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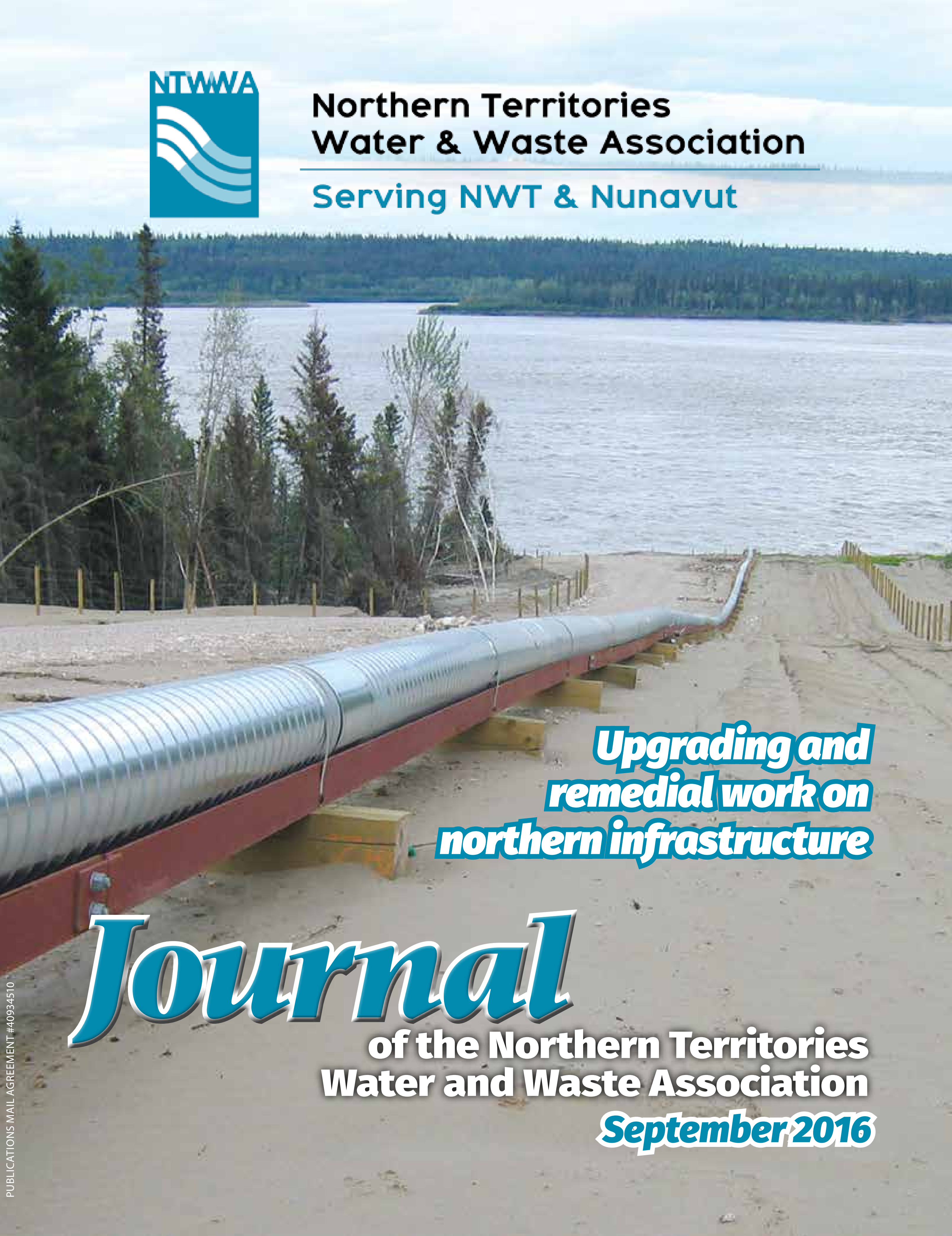

Upgrading and remedial work on northern infrastructure

Journal

of the Northern Territories
Water and Waste Association

September 2016

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TABLE OF CONTENTS

ON THE COVER

Sewage lagoon discharge pipe near Fort Smith, NWT.
See article page 18.

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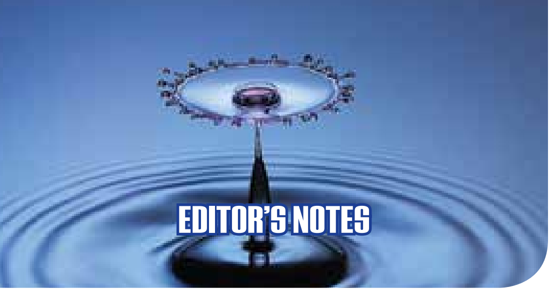


Editor's Notes

KEN JOHNSON

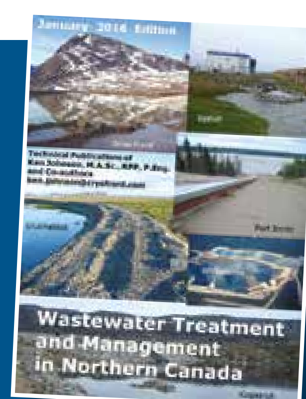
UPGRADING AND REMEDIAL WORK ON NORTHERN INFRASTRUCTURE

Remedial work on water and sanitation projects in the far north is another unique challenge that northern water professionals face. The service life for water and sanitation facilities in the north is generally shorter than that in southern climates, but the actual service life depends in large part on the appropriate design and the quality of the operation and maintenance. According the Cold Regions Utilities Monograph, water and sewer piping have a service life of 20 to 40 years – the Town of Inuvik has some sections of pipe that are approaching 60 years old.

Speaking of the Cold Regions Utilities Monograph, work is underway for upgrading and revising the 1996 edition of this "bible" of northern water and sanitation. Dan Smith has retired as editor, and Aaron Dotson from the University of Alaska is taking the lead. I will be assisting Aaron in this colossal effort, and if you would like to be involved, contact me by email, text, or telephone (see below). Any and all are welcome to get involved, and we all have information and experience to offer.

The crop of articles in the *Journal* have a variety of stories to offer from water treatment in the Yukon to water and sewer remediation in the NWT, and water and sewer remediation in Nunavut. It is a treat to have such a strong presence of Yukon articles to read. My favourite article this year was written by Chris Greencorn on the Northlands trailer park water and sewer remedial work. This is a project that I have been associated with on occasion over the past dozen years and heard firsthand about the political, technical and administrative challenges from a friend who lives in the trailer park.

Enjoy the *Journal*, and let me know what you think by email cryofront@shaw.ca, text or telephone 780-984-9085.



– BOOK ANNOUNCEMENT –

Wastewater Treatment and Management in Northern Canada **(Second Edition) is available. Contact Ken Johnson kenneth.johnson@stantec.com or 780-984-9085 to obtain your copy.**

CITY OF YELLOWKNIFE

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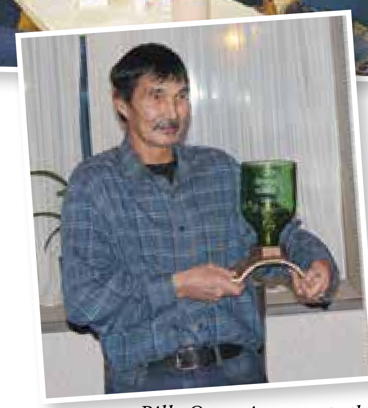
Keeping with the Flow

FIRST ANNOUNCEMENT

Annual Conference, Tradeshow & Workshop Yellowknife, NWT November 18-22, 2016

COME ONE, COME ALL water professionals to the NTWWA's Annual Conference and related events. The conference is the highlight of the year for water professionals across the north, which includes operators, engineers, technologists, suppliers, regulators, contractors, and administrators. The 2016 conference and workshop in Yellowknife will feature a conference with at least 20 technical presentations, and a two-day-long operator workshop. We expect that once again the Great Northern Drinking Water Challenge will be a fun event, with communities competing for the trophy for the best water in the North.



