Journal
of the Northern Territories Water and Waste Association

September 2007

Water and Sewer at THE OTHER POLE

Northern Territories Water & Waste Association

Published by:

DEL Communications Inc.

211 Hespeler Avenue
Winnipeg, Manitoba R2L 0L5
Toll Free: 1.866.831.4744

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Tel: (204) 895-2223
www.sgbennett.com

Layout & Design
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Publications mail agreement #40934510
Return undeliverable Canadian addresses to:
DEL Communications Inc.
211 Hespeler Avenue
Winnipeg, Manitoba
R2L 0L5
Email: david@delcommunications.com

PRINTED IN CANADA

Northern Territories Water & Waste Association Journal

In this issue

Iqaluit

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Northern Territories
Water & Waste Association

FIRST ANNOUNCEMENT

Annual Conference, Trade Show & Workshop

Iqaluit, Nunavut, November 3, 4 & 5

THEME: Camps & Communities – Managing Our Waters

The NTWWA's Annual Conference has become the highlight of the year, not only for the Association members, but also the water and waste management sector across the north, which includes engineers, technologists, suppliers, regulators, contractors, administrators, and operators. The 2007 conference and workshop in Iqaluit will feature a conference with 20 exceptional technical presentations, and a day-long operator workshop.

We are planning to repeat the "plumbing challenge", which matched the wits of the conference delegates with a poorly drawn isometric view of a pipe assembly. We are also planning for the 2007 Great Northern Drinking Water Challenge. In 2006, the Village of Fort Simpson was the winner of the second annual event, and Steve Squirrel was awarded the drinking water cup by Heather Scott, the NTWWA president.

TRADE SHOW

When our northern weather takes its toll on facilities and equipment, it is important to know the companies and professionals with the products and services to tackle the problems. The conference will feature exhibits with many products and services, and companies and product representatives who know what works in the north.

CONTINUING EDUCATION CREDITS AND OPERATOR WORKSHOP

Water Treatment Plant Operators earn 1 Continuing Education Credit for attending the conference and the Operator Workshop on November 5. The workshop will feature "hands-on" sessions with great practical information for Operators.

REGISTRATION

***Registration is now available, so visit* www.ntwwa.com *or call* 867.873.4325**

South Pole utility tunnel cut through solid ice.

WATER & SEWER AT THE OTHER POLE

South Pole station.

Introduction

Antarctica creates an image of a cold and desolate environment, not so different from its northern counterpart, but in a land of penguins instead of polar bears. What sets the South Pole apart from the North Pole is the fact that the Pole is actually located on a land base. The Pole sits on top of a featureless windswept icy plateau at an altitude of 2,835 meters (9,306 feet), about 1,300 kilometres (800 miles) from the nearest sea. The ice is estimated to be about 2,700 meters (9,000 feet) thick at the Pole, so the land surface is actually near sea level.

Antarctica is a multi-national jurisdiction devoted, in principle, to international cooperation. The Antarctic Treaty, in fact, prohibits any military activity in Antarctica, and military personnel or equipment is permitted only for scientific research or for other peaceful purposes. The "stations" operating on Antarctica employ slightly over 3,500 employees at 37 research stations run by 18 different nations.

Access to Antarctica is difficult and expensive even by northern standards, with the easiest access by air off the tip of South America, which requires a 1,500 kilometre flight to the British research station on Adelaide Island, at a cost of around $5,000.

Peter Christou's South Pole adventure in early 2007 is a rare glimpse of an important function at each and every station from a water and sewer operator's perspective.

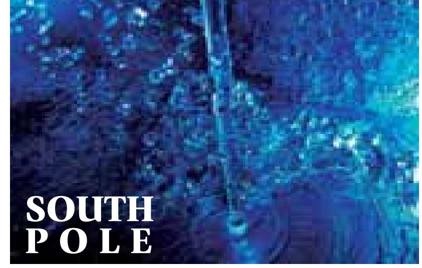
An Operator's Perspective on the South Pole

Not many people get the chance to go to Antarctica, so I knew it was an experience that I could not pass up. As I prepared for my stay at McMurdo Station, I packed for bitter cold, expecting gale force winds, and temperatures that would make fingers fall off after mere seconds, but it didn't take long to find out that summer time at McMurdo Station was nothing like I thought it was. I had preconceived notions that McMurdo would be like the remote camps in Northern Canada, but filled with scientists and the hardiest of men, living in conditions only fit for sled dogs. I was extremely surprised to find out that McMurdo Station is a community like no other, with a thriving social scene which constantly lets you experience things like rock climbing, swing dancing, and pottery. It is no wonder that people will stay at McMurdo for up to a year at a time.

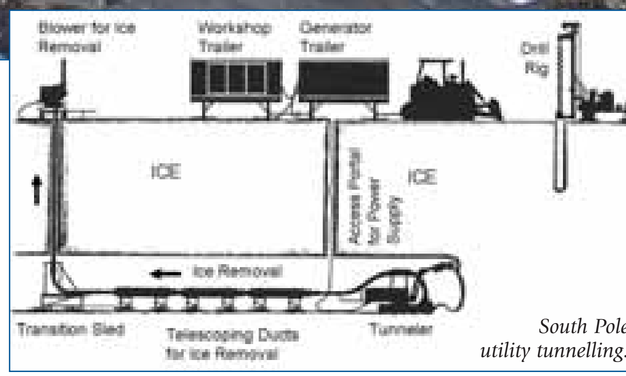
I came to McMurdo late in the season and began working right away. The McMurdo wastewater treatment plant was a standard extended aeration plant, and the water plant was a reverse osmosis desalination plant. The water treatment plant had a lot of operational points to monitor, but was very easy to operate. The wastewater treatment plant needed a bit more tweaking before the effluent improved; however the general operation of both the treatment plants was very simple. However, certain things needed to be optimized to ensure treatment consistency.

Things went so well at McMurdo, I was asked to help out at the New Zealand Antarctic research station called Scott base. At Scott base they are operating a fixed film aerated bed that wasn't working to its full potential. It was a lot of fun working there, and the New Zealanders made me feel right

By Peter Christou, Chief Director/Operation Specialist
Chimo Water & Wastewater Services Ltd.
Introduction by Ken Johnson, NTWWA, Southern Director



McMurdo Station, Antarctica.



South Pole utility tunnelling.

at home. I even got a chance to play rugby on the Ross Ice Shelf with the American team, and we tried to break the Kiwis 50 year winning streak. It was truly a great experience and I was able to make some life long friends with the Kiwi utility operators.

