

# Technology Design Development Report



Northlands Infrastructure Replacement Steering Committee  
June , 2008



**DILLON**  
CONSULTING

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## **1.0 Introduction**

### **1.1. General**

Yellowknife Condominium Corporation #8 (Northlands Condo Corp) is a residential mobile home development located in the fringe of the downtown area in the city of Yellowknife, within 1.2 kilometers of the downtown core. The development is occupied by an estimated 775 to 1,100 people occupying 258 mobile homes. The mobile home development was originally developed in the early 1970's and was transitioned into a condominium corporation in 1990. The sewer and water infrastructure that was installed in the 1970's has reached the end of its useful life and needs to be replaced.

Northlands Condo Corp, through its Infrastructure Committee, is working with the City of Yellowknife (City) to resolve the infrastructure issues that currently exist within the Condo Corp. A "working group" to the Infrastructure Committee is advising the committee on all technical matters pertaining to this project. The working group consists of one member from the Condominium Board, one member of the Condominium Corporation owners, and members from the City of Yellowknife, including the Director of Public Works and Engineering, the Manager of Planning and Lands, as well as a member of City Council.

The City of Yellowknife issued a Request for Proposals and Terms of Reference (TOR) to undertake a feasibility study. In December of 2007, the City retained Dillon Consulting to undertake the feasibility study. The working group is the Steering Committee responsible for the administration of the feasibility study.

The goals and objectives of the overall project as stated in the terms of reference are as follows:

- To develop and implement a sustainable infrastructure system within Northlands to provide satisfactory service levels to the residents of Northlands Condo Corp;
- To develop and implement an infrastructure system that meets the City of Yellowknife's servicing standards;
- To implement the project in a manner so as to optimize the access to available funding for the capital works to mitigate the financial impact to the Northlands Condo Corp.

**The feasibility study will chart a path the Corporation could follow to reach these goals**

The feasibility study has 3 major components.

1. Technology Design Development
2. Planning Review
3. Implementation Strategies and Financing

Reports were prepared for each major component of the study. An Executive Summary Report was also produced. The purpose of this report is to focus on water and sewer infrastructure design and technology to provide:

- An overview of the existing system
- Criteria for the development of a replacement system
- Concept designs for at least 3 options,
- An assessment of the options

## **1.2. Technology Review**

The study included an updated literature and industry review undertaken to capture more recent developments, including Canadian Council of the Ministers of the Environment (CCME) Water Task Force, Environment Canada, Canadian Water and Waste Association (CWWA) and Canadian Mortgage and Housing Corporation (CMHC). In developing options for the replacement of the infrastructure in Northlands Dillon undertook the following:

- a. Technology review of alternative or innovative water and sewer technologies relative to residential water and sewer infrastructure improvements in cold climate communities to provide a basis for developing site specific solutions for Northlands Condo Corp.
- b. Technology review of alternative or innovative construction materials, equipment and methods for water and sewer infrastructure improvements or replacement in cold climate communities to provide a basis for implementing the site specific solutions for Northlands Condo Corp.
- c. Reviewed the use of alternative servicing standards (deviation from the City Standard) that could provide capital and operational cost savings, while also meeting the intent of the City standards.
- d. Technology survey of materials, equipment and methods used by northern contractors for water and sewer infrastructure and improvement or replacement in the NWT to provide a basis for benchmarking the technology reviews.

## 2.0 Existing System

The existing sewer and water system was installed in the 1970's. The servicing standards used at the time did not meet the City of Yellowknife's (the City's) standards. The system included CSP piping, shallow burry piping, and single trail water connections. The site location also presents its own set of challenges. The Northlands trailer park area was constructed using fill material. The underlying ground is a combination of marsh/swamp and rock outcrop. The material used for the fill is a sandy material. The water and sewer mains currently have a circuitous path through the trailer



**Figure 2-1 Existing Water Service Location**

park as shown in Figure 2-1. Many mains located along the back yards for the properties, and in several locations the mains are located under the trailers.