Billy Qaqasiq accepts the drinking water trophy for the Hamlet of Pangnirtung.

Trade Show

The conference will feature exhibits with the products and services that work best in the northern context, and the companies and product representatives who know what works up here.

Continuing Education Credits and Operators Workshop

Operators earn Continuing Education Credits for attending the conference and the Operators Workshop on November 21 and 22.

Registration

Registration forms are now available, so visit www.ntwwa.com or call 867-873-4325.

Yellowknife Condominium Corporation No. 8 (Northlands) Water and Sewer Infrastructure Upgrades

Installation of mains, services and a manhole in a narrow street within Northlands trailer park.

By Chris Greencorn, City of Yellowknife

The City of Yellowknife and Yellowknife Condo Corp No. 8 are nearing the completion of a process that was initiated in 2004 and is one of the largest underground infrastructure replacement projects in the history of the capital city of the Northwest Territories. In 2010, the Canadian Mortgage and Housing Corporation (CMHC) ceased to insure any mortgage loans for homes in Northlands trailer park neighbourhood until the failing infrastructure was replaced. This essentially made the process of selling homes in Northland next to impossible.

In May 2012, a memorandum of understanding was signed between the City of Yellowknife and the condo board to further the process; this led to a petition of support from the condominium membership for a local improvement charge for the purpose of installing new water and sewer infrastructure for the entire condo development, which encompasses 258 individual units and common areas. There were no other funding sources from other levels of government. The total cost of the project was approximately $18 million dollars, which included $3 million dollars of City-specific infrastructure work that was necessary for the project.

Construction of a concrete water vault to house a fire hydrant and flow control valves for circulating water system.

As part of the City's cost saving measures for the project, the detailed design, tendering and inspection was all completed by City of Yellowknife Public Works staff. By industry standards, this arguably saved approximately $1.8 million dollars in project costs, which are ultimately paid by the members of the condominium corporation through the local improvement charge. The design and geotechnical investigations were completed in 2012, and the project was publicly tendered in 2013. RTL Robinson was the general contractor and the work was substantially completed in 2015. Upon completion, the new infrastructure was incorporated into the City of Yellowknife's water and sewer system and asset management plan.

There were several challenges to overcome throughout the course of the project.

- The pre-existing water and sewer infrastructure was not placed in the road allowances but was "zig-zagged" throughout the development. This led to water and sewer mains running beneath properties, and units were serviced through the rear of the individual properties with no easements for access or repairs.
- The terrain of the land is relatively flat which provided challenges for both sanitary sewer grading, as well as managing surface water runoff, as there was not adequate budget for installing new underground stormwater infrastructure.
- The road right-of-way(s) were very small and not built to City standards, and they also included underground power and other utili-

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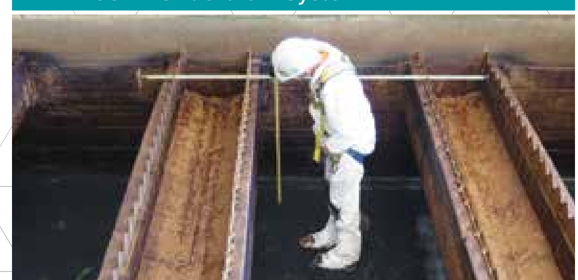

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Top right: Typical service installation, presence of utility infrastructure – note dual water services to accommodate water recirculation for freeze protection.

Bottom right: Service connection to existing trailer unit, with very low clearance under trailer for installation.

ties which were recently installed prior to this project.

- Some of the units in the development were very old and difficult for access under the homes to install the new water and sewer service connections.
- The phasing of the project had to be done in a manner to not disrupt water and sewer services to the entire neighbourhood, while also completing major excavations on the major thoroughfare of Franklin Avenue to tie into the City's infrastructure.

The detailed design of the new infrastructure for the project placed all new mains and services in the road right-of-way and according to City standard practices for the installation of water and sewer infrastructure. This increased the amount of water and sewer main pipe required and also provided some plumbing challenges as some of the units were previously serviced from the rear of the property, which is opposite to the new service.

A sanitary sewage lift station had to be incorporated into the design due to the challenging grades of the area. The pre-existing infrastructure took the "path of least resistance" regarding gravity sewer mains, which made the tie-in to City infrastructure easy. However, placing the new infrastructure in the road allowance reduced a significant amount of the pipe grade required for self-cleansing velocities with the sewer mains. This circumstance dictated the need for a lift station to accommodate the pipe grade.

The work was substantially complete in November 2015, with surface road works and grading to be completed in summer of 2016. The project was held on budget, which is a compliment to City staff given the complexity and challenges throughout the overall project. The City of Yellowknife was very pleased when CMHC announced it was revoking the blanket refusal to insure all mortgages in Northlands in November 2015.

Overall, the project was a resounding success for the City of Yellowknife, Yellowknife Condo No.8, City staff involved in the project, and it ultimately provides comfort and peace of mind for a large segment of our city's population knowing that they have new water and sewer infrastructure.

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For more information or assistance, contact your Regional Municipal and Community Affairs Office

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Government of
Northwest Territories

RESOLUTE BAY, NUNAVUT WATER AND SEWER REPLACEMENT PROJECT

Insulated HDPE water and sewer piping ready for installation.

The community of Resolute Bay, on Cornwallis Island in the high arctic, was originally developed as a weather station and air base. Inuit were relocated to the community from northern Quebec as part of a misguided sovereignty exercise in the mid-1950s, and settled in a residential settlement to the south of the base.

In the mid-1970s it was decided to relocate the settlement portion to an area outside the runway approach. One important infrastructure element of the creation of the new town site was an improvement of the level of water and sanitation services from trucked services to piped water distribution and sewage collection. These original installations were some of the first generation of the now standardized system of a shallow buried infrastructure, which incorporates pre-insulated high density polyethylene piping and concrete access vaults. These systems met the ongoing needs of the community over a period of 40 years, but a considerable ongoing operation effort was required to maintain the piped services. In late 2009, Community and Government Services of the Government of Nunavut (GN) commissioned a study to evaluate the status of the existing systems.

The 2009 investigation determined that annual water consumption was approaching 300,000 cubic metres. Approximately 95 per cent of this water consumption was the result of bleed water flows that had been initiated to reduce the risk of freeze of both the water and sewer networks. Water consumption was approaching the pumping capacity of the water supply lake. This study concluded that a further five years of service could be achieved, but this continuing service would require high levels of water consumption and attentive and persistent operating effort. It was clear that maintaining the existing system did not represent an effective and efficient long term solution.

The GN recognized the need for a long term solution, and in 2010 they commissioned a study to examine the question of a sustainable water and sewer system for Resolute Bay. The alternatives considered included replacement of the pipe networks, and installation of a trucked water and sewer system. One of the tools used in this assessment was an evaluation of the economic efficiency of these alternatives over a 30-year life span. It was determined that all alternatives presented similar life-cycle costs, with replacement of the existing pipe system representing the least costly alternative.

