.3 Water is pumped by the duty "jockey" pump (the second pump is for standby) or by one of the supply pumps through the Water Supply Main to the Signal Hill Reservoir and Treatment Plant. The "jockey" pump operates continuously and the operation of the supply pump is controlled by the water level in the reservoir at the Signal Hill facility. A supply pump starts when the water level drops to 3.7 m (12.2 ft.) and stops when the level reaches 4.5 m (14.7 ft.).

.4 The five modular boilers supply heat to the building through two unit heaters as well as the wet well through hot water injection.

.5 A diesel engine driven standby generator set supplies power to the facility in the event of an NTPC power failure.

.6 The alarm system for the facility which includes a new auto-dialler consists of the following alarms:

- Building Low Temperature
- Wet Well Low Level
- Water Supply Main No Flow
- Water Supply Main Low Temperature.

.7 The ventilation system is disabled for most of the year with ventilation and combustion air for the boilers and genset provided primarily by air infiltration.

3.1.2 Condition of Facility

This facility has been well maintained and appears to be generally in very good condition. A majority of the equipment in the facility is operating in a satisfactory manner with only regular maintenance procedures being required to date.

.1 Intake and Wet Well

The intake pipe was checked within the past three years by divers. According to the DPWS Maintainer, the divers reported the intake to be clear and in good condition.

An attempt was made to drain the wet well and inspect its condition during the inspection of the facility. However, water was entering the wet well either by infiltration through the wet well structure or through the shut off valve on the intake line from Char Lake. The shut off valve cannot be shut fully due to the heat trace cable in the intake line (Chesworth et al, 1995), which would most likely account for the water entering the wet well. To make a proper inspection of the wet well structure, the intake line would have to be plugged using an inflatable rubber plug prior to pumping out and cleaning the wet well.

.2 Piping and Pumps

There are four sets of pumps in the pumphouse consisting of the main supply pumps, the "jockey" pumps, the heat exchanger supply and the boiler feed pumps.

.1 Raw Water System

Except for the replacement of the electric motor on one, the main supply pumps have operated relatively trouble free. These pumps are currently operated automatically by the level controller in the water storage reservoir at the Signal Hill facility. One of these pumps, each with an operating point of 760 L/min. at 640 kPa (200 USGPM at 214 ft.), usually operate one or two times per week to maintain a sufficient level in the reservoir. A majority of the pumping duty is done by the jockey pumps.

The existing jockey pumps were installed within the past two years to replace smaller pumps which were undersized for the operating conditions. The new pumps have been operating without difficulties since being installed.

Problems due to corrosion or insufficient capacity of the raw water piping have not yet been experienced. According to DPWS Maintainer, there is some internal piping corrosion which was evident during recent repairs to the pipeline. The minor corrosion evident on the raw water piping and other uncoated metal surfaces in the wet well would indicate that the piping internal corrosion is not a significant problem, and therefore replacement of the piping within the next 20 years is not anticipated.

The manual valves in the system, except for the isolation valve for the supply line to the treatment plant and the wet well intake valve, will shut off water tight and are not difficult to operate. With the minor anticipated internal piping corrosion, it is expected that the internal condition of a majority of the valves should be satisfactory for the next 20 years of service life or "next 20 year period". The check valves on the pump discharge were replaced in 1992 after the first major freeze up of the Supply Main. The automatic mixing valve system for hot water injection into the wet well was installed in 1993 (Chesworth et at, 1995).

.2 Heating System

The heat exchanger supply pump draws untreated water directly from the wet well and pumps it through the heat exchanger for hot water supply to the unit heaters and for injection into the wet well. This system has been modified from the original design which circulated a glycol/treated water mixture from the boilers through the wet well. Using untreated water could cause more corrosion or scaling in the boiler and piping than with treated water. From the corrosion seen in the water piping, it is expected that the entire heating system is experiencing some corrosion. The change from treated to untreated water was made to eliminate any potential for contamination of the wet well by water treated for a boiler system.

The boiler feed pumps were replaced with new pumps approximately two years ago.

The boiler and heat exchanger heat untreated water which is drawn directly from the wet well, as previously described. This is likely the cause of corrosion problems in the hot water piping, including the heat exchangers which were replaced in 1994. Although the boilers have been operating satisfactorily, the corrosion in the piping indicates that it would be prudent to check the internal condition of the boilers during the yearly service shutdowns.

.3 Heating and Ventilation

The heating system consists of five modular boilers, two unit heaters plus appurtenances, and piping as described above. New burners were installed on the boilers in 1989 and new chimneys in 1993. In addition to this maintenance work, the boilers are also serviced yearly.