Over the past several years the level of service of the existing system has deteriorated. The Condo Corporation has spent increasing amounts of resources in maintaining and repairing the mains. Failure of the entire system or large parts of the system over the next several years is a potential. The components of the existing system include;

- Water distribution mains. This includes fire hydrants which provide the residential area with the required fire suppression water supply.
- The water main system is designed for a continuous flow to provide freeze protection to the mains.
- Sewer collection mains.
- Individual unit services. Each unit has a single water connection and single sewer connection. The water connection includes a heat trace system to prevent unit service freezing.
- Each unit has a water meter. Meter readings are recorded by the City.
- There are a series of manholes on the sewer collection system which provide access for servicing, flushing and thawing the sewer mains.
- In addition to servicing the trailer units, the sewer and water system also provides service to the Stanton Plaza (Reddi Mart) complex.

The sewer and water mains are tied into the City system at one point located on the corner of Franklin Avenue and Old Airport Road.

### 3.0 Design Criteria

The intent of the project is to develop a system that ultimately could be accepted and managed by the City. The City has a set of servicing standards that must be met to allow the utilities to be accepted by the City. In areas where substantial capital cost savings can be gained, options to the criteria can be considered. The design standards that form the basis of the conceptual option development are shown in the following table.

**Table 3.1** Design Criteria from the City of Yellowknife's Servicing Standards

Criteria	Value
<b>Water mains</b>	
Design Flow	Average day = 750 lcd *
Fire flow single family	76 L/s **
Minimum main pressure	280 kPa ***
Minimum fire hydrant pressure	140 kPa
Minimum pipe diameter	150 mm
Minimum service connection size	19 mm
Minimum depth of cover	3,000 mm
Hydrant coverage	Not more than 150 m apart on main or not more than 100 m from dwelling
<b>Sewer Mains</b>	
Domestic contribution	600 l/day
Peak factor	$1+(14/(4+pop/1000))$
Minimum velocity	0.76m/s
Minimum pipe size	200 mm
Minimum cover	2,750 mm
Manhole maximum spacing	120 m

\* Liters per capita day

\*\* Liters per second

\*\*\* kilo Pascal

Dillon completed preliminary design calculations to confirm that the required flow values can be met by the minimum pipe sizes. For the development of the options a 150 mm water main and a 200 mm sewer main will be used.

## 4.0 Option Development

### 4.1. Concept Requirements

Water and sewer servicing options developed for Northlands need to address several service requirements. Constraints taken into account in the development of the options are discussed in detail below and include:

- Fire Flows
- Land forms and physical space
- Constructability of the system
- Individual unit services

#### 4.1.1. Fire Flow

The major requirement for water service is the need for fire suppression water (hydrants) to provide fire protection to the residents. This requirement has a fundamental impact on the development of the options. The required fire flow volume can be met with the minimum water main size (150 mm). At the conceptual level this means that the provision of the fire flow system will also meet the requirements of the residential water demand. This will need to be verified as part of the final design process. Figure 4-1 shows the required fire hydrant and associated water main layout to meet the City



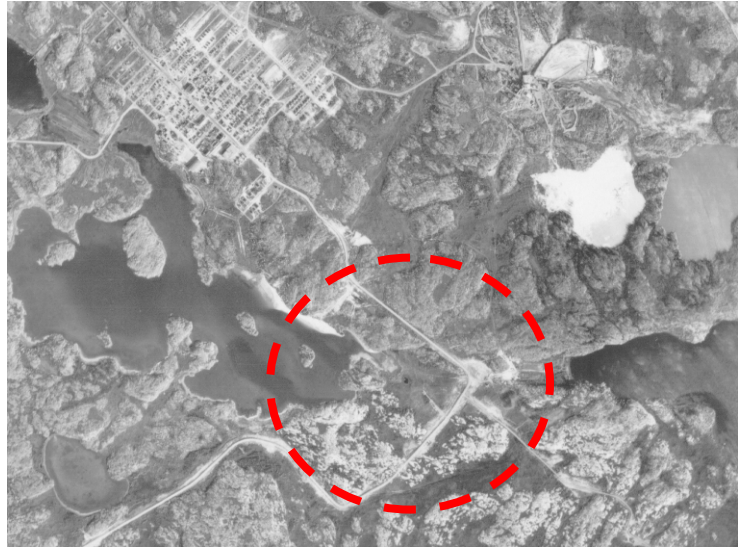
**Figure 4-1 Minimum Requirements for Fire Flow**

Servicing Standards for fire protection. The trailer park can basically be serviced for water supply by the installation of the mains required for fire flow.