To the surprise of some project participants, the capital cost for institution of trucked services was estimated to be approximately 30 per cent higher than those for piped servicing. This difference in capital costs was largely the result of the need to modify and expand every building envelope within the town site to accommodate tankage and pumps. In some instances, the required building modifications were substantial, especially in those instances when fire water storage was required. These findings demonstrated the merits of setting aside intuitive expectations, and conducting a methodical examination of alternatives.

The project advanced into preliminary design, detailed design

By Farrell McGovern, Engineering Consultant

and phased implementation in 2012. The first phase of improvements entailed the replacement of the buried water and sewer network with the town site. These new networks incorporate current practices in harsh climate utility design including pre-insulated high density polyethylene piping, steel access vaults, looped networks and continuous circulation of the water system.

Resolute Bay presents some of the greatest logistic and implementations challenges in Nunavut. Sea lift arrives late in the construction season, which provides for a very limited work program during the year that materials are shipped. The project design recognized the limitations in the scope of work that could be achieved in each season, as well as the requirement for reliable operation over the long winter. The water and sewer networks operated as a hybrid of new and old piping over two winters. Despite the challenges the project has advanced within the schedule and budget developed in 2012.

One element in the success of this project has been the broad understanding by all participants of the broad project objectives. This includes recognition of the need for ongoing service, especially over the long winter period when very few resources are available. The community must be recognized for its accommodation of some disruption during construction. The collaborative efforts of a long list of characters including the GN, the Hamlet of Resolute Bay, the Resolute Bay Housing Association, the contractor (Tower Arctic), the consultant team (Exp Services Inc), the residents, and the business community of Resolute Bay has been key to the success.

Installing section of new insulated pipe in Resolute.

First-generation concrete water and sewer manhole with hydrant installation in deteriorated condition in Resolute.

RECENT WAVE OF UPGRADES AT YUKON WATER TREATMENT FACILITIES

Over the past decade, 56 million dollars has been spent on 23 water treatment and distribution projects across the Yukon Territory, under the project management team at Yukon Government, Community Services, Infrastructure Development Branch (YG-IDB) and in collaboration with local government agencies, the federal government, numerous engineering consultants and construction contractors. The Yukon residents serviced by these new and upgraded water treatment facilities are located in service areas ranging in size from 100 people in Mendenhall subdivision, to 1,300 people in Dawson City. About 60 per cent of the population is serviced by Large Public Drinking Water Systems (LPDWS) (more than five service connections in the system), and the remaining by Small Water Systems or private wells. The Yukon Government – Environmental Health Branch (YG-EHS) oversees the LPDWS to ensure that safe drinking water is available at all times to Yukoners, however Small Water Systems and private systems are not yet regulated in the Yukon. The combined work of YG-IDB and YG-EHS is to ensure that proper infrastructure for treatment and distribution of drinking water are in place in the Yukon that respects the Guidelines for Canadian Drinking Water Quality (GCDWQ, Health Canada, 2012) and the National Building Code.

Although the water infrastructure throughout the territory is generally 20 and 40 years old, the age of the buildings and the equipment was not the only reason behind the wave of upgrades.

Tightening requirements of certain parameters in the GCDWQ, has been a big factor as well. The raw water resources in many Yukon communities, which were previously treated as groundwater only, became designated as Groundwater Under the Direct Influence of Surface Water (GUDI), requiring additional treatment barriers from source to tap to mitigate the risk of contamination

By Virginia Sarrazin, Opus Dayton Knight Consultants;
Alison Anderson, Opus Dayton Knight Consultants;
and Annika Palm, Yukon Government Community Services

Nacho Nyak Dun First Nation water treatment plant building in Mayo, Yukon.

Pumphouse #3 in Faro, Yukon.

Water treatment facility in Carcross, Yukon.

from pathogenic organisms, such as Cryptosporidium and Giardia. Some communities opted for the development of Well Head Protection Plans in order to limit contamination at the source. In general, for sources newly identified as GUDI, UV disinfection has been added, followed by chlorination.

Common in Yukon groundwater is the presence of hardness, iron, and manganese. While these metals are not a direct concern for public health, they become a system concern because hardness precipitation in pipes and plumbing fixtures promotes a favorable environment for bacterial growth. Iron and manganese present in a dissolved state in the groundwater, start precipitating by oxidation once they reach ground level, creating additional turbidity. Turbidity must be controlled

To improve the capacity of local operators, the Yukon College in Whitehorse started a Yukon Operator Training Program in 2011 to provide local training and certification for Yukon water and wastewater operators.

before distribution, as it can host pathogens and bacteria, and interfere with treatment, including chlorination. In some instances, the local geology also brings uranium into the groundwater, which is a contaminant of concern for public health.

The use of softening is common for removal of hardness and can also help control manganese. The main constraint with softening is the use of a resin regenerative brine (sodium chloride), which results in the release of high concentrations of sodium in the treated water that can be harmful to consumers suffering from hypertension and heart conditions. Softening has been installed in only one of the upgraded facilities. The removal of iron and manganese is commonly done using greensand filtration, however other medias have been used including AD26 (Adedge technology) and Berm media, to avoid the use of potassium permanganate. The use of AD33 for adsorption of arsenic has been done in four of the upgrades, with prior removal of iron and manganese. However, if arsenic is mostly under the Arsenic III form, precipitation along iron and manganese was sufficient.

New technology – in particular advances in SCADA and improved internet connections in the Yukon – have made it possible to build new water treatment facilities, where full time local oversight is not available. These technological advances increase the level of service available to smaller Yukon communities and reduces the responsibility put on operators who have to oversee several public works duties. SCADA systems allow operators to perform daily monitoring of the plants remotely, be alerted of and respond to alarms, and adjust set-points for operations. This helps in developing and maintaining a local workforce, while ensuring the safety of the public.

To improve the capacity of local operators, the Yukon College in Whitehorse started a Yukon Operator Training Program in 2011 to provide local training and certification for Yukon water and wastewater operators. Instead of taking extended leave to take training outside the territory, operators can obtain the mandatory EOCP (Environmental Operators Certification Program) certification, and the credits to maintain it, here in the Yukon. In some instances, the college dispatches the programs to communities to provide an even easier access to training. In addition, the Yukon Government – Community Services – Operations and Programs (YG-OP) has a team of supervisors that travels to communities to help on water, wastewater and solid waste operations. Indigenous and Northern Affairs Canada (INAC) has also be has been offering the Circuit Rider Program to First Nation operated systems, which provides regular technical support to operators to improve retention and ensure health and safety requirements are met.

It has taken considerable resources to oversee the design and construction of all these upgrades to water treatment facilities in the Yukon; work has also been undertaken on wastewater and solid waste facilities. The majority of funding for the water treatment upgrades across the Yukon has come from Federal and Territorial funding, with the largest funding source being the Building Canada Fund, a fund requiring 25 per cent contribution from Yukon Government.

A continuous effort and dedicated resources are required to maintain infrastructure that meets both community expectations and regulatory requirements. With the ever increasing competition for resources, it is essential that the correct investments are made with the available resources to ensure the provision of municipal services for Yukoners into the future.