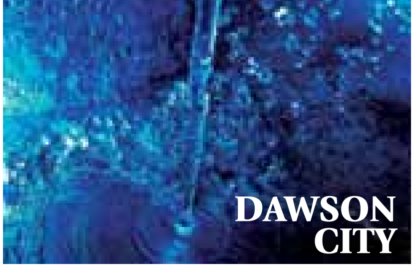
Just when I thought all the fun was over, I got to go to the geographic South Pole, and visit the South Pole Station. The camp at the South Pole Station is the most amazing feat of engineering I have ever seen in my life. I was really impressed by the building and living quarters, but I was amazed by all the utilities located so far beneath the snow. I didn't seem to care that my camera froze at -60 C inside the utility tunnels, because I couldn't even conceive of all the work and planning that it took to construct the hundreds of tunnels that keep the station working properly.

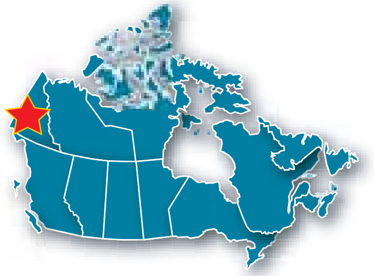
As I later found out, the utility tunnels were constructed using technology developed specifically at the South Pole. A tunneller concept for the construction was based on a small tracked excavator with an industrial snow blower mounted to the front for chip removal. The surface operations supporting the tunneller included a fan and drill, which operated at the same time as the tunneller, and an ice chip conveyance ducting below the surface. In operation, the tunneller machined the face of the tunnel, depositing the chips at the base of the face. The snow blower attached to the front of the tunneller was fed by the chip pile, centering and feeding the chips into the ejector pipe going over the tunneller. Tunnelling in the ice below the South Pole was a slow process of advancing less than 2 metres per hour.

At the surface, the vertical pipes were attached to the centrifugal fan (blower), which powered the chip conveyance system and blew the chips clear of the working area. A drill rig was used to construct holes for the vertical chip conveyance tubing and the power cord that supplied power from the sled-mounted generator module on the surface to the tunneller.

I personally walked at least 45 metres down into the "deep freeze" to see the current water and wastewater system. The South Pole was freezing even in the summer, and it left an impression on me that left me smiling the entire flight home.

I was surprised and honoured to find out that I was the first Canadian to operate the treatment plants at McMurdo Station in Antarctica. The guys at the wastewater treatment plant honoured this historical event by laminating some bio-solids from the belt filter press and giving them to me at a special presentation. I loved every minute I was in Antarctica – I highly recommend it to anyone who gets the chance.





WATER AND SEWER SYSTEMS SERVING DAWSON CITY, YUKON

Introduction

Dawson City, Yukon Territory is a community of approximately 1,500 people, located in the mid-western section of the Territory, in an area of discontinuous permafrost. The Town's water and sewer services are provided by a buried and insulated high density polyethylene pipe (HDPE) utility system, which was completed around 1980. The water and sewer infrastructure is reasonably complex in both its construction and operation; the operation alone requires a dedicated staff of 5 individuals.

The date of construction of the first components of the Dawson City water and sewer system is not known precisely, however, it has been recorded that Dawson had a water and sewer system in operation as early as 1904. A description of the system operation in 1911 states that "only three or four houses in Dawson were equipped with year-round running water. To prevent their freezing in winter, the water pipes had to be linked to parallel pipes of live steam which must be kept constantly hot. In addition, the water must be kept moving through the pipes continually, and thence through an insulated outlet all the way to the river." The original pipe installations were wood stave construction, and this piping continued to be used until the 1970's (See Figure 1).

FIGURE 1: *Installing stave wood pipe in Dawson City circa 1972.*

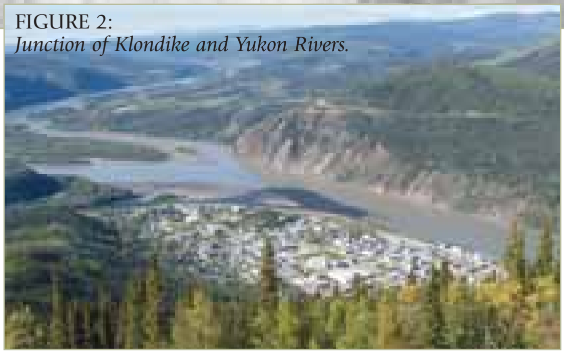


FIGURE 2: *Junction of Klondike and Yukon Rivers.*

Beyond the piping systems in Dawson City, there are 12 facilities that are an integral part of the infrastructure. The facilities handle approximately 850,000 cubic metres (190 million Imperial gallons) each of water and sewage in a year (2005 estimate).

Dawson Water System

Dawson City's water system facilities include of the water source, the water storage, and the water treatment and distribution. The water source is a series of three wells located along the river bank, near the junction of the Klondike and Yukon Rivers (See Figure 2), drilled to depths of approximately 22 metres (70 feet). One original well was installed in 1959, and three additional wells were installed in 1991 to provide additional capacity. The newer wells are situated in concrete access vaults with an adjacent well control building. The original well is situated in a wooden building, and is generally used only as an emergency back up supply.

The water storage components are two insulated steel reservoirs beside the water treatment and distribution building (See Figure 3). The two reservoirs have a combined storage of approximate 1,300 cubic metres (290,000 Imperial gallons), which provides storage for drinking water supply and fire protection. The water treatment and distribution is housed in a building which contains various chemical, heating, pumping, electrical, and piping systems for water treatment, freeze protection for the system, and water distribution. The water treatment process uses controlled chlorine gas injection into the water prior to distribution into the buried water system.

Freeze protection for the water system is needed during the winter; the water in the pipes cools as it flows through the distribution piping, there-

FIGURE 3: *Dawson City water storage.*

By Norm Carlson, Superintendent of Public Works, Dawson City, YT
& Ken Johnson, Senior Engineer and Planner,
Earth Tech Canada, Edmonton, AB

fore additional heat is required to prevent the water in the pipes from freezing. The water is also recirculated by pumping to confirm the water temperature in the pipe, and provide additional freeze protection. On-line hydrants are also a feature of this type of recirculating system (See Figure 4). The water distribution system itself includes 16 kilometres (10 miles) of insulated, buried HDPE water main. The distribution system includes approximately 700 service connections to buildings, 85 hydrants and a valve chamber building for controlling the flow of water.


FIGURE 4:
On-line hydrant in Dawson City.