The requirement for fire flow will affect the viability of any trucked water supply option because the fire flow requirement provides for approximately 60% of the required service mains for piped service.

#### 4.1.2. Land forms and Physical Space

The trailer park is located in an area that has both rock outcrops and low lying fill areas. Based on the historical air-photos it is apparent that the area was once a marsh/swamp through out the center of the trailer park. The land was in-filled using a sandy material. While this type of infill material is suitable for the installation of trailers on wood block foundations, it creates challenges for the installation of a stable water and sewer infrastructure.



**Figure 4-2 Aerial Photo 1953**

The presence of rock out crops presents engineering and construction challenges. If underground services are used the rock outcrop areas will require rock blasting and removal. Blasting and rock removal adjacent to the existing trailer units will be difficult and therefore the cost to complete this work will be higher.

There also exists the challenge of working next to Frame Lake. In particular, much of Catalina Drive is only 1 to 1.5 meters higher than Frame Lake. Installing underground utilities in this area will be difficult and costly. The tendency will be for the lake water to flow through the sandy soils and into the utility trench during construction. This will create additional costs during the construction to manage the ground water flow.

As shown in **Figure 2-1** the current utilities are located on trailer property, along the backs of lots, under trailers, and a variety of other locations. The standard of practice is to have utilities located on City property on the road right of ways, within the Right of Way (ROW) of alleys, or within easement ROW.

### 4.1.3. Constructability

There are a number of construction issues that need to be addressed or at least recognized in the development of the options and they need to be reflected in the cost estimates. The greatest single cost for the installation of piped services is the excavation and backfilling of the pipe trenches.

- The actual cost of the pipe is a very small cost item. The pipe size, or increasing the pipe size, has little impact of the project budget at the option development stage. The incremental cost to change the water mains from a 150 mm to a 200 mm pipe will not impact the overall project cost. For this reason, further work on refining the pipe size calculations are not recommended at this time.
- Installing water and sewer main in the same trench operation, while maintaining the required special separations, is the most cost effective way to install the system. This results in sewer mains and water mains following a similar alignment.
- There are underground utilities in place that must be incorporated into the construction plan. Northland Utilities Limited (NUL) has installed new underground power services to the majority to the trailer park. The primary and secondary power lines are installed in the road right of way. There is conduit on both sides of the roadway, as well as a number of road crossings and transformer (pedestal) installations. These are shown in the appendix. The drawing shown in the appendix was received from NUL on April 11, 2008.

In locating the new utilities consideration must also be given to the ability to install the systems. To complete the installation excavation equipment must be able to dig the trench. Pipe trenches are required to be properly excavated meeting the work place health and safety requirements.

Due to the location of the existing mains an on line replacement is not possible. The concepts for replacement need to account for the need to connect the existing to the new systems as needed over the phasing of the replacement.

### 4.1.4. Unit Service

Each trailer will be connected to the new mains. To allow for individual trailers to be metered and regulated, each unit must have its own service.

To provide for freeze protection, the City's standard for dual water services with a re-circulation pump in the trailer will be used. This type of pump will eliminate the need for heat traces on the services. The removal of the heat traces will reduce the units' power consumption.

