sewage and water systems assuming that the piped distribution system will be maintained in the community. Three reports were produced, namely;

Volume 1 - Utilidor Upgrade
Volume 2 - Water System Building Assessment
Volume 3 - Sewage treatment and Future System Expansion

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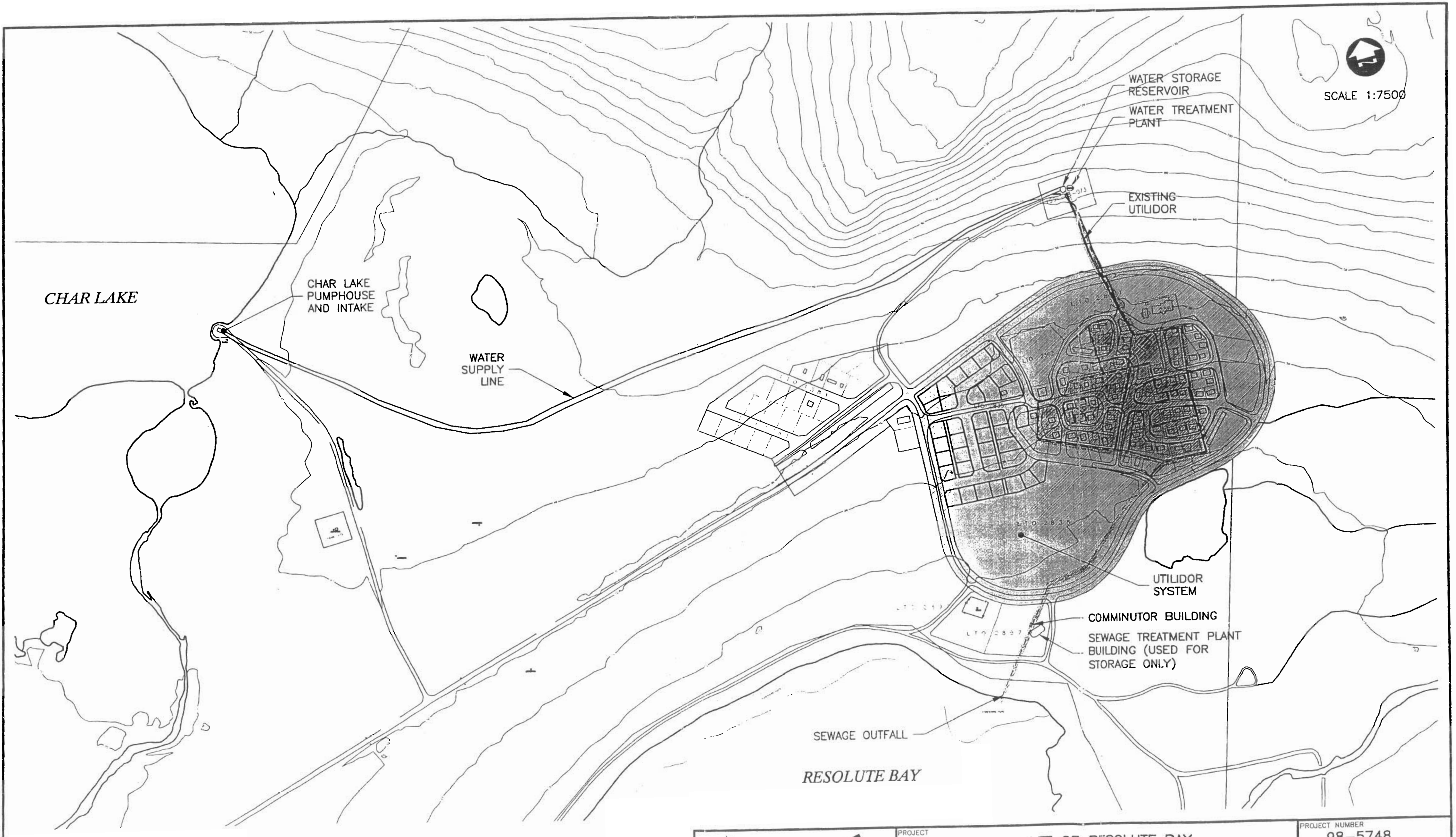

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PROJECT
HAMLET OF RESOLUTE BAY
UTILIDOR UPGRADE

TITLE
WATER SUPPLY AND
SEWAGE DISPOSAL SYSTEM

PROJECT NUMBER
98-5748

DATE
OCT 98

FIGURE NUMBER
FIG 1.1

1.2 Scope of work

The scope of work for this volume relates to the sewage discharge and the potential for the future expansion of the utilidor system.. A summary of the scope of work is described below:

- Complete a review of the existing documentation.
- Complete a site investigation to update the previous work.
- Complete a community consultation to determine the current perception of the impacts to the environment created by the sewage discharge.
- Debrief the system operator on his concerns, and review the system operator's records of the system.
- Complete a hydraulic model of the system to determine the requirement for system upgrades as the community grows.

2.0 EXISTING DATA REVIEW

2.1 Community Data

Resolute Bay is located on the south coast of Cornwallis Island and is about 1,660 km north east of Yellowknife and 1,550 Km north west of Iqaluit. The community is located at latitude N74-43-01 and longitude W94-58-10 (NAV CANADA). The average daily minimum and maximum temperatures for July and January are 1.3°C & 6.8°C and -35.8°C & -28.5°C respectively. An average of 50.4 mm of rainfall and 97.3 cm of snowfall for a total of 139.6 mm of precipitation is received each year (Environment Canada).

The community was founded in the early 1970's when it was decided to relocate the existing community from the beach area near the existing south camp to the present location. The development of the community and the initial infrastructure was based on a projected population of some 1,500 people. The expected growth was not realized and the current population is slightly less than 200 persons.

2.2 Population Projection

To be able to develop the system requirements it is necessary to determine the design flow rates for the piped system. The flow rates are based on the population of the community and the expected per capita consumption. The historic populations and per capita water use rates are based on the records found at the Hamlet's office, MACA's records and in previous reports (UMA, 1993, 1996). The population projections are based on the data supplied by the Bureau of Statistics. These are as follows:

Table 2.2.1

Population Projects from the Bureau of Statistics

Year	Population
1991	171
1992	174
1993	178
1994	181
1995	184
1996	197
2001	224
2006	238

The consumption is based on the formula developed by MACA (MACA, 1986) and on the historic consumption of the community. The formulae for predicting water consumption of communities with piped water distribution and populations less than 2,000 people is:

$$\text{Daily Consumption} = 225*(1 + 0.00023 * (\text{Population})) * \text{Population}$$

Based on this formula and the population projections shown in Table 2.2.1, the projected annual consumption for the Hamlet of Resolute Bay for the next 20 years can be predicted. The system uses bleed water from the watermains to provide freeze protection to the sewermains. The bleed water is not metered. The total water pumped into the system is metered, and the individual consumers are metered. The resultant of the water supplied to the system and the metered volume of the consumers is the total of the system losses. The total system losses include the bleed water, losses due to watermain breaks, and water losses within the system. Prior to 1996, this value was fairly constant at approximately 38,000 m^3 per year. As a result of increased problems with the system the amount of bleed water has increased in 1996 to 52,000 m^3 and again in 1997 to 56,000 m^3. *At the time of reporting, the Hamlet was projecting* an annual total consumption for 1998/99 of 55,000 m^3 of which 45,000 m^3 would be the bleeders and other system losses. For the purposes of water consumption projections the value of 45,000 m^3 of bleed water and other system losses is used. The projected annual consumption is shown in **Table 2.2.2.**

2.3 System Description

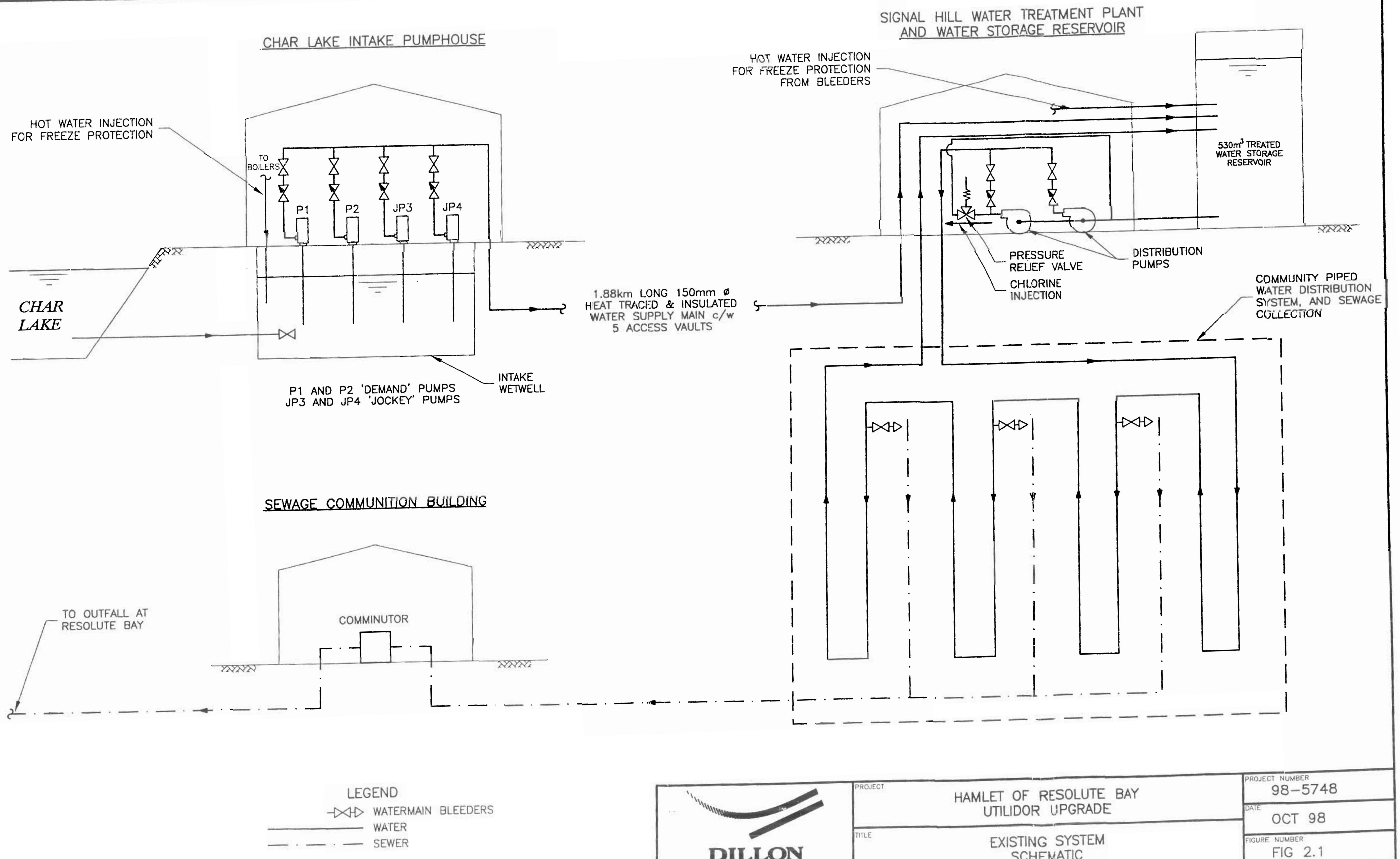
The following is a description of the complete water and sewage system from the up gradient intake to the down gradient sewer outfall. **Figure 2.1** illustrates this system in a schematic diagram.

Char Lake

- A ductile iron gravity intake line extends from Char Lake to wet wells in the Char Lake Pump House.
- Char Lake Pump House tempers the water using a hot water injection into the wet wells. Diesel fired boilers are used to heat the injection water. The tempered water is pumped through the 150 mm heat traced and insulated HDPE Water Supply Main to the Water Storage Reservoir at the Water Treatment Plant (WTP).
- Two jockey pumps and two demand pumps are operated in the Char Lake Pump House. Typically one jockey pump operates 24 hours a day, with one demand pump coming on for less than one hour per day. The second jockey pump and second demand pump are on-line standby pumps and are brought on-line automatically if the first pump fails.
- The Char Lake Pump House pumps are controlled from a level controller located in the Water Storage Reservoir. The controller has a high level alarm, jockey pump off, jockey pump on, demand pump off, demand pump on, and low level alarm control levels.
- A standby diesel engine generator is situated in the Char Lake Pump House in case of loss of power to the Pump House.

Table 2.2.2
Population and Consumption Projections

Design Year	Year	Population	Growth Rate	Consumtion lcd	Consumption Annual (historic)	Consumption Annual (MACA)	Bleeders Annual	Total Volume (Historic)	Total Volume (MACA)	Daily Average (Historic)	Daily Average (MACA)
	1991	171		145	9,050,175		38,400,000	47,450,175		130,000	
	1992	174	0.0175	145	9,208,950		38,400,000	47,608,950		130,435	
	1993	178	0.0230	145	9,420,650		38,400,000	47,820,650		131,015	
	1994	181	0.0169	145	9,579,425		38,400,000	47,979,425		131,450	
	1995	184	0.0166	145	9,738,200		38,400,000	48,138,200		131,885	
	1996	197	0.0707	145	10,426,225	16,911,678	51,868,684	62,294,909	68,780,362	142,106	188,439
	1997	205	0.0406	145	10,849,625	17,629,425	55,801,509	66,651,134	73,430,934	152,881	201,181
	1998	209	0.0195	145	11,061,325	17,989,204	45,000,000	56,061,325	62,989,204	123,288	172,573
0	1999	214	0.0239	145	11,325,950	18,439,779	45,000,000	56,325,950	63,439,779	123,288	173,808
1	2000	221	0.0327	145	11,696,425	19,072,170	45,000,000	56,696,425	64,072,170	123,288	175,540
2	2001	224	0.0136	145	11,855,200	19,343,762	45,000,000	56,855,200	64,343,762	123,288	176,284
3	2002	227	0.0134	145	12,013,975	19,615,693	45,000,000	57,013,975	64,615,693	123,288	177,029
4	2003	228	0.0044	145	12,066,900	19,706,413	45,000,000	57,066,900	64,706,413	123,288	177,278
5	2004	233	0.0219	145	12,331,525	20,160,576	45,000,000	57,331,525	65,160,576	123,288	178,522
6	2005	237	0.0172	145	12,543,225	20,524,587	45,000,000	57,543,225	65,524,587	123,288	179,519
7	2006	238	0.0042	145	12,596,150	20,615,684	45,000,000	57,596,150	65,615,684	123,288	179,769
8	2007	239	0.0042	145	12,649,298	20,707,204	45,000,000	57,649,298	65,707,204	123,288	180,020
9	2008	240	0.0042	145	12,702,671	20,799,148	45,000,000	57,702,671	65,799,148	123,288	180,272
10	2009	241	0.0042	145	12,756,269	20,891,519	45,000,000	57,756,269	65,891,519	123,288	180,525
11	2010	242	0.0042	145	12,810,093	20,984,318	45,000,000	57,810,093	65,984,318	123,288	180,779
12	2011	243	0.0042	145	12,864,144	21,077,548	45,000,000	57,864,144	66,077,548	123,288	181,034
13	2012	244	0.0042	145	12,918,423	21,171,212	45,000,000	57,918,423	66,171,212	123,288	181,291
14	2013	245	0.0042	145	12,972,931	21,265,310	45,000,000	57,972,931	66,265,310	123,288	181,549
15	2014	246	0.0042	145	13,027,669	21,359,846	45,000,000	58,027,669	66,359,846	123,288	181,808
16	2015	247	0.0042	145	13,082,638	21,454,821	45,000,000	58,082,638	66,454,821	123,288	182,068
17	2016	248	0.0042	145	13,137,839	21,550,239	45,000,000	58,137,839	66,550,239	123,288	182,329
18	2017	249	0.0042	145	13,193,273	21,646,100	45,000,000	58,193,273	66,646,100	123,288	182,592
19	2018	250	0.0042	145	13,248,941	21,742,407	45,000,000	58,248,941	66,742,407	123,288	182,856
20	2019	251	0.0042	145	13,304,843	21,839,163	45,000,000	58,304,843	66,839,163	123,288	183,121



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PROJECT	HAMLET OF RESOLUTE BAY UTILIDOR UPGRADE
TITLE	EXISTING SYSTEM SCHEMATIC
PROJECT NUMBER	98-5748
DATE	OCT 98
FIGURE NUMBER	FIG 2.1

Water Treatment Plant

- The Water Storage Reservoir is a steel 530 m^3 vertical steel tank constructed above grade. The tank is insulated and is freeze protected by the use of hot water injection.
- The Water Treatment Plant uses diesel fired boilers to provide tempering water for the Water Storage Reservoir hot water injection.
- The distribution water to the community is chlorinated using calcium hypochloride through injection pumps.
- The WTP uses pumps to provide distribution flow. The pressure is maintained at approximately 170 kPa (25 psi) at the WTP (October 1998 reading), and approximately 600 kPa (85 to 90 psi) at the low end of distribution system. The difference between the discharge pressure and the low end main pressure is the result of the static head difference in the mains due to elevation changes. The supply pump runs continuously at a constant rate of 1,700 rpm. The flow to the distribution mains is not regulated. Whatever water is not used within the distribution system is returned to the reservoir through the 150 mm return line.

Utilidor

- The distribution system is a looped HDPE insulated pipeline. The pipes are mostly 200 mm in diameter with two sections of 150 mm supply line and a 150 mm return line.
- Water is supplied to users (approximately 60 buildings) through a 20 mm copper heat traced (Stage 1A only) and insulated services. A return service is also installed from each building to the water main. Flow is moved continuously through the supply and return services by a small recirculation pump (1/4 h.p.) located in each building.
- The return water is directed back to the Water Storage Reservoir.
- The building sewage is collected using 100 mm insulated HDPE sewers to the sewer mains.
- The water and sewer services are in a common insulated jacket. The latent heat from the recirculation of the water services is used to freeze-protect the sewer service.
- Bleed water from the water mains is also used to provide freeze protection to the sewer mains during power failures when the water service recirculation pump is not operating
- The sewer mains are gravity run 150 mm insulated HDPE. These are installed in the same trench as the watermain.
- The sewermains and watermains are accessed through common concrete cast in place Access Vaults (AVs). The AVs contain all valves, hydrants, pipe connections and sewer clean outs.
- The sewer main is freeze-protected by the use of bleed water from the watermain to the sewermain. The bleeders are unmetered and located in the AVs.

Sewage Discharge

- The sewer mains join at the low end of the community and flow by gravity to a comminutor building.
- The sewage is macerated in this facility and discharged by gravity through an outfall pipe to the

shore line of the marine environment.

There have been several changes to the system since the original design. Some of these changes have been incorporated into the O&M manuals. The changes recorded during the site investigation completed on October 20 to 22, 1998 are from the discussions with the DPW Maintainer, Mr. Neil MacDonald, the Hamlet Administration, Mr. Dan Leman & Mr. Ralph, and from the existing documentation are as follows:

- A heat trace has been installed in the Water Supply Line from the Char Lake Pump House to the WTP in 1993. Five access vaults have been installed along this line as well. (Record Drawings)
- Two jockey pumps have been installed in the Char Lake Pump House.
- The utilidor heat trace system was abandoned in 1984 due to corrosion problems.(UMA, 1996)
- All electrical devices and service were removed from the Access Vaults in 1998. This includes the sump pumps, heat trace, and AV heaters. (N. Macdonald)
- The line to Block 1 is abandoned due to a freeze-up prior to 1986. The Health Centre water service currently uses the abandoned water main as a carrier pipe. The other buildings in this area are connected to the water and sewer mains between AV2 & 3. (N. MacDonald) The sewer service to the Health Centre is still in operation (D. Leman).
- The Hydrant in AV 20 was removed prior to 1986.
- AV 15 was never installed during the original construction. (N. MacDonald)
- A new hydrant was installed in 1998 in AV 13, (N. MacDonald)
- The valves in AV3 were replaced in 1998. These are the valves that were indicated to leak in the UMA 1996 report, but were incorrectly identified as AV2 valves in the UMA report (N. MacDonald).
- A new valve was installed in AV30 in 1998. This allows the section of main between AV21 and AV30 to be shut off. (N. MacDonald)
- The ventilation systems for the WTP and Char lake Pump House have been disabled and are blocked up in the winter. Combustion air for the facility burners is supplied through building envelope infiltration. It is reported by the DPW Maintainer that the buildings are very leaky and have poor insulation.

With respect to the utilidor system, there are no known changes made from the original construction other than the changes noted above. The complete system description and components is found in three sets of O&M Manuals. Copies of these manuals are stored in the community, DPW&S Iqaluit, and DPW&S Yellowknife.

3.0 REGULATORY COMPLIANCE OF THE UTILIDOR SYSTEM

3.1 The Public Health Act

The NWT Public Health Act (PHA) regulates the supply of potable water to consumers, and the methods for the collection of waste in the NWT. The applicable sections of the PHA are the"Consolidation of Public Water Supply Regulations, P-23" (PHA P - 23) and the "Consolidation of Public Sewerage Systems Regulations" (PHA P - 22). No other sections of the Public Health Act would relate directly to the water supply and sewage collection system. With respect to the utilidor system the requirements are set out in the in Part III of the PHA-P23.

The utilidor meets the requires of Part III of PHA-P23 except for the requirements of section 20.9 which states:

> "Where water and sewer pipes are contained in a utilidor, there shall be adequate provision for drainage in order to prevent contamination of the water supply during repairs to the system."

The AV's contain both water and sewer pipes. The sewer clean out covers have been removed to allow infiltration water to drain out of the AVs. This is an annual problem, as each spring run off water enters the AV and must be removed. This occurs from about June to October (N. MacDonald) and then the remaining water is pumped out of the AVs. The clean out cover remains open year round. This creates concern that in the event of a water main break a negative pressure in the watermain can be created within an upstream AV from a syphoning effect of the down stream main. If the watermain is not completely sealed, or during the repair of the water main, there is the possibility of cross contamination from the open sewer clean out. This is greatly reduced if the clean out is closed and sealed prior to the start of any maintenance on the water main system.

The PHA P - 22 has two requirements that are of issue for the utilidor system. The first is the same as described above. The second is the requirement for treatment for the sewage. The PHA P - 22 states in Part IV article 9:

> "Sewage treatment systems shall be designed to provide for adequate protection of the receiving water considering the possible uses of the receiving water"

This issue does not particularly relate to the operation of the utilidor system, but is raised as the UMA, 1996 report indicates that the Public Health Department required that sewage treatment is needed to meet the requirements of the Department. Based on the above section of the act, which is the only section of the PHA that addresses sewage treatment, there appears to be no specific requirement for treatment other than to protect the receiving body of water.

4.0 MODELLING

4.1 Water Distribution Network

4.1.1 Introduction

This section summarizes the development of the water distribution analysis model for the existing system and the 5 year proposed residential development in Resolute Bay, NT. Results of the analysis and recommendations are included.

4.1.2 Existing Conditions

There is approximately 2,500 m of pipe in the water distribution system. All water mains are 200 mm HDPE pipe with the exception of three 150 mm sections. A constant pressure of 150 kPa (20 psi) is provided at the water treatment plant to the distribution system. There are 20 mm bleeds into the sanitary sewer in AV17, AV19, AV22, and AV25. The outflow through these bleeds is approximately 5.25 l/s each.

The water is constantly being recirculated within the system with the aid of a 150 mm return line to the water treatment plant.

4.1.3 Future Conditions

An area to the southwest of the current community is proposed for 37 new residential lots. This will require approximately 1,090 m of 200 mm additional water main. A commercial area to the northwest is proposed but not expected to be developed within the next 5 years and therefore not included in the scope of this project. The connections to the existing system will be made at AV17 and AV11.

4.1.4 Hydraulic Model (EPANET)

EPANET is a computer program that performs extended simulation of hydraulic and water quality behaviour within pressurized pipe networks. A network can consist of pipes, nodes, pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, and the height of water in each tank during a multi-time period simulation. EPANET Version 1.1e was developed by the Water Supply and Water Resources Division, National Risk Management Research Laboratory of the U.S. Environmental Protection Agency in Cincinnati, Ohio.

