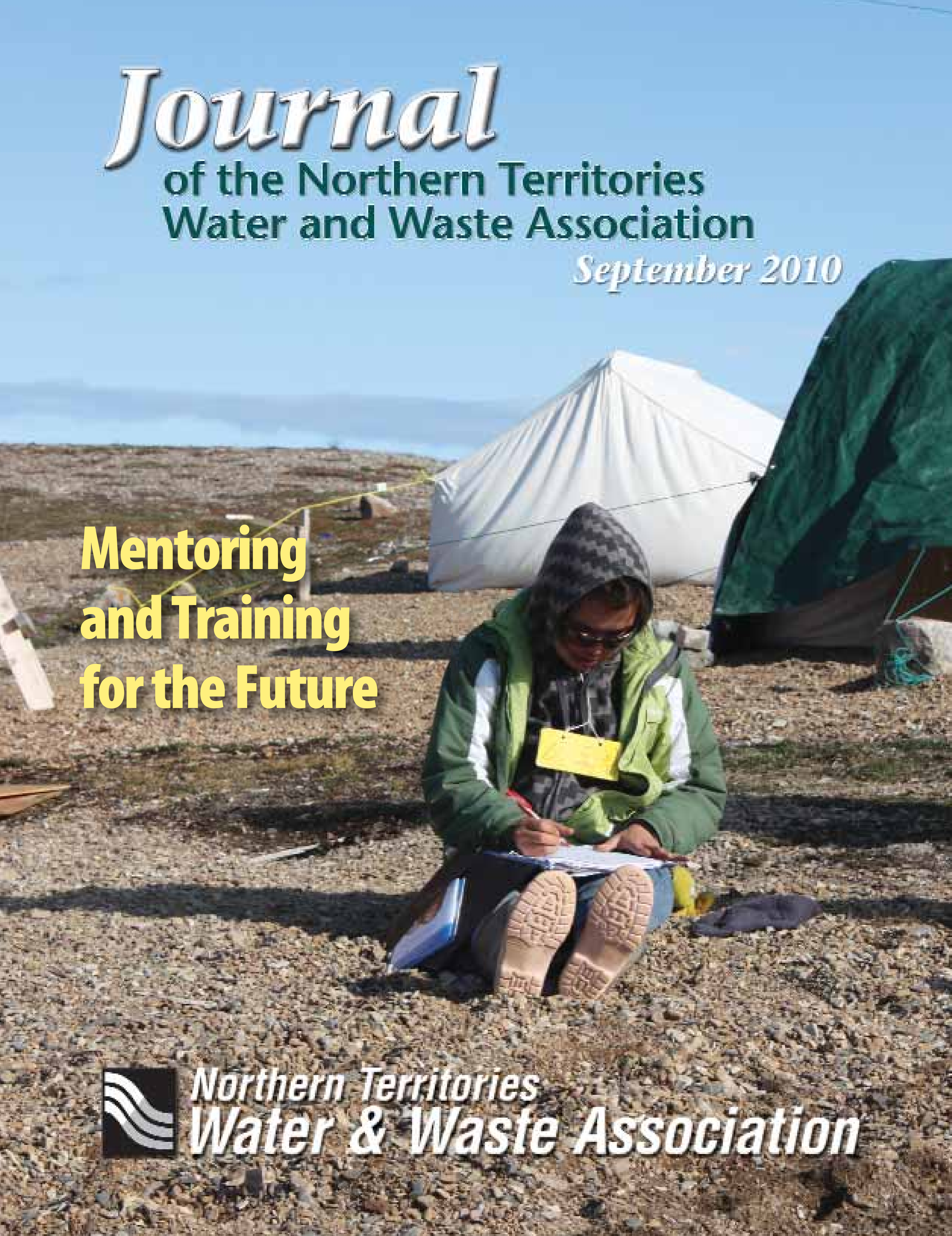
Journal
of the Northern Territories Water and Waste Association

September 2010



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Northern Territories
Water & Waste Association
Journal

In this issue

FEATURES

Cover photo courtesy of Government of Nunavut, Department of Education:
Kugluktuk Science Camp 2009

By Gary Strong, Partner
Dillon Consulting Limited

MANAGEMENT OF NON-DOMESTIC WASTE IN THE NORTH

Introduction

Waste management in the North has had a spotty past. There is no doubt that there has been a legacy of contaminated sites abandoned in the North, and the federal government through Indian and Northern Affairs Canada (INAC) has spent billons of dollars to address the most serious of these, and they have many more sites left. But that's looking in the rearview mirror. What of the future of waste management in the North?

