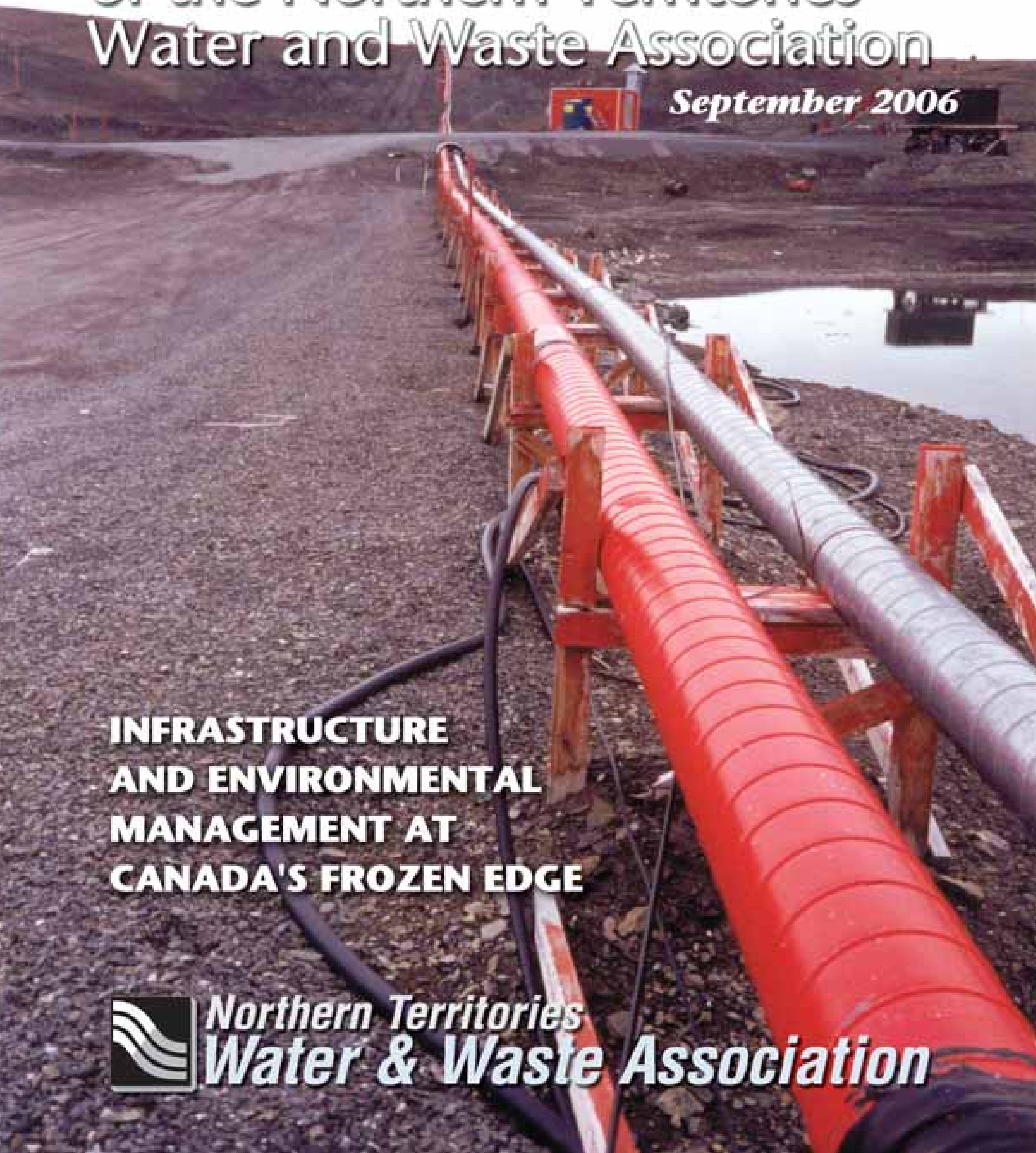
Journal of the Northern Territories Water and Waste Association

September 2006



INFRASTRUCTURE AND ENVIRONMENTAL MANAGEMENT AT CANADA'S FROZEN EDGE

Northern Territories Water & Waste Association

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Northern Territories Water & Waste Association Journal

In this issue

FEATURES

MESSAGE

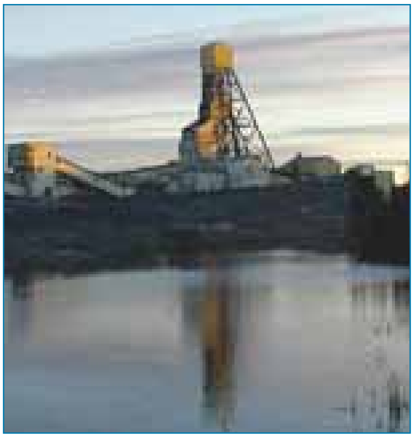
From the Editor
PADDY O'TOOLE

In anticipation of the Northern Territories Water and Waste Association's (NTWWA) Annual Conference, Trade Show & Workshop, scheduled for November 25-27 in Yellowknife, NWT, we are pleased to present this issue of the *NTWWA Journal*. Attendance at last year's Conference was an all time record, and it is hoped that the bar will be raised even higher this year.

On the page opposite is a summary of what to expect at the Conference, and the website address for registration – please visit the site and be sure to register early.

This issue, as always, contains a number of case studies and new approaches for dealing with the many water and waste management problems that are peculiar to our harsher northern climate. As populations grow and communities expand, the challenges to deal with the growing demands for services, while maintaining our pristine northern environment, are difficult ones. However, new approaches, technologies, and methodologies are being developed to accomplish this. By disseminating these approaches to you, we hope to share the growing knowledge pool of the Association. Should you be curious about any of these new innovations, then please plan to attend the Conference in Yellowknife, where you will have the opportunity to explore them at length.

Northern Territories Water & Waste Association



FIRST ANNOUNCEMENT

Annual Conference, Trade Show & Workshop
Yellowknife, NWT, November 25, 26 & 27

WHY ATTEND?

The NTWWA continues to demonstrate that our annual conference, trade show and workshop is the premier opportunity in Nunavut and the NWT for water and waste water practitioners to stay informed on activities and trends in the water and waste field. The Rankin Inlet event attracted close to 100 participants, setting an all time record for participation.

It is expected that this year's event will attract over 130 operators, engineers, regulators and suppliers from across northern and southern Canada. It will be a great opportunity for all participants to share experiences and information, take in over 20 quality presentations, and enjoy the fine hospitality our host, Yellowknife, has to offer.

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.

WORKSHOP

The NTWWA Operator's Workshop is a significant opportunity for operators to meet and take in a variety of presentations on the operation of northern water and sewer systems.

The Workshop will follow the conference on November 27, and present "hands-on" sessions with great practical information for operators; operators can earn 1 Continuing Education Credit for attending the workshop. Facility operators can also earn 1 Continuing Education Credit for attending the conference, as a way of maintain certification.

REGISTRATION

*Registration will be coming out in September, so visit **www.ntwwa.com** to keep updated.*

CANADIAN FORCES STATION ALERT:
INFRASTRUCTURE AND ENVIRONMENTAL MANAGEMENT AT CANADA'S FROZEN EDGE

Sign post at CFS Alert.

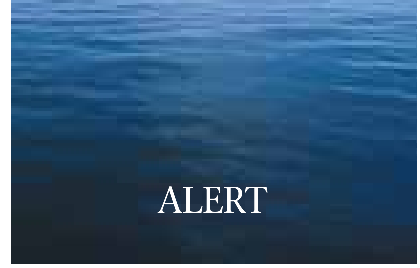
The start of the engines of the Hercules aircraft creates a vibration and noise that becomes very familiar over the day and a half of travel north to reach Canadian Forces Station (CFS) Alert, at the northern tip of Ellesmere Island. Not until landing in Alert does one come to realize that the only thing that lies between Alert and Santa's home is 800 kilometres of permanent ice pack. Edmonton, Alberta, the closest major Canadian city, is 3,500 kilometres to the south, while Stockholm, Sweden is a mere 3,200 km away.

CFS Alert is the most northern permanently inhabited settlement on the globe, situated at 82 degrees, 30 minutes north latitude, and 62 degrees, 19 minutes west longitude. Alert was first settled in the early 1950's as a weather station, and was followed by the establishment of a Canadian military station in 1958.

From early April to early September the sun never sets on Alert, and from early October to early March the other extreme occurs, and there is no direct sunlight. During the summer months Alert experiences 28 frost-free days on average, and an average daily high temperature of 10 degrees Celsius. The record high temperature for the station is 20 degrees Celsius, while the record low is -50 degrees Celsius.

The terrain in the vicinity of CFS Alert is rugged with undulating hills. The ocean pack ice remains close to shore during the short summer, and is continuous from shore to horizon in winter. The permafrost at the station thaws only to a maximum of one metre during the course of the summer.

Transportation in and out of Alert relies solely upon aircraft, and in particular, the C130 Hercules. Alert has one regularly scheduled flight each week from Canadian Forces Base Trenton, which is 4000 kilometres to the south. The Herc is an amazingly



ALERT

by Ken Johnson, MCIP, P.Eng.
Senior Engineer and Planner, Earth Tech Canada
Edmonton, AB

Canadian Forces Station Alert – view from airport.

Water and sewer pipe storage area.

transportation workhorse that not only airlifts the weekly supply of perishable essentials for the station, but also airlifts for the entire wet (fuel) and dry (all other materials) resupply for the station. This includes the building materials for the extensive water and sewer infrastructure that serves the station. The resupply is completed during the fall of each year, which requires round trip flights from the Thule Airbase 600 kilometres to the south in Greenland.