The performance of the heating system was not assessed in detail due to the anticipated replacement of the boiler heat exchangers at the time of the site inspection. The deteriorated condition of the heat exchangers would significantly affect the results of a performance check of the entire system, and therefore the results would no longer be valid once the heat exchangers were replaced. Now that the heat exchangers and piping have been replaced, heating system temperature readings should be recorded daily for future system assessments. DPWS staff were contacted for the results of the yearly maintenance tests performed on the boilers in order to better assess the current condition of the boilers, however this information was not available.

The ventilation system consists of a fresh air intake/return air mixing unit, a relief air unit and a combustion air intake. Both the fresh air supply and relief air units are shut off during the winter to prevent excess cool air from entering into the building. The supply air unit has had the return air louvres disabled and has been this way for a number of years. The combustion air intake control louvre is almost completely closed. The DPWS Maintainer has not reported any operational problems with the boilers or the standby genset motor due to inadequate outside combustion air in the building or cooling problems due to a lack of outside air supply. However, the boilers and genset engine require a combustion air supply intake with a combined minimum free area of 0.27 m^2 (420 in^2).

.4 Electrical/Instrumentation

The standby electrical generator has required only routine maintenance. The power outages at this facility are infrequent according to the DPWS Maintainer. The transfer switch for this facility has recently been replaced because the previous transfer switch did not meet electrical code requirements (Chesworth, 1994).

The low level switch in the wet well is not operating consistently and requires repair. The building low temperature sensor is located in a position where it is affected by strong winds which have caused false alarms. The building low temperature, main supply line no flow and wet well low level alarms were tested and operated properly except for the problems previously noted. The remaining alarms were not tested, but are assumed to be working.

A new electrical service was installed to the building by NTPC in 1993 because the previous service did not meet electrical code requirements (Chesworth, 1994). It was installed along the north wall of the pumphouse near the existing electrical equipment.

The lighting level in the pumphouse appeared to be sufficient. This observation was confirmed by the DPWS Maintainer. Refer to Section 3.1.5 "Occupational Health and Safety" of this report regarding lighting levels. The only light for the wet well is a "trouble light" which has its cord plugged into a wall receptacle. This should be replaced with a hard wired light fixture which is correctly rated for the service.

.5 Building

There are no signs of significant deterioration of the building structure. The exterior wall panels have suffered some damage from vehicle and snow plow impact. This is mainly an aesthetic concern as the damage rarely penetrates the exterior panel. The paint on the external surface of the building has deteriorated and should be redone. The large access door/panel has also been damaged by vehicle impact which has damaged the seals around the door allowing outside air into the building.

There are water stains on the ceiling which appear to be caused by the improper sealing of the boiler chimneys. The ceiling should be cleaned and monitored once the chimneys have been properly sealed. It is assumed for this report that the ceiling stains have been caused by the chimney seals.

The DPWS Operator reports that the building is cold during the winter months. The building was constructed with R10 insulation (U factor of 0.09 BTU/hr/sq.ft./F @ 15 mph wind) (UMA, 1975) which was the insulation standard at the time the facility was designed. The estimated heating costs are reviewed in Section 5.5 of this report, which indicates that increasing the insulation thickness would result in an annual cost saving of approximately $1,500. The life cycle cost of the additional insulation and sheet metal finish is approximately $500 more than the life cycle cost of the additional fuel and repainting the existing building exterior if the facility is not reinsulated.

3.1.3 Remaining Life

The building and its equipment have been well maintained and are in good condition. The facility, although not all equipment, should be capable of operating for the next twenty year period with continued proper maintenance at a level consistent with the previous and current maintenance. Maintenance does include the periodic replacement of unserviceable or failed equipment. Refer to Section 3.7 for a list of equipment which has been identified as requiring upgrading or replacement.

To extend the life of the current boilers, the entire heating system should be drained and flushed then filled with water which is treated for use in boiler systems and suitable for potable water systems. These water treatment additives are commercially available.

3.1.4 Capacity

The facility was designed to pump 960,000 litres per day (670 L/min.) of water from Char Lake to the Signal Hill Facility. This is equal to the ultimate design population level of 1,500 at the maximum day demand of 640 Lpcd (UMA, 1977).

The current total average day water volume pumped from Char Lake for the community is 132,000 litres per day (730 Lpcd). The current water usage, calculated from water meter readings, is 145 Lpcd (refer to Section 2.4). For the projected 20 year population of 251 (Statistics, 1994), an average day demand of 145 Lpcd, an estimated 105,000 L/day lost and bled to the sewer and a maximum day peaking factor of 2.0, the projected maximum day demand for Resolute Bay is 178,000 L/day (124 L/min.).