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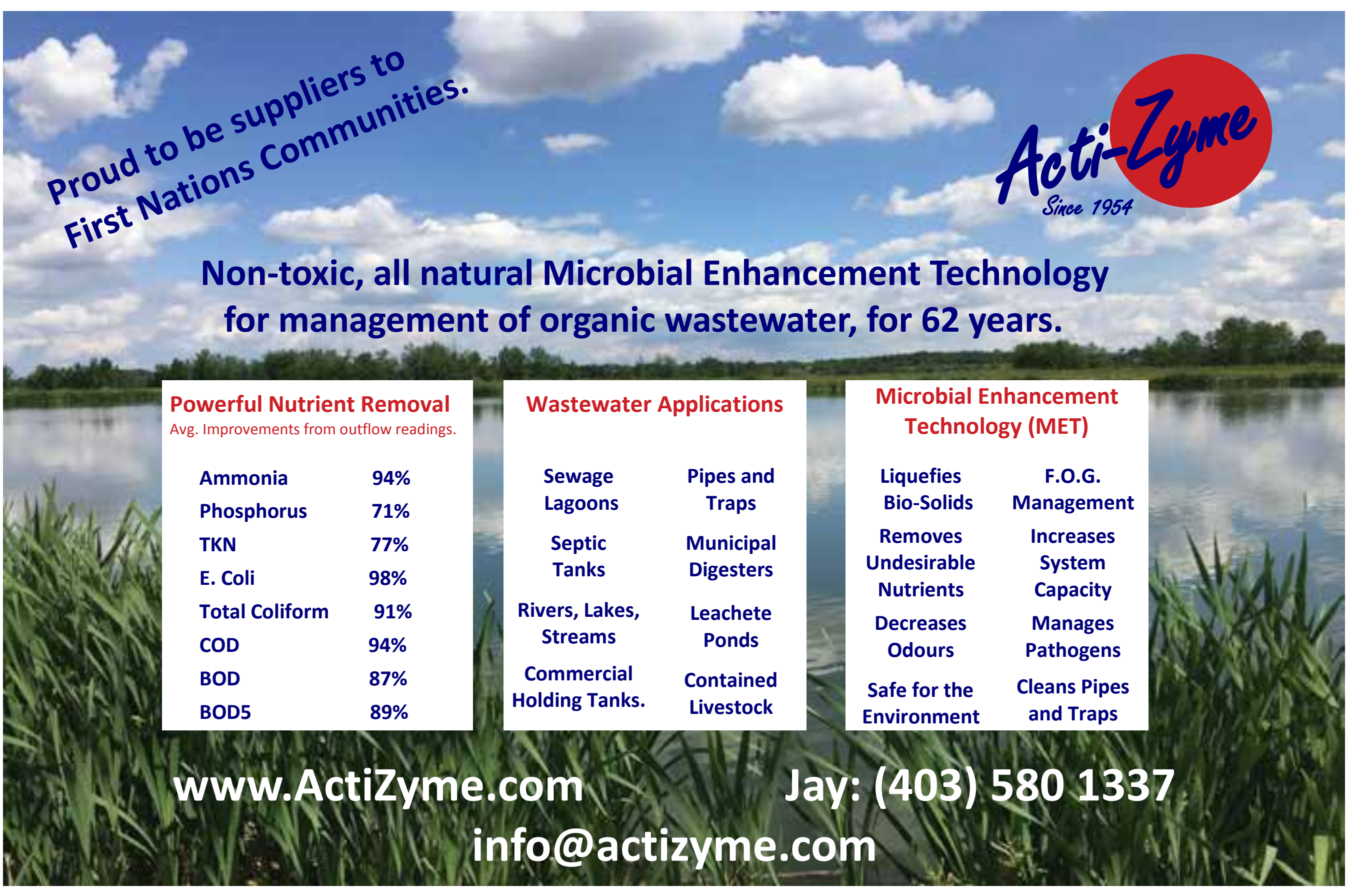
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DESIGN AND WINTER CONSTRUCTION OF SEWAGE LAGOON DISCHARGE PIPELINE IN LANDSLIDE AREA NEAR FORT SMITH, NWT

The banks of the Slave River, near Fort Smith, are prone to landslides, the most serious of which occurred in 1968 and caused the death of an individual. Another significant landslide occurred in 2004, covering about 500 metres along the river bank, and destroying the community's sewage discharge pipeline (See photo). This catastrophic event caused no injuries; however, it destroyed the sewage lagoon discharge pipeline, which is a significant element of the town's waste management system. It was immediately recognized that the uncontrolled sewage discharge created by the landslide would require immediate attention in the form of stabilizing the slide area and retaining the resources to design and complete construction of a new pipeline discharge system.

The slide originated in unconsolidated clay sediments above the bedrock surface near, or slightly below the level of the river. The slide was probably the result of both groundwater level fluctuations in the slope and ongoing erosion at the toe in the river. The slide essentially adjusted the internal slope stability by creating a flatter profile.

Within days of the slide, the Town of Fort Smith completed a temporary gravity discharge pipe (flexible hose) attached to the severed end of the original pipeline. The Town also began grading of the slide area, and the excavated material was pushed down slope into the slide zone. The purpose was to provide local stability to the escarpment created by the slide, and to construct a uniformly graded access for vehicles from the top of the slide to the edge of the river.

Slide area.

In addition to an anticipated continuing movement in the slope, the upper fill area of the slide immediately below the slide escarpment would be prone to fill settlement. This could result in eventual total settlements at ground surface in the range of 450 to 750 millimetres in this area. In the lower slide area, it was anticipated that the ongoing slide horizontal movement 50 to 200 millimetres per year could occur.

Given the magnitude and complexity of the ground movements in the slide area, it was obvious that a buried replacement pipeline would not be an appropriate solution the problem. Applying the experience that the Town has accumulated with a water supply pipeline in similarly unstable ground along the Slave River, two support configurations were developed for the pipeline replacement. The upper support system consisted of an I-beam "on edge" structure that cradles the pipe, and anchors it to the upper stable portion of the slide area; the I-beam is in turn supported by wood sleepers resting on the ground (See cover photo). The lower support system consisted of wooden sleepers supporting a metal clad insulated HDPE pipe, with wooden blocks bolted to each side of the sleeper.

The anchoring of the entire pipeline was accomplished by tying the I-beam into the base of a new manhole at the top of the slope, and tying the pipe itself to the I-beam. The overall configuration was essentially a pipeline with a single point of restraint at the top of the bank above the slide zone, and a discharge point at the bank of the Slave River. The onshore discharge was protected by an outfall anchoring system consisting of a cluster of large rocks.

The design, and regulatory review of the late summer slide necessitated that the project be scheduled for winter construction in order to replace the pipeline as soon as pos-

By Ken Johnson, Stantec

sible. Consideration was given to postponing the construction until the following summer; however this was ultimately rejected because of the unknown performance of the temporary discharge during the very cold midwinter temperatures, and the availability of the emergency funding from the territorial government. It was recognized that the above ground configuration of the replacement pipeline would accommodate winter construction.

The insulated, metal clad, HDPE pipe was pre-purchased by the Town in order to advance the construction schedule as much as possible. The construction work was undertaken by a local contractor and proceeded slowly, but steadily over the course of the winter. The most significant construction issue was the connection of the HDPE pipe on site. HDPE pipe is manufactured in discrete lengths and commonly connected on site using butt fusion technology (heating and connecting of pipe ends). Problems were encountered with the butt-fusion machinery; therefore, the contractor elected to use electrofusion technology (couplers that adhere to pipe end using internal heat coils).

The strength and flexibility of the pipe system was put to the test in the spring of 2005 with an exceptionally high spring runoff in the Slave River, which pushed the pipe 20 to 30 metres downstream. This occurred before the placement of the outlet anchoring system for the pipeline. The pipe length remained intact without any serious damage, and was pulled back into position and anchored.

The pipeline was commissioned in June 2005. The total cost of the pipeline replacement (engineering and construction) was approximately $400,000 (2005 $).