4.1.4.1 Model Setup and Assumptions

Since the network is relatively small, each pipe is modelled individually. Existing details such as slopes, diameters, elevations and the configuration were obtained from the as-built drawings obtained from PW&S. Elevations and slopes for the proposed development were interpreted from contour mapping. A schematic diagram is shown for existing conditions in **Figure 4.1** and for future conditions in **Figure 4.2**.

The Hazen-Williams head loss equation is used. (h=fn(C,d,L,q))

The Hazen-Williams coefficient (C) for HDPE pipe is assumed to be 110.

The return line to the water treatment plant is modelled with a check valve to ensure one direction of flow. The node at the end of the return line is modelled as a reservoir with a constant elevation equal to the inflow elevation at the plant. The water reservoir is modelled with a constant head of 17.3 m to simulate the a constant pressure of 150 kPa (20 psi) leaving the plant.

Demands in Resolute Bay are based on an estimated number of units of 63 in the existing model and 113 for the future conditions, and 5 people per unit.

Unit consumption rates are as follows:

Average Day	225 Lpcd
Maximum Day	450 Lpcd
Peak Hour	900 Lpcd

Total water use in a community can be estimated as a function of residential water use(RWU) (MACA, 1986).

Total water use=RWU*(1+(.00023*population)) for a community of less than 1000 people.

Total water use is used in the model, residential and commercial flows are not distinguished.

The allocation of demands is based on the as-built drawings and approximated for the future development. For both existing and future conditions the following scenarios are modelled. Average day demand, maximum day demand, peak hour demands and average day demands plus fire flow at the worst location. The results of these runs is in appendix A.

EPANET Resolute Bay October 1998 Existing Conditions Schematic

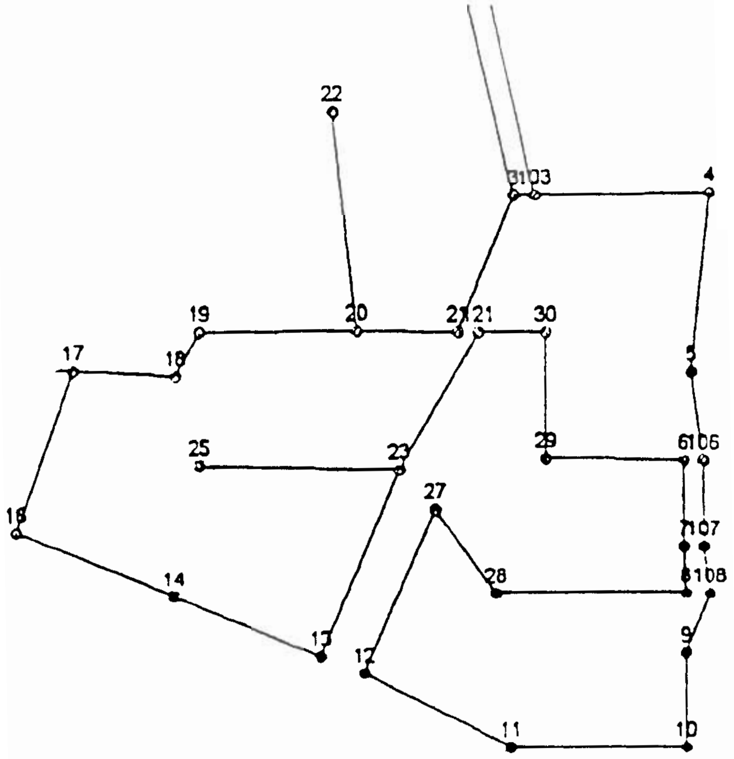

Figure 4.1

EPANET Resolute Bay October 1998 Future Conditions Schematic

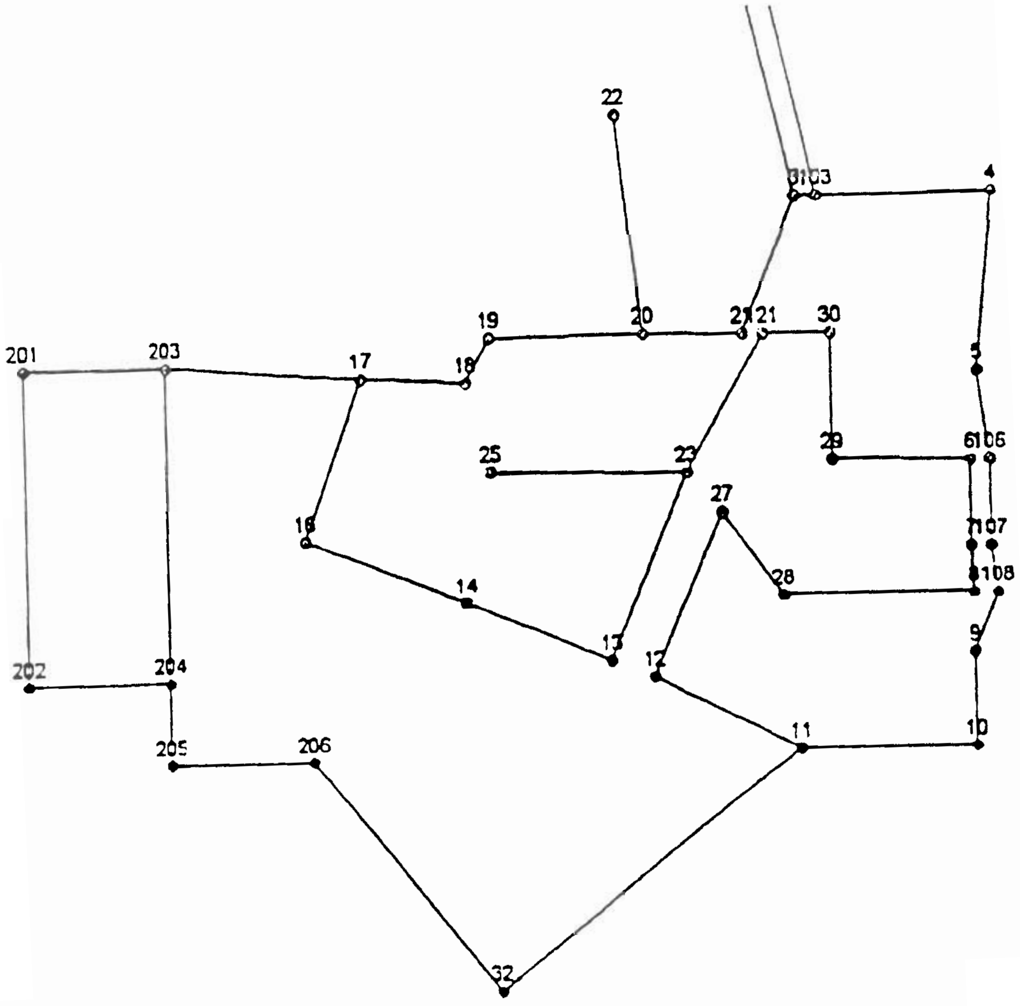

FIGURE 4.2

The fire flow rate based on MACA criteria is 3600 l/min for 2 hours during average day demands. Fire flows were simulated at the edges of the network and at the highest elevations to determine the worst case scenario and verify fire flows can be met. For existing conditions a fire at AV4 has the lowest pressures associated with it but the minimum pressure of 150 kPa can be easily maintained. For future conditions a fire at AV201 has the lowest pressures associated with it, but again the minimum of 150 kPa is maintained throughout the system.

The model was also run with pipe diameters of 150 mm instead of 200 mm to determine if the pipe size can be reduced, as the Community has not grown to the anticipated size. The model indicates that the 150 mm size is not sufficient to maintain the fire flow requirements.

4.2 Sanitary Sewer System

4.2.1 Introduction

This section summarizes the utilization of the existing sanitary sewer system, and estimates the peak hour flows for the 5 year proposed residential development in Resolute Bay, NT. Results of the analysis and recommendations are included.

4.2.2 Existing Conditions

There is approximately 2,500 m of sanitary sewer pipe. Most sewers are 150 mm HDPE pipe with five 200 mm sections at the downstream end of the system. There are 20 mm bleeds into the sanitary sewer in AV17, AV19, AV22, and AV25. The inflow through these bleeds is approximately 5.25 l/s each.

4.2.3 Future Conditions

An area to the southwest of the current community is proposed for 37 new residential lots. This will require approximately 768.5 m of 200 mm additional sewer pipe. A commercial area to the northwest is proposed but not expected to be developed within the next 5 years and therefore not included in the scope of this project. The connection to the existing system will be made at AV32. In addition to the existing 20 mm bleeds into the sanitary sewer, they were also added to AV201 and AV203 to prevent freezing.

4.2.4 Capacity Utilization Analysis

The full flow capacity of a circular pipe can be calculated using Manning's equation (Q=1/n*(A*R^2/3*S^1/2).

Model Setup and Assumptions

Each pipe with its details is identified in the spreadsheet shown for existing conditions in Table 4.1 and for the proposed development in Table 4.2. Existing details such as slopes, diameters, and the configuration were obtained from the as built drawings obtained from PW&S. Slopes for the proposed development were interpreted from contour mapping.

A schematic diagram is shown for existing conditions in **Figure 4.11** and for future conditions in **Figure 4.12**. The Manning's n coefficient for HDPE pipe is assumed to be 0.013.

Demands in Resolute Bay are based on an estimated number of units of 63 in the existing model and 113 for the future conditions, and 5 people per unit.

Unit consumption rates are as follows:

Average Day	225 Lpcd
Maximum Day	450 Lpcd
Peak Hour	900 Lpcd

Total water use in a community can be estimated as a function of residential water use(RWU) (MACA, 1986).

Total water use=RWU*(1+(.00023*population)) for a community of less than 1000 people.

It is assumed that waste water is equal to water use.

Results

Nearly all pipe in the system have adequate capacity to carry the peak hour flows. The exception is between AV11 and AV32 in the existing system due to a small slope, and between AV 11 and AV35 in the future system. The problem is solved by replacing the sewer pipes at these locations with 250 mm diameter pipe.

EPANET Resolute Bay October 1998 Existing Conditions Schematic

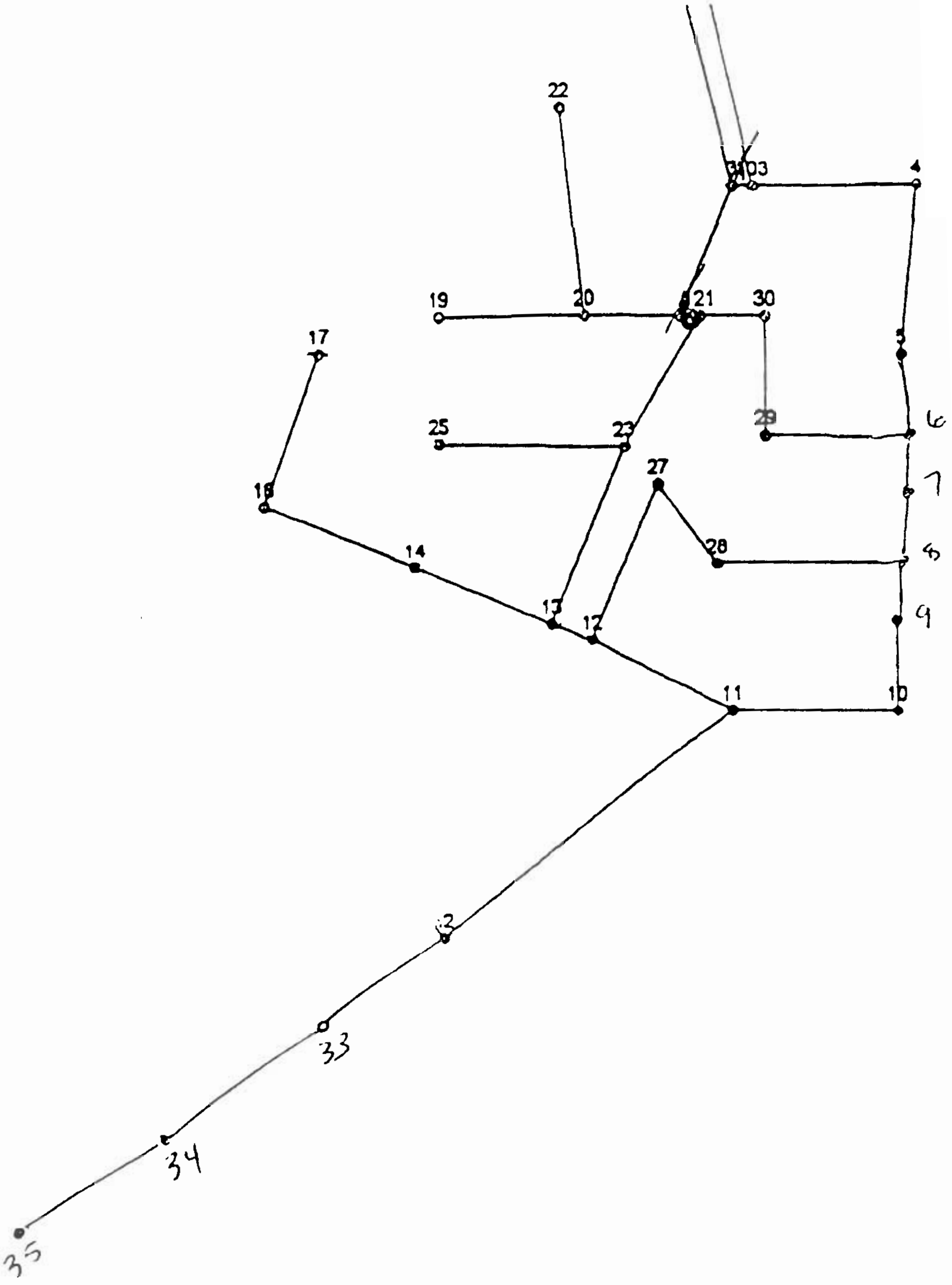

FIGURE 4 11

EPANET Resolute Bay October 1998 Future Conditions Schematic

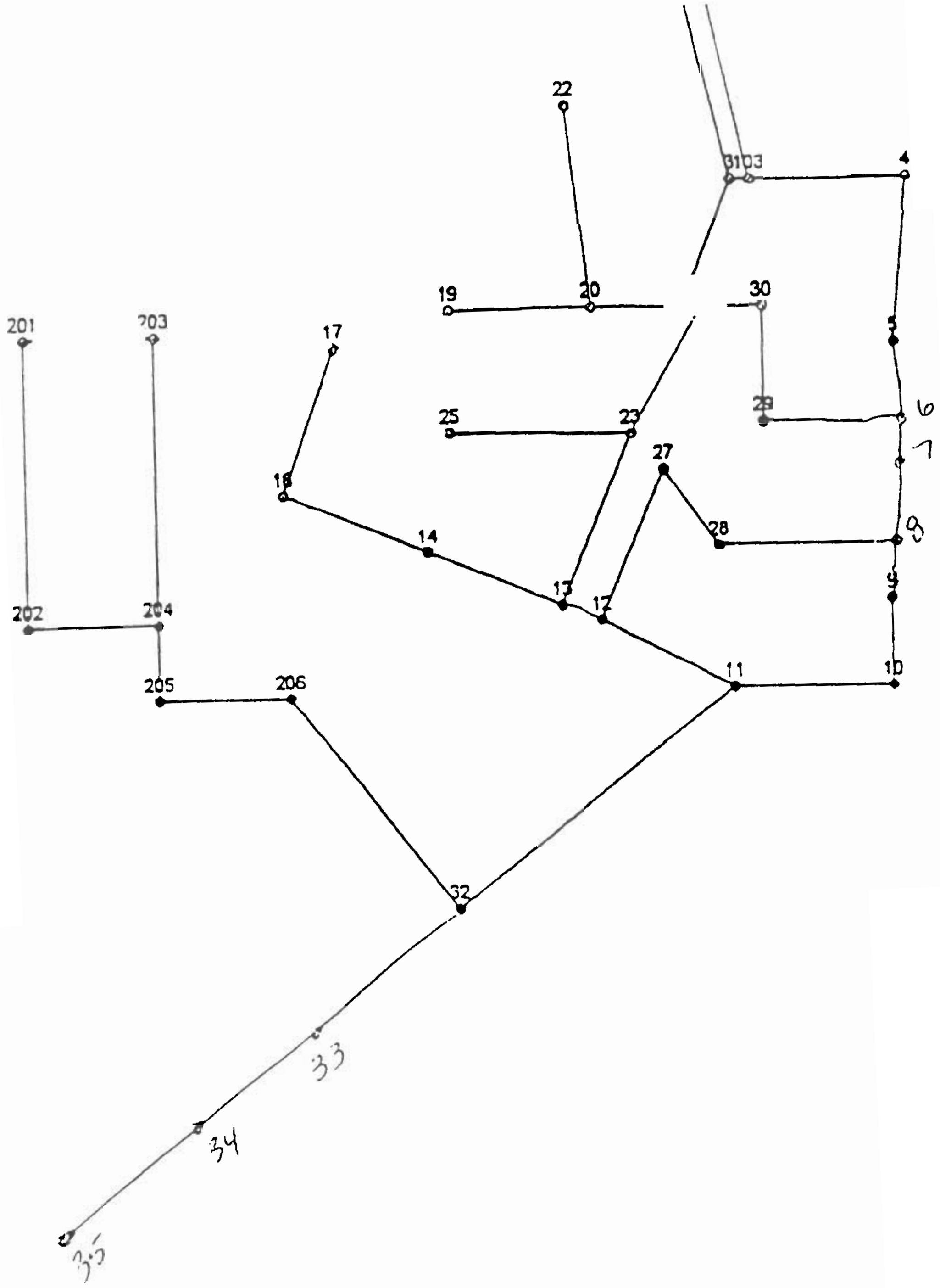

FIGURE 4.12

5.0 IMPACT STUDY

5.1 Introduction

This section presents an overview of the Environmental Impact Study (EIS) of the Hamlet's current sewage discharge practices to Resolute Bay. This study was initiated as a follow-up to a previous water and sewer facilities study by UMA Engineering Ltd. (1996). That study identified potential concerns relating to the Hamlet's sewage discharge with respect to health issues and components of the Federal Fisheries Act relating to the discharge of a deleterious substance.

The UMA Report reviewed the correspondence from the Baffin Region Medical Health Officer, and indicated that the sewage disposal system does not comply with the Public Health Act because, "*the discharge of sewage is directly into the ocean without any prior treatment*". However, the sewage does receive some treatment in the form of dilution from the bleed water.

There is uncertainty whether or not the sewage discharge complies with the Federal Fisheries Act as it relates to the introduction of a deleterious substance to a waterbody. It is not known if the current discharge would be considered deleterious, however, the UMA report states that the preparation of a DFO position brief on Resolute Bay is being considered. Currently, the status of the development of this position paper is unknown.

This EIS is based on existing environmental information for Resolute Bay, discussions with local residents, and Dillon's experience with similar studies (e.g. Repulse Bay Sewage Discharge - Preliminary Impact Assessment 1998). A major component of the EIS is a review of potential impacts of sewage discharge to the marine environment based on existing information. The EIS characterizes the existing environment of Resolute Bay including physical habitat characteristics, water quality, and marine flora and fauna. As part of this task data gaps or deficiencies have been identified to provide direction for a more detailed environmental assessment.

5.2 Potential Impacts of Discharging Sewage Waste to the Marine Environment

When wastewater is discharged to marine waters there are possible implications for the surrounding marine environment. The following discussion is intended to provide background regarding the potential environmental impacts of sewage to the marine environment.

The Department of Indian Affairs and Northern Development (DIAND, 1987), indicates that the principal components of sewage and the potential effects of these components to the receiving water body can be summarized in the following manner:

- *Organic Matter*: organic compound degradation may reduce the dissolved oxygen (DO) concentration of a receiving water body

- *Settleable Solids*: the benthic community structure may be altered if settling solids modify the particle size distribution of the sediments; localized anaerobic conditions may be a consequence of organic sediment decay

- *Inorganic Nutrients*: increased nitrogen and phosphorus levels could lead to increased primary production and hence decreased dissolved oxygen levels from microbial degradation of plant biomass at the sediments

- *Pathogenic Organisms*: the receiving water body may receive disease-causing bacteria and viruses

- *Residual Chlorine*: any chlorine remaining in the effluent that was used to reduce pathogenic micro-organism levels may be toxic to fish (not an issue in Resolute Bay)

- *Suspended Solids*: increased turbidity may alter fish migration patterns and reduce the amount of light available for photosynthesis

- *Floatables*: slowly degradable materials (i.e. fats, oils, plastic, rubber) may be aesthetically offensive if floating on the receiving water surface

Several of the impacts mentioned above are expanded upon in the following discussion as they relate to sewage discharge from coastal communities into the marine environment.

Of particular concern relating to impacts to the receiving environments is a potential decreased DO concentration due to the breakdown of organic matter, as well as the oxidation of hydrogen sulfide, ammonia, methane and iron compounds (DIAND, 1987). Anoxic conditions have been known to cause fish mortality in marine waters. Problems can arise where there is inadequate dilution or dispersion of an arctic communities sewage discharge which may result in anoxic conditions in the marine environment even when discharge is at relatively low volumes of sewage. DO reductions can also be exacerbated due to the long periods of ice-cover that effectively prevent atmospheric re-aeration. DIAND (1987) concluded that negligible decreases in dissolved oxygen levels could be expected in Arctic waters due to the small size of any one outfall, if dilutions greater than 100 to 200:1 are achieved.

The DO content immediately above the sediment and in its interstitial spaces may also decrease significantly due to organic compound decomposition. If the water at the level of the sediment were to become anoxic, this would have implications for the benthic and fish communities inhabiting this zone. In fact, Birtwell *et al.* (1983) suggested that the sediment chemical environment was a factor in the observed decrease in fish numbers near the sewage outfall of the Fraser River estuary. The accumulation of particulate organic matter may also have an effect on benthic invertebrates in the area and alter the relationships between benthic and pelagic trophic levels. Otte and Levings (1975) reported alterations in the benthic community associated with a sewage outfall discharging to the mud flats of the Fraser River estuary increased. The authors observed an increase in the number of individuals, biomass, and species with increasing distance from the discharge. The extent of impacts to the benthos community is dependent on many factors such as: the degree of deposition; the presence or absence of toxic materials; the decomposition rate of the organic matter; and any change to the characteristics of the sediment (i.e. particle size) (DIAND, 1987).

In addition to organic loading and decreased dissolved oxygen levels being potential consequences of sewage discharge, nutrient levels may increase in the marine environment, resulting in the stimulation of primary production. Welch (1980) has suggested that enhanced primary production as a result of increased nutrient levels may lead to increases in zooplankton production and biomass. However, during the open-water season, Arctic marine waters are likely nitrogen-limited, in addition to being light-limited when the sea is covered with ice (DIAND, 1987). Thus, it is unlikely that nitrogen loading from the relatively small sewage outfalls in the north will result in stimulating primary production to any noticeable degree. Furthermore, because zooplankton and phytoplankton are moved continuously through well-circulated areas, any local changes in species composition would likely not significantly alter the structure of the community (DIAND, 1987).

The potential impact of micro-organisms may also be a concern when sewage is discharged into Arctic marine waters. Faecal coliforms, such as *E. coli*, may contaminate local invertebrate species and hence pose a risk to human health if any of these organisms are harvested for consumption by the residents. Shellfish are of particular concern because they are filter feeders and tend to concentrate bacteria in their tissues. This makes shellfish harvesting for human consumption a potential risk. Coliform bacteria have a much higher survival in the Arctic, due to the cold temperatures and because there is less ultra violet light to provide natural disinfection in the winter months (DIAND, 1987).

It is suggested by DIAND, 1987 that sewage discharge to the marine environment from small northern communities may have an insignificant environmental impact at a regional level. There could be minimal impact at the local level if sewage is discharged to a not well-mixed waters where the effluent is not diluted. Any effects to the receiving water from raw or partially treated sewage may be limited to localized benthic impacts (DIAND, 1987). In addition, sewage generation rates for Resolute Bay, both in the present and predicted for future years, are relatively small.