3.1.5 Compliance with Codes

In order to review the water and sewer systems' compliance with the NWT Water Board License, Health and Safety Divisions and NWT Environmental codes, regulations and bylaws, the following government departments were contacted and provided documents relating to the operation and abandonment of municipal infrastructure as listed below:

.1 Environment Canada, Government of Canada (E. Collins, 1994)

.2 Department of Health, Government of NWT (McKinnon, 1994)

- Public Sewerage Systems Regulations (Department of Health, 1992)
- Public Water Supply Regulations (Department of Health, 1992)

.3 Occupational Health and Safety Division, Safety and Public Service, Government of NWT (Schreiner, 1994)

- Safety Act (GNWT, SA and GSR)

.4 Department of Renewable Resources, Government of NWT (Hall, 1994 and Thompson, 1994)

- Consolidation of Environmental Protection Act (Department of Justice, 1991)
- Guideline for Contaminated Site Remediation in the NWT (Renewable Resources)
- Analysis of Ocean Disposal in the Northwest Territories (Resources Futures International, 1994)

.5 NWT Water Board, Department of Indian Affairs and Northern Development, Government of Canada (NWT Water Board, 1994)

- Northwest Territories Water Regulations (Canada Gazette, 1993)
- Northwest Territories Water Act (DIAND, 1991)
- 1992, 1993 and 1994 Inspection Reports (NAP, 1992; NAP, 1993; and DIAND, 1994)
- Water License for Resolute Bay (NWT Water Board, 1990)

The above listed documents were reviewed for applicability to the water and sewer systems in Resolute Bay. The documents supplied by Renewable Resources are applicable mainly in the event of a spill of a contaminant at one of the sites or during reclamation of a site if it were to be abandoned.

The documents provided by the NWT Water Board regulate the operation of the entire system. The Hamlet's conformance to these regulations is reviewed yearly during an inspection by the Water Board, and the results are summarized in inspection reports (NAP, 1992; NAP, 1993; and DIAND, 1994). The Hamlet's compliance with their license is discussed below.

The Department of Health documents also regulate the operation of the facilities in Resolute Bay. The compliance with these regulations is also discussed below.

The GNWT Safety Act regulates the physical condition of the facilities in regards to safety for the workers in and around the facilities.

NWT Water Board Water License

Inspections of Resolute Bay for compliance with their Water License (No. N4L4-1571), issued by the NWT Water Board Indian Affairs and Northern Development, are done by Baffin District Northern Affairs Program. The reports of the inspections for 1992, 1993 and 1994 (NAP, 1992; NAP, 1993; and DIAND, 1994) indicate that this facility is in compliance with the Water License except for the absence of Surveillance Network Program (SNP) signs.

The current Water License, which expires April 30, 1996, allows the community to draw 50,000 cubic metres of water per year from Char Lake (NWT Water Board, 1990). The current usage is 48,000 cubic metres (NAP, 1993 and DIAND, 1994). Based on current per capita demand rates, current "bleeding" rates and projected population growth, the Hamlet will exceed its 50,000 cubic metre limit by the year 2004. Refer to Section 2.4 for water demand and population projections.

If piped water and sewer systems continue to be used in Resolute Bay and the current high water production rate is not reduced, the Hamlet should apply to the NWT Water Board for an increase to their water usage limit. This application for water usage increase, which is generally allowed by the Water Board, can be made by the Hamlet when applying for their Water License renewal (NWT Water Board, 1995). The Hamlet has been sent a copy of the forms to apply for their Water License renewal and have been informed that they should apply for this increase at this time.

Department of Health

Of the two documents supplied by the Department of Health (Department of Health, 1992), the Public Water Supply Regulations are most applicable to this facility. The pumphouse generally complies with this document, except for possibly the following area:

> Clause 14.4 - "The buildings shall be well ventilated by means of windows and doors, roof ventilators and other means". The current inoperable state of the ventilation system may mean the building could not be considered well ventilated.

This review did not consider water quality because the test results available from the Water Board yearly inspections (NAP, 1992 and NAP, 1993) did not contain values for all substances listed in the Public Water Supply Regulations. This review also did not assess Department of Health responsibilities, such as testing and reporting as outlined in the document.

Occupational Health and Safety

The Safety Act (GNWT, SA and GSR) was reviewed in regard to the Char Lake Intake Pumphouse and other facilities. This review was limited to the current physical equipment and layout of the building, and did not include training programs (except operation of boilers), responsibilities of employers or employees, employee conduct, equipment not normally present in the building (ladders, welders, explosive-activated tools, etc.), or potential construction or demolition work. However, the employer (GNWT) and employees associated with this facility should be familiar with their responsibilities under these regulations.