## 4.2. Evaluation Criteria

A set of criteria can be used to evaluate the options. The criteria shown in Table 4.2-1 below were developed based on the study terms of reference and through discussion with the steering committee:

**Table 4.2-1 Selection Criteria for Technical Options**

<b>Criteria</b>	<b>Description</b>
<b>Capital Cost</b>	<p>The capital cost is the cost to complete the upgrade. This is essentially the cost of construction. The total capital cost is shown in 2008 dollars based on the conceptual design for each option and historic tender values for similar work in the City of Yellowknife.</p> <p><i>A high rating indicates a relatively low capital cost. A low rating indicates a relatively high capital cost.</i></p>
<b>Operations and Maintenance Costs</b>	<p>The operational costs are the costs associated with the annual operation to deliver the service. The maintenance costs are the costs over 20 years to maintain the system.</p> <p><i>A high rating indicates a relatively low O&amp;M cost. A low rating indicates a relatively high O&amp;M cost</i></p>
<b>Innovative or Environmentally Friendly Rating</b>	<p>This is a measure of whether the option meets the philosophy of the Green Municipal Fund infrastructure program: promoting innovative approaches that could be widely applicable, and provide significant environmental benefits in terms of water use, energy consumption, or greenhouse gas emissions.</p> <p><i>A high rating indicates that the option clearly has elements that meet the funding program's criteria. A low rating indicates clearly there are elements that are counter to the funding program's criteria.</i></p>
<b>Meets City Standards</b>	<p>This is a measure of whether the option can meet the City's approval with respect to the transfer of the infrastructure to the City.</p> <p><i>A high rating means that it meets the current City Standards. A medium rating means it can meet the City Standards but may require some modification to the current by-laws. A low rating indicates that the option will not meet the City's Standards or requirements.</i></p>
<b>Residents Approval</b>	<p>This is a measure of how acceptable residents find the option.</p> <p><i>A high rating means that a majority of residents have a strong preference for the option. A low rating means that a majority of residents have a strong aversion to the option.</i></p>

### **4.3. Servicing Concepts**

Four different concept approaches were developed as part of the feasibility study:

- Full underground piped system that meets the City Standards in all respects.
- Modified underground piped system that will require the City to approve changes to the City's servicing by-laws to be implemented.
- Hybrid piped system. Both underground and above grade (utilidor) pipes are used to provide sewer and water services.
- Hybrid trucked system. The water supply is delivered through a piped system, but the sewage collection is by trucked service.

A description of each concept approach follows, including an evaluation of each using the criteria presented in 4.2. A summary of the evaluations is included as 4.4. Other options that were considered but not taken any further are also described in 4.4.

More detailed cost information is provided in section 5 of the report.

### 4.3.1. Full Underground Piped System Concept

This concept provides underground water and sewer throughout Northlands.



Figure 4-1 City Standard Option – Piped Water (left) and Sewer (right) Locations

The City Standard is for piped sewer and water through the road or alley right of Way (ROW).

Table 4.3-1 City Standard Option Evaluation

Criteria	Discussion	Suggested Rating
<b>Capital Cost</b>	This option has the second highest estimated capital cost of the options. However, at \$13,326,000, it is very close to the highest cost.	Low
<b>Operations and Maintenance Costs</b>	This option has the lowest operations and maintenance costs of the options. The City has shown through their years of experience that their standards provide for the lowest long term costs. The City Standards have been developed over a number of years to specifically address the life cycle costs of their utility system.	High
<b>Innovative or Environmentally friendly rating.</b>	There are a number a ways that the implementation through the City Standards meet the intent of the FCM Funding. These are; <ul style="list-style-type: none"> <li>➤ Reduce energy costs. The new system will use less energy due to the reduction in leakage and maintenance.</li> <li>➤ Increased environmental protection by reducing the risk of sewage leakage into the ground and Frame Lake.</li> <li>➤</li> </ul> However this option does not meet the requirements related to advancing technologies.	Medium
<b>Meets City Standards</b>	By definition, this option meets the City Standards.	High
<b>Residents Approval</b>	Based on feedback from residents to date this is the most acceptable option.	High

#### 4.3.2. Modified City Standard Option



Figure 4-2 Modified City Standard

The modified option uses the City Standards through the majority of the installation. However in two areas where the construction will be difficult due to ground conditions, and where the cost of the main installation is borne by only one side of the road, we developed a system using longer services to access trailers that are located along Anson Drive and Catalina Drive

The services will be run through the fronting lots to the trailers between. Each trailer will have an individual service connection for water. Combined connections will be used for sewer. This reduces both the main costs, and the service connection costs.