Dawson Sewage System

Dawson City's sewage system facilities includes five lift stations, and the sewage treatment plant. The sewage collection system has 16 kilometres (10 miles) of insulated, buried sanitary sewer, and approximately 3.5 kilometres (2 miles) of buried forcemain from the lift stations. The sewage lift stations are submersible pumping systems in wetwells, with control buildings either on top of or adjacent to the wet wells. Four of the lift stations may be considered "small" facilities, and the remaining facility may be considered a medium sized facility. Four of the lift stations collect sewage from the developments on the Klondike Highway, which is the access road into Dawson City.

The sewage treatment employs a primary screening operation using two 0.75 millimetre mesh rotostrainers housed in a multi level building (See Figure 5). The sewage discharges into the Yukon River, mid-channel 200 metres (650 feet) west of the perimeter dyke that surrounds the community.

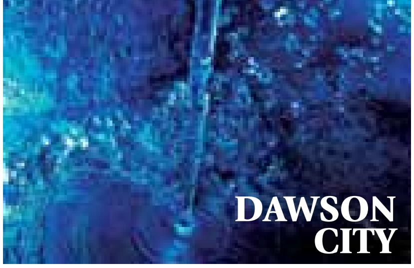


FIGURE 5:
Dawson City primary sewage treatment.

Challenges of Dawson City Water and Sewage System

Subsoil conditions in Dawson City typically consist of a surface layer of common road fill 0.6 to 0.9 metres in thickness, underlain by organics, organic silts, and silts to a depth of 3 to 5 metres. This layer of silt and organic silt has an ice content varying from zero to greater than 50 percent excess ice content. Beneath this layer of organic silt, a layer of alluvial gravels has been deposited by the Yukon River; these gravels are relatively dense and thaw stable.

This area is in the widespread discontinuous permafrost zone, with ground temperatures in the range of -1.5 C, which is considered to be "warm" permafrost. Since the permafrost temperature is just below freezing, the permafrost may thaw or degrade very easily from disturbances such as the installation of underground utilities. Problems with respect to water and sewer systems in these soil conditions have caused ground subsidence due to thaw of the ice rich permafrost, and seasonal frost heave of buried foundations and utility pipes. In a two year period in the mid 1980's, over 225 metres of polyethylene sewer pipe failed by ovalling or collapsing due to the permafrost conditions.

The problems due to frost action in the soils were compounded in the

FIGURE 6:
Insulated HDPE pipe with corrugated metal pipe cover in Dawson City.

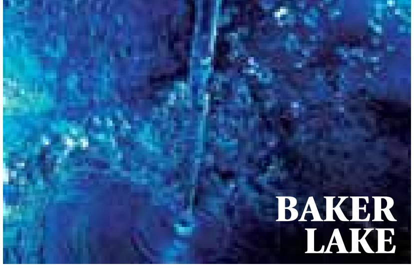
Dawson City continues to incrementally address the challenges of operating and maintaining water and sewer facilities in the heart of the Klondike.

vicinity of hydrants, vertical risers, and service connections because a vertical restraint is imposed on the piping system. At service connection locations there were numerous examples of service risers causing a local collapse of the main because of the vertical load on the horizontal sewer main. Adjacent to hydrants and valves, pipe failures occurred at fusion weld joints because of bending or torque along the connecting pipe.

The unique soil conditions in Dawson City have required the development of unique water and sewer piping materials and installation techniques. Several studies in the late 1980's compared pipe and bedding configurations, and developed the corrugated metal cover on insulated HDPE piping that is the pipe standard for Dawson City today (See Figures 6). The installation of the pipe requires consideration of the permafrost conditions to ensure that the area around the excavation is not significantly disturbed, particularly in areas where the permafrost has a lot of ice lensing.

Future Water and Sewer Improvements

Dawson City continues to incrementally address the challenges of operating and maintaining water and sewer facilities in the heart of Klondike. Bleeder reduction has been a priority over the past several years, and water metering has been implemented to reduce water usage down in the range of 500 litres/capita/day from winter extremes of 1500 litres/capita/day. A comprehensive water and sewer facility assessment was completed in 2006, which has provided Dawson with the framework for system improvements over the next 20 years. The most significant initiative has been the replacement of the preliminary treatment system with an aerated lagoon treatment system, which is scheduled for completion in 2010.



ENVIRONMENTAL STUDY & EVALUATION OF THE WATER & SEWAGE SYSTEMS AT BAKER LAKE, NUNAVUT

Introduction

The Hamlet of Baker Lake (Qamani'tuaq) is serviced by trucked water and wastewater disposal. Drinking water is drawn from Baker Lake, approximately 170 m offshore at a depth of 5 m below the water surface. Water is regularly trucked to building storage tanks throughout the community and is chlorinated prior to distribution. Wastewater is collected from the Hamlet's houses and other buildings also by truck and discharged into a holding cell, located approximately 1.2 km north of the community.

Sewage holding cell in Baker Lake, Nunavut.

The holding cell serves to hold back solids and provide a level of primary treatment. Wastewater from the holding cell exfiltrates through, or overtops the berms, and flows down – slope to the natural tundra wetland system (tundra wetland), which provides final treatment. The tundra wetland flows through a series of small lakes and channels, eventually reaching Baker Lake. Residents and regulators have expressed concern about the effectiveness of the wetland treatment system and its potential impact to drinking water quality, especially during the spring freshet.

The Tundra Wetland Treatment System

The tundra wetland treatment system consists of a holding cell and the natural tundra wetland, situated in a valley bound to the north and south by rocky hills. The flow of wastewater was examined to determine both treatment area and performance. The holding cell discharges continuously downslope into Lagoon Lake, from where the tundra wetland generally flows in an east-southeast direction. Lagoon Lake channels east into Finger Lake, where the current solid waste facility (landfill) is located near its southwest shore. Finger Lake then flows southeast into Airplane Lake through a defined channel. Airplane Lake subsequently flows south into Baker Lake via Garbage Creek. Applying the discharge into Airplane Lake as the treatment boundary (compliance point), the treatment area of the tundra wetland is estimated at 9.7 hectares. With the current wastewater volume estimated at 52,400 m3, the hydraulic loading rate is projected to be 5.7 ha/1000 m3/d, which is close to the 5.0 ha/1000 m3/d loading rate suggested in Doku and Heinke (1993). Initial concerns about the tundra wetland treatment system include the capability of the tundra wetland to handle current and future wastewater volumes, potential impacts to

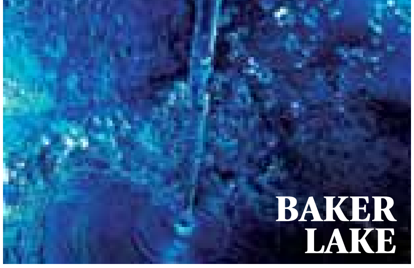
By Carey Sibbald, Aquatic Biologist,
and Nick Lawson, Operations Manager, Nunami Jacques Whitford

effluent quality from landfill leachate and potential impact of effluent from the tundra wetland on the water quality of Baker Lake, where the community draws its drinking water.