The pumphouse requires attention to the following areas to be in compliance with the Safety Act (GNWT, SA and GSR):

.1 Clause 11 of the General Safety Regulations require all persons operating equipment be adequately trained to operate the equipment safely. This clause is primarily a concern in relation to the boilers in the pumphouse. At least one employee should be adequately trained and certified to operate the boilers.

.2 Clause 19 of the General Safety Regulations sets minimum lighting levels for work areas. For the pumphouse, the requirements are between 50 and 80 foot candles, depending upon interpretation of this clause. Interpretation should be obtained from GNWT, Safety and Public Service, and lighting levels should be checked.

.3 Clause 31 of the General Safety Regulations requires workers who work in a noisy area to wear protection equipment. For this facility, this would be applicable while the standby generator is running. Hearing protection should be available in the pumphouse and worn by workers as required.

.4 According to Clauses 1, 36 and 37 of the General Safety Regulations, the intake wet well may be considered a "confined space" under certain conditions, including when the intake line has been closed and the wet well drained. Prior to entering the wet well, appropriate safety precautions should be taken and safety equipment and clothing should be used.

.5 Clause 67 of the General Safety Regulations indicates an NWT No. 1 safety kit is required for this facility, assuming less than three employees and being within 20 minutes of a nursing station.

.6 Clause 95 of the General Safety Regulations indicates the provision of fire fighting equipment for the facility must conform to the Fire Prevention Act. According to Section 10 of National Fire Codes (NFPA, 1990), which is referred to for selection and installation of portable extinguishers by the National Fire Code (NRC - Fire Code, 1990), one portable fire extinguisher is required. This extinguisher must comply with all applicable requirements of these codes.

3.2 WATER SUPPLY MAIN

3.2.1 Operation

The Water Supply Main transfers water pumped from the Char Lake Pumphouse to the reservoir located at the Signal Hill facility as shown in Figure 3-1. Pipeline construction consists of insulated and yellow-jacketed butt fused 150 mm dia. HDPE pipe.

The pipeline is completely heat traced, with the heat trace accessible from five newly constructed wooden access boxes located along the pipeline. The heat trace was originally energized automatically when the No Flow Alarm for the pipeline was activated. However, new higher wattage heat trace has been installed which cannot be energized when the main pumps (P1 or P2) are operating due to limitations in available power (Chesworth et al, 1995). Therefore, if a No Flow Alarm is activated, the heat trace is energized manually by the Maintainer after the main pumps are disconnected to prevent a power overload.

An HDPE pipe section mounted on the exterior of the building contains a section of heat trace cable and a temperature sensor to act as a high temperature sensor for the heat trace system. The heat trace is energized when the supply main heat trace is energized. The heat trace controller will deenergize the heat trace and signal an alarm when the sensor senses a high temperature.

The temperature of the water entering and leaving the pipeline is also monitored by an alarm.

3.2.2 Condition

The pipeline has experienced two major freeze ups as follows:

.1 The first, which occurred in 1992, was caused by a check valve held open by a piece of plastic which broke from an upstream plastic check valve. This caused water to recirculate in the pumphouse piping rather than be pumped through the pipeline, causing a no flow condition in the line. The plastic check valves have been replaced with steel check valves to prevent this from occurring again.

.2 The second, which occurred in 1993, was caused by one of the original jockey pumps in the Char Lake Pumphouse shutting down due to a tripped starter, which also caused a no flow condition in the line. The jockey pumps have been replaced with larger pumps and a flow switch and No Flow Alarm have been installed to prevent future freeze ups.

The pipeline is buried so the condition of most of the pipeline insulation and yellow-jacketing could not be checked.

The freeze ups of the HDPE pipe should not have caused any damage to the pipeline since HDPE usually completely recovers from a freeze up. A pressure test of the pipeline would identify any significant weaknesses in the system. However, a pressure test could result in failure of the weakness, which would require readily available resources for repair to avoid a prolonged shutdown of the line.

Shallow buried pipelines in the NWT, as has been experienced in the community's piped sewage collection system, have experienced ovalling and complete collapse of the pipeline due to high external pressures on the pipe. While this is usually a more frequent problem with sewer piping, damaged insulation and yellow jacketing could be an indicator for this problem. Therefore, it is possible that the Water Supply Main is experiencing this ovalling to some degree. However, the condition of the pipeline could not be determined without exposing the entire line to view the condition of the yellow jacket and insulation and viewing the entire internal surfaces of the line with a video camera. A flow/friction loss test combined with the pressure test described above would give some indication of the condition of the pipeline.