Transportation around the station makes use of a variety of wheeled and tracked vehicles, on a limited length of roads. The most significant roads provide access to the water supply, 4 kilometres from the base, and the

From early April to early September the sun never sets on Alert, and from early October to early March the other extreme occurs, and there is no direct sunlight.

atmospheric observatory operated by Environment Canada. Vehicles are kept running 24 hours per day during the winter months in order to minimize vehicle freezing problems, and wheel blocks are used instead of emergency brakes .

Characterization of abandoned barrels.

An evolution in the station transportation has been the conversion to a common fuel (JP8) for all engines on the station, including the power supply generators. This simple change in operations has greatly improved the waste management practices for the station by accommodating bulk fuel supply for the majority of the base operations and reducing the need for fuel supplied in barrels.

CFS Alert, like many northern facilities, has suffered from the accumulation of thousands of fuel supply barrels over its operat-

Water and sewer piping network around buildings.

Potable water for the station is pumped four kilometres from Dumbbell Lake in an above ground insulated high density polyethylene water line...

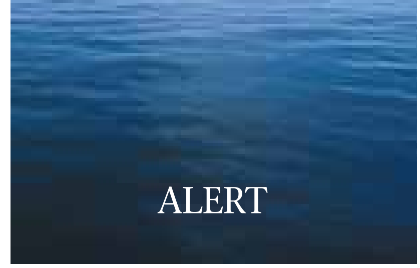
Raw water supply line and recirculation line from Dumbbell Lake.

ing life. The use of barrels presents problems for resupply, organization on site, and management of old barrels, many of which are partially full and poorly marked. The transition to a common bulk fuel on the station has reduced the resupply and organization problems, and a program to catalogue and appropriately dispose of the old barrels and their contents has reduced the problem of managing old barrels.

Waste management creates its own set of unique challenges for the CFS Alert.

Potable water for the station is pumped four kilometres from Dumbbell Lake in an above ground insulated high density polyethylene water line with a smaller recirculating water line. The three water intake points in Dumbbell Lake are positioned well below the thick ice which forms on the lake. The water is chlorinated and stored in two 50,000 gallon storage tanks in the water building, and the water is distributed above ground throughout the station with an independent piped recirculating system. A labyrinth of above ground piping circulates between buildings throughout the entire station.

Waste management creates its own set of unique challenges for the CFS Alert. The station is served with an insulated high density polyethylene gravity sewer which dis-



Sewage discharge into natural lagoon near CFS Alert.

Solid waste bundled for deposit in incinerator.

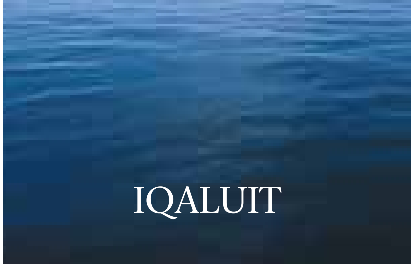
Incinerator at CFB Alert.

charges into a natural lagoon open to the ocean. The solid waste management program for the station has a segregation program to employ either recycling for transportation south, or incineration at the station. A landfill is still utilized for the incineration residuals.

Communication is another critical aspect of the station's operation and survival. Since global communication satellites are too far below the horizon at Alert, a six station ground based microwave system must be used to relay the communication signals to a latitude where satellite uplink is possible. Eureka, a station 400 km to the south of Alert, plays this critical role as a communications centre for the high arctic. Eureka is also known for its abundance of wildlife, including arctic wolves that are bold enough to stand up to a Twin Otter aircraft.

Canadian Forces may occasionally joke that is the Russians who justify the presence at Canada's frozen edge; however this threat has significantly decreased since the end of the Cold War. The Canadian military at CFS Alert, in addition to their communications research, are in fact asserting Canadian sovereignty to the world's most northerly inhabited place.

Arctic wolf challenges Twin Otter at Eureka station.



NORTHERN OPERATOR:

INNOVATIVE SOLID WASTE MANAGEMENT IN IQALUIT, NUNAVUT

INTRODUCTION

Community landfills are certainly not normally considered the "high" point of any community tour, and very few people come to town just to look at the landfill (members of NTWWA excluded), but an exception should be made in the case of Iqaluit, Nunavut. Landfills in Iqaluit have a very interesting history, and the Nunavut Water Board Hearings in March, 2006 certainly highlighted the trials and advancements that solid waste management in Iqaluit has made in the past decade. At the centre of these advancements in the landfill is Darcy Reist, the landfill foreman, who has demonstrated a tremendous amount of innovation in his management of the landfill over the past 5 years.

Darcy's innovations have not only included the overall management of the landfill, which has been redeveloped to accommodate no-burning operations in 2001, but also waste diversion practices that are uniquely northern in their context.

BACKGROUND

The City of Iqaluit's Solid Waste Collection and Disposal system consists of 2 garbage trucks, a solid waste disposal area, 5 collection staff and 3 landfill staff. The landfill staff operates a dozer, a compactor, a loader and a shredder in the day to day landfill operations.

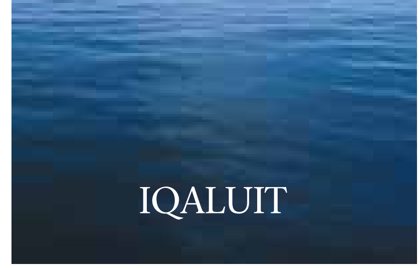
The City produces approximately 10,000 cubic meters of compacted waste, which enters the landfill each year, and includes residential, commercial and industrial wastes. Recycling is currently limited to the collection and diversion of aluminum cans; the practical restraints imposed by location and cost make any additional product recycling impracticable at the present time.

Application of mulch cover material in active area of Iqaluit landfill.

Community landfills are certainly not normally considered the "high" point of any community tour...

The City's landfill operation uses the area method, which involves placing waste above grade against a berm, compacting the waste using a wheeled loader, and covering the waste using a mulch material. The waste is covered once per day during the summer and once per week during the winter months. The City utilizes a "Shred Max" to create the mulch cover material from selected construction waste, and other municipal waste.

The City's landfill includes a hazardous waste management area; the dedicated site consists of 5 sea-lift containers for storage of hazardous waste. Only household hazardous waste is accepted at the landfill, which is separated from the main waste stream and stored in sealift containers for future shipping south to a disposal facility.



by Darcy Reist, Landfill Foreman, City of Iqaluit, NU
with introduction by Ken Johnson

Shredder for wood waste processing.

DIVERSION OF WASTE FOR USE AS COVER MATERIAL

The City of Iqaluit landfill staff has taken significant steps in attempting to reduce the amount of waste entering the existing operational cell. The shredding of waste was identified as a significant volume reduction measure, as the resulting mulch may be used as a waste cover material. The amount of waste deposited at the City's landfill, which is available for reuse as cover material, is approximately 20% of the total annual volume. This waste for reuse consists mainly of select construction debris, furniture, cardboard and plastic. The waste is segregated from the general waste stream and stockpiled in a specific area of the landfill. Some initial processing of the waste is completed by limited compaction in preparation for loading the material in the 120 hp Shred-Max shredder.

Once these materials have been properly shredded, the material is once again stockpiled in preparation for use as landfill cover material, local road building (within landfill) and berm reinforcement during the winter months.

IQALUIT

Stockpile of wood waste.

COMPOSTING OF SEWAGE BIOSOLIDS

The City of Iqaluit landfill facility is pursuing the diversion of sewage biosolids from the newly commissioned municipal wastewater treatment plant. The management of biosolids in the north represents a new challenge to communities because mechanical treatment systems are relatively new to the north, and biosolids are a material that presents a public health and environmental hazard. The plan is to dry the solids throughout the long winter making use of the Iqaluit's cold and dry weather winters, and compost the dried solids during the short warm summers producing a cover material for the landfill. The outcome that makes this process so attractive is that the finished material will be non-hazardous, and will reduce the use of precious granular material at the landfill.

Sewage sludge freeze/thaw process.

This innovation follows in the steps of groundbreaking work by the Bill MacKenzie Humanitarian Society, which proved that composting is feasible in Iqaluit. Unfortunately the composting of household organics was not a financially viable solution for the City at this point in time. The innovation has captured the attention of the Federation of Canadian Municipalities, which is considering a grant application from the City for equipment and testing.

SITE EXPANSION AND DRAINAGE MANAGEMENT

The landfill expansion has been an expected part of the continuing operation of the existing site for the past 6 years, and the implementation of the expansion is an absolute necessity to properly manage the site. With the expansion comes the necessity to manage the runoff in and around the site in order to minimize the impact of contaminated runoff that is inherent to any landfill operation.

Once again, innovation is coming forward from the City with the consideration of wetlands to provide "treatment" to the runoff before it is discharged into the environment. Wetland treatment systems have been applied to municipal wastewater treatment for the past decade, but landfill runoff has not been considered in the application of this process. Regulatory scrutiny and incremental improvements by the communities has made landfill runoff treatment a new priority for water licence compliance.

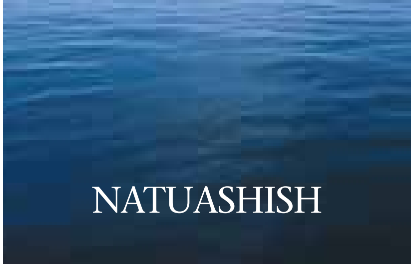
In recognizing this need, the City is looking at the opportunities to apply this technology, which will not only provide an economical solution to their own challenges, but also provide a potential solution for landfills across Nunavut.

The City is not only responding to the current needs of the community, but is also committing to solid waste planning for the future.

Landfill berm constructed of wood waste – Darcy Reist in foreground.