To evaluate the performance of the tundra wetland treatment system, wastewater samples were collected from seven stations throughout the wetland during the summer and fall of 2006. Analyses of samples to date confirmed that the tundra wetland is able to effectively treat municipal wastewater to compliance. Ammonia nitrogen, biological oxygen demand (BOD), fecal coliforms, and total suspended solids (TSS), among other parameters, decreased in concentration through the wetland and were well within licence levels at the compliance point specified in the Water Licence.

Runoff from the municipal landfill presently drains into the tundra wetland. Select metal parameters at stations downstream of the landfill and at the licence compliance point were measured at concentrations exceeding Canadian Council of Ministers (CCME) Protection of Freshwater Aquatic Life Guidelines during both sampling events in 2006. Previous concerns regarding impacts of landfill leachate on effluent quality appear to be substantiated by these results. Nonetheless, once effluent from the tundra wetland entered Baker Lake, all parameters were within compliance for NWB and CCME Guidelines. A bioassay completed on effluent collected at the outflow of the wetland into Baker Lake further confirmed that the treated water was non-toxic to fish.

Presently, the tundra wetland treatment system is meeting NWB effluent discharge requirements at the compliance point with the current loading rate. Future wastewater volumes are estimated to be 76,000 m3 by 2026, based on population projections from the Government of Nunavut. Applying the current effective treatment area, future loading rates are approximated at 4.0 ha/1000 m3/d, which is higher than suggested, implying that the tundra wetland may not meet future NWB requirements. Enlarging the holding cell to meet future wastewater volumes and employing a typical 10-month storage and release regime to improve effluent quality may be cost prohibitive due to the large size of holding cell required. Alternatively, the effective area of the tundra wetland can be increased by utilizing one of a number of engineered options. These include constructing a slightly larger holding cell to increase retention time, expanding the



All parameters analysed were well within Health Canada's Guidelines for Canadian Drinking Water Quality.

Baker Lake sewage wetland.

flow and treatment areas between ponds/lakes, and constructing a landfill holding cell to impound and treat leachate before it flows into the tundra wetland. Through engineered changes to current wetland flow channels, the effective treatment area can be expanded to 41 ha, reducing effluent loading to within recommended levels.

Water Quality of Baker Lake

During the summer 2006, water samples were collected from ten (10) stations across Baker Lake in front of the Hamlet. Sampling effort was reduced in the fall of 2006 and only five (5) stations were sampled. Stations were located within 2,000 m on either side of the drinking water intake, with one additional station located at the mouth of the Thelon River, where it was reported some residents collect drinking water. The final station east of the intake acted also as the final tundra wetland wastewater station, as it was the outflow of Garbage Creek into Baker Lake.

Results of the sample analysis indicated that water from Baker Lake was clear and relatively soft. In the summer, Baker Lake was thermally stratified, with the thermocline found at a depth between 4 and 6 m. Fall sampling determined the thermocline was no longer present, indicating fall turnover was occurring at the time. Analyses of samples during both sampling events demonstrated the water of Baker Lake to be of good quality for drinking purposes. All parameters analyzed were well within Health Canada's Guidelines for Canadian Drinking Water Quality. Water samples collected from the outlet of the tundra wetland, Garbage Creek, were also within Health Canada Guidelines. Therefore, the wetland effluent does not appear to negatively impact the drinking water quality of Baker Lake, at least during the summer and fall periods when samples were collected.

Several metals were noted to exceed the CCME Protection of Freshwater Aquatic Life Guidelines during both summer and fall sampling at one or more stations. These CCME Guidelines are much stricter than Health Canada Guidelines, and hence do not affect the drinking water quality of Baker Lake. The origin and cause of these elevated metals is not clear at this time and is being investigated further.

Conclusions

To date, the tundra wetland is successful-


Water sampling on Baker Lake.

The tundra wetland is successfully treating wastewater to the required NWB effluent discharge criteria.

ly treating wastewater to the required NWB effluent discharge criteria at the compliance point. However, there is some concern regarding the impact of landfill leachate on wastewater effluent quality, as some metals exceeded applicable guidelines at the compliance point. Additionally, effluent discharged from the tundra wetland does not appear to be affecting the water quality of Baker Lake, as water samples from Garbage Creek met Health Canada's Guidelines for Canadian Drinking Water Quality. Analysis of samples collected from Baker Lake in the vicinity of the Hamlet indicated that the water was of good quality and met drinking water quality guidelines.

WATER SUPPLY AND TREATMENT IMPROVEMENTS IN GJOA HAVEN, NUNAVUT

Background

The Government of Nunavut, through the department of Community and Government Services (CGS) undertook to improve the water supply system in Gjoa Haven, NU. The original intent was to develop a system that would be able to treat the water in both the Water Lake reservoir and Swan Lake. Swan Lake is the raw water source, located approximately 3.2 kilometers from the then-existing truck fill station at Water Lake (See Figure 1). On an annual basis the community would pump water from Swan Lake to this in-town reservoir, which is a small pond that had been raised to provide water storage over the winter. Concerns with the existing system included:

- The raw water is above the current guidelines for turbidity.
- The water supplied to the community residents would at times contain "blood worms" (the larvae of the Chironomid midge).
- The existing intake system was subject to freeze up.

The proposed undertaking was to develop the new water supply system in two phases. Phase I would be the development of a new Water Treatment Plant (WTP) on the shores of the in-town storage lake. This WTP would have an intake into Water Lake and would provide treated water through a truck fill system. Phase II would be a shallow buried year round pipeline to Swan Lake (See Figure 2). This would allow water to be piped from Swan Lake to the WTP, and eliminate the need for the in-town reservoir. An essential component was an intake pump house (IPH) on the shore of Swan Lake. This IPH had its own built-in truck-fill arm and chlorination pump, which were provided as redundant systems in case of emergency need (See Figure 3).

FIGURE 1:
Raw water pipeline routing.