5.3 Existing Environment

Information regarding the existing environment of Resolute Bay is extremely limited, and is generally restricted to marine studies completed in the early 1970's (see summary by Buchanan and Ragnit 1978). Several of the studies provide descriptions and information regarding the general marine biological characteristics of the Resolute Bay and Wellington Channel. Study components include physical measurements, phytoplankton, zooplankton, benthos, and fish.

The following sections provide brief summaries for each of these components or areas:

5.3.1 Physical Environment

The physical data summarized in this section is related to tides and winds. Tidal influences experienced by Resolute Bay are considerably less than those observed in other areas in the eastern Arctic. Resolute Bay has a mean tidal variation of 1.3 m and a maximum tidal variation of 2.1 m (UMA 1996).

Wind speed and direction information is particularly noteworthy as they have a direct effect on physical oceanography of an area and can play an important role in the behaviour and distribution of any pollutant. Mean wind speeds for Resolute Bay are reported to be between 10.4 and 12.6 mph with a predominant wind direction from the northwest (Bitello 1973 *cited in* Buchanan and Ragnit 1978).

5.3.2 Water Quality

Water quality monitoring has been completed periodically for the sewage discharge to Resolute Bay The water quality data includes a small sub-set of parameters from the final sewage discharge into Resolute Bay as well as from a station located 5-10 meters down current of the final discharge. Additional water quality information is available for comparative purposes for run-off from the solid waste disposal facility and for Char Lake waters.

Water quality data related to the sewage discharge are parameters pH, conductivity, total suspended solids, dissolved solids, biochemical oxygen demand (BOD), turbidity, total nitrogen, ammonia-N, nitrate, total phosphorus, and coliform bacteria. The effluent has not been characterized with respect to other parameters of potential concern such as metals or organics. Metal levels have been evaluated however, for the run-off from the solid waste disposal facility and for Char Lake.

The results of water quality monitoring completed between 1992 and 1997 for the Resolute Bay sewage discharge are presented in Table 5.1. Relevant guidelines and criteria have been included for comparison where possible. The solid waste site is not the subject of this assessment and is not discussed further in this report.

Generally, water quality is quite variable between sampling periods, although in all cases within relevant guidelines or criteria. The high variation is not surprising given that sampling likely took place over a wide range of physical conditions and as such may reflect tidal differences, wind- and wave-induced differences, etc.

Table 5.1

Water Quality Parameters at the sewage discharge to Resolute Bay and at a station located 5-10meters downcurrent of the discharge (data supplied by DIAND).

Parameter	Guideline/ Criteria	Sewage Discharge at End of Pipe (Stn 1571-3)					Resolute Bay[1] (Stn 1571-4)	Water Licence Criteria
		July 17, 1992	June 28, 1993	Aug. 17, 1994	July 26, 1996	July 8, 1997	July 17, 1992	
CONVENTIONAL PARAMETERS								
pH	7.0-8.7[2]	7.2	7.24		7.82	8.00; 8.03	7.39	6 to 9
Conductivity (uS/cm)	-	450	304			201	420	
Total Suspended Solids (mg/L)	1203	27	19	<3	10	15; 15	26	80
Dissolved Solids (mg/L)	-			260				
BOD (mg/L)	1003				76	15; 18		120
Turbidity (NTU)	-		15	2.9				
NUTRIENTS								
Nitrates/ Nitrites (mg/L)	-	<0.01	1.26	2.21			<0.01	
Ammonia-N (mg/L)	124			1.41	0.721	0.561; 0.597		
Nitrate (mg/L)	-			2.2				
Total Phosphorus (mg/L)	-	1.3	1.115	0.219			0.691	
BACTERIA								
Total Coliform (CFU/dL)	-				300,000	2,600,000		
Faecal Coliform (CFU/dL)	-				110,000	210,000		

Notes:

1- Resolute Bay 10m down current from discharge pipe.

2- CCME Interim Marine and Estuarine Water Quality Variable (December 1996)

3- Effluent discharge to a marine bay or fjord (Guidelines or the Discharge of Treated Municipal Wastewater in the Northwest Territories, 1992)

4- BCMoELP (Nordin 1990) *cited in* BCMoELP (1995) - water quality criteria for saltwater life. Ammonia to (T = 0°C; Salinity 30g/kg; pH = 7.6)

The range of pH, 7.0 to 8.7, is recommended by the Canadian Water Quality Interim Guidelines for marine and estuarine environments (CCME 1996). The guideline also states that within this range, pH should not vary by more than 0.2 pH units from the natural pH expected at that time. This is intended to protect marine organisms which have narrow pH tolerances. During the July 1992 sampling, the pH 5-10 meters down current of the effluent discharge point is almost 0.2 pH units higher that the pH at the point of discharge (Table 5.2) indicating that the sewage effluent may be resulting in a slight decrease in pH in the immediate vicinity of the discharge.

TSS levels were some what variable between sampling periods which is not surprising given that sewage strength will vary over the day. Diurial testing of the sewage discharge would be required to determine daily/weekly peaks for this parameter.

The Faecal and Total Coliform tests varied considerably (10 fold) over the tests. Like TSS this is an indication of varied sewer strengths. The fact that the FC levels are high when the BODs is low can not be explained. Logically, these levels should follow somewhat similar trends.

5.3.3 Phytoplankton

The following information regarding phytoplankton communities is summarized from Bain *et. al.* (1977 *cited in* Buchanan and Ragnit 1978).

Common "spring" phytoplankton species reported in the area include *Nitzschia grunowii,* followed to a less extent by *Nitzschia seriata*, and *Thalassiosira nordenstioeldii.* Common "Summer" phytoplankton species include *Chaetoceros socialis.* No differences in phytoplankton populations observed between sites sampled under ice and those sampled in open water, most likely due to the presence of strong southward moving currents in Wellington Channel. Similarity, phytoplankton communities demonstrated no consistent depth preference, again most likely due to physical influences such as tidal action and light intensity.

Phytoplankton communities reported along the Resolute Passage ice-edge sampled in early July exhibited low standing stock and differed considerably in composition from populations in the Wellington Channel.

Particularly noteworthy is a study by Welch and Kalff (1975 *cited in* Buchanan and Ragnit 1978) which presents measurements of marine photosynthesis and respiration in Resolute Bay. The authors reported chlorophyll concentrations in the water ranging from 0.001 - 0.1 mg/m^3 during the winter to 15 mg/m^3 in August. This information could potentially provide an interesting comparison to current conditions within Resolute Bay.

Potential impacts to phytoplankton populations due to the sewage discharge to the bay are expected to be minimal and restricted to the area in the immediate vicinity of the discharge point. Increased loadings of nutrients may result in a localized increase in phytoplankton productivity, however the magnitude of this increase would be determined by overall nutrient loadings, characteristics of the mixing zone, and physical aspects such as tidal and weather (ie. wind, waves, etc.) effects.

5.3.4 Zooplankton

Thirty-five zooplankton species were identified by Bain *et al.* (1977). The community was numerically dominated by copepods such as *Pseudocalanus* spp., but in terms of biomass the community was dominated by the copepods *Calanus glacialis* and *Calanus hyperboreus*. Barnacle nauplii were also extremely abundant in some samples. Unlike phytoplankton, pelagic and under-ice fauna are generally less abundant (Green and Steele 1975 *cited in* Buchanan and Ragnit 1978).

As with phytoplankton, potential impacts to zooplankton populations inhabiting Resolute Bay would most likely be minimal and restricted to the area in the immediate vicinity of the discharge point. Increased phytoplankton productivity due to nutrient loadings could potentially result in an associated increase in zooplankton productivity, but any increases would be expected to be small.

5.3.5 Benthic Invertebrates

Dominant benthic invertebrates reported (Green and Steele 1975 *cited in* Buchanan and Ragnit 1978) in Resolute Bay include:

- clams (*Mya truncata*)
- brittle star (*Ophiura sarsi*)
- starfish (*Lepasterias groenlandicus*)
- mud shrimp (*Sclerocrangon boreas*)
- isopods (*Munnopsis typica*)
- whelk (*Buccinum belcheri*)

Motile invertebrates such as amphipods are often concentrated at the tidal surface and as such provide an important food source to shorebirds and seabirds and fish, particularly Arctic char (Ellis and Wilce 1961).

Benthic invertebrates, including shellfish, within the sewage discharge area could potentially be impacted by contaminant loadings. Unlike phytoplankton and zooplankton which are directly influenced by tides and water currents, benthos form a relatively sedentary population which continually exposed (to varying degrees) to diluted sewage and associated contaminants, and as such, the health of the organisms reflect the quality of the environment they inhabit. Shellfish, such as clams can also bioaccumulate various contaminants such as metals. Shellfish also filter out coliform bacteria from the water column, resulting in a potential health risk to humans if the shellfish are harvested.

5.3.6 Fisheries and Marine Mammals

Available information regarding fish and marine mammal communities is extremely limited for Resolute Bay.

Fish species reported in the area include arctic cod (*Boreogadus saida*), and ninespine stickleback (*Pungitius pungitius*). All fish were found to be actively feeding on amphipods Several species of marine mammals are reported in the Resolute Bay area including Narwhal (*Monodon monoceros*), bowhead (*Balena mysticetus*), and white whales (*Delphinapterus leucas*)

Given the relatively low levels of discharge of sewage to Resolute Bay, fish and marine mammals communities are not likely to be directly impacted. Nutrient enrichment of the bay may in fact result in a localized increase in primary and secondary production (phytoplankton, zooplankton, benthos) which could potentially provide a greater food source for fish.

5.4 Public and Regulatory Agency Consultation

In an effort to further determine the status of a "Position Paper or Brief"(UMA 1996) regarding current sewage treatment and disposal for the Hamlet of Resolute Bay and authored by Fisheries and Oceans Canada and/or Environment Canada, several attempts have been made to contact appropriate staff from both federal agencies. However, no new information has been provided to establish what requirements may or may not be needed to further explore regulatory issues. This being the case, it is still unclear whether or not there are issues and concerns relating to sewage disposal that justify those requirements of the *Act*.

On November 4, 1998 an information session and consultation meeting was held at the Hamlet of Resolute Bay. This session was to provide Hamlet administrators and residents information regarding this study. An introduction to this study was provided to identify the scope of work being completed. The main focus of the meeting was to discuss the current and historical operational practices of sewage outfall and the perceived and potential environmental effects of the discharged wastes to the marine environment.

Consultation with the community consisted of an evening meeting at the Hamlet's community center. The meeting received publication through radio, television and newsprint media one week and again, one day prior to the event to ensure that community members were given adequate notice and the opportunity to attend.

Approximately 20 members of the community, including three Hamlet councilors and the Hamlet's Senior Administrative Officer (SAO), attended the session. Dillons' staff presented a study overview and described the intended scope of work through the use of overhead slides. One member of the community assisted in the presentation of materials to the community group by providing language translation services for both the presentation of information and follow-up inquiries from local residents. A copy of Dillon's presentation is provided in Appendix 1.

Provided below is a summary of those comments, questions and discussions brought forward by community members at the meeting;

- During certain times of the open water season and when specific wind patterns exist the smell of sewage is very apparent within the Hamlet;
- What were the concerns raised under the NWT Health Act, with respect to the sewage issue?
- What is a cut off population for which the existing type of utilidor facility structure is not appropriate?
- How far out into the bay does effluent travel beyond the immediate discharge point?
- During the open water season the beach or shoreline area, in the vicinity of the sewage outfall, is used as an access point for boating;
- The current discharge location is not considered appropriate, as it is limiting the community development, small boat access, and there are olfactory problems during the summer period;
- Successful hunters will bring their animals (primarily seals) to the beach area where they are partially butchered;
- Some hunting does occur in Resolute Bay. Baffin Health Board was to have conducted a study to determine any impact from the sewage outfall. Therefore the people of Resolute Bay submitted some food samples (seals, whales that were captured from all over, including the Bay) to DFO, but no results are available so far. Some seal liver and fat studies were also to have been conducted;
- Due to DFO's long-time presence in Resolute, they should be able to provide some information and documents to Dillon with respect to sewage issues;
- Resolute Bay is not a heavily fished area, due to the lack of fish. Shellfish and clams are not typically collected from the Bay area, but it was suggested that they be studied as these food items are considered as a delicacy by the local people;
- Schools of cod are noted to inhabit the bay area in the vicinity of the outfall, especially when forced close to the shore as a result of feeding whales in the area;
- The bay area is not specifically used by the community for fishing and the cod that are forced

into the near shore area are not typically fished;

- Raw sewage is visible along the shoreline area in close proximity to the outfall location;
- No particular care is taken with respect to the substances being flushed. It is unknown (to the people of Resolute) whether DPW has any problems with their cleaning facility;
- There were several questions raised with respect to the acceptability of the current system (only grinding, no treatment) and constant flow towards the Bay. The community suggested that they would like an upgrade to a cleaning process to be done (e.g., filters at the very least) or any other appropriate improvement;
- Although significant concerns regarding the discharge of sewage at this location were not voiced, the potential impacts of the discharged sewage to the marine environment were identified as not being well known to the community;
- Should there be the potential for impact to the marine environment at this location it was noted that further study should be conducted to confirm it's significance and to identify/incorporate potential changes to the current sewage treatment system that would minimize those impacts and any community concern;
- One alternative identified was the relocation of the piped outfall location from its' existing location to a location south along the shoreline away from shoreline areas of use;
- Deep water discharge (e.g., 10-20 m off shore) would also be an acceptable alternative, from the prospective of the boat access, quick freezing which typically happens in the winter (which would be avoided if the discharge would be somewhere further from the shore), and to establish a deeper water discharge location and the enhancement of potential mixing;
- Discussion included the identification of requirements of the federal *Fisheries Act* and how it might apply to the current sewage treatment system and discharge at Resolute Bay;
- Compliance requirements of the Nunuvat Water Board and the associated water licence were also discussed resulting in the identification of current and historical licence compliance with the required discharge requirements.

In summary, no significant issues were raised by the community with regard to the discharge of sewage to the marine environment. However, they acknowledged that they were not totally familiar with what maybe the potential impacts. Certain activities that involve the processing of hunted seals and other mammals are conducted within the Bay and near shore areas the sewage smells and wastes are obvious to the residents at certain times. Certain food items, such as clams, are opportunistically harvested from the outfall area. Based on these issues it was noted that further consideration of these potential impacts should be reviewed.

6.0 REMEDIAL SYSTEM NEEDS

6.1 Water Mains

Future Capacity

The system was designed for a population of 1,500 people and a consumption of 225 lcd. The total daily average consumption for the original design was approximately 340,000 l/day. The projected 20 year demand based on the current growth rate and bleeder rate is approximately 183,000 l/day. Section 4 developed and completed a model for the distribution system to verify that there is sufficient capacity for the peak demand and the fire flow requirements. The model indicates that the fire flow demand is met by operating a valve in AV3 during the fire flow conditions. This should be verified as part of the standard operating procedures for the facility Maintainer.

One section of sewer main AV11 to AV32 is required to be increased to 250 mm to meet the design flows.

The flow requirements for the proposed new subdivision can be met through the expansion of the existing system. The new areas can be serviced with a 150 mm pipe line for the Water mains and the sewer mains.

The model was also run using 150 mm piping throughout the system. This run indicates that the 150 mm size will not meet the 20 year demand of the community. Therefore all replacement piping should maintain the 200 mm pipe size for the water main.

It should be noted that a significant amount of the system capacity is consumed through the use of the bleeders. These bleeders are not metered for flows. It would be useful to have actual measurements of the bleeder flows, bleed water temperature, as well as sewer pipe temperatures throughout the system. These measurements can be used to assess the required bleeder rates with the indent to reduce the overall bleed water consumption. As the community expands, this will become necessary to allow for the expansion of the system beyond the 20 year horizon to the 40 year planning horizon. The metres can be mechanical type metres, identical to house water metres. They should be read on a weekly bases and recorded by the Hamlet, and/or the system Maintainer. The cost to install the metres would be approximately $2,000 per unit.

The measurement of the sewer temperatures should be completed for each leg of the sewer system. This will allow for the balancing of the bleed water. The sewer flow temperature should be measured weekly and recorded by the Hamlet and/or DPW&S Maintainer. The temperature metres can be installed for approximately $1,000 per unit.

Once a year of data is collected, the information can be used to determine the required flows on a seasonal bases for the bleeder system. This will need to be fine tuned through the continued recording of the bleeder flow metres and the sewer temperature readings.

6.2 Sewage Discharge

The limited water quality data collected from the sewage discharge to Resolute Bay, and a sampling location 5-10 metres down current from the discharge location, tends to indicate that there is localized impacts to the marine receiving environment. The extent or magnitude of these impacts cannot be determined in detail based on the extremely limited data collected to date for water quality and for the biota inhabiting the marine receiving environment.

The Hamlet of Resolute Bay currently meets the discharge requirements of their water licence issued by the Nunavut Water Board. It is also apparent from the results that the strengths of the sewage could be increased two or three times and still meet compliance. This may occur in the bleeding rate is decreased over time.

Regardless of the bleeder rate, the total mass loadings of the contaminant to the receiving environment will remain consistent. The long term environmental and human impacts are more related to the mass loading, rather than the concentration of the discharge. There are impacts related to "shocks" to the marine system created by sudden increases in the contaminants of concern. This would be related to at shore organisms, only. As such, a reduction in the bleeding rate by 1 or 2 fold is not expected to impact the effects of the sewage and the receiving environment. To determine the long term impact of the sewage mass loadings, there is the requirement to collect and assess data at the marine environment. A summary is shown in **Table 5.2**.

Table 5.2
Summary of Information Required for Detailed Impact Assessment

Information/Data Required	Rationale
Physical	
- tidal information, wind speeds, wind directions, wave climate, etc.	- this information will help determine the magnitude and extent of any plume, etc. - also help address any dilution issues - much of this information should be readily available from Environment Canada
Chemical (i.e. water and sediment quality)	
- more detailed characterization of effluent and receiving environment water quality.	- current annual sampling results do not provide the necessary detail to assess diurnal variation in effluent characteristics - the current program also does not assist in the determination of the spatial extent of any effluent plume - this information would be used to determine average effluent concentrations
- include a control location in any sampling program perhaps in an adjacent bay	- control site data will provide a good comparison to sewage discharge results
- evaluation of dissolved oxygen levels within Resolute Bay	- given concerns with respect to oxygen depletion in the bay it would be worthwhile to determine oxygen levels in the bay particularly under the ice-cover.
- characterize sediment quality with the receiving environment	- determine distribution of any contaminants within the marine sediments - sampling program would be designed to delineate impacts from the sewage discharge and those potentially from the solid waste disposal site.
Biological	
Shellfish, such as clams (*Mya truncata)* should be sampled to assess potential shellfish contamination	- elevated coliform levels observed in the vicinity of the discharge could potentially result in shellfish contamination - clams are also excellent biomonitors for other contaminants such as metals.
Benthic-invertebrate communities	- benthic invertebrates provide excellent indicators of overall environmental quality - benthos information can be related back to water and sediment quality data to assess impacts

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APPENDIX A

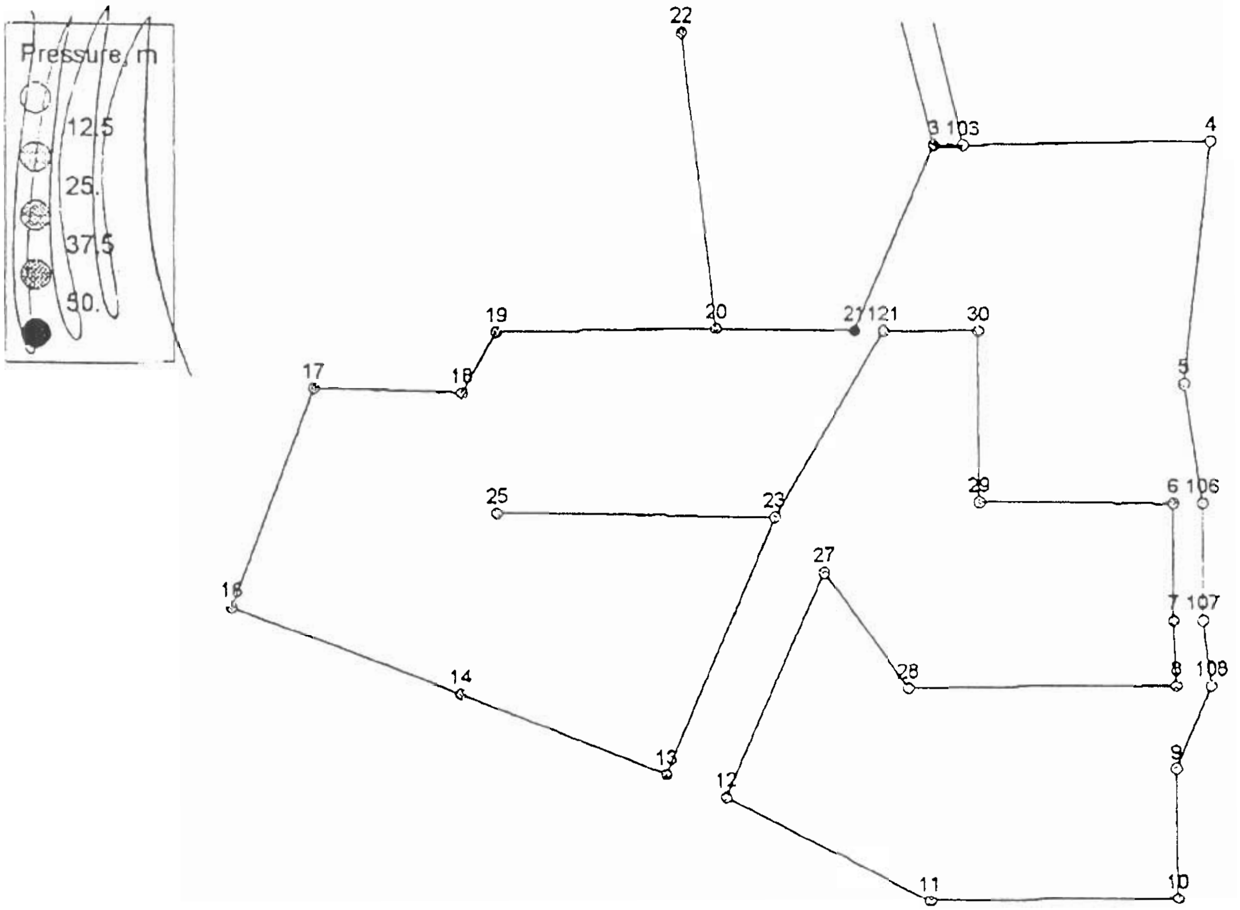
Pipe Network Model Results

```
[TITLE]
EPANET Resolute Bay October 1998 Run 1 Existing Conditions
;Vavle at AV3 open
[JUNCTIONS]
;-----------------------------------------------------------------
;            Node        Elevation      Demand   Pattern
;                           (m)         (homes)
;-----------------------------------------------------------------
;            101           71.68
               2           36.48
               3           25.44          2
             103           25.44
               4           26.51          3
               5           18.78          4
               6           16.55          4
             106           16.55          2
               7           14.12
             107           14.12          3
               8           12.96          4
             108           12.96          1
               9           11.60          5
              10            9.65
              11            9.14          3
              12           12.95          3
              13           13.82          1
              14           16.87          3
              16           19.66          1
              17           22.77
              18           21.50
              19           22.34          5
              20           21.14          3
              21           20.93          2
             121           20.93
              22           28.17          1
              23           17.11          2
              25           19.41          4
              27           16.72          2
              28           13.72          3
              29           17.08          1
              30           20.48          1
[DEMANDS]
MULTIPLY    .01302   ;225 lpcd * 1/(24*3600) * 5 peolpe/dwelling
;
;  System bleeds  (l/s)
;  Node         Demand    Pattern
    17           5.25
    19           5.25
    22           5.25
    25           5.25
    30          1            2
     4          1            3
;
;
;
[TANKS]
;--------------------------------------------------------------------------
;    Node       Elevation       Initial     Minimum    Maximum     Diameter
;     (m)          (m)            (m)         (m)        (m)          (m)
;--------------------------------------------------------------------------
      1          88.98
```

```
    101         71.68
;
[PIPES]
;-----------------------------------------------------------------------------
;      Pipe            Start           End          Length         Diameter        C
;                                                    (m)            (m)
;-----------------------------------------------------------------------------
         1              1               2           211.15          200          110
         2              2               3           118.26          200          110
; open valve between 3 and 103 for fire flows
       103            103             101           329.41          150          110   CV
       203              3             103            10.0           200          110
         3              3              21            70.71          200          110
         4              4             103            93.38          200          110
         5              5               4            86.74          200          110
         6            106               5            41.59          200          110
       107            106             107            41.45          200          110
       108            107             108            22.86          200          110
       109              9             108            22.57          200          110
         7              6               7            41.45          200          110
         8              7               8            22.86          200          110
        10             10               9            46.02          200          110
        11             10              11            83.82          200          110
        12             12              11            78.82          200          110
        14             14              13            78.16          200          110
        16             16              14            83.23          200          110
        17             17              16            80.36          200          110
        18             18              17            50.94          200          110
        19             19              18            24.24          200          110
        20             20              19            76.45          200          110
        21             21              20            48.23          200          110
        22             22              20           105.20          150          110
        23             13              23            98.15          200          110
        25             25              23            98.27          150          110
        26             27              12            86.00          200          110
        27             28              27            69.27          200          110
        28              8              28            91.03          200          110
        29             29               6            66.75          200          110
        30             30              29            60.66          200          110
        31            121              30            41.89          200          110
        32             23             121            70.33          200          110
[PATTERNS]
;Pattern 1: first hour is avg day, second is max day,
;           third is peak hour, others are avg day plus fire
;
1 1.0  2.0  4.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0
2 0.0  0.0  0.0 60.0 60.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
3 0.0  0.0  0.0  0.0  0.0 60.0 60.0  0.0  0.0  0.0  0.0  0.0
4 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
5 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
;
;
[TIMES]
DURATION 6
PATTERN TIMESTEP 1
[OPTIONS]
UNITS      SI
MAP exist.map
[END]
```