Winter construction of civil-related projects in the far north is generally expensive because of extreme temperatures and darkness that will significantly reduce working efficiencies. Frozen ground may also make excavation expensive and time consuming. This particular project was successfully executed during the winter because the majority of the construction was above ground, and the limited excavation was completed in very dry sandy soil.

The design of the project was based upon the experience of the geotechnical consultant, the design engineers, and the operating staff of the Town of Fort Smith, in particular Jean Soucy. This combination of experience has provided the Town with a very robust and timely solution to this catastrophic event.

HAPPY VALLEY SANITARY SEWER REHABILITATION – CITY OF IQALUIT

Excavation showing existing water and sewer pipe in Happy Valley.

Replacement of sewer main in early winter conditions.

The City of Iqaluit (City) has experienced ongoing operational issues with the sanitary sewer system in an area of the city known as Happy Valley. The problems have generally occurred in the form of backed up sanitary sewers, which sometimes impacts the local residents. In response to these issues, the City's Public Works & Engineering Department was forced to undertake a more frequent maintenance program that includes flushing and cleaning of the sewers. In severe situations, the City has been required to repair or replace sections of sanitary sewer mains due to localized failures.

The sanitary sewer systems in Happy Valley consist of insulated high-density polyethylene (HDPE) pipe. The sanitary sewers are only 30 years old, which is generally well within the operational life expectancy for HDPE pipe. However, the pipes installed in Happy Valley were Series 60 (DR26), which are a considerably thinner-walled pipe than the current standard of Series 160 (DR11).

In the early 1990s, the City revised its design standards based on an investigation undertaken by Hardy BBT Limited (now AMEC). The study concluded that ongoing operational issues with the city's sewer sys-

By Richard J. Sparham, City of Iqaluit,
and Steven Burden, exp Services Inc.

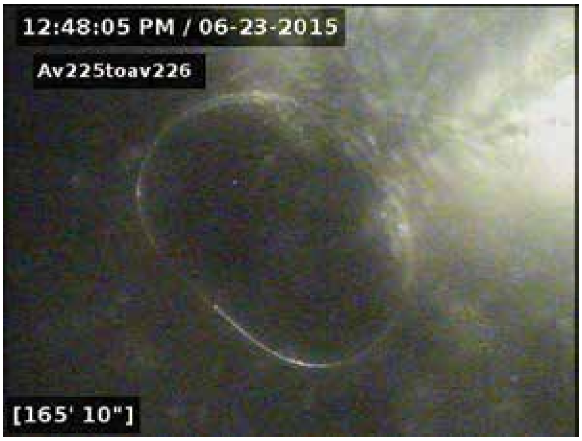
tem were in part due to the sanitary sewers not being buried within the permafrost, but within the "active layer, and therefore subject to a yearly freeze thaw cycle, and the ice forces that may accompany this annual cycle." The new design standards included:

1. A minimum standard for depth of bury for sanitary sewers of three metres to make sure the pipe is buried below the active layer.
2. A 50-millimetre-thick layer of trench insulation (Styrofoam board insulation) installed above the water and sewer mains as an added measure to maintain a pipe zone below the active layer.
3. A standard sanitary sewer pipe change to Series 160 (DR11) HDPE pipe to provide greater strength to the ice forces that may be encountered.

As the sewers in Happy Valley were installed prior to these new standards, it could be expected that the sewers have been exposed to multiple freeze/thaw cycles and the associated freeze-back pressure. Therefore, the operational issues being experienced in Happy Valley were expected to be caused by a loss of vertical alignment due to movement caused by the yearly freeze/thaw cycles or by freeze-back pressure, which can be created as a result of this yearly cycle. If the sewers experience movement due to the freeze/thaw cycle, a loss of vertical profile can occur, resulting in high and low points in the sewer. This creates localized low points that can accumulate solids and potentially affect flow in the sewer. If the sewers have been exposed to freeze-back pressures, the pipe's cross section can be deformed or the pipe can collapse. The effects of freeze-back pressure can be expected to be seen as horizontal ovalling of the sewers.

As a result of the ongoing operational issues, the City undertook a rehabilitation program in 2015, which included the replacement of three sections of sewer and a closed-circuit television (CCTV) investigation. The CCTV investigation included all the sanitary sewers, with the exception of three sections, which were known to be collapsed or partially collapsed and were to be replaced.

The three sections of sewer were replaced from access vault to access vault with Series 160 (DR11) HDPE pipe and includ-



Severe pipe deformations from CCTV investigation.

Based on the CCTV investigation, there were no requirements for immediate repairs, and the City can develop a rehabilitation program which addresses the issues in a structured manner.

ed the installation of trench insulation. The sewer replacement was scheduled for late fall to reduce the groundwater and allow the ground to freeze to reduce the potential for damage to the adjacent pavement. The rehabilitation of the sewers in older sections of the city cannot be installed to the minimum depth of cover, as the cover is restricted by the existing sewer elevation.

The CCTV assessment of the sewers categorized the pipe condition, which was evaluated against a series of with recommended action plans. The assessment applied six categories of issues, including minor deformation of pipe, moderate deformation of pipe, severe deformation of pipe, collapsed or partially collapse pipe, sewer sump (loss of grade) with no effect on flow, and sewer sump (loss of grade), with a possible sedimentation issue.

As a result of the CCTV investigation and assessment, a total of 60 issues were identified with minor deformation and sewer sump, with possible sedimentation issues, being the most common with 17 occurrences each. The next most prevalent issue was moderate deformation with 14 occurrences, and there were only four severe deformations identified (see figure 3) and zero collapses or partial collapses.

Based on the CCTV investigation, there were no requirements for immediate repairs, and the City can develop a rehabilitation program which addresses the issues in a structured manner. In addition, the City now has the ability to monitor the sewers in Happy Valley and throughout the city to determine if the pipe condition is changing which may influence the decisions regarding an annual rehabilitation program.

The City anticipates being able to utilize the approach of using CCTV condition assessment throughout the remaining sewer system as a basis of performance prediction in forecasting and budgeting for future replacement before any major failures occur.

WATER AND WASTEWATER TECHNICIAN CONTINUING EDUCATION UNIT (CEU) COURSES

Operators across the province can now earn additional Continuing Education Units towards certification by Alberta Environment.

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NAIT

CITY OF WHITEHORSE UPGRADES CRITICAL WATER SYSTEM INFRASTRUCTURE

The station houses three new high-efficiency 100 HP booster pumps, with space to add one more pump in the future.

On-site sodium hypochlorite generation (OSHG) system at the new pump station, which generates a weak solution (~0.8 per cent) of sodium hypochlorite.

Selkirk Pump Station is the point in the City of Whitehorse water system where all drinking water is chlorinated and enters the distribution system. The water supply to Whitehorse is unique because it uses only groundwater, which needs only disinfection for treatment, and will avoid the future necessity for a filtration system that would be required for a surface water supply.

A new station was constructed and commissioned in 2014, replacing the original that was built in 1955. The new station streamlines control of the city's seven groundwater supply wells and was designed to be energy efficient and economic, utilizing natural lighting, high-efficiency booster pumps, and the highest standards of building insulation.

The objectives for the new station were the following:

- Integrate and streamline flexible control of seven water supply wells to maximize the quality of the public drinking water supply;
- Have flexibility to use different well combinations to feed the station;
- Maximize the use of the best quality wells;
- Maximize pumping efficiency;
- Operate through power outages with centralized back up for the station and wells;
- Provide an economically viable, safer alternative to the existing gas chlorine treatment system;
- Utilize sustainable design features.