FIGURE 2:
Shallow buried raw water pipeline installation.

The Roadblocks

Due to funding availability, it was expected that the WTP would operate for several years using Water Lake prior to the construction of the Swan Lake pipeline system. Construction was started on the WTP in the fall of 2003, and essentially completed by January 2005.

By Heather Scott, M.A.Sc., P.Chem.,
Waster/Wastewater Systems Design, Dillon Consulting Ltd.

However, in the fall of 2005, the reservoir berm of Water Lake breeched, and the community's winter water supply was placed in peril. CGS initiated an emergency response that included utilizing equipment mobilized for the Phase II construction and mothballing the WTP until it once more would be connected to a water source. Accordingly, parts of the Phase II work were completed in the fall and winter of 2005, and the community was able to use the Swan Lake intake system of the phase II works throughout that winter and spring.

Completion of Construction

In 2006, the phase II works were completed, and connected to the WTP. The system as a whole was commissioned and put in use by the fall of 2006. Substantial completion of the works was achieved in March 2007. The new system includes:

- An intake and pump house at Swan Lake.
- 3.2 kilometers of pipeline, road, power and communications line from Swan Lake to the WTP. These include access vaults, heater stations, and a recirculation system.
- A water treatment process using mixed medium pressure sand filtration and chlorination.
- Water storage in the WTP (400,000L tank).
- Stand-by power generation.
- Monitoring and controls.

A New Task: Operator Training

With the near-completion of the water treatment plant, the Government of Nunavut and the Hamlet of Gjoa Haven were faced with a new challenge: a state-of-the-art facility without a fully qualified operator in the community. Dillon had conducted a great deal of water treatment plant operator training in the NWT, and therefore compiled a training plan that they could deliver to suit the needs of those who were available to operate the Gjoa Haven Plant. A three phase plan was recommended:

- Phase I: Instruction of Preparatory Math and Science Skills for Water Treatment Plant Operators
- Phase II: Instruction of Small Systems Water Treatment Plant Operation
- Phase III: Class I Water Treatment Plant Operation through on-the-job training and a Circuit Rider Program

CGS decided to take full advantage of the proposed training program by inviting all water treatment plant operators in the Kitikmeot Region of Nunavut to participate.

Phase I

Ten Operators from Kugluktuk, Kugaaruk, Gjoa Haven, Grise Fiord, Resolute Bay, and Taloyoak gathered in Cambridge Bay in March, 2006 to participate in a three day course to develop and refresh math and science skills related to water treatment plant operation (See Figure 4).

The participants' levels of education and skills were quite varied; some participants had not taken math since primary school, while others had post secondary math experience. Some participants had used math as recently as that week; others had not used math in over a year. Therefore, the course curriculum had to accommodate a variety of math and science skills. Curriculum was developed specifically for the course from a variety of sources. The manual was developed so that participants were first introduced to basic math concepts, and the material eventually built into more complex operations related to water treatment.

Recognizing that the various course participants would learn and absorb information in different ways, the course curriculum was delivered using a variety of methods: group discussions, videos, games, problem solving, assignments, group work, and hands-on learning.

At right – FIGURE 3: *Truckfill station.*

Below – FIGURE 4: *Operator classroom training.*

Phase II

The second phase of training consisted of instruction of "Small Systems" water treatment plant operation. The class consisted of eleven participants from the communities of the Kitikmeot Region of Nunavut, with five of those participants having attended the first phase of training. Again, most participants were currently employed as works staff in their respective Hamlets, and had experience with water treatment in some capacity.

The Curriculum for this course was adapted from the "Small Systems Water Treatment Plant Operator" manual used by the School of Community Government, Municipal and Community Affairs, Government of the Northwest Territories. Permission was granted from the GNWT to use this material. Topics included:

FIGURE 5:
Operator demonstration training.

With the near-completion of the water treatment plant, the Government of Nunavut and the Hamlet of Gjoa Haven were faced with a new challenge: a state-of-the-art facility without a fully qualified operator in the community.

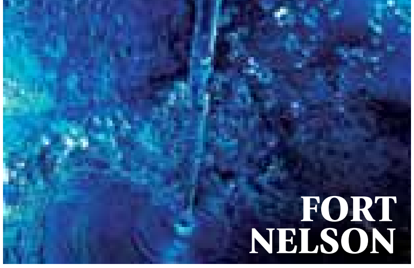
- Introduction to Water Treatment;
- Regulations, Guidelines and Codes of Practice;
- Water Sources & Characteristics;
- System Components;
- Disinfection;
- Operation and Maintenance;
- Operator Health and Safety.

Phase III

During the commissioning of the water treatment plant, Dillon personnel spent two weeks operating the treatment plant with Hamlet of Gjoa Haven staff (See Figure 5). Additional training is planned for 2007 to provide training in the areas of;

- Electrical systems and controls
- HVAC systems
- Trouble shooting
- Process system optimization

The overall response from the program participants was extremely positive. Gaining skills in math, science, and specific water treatment operation proved to be useful to the participants. All participants noted an increased knowledge in the theory, regulation, and practice of water treatment plant operation. In addition, the opportunity to network with other Community Works staff in the Region was a unique and invaluable experience.



AERATED LAGOONS IN THE CANADIAN NORTH – FORT NELSON, BC FACILITY

Introduction

Research on the application of aerated lagoons in the far north has been non-existent since facultative (non aerated) lagoons are the sewage treatment process of choice for most northern communities because of the cost effectiveness, simplicity of operation, and abundance of space available to most communities. This situation has been changing over the past decade as regulators have lobbied Water Boards and pressured communities to improve effluent quality by applying conventional "southern" mechanical technologies.

FIGURE 1:
Aerated lagoon system in northern Alberta near Fort McMurray.

This evolution has exhibited mixed results, with "new" mechanical systems operating in the northern communities of Fort Simpson, Rankin Inlet, Iqaluit and Pangnirtung. Although it may be said that these systems are generally operating in compliance with the water licence parameters, the communities are faced with a legacy of sustaining these processes with limited financial and human resources. New challenges are emerging for these communities because of the demands for managing the significant biosolids waste stream produced by the waste treatment process.

Interest in the application of aerated lagoon systems in the far north is gaining momentum, as regulators and senior governments recognize that this is appropriate technology based upon the successful operation of aerated lagoon systems in Alaska and the northern reaches of the provinces. The aerated lagoon system in Fort Nelson is one example of an aerated lagoon system operating in the near north, other examples include aerated lagoon systems operating in northern Alberta, near Fort McMurray (See Figure 1).