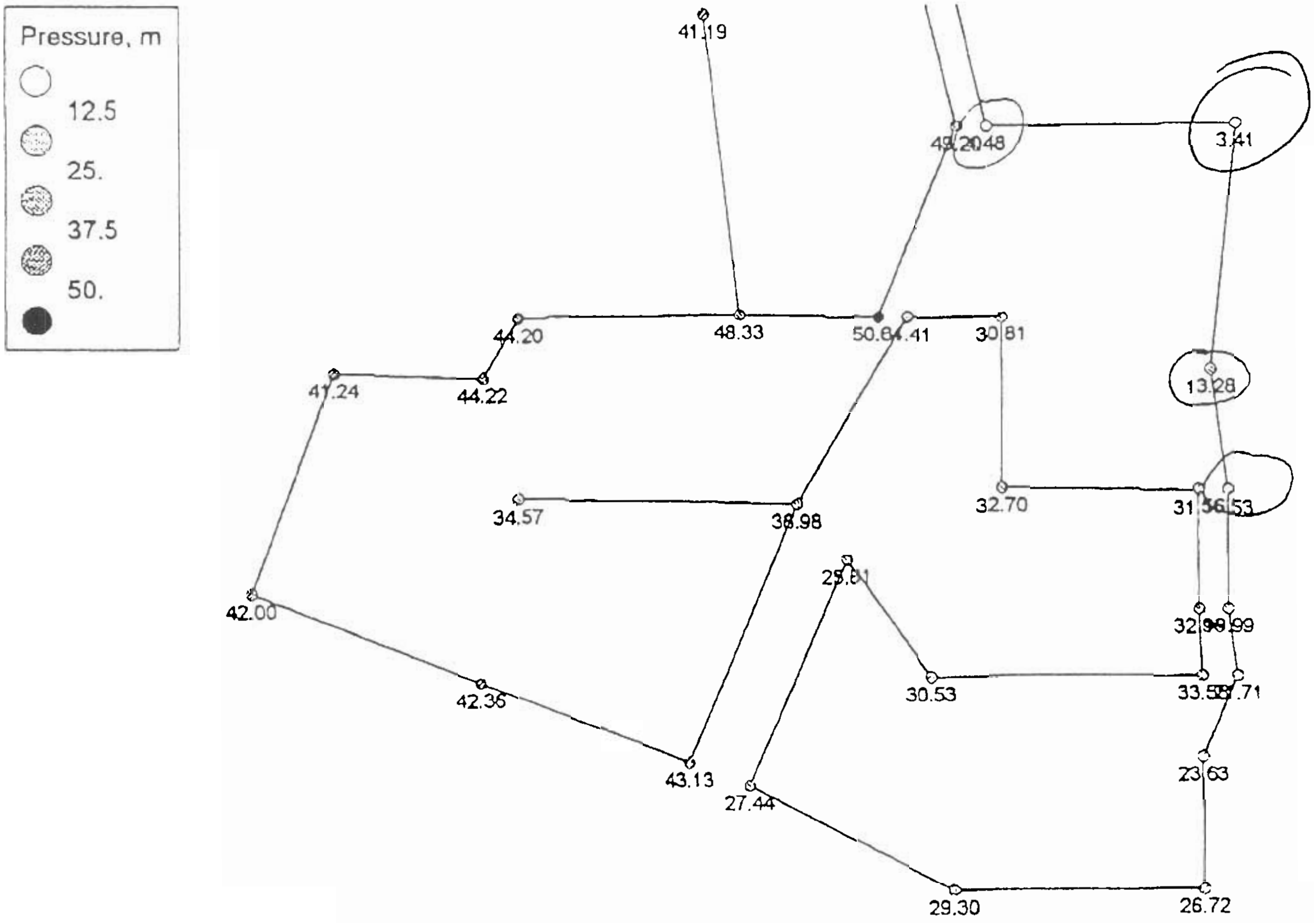
NETWORK SCHEMATIC

EPANET Resolute Bay October 1998 Run 1 Existing Conditions (6:00 hrs)



NO CONNECTION AT AV3 - AV103

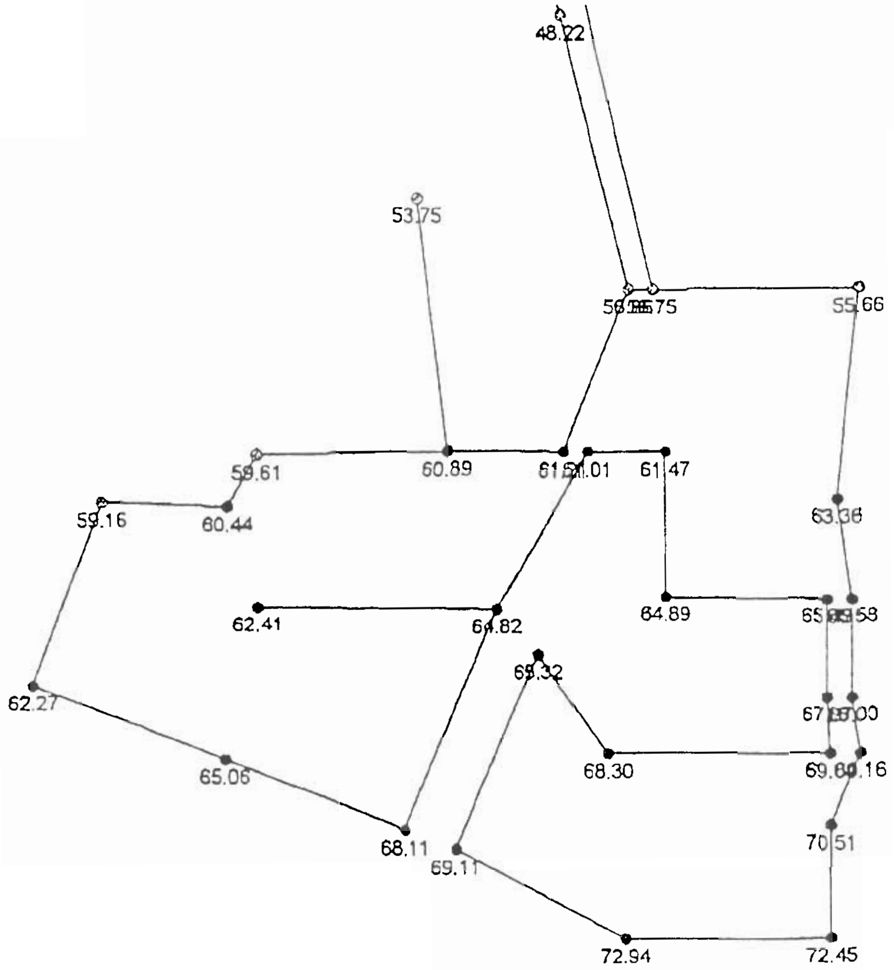
EPANET Resolute Bay October 1998 Run 1 Existing Conditions (5:00 hrs)



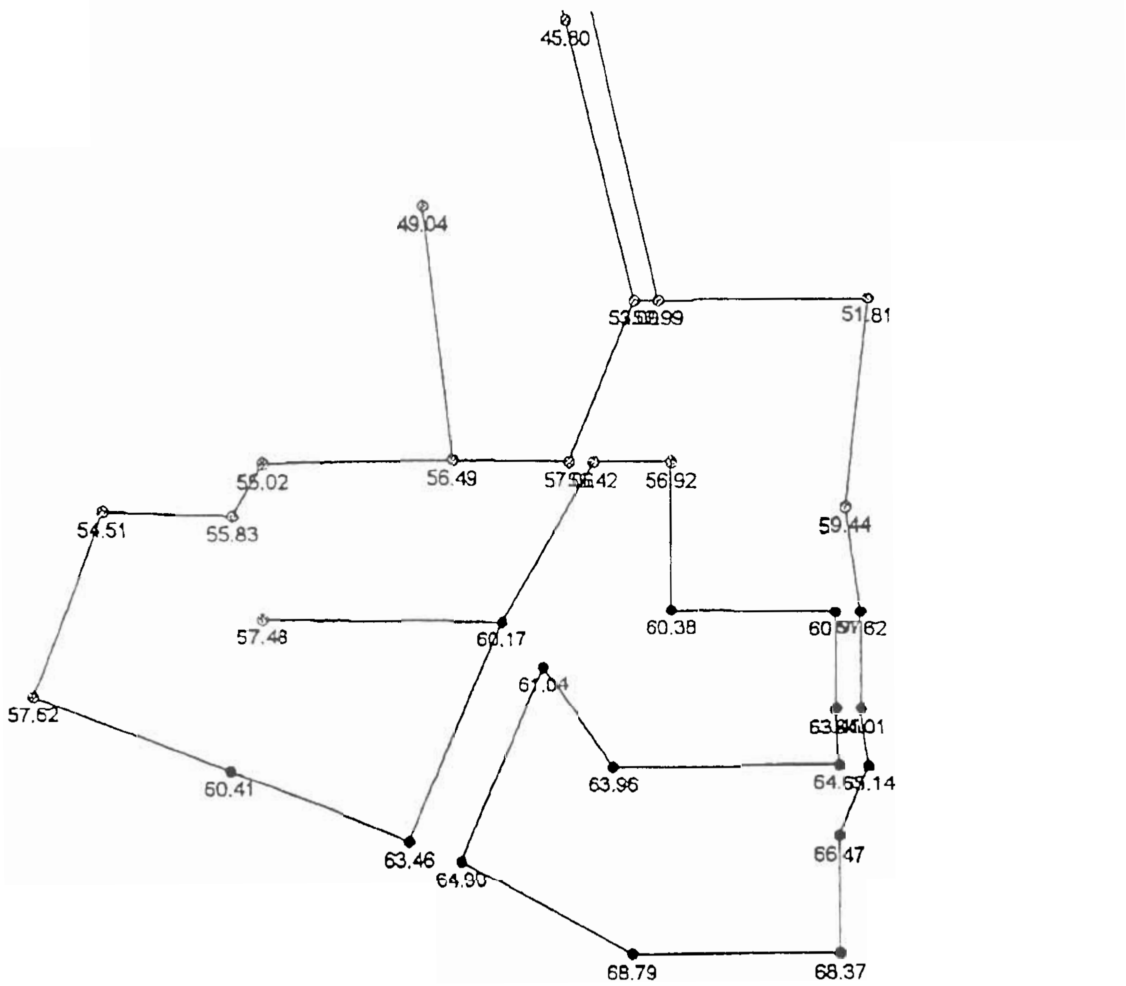
FIRE AT 4

Min pressures not met at ~~3~~ 4 nodes.
of 150kPa

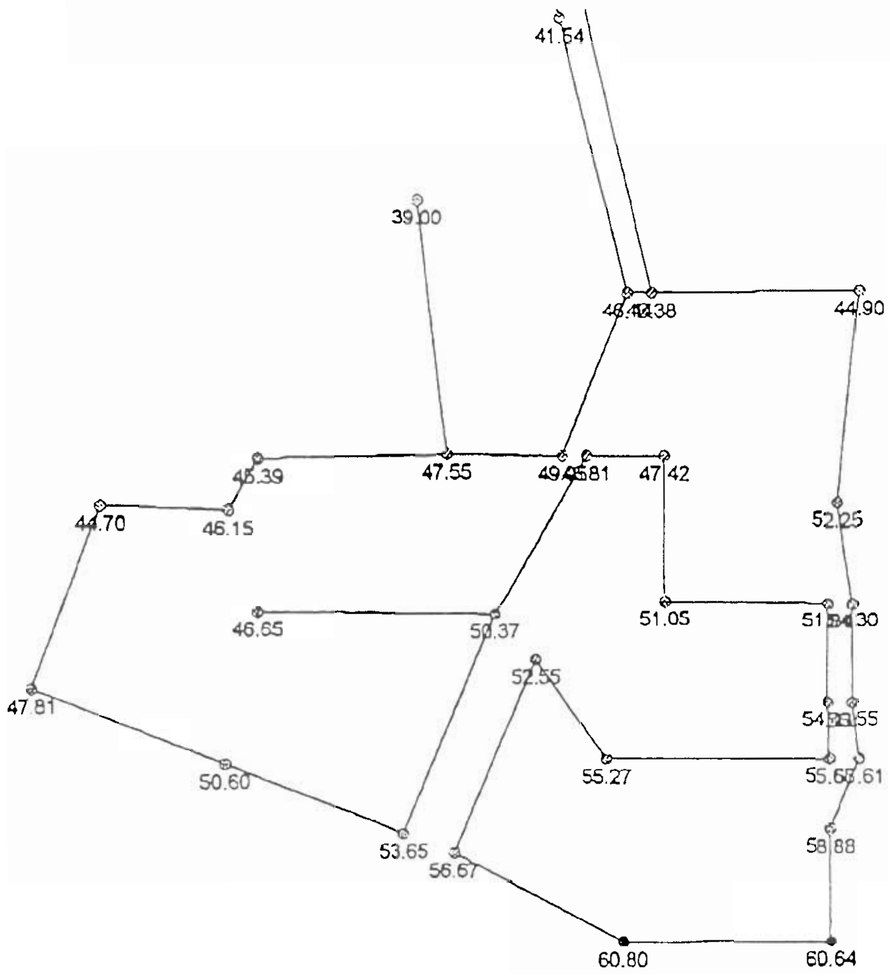
EPANET Resolute Bay October 1998 Run 1 Existing Conditions Avg Day



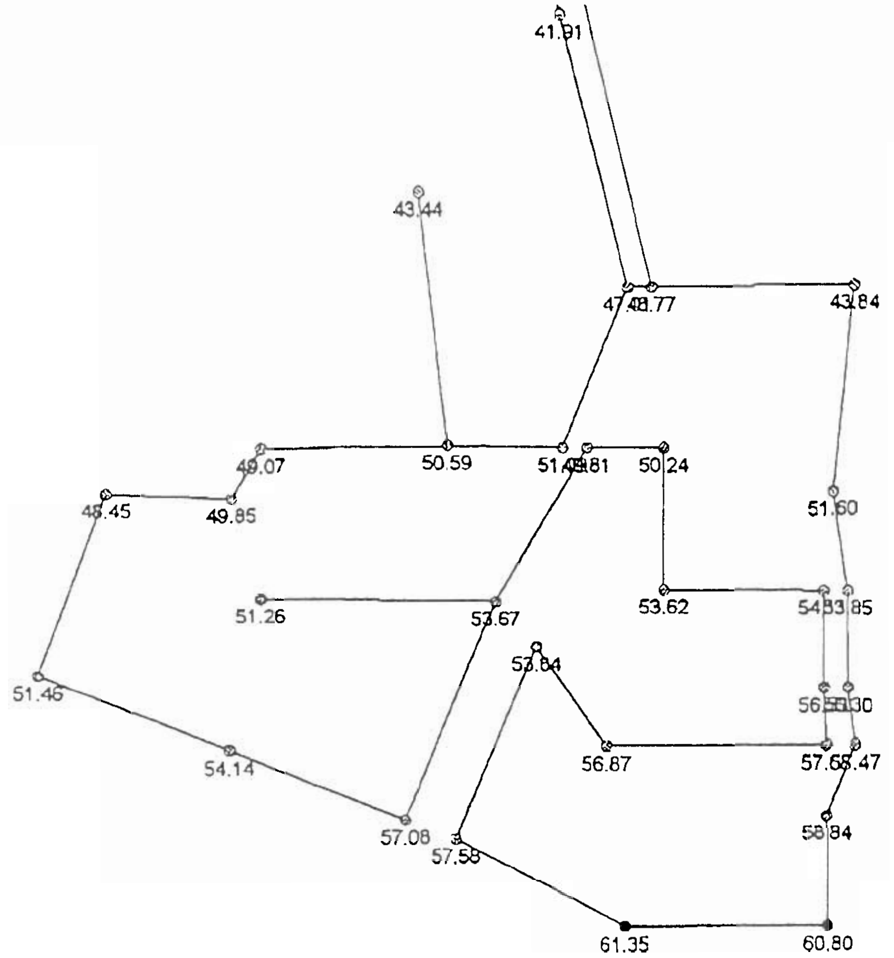
EPANET Resolute Bay October 1998 Run 1 Existing Conditions Max Day



EPANET Resolute Bay October 1998 Run 1 Existing Conditions Peak Hour



EPANET Resolute Bay October 1998 Run 1 Existing Conditions Avg Day plus Fire at 4

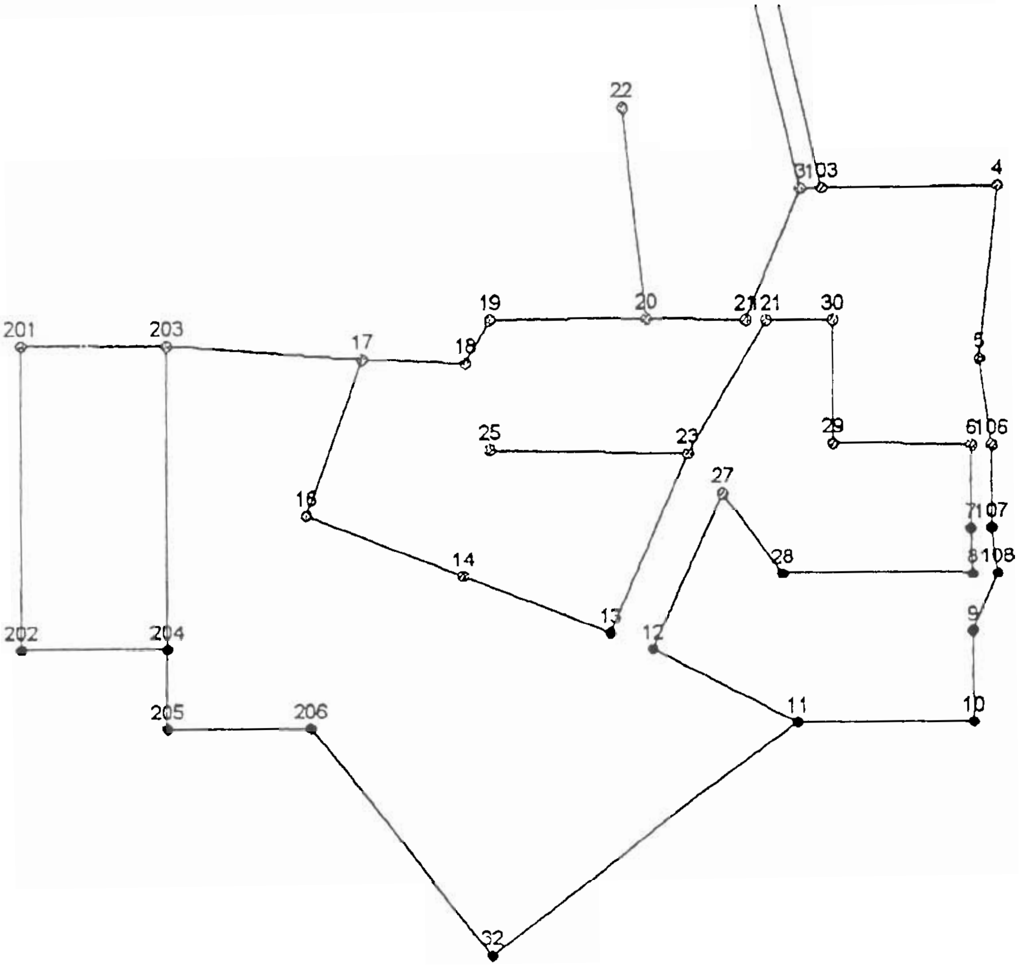


```
[TITLE]
EPANET Resolute Bay October 1998 Run 2 Future Conditions
;Valve at AV3 open
[JUNCTIONS]
;-----------------------------------------------------------------------------
;            Node        Elevation     Demand   Pattern
;                           (m)         (homes)
;-----------------------------------------------------------------------------
;            101           71.68
               2          36.48
               3          25.44           2
             103          25.44
               4          26.51           3
               5          18.78           4
               6          16.55           4
             106          16.55           2
               7          14.12
             107          14.12           3
               8          12.96           4
             108          12.96           1
               9          11.60           5
              10           9.65
              11           9.14           3
              12          12.95           3
              13          13.82           2
              14          16.87           6
              16          19.66           4
              17          22.77
              18          21.50
              19          22.34           5
              20          21.14           3
              21          20.93           2
             121          20.93
              22          28.17           4
              23          17.11           2
              25          19.41           4
              27          16.72           2
              28          13.72           3
              29          17.08           1
              30          20.48           1
; future conditions, elevations are approximate
             201          25.0            5
             202          14.0            8
             203          25.0            5
             204          14.0            8
             205          13.0            3
             206          13.0            5
              32           9.0            3
 DEMANDS]
MULTIPLY    .01302   ;225 lpcd * 1/(24*3600) * 5 peolpe/dwelling
.
   System bleeds  (l/s)
,  Node        Demand   Pattern
    17          5.25
    19          5.25
    22          5.25
    25          5.25
   201          5.25
   203          5.25
   201        1              2
```