A challenge of this option is the need to have an easement on the side of each trailer lot that fronts the main in order to access the trailer directly behind. This easement will be needed to allow City access to the services should the service need replacement at some time in the future. Also, depending on the nature of a service failure, more than one unit maybe affected (loss of service) by the need to repair a service failure.

Table 4.3-2 Modified City Standard Option Evaluation

Criteria	Discussion	Suggested Rating
<b>Minimize Capital Cost</b>	This option has the highest estimated capital cost at \$13,777,000.	Low
<b>Operations and Maintenance Costs</b>	The operations and maintenance costs are expected to be equivalent to those of the City Standards option.	High
<b>Green or Environmentally Friendly Rating.</b>	This option is similar to the City Standard option. It has elements to the implementation that meet the requirements for the reduction of GHG; however there are no elements that advance the technology of infrastructure.	Medium
<b>Meets City Standards</b>	While the option does not meet the City Standards, preliminary discussion with the City indicate that this option could be implemented, and the Sewer and Water By-law adjusted to allow the system to meet the City's Standards.	Medium
<b>Gains Residents Approval</b>	Based on feedback from residents to date this option would be acceptable if it became necessary.	Medium

### 4.3.3. Hybrid Underground and Utilidor Piped System Concept

The hybrid piped concept uses the City standard for the majority of the system. A utilidor is used in areas where construction challenges increase the cost of pipe installation. A utilidor in this case is an at grade piping system where the sewer and water are installed in an insulated and heat traced conduit. Portions of the utilidor will use a force main sewage system in lieu of a gravity flow sewage system.



4-3-3: Piped System (blue) with Utilidor (green)

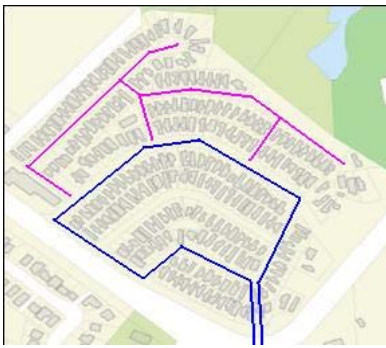
The utilidor concept has been successfully used in the NWT. Much of Inuvik has been on a utilidor for several decades. New sections of the underground systems in Iqaluit and Rankin Inlet use a utilidor where underground piping is not feasible.

There are some drawbacks to a utilidor. The operating cost is high because the mains require heat tracing, and macerating pumps used to evacuate the sewage from the trailers will increase home owner energy costs. The utilidor will be very visible and the city will require access to the utilidor for repairs and maintenance over the life of the system.

**Table 4.4 Evaluation of Hybrid Underground and Utilidor Concept**

Criteria	Discussion	Suggested Rating
<b>Capital Cost</b>	This option has the lowest estimated capital cost of the options at \$9,044,000.	High
<b>Operations and Maintenance Costs</b>	The operations and maintenance costs are expected to be higher than those of the City Standards option.	Medium
<b>Innovative or Environmentally Friendly Rating</b>	This option has some elements that lead to a reduction of GHG, however the use of heat trace and pumped sewer would cancel any benefits.	Low
<b>Meets City Standards</b>	Preliminary discussion with the City indicate that this option could be implemented, and the Sewer and Water By-law adjusted to allow the system to meet the City's Standards.	Medium
<b>Residents Approval</b>	Based on feedback from residents to date, this option would be less acceptable than a fully underground piped system.	Medium

#### 4.3.4. Hybrid trucked system concept



The hybrid trucked concept uses a combination of underground services and a trucked system to provide sewage and water services. As outlined in section 4.1.1 there is a requirement to install a minimum level of water mains to achieve the fire protection. This minimum level of service can be combined with trucked sewage. This system would be similar to the system used in Old Town and Latham Island during the summer months when the houses are on the summer water line.