CONCLUSIONS

The City of Iqaluit has taken significant steps to improve its waste management practices over the last decade. The City is devoted to being environmentally responsible, and compliant with the regulatory requirements of the various local, territorial and federal agencies. The City is not only responding to the current needs of the community, but is also committing to solid waste planning for the future. The existing and proposed innovations in solid waste management have demonstrated that the City of Iqaluit intends to lead the way in waste management for the communities of Nunavut.

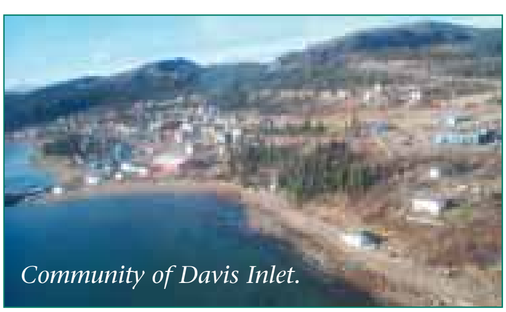


DEVELOPMENT OF THE WATER AND SEWER SYSTEM, NATUASHISH, NUNATSIAVUT

The Mushuau Innu (People of the Barrens) settled in Utshimassits (Davis Inlet) on Iluikoyak Island, Labrador in 1967. The circumstances surrounding their settlement are unclear, however, Davis Inlet proved to be an unsuitable site for a permanent community. The Mushuau Innu were unable to access productive hunting, fishing and trapping grounds on the mainland for some five months a year during the freeze-up and break-up of the ice, and the virtual absence of alternative economic activities resulted in a very rapid decline of the socio-economic fabric in the following years.

For many years the Mushuau Innu sought a better community and life and in the early 1990s the idea of relocating to a place known to the Innu as Natuashish was revived. In 1993, the Mushuau Innu, at a population of 500, voted overwhelmingly in a community referendum to relocate. Natuashish was to be constructed on the mainland of Labrador, approximately 15 km west of Davis Inlet at a traditional hunting, fishing and trapping site of the Mushuau Innu.


Natuashish community.


Community of Davis Inlet.

Natuashish was to be constructed on the mainland of Labrador, approximately 15 km west of Davis Inlet at a traditional hunting, fishing and trapping site of the Mushuau Innu.

Between 1992 and 1995, the Mushuau Innu, in collaboration with the Department of Indian Affairs and Northern Development ("DIAND") conducted over 40 technical and socio-economic studies. In November 1996, the Mushuau Innu, Government of Canada, and Government of Newfoundland and Labrador signed the Mushuau Innu Relocation Agreement ("MIRA") to relocate the Mushuau Innu from Davis Inlet to Natuashish, a community yet to exist. Design and construction began in 1997, with the new community including many project elements: community and service roads, water and sewer system, airport, wharf, power generation and distribution system, fuel transfer and storage system, telecommunications system, landfill, housing, school, nursing clinic, band council office, store, school, fire hall, maintenance garage, police station, and recreation facilities.

Municipal servicing for Natuashish was initially studied as early as 1992 via a feasibility study that compared the redevelopment of Davis Inlet to construction of a

by Roger Butt, P.Eng., AET, Project Engineer
Rutter Engineering and Automation Inc.,
Clarenville, NL

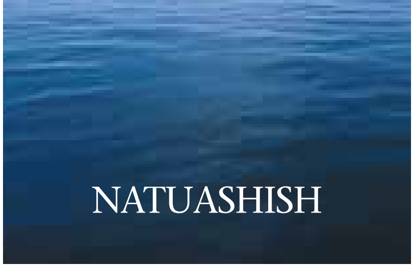
Site plan of Natuashish infrastructure.

new community. Once the latter alternative was chosen, numerous studies were commenced to further evaluate and define the new community, including community planning, heritage, archaeological, geotechnical, environmental, mapping, etc. A detailed municipal services study was completed in 1995 and included the development of design criteria, field programs, correlation with other studies and evaluation of alternatives, culminating in recommendations for water supply and distribution, as well as sewage treatment, collection and disposal. Establishing design criteria was critical for evaluating alternatives, as well as future concept and detail design.

A review of published, recommended and empirical data was undertaken with the objective of determining population forecasts, water supply demand and sewage flow rates.

Population projections were completed using multiple models that accounted for the three (3) components of population growth: fertility, mortality and migration. From this a 20-year population forecast of 1100 persons and a 50-year forecast of 2300 persons was projected.

Water supply demand and storage design criteria included an assessment of domestic demand and fire protection. Domestic demand recommendations included 225 litres/capita/day (L/c/d) for consumption, a maximum day factor of 2.5, and a peak hour factor of 4.0. The long-term capacity of the distribution system was recommended to be 60 litres/second (L/s), and the 20-year and 50-year storage requirements were recommended to be 340,000 litres (L) and 810,000 L, respectively.



NATUASHISH

Raw water pumphouse.

Sewage treatment facility selection and design was based on the recommended hydraulic and organic loading. The 20-year design criteria was 247,500 litres/day (L/d) for hydraulic loading ("Q"), 82.5 kilograms/day (kg/d) for 5-day biochemical oxygen demand ("BOD_5"), and a suspended solids loading ("SS") of 99.0 kg/d. 50-year values were recommended to be a Q of 517,500 L/d, BOD_5 of 172.5 kg/d and a SS of 207.0 kg/d.

Field programs conducted over the summers of 1994 and 1995 were utilized to review pipeline routes, reservoir/plant location and sewage lagoon sites. Tasks included surveying, soundings, water sampling, water surface profiling, boreholes, test pitting, soil sampling, installation of piezometers and percolation tests. As a result of these tests, in concert with the balance of studies being undertaken, the final layout of major project elements was completed.

Evaluation of potential sources for a water supply considered groundwater and surface sources. The analysis considered geological data, water quality, salt water intrusion, drainage area, ice flow, flow rates, etc. Ultimately, the water supply included an intake from Sango Brook, located approximately 800 m upstream from Little Sango Pond. Water was to be extracted from the river via a sheet pile intake channel, two (2) deep-buried intake pipes approximately 100 metres (m) long, and a booster station consisting of a concrete wet well and pumping system. The water is pumped 4 kilometres (km) via a 200 millimetres (mm) waterline to the treatment plant.

Sewage collection is achieved via a conventional gravity sewer system. The sewers are buried at a depth between 2 and 4 m at a minimum grade of 0.5 percent.

Results of water sample analysis, evaluation of design criteria, as well as a pilot project, were used to evaluate potential plant designs and treatment methodologies. Treatment and storage is provided by slow sand filtration and an in-ground reservoir. Disinfection is provided by chlorination, with the plant being located at a site whose elevation facilitates gravity feed to the community.

From the treatment plant the water is distributed via insulated watermains of 150 mm and 200 mm diameter, buried to a depth of 3 m. Freeze protection is provided by heat tracing and recirculation, with additional heat added from a waste heat recovery system at the community's generating station. Under normal operating conditions, the heat-tracing is not activated. Freeze protection for individual house services is provided by conventional electric heat trace cables.

Sewage collection is achieved via a conventional gravity sewer system. The sewers are buried at a depth between 2 and 4 m at a minimum grade of 0.5 percent. The sewers and manholes are insulated, but not heat traced. A total of five pumping stations were required for the 20-year design.

The sewage treatment option selected was a facultative lagoon located in an area of poor drainage east of the community

Water treatment plant.

Sewage lagoon.

site. The design consists of a two (2) cell lined lagoon with each cell designed for one year's storage of the average daily sewage flow. The land area required for the 20 year design was approximately 17 hectares (ha).

Design and construction of the water and sewer system took place from 1997 to 2002 and was completed via multiple contracts in concert with other project elements. The Mushuau Innu relocated to Natuashish during the winter of 2002/2003. The cost of the new community was approximately $152 million.

CORAL HARBOUR

PERFORMANCE OF A TUNDRA WETLAND SEWAGE TREATMENT SYSTEM IN CORAL HABOUR, NUNAVUT

Berm structure of Coral Harbour sewage lagoon.

INTRODUCTION

In addition to their ecological and aesthetic qualities, wetlands provide a variety of benefits to Canadians, including the treatment of municipal and industrial wastewaters. Wetlands are defined as lands which are seasonally or permanently inundated by shallow water. There are different types of wetlands, depending on whether they are naturally occurring or have been created or constructed for a specific purpose (i.e. wastewater treatment, habitat). Natural wetlands are prevalent throughout northern Canada.

The large number and wide distribution of wetlands in the north provides significant benefit opportunity for northerners. Wetlands can provide a natural, reliable and effective means of filtering, cleaning and detoxifying wastewaters. Wetland treatment systems are also economically attractive in comparison to other wastewater treatment systems, such as mechanical treatment or conventional lagoon treatment. Additionally, once operational wetlands do not require skilled operators or maintainers, some times a challenge to find and retain in remote communities.