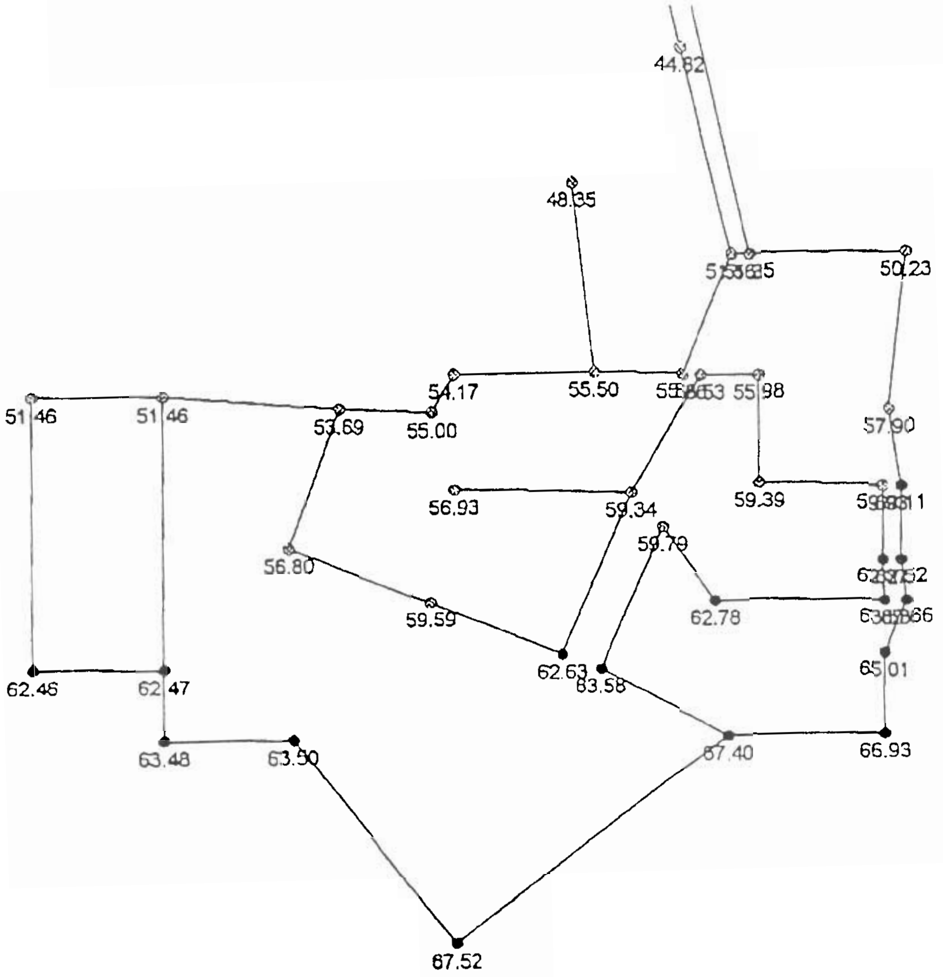
```
   205          1                3
    32          1                4
;
;
[TANKS]
;-------------------------------------------------------------------------------------
;     Node         Elevation        Initial       Minimum    Maximum     Diameter
;      (m)           (m)              (m)           (m)        (m)         (m)
;-------------------------------------------------------------------------------------
         1         88.98
       101         71.68
;
[PIPES]
;-------------------------------------------------------------------------------------
;       Pipe            Start            End          Length         Diameter        C
;                                                      (m)            (m)
;-------------------------------------------------------------------------------------
         1               1                2           211.15           200          110
         2               2                3           118.26           200          110
         2003          103                3            10.0            200          110
          103          103              101           329.41           200          110   CV
         3               3               21            70.71           200          110
         4               4              103            93.38           200          110
         5               5                4            86.74           200          110
         6             106                5            41.59           200          110
       107             106              107            41.45           200          110
       108             107              108            22.86           200          110
       109               9              108            22.57           200          110
         7               6                7            41.45           200          110
         8               7                8            22.86           200          110
        10              10                9            46.02           200          110
        11              10               11            83.82           200          110
        12              12               11            78.82           200          110
        14              14               13            78.16           200          110
        16              16               14            83.23           200          110
        17              17               16            80.36           200          110
        18              18               17            50.94           200          110
        19              19               18            24.24           200          110
        20              20               19            76.45           200          110
        21              21               20            48.23           200          110
        22              22               20           105.20           150          110
        23              13               23            98.15           200          110
        25              25               23            98.27           150          110
        26              27               12            86.00           200          110
        27              28               27            69.27           200          110
        28               8               28            91.03           200          110
        29              29                6            66.75           200          110
        30              30               29            60.66           200          110
        31             121               30            41.89           200          110
        32              23              121            70.33           200          110
;   future conditions
        203             17              203           122.5            200          110
        201            203              201           105.0            200          110
        204            203              204           157.0            200          110
        202            201              202           157.0            200          110
        304            202              204           105.0            200          110
        205            204              205            70.0            200          110
        206            205              206           122.5            200          110
        232            206               32           157.0            200          110
        211             32               11            91.44           200          110
```

```
[PATTERNS]
;Pattern 1: first hour is avg day, second is max day,
;           third is peak hour, others are avg day plus fire
;
1 1.0   2.0  4.0   1.0  1.0   1.0   1.0  1.0   1.0  1.0  1.0  1.0
2 0.0   0.0  0.0  60.0 60.0   0.0   0.0  0.0   0.0  0.0  0.0  0.0
3 0.0   0.0  0.0   0.0  0.0  60.0  60.0  0.0   0.0  0.0  0.0  0.0
4 0.0   0.0  0.0   0.0  0.0   0.0   0.0 60.0  60.0  0.0  0.0  0.0
5 0.0   0.0  0.0   0.0  0.0   0.0   0.0  0.0   0.0  0.0  0.0  0.0
;
;
[TIMES]
DURATION 8
PATTERN TIMESTEP 1
[OPTIONS]
UNITS      SI
MAP future.map
[END]
```

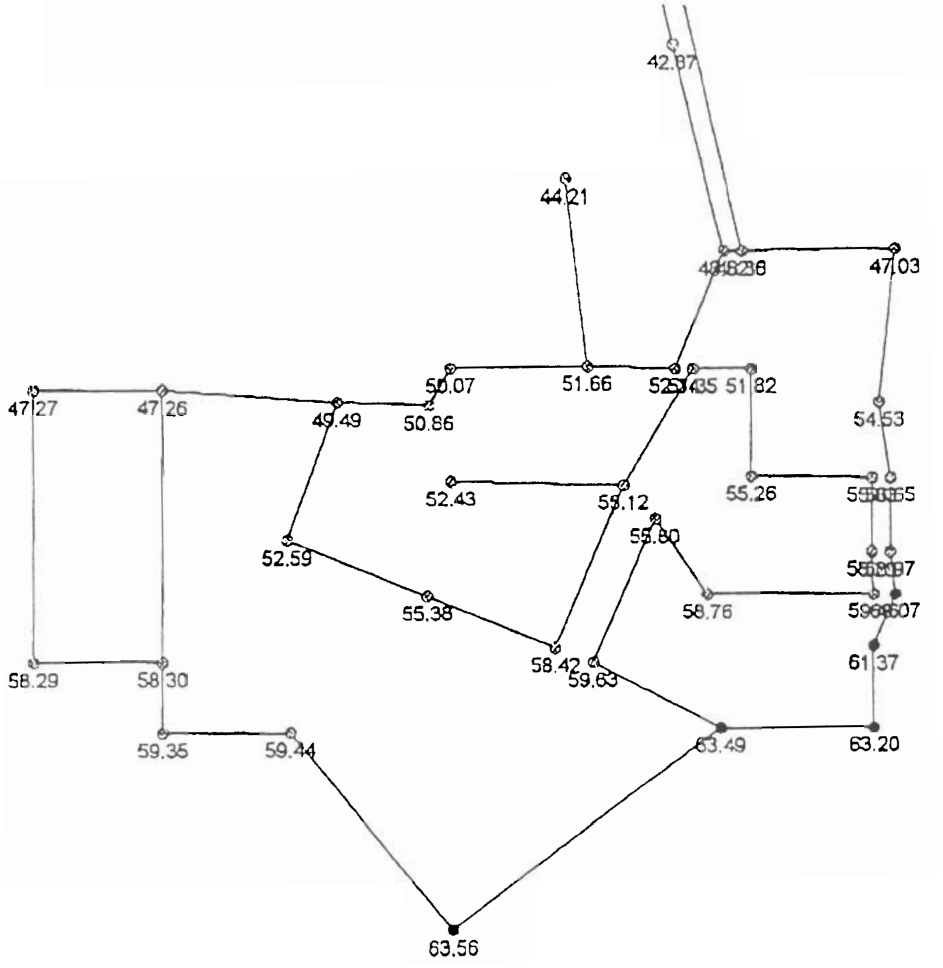
EPANET Resolute Bay October 1998 Run 2 Future Conditions Schematic



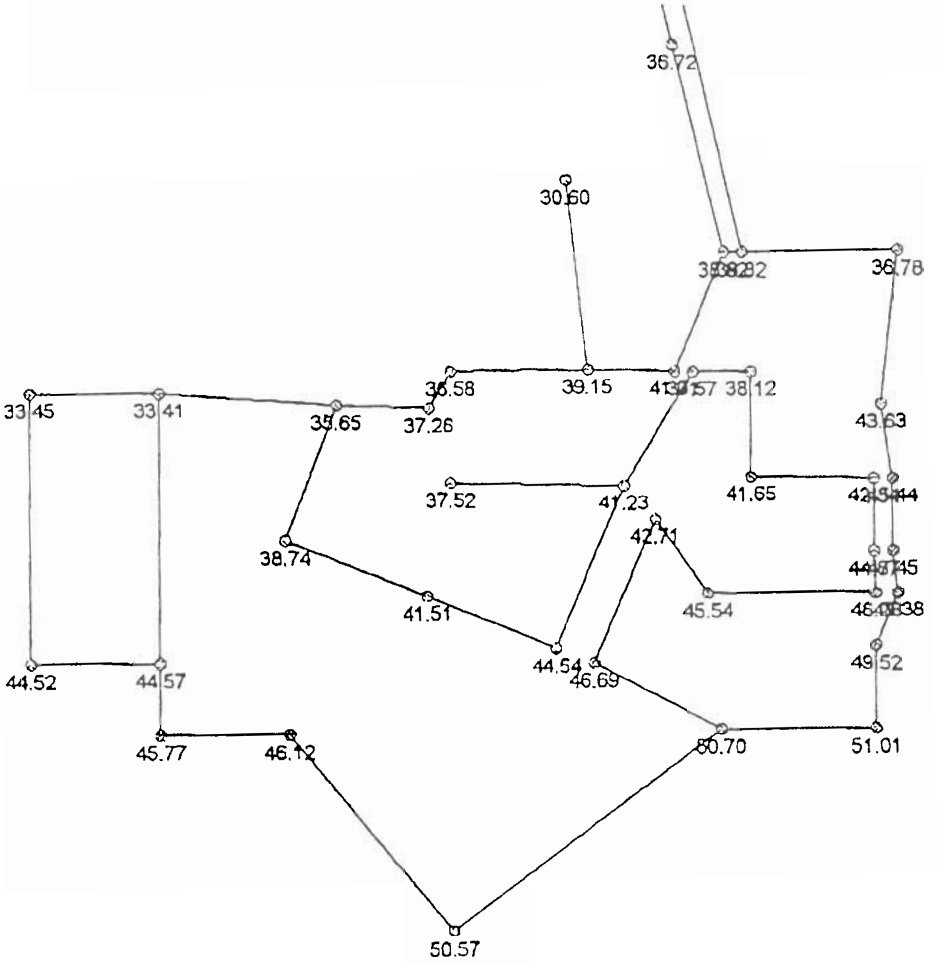
EPANET Resolute Bay October 1998 Run 2 Future Conditions Avg Day



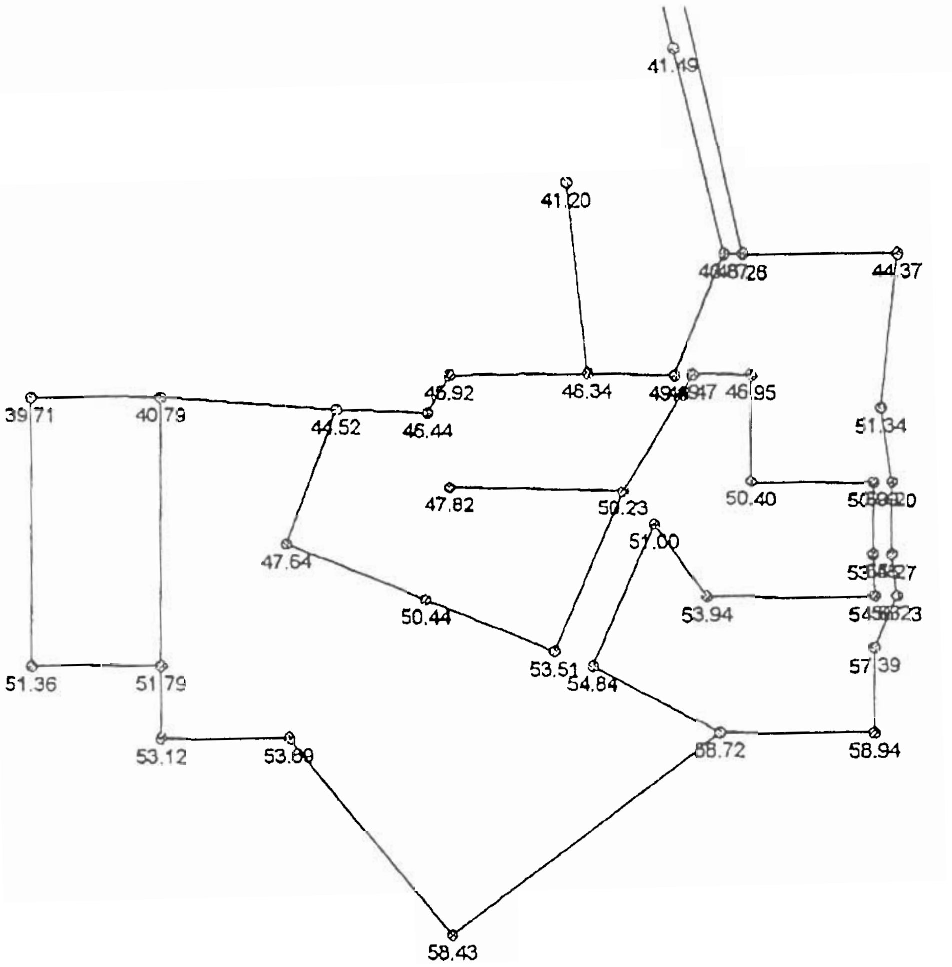
EPANET Resolute Bay October 1998 Run 2 Future Conditions Max Day



EPANET Resolute Bay October 1998 Run 2 Future Conditions Peak Hour



EPANET Resolute Bay October 1998 Run 2 Future Conditions Avg Day Plus Fire at AV201



RESOLUTE BAY SANITARY SEWER
pop 209 1998

Assunmptions 5 people per household, 225 lpcd, PF=4, n=0.013
Total water use=RWU*(1+(.00023*Population)

Pipe	From AV	To AV	Length (m)	Incremental Dwellings	Total Dwellings	Sewage Flow (L/day) (peakhour)	Sewage Flow (m3/s)	Diameter (m)	Slope	Capacity (m3/s)	Utilization (%)
1	Plant	AV2	211.53	0	0	0	0.0000	0.150	0.1160	0.052	0.0
2	AV2	AV3	118.26	2	2	9433	0.0001	0.150	0.0790	0.043	0.3
3	AV3	AV21	70.85	1	3	14149	0.0002	0.150	0.0595	0.037	0.4
32	AV21	AV23	70.33	3	6	28298	0.0003	0.150	0.0565	0.036	0.9
*25	AV25	AV23	98.27	4	4	18865	0.0055	0.150	0.0199	0.021	25.5
23	AV23	AV13	98.15	1	11	51879	0.0059	0.150	0.0280	0.025	23.0
*17	AV17	AV16	80.36	0	0	0	0.0053	0.150	0.0364	0.029	18.1
16	AV16	AV14	83.23	2	2	9433	0.0054	0.150	0.0321	0.027	19.6
14	AV14	AV13	78.18	2	4	18865	0.0055	0.150	0.0422	0.031	17.5
13	AV13	AV12	23.45	0	15	70745	0.0113	0.150	0.0455	0.032	34.8
26	AV27	AV12	86.00	4	4	18865	0.0002	0.150	0.0450	0.032	0.7
12	AV12	AV11	78.82	3	22	103759	0.0117	0.150	0.0432	0.032	37.0
*20	AV19	AV20	76.45	7	7	33014	0.0056	0.150	0.0157	0.019	29.5
*22	AV22	AV20	105.20	1	1	4716	0.0053	0.150	0.0659	0.039	13.6
21	AV20	AV21	48.23	1	9	42447	0.0110	0.150	0.0060	0.012	93.2
31	AV21	AV30	41.89	0	9	42447	0.0110	0.150	0.0089	0.014	76.5
30	AV30	AV29	60.66	2	11	51879	0.0111	0.150	0.0561	0.036	30.8
29	AV29	AV6	66.75	4	15	70745	0.0113	0.150	0.0077	0.013	84.7
5	AV4	AV5	86.74	7	7	33014	0.0004	0.150	0.0889	0.045	0.8
6	AV5	AV6	41.59	2	9	42447	0.0005	0.150	0.0503	0.034	1.4
7	AV6	AV7	41.45	3	27	127341	0.0120	0.150	0.0584	0.037	32.5
8	AV7	AV8	22.86	2	29	136773	0.0121	0.150	0.0401	0.030	39.6
28	AV28	AV8	91.03	6	6	28298	0.0003	0.150	0.0056	0.011	2.9
9	AV8	AV9	29.57	0	35	165071	0.0124	0.150	0.0464	0.033	37.8
10	AV9	AV10	46.02	5	40	188653	0.0127	0.150	0.0430	0.032	40.2
11	AV10	AV11	83.82	1	41	193369	0.0127	0.200	0.0057	0.025	51.4
311	AV11	AV32	91.44	0	63	297128	0.0244	0.200	0.0028	0.017	140.8
33	AV32	AV33	91.14	0	63	297128	0.0244	0.200	0.0060	0.025	96.2
34	AV33	AV34	88.09	0	63	297128	0.0244	0.200	0.0131	0.038	65.1
35	AV34	AV35	39.32	0	63	297128	0.0244	0.200	0.0084	0.030	81.3

*3/4" bleed into sewer, .00525 m^3/s

APPENDIX B

Cost Estimate Data

FALL ARREST EQUIPMENT

ANCHORAGE CONNECTORS *New!*

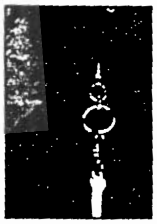
MILLER EQUIPMENT

nchorage connectors meet the many needs and pplications of fall protection users in construction, industrial and aintenance markets. These connectors must be attached to a structure that can upport a 5,000 pound static pull and can only be used by one worker. All the nchorage connectors meet the requirement of OSHA 1926.502 and ANSI 10.14

D-BOLT ANCHOR

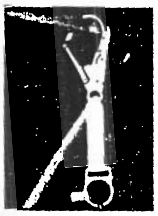
nique D-shape designed pecifically to minate rollout. ade of drop rged steel, cadmium/zinc plating nd forged steel. ngle attached stener with nut washer is easy to install and can e mounted in a variety of positions. eal with the retractable lifelines. aximum working load of 310 lbs.

BEAM CLAMP



e beam clamp is steel anchorage nnector designed for use with rizontal I-beams, beams and W-eams. This steel ated construction nt features a ivel attachment ng to prevent isting of the orker's lanyard or connecting device. amps come in two sizes: **Model** D006 fits beams up to 9" wide: odel SD007 can be used on beams to 12 1/2" wide. Working load of 0 lbs. maximum. Colour: Red with ack handle.

WEBBING/HOOK ANCHOR



esigned to facilitate ancho to caffolding, e or angle iron. atures a large, 2 " snap hook for sy one-hand tallation and a ing to accommodate the nnecting device. No tools required. o forged steel, zinc plated hardware with 1 3/4" nylon webbing.

D. HOOK ANCHOR W/SHOCK ABSORBER

This anchorage connector offers the same benefits as Model SD008, but includes a *Sofstop™* shock absorber to reduce the forces of falling.

E. CROSS-ARM STRAP

Designed to wrap around I-beams and other structures forming a secure attachment point for lanyards and other connecting devices. Manufactured from 2" nylon webbing for maximum strength, the strap features a 2" forged D-ring on one end which slips through a 3" D-ring on opposite end to form a secure anchor. Available in 6 feet length.

F. BEAM TROLLEY

Steel beam trolley creates an anchorage point that moves with the work for maxi-mum mobility. Accommodates I-beams from 3" to 8" wide, and is ideally suited for the attachment of lanyards, carabiners and retractable lifelines. Working load 310 lbs.

G. CROSS-ARM STRAP W/SHOCK ABSORBER

Designed to form a secure, low cost anchorage point for various connecting devices. Features 2" nylon webbing, forged D-rings and an integral *Sofstop™* shock absorber which greatly reduces the force of falling. Install on beams, pipes and railings is easily accomplished. No tools required.

Model No.	Description	Each
SD0	D-Bolt anchor	$ 61.02
SD006	Beam clamp, 9" wide	352.00
SD007	Beam clamp, 12 1/2" wide	505.00
SD008	Webbing/hook anchor	122.00
SD538	Hook anchor w/shock absorber	151.00
SD009	Cross-arm strap	34.97
SD010	Beam trolley	324.00
SD539	Cross-arm strap w/shock absorber	112.00

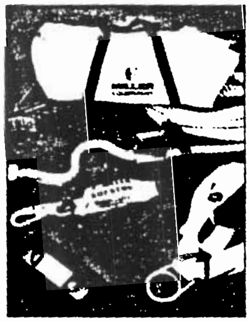
CONFINED SPACE RESCUE SYSTEMS

Accessing confined spaces involves a number of life threatening hazards, including the possibility of a vertical fall or being overcome by fumes or gases. Confined space access, rescue and retrieval systems are designed to provide a safe means of accessing a confined space area. In an emergency, confined space systems allow rescuers to retrieve injured or unconscious workers without exposing themselves to similar potential hazards.

Confined space systems meet all applicable OSHA, CSA and ANSI standards. A standard confined space system for fall protection and emergency retrieval. Includes a retrieval/retracting lifeline, 7 foot tripod, pulley block, winch bracket and a full body harness. Where primary access is unavailable, a drum winch can be used as primary access into the confined space. In addition to the drum winch, a retrieval lifeline is used as a secondary backup for fall protection and rescue. The drum winch can be used to lower and raise materials after the worker has accessed the confined space, while still ensuring rescue in the event of an emergency.

Model No.	Description	Each
SE139	7' Aluminum telescopic tripod 10,000 lbs. rated	$ 1003.00
SA057	Bi-directional retrieval/retracting lifeline S/S wire 60'	2468.00
SD698	Tripod mounting bracket	326.00
SD699	Pulley block	263.00
SD700	Drum winch 55' galvanized steel wire and bracket	1055.00
SA046	Full body harness, one size	89.44

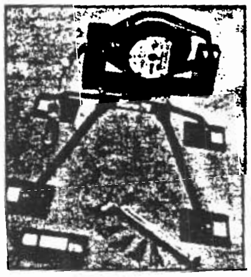
ROOF ANCHOR KITS *New!*



Installs on steep-pitched or flat surface roofs. When roofing is complete, it is easily removed and ready for the next job. Includes 25 foot or 50 foot 5/8" nylon rope lifeline, carabiner, rope grab with 24" *Sofstop™* shock absorbing lanyard, *Duralite* harness (fits medium to extra large), two reusable roof anchors, 20 pan head sheet metal screws, instructions, instructional video, and carrying bag. Replacement roof anchor brackets with screws available. Meets OSHA regulations.

Model No.	Description	Each
SD011	Roofer's kit, 25'	$491.00
SD012	Roofer's kit, 50'	508.00
SD013	Roof anchor brackets	28.56

ROOFSTRIDER KIT *New!*



Kit is easily installed with a hammer and features 360° rotation for great working mobility and provides workers with constant protection through long, hard hours of work. Built to perform, protect, under tough conditions and on steep roofing angles. The retractable lifeline unit easily attaches to the four-legged roof mounting assembly with two integral push pins. The foot pad on the roof mounting assembly are easily adjustable to fit variable roof pitches and should be attached to a roof with 16d nails. System must be installed in accordance with the manufacturer's instructions. Allowing hands free worker mobility, the locking snap hook of the retractable lifeline unit attaches to the back dee ring of the roofer's harness. If a slip or fall should occur, the inertia brakes of the retractable lifeline unit activate, keeping cable payout to two feet or less. The complete kit consists of a self-contained 25 foot or 50 foot retractable lifeline, four-legged roof mounting assembly, *DuraLite* Harness, 24 16d cement-coated nails, instructions, instructional video, and carrying bag. Complies with OSHA's Construction Fall Protection Standard 1926.500.