Aerated Lagoon Process and Configuration

The aerated lagoon is a fairly straightforward, easy to operate technology that has been successfully used in cold climates. In the past, there was a degree of resistance to aerated lagoons in the North, primarily due

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With background information provided by
Kriss Sarson, P.Eng., Government of the Yukon

to the higher energy costs and lack of appropriate cold climate aeration technology. Though higher energy costs are still a feature of operating costs in the North, aeration systems have been advanced sufficiently to allow for effective treatment in the North.

Throughout the past forty years, a number of process models have been advanced that describe the overall size and treatment efficiency of aerated lagoons. For the most part, they rely upon first order kinetics, and are therefore dependant upon the correct selection of the values for k and θ. For lagoon applications, the value of k can range from 0.14 to 0.3 and θ can range from 1.06 to 1.12. The size of the lagoon cells is also a function of the influent and effluent Biochemical Oxygen Demand (BOD) concentrations, along with the influent flow rate. Combined, these factors equate to the overall BOD load being "processed" by the lagoon.

FIGURE 2:
Fort Nelson aerated lagoon location.

The general configuration in an aerated lagoon uses a combination of completely mixed and partially mixed cells. A typical three cell aerated lagoon configuration is comprised of a completely mixed cell, followed by a partially mixed/plug flow cell, and then finally by a combination partially mixed/plug flow cell with a quiescent set-

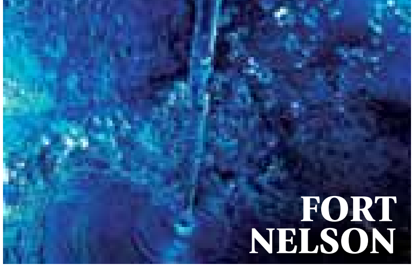


TABLE 1. Average Yearly Performance for Fort Nelson Aerated Lagoon

Year	Average % BOD_5 Removal	Average % TSS Removal
2000	79	86
2001	68	92
2002	82	86
2003	83	84
2004	83	81
2005	83	88
2006	88	90
Overall Averages	**81**	**87**

Other factors have to be considered with respect to the layout of the facility, such as subsurface conditions, site topography, ease of geomembrane liner application, and the treatment plant building layout.

In a conventional mechanical secondary wastewater treatment plants, aeration requirements are dictated by the process air requirements, not mixing requirements. However, in an aerated lagoon application, the opposite is true. The aeration for the lagoon cells is generally supplied by a fine bubble aeration system supplied by a defined number of process air blowers.

Performance of Fort Nelson Aerated Lagoon

The aerated lagoon system serving the community of Fort Nelson is an example of the successful operation of an aerated lagoon in a cold climate (See Figure 2). The average performance for the aerated lagoon over the past 7 years (2000 to 2006) has maintained BOD_5 and Total Suspended Solids (TSS) removal greater that 80 percent (See Table 1). Average effluent BOD_5 and TSS has been less than 25 mg/L for both parameters for the years 2004, 2005, and 2006; average effluent fecal coliforms have been less than 40,000 CFU per 100 mL (See Table 2).

TABLE 2. Average Influent and Effluent Quality for Fort Nelson Aerated Lagoon

Year	Influent BOD_5 mg/L	Effluent BOD_5 mg/L	Influent TSS mg/L	Effluent TSS mg/L	Influent FC CFU/dL	Effluent FC CFU/dL
2004	140	24	147	22	3.0×10^6	17.1×10^3
2005	115	19	197	22	2.9×10^6	37.4×10^3
2006	133	17	200	19	2.0×10^6	1.3×10^3

tling zone. The advantage of a three cell configuration versus a two cell system is process flexibility. It is advantageous to have the operating flexibility to take one cell out of service, while still maintaining effluent quality. This will become critical 20 or more years down the road, when cell de-sludging may be required.

The process concept of an aerated lagoon system allows for a significant portion of the organic load to be taken up in the first cell (completely mixed), so for this reason a slightly higher reaction rate constant may be applied to this cell, and a more modest one for the subsequent partially mixed cells. With this type of model there is a degree of variability, and the effluent BOD_5 values for each of the cells are approximated, along with the appropriate size of the cells.

TABLE 3. Average Winter Temperatures in Fort Nelson

	November	December	January	February	March
Average Temperature (degrees C)	-13.0	-19.9	-21.2	-16.1	-7.7

FIGURE 3:
Winter operation of Rae, NWT aerated lagoon research project.

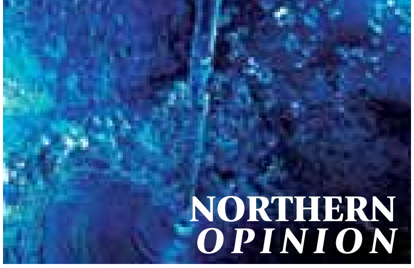
Independent aerated lagoon research by Environment Canada is also underway in the community of Rae, Northwest Territories.

Winter performance during the months of November through March (2000 to 2006) has produced a yearly average BOD_5 removal in the range of 70 to 93 percent, and a yearly average TSS removal in the range of 72 to 98 percent. The average winter air temperature is as low as -20°C (See Table 3).

Advancing Applications of Aerated Lagoons in the Far North

In 2004, Dawson City and the Government of the Yukon evaluated the application of aerated lagoon technology for producing a secondary non-toxic effluent compliant with the Fisheries Act, Water License and the Court Order. This work included a preliminary site selection and costing, along with an aerated lagoon pilot test. Initial sites were selected for a 3 cell system comprised of 2 aerated cells (15 day retention each) and one facultative cell (60 day retention). The pilot plant results confirmed that an aerated lagoon had the potential to produce a non-toxic secondary effluent without the need for a facultative cell. This work was advanced to the preliminary engineering of an aerated lagoon system to serve Dawson City, and design work may proceed in 2007, with anticipated construction to be completed by 2010.

Independent aerated lagoon research by Environment Canada is also underway in the community of Rae, Northwest Territories. The research is focusing on the application of submerged and surface aeration systems, and the performance of these systems during the winter months.



WATER FOR PEOPLE – SAVING THE WORLD, ONE DROP AT A TIME

• In the past ten years, diarrhea has killed more children than all the people lost to armed conflict since WWII.

• An estimated 1.1 billion people don't have access to safe water.

• 4,000 children die each day as a result of water-related illnesses.

• At any given time, half the world's hospital beds are occupied by patients suffering from water-borne diseases, including cholera, typhoid, dysentery, hepatitis, and giardia.