The problem of HDPE sewer main and collapse has been investigated for other NWT communities (Hardy BBT, 1990) and recommendations made regarding remediation of existing mains and installation of future mains to prevent this occurrence in new mains (HBT Agra, 1993). The remediation recommendations include monitoring of the pipe and installation of board insulation over the pipes. For this water supply line, monitoring is sufficient for now due to little evidence of ovalling. The monitoring should include recording pump discharge pressures at the Char Lake Pumphouse; an increase in the pump discharge pressure would indicate some type of line blockage.

3.2.3 Remaining Life

The design capacity of the pipeline is 670 L/min. (640 Lpcd for 1,500 persons) (UMA, 1977). This capacity is reduced slightly due to the installation of the heat trace cable inside the pipeline and possibly further reduced by ovalling of the pipeline. The projected 20 year maximum day demand for Resolute Bay is 124 L/min. Therefore, provided there is not a severe problem with pipeline ovalling, or other significant blockage, the pipeline is sufficient for the next 20 years (life cycle planning horizon for this report). A significant blockage or ovalling could be detected by low flow rate or high pressure loss during a flow/friction loss test.

The heat trace for the pipeline is less than one year old and is easily accessible for repair and replacement. Therefore it is also expected to last for the next 20 years.

3.3 SIGNAL HILL RESERVOIR AND TREATMENT PLANT

3.3.1 Operation of Facility

The Char Lake Pumphouse is shown schematically in Figure 3-1. Raw water from the Char Lake Pumphouse which has been pumped through the Water Supply Main is chlorinated and then enters the reservoir. After leaving the reservoir, it flows by gravity into the piped water distribution system. The piped distribution system is a looped system, and a circulation pump boosts supply pressure so water which is not consumed or bled into the sewer is recirculated back to the reservoir. The temperatures of the supply water to the Hamlet, the return water from the Hamlet, and the Supply Line discharge water are recorded. The return water from the Hamlet and the Supply Line discharge water temperatures are also monitored by the alarm system which is connected to the auto-dialler.

The water temperature in the reservoir is maintained at 10°C by injecting hot water into the reservoir. Water piped from the main circulation pumps discharge is heated by the boiler heat exchangers then injected into the reservoir.

The water level in the reservoir is maintained by automatic control. The water is continually fed to the reservoir by the jockey pumps in the Char Lake Pumphouse. When the level in the reservoir drops below 3.7 m (12.2 ft.), one of the main supply pumps starts to fill the reservoir to 4.5 m (14.7 ft.).

The distribution water is chlorinated by a chlorine injection pump which draws chlorine solution from a 450 L plastic tank. The tank is filled regularly by the DPWS Operator from a chlorine mixing tank. The solution in the mixing tank is prepared by the operator from powdered calcium hypochlorite and water. The residual chlorine levels are checked daily with samples taken from the distribution supply piping inside the building. The levels are generally in the range of 0.2 to 0.4 mg/L.

The building is heated by three unit heaters which receive hot water from the five modular boilers.

A diesel engine driven standby generator supplies electrical power to the building in the event of loss of NTPC power.

The alarm system for the building consists of an enunciator panel, an auto dialler and the following alarms:

- utilidor circulation lost
- no flow from Char Lake
- low reservoir level
- high reservoir level
- low utilidor return temperature
- low inlet (supply line discharge) temperature
- low building temperature.

The ventilation system for the facility consists of a relief air unit, generator fan and combustion air intake unit. Most of this equipment has either been disabled or is not functioning for other reasons.

3.3.2 Condition of Facility

This facility has been well maintained and appears to be generally in very good condition. A majority of the equipment in the facility is operating in a satisfactory manner with only regular maintenance procedures being required to date.

.1 Reservoir Tank

The water storage reservoir tank, located at the east end of the Signal Hill Treatment facility, consists of an aluminum jacketed insulated 530 cubic metre steel vertical tank. The exterior of the tank has suffered some damage due to impact by snowplows and automobiles and by vandalism. Most of the damage has been restricted to the aluminum jacketing but some has penetrated the tank itself. The damage which has penetrated the tank has been repaired. The roof insulation has been replaced in the past few years after it was blown off in a windstorm. The tank was galvanized after construction. The interior surface of the tank has rusted (Chesworth, 1994), which indicates the galvanizing has deteriorated.

.2 Piping and Pumps

There are three sets of pumps in this facility which consist of water main circulation pumps, the chlorine injection pumps and the boiler feed pumps.