Model No.	Description	Each
SD541	Roof strider Kit, 25'	$2053.00
SD542	Roof strider Kit, 50'	2072.00

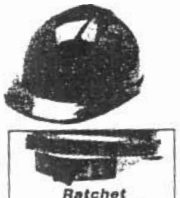
CSA Z94.1.92 APPROVED HARD HATS

A-SAFE

ghs less than 19.5 ozs. High-density polyethylene outer shell provides all-round lim mpact and penetration protection. Universal slots will accept all achment xpanded polystyrene inner shell prevents injuries from lateral, and b ck impacts. Choice of ratchet or pinlock type suspension. 6 point chet suspension system comes with 2 adjustment levels for headband on front d rear tab for additional stability and comfort. 4 point pinlock self-sizing pension is also available. Sliding mechanism on rear tabs allow for centering of met on head. Crown pad and sweatband for user comfort. Meets CSA Z94.1.92.

Model			Each	
No.	Suspension	Colour	1	12
SA650	Ratchet	Sky Blue	$31.31	$28.18
SA651	Ratchet	White	31.31	28.18
SA652	Ratchet	Yellow	31.31	28.18
SC064	Pinlock	White	$23.55	$21.20
SC065	Pinlock	Yellow	23.55	21.20

Other colours available upon request.

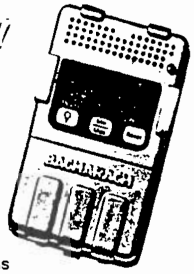


Ratchet Suspension

PERSONAL GAS MONITORS & AIR MONITORS

PERSONAL GAS MONITOR

New!



Features:
- Available in one, two, or three gas models
- High visibility LCD shows continuous gas identification
- Adjustable audible and visual alarms
- Simple operation with one-step zeroing
- Automatic calibration
- Interchangeable alkaline or NiCad batteries
- Rugged and lightweight

Simple and intuitive, the *Bodyguard* monitor detects the presence of oxygen, combustibles and toxic gases. It is available as a one-gas, two-gas or three-gas monitor, and can easily be upgraded in the field for any combination of gases.

Two versions are now available. The basic unit simply displays gases and battery life. The only button is for the backlight. This unit is ideal for confined space entry and applications where user interface is minimal, such as oil, and petroleum refining, waste water treatment, coal mines and general industry.

The advanced version includes peak displays and the option of latching alarms for use in similar applications. On both versions, buttons are clearly marked for easy identification.

Rugged and water resistant, the *Bodyguard* monitor can withstand the most abusive conditions. Adjustable audible and visual alarms help to ensure user safety.

The *Bodyguard* uses alkaline or nickel-cadmium batteries. Battery packs are interchangeable and easily replaceable. The water-resistant case is made of high-strength alloy, coated for added durability. Visual alarms on the front and bottom of the instrument ensure visibility from all angles. The audible alarm uses alternating tones to make sure it can be heard in noisy environments. Built-in diagnostics continually monitor the functionality of the unit. A confidence light on the bottom of the instrument lets the user know that it is working properly.

Each *Bodyguard* comes with a calibration cup, screwdriver and a durable leather case. The case provides added protection and allows the *Bodyguard* to be carried easily on a belt, harness or shoulder strap. A Confined Space Kit is available for mobile applications like construction, utilities and hazmat teams. It includes a hand-aspirated pump, tubing and personal alarm packaged in a durable *Pelican*-brand case for storing the instrument and accessories.

Specifications:

Gases Detected & Range:		
	Oxygen:	0 - 30%
	Combustible Gases:	0 - 100% LEL (0 - 5% CH4)
	Carbon Monoxide:	0 - 999 ppm
	Hydrogen Sulfide:	0 - 500 ppm
Sampling Method:	Diffusion; pump (optional)	
Power Supply:	2 "AA" alkaline or NiCad battery pack	
Battery Life:	10 - 12 hours	
Operating Conditions:	-4 to 122°F (-20 to 50°C); 0 to 99% RH, non-condensing	
Dimensions:	2.87" x 1.62" x 4.73" (7.3 x 4.1 x 12.0 cm)	
Weight:	14 oz (392 g)	
Safety Rating:	Intrinsically safe for use in Class I, Division 1 & 2, Groups A, B, C and D and Class II, Divisions 1 & 2, Groups E, F and G hazardous areas. UL, MSHA, CSA and CENELEC approvals pendings.	

Model No.	Description	Each
BASIC UNITS		
HM550	1 Gas Personal Monitor, O_2	$1165.00
HM551	1 Gas Personal Monitor, LEL	1195.00
HM552	1 Gas Personal Monitor, CO	1265.00
HM553	1 Gas Personal Monitor, H_2S	1265.00
HM554	2 Gas Personal Monitor, O_2, LEL	1495.00
HM555	3 Gas Personal Monitor, O_2, LEL, CO	1795.00
HM556	3 Gas Personal Monitor, O_2, LEL, H_2S	1795.00
ADVANCED UNITS		
HM557	1 Gas Personal Monitor, O_2	$1240.00
HM558	1 Gas Personal Monitor, LEL	1265.00
H[illegible]9	1 Gas Personal Monitor, CO	1340.00
H[illegible]560	1 Gas Personal Monitor, H_2S	1340.00
HM561	2 Gas Personal Monitor, O_2, LEL	1560.00
HM562	3 Gas Personal Monitor, O_2, LEL, CO	1860.00
HM563	3 Gas Personal Monitor, O_2, LEL, H_2S	1860.00
ACCESSORIES		
HM564	Confined Space Kit	$375.00
HM565	Calibration Kit	210.00

PERSONAL GAS MONITOR

New!

Features:
- Capable of monitoring 10 different gases
- High visibility LCD shows continuous gas concentrations
- Audible and visual alarms
- Easy to operate
- Water resistant
- Interchangeable alkaline or NiCad batteries
- Compact and lightweight

The *Canary* offers personal protection in a compact, reliable instrument. Portable monitoring for 10 different gases allows you the freedom to work in any environment without the worry of atmospheric hazards. A factory installed, gas specific sensor on the top of the instrument monitors the surrounding air to alert you to changes in air quality.

Ten gas versatility makes this instrument easily adaptable for monitoring in a variety of hazardous areas. The range of industry applications is vast including steel manufacturing, pulp and paper mills, oil and petrochemical refineries, water and wastewater treatment, chemical plants, offshore drilling, and more.
Weighing just 10 ounces, the *Canary* is easily carried in a shirt pocket or with its convenient belt clip. An optional carrying case with neck strap is also available.
A red flashing LED and audible alarm let the user know when a dangerous situation occurs and an LCD display gives accurate readings of the amount of gas encountered. Once the gas concentration has dropped out of alarm range, the *Canary* automatically resets. A push-button backlight and dust and water resistant case allow you to work under many conditions.

For added security, a green LED confidence light flashes every three seconds, letting you know the instrument is working properly and battery levels are adequate. The *Canary* can be powered by four "AA" size alkaline batteries or a rechargeable Nicad pack.

Maintenance on the *Canary* is fast and easy, to get you on the job quickly and allow you to make necessary changes in the field. Zeroing the *Canary* can be done in just one step. Simply open the cover below the display and adjust the preset zero until the display shows the correct reading. Sensor replacement can also be done with minimum effort. Remove the back cover and batteries, unplug the used sensor and replace it with a new sensor.

Specifications:

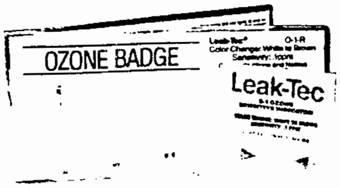
Gases Detected & Range:		
	Oxygen:	0 - 25% O_2
	Methane:	0 - 100% LEL CH_4
	Carbon Monoxide:	0 - 500 ppm CO
	Hydrogen Sulfide:	0 - 50 ppm H_2S
	Sulfur Dioxide:	0 - 10 ppm SO_2
	Chlorine:	0 - 5 ppm Cl_2
	Nitrogen Dioxide:	0 - 10 ppm NO_2
	Hydrogen Chloride:	0 - 10 ppm HCl_2
	Hydrogen Cyanide:	0 - 25 ppm HCN
	Ammonia:	0 - 50 ppm NH_3
Sampling Method:		Diffusion
Power Supply:		4 "AA" alkaline or NiCad battery pack
Operating Conditions:		14 to 122°F (-10 to 50°C); 0 to 90% RH, non-condensing
Dimensions:		2.5" x 1.5" x 4.5" (6.4 x 3.8 x 11.4 cm)
Weight:		Less than 10 oz (268 g)
Safety Rating:		Intrinsically safe for use in Class I, Division 1, Groups A, B, C and D. CSA certified.

Model No.	Description	Each
HM566	Personal Gas Monitor, O_2	$595.00
HM567	Personal Gas Monitor, CH_4	855.00
HM568	Personal Gas Monitor, CO	870.00
HM569	Personal Gas Monitor, H_2S	870.00
HM570	Personal Gas Monitor, SO_2	895.00
HM571	Personal Gas Monitor, Cl_2	930.00
HM572	Personal Gas Monitor, NO_2	930.00
HM573	Personal Gas Monitor, HCl_2	980.00
HM574	Personal Gas Monitor, HCN	980.00
HM575	Personal Gas Monitor, NH_3	980.00

AIR MONITORS

The monitor shows an immediate colour change in the presence of a specific gas. Compare colour on badge to chart which indicates OSHA and ACGIH time limit values, to find precise accumulation or exposure to that substance. No laboratory analysis required. Ideal for monitoring areas for accumulation and ceilings, for monitoring critical joints, and for sampling the environment to indicate the ppm present. Exposed monitors may be retained as a permanent record.
Note: Supplied in cartons of 10 badges.

Model No.	Critical Level	Toxic Substance	Colour Change	Each
HD654	25 ppm	Ammonia	Yellow - Blue	$48.00
HF169	1 ppm	Chlorine	White - Yellow	48.00
HF746	.1 ppm	Hydrazine	White - Yellow	48.00
HF902	10 ppm	Hydrogen Sulfide	White - Brown	48.00
HK247	5 ppm	Nitrogen Dioxide	White - Yellow	48.00
HK278	.1 ppm	Ozone	White - Brown	48.00
HF223	50 ppm	Carbon Monoxide	Tan - Black	48.00



REGULATION FIRST AID KITS CONT.

NEW BRUNSWICK FIRST AID KITS

Component Product Description	Contents CSST plus 1 - 9 Emp.	 10 - 100 Emp.
First aid manual	1	1
Scissors 5 1/2"	1	1
Tweezers	1	1
Assorted safety pins (12)	1	1
Plastic adhesive strips 3/4" x 3" sterile	-	25
Plastic adhesive strips 1" x 3" sterile	25	25
Gauze pad sterile 4" x 4"	5	24
Gauze bandage 3" x 10 yds.	-	4
Gauze bandage 2" x 10 yds.	1	-
Pressure bandage 4" sterile	2	4
Triangular bandage	2	6
Adhesive tape 1" x 10 yds.	1	2
Eye pad oval sterile	2	4
Peroxide 100 ml.	1	1
P.E.G. water soluble burn ointment 65 g.	1	1
Latex gloves (1 pair)	1	1
Emersafe pocket mask	1	1
Cotton tipped applicators 3" (100)	1	1
Hand cleansers	24	36
Tongue depressors	2	6

Model No.	No. of Employees	Box Dimensions W" x H" x D"	Unit/ Box	Each
PLASTIC				
SD790	1 - 9	10 x 7 x 3	16	**$29.74**
SD791	10 - 100	13.5 x 9.5 x 3	36	**57.51**
METAL				
SD792	1 - 9	7 x 10 x 3	16	**$43.55**
SD793	10 - 100	13.5 x 9.5 x 3	36	**65.83**
BULK REFILLS				
SD794	For 1 - 9 employees			**$26.13**
SD795	For 10-100 employees			**41.82**

NEWFOUNDLAND & LABRADOR FIRST AID KITS

Component Product Description	 1 - 5 Emp.	Contents 6 - 14 Emp.	 15 - 200 Emp.
First Aid manual	1	1	1
Accident record book	1	1	1
Instrument kit in unit box	1	1	1
		(12) pack safety pins (1) splinter tweezers (1) pair scissors	
Pressure bandage, 4" sterile	2	2	6
Plastic strips, 1" x 3" sterile	12	16	32
Gauze pad sterile, 3" x 3"	12	16	32
Triangular bandage	4	6	6
Adhesive tape 1" x 5 yds.	-	1	2
Tubular dressing w/applicator	-	-	1
Fingertips large sterile	-	-	10
Knuckle bands sterile	-	-	10
Peroxide 100 ml.	1	1	1
Adhesive tape 1/2" x 5 yds.	1	-	-
Pair latex gloves	1	1	1

Model No.	No. of Employees	Box Dimensions W" x H" x D"	Unit/ Box	Each
PLASTIC				
SD796	1 - 5	7.5 x 5 x 3.5	10	**$15.61**
SD797	6 - 14	10 x 7 x 3	16	**20.87**
SD798	15 - 200	10 x 10 x 3	24	**45.27**
METAL				
SD799	1 - 5	7.5 x 5 x 3	10	**$27.85**
SD800	6 - 14	7 x 10 x 3	16	**33.11**
SD801	15 - 200	10 x 10 x 3	24	**50.53**
BULK REFILLS				
SD802	For 1 - 5 employees			**$12.16**
SD803	For 6 - 14 employees			**15.61**
SD804	For 15 - 200 employees			**29.58**

NORTHWEST TERRITORIES FIRST AID KITS

Optional items not included in kits, should be ordered separately.

Component Product Description	 Kit #1	Contents Kit #2	 Kit
First Aid manual	1	1	1
Accident record book	1	1	1
Latex gloves large (1 pair)	5	5	5
Instant cold pack	-	-	3
Emersafe pocket mask / one way valve	2	2	1
Fabric adhesive strips 3/4" x 3" sterile	50	100	10
Fabric adhesive strips 1" x 3" sterile	50	100	10
Gauze pad 2" x 2" sterile	-	12	12
Gauze pad 3" x 3" sterile	6	6	54
Pressure bandage 2" sterile	-	-	6
Pressure bandage 3" sterile	-	-	6
Pressure bandage 4" sterile	1	1	6
Field dressing 6" sterile	-	4	-
Pressure bandage 6" sterile	-	5	-
Combine pad 7 1/2" x 8" sterile	-	-	6
Combine pad 8" x 10" sterile	1	5	5
Eye pad oval sterile	2	6	6
Double adhesive strips for eye pads	2	3	6
Elastic bandage 3" x 5 yds.	1	3	6
Elastic pressure bandage 6" sterile	1	1	1
Gauze bandage 2" x 5 yds.	6	10	10
Gauze bandage 1" x 10 yds.	-	1	1
Adhesive tape 1" x 5 yds.	1	1	2
Esmarch bandage 1 box	-	-	2
Safety pins assorted	12	12	12
Antiseptic sachet *Benzalkonium*	6	12	12
Antiseptic green soap 50 ml.	-	-	1
Eye wash 8 oz. sterile	-	-	1
Eye dropper	-	-	1
Eye bath	-	-	1
Eye shield	-	-	2
Tongue depressor I.W.	-	-	12
Tweezers 3 1/2"	1	1	1
X-fine splinter tweezers 4.5"	-	-	1
Scissor angled lister	1	1	1
Wire splint 3 5/8" x 24"	-	1	2
Scrub (nail) brush	-	1	1
Kidney basin stainless steel	-	-	1
Steri strip skin closure 1/4" x 3"	-	-	5
Triangular bandage	2	3	12
Ammonia inhalants	-	-	20
Burn Free dressing	-	12	-
OPTIONAL ITEMS			
*Blanket, 100% wool	-	-	3
*Wood splints (set of 6)	-	-	1
**Burn Free* emergency burn trauma kit	-	-	1
*Collapsible stretcher	-	-	1

Model No.	No. of Kit	Box Dimensions L" x W" x D"	Unit/ Box	Each
PLASTIC				
SD805	#1	10 x 10 x 3	24	**$47.00**
METAL				
SD806	#1	10 x 10 x 3	24	**$ 52.28**
SD807	#2	15.5 x 12 x 4.5	-	**124.00**
SD808	#3	14.5 x 16.5 x 6.5	-	**196.00**
BULK REFILLS				
SD809	For kit #1			**$ 31.31**
SD810	For kit #2			[illegible]
SD811	For kit #3			**148.00**

OPTIONAL ITEMS

Model No.	Description	Each
SE082	Blanket, 100% wool, 54" x 90"	**$ 58.01**
SE077	Wood splints (set of 6 assorted)	**3.62**
SD857	*Burn Free* burn trauma kit	**197.00**
SC408	Collapsible stretcher	**213.00**

Blanket: 100% red wool. 54" x 90".
Wooden splints: Sets of six assorted sizes; 2 of each: 2" x 8", 3" x 10", and 3" x 12".
Collapsible stretcher: Fibre reinforced vinyl, fire retardant with a load capacity of 400 lbs. In carrying case.

Cost Estimates

		W/M Length (m)		S/M Length	Scenario 1 Total Replacement					Scenario 2 Water & Sewer for Various Lines				
Start AV	End AV	200 mm	150 mm	150 mm (m)	W & S (m)	W Only (m)	S Only (m)	Unit Cost ($/m)	Extension ($)	W & S (m)	W Only (m)	S Only (m)	Unit Cost ($/m)	Extension ($)
WTP	2	205.1	205.1	205.1	205.1			$1,927	$395,228					$0
2	3	118.3	118.3	118.3	118.3			$1,927	$227,964					$0
3	4	93.3				93.3		$1,717	$160,196					$0
4	5	86.6		86.6	86.6			$1,927	$166,878	86.6			$1,927	$166,878
5	6	41.5		41.5	41.5			$1,927	$79,971	41.5			$1,927	$79,971
6	7	41.5		41.5	41.5			$1,927	$79,971	41.5			$1,927	$79,971
7	8	22.9		22.9	22.9			$1,927	$44,128	22.9			$1,927	$44,128
8	9	29.6		29.6	29.6			$1,927	$57,039	29.6			$1,927	$57,039
9	10	46		46	46			$1,927	$88,642	46			$1,927	$88,642
10	11	83.8		83.8	83.8			$1,927	$161,483	83.8			$1,927	$161,483
11	12	78.6		78.6	78.6			$1,927	$151,462					$0
12	27	86		86	86			$1,927	$165,722					$0
27	28	69.2				69.2		$1,717	$118,816					$0
28	8	91.1		91.1	91.1			$1,927	$175,550					$0
3	21	70.7		70.7	70.7			$1,927	$136,239					$0
21	30	41.8		41.8	41.8			$1,927	$80,549	41.8			$1,927	$80,549
30	29	60.7		60.7	60.7			$1,927	$116,969	60.7			$1,927	$116,969
29	6	66.8		66.8	66.8			$1,927	$128,724	66.8			$1,927	$128,724
11	32			91.1	91.1		91.1	$1,542	$140,476					$0
32	33			91.3	91.3		91.3	$1,542	$140,785					$0
33	34			88.1	88.1		88.1	$1,542	$135,850					$0
34	35			39.8	39.8		39.8	$1,542	$61,372					$0
35	STP			60	60		60	$1,542	$92,520					$0
Stage 1a Total		1333.5	323.4	1541.3	1541.3	162.5	370.3		$3,106,532	521.2	0	0		$1,004,352
Stage 1b														
22	20		105.2	105.2	105.2			$1,927	$202,720					$0
25	23		98.3	98.3	98.3			$1,927	$189,424					$0
21	20	48.2		48.2	48.2			$1,927	$92,881					$0
20	19	76.45		76.45	76.45			$1,927	$147,319					$0
19	18	24.2				24.2		$1,717	$41,551					$0
18	17	50.9				50.9		$1,717	$87,395					$0
17	16	80.4		80.4			80.4	$1,542	$123,977					$0
16	14	83.2		83.2			83.2	$1,542	$128,294					$0
14	13	78.2		78.2			78.2	$1,542	$120,584					$0
13	12	23.3		23.3			23.3	$1,542	$35,929					$0
13	23	98.2		98.2			98.2	$1,542	$151,424					$0
23	21	70.3		70.3			70.3	$1,542	$108,403					$0
Stage 1b Total		633.35	203.5	761.75	328.15	75.1	433.6		$1,429,903					$0
Totals		1966.85	526.9	2303.05	1869.45	237.6	803.9		$4,536,435	521.2	0	0		$1,004,352

	Unit Costs ($/m)
W&S Replacement	$1,927
Water Only	$1,717
Sewer Only	$1,542

	Unit Costs ($/m)
W&S Replacement	$1,927
Water Only	na
Sewer Only	na

Cost Estimates

					Scenario 3					Scenario 4				
					Water Only with Min. Cover Various Pipes					Replace Sewer Main where Poor Flow				
		W/M Length (m)		S/M Length	W & S	W Only	S Only	Unit Cost	Extension	W & S	W Only	S Only	Unit Cost	Extension
Start AV	End AV	200 mm	150 mm	150 mm (m)	(m)	(m)	(m)	($/m)	($)	(m)	(m)	(m)	($/m)	($)
WTP	2	205.1	205.1	205.1					$0					$0
2	3	118.3	118.3	118.3					$0					$0
3	4	93.3							$0					$0
4	5	86.6		86.6		86.6		$1,550	$134,230					$0
5	6	41.5		41.5		41.5		$1,550	$64,325					$0
6	7	41.5		41.5		41.5		$1,550	$64,325					$0
7	8	22.9		22.9		22.9		$1,550	$35,495					$0
8	9	29.6		29.6		29.6		$1,550	$45,880					$0
9	10	46		46		46		$1,550	$71,300					$0
10	11	83.8		83.8		83.8		$1,550	$129,890					$0
11	12	78.6		78.6					$0			78.6	$771	$60,601
12	27	86		86					$0					$0
27	28	69.2							$0					$0
28	8	91.1		91.1					$0					$0
3	21	70.7		70.7					$0					$0
21	30	41.8		41.8		41.8		$1,550	$64,790					$0
30	29	60.7		60.7		60.7		$1,550	$94,085					$0
29	6	66.8		66.8		66.8		$1,550	$103,540					$0
11	32			91.1					$0					$0
32	33			91.3					$0					$0
33	34			88.1					$0					$0
34	35			39.8					$0					$0
35	STP			60					$0					$0
Stage 1a Total		1333.5	323.4	1541.3	0	521.2	0		$807,860	0	0	78.6		$60,601
Stage 1b														
22	20		105.2	105.2					$0					$0
25	23		98.3	98.3					$0			50	$771	$38,550
21	20	48.2		48.2					$0			48.2	$771	$37,162
20	19	76.45		76.45					$0			76.45	$771	$58,943
19	18	24.2							$0					$0
18	17	50.9							$0					$0
17	16	80.4		80.4					$0					$0
16	14	83.2		83.2					$0					$0
14	13	78.2		78.2					$0			40	$771	$30,840
13	12	23.3		23.3					$0					$0
13	23	98.2		98.2					$0					$0
23	21	70.3		70.3					$0					$0
Stage 1b Total		633.35	203.5	761.75					$0					$165,495
Totals		1966.85	526.9	2303.05	0	521.2	0		$807,860	0	0	78.6		$226,096

Unit Costs ($/m)	
W&S Replacement	na
Water Only	$1,550
Sewer Only	na

Unit Costs ($/m)	
W&S Replacement	na
Water Only	na
Sewer Only	$771

Cost Estimates

Scenario 5

Replace W & S Mains from AV20 to AV22

Start AV	End AV	W/M Length (m) 200 mm	150 mm	S/M Length 150 mm (m)	W & S (m)	W Only (m)	S Only (m)	Unit Cost ($/m)	Extension ($)
WTP	2	205.1	205.1	205.1					$0
2	3	118.3	118.3	118.3					$0
3	4	93.3							$0
4	5	86.6		86.6					$0
5	6	41.5		41.5					$0
6	7	41.5		41.5					$0
7	8	22.9		22.9					$0
8	9	29.6		29.6					$0
9	10	46		46					$0
10	11	83.8		83.8					$0
11	12	78.6		78.6					$0
12	27	86		86					$0
27	28	69.2							$0
28	8	91.1		91.1					$0
3	21	70.7		70.7					$0
21	30	41.8		41.8					$0
30	29	60.7		60.7					$0
29	6	66.8		66.8					$0
11	32			91.1					$0
32	33			91.3					$0
33	34			88.1					$0
34	35			39.8					$0
35	STP			60					$0
Stage 1a Total		1333.5	323.4	1541.3	0	0	0		$0
Stage 1b									
22	20		105.2	105.2	105.2			$1,927	$202,720
25	23		98.3	98.3					$0
21	20	48.2		48.2					$0
20	19	76.45		76.45					$0
19	18	24.2							$0
18	17	50.9							$0
17	16	80.4		80.4					$0
16	14	83.2		83.2					$0
14	13	78.2		78.2					$0
13	12	23.3		23.3					$0
13	23	98.2		98.2					$0
23	21	70.3		70.3					$0
Stage 1b Total		633.35	203.5	761.75					$202,720
Totals		1966.85	526.9	2303.05	0	0	0		$202,720

	Unit Costs ($/m)
W&S Replacement	$1,927
Water Only	na
Sewer Only	na

Northwest
Territories Keewatin Region

From: Joe Hidalgo, P. Eng.
Project Management
Department of Public works and Services
Fax Number: (8~~19~~) 645-2116
Phone Number: (8~~19~~) 645-5013
867

Date: OCT. 23, 1998

TO: KIRK GUENTHER, P. ENG.
Company: DILLON CONSULTING LTD. YELLOWKNIFE, NT
Fax Number: (867) 873-3328

Total Number of Pages Including Cover: 7

Your Reference: Unit Prices for Nuvuk Subdivision.