• Diarrhea alone kills over three million people per year.

• Women in developing countries walk an average of 6 kilometers per day to collect water, and carry an average 20 kilograms (44 pounds) of water on their heads!

Startling statistics, but what can you do about it? Guess what, you are doing something about it! By supporting the NTWWA's annual fundraiser you're helping Water for People improve the water supply and sanitation systems for thousands of people in Bolivia, Guatemala, Honduras, India and Malawi – some of the poorest countries in the world. Water for People works with partner organizations in these countries to help the local people plan for and build their own water and sanitation systems, develop the skills they need to operate and maintain those systems, and learn more about hygiene practices that help prevent the spread of disease. In 2006, Water for People improved the water supply or sanitation system for

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89,057 people, and the NTWWA was a part of that work!

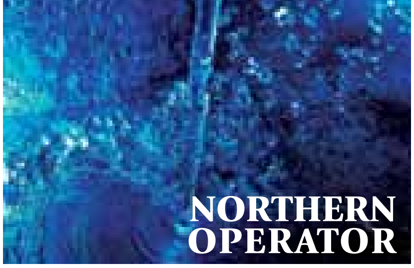
The NTWWA's first annual Water for People fundraiser, at the Conference in Inuvik in November 2004, was a great success! That year, we raised $425 selling raffle tickets for prizes donated by First Air, Canadian North, the Mackenzie Valley Land and Water Board, the Town of Inuvik, and tradeshow sponsors. Prizes included fleece jackets, hats, vest, T-shirts, and books.

In Rankin Inlet, November 2005, we tried skill-testing games, giving delegates a choice of tabletop NHL hockey shootout or Homer Simpson's Wheel of Fortune. Prizes included such things as goodie-filled mugs donated by Clear Artic Springs, Fisheries and Oceans Canada and others, but the big money-maker came in the form of a print from Pond Inlet donated by Peter Christou of Chimo Water and Wastewater Services Ltd. The print was auctioned off at the banquet, purchased by the NTWWA Board and given to our tireless administrator, Pearl Benyk.


Kim Philip (left) promotes "Water the People" at the NTWWA conference in Rankin Inlet.

In 2006, Pearl paid us back in full by organizing a silent auction for the Yellowknife conference. Pearl canvassed local artists and tradeshow sponsors to collect an assortment of valuable objects, ranging from original prints, paintings and sculptures to deep-cycle batteries and trips to Edmonton. Thanks to Pearl's efforts, our sponsor's donations, and to our delegate's support, the NTWWA raised a record $1,484 for Water for People! Not bad for our first three years!

We hope you'll support the 2007 fundraiser, and will take the time to learn more about Water for People by checking out their website at: http://www.waterforpeople.org/. There are lots of ways to get involved: you can sit on an organizing committee, pull together or support a fundraiser, raise awareness through the Water Buffalo's motorcycle ride, even go overseas to tour the project sites or help out through the new Water Corps program! Either way, I'd encourage you to get involved. It's an exciting organization that's doing great work, and they need your help!



EMERGENCY MEASURES ORGANIZATION EXERCISE IN NORMAN WELLS

A couple of years ago the Town of Norman Wells took part in an Emergency Measures Organization Exercise, in co-operation with the government of the NWT. The exercise included medical personnel, Esso Imperial Oil, the Volunteer Fire Department, as well as just about everyone else in town. The exercise was to get everyone informed, ready, and trained for a real emergency. It was a very informative procedure that gave invaluable experience and lessons for all involved.


Town of Norman Wells.

The exercise consisted of a hypothetical mid-air collision, a potentially real disaster for Norman Wells given the volume of air traffic, and the potential damage that could occur with a crash. In the disaster scenario, the 75 mm (3") gas main that delivers natural gas to the entire town was struck by a falling helicopter; the explosion that followed the crash damaged the main 200 mm (8") water supply line for the town. The explosion also damaged the water plant building, and caused the utilities operator, who was cleaning water testing equipment inside, to be severely injured by the chemicals he was using. As there was no procedure in the Town's Emergency Response Plan concerning an emergency at the water treatment plant, it took almost an hour for emergency personnel to find the injured worker.

To further complicate matters in the emergency scenario, the utilities manager was on vacation, so there were no other utility staff available to respond to the emergency situation. In response to the crash, Esso closed their gate valves on the gas main to prevent further damage and loss of gas. The Regional Environmental Health Officer was immediately called at Inuvik to help the town deal with the water emergency, and the utilities manager was contacted and requested to return to Town as quickly as possible. The injuries sustained by the utilities operator

By Sean Austen-Kempel, Utilities Manager,
Town of Norman Wells

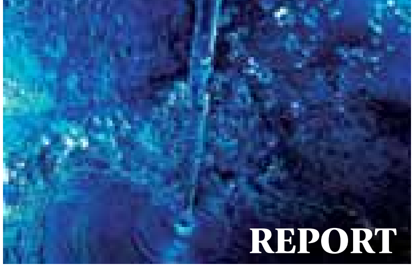
were treated at the Nursing Station, and included a wash with water to clean the chemical burns.

There are some great lessons learned through this exercise, and everyone involved took some invaluable experiences away from it. First of all, it was really a great demonstration of how important a utilities department is, and how vital water is in an emergency situation (firefighting, for example, and hydration for everyone involved). An outcome of this experience was the initiative of training more staff in the utilities department, and a realization of the need to have at least two staff in town at all times. It would be ideal to have two fulltime staff and two on-call trained staff for every water plant in the NWT.

Another important aspect of emergency planning is having written procedures for a variety of potential disaster scenarios. Emergency planning should include lists of contact names and numbers, as well the actions on how to respond to different emergencies. These Emergency Response Procedures should be understood by anyone who may have to deal with said emergency, and they should be posted in visible locations, such as on the wall above your desk at work.

It was also realized how important information sharing is amongst the emergency personnel in your community, and not just firefighters and nurses. All levels of community government have a role to play in emergency response. Of particular importance for a water treatment facility is information on the hazardous chemicals; copies of the WHIMIS documentation should be available to all emergency personnel. The distribution of this information should also be reviewed on a regular basis because of the high turnover in Nursing Stations and Fire Departments staff in northern communities.

The water plant in Norman Wells has taken positive action as a result of the mock disaster. The plant now has at least one backup distribution pump available at all times. This positive action also carried over to other parts of the utilities department with the realization of how important it is to have backup equipment and materials for all essential services. This is not to say that this was not already in place, but the mock disaster brought this need into the forefront of everyone's mind to create a more proactive approach to making sure these pieces come into place.