The pump station replacement integrated and streamlined control of the City of Whitehorse's seven groundwater supply wells via complex automatic well sequencing and staging, complete with SCADA control and monitoring. The wells, which had been controlled via controllers at each of the wells, are now controlled by a master controller located in the new pump station. The well supply pumps are controlled and staged to maintain a constant pressure on the suction side of the booster pumps and to maximize the quality of the public drinking water supply by optimally blending wells of differing water quality. The booster pumps' motorized discharge valves are controlled such that the booster pumps operate at flowrates which correspond to the well supply flowrates.

The station houses three new high-efficiency 100-horsepower booster pumps, with space to add one more pump in the future. The pumps were selected based on lowest amortized cost which accounts for efficiency of pumps. During periods of low flow at night, the station's booster pumps can be turned off and water pumped directly into the distribution system from one well pump operating. Piloting was added to the station's pressure relief valve to allow for reverse flow so that the water can pass through the station to be chlorinated. One of the wells was designed in conjunction with the new pump station, utilizing a pump and VFD to pump at two operat-

ing points – one to feed the booster pumps and one which enables water to be pumped through pump station, receive chlorination and enter the distribution system without the need to run the booster pumps in the station.

Located near the Yukon River and near residential development, the City opted to replace the gas-chlorination system at their old station with an on-site sodium hypochlorite-generation (OSHG) system at the new pump station, which generates a weak solution (~0.8 per cent) of sodium hypochlorite. The OSHG system utilizes high-purity (99.7 per cent) salt, water, and electricity to economically batch sodium hypochlorite on site. Hydrogen gas, a by-product of the batch process, is removed via hydrogen dilution blowers and vented outside. The new on-site sodium hypochlorite system has significantly improved the safety of operational staff and the public.

A back-up power generator provides emergency power to the station, as well as two of the City of Whitehorse's key supply wells, and a remote radiator for the backup generator takes advantage of winter cooling of generator fluids. This design allows water flow and treatment at the station – which is critical to the City of Whitehorse's drinking water – to be maintained during power failures.


The building is located near residential areas and combines industrial construction with a modern aesthetic.

The building is located near residential areas and combines industrial construction with a modern aesthetic; particular attention was paid to preserving the wooded areas around the site. South-facing clearstory windows and solotubes in the roof that allow natural light into the facility, and the building is constructed to a very high insulation standard and fitted with quadruple-paned windows to minimize energy costs for heating.

In combination with the well water supply system, the new Selkirk Pump Station has provided the City of Whitehorse with a modern and versatile water supply and treatment facility, which will provide decades of reliable and economical service to the community.

CAMBRIDGE BAY WATER SYSTEM UPGRADES

The process backwash is collected in a 60 m3 insulated steel tank (on the right) and treated water is stored in a 570 m^3 tank (on the left).

The hamlet of Cambridge Bay has a population of approximately 1,800 people and growing, and it is the largest stop for passenger and research vessels traversing the Northwest Passage. It's located approximately 700 kilometres northeast of Yellowknife, at a latitude of 69.4° N.

The hamlet's aged and undersized potable water infrastructure was causing significant issues with water shortages and reliability concerns. The system had been upgraded several times since the construction of its first intake pump house in 1970. Since two major upgrades in 1980 and 2002, various replacements and maintenance items were completed at the facility. The community's potable water system, at this point, consisted of assorted and various types of "upgrades", resulting in this much-needed replacement project.

From a water supply perspective, the community's population is projected to grow from the 1,600 in 2010 to 3,800 by 2045. With the future operation of the Canada High Arctic Research Station (CHARS), which is scheduled to open in 2017, the population could grow to 4,000 by 2045.

The water delivery system consisted of three 12,500-litreL water trucks operating on a seven-day, eight hour per day delivery schedule. The facility design needed to address ongoing problems associated with trucked delivery system, the limited underground distribution lines, and a consistent chlorine residual. The scope of the design included a new intake structure, pump house, and treatment facility, along with the replacement, and an expansion of the buried distribution system.

Stantec was retained as the design consultant, and the upgrades were planned in two phases. In phase I, a new lake intake and pump house was installed. In phase II, the 1.7-kilometre supply lines from the new intake to the new water treatment plant were replaced.

The treatment system production was awarded to BIPure, and a "plug and play" package water treatment system has delivered and installed in the community. The four-unit modular system was fabricated in Surrey, B.C., trucked to Hay River in July 2015, and barged more than 1,800 kilometres up the MacKenzie River to Tuktoyaktuk. It was then barged another 1,800 kilometres east to Cambridge Bay, arriving in August 2015, when the modules were skidded to site. The building was set on piles and zipped up, as the snow was about to start falling, and further work on site was halted until the spring of 2016.

The central feature of the water supply system is a water treatment plant using a zeolite-based filtration system combined with chlorination and UV treatment. The system can handle a design flow of 1,200 L/min and generates half the backwash wastewater of alternate systems that were considered. This is an important feature, as the backwash must be collected in a 60-cubic-metre insulated steel tank stored on-site and hauled away by trucks. A 570-cubic-metre tank stores treated water to be pumped through the underground infrastructure, as well as trucks for distribution to homes. A highly insulated building contains a standby generator, electrical room with MCC, boilers and related hot water mechanical piping, ventilation equipment, process piping and the treatment system.

A touch screen HMI and advanced PLC allow for optimal control and monitoring of the process and the plant. The vessels are automatically controlled by the PLC to initiate service and backwash modes. To assist operators, a video of the operation and maintenance tasks was produced. As well, remote access of the control sys-

By George Thorpe, BI Pure Water Inc.,
and Matthew Follett, Stantec

The water treatment plant uses a zeolite-based filtration system combined with chlorination and UV treatment.

A "plug and play", four-unit, modular package water treatment system fabricated in Surrey, B.C. and delivered and installed in the community.

tem is possible to allow technical resources outside the community the ability to monitor operations and advise and train the operators.

The project also improved the existing supply mains in the community. A new 2,000-metre-long water main will create a complete circulation loop that will help reduce the operation and maintenance costs of the existing main by eliminating costly pumping and repairs associated with the previous pipe in a pipe recirculation system. The new loop will also service to the CHARS.

By providing a piped water system to the community core, significant cost savings are starting to be realized on several levels from insurance savings, as firefighting measures are greatly increased, leading to capital cost savings for building developments due to the removal of the need for individual storage tanks. The community will be able to continue to expand the water-distribution network over time, reducing the reliance on expensive water truck deliveries.

FORT SIMPSON WASTEWATER IMPROVEMENTS

In the arctic regions of Canada, mechanical wastewater treatment plants (WWTP) are far and few between, and those that exist often have been plagued with struggles ranging from improper installations to specialized operation and maintenance requirements. The Village of Fort Simpson (Village) was no exception to this. The Village owned and operated the only mechanical wastewater treatment plant in the Northwest Territories, and was experiencing significant difficulties meeting the environmental discharge requirements. This issue stemmed from a long history of struggles with the plant dating back to its original inception in the early 1990s.

Due to the ongoing struggles in meeting the water license, the Village received an Inspector's Directive from Environment Canada (EC) to address all the problems or receive financial penalties. Work began to reach initial compliance with the Directive by providing an engineering and assessment report on the current WWTP. The engineering report provided preliminary design options for upgrades to the existing WWTP.

Choosing the treatment process was constrained by various factors including local construction, operation and maintenance availability as well as financial limitations. However, one of the biggest challenges was determining the necessary upgrades to the mechanical and electrical components within the existing building. The new treatment process system had to fit within the existing structure in addition to all the ventilation, instrumentation and control components necessary to meet new code requirements. Several options were presented and through rigorous comparison and evaluation, and a final treatment process was agreed upon which consisted of a screening system, equalization storage, sequencing batch reactor (SBR), sludge press and ultraviolet light (UV) disinfection.