CORAL HARBOUR WASTEWATER SYSTEM

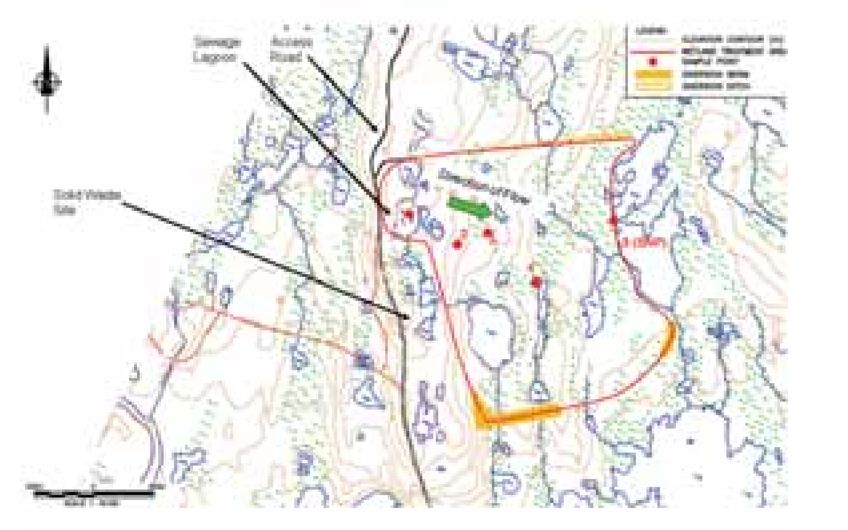
Coral Harbour is located on the southern coast of Southampton Island in northern Hudson Bay. The population was estimated at 845 in 2000 and is expected to grow to 1376 by 2020. Economic activities in the Hamlet are primarily limited to renewable resource harvesting, tourism, arts and crafts, and provision of public services. Potable water is pumped from a lake to a storage reservoir in the community where it is transferred into trucks for distribution to individual buildings. Wastewater is removed by truck from holding tanks in each building for disposal in the wetland.

Historically, the Hamlet's sewage trucks discharged wastewater at an open disposal area approximately 3 km north of the community. The effluent flowed from this dumpsite east across the tundra wetland, eventually reaching the ocean approximately 3 kilometres (km) away. Previous investigations between 1994 and 2002 concluded that the tundra wetland was effectively treating the wastewater and could meet long-term treatment requirements. In 2002, the community received its first ever Water Licence, which stipulated effluent quality criteria to be met in the discharge from the last point of control in its sewage treatment system (which at the time was the discharge from the sewage trucks). In an attempt to provide treatment within a controlled system, thereby achieving licence compliance, a detention cell with a controlled discharge

CORAL HARBOUR

by Brian Purdy, P.Eng., Municipal Planning Engineer,
Kivaliq Region, Government of Nunavut, Rankin Inlet, NU &
Nick Lawson, Area Manager, Jacques Whitford Limited, Yellowknife, NWT

The large number and wide distribution of wetlands in the north provides significant benefit opportunity for northerners.



structure was constructed in 2003. However, the cell berms have since proven to be permeable so the "last point of control" remains the truck discharge. As was the case previously, discharge from the sewage truck does not meet the effluent quality standards.

INVESTIGATION OF WETLAND APPLICATION

The investigation of the wastewater treatment system focused on three main issues: status of the detention cell; effect of landfill leachate on wetland performance; and, current and future treatment performance of the wetland.

Visual inspection of the detainment cell 2003, 2004, and 2005 confirmed that wastewater was leaking out from beneath and through its north, east and southern berms. A geotechnical investigation identified that there were insufficient fines within the granular material to provide an impermeable barrier. Options to repair the existing detention cell berms to meet design objectives were considered too costly, especially given that previous evidence suggested that the tundra wetland was effective in meeting current and future treatment requirements.

The community's solid waste facility is located approximately 150 metres (m) south of the detention cell. Leachate from the northern portion of the solid waste site was observed flowing into the wetland in 2004 and 2005. Analysis of water samples from


Wetland area adjacent to sewage lagoon.

Effluent samples were collected throughout the wetland in 2004 and 2005.

within the wetland confirmed that some metals were present in concentrations greater than allowed under the CCME Guidelines for the Protection of Aquatic Life.

The routing of wastewater flows through the wetland was investigated to determine both treatment area and performance. Wastewater flows were observed to travel in an east and southeasterly direction through a combination of overland and subsurface flows to the entrance of a large pond, before flowing to a larger lake and eventually reaching Hudson Bay. Using the discharge from the wetland into the large pond as the boundary of the wetland, the treatment area is estimated at approximately 10.5 hectares. With estimated organic loads of 6 to 15 kilograms/hectare/day (kg/ha/d) and hydraulic loads of 104 to 168 (cubic metres/hectare/day (m^3/ha/d) from the wastewater, the wetland appears to be within design loading recommended by Dillon's (1998) study of sewage treatment by wetlands.

Effluent samples were collected throughout the wetland in 2004 and 2005. Field analyses of samples collected in 2004 demonstrated that ammonia nitrogen was reduced to trace quantities within 250 m downstream of the detention cell, implying biochemical oxygen demand (BOD), and total suspended solids (TSS) removal were also high. Laboratory analyses of the samples confirmed field observations: that the tundra wetland was capable of achieving compliance with both existing effluent quality criteria and the anticipated requirements of the Canada Wide Strategy for Municipal Wastewater Effluents (CCME CWS for MWWE). Additionally, analysis of samples collected at the discharge from the wetland indicated that the treated water was non-toxic to fish. Additional effluent samples collected in 2005 demonstrated compliance with existing and anticipated wastewater treatment parameters.

The results of the 2004 and 2005 effluent sample analysis are in accordance with the conclusions of previous investigations, which suggested the existing tundra wetland provided adequate treatment to, and even beyond, the regulatory standards. However, further investigation of the wetland is required before a formal application to incorporate the wetland as part of the community's sewage disposal facility is required. A better understanding of the flows and concentrations of wastewater parameters during the annual spring melt is also required. Additionally, a more detailed topographic analysis of the wetland is required to confirm the need for and location of flow attenuating berms to prevent wastewater from traveling south towards the community at different times of the year. Finally, additional samples from throughout the wetland will be collected to provide further


Sampling from wetland area adjacent to lagoon.

data for analysis and substantiate incorporation of the tundra wetland under its next Water Licence.

CONCLUSIONS

The tundra wetland at Coral Harbour has successfully treated the community's wastewater for over 20 years. While the detention cell constructed at the head of the system in 2003 was intended to provide for settling of solids and pre-treatment prior to an annual release, its failure to detain wastewater has not prevented the tundra wetland from achieving compliance with existing and anticipated effluent quality criteria. With further analysis in 2006, it is expected that the community will apply to have the tundra wetland recognized as part of the sewage disposal facilities in its next water licence.

REFERENCES

Dillon Consulting Limited. 1998. "Sewage Treatment Using Tundra Wetlands." Prepared for the Department of Municipal and community Affairs, Government of the NWT.

Government of Nunavut. 2000. "Nunavut: Community Population Projections 2000 - 2020". Nunavut Bureau of Statistics, Iqaluit, Nunavut. (www.stats.gov.nu.ca)

Jacques Whitford. 2005. "Study of the Wetland Sewage Treatment Area, Coral Harbour, Nunavut". Prepared for the Department of Community and Government Services, Government of Nunavut.

Finally, additional samples from throughout the wetland will be collected to provide further data for analysis and substantiate incorporation of the tundra wetland under its next Water Licence.

DESTRUCTION BAY

APPLICATION OF BURNING VESSELS FOR SOLID WASTE IN DESTRUCTION BAY, YUKON

Burning in northern communities remains a common sight.

INTRODUCTION

The practice of burning garbage is currently an integral part of waste management in rural Yukon. Other than the strictly landfill operations in Whitehorse, Haines Junction, Dawson, and Carmacks, all Yukon communities use some form of burning to manage their garbage. The historical practice has been to place the waste in trenches, burn it, and then cover the trenches. This "burn and bury" method allows for a significant reduction in the volume of waste, to about 15% of its original volume. This extends the life of the landfill site and reduces equipment operating times, making it more economical than a sanitary landfill both in capital and operating costs.

However, the toxic emissions from burning garbage, while difficult to quantify, pose a significant risk to public health and the environment. Studies have suggested that the dioxin and furan emissions from a landfill burning may be very high. This adds some argument that that the Yukon should consider the possibility of a ban on the open burning of garbage.

ALTERNATIVE STRATEGIES TO CONVENTIONAL BURNING

Eliminating the burning of municipal solid waste in the Yukon would require significant increases in capital, and operation and maintenance spending. Under the current waste management strategy this would certainly be the case, but it is certainly not impossible to eliminate burning, and there are alternative methods to account for the extra cost. Whitehorse, Haines Junction, Dawson, and Carmacks have all ceased burning of domestic waste; this was accomplished through intentional investment and the establishment of waste diversion programs.

Whitehorse, for example, has a well-established private recycling sector, and the City operates a large scale composting service. Carmacks opened a new landfill site to accommodate the extra garbage resulting from a burning ban. Haines Junction has purchased a compactor system at a cost of C$ 98,000.00, allowing the community to compress its garbage and extend the life of the landfill.

Incineration has been applied as a cleaner, more efficient method of waste disposal compared to open burning, but at a cost of millions of dollars. The high-efficiency incinerator used by the City of Skagway, Alaska had a capital cost of about US$2.3 million (1998), and the community spends about US$50,000 per year on fuel, in addition to staffing 1.5 operators. While incineration is certainly cleaner and more efficient than open burning, many communities like Skagway have found that it

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with contributions by
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and Pat McInroy, Government of Yukon

Open burning in a northern solid waste disposal site.

Large burning vessel configuration.

Small burning vessel configuration.

requires a large capital investment, high operation costs, a large amount of garbage, and constant supervision by skilled operators.

It is estimated that paper and other organics make up about 65% of the waste stream in the Yukon. If every residence in the Yukon used a backyard composter, it is conceivable that landfilled waste could be reduced by half.

PUBLIC EDUCATION

Ultimately the most important option for waste reduction is public education. It is estimated that paper and other organics make up about 65% of the waste stream in the Yukon. If every residence in the Yukon used a backyard composter, it is conceivable that landfilled waste could be reduced by half. Another worthy target of public education campaigns is recycling participation. Recycling programs are becoming increasingly accessible in the Yukon, but people need to use this service if it is going to make a difference. The authorities responsible for waste management in each community may encourage residents in rural areas to make use of available recycling programs, adjusting their disposal practices in accordance with a realization of the quantity of recyclable material they normally throw away. According to a 1995 waste management report, plastics, glass and metals make up 25% of the waste stream by weight.