NTWWA 2007 PRESIDENT'S REPORT

HEATHER SCOTT, M.A.Sc., P.Chem.

Two territories, 3,500,000 square kilometers of land from Ellesmere Island to the Liard River Valley, and scattered throughout – a handful of communities that provide the same basic services of any large municipality: clean and safe drinking water, proper sanitation, and good solid waste management practices.

Separated by vast amounts of space with few road networks, communities of the NWT and Nunavut are municipal "islands" in the northern wilderness, so having an organization to bring together the water/waste industry in Northern Canada is of the utmost importance. The NTWWA does just that in two key ways: our annual conference and journal publication.

The NTWWA Annual Conference and Operators Workshop provides a forum to present and learn about the goings-on, challenges, and future of water and waste management in the north. The Operators Workshop, which traditionally appends the conference, provides both learning and networking opportunities for the trusty municipal staff that keep our water and waste systems flowing, so to speak!

You are currently reading our 3rd NTTWA journal, a showcase of the unique northern projects that most of us spend our days brewing over.

The 2006 NTWWA Conference was held in the metropolis of Yellowknife. Highlights included a close look on the Canada Wide Strategy for Municipal Wastewater Effluent, a key-note speech on Climate Change delivered by Bob Bromley, and an impromptu yoga session held by yours truly! The Operators Workshop organized by Ken Johnson was a hit, being chock full of field trips to Taiga Environmental Laboratory, Midnight Sun Bearing and Supply Limited, and the newly built water treatment plant in Behchoko, NWT. As a side note, the NTWWA is also proud to now have three operators on the 2006/2007 Board of Directors.

Enjoy the *Journal,* and we're looking forward to seeing you in Iqaluit for our 2007 Conference!

NTWWA 2007 EXECUTIVE DIRECTOR REPORT

OLIVIA LEE, B.A.Sc.

The 3rd annual publication of the NTWWA has arrived! The journal features a variety of articles relating to the fields of water, wastewater, and solid waste that the Association hopes you find interesting and informative.

The 2007 NTWWA annual conference, trade show, workshop, drinking water competition, and annual general meeting hosted in Yellowknife were extremely successful. The 2006 NTWWA Conference, held at the end of November, attracted 98 registered participants, including 12 trade show booths, who made the conference a great success. The 2nd annual drinking water competition was well received, and we look forward to continuing this friendly competition in the year to come. As the conference location alternates between Nunavut and the Northwest Territories, the next conference will be held in Iqaluit. Reserve the 3rd to the 5th of November for the NTWWA Conference on your calendars now!

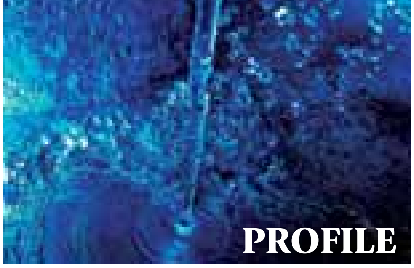
Key goals and objectives of the NTWWA are the production of the Journal, and the Annual Conference. With these 2 key goals and objectives in mind the NTWWA Board of Directors works hard to fulfill its mandate. The Northern Territories Water & Waste Association's mandate is:

- The advancement of knowledge in the design, construction, operation, and management of water works, wastewater treatment and disposal works, and solid waste site works;
- The encouragement amongst its members of a friendly exchange of information and experience in an effort to continuously improve the provision of water and sanitation provided to the public; and
- The improvement of the professional status of all personnel engaged in any aspect of the provision of water and sanitation services to the public.

The Board meets once a month via conference call to discuss administration, training courses, and regulatory change and its impacts on northern communities. As a Board we strive for diverse representation. The NTWWA Board members bring with them different expertise in operations, consulting, design, supply, government, or combined experiences as they relate to the water and waste field.

I would like to thank the NTWWA Board of Directors for allowing me the opportunity to work with them as their Executive Director. The experience has been great and I look forward to working with the Board throughout the upcoming year. Unfortunately, this year the Association said goodbye to several dedicated Directors with a wealth of knowledge and experience, and I would like to take this opportunity to thank them on behalf of the Association for their hard work throughout their term(s). At the same time, the Association has welcomed many new energetic, enthusiastic Directors with new experience and knowledge to the Board, and we look forward to working with them to fulfill our mandate. Special thanks are due for the efforts of President Heather Scott, past President Bryan Purdy, and the Journal's technical editor Ken Johnson. This Association also owes thanks to Pearl Benyk, our administrator.

I'm looking forward to meeting new people and seeing some familiar faces at this year's conference in Iqaluit. Enjoy the read.



WCWWA 2007 DIRECTOR'S REPORT

KEN JOHNSON, M.A.Sc., P.Eng.

The NTWWA has maintained a successful, and independent existence "North of 60" for many years, drawing upon an enthusiastic, but limited group of water and waste practitioners from across the north. Although we have always recognized that we were unique because of our geography, there has been an underlying sense of isolation – but this is no more.

Near the end of 2006, the Board of the NTWWA made the ground breaking decision to become a Constituent Organization of the Western Canada Water and Waste Association (WCWWA), joining similar organizations from Alberta, Saskatchewan and Manitoba. The WCWWA was founded in 1948 to promote the exchange of knowledge of water treatment, sewage treatment, distribution of water and collection of sewage for towns and cities in Western Canada – a mandate that is essentially the same as the NTWWA, just located a few degrees of latitude to the south. The NTWWA is now part of a larger organization that has approximately 4,000 members who work in this industry, and for the cities, towns, and governments in Western Canada.

The WCWWA provides conferences, seminars, training books, and a magazine to promote communications and training in the municipal water and sewage industry in Western Canada. In fact, members of the NTWWA have been taking advantage of the WCWWA activities for many years, with attendance at the annual WCWWA conference, and training activities.

Our association with the WCWWA comes at a very exciting time for the WCWWA organization, with a "branding" process underway to review the services to members, and the delivery of services. We are essentially providing an opportunity for the WCWWA to redraw the map of the area of Canada where their Constituent Organizations reside – the NTWWA brings almost 40 percent of Canada's land mass to the organization.

NTWWA members will have already received the summer issue of the Western Canada Water magazine, and noted a very gracious welcome, and the extensive coverage of our new association with the WCWWA. We are looking forward to a strong contributing involvement with the WCWWA, the opportunity to expand the services to our members, and expand our exposure "South of 60."

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