.1 Raw and Treated Water System

The water main circulation pumps operate continuously (one duty and one standby) to maintain flow in the piped water distribution system. These pumps, each with a fixed speed motor and a duty point of 1,700 L/min. at 250 kPa (450 USGPM at 83 ft.), have been operating continuously at their design flow rate, as intended, to prevent freeze up in the distribution system. Because the return water from the piped distribution system contains residual chlorine and is dumped back into the reservoir, the water main circulation pumps are pumping chlorinated water which will shorten the life of the pump due to accelerated internal corrosion of the pump. However, the residual chlorine levels are relatively low (0.2 to 0.4 mg/L), and therefore corrosion of the pump is not expected to be a significant problem.

The chlorine injection pumps also operate on a duty and standby basis. The pumps are used to inject aqueous calcium hypochloride into the water supply to maintain the desired chlorine level in the water supplied to the Hamlet. The pumps are operating continuously and pump a low concentration chlorine solution. The pumps are designed for use with high chlorine concentrations, so the condition of these pumps is expected to be satisfactory for the next 20 years.

The piping in this facility, like the circulation pumps, are exposed to chlorinated water. Although the chlorine is a relatively low concentration, it will increase the corrosiveness of the water, particularly in the piping for heated water. This was evidenced during the removal of the piping section from the hot water supply piping to the circulation pump intakes. According to the DPWS Maintainer, this piping was quite corroded but is not typical of the piping for unheated water.

The valves in the piping will also be affected by the corrosion by the chlorinated water but there are currently no problems experienced with the valves and they do shut off tight.

Due to the accelerated corrosion in the piping for the heated water, future replacement of the piping and valves may be required. However, the operating pressure of the system is quite low and therefore significant pipe wall thickness reduction is required before failure would occur. Pipeline failure at current pressures would consist of pinhole leaks requiring patching and eventual pipe replacement.

.2 Heating System

The boiler feed pumps were replaced with new pumps approximately two years ago.

The heat exchangers (and boilers) heat chlorinated water, which is drawn directly from the discharge of the main circulation pumps, without treatment for use in a boiler system. Heating of untreated and chlorinated water has likely accelerated the corrosion problems in the hot water piping including the heat exchangers. The heat exchangers and the piping on the boiler side of the heat exchangers were replaced in 1994.

The reservoir tank temperature automatic control valve on the hot water injection piping has been disabled so the injection (and therefore water temperature in the reservoir) is being controlled by a manually adjusted valve.

.3 Heating and Ventilation

The heating system consists of five modular boilers and three unit heaters plus appurtenances. New burners were installed on the boilers in approximately 1989 and new chimneys in 1993. The tops of the chimney stacks have started to collapse internally which may be caused by the downdraft preventers on the chimneys but more likely caused by internal corrosion. While the amount of collapse is not yet serious, the condition of the stacks should be monitored for additional collapse.

As described for the heating system for the Char Lake Pumphouse, the performance of the entire heating system was not assessed in detail due to the poor condition and anticipated replacement of the heat exchangers at the time of the site visit. With the heat exchangers and piping being replaced, heating system temperatures should be recorded daily for any future system assessments. The results of yearly maintenance tests for these boilers were also not available, and therefore the condition of these boilers also could not be assessed in more detail.

Although the boilers have been operating satisfactorily, the corrosion in the piping indicate that it would be prudent to check the internal condition of the boilers during the yearly service shutdowns.

The ventilation system consists of a fresh air intake/return air mixing unit, a relief air unit and a combustion air intake. Both the fresh air supply and relief air units are shut off during the winter to prevent excess cool air from entering into the building. The supply air unit has had the return air louvres disabled and has been this way for a number of years. The combustion air intake control louvre is almost completely closed. The DPWS Maintainer has not reported any operational problems with the boilers or the standby genset motor due to inadequate outside combustion air in the building or cooling problems due to a lack of outside air supply. However, the boilers and genset engine require a combustion air supply intake with a combined minimum free area of 0.27 m^2 (420 $in.^2$).

.4 Electrical/Instrumentation

The standby electrical generator has required only routine maintenance. The transfer switch for this facility is the original unit installed during the construction of the facility. The transfer switch which was removed from the Char Lake Pumphouse has been kept for spare parts for this switch.

The lighting level in the facility appeared sufficient and was similar to the Char Lake Pumphouse.

The following alarms along with the auto-dialler and its battery backup were tested and are working properly:

- low building temperature.

The following alarms are tested regularly by the DPWS Maintainer and are working properly:

- utilidor circulation lost (weekly)
- no flow from Char Lake (weekly)
- low reservoir level (yearly)
- high reservoir level (yearly).