Message:

Here are the prices that you were requesting. Our plane was delayed, we almost flew over Rankin Inlet because of bad weather here as always.

Joe

The Original of This Fax Will Not Be Sent Unless Requested

Government of the Northwest Territories, Rankin Inlet, NT, X0C 0G0

CONSULTANT

IIUVIK SUBDIVISION
RANKIN INLET
Phase 3, 1998

LIST OF UNIT PRICES
UNIT PRICE CONTRACT
SCHEDULE OF QUANTITIES AND
UNIT PRICE TABLE

APPENDIX D

Page 1 of 6

Pg III

ITEM NO	DESCRIPTION	PAYMENT CLAUSE	EST QUANTITY	UNIT	UNIT PRICE	EXTENSION	RTL Tender UNIT PRICE	Exl. EXTENSION	Sanajiit Tender UNIT PRICE	Exl. EXTENSION	Kudlik Tender UNIT PRICE	Exl. EXTENSION
	Part A - Mains & Services (Sts. 7 & 8)											
A1	Rock Excavation, If Req'd	02211 1.6.1	100	cu m	$60	$5,000	$140.00	$14,000.00			$70.00	$7,000.00
A2	Prefinal Inspection, If Req'd	02211 1.6.2	1	L.S.	$1,000	$1,000	$8,500.00	$8,500.00			$3,000.00	$3,000.00
A3	Mob / Demob for Rock Excavation If Req'd	02211 1.6.3	1	L.S.	$ 4,000	$4,000	$4,800.00	$4,800.00	$5,000.00	$5,000.00	$25,000.00	$25,000.00
A4	Rock Locating/Verification	02211 1.6.4	640	m	$ 5	$3,200	$15.00	$9,600.00			$5.50	$3,520.00
A5	Install 200mm dia Watermain Common Trench	02666 1.3.1	660	m	165	$108,900	$450.00	$297,000.00	$204.00	$134,640.00	$165.00	$108,900.00
A5	Install 200mm dia Watermain Single Main	02666 1.3.2	35	m	165	$5,775	$450.00	$15,750.00	$247.00	$8,645.00	$330.00	$11,550.00
A7	Install 200mm dia Sanitary Sewer Common Trench	02667 1.3.1	351	m	165	$57,915	$450.00	$157,950.00	$204.00	$71,604.00	$165.00	$57,915.00
A8	Install 150mm dia Sanitary Sewer Common Trench	02667 1.3.1	273	m	165	$45,045	$450.00	$122,850.00	$204.00	$55,692.00	$165.00	$45,045.00
A9	Install 150mm dia Sanitary Sewer Single Main	02667 1.3.2	5	m	165	$825	$450.00	$2,250.00	$408.00	$2,040.00	$330.00	$1,650.00
A10	Supply 200mm HDPE Sewer/Water	02666/02667 1.3.3	1,046	m	210	$219,660	$128.00	$133,888.00	$175.15	$183,205.90	$127.60	$133,469.60
A11	Supply 150mm HDPE Sewer	02667 1.3.3	278	m	135	$37,530	$99.00	$27,522.00	$121.70	$33,832.60	$96.80	$26,910.40
A12	Supply Access Vaults	02725 1.4.1										
	- AV 98-18		1	L.S	40000	$40,000	$37,000.00	$37,000.00	$39,447.45	$39,447.45	$34,771.00	$34,771.00
	- AV 98-19		1	L.S	40000	$40,000	$33,000.00	$33,000.00	$35,203.18	$35,203.18	$35,252.80	$35,252.80
	- AV 98-20		1	L.S	40000	$40,000	$45,000.00	$46,000.00	$49,063.29	$49,063.29	$50,479.00	$50,479.00
	- AV 98-21		1	L.S	40000	$40,000	$46,000.00	$46,000.00	$49,532.65	$49,532.65	$50,259.00	$50,259.00
	- AV 98-22		1	L.S	40000	$40,000	$37,000.00	$37,000.00	$38,606.69	$38,606.69	$38,278.90	$38,278.90
	- AV 98-23		1	L.S.	40000	$40,000	$44,000.00	$44,000.00	$46,824.79	$46,824.79	$41,882.50	$41,882.50
	- AV 98-WLP		1	L.S.	33000	$33,000	$39,000.00	$39,000.00	$41,212.59	$41,212.59	$36,333.00	$36,333.00
A13	Supply & Install Ladders on Avs 94-1 to 94-3 and 95-1 to 95-17	02725 1.4.2	20	Each	400	$8,000	$860.00	$17,200.00	$277.20	$5,544.00	$308.00	$6,160.00
A14	Install Access Vaults	02725 1.4.3	7	Each	9000	$63,000	$10,000.00	$70,000.00	$7,142.86	$50,000.02	$6,600.00	$46,200.00
A15	Over-excavation (if req'd).	02221 1.4.2	100	cu m	10	$1,000	$16.50	$1,650.00	$10.00	$1,000.00	$11.00	$1,100.00
A16	Granular Backfill (Load Haul and Place) (If required)	02221 1.4.5	400	cu m	15	$6,000	$58.00	$23,200.00	$16.00	$6,400.00	$22.00	$8,800.00
A17	Crushed Road Gravel (Supply and Install) (If required)	02221 1.4.6	200	cu m	50	$10,000	$70.00	$14,000.00	$58.00	$11,600.00	$22.00	$4,400.00
A18	Mobilization/Demobilization	01500 2.4	1	L.S.	250000	$250,000	$500,000.00	$500,000.00	$208,850.00	$208,850.00	$484,362.13	$484,362.13
	Subtotal Part A - Page 1				"A"	$1,102,650		$1,702,160.00		$1,079,945.16		$1,262,239.33

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IIUVIK SUBDIVISION
RANKIN INLET
Phase 3, 1998

LIST OF UNIT PRICES
UNIT PRICE CONTRACT
SCHEDULE OF QUANTITIES AND
UNIT PRICE TABLE

APPENDIX D

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Pg. III

ITEM NO.	DESCRIPTION	PAYMENT CLAUSE	EST. QUANTITY	UNIT	UNIT PRICE	EXTENSION						
	Part A - Mains & Services (Sts. 7 & 8)											
A19	Install 100mm dia Water Service Carrier Pipe c/w 2-25mm dia water service pipes	02665 1.3.1	690	m	200	$138,000	$315.00	$217,350.00	$219.04	$151,137.60	$143.00	$98,670.00
A20	Install 150mm dia Water Service Carrier Pipe c/w 1-25mm dia and 1-50mm dia water service pipes	02665 1.3.1	40	m	250	$10,000	$315.00	$12,600.00	$219.04	$8,761.60	$143.00	$5,720.00
A21	Install 100mm dia Sewer Service	02665	690	m	200	$138,000	$315.00	$217,350.00	$219.04	$151,137.60	$143.00	$98,670.00

						CONSULTANT		RTL		SAN.		KUDLIK
A22	Install 150mm dia Sewer Service	1.3.1 02565 1.3.1	40	m	200	$8,000	$315.00	$12,600.00	$219.04	$8,761.60	$143.00	$5,720.00
A23	Supply 25mm Water Service Pipe	07565 1.3.2	2,074	m	2	$4,148	$1.00	$2,074.00	$1.21	$2,509.54	$1.87	$3,878.38
A24	Supply 50mm Water Service Pipe	07665 1.3.2	40	m	10	$400	$4.00	$160.00	$5.97	$238.80	$2.90	$116.00
A25	Supply 100mm Water Service carrier pipe	02865 1.3.2	690	m	80	$55,200	$51.00	$35,190.00	$353.55	$243,949.50	$52.80	$36,432.00
A26	Supply 150mm Water Service carrier pipe	02865 1.3.2	40	m	100	$4,000	$71.00	$2,840.00	$104.00	$4,160.00	$71.50	$2,860.00
A27	Supply 100mm HDPE Sewer Service	02655 1.3.7	690	m	80	$55,200	$51.00	$35,190.00	$301.45	$208,000.50	$52.80	$36,432.00
A28	Supply 150mm HDPE Sewer Service	07665 1.1.2	40	m	100	$4,000	$71.00	$2,840.00	$104.00	$4,160.00	$71.50	$2,600.00
A29	Supply and Install Connection to services in existing houses Adjusting	07665 1.3.2	22	ea	5000	$110,000	$3,990.00	$87,780.00	$2,701.60	$59,435.20	$11,000.00	$242,000.00
Subtotal Part A - Page 2 15 - 15%					"B"	$516,948		$825,974.00		$842,751.94		[illegible]
Total Part A					"A"+"B"="C"	$1,619,798		$2,328,134.00		$1,922,197.10		$1,795,595.71
Part B - Services for Sts 4 & 5 (Provisional)												
B30	Install 100mm. dia. Water Service Carrier Pipe c/w 2-25mm dia water service pipes	02665 1.3.1	885	m.	200	$177,000	$190.00	$169,150.00	$173.00	$153,105.00	$143.00	$126,555.00
B31	Install 100mm dia Sewer Service	02665 1.3.1	885	m	200	$177,000	$190.00	$168,150.00	$173.00	$153,105.00	$143.00	$126,555.00
B32	Supply 25mm Water Service Pipe	02665 1.3.2	2,034	m	2	$4,068	$1.00	$2,034.00	$1.26	$2,562.84	$1.87	$3,803.58
B33	Supply 100mm Water Service carrier pipe	02665 1.3.2	885	m	80	$70,600	$51.00	$45,135.00	$222.31	$196,744.35	$52.80	$46,728.00
B34	Supply 100mm HDPE Sewer Service	02665 1.3.2	885	m	80	$70,800	$51.00	$45,135.00	$60.78	$53,790.30	$52.80	$46,728.00
B35	Supply and Install Connection To services in existing houses	02665 1.3.2	33	ea	5000	$165,000	$11,000.00	$363,000.00	$3,801.60	$125,452.80	$8,937.50	$294,927.50
Total Part B - Services (Provisional)					"D"	$564,668.00		$791,604.00		$584,760.29		$645,397.00
Tender Summary												
Total Part A - Mains & Services (Streets 7 & 8)					"C"	$1,679,798.00		$2,328,134.00		$1,922,197.10		$1,795,595.71
Total Part B - Services Streets 4 & 5 (Provisional)					"D"	$654,658.00		$791,604.00		$684,760.29		$545,307.09
Total Tender					"C"+"D"="E"	$2,294,466.00		$3,119,738.00		$2,606,957.39		$2,440,903.79
GST					7% X "E"="F"	$160,612.62		$218,381.66		$182,497.02		$170,863.27
Total Tender (including GST)					"E"+"F"	$2,455,078.62		$3,338,119.66		$2,789,444.41		$2,611,767.06

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CONSULTANT

NUVUK SUBDIVISION
RANKIN INLET
Phase 4, 1999

LIST OF UNIT PRICES
UNIT PRICE CONTRACT
SCHEDULE OF QUANTITIES AND
UNIT PRICE TABLE

APPENDIX D
CONSULT.
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							RTL Tender	Ext.	Sanajiit Tender	Ext	Kudlik Tender	Ext
ITEM NO	DESCRIPTION	PAYMENT CLAUSE	EST. QUANTITY	UNIT	UNIT PRICE	EXTENSION	UNIT PRICE	EXTENSION	UNIT PRICE	EXTENSION	UNIT PRICE	EXTENSION
	Part A - Mains & Services (Sts. 2 & 3)											
A1	Rock Excavation, If Req'd	02211 1.6.1	100	cu m	180	$18,000	$140 00	$14,000.00			$77 00	$7,700 00
A2	Preblast Inspection, If Req'd	02211 1.6.2	1	L S	$1,000	$1,000	$8,500 00	$8,500.00			$110 00	$110.00
A3	Mob / Demob for Rock Excavation, If Req'd	02211 1.6.3	1	L S	$ 4,000	$4,000	$4,800 00	$4,800 00	$5,000 00	$5,000 00	$5,500 00	$5,500 00
A4	Rock Locating/Verification	02211 1.6.4	640	m	$ 5	$3,200	$15 00	$9,600 00			$5 50	$3,520 00
A5	Install 200mm dia Watermain Common Trench	02666 1.3.1	806	m	165	$132,990	$450 00	$362,700 00	$204 00	$164,424 00	$165 00	$132,990 00
A7	Install 200mm dia Sanitary Sewer Common Trench	02667 1.3.1	703	m	165	$115,995	$450.00	$316,350 00	$204 00	$143,412 00	$165 00	$115,995 00
A8	Install 150mm dia Sanitary Sewer Common Trench	02667 1.3.1	104	m	165	$17,160	$450.00	$46,800 00	$204 00	$21,216 00	$165 00	$17,160 00
A9	Instal 200mm dia Sanitary Sewer Single Main	02667 1.3.2	228	m	165	$37,620	$450 00	$102,600 00	$407 58	$92,928 24	$330 00	$75,240 00
A10	Supply 200mm HDPE Sewer/Water	02666/02667 1.3.3	1,737	m	210	$354,770	$132.00	$229,284 00	$165 24	$287,021 89	$127 00	$220,599 00
A11	Supply 150mm HDPE Sewer	02667 1.3.3	104	m	135	$14,040	$102.00	$10,608 00	$133 62	$13,896.48	$96 80	$10,067 20
A12	Supply Access Vaults	02725 1.4.1										
	- AV 97-24		1	L S	40000	$40,000	$43,000 00	$43,000.00	$45,498.16	$45,498 16	$47,631 10	$47 631 10
	- AV 97-25		1	L S	40000	$40,000	$37,000.00	$37 000.00	$39,351 58	$39,351 58	$39,320 60	$39,320 60
	- AV 97-26		1	L S	40000	$40,000	$38,000 00	$38,000 00	$40,190 88	$40,190 88	$46,777 50	$46,777 50
	- AV 97-27		1	L S	40000	$40,000	$41,000 00	$41,000.00	$43,512 44	$43,512.44	$46,514 60	$46,514 60
	- AV 97-28		1	L S	40000	$40,000	$47,000 00	$47,000 00	$50,480 72	$50,480.72	$53,302 70	$53,302.70
	AV 97-29		1	L S.	40000	$40,000	$37,000 00	$37,000 00	$39,125 64	$39,125 64	$39,327 20	$39 327 20
	- AV 97-30		1	L S	40000	$40,000	$38,000 00	$38,000 00	$39,851 64	$39,851 64	$39,491.10	$39,491 10
	AV 97-31		1	L S	40000	$40,000	$37,000 00	$37,000 00	$39,328.92	$39,328.92	$41,661 40	$41,661 40
	- AV 97-32		1	L S	40000	$40,000	$40,000 00	$40,000.00	$41,477.22	$41,477 22	$41,948 50	$41,948 50
	- AV 97-33		1	L S	40000	$40,000	$32,000 00	$32,000 00	$33,669 42	$33,669.42	$31,335.70	$31,335 70
	- AV 97-34		1	L S	40000	$40,000	$33,000 00	$33,000.00	$33,831 12	$33,831.12-	$31,644 80	$31,644 80
A14	Install Access Vaults	02725 1.4.3	11	Each	9000	$99,000	$10,000.00	$110,000 00	$7,000 00	$77,000 00	$6,600.00	$72,600 00
A15	Over-excavation (if req'd).	02221 1.4.2	100	cu m	10	$1,000	$16 50	$1,650 00	$10 00	$1,000 00	$11 00	$1,100.00
A16	Granular Backfill (Load Haul and Place) (If required)	02221 1.4.5	240	cu m	15	$3,600	$58 00	$13,920 00	$16 00	$3,840 00	$22 00	$5,280 00
A17	Crushed Road Gravel (Supply and Install) (If required)	02221 1.4.6	240	cu m	50	$12,000	$70 00	$16,800.00	$16 00	$3,840.00	$22.00	$5,280 00
A18	Mobilization/Demobilization	01500 2.4	1	L S	-		$141,000 00	$141,000.00	$137,600 00	$137,600 00	$247,918 66	$247,918 66
Subtotal Part A - Page 1					"G"	$1,254,375		$1,811,612.00		$1,397,496.34		$1,390,015 05

NUVUK SUBDIVISION
RANKIN INLET
Phase 4, 1999

LIST OF UNIT PRICES
UNIT PRICE CONTRACT
SCHEDULE OF QUANTITIES AND
UNIT PRICE TABLE

APPENDIX D
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ITEM NO	DESCRIPTION	PAYMENT CLAUSE	EST. QUANTITY	UNIT	UNIT PRICE	EXTENSION						
	Part A - Mains & Services (Sts. 2 & 3)											
A19	Install 100mm dia Water Service Carrier Pipe c/w 2-25mm dia water service pipes	02665 1.3.1	610	m	200	$122,000	$315 00	$192,150 00	$219 04	$133,614 40	$143 00	$87,230 00

						CONSULTANT	RTL		SAN.		KODIAK	
A20	Install 150mm dia Water Service Carrier Pipe c/w 1-25mm dia and 1 50mm dia water servic	02665 1.3.1	140	m	250	$35,000	$315.00	$44,100.00	$219.04	$30,665.60	$143.00	$20,020.00
A21	Install 100mm dia Sewer Service	02665 1.3.1	610	m	200	$122,000	$315.00	$192,150.00	$219.04	$133,614.40	$143.00	$87,230.00
A22	Install 150mm dia Sewer Service	02665 1.3.1	140	m	200	$28,000	$315.00	$44,100.00	$219.04	$30,565.60	$143.00	$20,020.00
A23	Supply 25mm Water Service Pipe	02665 1.3.2	1,533	m	2	$3,066	$1.00	$1,533.00	$1.23	$1,885.59	$1.87	$2,866.71
A24	Supply 50mm Water Service Pipe	02665 1.3.2	140	m	10	$1,400	$4.00	$560.00	$4.58	$641.20	$2.90	$406.00
A25	Supply 100mm Water Service carrier pipe	02665 1.3.2	610	m	80	$48,800	$51.00	$31,110.00	$255.88	$156,086.80	$52.80	$32,208.00
A26	Supply 150mm Water Service carrier pipe	02665 1.3.2	140	m	100	$14,000	$71.00	$9,940.00	$89.93	$12,590.20	$71.50	$10,010.00
A27	Supply 100mm HDPE Sewer Service	02665 1.3.2	610	m	80	$48,800	$51.00	$31,110.00	$266.47	$162,546.70	$52.80	$32,208.00
A28	Supply 150mm HDPE Sewer Service	02665 1.3.2	140	m	100	$14,000	$71.00	$9,940.00	$89.93	$12,590.20	$71.50	$10,010.00
A29	Supply and Install Connection To services in existing houses	02665 1.3.2	28	ea	5000	$140,000	$3,990.00	$111,720.00	$3,251.60	$91,044.80	$8,937.50	$250,250.00
Subtotal Part A - Page 2					"H"	$577,066.00		$668,413.00		$765,945.49		$552,458.71
Total Tender					"G"+"H"="I"	$1,831,441.00		$2,460,025.00		$2,163,441.83		$1,932,473.77
GST					7% X "I"="J"	$128,200.87		$173,601.75		$151,440.93		$135,273.16
Total Tender (including GST)					"I"+"J"	$1,959,641.87		$2,653,626.75		$2,314,882.76		$2,067,746.93

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NUVUK SUBDIVISION
RANKIN INLET
Phase 5, 2000

LIST OF UNIT PRICES
UNIT PRICE CONTRACT
SCHEDULE OF QUANTITIES AND
UNIT PRICE TABLE

APPENDIX D

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CONSULTANT RTC SAN KUDLIK

ITEM NO	DESCRIPTION	PAYMENT CLAUSE	EST QUANTITY	UNIT	UNIT PRICE	EXTENSION	RTL Tender UNIT PRICE	Ext. EXTENSION	Sanajuit Tender UNIT PRICE	Ext. EXTENSION	Kudlik Tender UNIT PRICE	Ext. EXTENSION
	Part A - Mains & Services (Sls. 1 & 6)											
A1	Rock Excavation, If Req'd	02211 1.6.1	100	cu m	$80	$8,000	140 00	14000 00			77 00	7700
A2	Prefast Inspection, If Req'd	02711 1.6.2	1	L.S.	$1,000	$1,000	8500 00	8500 00			550 00	550
A3	Mob / Demob for Rock Excavation, If Req'd	02211 1.6.3	1	L.S.	$ 4,000	$4,000	4800.00	4800 00	5000 00	5000 00	5500 00	5500
A4	Rock Locating/Verification	02711 1.6.4	640	m	$ 5	$3,200	15.00	9600 00			5 50	3520
A5	Install 200mm dia Watermain Common Trench	02660 1.3.1	750	m	165	$123,750	450.00	337500 00	204 00	153000 00	165 00	123750
A7	Install 200mm dia. Sanitary Sewer Common Trench	02667 1.3.1	225	m	165	$37,125	450 00	101250 00	204 00	45900 00	165 00	37125
A8	Install 150mm dia Sanitary Sewer Common Trench	02667 1.3.1	438	m	165	$72,270	450.00	197100.00	204 00	89352 00	165 00	72270
A9	Install 150mm dia. Sanitary Sewer Single Main	02667 1.3.2	52	m	165	$9,580	450 00	23400 00	408 00	21216 00	330 00	17160
A10	Supply 200mm HDPE Sewer/Water	02656/02667 1.3.3	972	m	210	$204,120	132.00	128304 00	175.30	170391 60	127.60	124027
A11	Supply 150mm HDPE Sewer	02667 1.3.3	490	m	135	$66,150	102.00	49980.00	130.95	64165.50	96 80	47432
A12	Supply Access Vaults	02725 1.4.1										
	- AV 00-35		1	L.S.	40000	$40,000	39000.00	39000.00	40810 65	40810.65	37739.90	37739
	- AV 00-36		1	L.S.	40000	$40,000	41000.00	41000 00	42698.91	42698 91	40540.50	40540
	- AV 00-37		1	L.S.	40000	$40,000	46000 00	46000 00	48288.89	48288.89	52707 00	52707
	- AV 00-38		1	L.S.	40000	$40,000	35000 00	35000 00	36721.29	36721.29	39552.70	39552
	- AV 00-39		1	L.S.	40000	$40,000	36000 00	36000 00	37495.69	37495 69	35491.50	35491
	- AV 00-40		1	L.S.	40000	$40,000	46000 00	46000 00	48748 69	48748 69	49868 50	49868
	- AV 00-41		1	L.S.	40000	$40,000	39000 00	39000 00	41035.05	41035.05	43484 10	43484
A14	Install Access Vaults	07725 1.4.3	7	Each	9000	$63,000	10000 00	70000.00	7000.00	49000 00	6600.00	46200
A15	Over-excavation (If req'd).	02221 1.4.2	100	cu.m.	10	$1,000	16.50	1650.00	10 00	1000 00	11 00	1100
A16	Granular Backfill (Load Haul and Place) (If required)	02221 1.4.5	240	cu m	15	$3,600	58 00	13920 00	16 00	3840 00	16 50	3960
A17	Crushed Road Gravel (Supply and Install) (If required)	02221 1.4.6	240	cu.m	50	$12,000	70 00	16800 00	16 00	3840 00	22 00	5280
A18	Mobilization/Demobilization	01500 2.4	1	L.S.	$250,000	$250,000	124300.00	124300.00	32000.00	32000 00	199637 52	199637
Subtotal Part A - Page 1					"K"	$1,137,795		$ 1,383,104 00		$ 934,534 27		994595