Figure 4-4: Piped System (blue) with Trucked Service (magenta)

Table 4.5 Evaluation of Hybrid Trucked Concept

Criteria	Discussion	Rating
<b>Minimize Capital Cost</b>	At \$10,045,000 this option does not have the lowest estimated capital cost. In fact the cost difference between this option and the fully piped options is not as significant as one might expect. The cost to install both sewer and water in one trench is only 25% higher than the cost to install just the water main.  Any savings from not using buried sewer mains is offset by the need to install sewer tanks into every building. In some buildings there is not room for the tanks, and the tanks will need to be housed in a small building attached to each house.	Medium
<b>Minimize Operations and Maintenance Costs</b>	The operational and maintenance cost for this option are the highest due to the need to operate sewer trucks on a year round basis.	Low
<b>Innovative or Environmentally Friendly Rating</b>	This option is counter to the FCM funding for a number of reasons. The increased use of fossil fuels to operate the sewage trucks is one example. The technology used (trucked sewage) is not a new technology, nor does it advance any knowledge base.	Low
<b>Meets City Standards</b>	The City has reviewed the option to increase the use of trucked services (example Niven lake) and has determined that this is not an option that it wants to pursue.	Low
<b>Residents Approval</b>	Based on feedback from residents to date, this option would be not be acceptable to many residents.	Low

#### 4.4. Concept Evaluation Summary

The table below summarizes the evaluations for each servicing concept option presented in 4.3 above. This table uses suggested rating and priorities that may be reviewed and modified by Northlands Condo Corp in order to arrive at a decision about the preferred technical concept.

The suggested ratings are brought forward from the previous section of the report. A numerical approach is shown below where a value of 3 was assigned to high rating, a value of 2 to medium, and a value of 1 to low ratings. A % priority has also been suggested for each criterion. A higher percentage indicates a higher priority was placed on this criterion, than others. Again, these values may be reviewed and modified by Northlands Condo Corp if they follow this approach to determining a preferred technical option.

Totals can then be determined by multiplying the priority value by the rating for each criterion, and adding the each option's scores.

**Table 4.4-1 SAMPLE Evaluation**

Criteria	Suggested Priority %	Summary of Suggested Ratings By Concept			
		Underground City Standard	Underground Modified City Standard	Hybrid Piped and Utilidor	Hybrid Trucked
<b>Capital Cost</b>	<b>30</b>	1 (30)	1 (30)	3 (90)	2 (60)
<b>Operations and Maintenance Costs</b>	<b>25</b>	3 (75)	3 (75)	2 (50)	1 (25)
<b>Innovative or Environmentally Friendly Rating</b>	<b>10</b>	2 (20)	2 (20)	1 (10)	1 (10)
<b>Meets City Standards</b>	<b>25</b>	3 (75)	2 (50)	2 (50)	1 (25)
<b>Residents Approval</b>	<b>10</b>	3 (30)	2 (20)	2 (20)	1 (10)
<b>Total</b>	100	<b>230</b>	<b>195</b>	<b>220</b>	<b>130</b>

## **4.5. Servicing Concepts Not Assessed**

Other servicing concept options that seemed promising were reviewed but not carried further for assessment. A discussion of the concepts and reasons for not carrying them forward follows:

### **4.5.1. Fully trucked system**

This system would use trucked servicing for all units for both sewer and water services. This will require each unit to have water and sewer tanks, as well as a domestic pressure system for the water. As a point of reference the estimated cost to install tanks and pressure systems in each unit would range from \$10,000 to \$25,000. A number of the units will not have sufficient room within the unit to install the required tanks and a building addition or separate building will be required. Access to the tank filling and discharge points would also need to be provided at the front of the building. Many units do not have sufficient space on the property, within the required setbacks, to install a separate building to house the required tanks. Dispensation is not appropriate, nor likely to be made by the authority having jurisdiction.

Because there would be no underground services in this option there would be no hydrants within Northlands. This issue alone may be significant enough to prevent further consideration. Without adequate fire suppression the requirements for building separation and construction materials change. Without doing a through review of each unit, it is reasonable to assume that the vast majority, if not all of the units, do not conform to the requirements.