The low utilidor return temperature and low inlet (supply line discharge) temperature have not been checked recently but are assumed to be working.

A visual inspection of the temperature gauges in the facility is performed daily (Chesworth et al, 1995).

The flow indicator for the supply water to the water distribution system did not agree with the flow indicator in the Char Lake Pumphouse so its accuracy, along with the accuracy of the totalizer, is questionable. It is our understanding that this problem has been recently corrected.

There is no flowmeter for the return water from the distribution system, so actual water usage from the facility can only be determined using the flowmeter for water pumped from the Char Lake Pumphouse.

.5 Building

Like the Char Lake Pumphouse, there are no signs of significant deterioration of the building structure. The exterior wall panels have suffered some damage from vehicle and snow plow impact. This is mainly an aesthetic concern for this facility as well since the damage rarely penetrates the exterior panel. The paint on the external surface of the building has deteriorated and should be redone.

There is some minor pitting and corrosion on the interior surface of the building. It occurs randomly in patches throughout the building, but is particularly severe around the chlorine tank which would indicate that this pitting and corrosion is caused by chlorine fumes. The damage is minor and would have little, if any, effect on the life of the facility.

This building, like the Char Lake Pumphouse, was constructed with R10 insulation(U factor of 0.09 BTU/hr/sq.ft./F @ 15 mph wind) (UMA 1975). The heating costs are reviewed in Section 5.5 of this report and indicate that increasing the insulation thickness would result in an annual reduction in fuel costs of approximately $2,100. The life cycle cost of the extra insulation and sheet metal finish is approximately $6,700 more than the life cycle cost of the additional fuel and repainting the existing building exterior if the building is not reinsulated.

3.3.3 Remaining Life

This facility has also been well maintained and appears to be in good condition. With continued maintenance (refer to Section 3.1.3) at the same level as is currently occurring, the facility, although not all equipment, should last for the next 20 years if Resolute Bay continues with a piped system. Refer to Section 3.7 for the equipment which has been identified as requiring upgrading or replacement.

To extend the life of the current boilers, the entire heating system should be drained, flushed and refilled with treated water as described for the Char Lake Pumphouse boilers.

3.3.4 Capacity

The following equipment capacities for this facility were obtained from the O&M Manuals (UMA, 1977) for the facility:

Reservoir Fire Storage:	528,000 L (4,400 L/min. for 2 hours)
Boiler Capacity[1]:	400 L/min. treated water demand (900 persons @ 640 LCPD)
Distribution (Circulation) Pumps:	1,700 L/min.

(1) Boiler capacity has been given in terms of treated water flow rate (based on raising treated water temperature to 5.6°C). Combined capacity is 443 kW for 5 modules.

The projected 20 year maximum day demand rate is 124 L/min.

3.3.5 Compliance with Codes and Regulations

The documents listed in Section 3.1.5 of this report were reviewed to check compliance of this facility with applicable codes, regulations and bylaws. The results of this check are described below.

NWT Water Board Water License

Inspections of Resolute Bay for compliance with their Water License, issued by the NWT Water Board Indian Affairs and Northern Development, are done by Baffin District Northern Affairs Program. The reports of the inspections for 1992, 1993 and 1994 (NAP, 1992; NAP, 1993; and NAP, 1994) indicate that this facility is in compliance with the Water License except for the absence of SNP signs.

The inspection of the facilities include testing samples of water before and after chlorination. The test results from the samples taken in 1992 (NAP, 1992) indicated that the raw water from Char Lake had a high iron level (994 ug/L) yet the treated (chlorinated only) water to the community had a level within Guidelines for Canadian Drinking Water Quality (GCDWQ, 1993) Maximum Acceptable Concentrations (MAC). The GCDWQ MAC for iron is 0.3 mg/L. The 1993 inspection report (NAP, 1993) indicates that all test results from the samples taken in 1993 meets all the requirements under the Canadian Drinking Water Quality Guidelines. A copy of the test results with the 1992 and 1993 inspection reports are contained in Appendix IV.

The high level of iron in the one sample of the water from Char Lake is more of an aesthetic problem than a health concern (NAP, 1992). Because the water is tested yearly for compliance with the Water License and the level of iron present in the one test is not a health concern, it is premature to consider treatment for reduction of iron levels at this time.

Department of Health

The Public Water Supply Regulations is again the most relevant document for this facility. This facility also generally complies with this document, except for possibly in the following areas:

.1 Clause 14.4 - "The buildings shall be well ventilated by means of windows and doors, roof ventilators and other means."