DESTRUCTION BAY BURNING VESSEL

There are a number of ways to increase the efficiency of open burning, mostly by increasing the available airflow. These methods cause a significant reduction in the production of dangerous emissions, and it is recommended that some of these be adopted in the Yukon if open burning continues. Applying this principle using "made in the Yukon" technology, the Community Development Branch of the Government of the Yukon, has implemented a burning vessel.

The burning vessels are making good use of abandoned fuel tanks along the Alaska Highway that were part of the operation of the Highway over the past 60 years. The tanks are generally about 7 metres in diameter (24 feet), and are modified with a cutting torch to provide 12 millimetre (mm) venting screens, and reinforced doors. The burning vessels are easily loaded into the back of pickup truck. Another added benefit to the burning vessels is that they are completely portable by demolition with a cutting torch, and reconstruction at more distant locations.

Not only do the burning vessels provide an increased burning efficiency, reducing pollution, but they also provide a controlled burn. This additional benefit is in response to the increasing wildfire danger in the Yukon, which may require a buffer zone of 50 metres if conventional burning is used. The increased buffer zone from 30 metres to 50 metres is an expensive undertaking for the additional clearing.

The regulatory authorities have provided generally positive feedback to this innovation, and a total of 6 installations are expected by the end of 2006.

The Yukon burning vessel concept is an excellent example of appropriate technology applied in a northern context, and providing an incremental improvement to waste management practices.

FORT GOOD HOPE

APPLICATION OF LARGE SCALE AT-GRADE SEWAGE TREATMENT AND DISPOSAL IN FORT GOOD HOPE, NWT

Satellite photo of Fort Good Hope area.

1. INTRODUCTION

1.1 Community Environment

The Charter Community of Fort Good Hope (K'asho Got'ine) is a Dene community in the Sahtu Region of the Northwest Territories, located at 66º 15' North and 128º 3' West. The town site is 27 kilometres south of the Arctic Circle, about 805 kilometres northwest by air from Yellowknife, and 145 kilometres northwest of Norman Wells.

The terrain surrounding Fort Good Hope generally consists of muskeg, swamp, and areas covered with trees ranging in size from stunted growth up to 12 metres in height. However, several significant glacial and fluvial deposits surround the community, and provide one of the few nearby community deposits of concrete gravel in the NWT. Fort Good Hope is situated within the continuous permafrost zone; the active layer penetrates 0.5 to 1.2 metres below the ground surface in the summer.

Sewage collection in Fort Good Hope employs sewage pumpout tanks. Pumped out sewage is trucked to an exfiltration trench located at the waste disposal facility about 3.5 kilometres north of the community. The estimated monthly volume of pumpout sewage discharged to the exfiltration trench is 1.6 million litres, which is approximately 140 litres per capita per day (550 estimated population). The exfiltration trench is approximately 98 metres long, 12 metre wide and up to 3 metres deep; the approximate working volume of the trench is 1500 cubic metres.

1.2 Existing Sewage Exfiltration Area

The 9.0 hectare waste disposal site (240 metres wide by 375 metres long), and is part of a 90 hectare glacial outwash plain located between the townsite and the Hare Indian River. The average depth of the glacial outwash plain is approximately 10 metres, and

Airphoto of waste disposal site.

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the deposit contains approximately 9 million cubic metres of poorly graded gravel. The glacial out wash place is one of a series of granular deposits around Fort Good Hope.

The deposit is comprised of medium grained gravel that ranges in soil classification from "poorly graded gravel, gravel-sand mix, little or no fines" to "poorly graded sand, gravelly sand, little or no fines". The gradation of the gravel in the area ranges between 20% and 95% sand, 2% and 79% gravel, and 1% to 14% silt-clay. The high permeability of the gravel results in good drainage within the area, and the water table in this area appears to be deeper than 15 metres, while the depth of the sewage trench is up to 3 metres deep.

The exfiltration trench does not have any "controlled" discharge system. Upon discharge into the trench, the sewage flows by gravity to fill the entire trench to a level surface. The sewage then "exfiltrates" from the bottom and sides of the trench into the glacial outwash plain deposit, and then "percolates" downward through the deposit (unsaturated flow) until the groundwater table, and then flows into the groundwater (saturated flow).

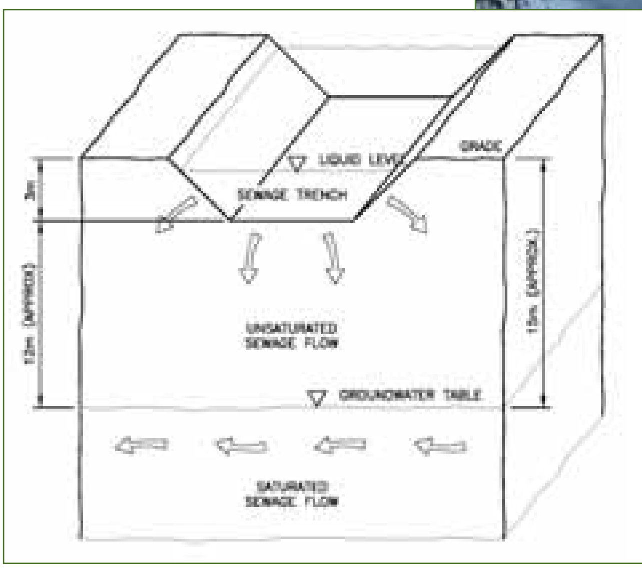
The exfiltration trench in the glacial outwash plain is situated at an elevation of approximately 230 metres, which is about 225 metres above the Mackenzie River elevation of 75 metres. The exfiltration trench is about 1200 metres from the Mackenzie River. The exfiltration trench and the outwash plain are both oriented parallel to the Mackenzie River.

2. SYSTEM OPERATION AND PERFORMANCE

The exfiltration trench treats the sewage in a much different way than the more conventional sewage retention lagoon. An exfiltration trench uses the elements of nature in the available soil "matrix", and the processes of biodegradation, filtration, adsorption and absorption to remove the contaminants in sewage.

The trench is currently capable of accommodating the volume of sewage produced by Fort Good Hope based upon the community observations; in fact, the sewage percolates quickly into the gravel. However, the community has observed that the level of liquid in the trench has been steadily increasing with time, which is an anticipated part of the performance of an

Fort Good Hope sewage exfiltration system.



Flow characteristics from sewage exfiltration system.

exfiltration process. Sewage solids accumulate with time over the bottom of the trench, and reduce the permeability of the soil; at the same time, this reduction in permeability also reduces the flow through the soil, and enhances the processes removing the contaminants in the soil.

3. WASTE GENERATION AND SYSTEM CAPACITIES

The production of sewage in Fort Good Hope is expected to increase substantially in the next 20 years. Statistics from the Government of the Northwest Territories projects that aboriginal populations may increase at a rate of 0.5 % annually. Based on the estimated population of Fort Good Hope in the year 2003 of 550, and a water consumption volume of 140 litres (0.140 m^3) per person per day (April 2004), an estimated 25,000 cubic metres (m^3) of domestic sewage will be produced annually by the year 2015, and 32,000 m^3 by the year 2025.

The existing exfiltration trench has never overflowed, however, the community is concerned that the trench is filling up higher than it ever has before, and could overflow in the near future. The ultimate capacity of the existing system is impossible to calculate given the many factors that influence the hydraulic capacity of the trench. These factors include the granular material in the base and side of the trench, the solids accumulation in the base and sides of the trench, the influence of seasonal frost in reducing the soil permeability, and the influence of permafrost on the soil permeability. The best indicators of system capacity are site observations on the rate of exfiltration from the trench; this activity is essentially a "percolation test" of the soil.

From a design perspective, the general operational range or hydraulic loading for a "rapid infiltration" system such as this is 6 to 125 metres per year. The estimated loading rate of the Fort Good Hope exfiltration trench is about 20 metres per year based upon sewage generation of 50 m^3 per day, and an estimated infiltration surface of 900 square metres (m^2).

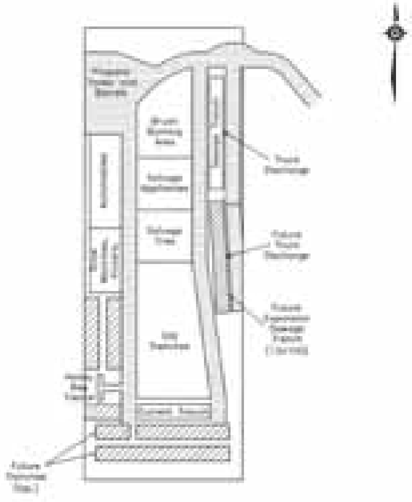
4. SOIL EXFILTRATION TREATMENT PROCESSES

Soil exfiltration of wastewater uses the elements of nature in the available soil "matrix", and the processes of biodegradation, filtration, adsorption and absorption to remove the contaminants in sewage. All soils have a natural capability to "filter" contaminants because of the inherent biology, and chemical activities that occur in soil. A soil exfiltration system may produce a tertiary quality effluent, if engineered and operated properly.

Coliforms and other pathogen organisms are removed by physical straining, and "die off" as a result of the harsh environment of the soil. This harsh environment includes the temperature, the absence of any nutrients for the coliforms, and the natural antibiotics in the soil. Biodegradable material is removed by the bacterial metabolism with the "living filter" of the soil - the natural or introduced bacteria literally consume the biodegradable material as it flows through the soil.