A very rough estimate is that the capital cost of a fully trucked servicing option would be in the \$5 million range.

### **4.5.2. A dry fire suppression system**

The dry system has not been used in the NWT or Nunavut and there are a number of unknowns:

- Are there specific training requirements for the fire department?
- Can the technology be appropriately adapted to the cold region?

If we assume that the above issues can be resolved through detailed design of the system, then the next question to be asked is whether the system provides any advantage over the hybrid trucked system that is proposed for assessment. The capital costs to install the mains for a dry system are equivalent to that of the wet fire system. The disadvantage of the dry system is that there is no opportunity to provide piped water supply to the units that are along the fire suppression lines. The cost of the option escalates as there are all the costs of the fully trucked system, in addition to the costs of the dry fire suppression system. Therefore there is no advantage to the dry fire suppression system.

## 5.0 Cost Estimates

### 5.1. Capital Costs

For each of the options estimated capital costs were generated using historic City tender values for similar work. The conceptual designs were used to develop preliminary quantity estimates. Table 5.1 below illustrates the comparative estimated capital costs for each concept option. Costs are shown in both 2008 dollars and 2011 dollars, as the project will not begin immediately.

Table 5.1: Comparative Capital Costs

Option	Estimated Cost 2008	Estimated Capital Cost 2011
City Standard	\$13,265,000	\$18,459,000
Modified City Standard	\$13,777,000	\$19,171,000
Hybrid Underground and Utilidor Piped System	\$9,044,000	\$12,585,000
Hybrid Trucked System	\$10,045,000	\$13,978,000

### 5.2. Operational and Maintenance Costs

The City has historic and current operational cost data for the operation of the sewer and water mains. This data set covers the operation of both piped and trucked systems. The cost to operate and maintain the City's piped system is approximately 1.43 cents per liter. This includes the cost of renewal of the mains and services at the end of the system design life.

The delivery of trucked services is slightly more expensive to operate than the piped system. The approximate increase in costs for a trucked system is 25 to 30% based on the historic cost to operate the trucked sewer and water systems in Yellowknife. The operating costs that the City incurs do not include the costs borne directly by the home owner. The home owner costs include the operation and maintenance of the domestic pressure pump, the waste water pump, and any heat trace systems.

Each option carries a different customer cost that needs to be considered. One of the challenges with any system other than the City Standard System is that there will be different levels of service for different locations in the trailer park. There will also be a varying cost to the customer. The Corporation will need to determine if there will be a standardization of the customer costs through cross subsidies, or if each person unit will pay their specific costs. The table below discusses the cost elements for each option.

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Option	Cost Elements	Monthly Cost Per Unit	Additional Total Costs Over 20 Years
<b>City Standard</b>	Standard City Water Bill	\$107	\$0
<b>Modified City Standard</b>	<p>All units will pay the standard monthly cost for the piped service.</p> <p>38 units will pay the cost of maintaining heat to the longer sewer lines. This is estimated to be at 5 watts per meter.</p>	<p>\$107</p> <p><math>\\$107 + 32 = \\$139</math></p>	\$143,000
<b>Hybrid Underground and Utilidor Piped System</b>	<p>115 units will pay the standard monthly cost for the piped service</p> <p>38 units will pay the cost of standard water service (piped) plus the cost of maintaining heat to the longer sewer lines. This is estimated to be at 5 watts per meter.</p> <p>105 units will pay the cost of standard water service (piped ) plus the cost of maintaining heat to the sewage service to the utilidor. This is estimated to be at 5 watts per meter. Plus the cost of maintaining the sewage force main to the utilidor system.</p>	<p>\$107</p> <p><math>\\$107+32 = \\$139</math></p> <p><math>\\$107+32+50 = \\$189</math></p>	\$1,311,000
<b>Hybrid Trucked System</b>	<p>For 115 units there will be the standard monthly Water Bill for Piped Services</p> <p>For 143 units there will be the standard monthly water bill for trucked Services. These residents will also pay the cost of operating a tanked system which will include the electrical pumping costs. In many cases this will include pumping sewage. And the cost of heating the tank room (or separate building)</p>	<p>\$107</p> <p><math>\\$142+15 = \\$157</math></p>	\$842,000