Clause 15.12 - "There should be a continuous mechanical ventilation rate of three air changes an hour" (for chlorination in water treatment plants).

The current inoperable state of the ventilation system may mean the building, particulary near the chlorine mixing equipment, is not adequately ventilated.

.2 Clause 15.10 - "Areas containing chlorine or chlorinator equipment shall be clearly marked . . ." There are currently no markings on the interior or exterior of the building.

.3 Clause 17.1 - "Fluoridation is recommended for community water supplies." This water supply system, like most in the Northwest Territories, does not have fluoride added to the water. Fluoride is not added to the water supplies in most communities due to the operational and maintenance aspects of a fluoridation system and the health risks associated with over-fluoridating the water.

These items which are not in compliance with the Public Water Supply Regulations are very minor items which can be easily rectified, except perhaps for Item 3 regarding fluoridation. The distribution system recirculates water back to the treated water storage tank as described earlier. This could cause increased levels of fluoride in the treated water if fluoride is injected into the raw water without regular monitoring of the treated water fluoride level. Therefore, a fluoride injection system should not be installed without careful consideration of monitoring treated water fluoride levels and the implications of interruptions in the monitoring procedures.

Occupational Health and Safety

Refer to Section 3.1.5 of this report regarding the scope of the review of the Safety Act (GNWT, SA and GSR). The items for the Char Lake Pumphouse which require attention also apply to the Signal Hill Treatment Facility, except for Item 4 regarding the wet well. In addition to the items listed in Section 3.1.5, the Signal Hill Facility also requires attention to the following areas to be in compliance with the Safety Act (GNWT, SA and GSR):

.1 The chlorine mixing and handling procedures and equipment require personal safety equipment and identification.

Clauses 38, 46, 48 and 55 of General Safety Regulations indicate the requirements for eye, hand, and respiratory protection for workers. Clauses 52 and Table 2 of the General Safety Act describe additional ventilation requirements and allowable worker exposure rates for calcium hypochlorite. The allowable ceiling and 15 minute Occupational Exposure Limits are 3 ppm (8.7 mg/m^3).

Clauses 6 and 8 of Work Site Hazardous Materials Information System Regulations identify the requirements for labelling of stored chemical (calcium hypochlorite) at the worksite, and Clause 12 indicates that Material Safety Data Sheets (MSDS) are to be readily available at the site.

.2 The water storage tank, like the wet well, may be considered a "confined space" under certain conditions. Prior to entering the tank, appropriate safety precautions should be taken.

3.4 WATER DISTRIBUTION SYSTEM

3.4.1 Operation of System

The water distribution system delivers pressurized water to the buildings in Resolute Bay which flows by gravity from the Signal Hill Treatment facility. The circulation pumps in the Signal Hill Plant ensures water is circulated through all mains and all unused water is returned to the plant.

The system is comprised of water mains consisting of insulated, shallow buried, Series 125 HDPE pipe and heated cast in place concrete access vaults (which also act as sewer clean-out vaults). The water piping consists of a recirculation loop system to keep water moving at all times, in all pipes, which will keep it from freezing. Refer to Figure 3-2 for a plan of the piped system.

The system was designed with heat trace cables in all sections of the water mains which could be energized to prevent freeze up in the event of a system shut down or to recover the mains in the event of a freeze-up. Most of the heat trace is not functioning so the circulation of the water is the only means to prevent freeze-up and a high pressure water thaw lance is the only means to recover a frozen main.

The water service lines to the buildings are primarily two line recirculation systems with recirculation pumps located in the buildings.

3.4.2 Condition of System

The water distribution system has experienced an increasing number of line breaks and freeze-ups in the past few years. Most of the freeze-ups have been caused by line breaks which allow the water to sit in the mains while the breaks are being repaired.

The internal components of the access vaults are showing some signs of deterioration. A typical access vault has significant groundwater infiltration around the piping penetrations of the vault walls which has caused electrical components (heat trace, vault heaters and sump pump wiring) to become badly corroded and inoperable. The infiltration water is currently drained into the sewer system by leaving the cover off the sewer cleanouts.

The groundwater infiltration which immerses both the water and sewer pipe along with the open sewer clean out creates a potential for contamination of the water in the water distribution piping. If the water main were to be shut off or blocked upstream of a bleeder, the water main would likely be put into a vacuum condition as a result of the elevational differences in the water distribution system. This vacuum condition would cause contaminated water in the valve to be drawn into the water main. A backflow preventer valve at each bleeder could reduce this risk of contamination of the water main.

The concrete walls of the vaults and exterior insulation show little sign of deterioration except for some exterior damage caused by vandalism, which has been repaired.