The building mechanical systems for the upgraded WWTP provided a comfortable and safe environment for the building occupants while operating in an efficient and reliable manner. In deference to the cold operating climate, limited community resources and harsh operating environment, these systems are robust, simple in design, easy to maintain and repair, and incorporate equipment redundancy. The mechanical system upgrades for the plant focused

By Arlen Foster, Stantec

on providing sufficient heat and ventilation to the process spaces. The primary goal was to meet the ventilation requirements. Not only were high-efficiency components chosen, but the controls of the heating and ventilation system were designed with variable speeds, and included negatively pressured rooms to address hazardous ratings and reduced capital costs.

A SCADA system, PLC and MCC were provided with main components located in the electrical/mechanical room where they could be suitably "cut-off" in electrical terms from the remainder of the building such that equipment located within the area does not have to be rated for hazardous locations. The instrumentation and controls of the plant were designed for full automation of the treatment process. Alarms were set with the local operators so that significant issues were brought to their attention immediately. Remote access was also included so that monitoring and general modifications to the process could be accomplished. This remote access was vital

in providing the Village with expert technical support without having to expend high travel costs and delay times to receive onsite assistance. Similar to the process and building mechanical components, space saving wall or ceiling mounted electrical equipment was used as much as possible to maximize available areas of the building.

The facility presented a challenge due to the corrosive atmosphere; and particular attention was paid to the wiring methods and equipment being installed. The main area of the facility as designated by the Canadian Electrical Code is a hazardous location and also a location where wet and corrosive vapors are present. All devices in the facility other than the electrical/mechanical room are rated for hazardous locations and wiring systems within this area are of a type for wet and corrosive locations. Lighting was all fully gasketed and rated for wet locations and used LED fixtures to lower the operational costs of the facility.

Significant structural calculations and ingenuity were required to address the constraint of installing all the new components within the small existing structure. As such, parts of the main floor slab were removed to extend components from the basement to the ceiling. A combination of concrete slabs and steel beams were installed to properly support the new components of the treatment system and allow for modifications to the existing structure.

Maintaining operation of the existing treatment system was of upmost importance and thus staged construction was planned. Further scheduling by the contractor with input from the team ensured the installation process was successful in the required timeframes for existing infrastructure to be decommissioned. In spite of several emergency and unexpected situations, untreated wastewater was never discharged to the environment at any point during the construction and installation stages of work.

Above: New VFold sludge press.

Below: New process sludge pumps.

During construction, the project allowed all the building mechanical and electrical work to be completed by northern and local businesses ensuring local employment and ultimately putting money back into the community and its residents. Once substantially completed in the fall of 2015, the WWTP was already performing exceptionally well, meeting and surpassing all regulatory compliance limits set by the governing agencies. The EC Directive was thus removed with no financial penalties. Further, the automated process has allowed the Village to dedicate some of its operator's hours to matters outside of the WWTP itself; something that was never possible with the existing system. Through partnering with the Village, not just as an end client, but as a vested stakeholder with input through all parts of the design and construction phases, the engineering and construction teams provided an end product that all parties could be proud of.

GOOD ENGINEERING PRACTICE FOR NORTHERN WATER AND SEWER SYSTEMS

The currently style of access vaults are often operated with the sewer cleanout left open, which leads to vaults flooded with sewage and a risk of cross contamination of the water system.

The use stainless steel bands instead of tape to secure cables to intake pipes may reduce the possibility of leaving the heat trace and power cables loose.

Good Engineering Practice for Northern Water and Sewer Systems (GEP) was originally published by the GNWT Department of Public Works (PWS) in 2004 as a supplement to other available technical references and codes, and in cases where the GNWT decided that northern conditions required a different approach, or had specific preferences for designs or products that had a history of success. During the 12 years since the first edition of publication of GEP, there have been many lessons learned and changes in technologies. In addition, the Guidelines for Canadian Drinking Water Quality are continuously updated and have been adopted in the NWT under the Public Health Act and Water Supply System Regulations, resulting in new requirements for drinking water systems. More complex water treatment plants are now being installed in the NWT to meet the new regulations, with support from a mandatory operator certification and MACA's circuit rider program. In recent years, the CCME has introduced new wastewater discharge limits, which may eventually lead to changes in the design of northern water treatment systems. Many of the standard reference books for northern utilities design, in particular the Cold Regions Utilities Monograph, has not been updated in 20 years, and do not re-

By Justin Hazenberg,
Department of Municipal and Community Affairs (MACA), GNWT

flect the current regulatory environment or available technologies.

The standard details included in the GEP will also be reviewed and updated based on the observed performance over the past decade. For example, the currently recommended style of combined access vaults are often operated with the sewer cleanout left open, which leads to vaults flooded with sewage and a risk of cross contamination of the water system. Another proposed change is a recommendation to use stainless steel bands instead of tape to secure cables to intake pipes. Tape has been found to lose its adhesion after being submerged in the water for a while, leaving the heat trace and power cables loose in the casing pipe and sometimes plugging the intake pump with strips of tape.

Over the past few years, the GNWT Department of Municipal and Community Affairs (MACA) has taken over most of PWS' responsibilities in the areas of water and wastewater. MACA has recently begun updating the GEP to reflect current practices and regulations. The document will also be expanded with several new topics. Proposed topics so far include:

- Basic information on cold regions issues such as frozen ground, permafrost, climate, remote location logistics, and appropriate technologies, in order to alert designers who are new to the north to issues that they may not have considered before;
- Drinking water intake design considerations, including airburst and backwash systems, minimizing problems with silt, preventing floating intakes, freeze protection, materials, siting, design criteria, and common problems;
- Up-to-date water treatment technologies such as membrane filtration, coagulation, and UV disinfection;
- Sewage lagoon and wetland siting and design, along with a discussion of the pros and cons of mechanical sewage treatment in the north;
- Water treatment plant layout considerations, such as lab area and storage requirements that are specific to water plants. Other guidelines will be referenced for items such as insulation and heating of northern buildings.

MACA's intent is that each recommendation will be accompanied by a rationale so that communities and designers understand why it was made and can make decisions on when a deviation from the standard may be appropriate based on their situation. Recent scientific research will be referenced where available to back up the recommendations; history and practical experience will also be important sources.

MACA plans to hold a workshop around the time of the 2016 NTWWA Conference in Yellowknife. Engineers, operators, and other interested people will be invited to give feedback, suggestions, and stories of designs that have and have not worked. Publication of the updated document is tentatively planned for 2017. Presentations will be done at the NTWWA and NAPEG conferences to help launch the new edition.

A SERIES OF UPGRADES TO THE VILLAGE OF MAYO WATER TREATMENT PLANT

Mayo water treatment plant improvements in progress.

Gas chlorination in Mayo.

UV disinfection system in Mayo.

The Village of Mayo is one of the 18 Yukon communities outside of Whitehorse, located 406 kilometres from the capital traveling north on the Klondike Highway and east on the Silver Trail. It is home to about 490 residents, including members of the Na-Cho Nyäk Dun First Nation (NNDFN). The establishment of the community started in 1903, and is known for being both the coldest and hottest place in the Yukon.

Like every Yukon community, Mayo operates its own Large Public Drinking Water System, with the current treatment originally built in 1987. At the time, a single well, pumping at 16 L/s, was the only source of raw water for the community, and was chlorine disinfected before storage and distribution. About 80 per cent of the community benefits from a water distribution system, with the remainder of the community on a trucked water delivery.