## **6.0 Construction Sequence**

Completing the works over a four (4) year horizon has been discussed in previous sections of the report. A logical installation sequence needs to consider:

- maintaining water and sewer services to all residents throughout the construction period
- maintaining fire flow throughout the construction period
- re-working and the risk of system failure

### **6.1. Installation**

#### **6.1.1. Watermains**

The installation of the water system needs to allow for continuation of service to those units that remain on the old part of the system. Since the system will take several years to fully upgrade, a phased approach will be required.

In discussion with members of the infrastructure committee it was noted that the 600 block is in marginally better condition than the other areas. This is likely because the area has had a fairly long upgrade (17 units) and that the area is founded on more stable ground. It would therefore be logical to complete the upgrades in the other areas as a first priority.

#### **6.1.2. Sewers**

The construction of sewer mains is normally initiated at the low end of the system, which in this case is where the mains tie into the Franklin Avenue mains. The reason for starting at the low end is related to the pipe hydraulics.

New pipe have a higher “C” value, which is a measure of the smoothness of the pipe. The higher the C value the lower the resistance in the pipe, and the more sewage that the pipe can carry. Because the velocity of the sewage in the pipe will be higher the new pipe will carry more sewage faster than the old pipe. Therefore we want the new pipe down stream of the old pipe. Having new pipe upstream of old pipe may result in the old pipe sections becoming surcharged, and backing up into the trailer units.

Construction of sewers is completed from the low end to the high end for each section. This allows the construction crew to use the new line as a drain to the operation. If the line is laid down stream, then the working end of the system is collecting all the drainage from the pipeline.

### **6.1.3. Fire Flow**

Completing the minimum requirements for the fire flow needs early in the upgrade also has some merit. The maintenance of this part of the system is vital to the provision of the required fire suppression. If needed, housing units can be supplied with temporary water and sewer through a trucked system (or summer line system). However fire flow must be provided through the mains.

Phasing work so that minimum fire flow was given priority would provide for a number of benefits, namely:

- Provides new services to 47% units.
- Provides fire flow supply to 100% of the trailer park
- Removes 58% of the old mains from primary service.
- Installs a total of 50% of the new mains.

## **6.2. Maintaining Services**

During the City's annual sewer and water renewal programs the contractors are required to provide temporary water and sewer services.

### **6.2.1. Water Supply**

The approach used for these contracts for water supply is to use overland temporary piping to the housing units. The piping typically enters the housing unit through the garden hose connection. The housing units are provided water through the construction period using 50 mm temporary piping along the frontages of the units, and 19 mm hose connection to each housing unit from the 50mm piping.

The temporary piping is protected at road and driveway crossings by providing blocking and/or asphalt cover to allow vehicles to drive over the line without damaging the piping. The water entering the units is not metered during the construction period.

### **6.2.2. Sewage Collection**

Sewer collection poses more of a challenge. Where possible the existing sewer mains and connection are maintained throughout the construction. Where this is not possible, then over land piping is used, along with a pumping system to transport the sewage around the project site. This requires that each unit sewer service needs to be pumped around the project site. If at all possible this approach is avoided.

In some areas it will not be possible to maintain water and sewer services throughout the construction season. There may also be areas that the water and sewer mains are not maintained

over one or more winter seasons. An option to consider is the use of temporary trucked services. This could be achieved using a potable tanked system housed in an independent building (3 m x 3 m). The temporary building could be moved as required from unit to unit through the multi-year construction sequence.

### 6.2.3. Fire Protection

Fire protection must be maintained to the requirements of the Fire Chief of the City of Yellowknife. The project site is fortunately located adjacent to the fire hall. Access to the site should not pose a concern during construction. The project site also has two entrances. During construction access to the entire site will need to be maintained by at least one of the two entrances.