NUVUK SUBDIVISION
RANKIN INLET
Phase 5, 2000

LIST OF UNIT PRICES
UNIT PRICE CONTRACT
SCHEDULE OF QUANTITIES AND
UNIT PRICE TABLE

APPENDIX D

Page 6 of 6

ITEM NO.	DESCRIPTION	PAYMENT CLAUSE	EST. QUANTITY	UNIT	UNIT PRICE	EXTENSION						
	Part A - Mains & Services (Sls. 1 & 6)											
A19	Install 100mm dia. Water Service Carrier Pipe c/w 2-25mm dia. water service pipes	02665 1.3.1	420	m	200	$84,000	315.00	132300.00	219 00	91980.00	143 00	60060
A20	Install 150mm dia. Water Service Carrier Pipe c/w 1-25mm dia. and 1-50mm dia. water service pp	02665 1.3.1	250	m	250	162,500	315 00	78750 00	219.00	54750.00	143 00	35750

					CONSULTANT		RTL		SANAJIIT		KUDLIK	
A21	Install 100mm dia Sewer Service	02665 1.3.1	420	m	200	$84,000	315 00	132300 00	219 00	91980 00	143 00	60060 0
A22	Install 150mm dia Sewer Service	02665 1.3.1	250	m	200	$50,000	315 00	78750.00	219.00	54750 00	143 00	35750 0
A23	Supply 25mm Water Service Pipe	02665 1.3.2	1,325	m	2	$2,650	1 00	1325 00	1.32	1749.00	1.87	2477 7
A24	Supply 50mm Water Service Pipe	02665 1.3.2	250	m	10	$2,500	4.00	1000 00	5 26	1315 00	2 90	725 0
A25	Supply 100mm Water Service carrier pipe	02665 1.3.2	420	m	80	$33,600	51 00	21420 00	213.43	89640 60	52 80	22176 0
A26	Supply 150mm Water Service carrier pipe	02655 1.3.2	250	m	100	$25,000	71 00	17750.00	91.89	22972 50	71 50	17875 0
A27	Supply 100mm HDPE Sewer Service	02665 1.3.2	420	m	80	$33,600	51.00	21420 00	216.78	91047 60	52 80	22176 0
A28	Supply 150mm HDPE Sewer Service	02665 1.3.2	250	m	100	$25,000	71 00	17750 00	222 19	55547 50	71.50	17875 0
A29	Supply and Install Connection To services in existing houses	02665 1.3.2	24	ea	5000	$120,000	3990 00	95760 00	3251 60	78038 40	8937 50	214500 0
Subtotal Part A - Page 2					"L"	$522,850		$ 558,525 00		$ 633,770 60		$ 489,424 7
Total Tender					"K"+"L"="M"	$1,660,645		$ 1,981,629.00		$ 1,568,274 07		$ 1,404,021 2
GST					7% X "M"="N"	$116,245		$ 138,714.03		$ 109,779.24		$ 103,881.4
Total Tender (including GST)		Pt. 5			"M"+"N"	$1,776,890		$ 2,120,343.03		$ 1,678,054 11		$ 1,507,902 7

TENDER SUMMARY

Total Tender (including GST) Phase 3 (from Page 2 of 6)	Pt. 3	"E"+"F"	$2,455,078 62	$ 3,338,119 66	$ 2,789,414.41	$ 2,611,767 0
Total Tender (including GST) Phase 4 (from Page 4 of 6)	Pt 4	"I"+"J"	$1,959,641.87	$ 2,653,626.75	$ 2,314,882.76	$ 2,067,746 9
Total Tender (including GST) Phase 5 (from above)	Pt 5	"M"+"N"	$1,776,890 15	$ 2,120,343 03	$ 1,678,054.11	$ 1,587,902 7
TOTAL TENDER ALL PHASES (including GST)			$6,191,610.64	$ 8,112,089 44	$ 6,782,381.28	$ 6,267,416 7
TOTAL TENDER ALL PHASES (Excluding GST)			$ 5,786,552.00	$ 7,581,392.00	$ 6,338,674 09	$ 5,857,398 8
	BIP	LOCAL		$ 1,132,500 00	$ 6,034,804 60	$ 5,068,828 9
		NORTHERN		$ 3,770,742.47	$ 60,000 00	$ 112,149 5
		OTHER		$ 2,678,149.53	$ 185,500 00	$ 654,205 61
		TOTAL		$ 7,581,392 00	$ 6,281,304 60	$ 5,835,184 1
		BIP Local		$ (226,500 00)	$ (1,206,960 92)	$ (1,013,765 7
		BIP Northern		$ (565,611.37)	$ (9,000 00)	$ (16,822 4
Adjusted Tender (Excluding GST)				$ 6,789,280.63	$ 6,122,713.17	$ 4,826,810.61
Adjusted Tender (including GST)				$ 7,264,530.27	$ 5,481,303 09	$ 5,164,687 3
		Vaults		$ 987,000.00	#REF!	$ 758,340 0
		Mains		$ 675,366 00	#REF!	$ 562,505 4
		Services		$ 243,152 00	#REF!	$ 171,013 4
				$ 1,905,518 00	#REF!	$ 1,491,858.8

COST ESTIMATES FOR RESOLUTE WATER AND SEWER CONSTRUCTION AND RETROFITTING

ASSUMPTIONS:

1. NO ROCK EXCAVATION WILL BE REQUIRED. THE BACKFILLED EXISTING TRENCH CAN BE EXCAVATED AND REUSED.

2. WHERE APPLICABLE REMOVAL OF EXISTING WATER/SEWER LINES WILL COST EXTRA.

3. LOCAL CONTRACTOR WILL BID ON THE JOB, THEREFORE MOB/DEMOB COST WILL BE LOCAL

NOTE: ANY OTHER ASSUMPTIONS THAT ARE USED WILL BE NOTED IN ESTIMATE.

4. SERVICE LINES WILL BE REUSED, BUT SERVICE SADDLES WILL BE NEW

SCENARIO 1 - TOTAL WATER/SEWER REPLACEMENT

(1) WATER MAIN SUPPLY AND RETURN LINES

i. SUPPLY

2 LINES × $175/m/LINE
= $350/m

ii. INSTALLATION

$450/TRENCH/m × 1 TRENCH
= $450/m

NOTE: THIS IS A COMMON TRENCH FOR SEWER ALSO

ASSUME: COST FOR 150 IS SIMILAR TO 200 PIPE AS THERE IS ONLY A SMALL PORTION OF 150 PIPE REQUIRED.

By KAG Date OCT 27/98 Project Name UTILIDOR UPGRADE
Checked Date RESOLUTE BAY, NT
Page 1 of 7 Project No. 98-5748

DILLON

iii. SEWER MAIN

1 LINE × $ 175 /m /LINE
= $175 /m

iv. ACCESS VAULTS

	-SUPPLY VAULT	$ 40,000
COUNTED 30 AV'S ON PROJECT	-SUPPLY VAULT APPURTENANCES	900
	-INSTALL VAULTS	10,000
		$ 50,900 / AV

NOTE: ONE ACCESS VAULT ALLOCATE PER SECTION OF TRENCH, IE AV4 TO AV6.
per unit price
$776/m

v. MOB/ DEMOB
$ 210,000 LUMP SUM
$107/m

vi. REMOVE AND DISPOSE OF EXISTING PIPES

ASSUME: LANDFILL WILL ACCEPT SCRAP PIPING WITHOUT CHARGE TO CONTRACTOR.
TRENCHING IS ALREADY ACCOUNTED FOR IN ITEM ii. PIPE NEEDS TO BE CUT AND HAULED TO DUMP. SERVICE CONNECTIONS NEED TO BE DETACHED, PARTS TO BE SALVAGED WHERE APPLICABLE, IE. SLIP ON FLANGES, SADDLES ETC.

(a) DETACH SERVICES
$50 / DETTACHMENT OF CONNECTION
IE. AV4 TO AV6 — ≅ 15 CONNECTIONS

15 × $50 = $750
$750 / 128 m ≐ $5.90

(b) CUTTING AND SALVAGING (420 ft = 128 m)
12 m LENGTHS TO MANAGE
128 m / 12 m/CUT ≐ 11 CUTS
$30 / CUT × 11 = $330
NOTE INCLUDES SALVAGING
$330 / 128 m
≐ $2.60/m

By YAG Date

Checked Date

Page 2 of 4

Project Name

Project No. 985749

DILLON

121 - 90

(c) HAUL & DISPOSE

ASSUME TANDEMS AVAILABLE
APX 10 SECTIONS PER TANDEM
(1 SECTION IS 3 PIPES)
LOAD AND HAUL TO LANDFILL
$ 200 / LOAD (2 HRS OF TRUCK TIME AND LOADER TIME)

$200 / LOAD ÷ 128 m / LOAD
≐ $ 1.60 / m

SUM a, b, c FOR $ / m FOR ITEM VI.

($5.90 + $260 + $1.60) / m = $10.1 / m

VII. SUPPLY AND INSTALL SERVICE CONNECTIONS TO WATER AND SEWER

ASSUME EXISTING SERVICE LINES WILL REMAIN. ALL THAT IS REQUIRED ARE SADDLES FOR CONNECTIONS, CONNECTING TO EXISTING, AND SOME FILLING TO MAINS.

$ 200 / SADDLE
$ 200 / EXCAVATION & COVER
$ 100 / LABOUR

$ 500 / CONNECTION

$500/c × 15 CONNECTIONS = $7,500

$7500 / 128 m ≐ $ 58.60 / m

TOTAL ITEMS FOR $ / m COST OF ENTIRE REPLACEMENT.

i. + ii + iii + [(iv × No. AVs) / TOTAL m] + (V. / TOTAL m)
+ Vi + Vii = $ / m

$350/m + $450/m + $175/m

+ [($50,900/AV x 30 AV)/1966.85 m] → $776/m

+ $210,000/1966.55 m + $10.10/m + $58.60/m

= $975/m + $776/m + $106.8/m + $68.7/m

= $1927/m

SAY WATER & SEWER REPLACEMENT

WATER ONLY

INCLUDES
- SUPPLY 2 WATER LINES
- TRENCHING / INSTALLATION
- ACCESS VAULTS
- MOB / DEMOB
- REMOVE / DISPOSE OF EXISTING W/M
- NEW SADDLES & RECONNECT SERVICES

$350/m + $450/m + $776/m + $107/m
+ $10.10/2/m + $58.60/2/m

1/2 WORK OF BOTH FOR REMOVE & DISPOSE

1/2 WORK OF BOTH FOR RECONNECTION

= $1717/m

SEWER ONLY

INCLUDES
- SUPPLY 1 SEWER LINE
- TRENCHING / INSTALLATION
- ACCESS VAULTS
- MOB / DEMOB
- REMOVE DISPOSE EXISTING SEWER
- NEW SADDLES / RECONNECT

$450 + 175 + 776 + 107 + 5 + 29

= $1542/m

SCENARIO 2

REPLACE FROM AV4 TO AV10 ✓
AV10 TO AV11 ✓
AV21 TO AV6 ✓
FOR BOTH WATER AND SEWER.

$1927/m PER SCENARIO 1.

SCENARIO 3

REPLACE W/M'S ONLY FOR
AV4 TO AV10
AV10 TO AV11
AV21 TO AV6

CONSTRUCT IN SHALLOW TRENCH ≤ 1 m COVER.

i. W/M SUPPLY
$350/m (P.1)

ii. INSTALLATION
- APX. 1/2 DEPTH OF EXISTING TRENCH
- INSTALLATION REMAINS THE SAME √ REFLECT LESS EXCAVATION

$456/m X 60% ≐ $270/m (P.1)

iii NONE

IV. ACCESS VAULT COST IS CONSTANT WITH LENGTH STILL (P.2)

$776/m

v. MOB/DEMOB SAME $107/m

vi REMOVE & DISPOSE OF EXISTING PIPES
~~NONE~~ SOME
- ASSUME EXISTING W/M'S CAN REMAIN IN PLACE ABANDONED.
- ACCOUNT FOR AV'S. REMOVAL AND SERVICE DISCONNECTIONS.

(a) DETTACH SERVICES
$5.9/m (P.2)

(b) SOME PIPE CUTTING AND ADJ'S
ETC
ONLY 40% OF THE WORK
0.4 × $2.60/m ≐ $1.00/m

(c) HAUL AND DISPOSE
APX. 60% WORK $1.00/m

a+b+c = $7.9/m

vii. SERVICE CONNECTIONS TO WATER
ONLY
2/3 WORK OF P.3
$\frac{2}{3}$ × $58.6/m ≐ $39/m

TOTAL ITEMS FOR WATER LINE REPLACEMENT
≐ 1 m BELOW GRADE.

i + ii + iv. + v. + vi + vii

(350 + 270 + 776 + 107 + 7.9 + 39) $/m

≐ $1550/m

SCENARIO 4

REPLACE SEWERS AND LIPS.
ASSUME ACCESS VAULTS WILL REMAIN IN
PLACE. MUST REMOVE AND DISPOSE OF EXISTING

i. NO W/M
ii. INSTALLATION $450/m
iii. SEWER $175/m
iv. NONE
v. MOB/DEMOB $107/m

Vi. REMOVE DISPOSE OF EXISTING PIPE $10.1/m

Vii. SUPPLY & INSTALL SERVICE CONNECTIONS TO SEWER

APX 1/2 WORK
1/2 x $58.60/m ≐ $29/m

TOTAL ITEMS
ii + iii + V. + Vi + Vii
= $(450 + 175 + 107 + 10.1 + 29)
≐ $771/m

SAGS ON SEGMENTS		APX. DIST TO REPLACE
✓ AV14	- AV13	40 m
✓ AV25	- AV23	50 m → 10 m MORE TO
✓ AV12	- AV11	78.6 m - ALL } REFLECT PAID
AV19	AV20 AV21	ALL PER DWG. (EXCAVATION)

SCENARIO 5

REPLACE WATER & SEWER FROM AV20 TO AV22

SAME COST ESTIMATES AS FOR SCENARIO 1.

$1927/m

APPENDIX C

Impact Study -
Community Consultation

HAMLET OF RESOLUTE BAY

1998/99
UTILIDOR UPGRADE PROJECT

IMPACT STUDY
COMMUNITY CONSULTATION

DILLON
CONSULTING

HAMLET OF RESOLUTE BAY
UTILIDOR UPGRADE PROJECT

SCOPE OF WORK

- Review of Existing Documentation
- Complete Site Investigation of Utilidor to Update Latest Reported Information (UMA 1996)
- Review Utilidor Operations and Identify Concerns
- Complete an Assessment of the Hydraulic and Thermal Capacity of the System to meet 20 Year Design Requirements
- **Complete an Impact Study to Develop an Understanding of Potential Environmental Effects of Sewage Discharge to Resolute Bay**
- Develop a List of Utilidor Upgrades Required to meet the Hamlet's 20 Year Needs
- Develop a Plan and Cost Estimate for System Upgrades

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CONSULTING

HAMLET OF RESOLUTE BAY
UTILIDOR UPGRADE PROJECT

IMPACT STUDY

SCOPE OF WORK

- **Task 1 - Background Review and Consultation**

  If Required Proceed

- Task 2 - Data Collection and Field Assessment

- Task 3 - Data Assessment and Reporting

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HAMLET OF RESOLUTE BAY UTILIDOR UPGRADE PROJECT

IMPACT STUDY

TASK 1 - BACKGROUND REVIEW AND CONSULTATION

- Review Relevant Sewage Treatment Reports, Designs, Licences, SNP Results, and Scientific Literature;
- Consult Government Agencies (i.e., Department of Fisheries and Oceans, Environment Canada, and Nunavut Water Board) to Determine Historical and Current Positions Relevant to Existing Legislation and Operations for the Community;
- **Consult the Community of Resolute Bay Regarding the Current Sewage Disposal Operations and the Needs and Requirements of an Impact Study;**
- Identify Regulatory and Licence Performance Requirements for Discharged Effluent; and
- Proceed to Task 2, if Required

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HAMLET OF RESOLUTE BAY UTILIDOR UPGRADE PROJECT

IMPACT STUDY

POTENTIAL IMPACTS OF SEWAGE WASTE DISCHARGE TO THE MARINE ENVIRONMENT [1]

●	Organic Matter:	Organic compound degradation may reduce the dissolved oxygen concentration of a receiving marine environment.
●	Settleable Solids:	Benthic community structure may be altered due to particle size change and/or anaerobic conditions as a result of organic sediment decay.
●	Inorganic Nutrients:	Increased levels of nitrogen and phosphorous could increase primary production and therefore decrease dissolved oxygen levels at or near sediments.
●	Pathogenic Organisms:	Receiving environment may be subjected to disease-causing bacteria or viruses.
●	Residual Chlorine:	Chlorine within discharged water may be toxic to fish if levels are high enough.
●	Suspended Solids:	An increase in turbidity may alter fish behaviour and available light for primary production.
●	Floatables:	Slowly degradeable materials that may be aesthetically offensive.

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[1] Department of Indian Affairs and Northern Development 1987. Sewage waste Disposal to the Arctic Marine Environment. Environmental Studies No. 55. Stanley Associates Engineering Ltd.

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HAMLET OF RESOLUTE BAY UTILIDOR UPGRADE PROJECT

IMPACT STUDY

PREVIOUSLY IDENTIFIED ISSUES [1]

- Complience with the NWT *Health Act* as it relates to the Discharge of Untreated Sewage to the Ocean Environment

- Complience with the Federal *Fisheries Act* as it Relates to the Disposal of a Deleterious Substance

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[1] Resolute Bay, NWT, Water and Sewer Facilities Investigations, Final Report. 1996. UMA Engineering Ltd.

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HAMLET OF RESOLUTE BAY
UTILIDOR UPGRADE PROJECT

IMPACT STUDY

COMMUNITY CONSULTATION

- Discuss with the Hamlet of Resolute Bay Waste Disposal System;

- Identify Historical and Current uses of the Marine Area where Discharge Occurs

- Identify Environmental Concerns, **if any**, Regarding the Current Disposal System; and

- Identify any Significant Changes to the Area from Past to Present.

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RESOLUTE BAY SANITARY SEWER
pop 251 (2019)

Assumptions 5 people per household, 225 lpcd, PF=4, n=0.013
Total water use=RWU*(1+(.00023*Population)

Pipe	From AV	To AV	Length (m)	Incremental Population	Total Population	Sewage Flow (L/day)	Sewage Flow (m3/s)	Diameter (m)	Slope	Capacity (m3/s)	Utilization (%)
				houses	houses						
1	Plant	AV2	211.53	0	0	0	0.0000	0.150	0.1160	0.052	0.0
2	AV2	AV3	118.26	2	2	9520	0.0001	0.150	0.0790	0.043	0.3
3	AV3	AV21	70.85	1	3	14279	0.0002	0.150	0.0595	0.037	0.4
32	AV21	AV23	70.33	3	6	28559	0.0003	0.150	0.0565	0.036	0.9
*25	AV25	AV23	98.27	4	4	19039	0.0055	0.150	0.0199	0.021	25.5
23	AV23	AV13	98.15	1	11	52358	0.0059	0.150	0.0280	0.025	23.0
*17	AV17	AV16	80.36	2	2	9520	0.0054	0.150	0.0364	0.029	18.4
16	AV16	AV14	83.23	5	7	33318	0.0056	0.150	0.0321	0.027	20.7
14	AV14	AV13	78.16	5	12	57117	0.0059	0.150	0.0422	0.031	18.9
13	AV13	AV12	23.45	0	23	109475	0.0118	0.150	0.0455	0.032	36.2
26	AV27	AV12	86.00	4	4	19039	0.0002	0.150	0.0450	0.032	0.7
12	AV12	AV11	78.82	3	30	142794	0.0122	0.150	0.0432	0.032	38.4
*20	AV19	AV20	76.45	8	8	38078	0.0057	0.150	0.0157	0.019	29.8
*22	AV22	AV20	105.20	3	3	14279	0.0054	0.150	0.0659	0.039	13.9
21	AV20	AV21	48.23	1	12	57117	0.0112	0.150	0.0060	0.012	94.6
31	AV21	AV30	41.89	1	13	61877	0.0112	0.150	0.0089	0.014	78.1
30	AV30	AV29	60.66	2	15	71397	0.0113	0.150	0.0561	0.036	31.4
29	AV29	AV8	66.75	4	19	90436	0.0115	0.150	0.0077	0.013	86.4
5	AV4	AV5	86.74	7	7	33318	0.0004	0.150	0.0889	0.045	0.8
6	AV5	AV6	41.59	2	9	42838	0.0005	0.150	0.0503	0.034	1.5
7	AV6	AV7	41.45	3	31	147553	0.0122	0.150	0.0584	0.037	33.2
8	AV7	AV8	22.86	2	33	157073	0.0123	0.150	0.0401	0.030	40.4
28	AV28	AV8	91.03	7	7	33318	0.0004	0.150	0.0056	0.011	3.4
9	AV8	AV9	29.57	0	40	190391	0.0127	0.150	0.0464	0.033	38.7
10	AV9	AV10	46.02	5	45	214190	0.0130	0.150	0.0430	0.032	41.1
11	AV10	AV11	83.82	1	46	218950	0.0130	0.200	0.0057	0.025	52.6
*101	AV101	AV102	157.00	10	10	47598	0.0058	0.200	0.0440	0.069	8.4
102	AV102	AV104	105.00	5	15	71397	0.0061	0.200	0.0050	0.023	26.2
*103	AV103	AV104	157.00	11	11	52358	0.0059	0.200	0.0440	0.069	8.5
104	AV104	AV105	70.00	0	26	123754	0.0119	0.200	0.0440	0.069	17.3
105	AV105	AV106	122.50	5	31	147553	0.0122	0.200	0.0050	0.023	52.6
106	AV106	AV32	157.00	6	37	176112	0.0125	0.200	0.0440	0.069	18.2
311	AV11	AV32	91.44	0	76	361744	0.0252	0.200	0.0028	0.017	145.1
33	AV32	AV33	91.14	0	113	537858	0.0377	0.200	0.0060	0.025	148.5
34	AV33	AV34	88.09	0	113	537856	0.0377	0.200	0.0131	0.038	100.5
35	AV34	AV35	39.32	0	113	537856	0.0377	0.200	0.0084	0.030	125.5

V= 0.51 m/s

?

* 3/4" bleed into sewer, 0.00525 m^3/s