Nitrogen compounds, primarily in the form of ammonia, undergo a series of reactions with a soil profile resulting in the transformation, and potentially the complete removal of nitrogen from the soil, or the storage of nitrogen in the soil. Phosphorous compounds are "retained" by soil through either a chemical reaction or an adsorption reaction.

Temperature may have a significant influence on the biochemical and chemical processes within the soil; however, biochemical and



Configuration to expand sewage exfiltration system.

The existing sewage exfiltration trench in Charter Community Fort Good Hope is an appropriate sewage treatment technology for this community, based upon the technical process information, and the limited performance data.

chemical process still occur at cold temperatures, but at slower rates. In practical terms, slower rates demand either a lower sewage application on a given soil profile, or an increased soil profile to achieve the same level of treatment.

5. CONCLUSIONS AND RECOMMENDATIONS

The existing sewage exfiltration trench in Charter Community Fort Good Hope is an appropriate sewage treatment technology for this community, based upon the technical process information, and the limited performance data. The process is capable of providing a very high quality sewage effluent before discharge into the receiving environment.

The capacity limitation of the existing trench is difficult to determine, therefore the regular monitoring of the water level will provide the necessary data to determine the timeframe for increasing the capacity of the sewage exfiltration system. When a second trench is required, it should be constructed beyond the existing trench, and not parallel to the existing trench, in order to take advantage of additional treatment capacity in the granular deposit. The design criteria for the trench should include a long narrow excavation with a minimum depth of 3 metres in order to minimize the surface area exposed to the atmosphere, and to maximize the heat retention.

WATER TREATMENT HISTORY IN CITY OF YELLOWKNIFE, NWT

Yellowknife community showing mines, water supply and related features.

Yellowknife, capital of the Northwest Territories, boasts a population of approximately 19,000 people and Canada's largest underground water distribution system in the Arctic. This underground system consists of 70 kilometers of water mains, 5 Pumphouses and 3 reservoirs.

The history of Yellowknife's water supply is intrinsically linked to its start as a mining town. When gold was discovered on the shores of Great Slave Lake and the claims were staked, Yellowknife was born as gold mining boomtown. The two most longstanding and productive mines, well known to the North, the Con and Giant Mines, were a result of the original exploration. Con closed in 2003 after 65 years of production and Giant closed in 2005 after 60 plus years of production. Both mines have left significant legacies on the shores of Great Slave Lake.

By 1939 the community along Great Slave Lake was granted a defined settlement area, which began with Old Town, Latham & Joliffe Islands, and 410 acres on the mainland to the south. The Territorial Council also began to provide government services to the area in and around Yellowknife. For water supply Yellowknifer's in Old Town hauled water by bucket from Back Bay. Yellowknifer's in the 'New Town' established a pumphouse on the lakeshore to bring potable water to its residents. Unfortunately up until 1961, Back Bay received the effluent from the Niven lake sewage lagoon and grey water from the Old Town inhabitants, in addition to supplying the Old Town community with its drinking water supply.

The gold extraction process used in Yellowknife required a 'roasting' process to extract the gold from arsenopyrite rock. Until the use of pollution control devices in the 1950's, this process released uncontrolled quantities of arsenic trioxide and sulphur dioxide into the air around the community, which came to rest on the land and water bodies. Following the death of a baby, that was attributed to drinking melted snow laden with arsenic fly ash, public pressure was put on the mines to implement pollution control. Investigations were done on the soils, vegetation, and water in the area to determine the extent of the arsenic contamination.

Despite the fact that arsenic concentrations in the water supply were within the limit for human consumption, in the late 1960's Yellowknife changed water sources from Yellowknife Bay to the Yellowknife River. The reasoning behind this major change in water supply was the perceived arsenic contamination from the mines, and the sewage contamination from the Niven Lake lagoon. The Niven Lake lagoon was taken out of service in the early 1970's, and finally decommissioned in the 1980's.

By 1969, a new pumphouse was established on the Yellowknife River, and water was pumped through an 8 kilometre submarine pipeline to the townsite. This is the current water supply source for

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the City of Yellowknife today. Water is pumped to the original pumphouse on the lakeshore of Great Slave Lake, where it is dosed with gaseous chlorine and liquid flouride before being stored in the first of three reservoirs in the distribution system. During the winter, the treated water is heated before distribution in order to provide freeze protection to the water distribution network. The water returns to the pumphouse after circulation to the farthest reaches of the system at temperatures in the range of 1 to 2ºC.

For many years the water supply in Yellowknife was considered to provide the community with a very good potable water supply. However, with the new multiple barrier approach to safe drinking water, events like the Walkerton and North Battleford pathogen outbreaks, and increasingly stringent water quality criteria, the pristine waters of Yellowknife must now expect to receive an increased level of treatment.

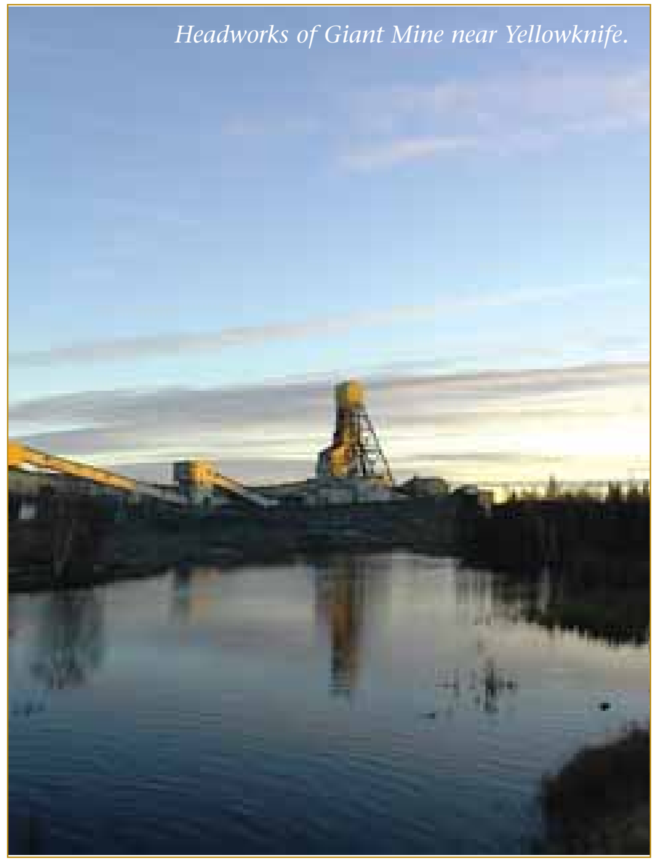
In the 65 plus years of water supply in the City of Yellowknfe, there has been no reported biological contamination in the water supply. The only two events of concern have been the arsenic detection in the 1970's, and excessive turbidities in the Yellowknife River water during the spring of 2004; a 3 week boil water order was issued for the 2004 event. The persistence of arsenic in the water, and the probability of another high turbidity event are being taken into consideration for the inevitable water treatment process selection.

In 2004 and 2005, the City installed two pilot plants to test different treatment processes on the Yellowknife water supply. The water treatment processes of membrane filtration, and direct filtration were tested for the both a Yellowknife River raw water supply, and a Yellowknife Bay raw water supply. The advantage of a Yellowknife Bay water supply would be the decommissioning of the 37 year old submarine pipeline from the Yellowknife River.

The primary target for Yellowknife drinking water is to meet the proposed turbidity guideline of the Guidelines for Canadian Drinking Water Quality (GCDWQ). The objective of the proposed guideline is to maintain turbidity levels consistently below 0.1 or 0.3 NTU; Yellowknife has no other significant contaminants that fall outside all of the other current guidelines of the GCDWQ. Arsenic, due to its historical presence in the water system remains a concern, especially if the Yellowknife Bay were to be restored as the drinking water source. During the treatment pilot program, the concentration of arsenic in the water source was monitored and found to be well below the Interim Maximum Acceptable Concentration of arsenic in a water supply of 25 parts per billion.

The results of the pilot studies suggest that either of the piloted treatment processes would provide effective water treatment for the City of Yellowknife. One notable concern is that the cold temperature of the water will complicate the treatment process because cold water is increasingly viscous and inhospitable to treatment chemicals.

Headworks of Giant Mine near Yellowknife.



The primary outcome of the pilot testing is that the City of Yellowknife is poised to address a multi-barrier approach to the treatment of the Yellowknife water supply if problems such as the 2004 turbidity event continue, or when the treatment is ultimately legislated. Time will tell.

WATER RESERVOIR IMPROVEMENTS IN QIKITARJUAQ, NUNAVUT

Partially drained reservoir showing truckfill and intake pipeline.

INTRODUCTION

The Hamlet of Qikiqtarjuaq (formerly Broughton Island) is located on Broughton Island, Nunavut, 470 kilometres northeast of Iqaluit. The geographic co-ordinates of the community are 67° 33' North 64° 02' West. The population of the community is estimated at 600, and is projected to reach 800 by 2020.

Qikiqtarjuaq is in the zone of continuous permafrost, and permafrost is encountered at depths ranging from 1.3 to 1.8 metres (m) below ground level. Average high temperatures for January and July are -20°C and 7°C respectively. Annual precipitation totals approximately 290 millimetres (mm), consisting of 40 mm of rain and 250 mm of snow.

The Hamlet provides trucked water to community residents and institutions. Water is collected from the Tulugak River and trucked to community users. In summer trucks collect the water directly from the river. During the rest of the year trucks collect water from a reservoir filled from the river.