Since 2010, several improvements to the village's water treatment plant have been undertaken, including the addition of three new wells were drilled between 2010 and 2011, due to an increasing water demand in the community. Two of the three new wells proved to have insufficient capacity; however, the third well provided a higher yield and was connected to the treatment plant as an emergency measure in 2011 to sustain the additional demand. Replacement of the control system was also necessitated by two chlorine gas leaks.

In 2012, the wells were defined as GUDI (Groundwater Under the Direct Influence) and additional treatment was required as a result. The Yukon Government – Community Services – Infrastructure Development Branch (YG-IDB) contracted Associated Engineering to complete the design and construction services for the connection of the wells and process upgrades to the treatment. In addition, a Wellhead Protection Plan (WHPP) was requested to mitigate contamination of the source which is located in the Village's core. A first assessment of the plant revealed that additional upgrades were required mainly to contain further chlorine leaks and make the building conform to the Building Code and Occupation Health and Safety regulations. In addition, one of the three wells was judged to be too shallow, and therefore had to be decommissioned; a replacement well was needed for the decommissioned well.

In 2013, a new well was drilled, and with the additional flow from of the two other wells provided the expected redundancy in water supply. Construction of the upgrades were undertaken between 2015 and 2016. All the wells are now equipped with pitless adapters and wellheads are enclosed in a heated enclosure for electrical and control panels that could not fit into the existing treatment plant.

In addition to a safe and reliable source, the village can now rely on cartridge filtration to control turbidity peaks observed in the spring, and UV disinfection and chlorination. The chlorination room was entirely refurbished to ensure proper containment

By Virginia Sarrazin, Opus Dayton Knight Consultants

of a potential leak, the injection system was fully replaced for reliability, and a chlorine scrubber was installed to neutralize chlorine gas in case of a system leak. An emergency shower was also installed to provide a required level of safety for plant operators. Additional instrumentation was added including an online transmittance analyzer before UV disinfection in addition to turbidity monitoring.

A new control panel, control system and HMI (Human Machine Interface) now allows the operator to better monitor the plant, and SCADA connectivity brings additional support with the ability of remote monitoring. For the building itself, a new roof was added to the existing one to create a cold roof effect and therefore reduce heat loss and mitigate water leaking through the roof due to ice damming. A new fuel storage and transfer system was installed for higher autonomy and better containment of potential leaks.

The project did not remain without its challenges, including residential fuel tanks without double containment and/or seismic restraints that are within the capture area of the wells. Unfortunately, there are no regulations in place that can initiate a change in the type or configuration of the fuel tanks that may prevent a potential hydrocarbon contamination of the water source. The water level in the wells is greatly influenced by the nearby Mayo River, and during dry and early summers like in 2016, only one well has a sufficient yield to remain in operation.

YG-IDB has initiated a second phase of upgrades that will hopefully help mitigate the issue with increased storage capacity. The existing above ground storage tank will be replaced by two new reservoirs, with one dedicated to contact time for disinfection and fire protection. A new booster pump will replace the existing diesel fire pump, and will be connected to a new backup generator that will have the capacity to power the treatment, distribution and the building during power outages that regularly occur in Mayo during the winter months. An addition to the building will be built to provide the operators with a better office space, a lab and proper storage space.

With the ongoing upgrades to its distribution system, the residents of Mayo will soon have a water system better equipped to reduce risks and improve water quality. The Village of Mayo water team were engaged early in the preliminary design and have remained an important asset to the successful completion of the upgrades.

NTWWA Executive Director's Report

JENNIFER SPENCER-HAZENBERG

The 2016 NTWWA Annual Conference, Trade Show, and Operator's Workshop will be hosted in Yellowknife, NT November 18th to 22nd. The theme for this year's conference is "Keeping with the Flow". The conference program will include approximately 20 technical presentations, and the conference will be followed by a two-day Operators Workshop.

The NTWWA provides a very worthwhile and interesting opportunity for those working in the northern field of water, and waste, and others who are concerned about these vital services, to meet, network and hear about the projects others have been working on during the past year. If you are a northern water or waste professional, mark your calendars and join us at the annual event to share ideas and learn about northern water and waste challenges and solutions.

Last year the Annual Conference, Trade Show and Operators Workshop in Iqaluit was a huge success, with approximately 70 delegates. Thanks to those operators who sat on the Operator's Panel and shared their experiences. A big thank you to Pearl Benyk for all the hard work coordinating the logistics of the 2015 NTWWA annual event. The delegates, presenters and trade show participants are key to the success of the annual event, so thank you very much for your participation.

Since 2005, the NTWWA has been hosting a friendly drinking water competition for the water treatment plant operators who attend the conference. If you want to take home the trophy and bragging rights, remember your H_2O in 2016!

The board tries to maintain diverse representation and currently consists of water treatment plant operators, consultants with expertise in the areas of water and waste, a water and waste industry representative, and government employees. If you are interested in becoming a board member, please step forward at the Annual General Meeting held following the conference.

This is my fourth year as Executive Director of the NTWWA, and I want to thank the NTWWA Board of Directors for their support. I would especially like to thank Pearl Benyk for all of her help in keeping the organization running smoothly. Every year we say goodbye to dedicated members and welcome newcomers, and this year is no exception. On behalf of the board, I would like to thank all of the board members who are leaving us for their dedication. To all of the new board members, thanks for volunteering your time – we are excited about the new experiences, knowledge and ideas you bring. Special thanks are due for the efforts of President Arlen Foster, the *Journal* editor Ken Johnson, and our administrator Pearl Benyk.

I look forward to you joining us in Yellowknife.

NTWWA President's Report

ARLEN FOSTER

First, I'd like to offer a big thank you on behalf of the Board of Directors to everyone who attended the 2015 annual conference in Iqaluit last November. We had a great conference, and considering the economic times, logistics in attending in Iqaluit and last minute weather issues, we had just over 60 people attending and seven tradeshow booths.

The event was a success not only due to the number of attendees and positive comments received, but we were also lucky enough to have the Honorable Hunter Tootoo, Federal Cabinet Minister, join us and encourage the association to continue discussing and advancing northern water and wastewater technologies. "Groups such as yours, discussing cutting-edge technologies and how they can be provided in our unique northern environment, are key," Mr. Tootoo stated. Having individuals like Mr. Tootoo and other federal and territorial leaders attend the conference inspires the board and demonstrates the importance of the association. We continue to highlight that this annual conference and tradeshow remains the best place to network and promote northern water and waste technologies. Thank you to all for continuing to show your support and expand this event with us!

The 2016 annual conference is fast approaching and will be held in Yellowknife, Northwest Territories this year. We are excited to reach new northern leaders from all levels of government, consulting and construction industries for this event. The planning is well on its way, and I encourage all to come and take part in this event whether it is to learn, network, provide a presentation or have a tradeshow booth. As always, planning and preparing for this conference is a big task, and I would like to acknowledge and thank all those involved especially Jennifer Spencer, our Executive Director, and Pearl Benyk, our administrator.

I hope you all enjoy the annual *Journal* and find information that can be shared amongst your organization to improve the use and protection of water and land across the northern environment. Last but not least, I cannot thank all those that provide financial support to our association enough, and encourage your ongoing participation in this matter. I know I've said it before, but without the water professionals across the north, the industry folk, the two territorial governments, the Government of Canada, as well as the constituent organizations of Western Canada Water, we would not be able to succeed the way we do!

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