HISTORY OF RESERVOIR AND TRUCKFILL STATION

An earthen water reservoir for water storage was constructed out of a borrow pit approximately 4.5 kilometres (km) from the Hamlet of Qikiqtarjuaq in 1974. The original reservoir was later enlarged in 1978. The reservoir has been filled in the summer months by pumping water from the Tulugak River into the reservoir.

During the construction in 1978 the 90 metre by 90 m and 9 m deep reservoir was lined with a geosynthetic fabric and a gravity feed line to the community was also installed. Approximately eighteen months after being placed into service, the gravity line froze. The community decided to switch to truck haul service and abandon the gravity feed line.

Intake pipeline with concrete anchors.

Construction of the truckfill facility was completed in 1984. The facility was designed so that when trucks go to the truckfill, the operator could turn on the pump, and wait while the truck was filled with water. Chlorine was added automatically.

During the 1984 truckfill facility installation, problems with the reservoir were observed. Repairs to the liner were carried out in 1986. In 1988, an examination of the cost of relining the reservoir, concluded that $70,000 per year maintenance costs could be borne rather than proceed with the relining project.

In 1995 an updated analysis of maintaining the existing liner was re-examined and again, replacement of the liner was not considered economic. It was noted that liner repairs were difficult because the original liner material did not bond well to the lining materials. Evidence of the intake pipe slipping down slope was also noted, and repairs were recommended.

CONDITION OF WATER RESERVOIR FACILITIES

Intake Pipeline

The intake pipeline was designed for placement along the slope of the reservoir of the reservoir from the pumphouse to the base of the reservoir. Concrete weights provide a force to counteract the buoyancy

Intake pipeline connection to truckfill.

by Nick Lawson, Area Manager,
Jacques Whitford Limited, Yellowknife, NWT,
with contributions from Ken Johnson, P.Eng.

Deterioration in concrete anchors.

The facility was designed so that when trucks go to the truckfill, the operator could turn on the pump and wait while the truck was filled with water.

of the pipe. The 150 mm intake pipeline is surrounded in a 400 mm casing pipe with 100 mm of insulation, which provides freeze protection for the pipe. Some bending of the pipe is part of engineering design, but settlement in the reservoir embankment has created additional bends in the intake pipe.

The intake pumps are positioned at the bottom of the intake pipeline. Intake pumps are equipped with a guide system to assist with their initial installation and for periodic maintenance removal. Unexpected bends in the intake pipeline may make it difficult to install and remove the intake pumps. If the bends are severe enough, the pump could become physically lodged in the pipe.

The intake piping is under tensile stress from the sliding of the intake pipe down the reservoir slope. In 1995, the intake pipeline was reported to be 9 centimetres (cm) down slope from its original position; in 2003, the pipeline was 11 cm down slope.

Approximately 60% of the concrete weights are in poor condition. Virtually all

The design volume of the reservoir is approximately 21,000 m^3, and the current annual water consumption of 20,903 m^3 is near the design volume.


Deterioration in reservoir lining joints.

the weights that are submerged, show evidence of cracks and spalling concrete. In some cases, the internal structural steel now rests on the liner, which may create a hole if surface ice hits the steel. The collapse of the weights may also create additional stresses on the casing pipe.

Reservoir Liner

The water reservoir liner was originally covered completely by sand, and today approximately 40% remains covered. The visible liner has hundreds of small holes and tears, including failures of patches from previous repair efforts. The lower portion of the liner is starting to exhibit some brittleness. Tears of more than 0.5 m long were noted in the north east corner of the liner.

A bulge in the liner was observed on the east berm, approximately 6 m south of the intake pipes at approximately the 5 m water level. The bulge in the liner was approximately 8 m length. It represents a potential point where air can accumulate and float the liner. It also demonstrates that movement under the liner is possible, which can lead to pipe settlement, and eventually a lodged pump.

WATER RESERVOIR IMPROVEMENTS

The design volume of the reservoir is approximately 21,000 cubic metres (m^3),

Deterioration in intake pipeline insulation.

and the current annual water consumption of 20,903 m^3 is near the design volume. The Hamlet staff can fill up trucks directly from the Tulugak River for several weeks each year, thereby reducing the demand on the reservoir. However, the operators' prefer to use the truckfill at the reservoir because using the river requires an operator to climb on top of the truck with a cup of bleach to dump into the truck tank for chlorination of the water. Given the water demand and reservoir size, the reservoir is at approximately 90% capacity.

A priority for the reservoir is ensuring that the water reservoir should be protected from fuel spills resulting from the generator building or vehicles visiting the site. A secondary containment berm is needed for the fuel tank and piping. Improved site grading will also direct runoff away from the reservoir.

For improvements to the water reservoir, one of 3 approaches may be undertaken:

1. Repair reservoir now and build a new reservoir when capacity reached.
2. Build a new reservoir now, and then reline and repair existing reservoir.
3. Build a new reservoir, upgrading the treatment system and truckfill station, and then reline and repair existing reservoir.

Options 2 or 3 have been recommended for implementation. The reasoning behind this is that the reservoir truckfill station itself has problems related to power delivery, pumping capability and maintenance of equipment, which jeopardizes the Hamlet's ability to deliver water. Construction of a new reservoir would enable a fully functional truckfill station to be built for the future, as well as allow the existing reservoir to undergo significant repairs. The construction of a new facility should be undertaken with consideration of potential needs to treat the water in the future, a decision which requires further analysis.

ARCTIC OIL AND GAS, AND ARCTIC SEWAGE TREATMENT

With the discovery of hydrocarbons in the Northwest Territories (NWT) Arctic Region (particularly the Inuvialuit Settlement Region) much industrial activity has stemmed around the oil and gas exploration industry and related activities such as drilling, seismic and geotechnical investigations, support camps, etc. Now, as a result of this activity in the last few decades, and resulting significant oil and gas discoveries, northerners are faced with a multi-billion dollar "collection" project called the Mackenzie Gas Project (MGP). One issue of particular importance to the MGP is waste management, and specifically the treatment and responsible disposal of sewage wastewater from associated, mobile or not, support camps.

WHAT ARE THE TREATMENT OPTIONS?

In the N.W.T. there are many effluent treatment technologies that can be utilized. As discussed in Indian and Northern Affairs Canada publication called "Best Available Technology for Sewage Treatment in the North" there are many technologies for sewage treatment and include: activated sludge - extended aeration, sequencing batch reactors, lagoons, wetlands and overland flow, membranes, physical-chemical treatment, bio-filters, and rotating biological contractors. It is these Best Available Treatment Technologies (BATT), and the amalgamation of many of these technologies through primary, secondary, and tertiary processes that make sewage treatment in the Arctic possible. Depending on the situation, some processes are more practical than others and some, depending on the situation, are simply not feasible. These BATT are utilized

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not only by municipalities, but also by industry.

In recent years industry has used these BATT to ensure that sewage is treated and meets certain obligations, usually in the form of a discharge standard, as dictated under a Water Licence. Specifically, portable or permanent "packaged" treatment systems have been utilized to meet the obligations. Generally, these packaged systems utilize many of the aforementioned BATT to ensure the treatment processes are being achieved thus increasing the chances of meeting target discharge standards.

In general, if a system proves unsuccessful and discharge standards can not be met under a particular Water Licence, a "contingency" Effluent Treatment Facility (ETF) must be considered. Realistically, the primary contingency in the Arctic is a municipal ETF (lagoon), where effluent is trucked, in some cases, hundreds of kilometers to the contingency location. Therefore, depending on the specific challenge, obtaining a system and ensuring its optimum performance is essential to the overall waste management success of a particular program.

WHAT ARE THE SPECIFIC CHALLENGES RELATING TO THE TREATMENT OPTIONS?

Specifically, in the Arctic there are a plethora of treatment challenges that will ultimately lead to an undesired result if not considered in a waste management plan; the undesired result will ultimately take the form of increased costs. The main challenges of waste management are regulatory, environmental, logistical and operational; all of which are not new concepts in the realm of waste management. It is these main challenges, and if they are considered, that deem whether a waste management plan will have the desired outcome.

The regulatory challenges in the north, like everywhere, are numerous, and the main regulatory challenge is compliance with the Water Licence. The deposit of a "waste" (in this case effluent) is mandated under the NWT Waters Act and administered by a regional Water Board in the form of a Water Licence. A Water Licence will contain conditions pertaining to "Waste Disposal" that the Licencee must achieve before an effluent discharge is possible. A Water Licence may contain conditions pertaining to the method of treatment, effluent discharge and sampling locations, effluent parameter specifications, effluent discharge parameter limits, and contingency options.

For the process environment, the main challenge is temperature, and in the Arctic long winters and extreme cold are normal conditions which may encumber any treatment system. Maintaining proper system temperature to optimum operating specifications is crucial; not only for the actual treatment process, but to ensure essential components of the system do not freeze causing failure or permanent damage. Consequently, effluent spills during a particular operation are often in some way related to the cold, therefore constant monitoring and attention to the system is essential. In all cases it is necessary to mandate one or more persons with the system operation and management to ensure this major environmental challenge is achieved. Even then, success is not guaranteed and depends on the other challenges!

A second environmental variable is the unpredictably of Arctic; violent winter storms are common and may last up to a week. As a result of extreme low temperatures and poor visibility, all activities may temporarily grind to a halt. However, as a result of personnel concentrated in support camps during storms, sewage generation and resulting treatment needs increase. Every system must be engineered to ensure treatment of camp capacity with no supplies or outside support for the duration of a storm.

An additional challenge to the issue is the mere logistics of many exploratory programs and the fact that the programs largely lie great distances from any major centre. Logistical related issues include operator change over, system parts, and even utilization of the contingency location, if the treatment option falls short of its treatment target. Even then there are questions as to the necessity of hauling treated effluent that is just beyond a discharge standard great distances to a contingency location.

Well site and camp.

Operational challenges are many-fold, and are sometimes related to the aforementioned challenges and the system that may be used. From an operational perspective the challenges include: ensuring dedicated and qualified professionals are managing the system; system input equalization; handling of effluent where handling increases the likelihood of spill; availability of parts; and the time required to get a system operational. In most cases getting the system to operating specifications may take several weeks, and may encompass on site "tweeking" and engineering modifications. During this period effluent quality may not be to specification, and therefore contingency options may have to be considered.

ARE THE TREATMENT OPTIONS SUCCESSFUL?

The ultimate question that most want to know is what treatment options are successful. ALL systems have the potential for success and ALL have the potential for failure. When a system is up and running, sewage is treated to some degree. Whether it is treated to the limits of the system and to Water Licence specifications depends on many of the aforementioned challenges. It has been suggested that the available systems simply cannot meet the discharge targets as specified in Water Licence because the targets are too stringent. Further, the question has been posed that regardless of their obligations under a Water Licence, is the effort worth the cost? Man has traveled to the moon, and to the deepest parts of our oceans, man has developed nuclear power, and now the technology is available to drill to several kilometres below the earth surface. If the challenges are considered during the waste management planning, the likelihood of success will increase dramatically and the costs may decrease. Keep in mind that problems will arise, usually in the form of effluent quality, providing a perspective of being at the bottom of a filled pool looking up!!! Water wings anyone?

2006 PRESIDENT'S REPORT: *BRYAN W. PURDY, P.Eng.*

It has been a great year so far for the NTWWA, which was "kicked off" by the 2005 Conference in Rankin Inlet. The conference was a huge success and one of the biggest ever, with over 90 individuals in attendance. The representatives included water and sewage treatment plant operators, engineers, and industry and government representatives. We also had representation from across the country, including the Centre for Alternative Wastewater Treatment at Fleming College in Lindsay, Ontario, and industry participants from Winnipeg, Edmonton and Vancouver.

One of NTWWA's goals is to foster an environment of learning and skill development for water and sewage facility operators through the operators' workshop. The strong attendance at the operators' workshop on November 7th demonstrated our continuing advancement of this goal. This year also saw an increase in the number of operators from the smaller Hamlets in Nunavut attending the conference. The Monday workshop had several interesting and practical presentations. The presentation on the Pangnirtung sewage plant by Peter Christou, and Bob Hanley's demonstration of presence absence testing were among the several talks that were appreciated by all.

Both the Government of Northwest Territories and Nunavut are in the process of putting in place a certification process for water plant operators and sewage treatment operators. The annual operators' workshop provides an additional learning venue at which operators can ask questions and share day-to-day problems. We are pleased that operator Billy Qaqasiq of Pangnirtung, Nunavut was elected to the NTWWA board at the AGM following the Rankin Inlet conference. Billy and other operators in both Territories are forming an operators committee, which will meet via conference calls.

The Board of NTWWA is looking forward to a very successful 2006 conference in late November. All participants from the 2005 conference are urged to share the value of joining NTWWA with your colleagues, and to encourage them to attend the 2006 conference in Yellowknife from November 25 to 27, 2006.

REPORT

2006 EXECUTIVE DIRECTOR'S REPORT:
MATTHEW HOUGH, P.Eng.

Over the last year, the activities of the NTWWA have leaped from strength to strength. The inaugural edition of the *NTWWA Journal* was extremely well received by members of the association, and interested audiences across the country. Unique recognition was given the Journal by the Government of the Northwest Territories Department of Municipal and Community Affairs as a link to a PDF version of the Journal was placed on their website for all to see.

The success of the NTWWA annual conference, trade show, workshop and annual general meeting in Rankin Inlet was a pleasant surprise to all involved. Held at the start of November, 93 registered participants made that conference the most successful yet. As the conference location alternates between Nunavut and the Northwest Territories, the next conference will be held in Yellowknife. The conference will be held following the very popular Geoscience Forum and the NAPEGG Annual General Meeting. We expect that by situating the conference in Yellowknife, and by following these two events, we will see the largest conference to date. This success is bitter-sweet as the conference may have become too large to host in many communities in the territories. I do hope, however, that the mandate of the NTTWA remains at the heart of planning for the conference regardless of where it is held. As was printed in my column last year, I offer the following information as a reminder of the purpose of the NTWWA:

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.

Although the Journal, and the Annual Conference are the marquee achievements of the NTWWA, the mandate of the association is pursued on a regular basis by the NTWWA Board of Directors. The Board meets once a month via conference call. Participants on a recent call phoned in from 'sea to sea to sea' including Vancouver, Halifax, Cambridge Bay, Rankin Inlet, Pangnirtung, Yellowknife and Edmonton. The background and experience of each Board member is just as varied as their residence with operators, consultants, suppliers, and government personnel participating. Topics of discussion range from the administration of the NTWWA, to advocating for improved training courses for operators. The water and waste industry in the north may be small, but its importance is recognized by all who invest their time in this association.

> *I do hope, however, that the mandate of the NTTWA remains at the heart of planning for the conference regardless of where it is held.*

In closing I would like to say thank you to all members of the Board of Directors for their time. Special thanks are due for the efforts of President Bryan Purdy, past President Kim Philip, and the Journal's technical editor Ken Johnson. This association also owes thanks to Pearl Benyk, our administrator; Pearl keeps this association extremely well organized and is the institutional memory of the NTWWA.

I look forward to seeing everyone in Yellowknife in November.

REPORT

2006 CWWA DIRECTOR'S REPORT

DELE MORAKINYO, *Ph.D., P.Eng.*

This report covers the period between May 2005 and April 2006. During this period, Canadian Water and Wastewater Association (CWWA) was involved in several Events Planning, Events Support and Government Liaison activities.

CWWA planned the 2005 Window on Ottawa. The event, which took place in Ottawa, December 1 and 2, 2005, was attended by more than 100 representatives from across Canada. The key issues addressed during the meeting were federal, national and global initiatives having potential impacts on the water and wastewater sector. Principal among the initiatives are the Canadian Council of the Ministers of Environment (CCME) Municipal Wastewater Effluent (MWWE) Strategy, National Water Quality Index, federal environmental assessment program, and the New Deal for Cities from Infrastructure Canada among others. CWWA also planned and carried out the 12th Canadian National Drinking Water Conference and Policy Forum in Saint John, NB, April 1 to 4, 2006. The theme of the conference was "Safe Drinking Water: Moving Forward Together".

CWWA is currently working on the plans for the Window on Ottawa 2006. The exact date is not yet fixed, but it will be after December 1, 2006 to avoid conflict with events planned by other associations. The 2nd National Wastewater Management Forum is also being planned for the spring of 2007, and will likely take place in Western Canada. CWWA is fully supporting the initiative of the Greater Moncton Sewerage Commission to host the event "Moving Forward - Wastewater Biosolids Sustainability" in June 2007

CWWA's Government Liaison activities include the CCME MWWE Strategy. In January 2006, CWWA submitted additional comments, re-emphasizing its previous submissions, and representing the views of its members to the CCME MWWE Development Committee (DC). The final strategy is expected to be submitted to the Ministers by December 2006.

Other Liaison activities undertaken during the period of this report include:

- Pollution Prevention (P2) Plans for the Management of Chloramines and Chlorinated Municipal Effluents: Producing a template chlorine audit protocol for use by municipalities;
- National Pollutant Release Inventory (NPRI): Developing a harmonized position on the number of substances to be reported, the reporting requirements and the issue of wastes vs. products;
- Working with other stakeholders on the potential formation of a Canadian Biosolids Partnership;
- Data collection on reporting mechanisms for adverse water quality events (Health Canada Contract);
- Canadian Guidance document for risk assessment and risk management evaluations for drinking water supply systems (Health Canada Contract);
- Data collection on provincial and territorial practices for routine water quality reporting (Health Canada, First Nations and Inuit Health Branch Contract);
- Health Canada's research findings on updates to water quality parameter guidance for non-potable water uses (Grey water and rain water use);

- Performance testing of 6 litre toilets (http://www.cwwa.ca/freepub_e.asp#toilet);
- The Drain Line Carry Evaluation Report assessing the impact of low flush toilets on drain line carry of solid materials (http://www.cwwa.ca/freepub_e.asp#toilet);
- Representation on the Critical Sectors National Committee of Environmental Careers Organization (ECO, Canada) on operator training and certification;
- Maintaining a close watch on enforcement actions under the Fisheries Act that impacted municipal operations;
- Submission of comments on Canadian Food Inspection Agency (CFIA) proposal to delete exemptions for several municipal organic waste byproducts from registration as part of their proposal to prevent the spread of BSE propagating materials;
- Contributions to the administration of the Canadian Environmental Protection Act, 1999 that is entering the five-year review; and
- Representation on the Critical Sectors National Committee of the Public Safety and Emergency Planning Canada on security (including cyber security);

Further pursuits of the above activities and other emerging federal, national and global initiatives will be the focus of CWWA for the immediate future. The CWWA main and support events that all stakeholders in water and wastewater sector should pay immediate attention to are: Window on Ottawa (2006); 2nd National Wastewater Management Forum (2007) and the Greater Moncton Sewerage Commission conference - "Moving Forward - Wastewater Biosolids Sustainability" (June 2007). The federal/national initiative that is expected to command significant immediate attention for the remainder of 2006 and beyond is the CCME MWWE Strategy; the final strategy is expected to be submitted to the Ministers by December 2006.

For further details on CWWA's events planning, events support and government liaison activities, readers could contact me by e-mail: dele_m@hotmail.com. Readers are also encouraged to visit CWWA website, www.cwwa.ca.

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