Those of us who live in the North are often the first to identify problems in the South that affect our environment. Whether that is greenhouse gases, persistent organic pollutants, contaminated north flowing rivers, or the most recent media heightened concern, drilling for oil in the Beaufort, we should be concerned and vocal. Each of us gets one voice in the debate on these important issues.

However, if we do not want to be the dumping ground for wastes and contamination from the South, shouldn't we as northerners take care of our wastes first? Our striving for a better life in the North has often led to the desire for the new and improved: new buildings, new vehicles, new TVs, new … well, new everything. Part of this consumerism is, unfortunately, inherent in the world today. Try to buy a replacement battery for a cell phone. The battery (and likely the phone) is either obsolete, or it's simply cheaper to throw away the old cell phone and get a new one (and the new one has 9,000 "apps"). All these new things are great, but what is the cost to our communities and the environment?

Some waste is unavoidable, and much of our northern waste we can properly manage in the North. Other waste we have not been able, or perhaps not willing, to deal with appropriately

Waste oil burning in the North.

within our jurisdictions. These wastes are hazardous wastes such as paint, oil, glycol, CFCs, solvents, batteries, end-of-life vehicles (ELV), special buildings waste (asbestos, lead paint), mining and exploration wastes (drilling mud), and biomedical wastes.

Current practice is to store hazardous waste for an indefinite period of time, and then at some future date, ship the waste to a southern disposal location. This approach is completed at great cost, financial cost to the government and people of the North, and environmental cost when the hazardous wastes are not stored properly. The question at hand is, Where is our environmental stewardship?

So who's responsible for all this waste and the disposal of the waste? We are! So, who's "we"?

- The people who generate the new goods.
- The people who buy the new goods.
- The people who want to get rid of the old goods.
- The people who regulate how to transport the waste.
- The people who regulate how to dispose of the waste.
- The people who decide that an old building should not be fixed, but demolished to make way for new.

In other words, "we" is us. You and me.

Storing wastes in the community and then, maybe, shipping wastes "south" is not an environmentally sustainable approach. Shipping waste to other jurisdictions for disposal, is the equivalent of all those southern issues identified earlier – wastes flowing north on the water and air streams.

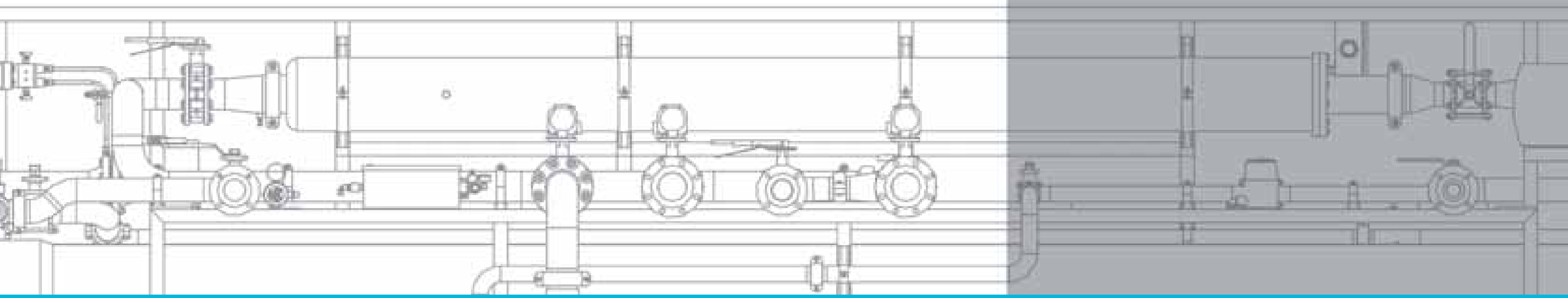
I'm not suggesting that we impose such draconian measures on the people of the North so as to prevent the purchase of new materials. What I am proposing is that northerners collectively should take accountability for the waste we generate. This would mean governments should regulate waste disposal such that all waste generated in the territory is disposed of in that territory. People should act like all their waste they generate should be disposed of in their community, and you have to live with the environmental consequences of your waste generation.

There are great initiatives occurring in the North that manage our wastes far better than we have in the past. Initiatives undertaken at the territorial level (GN and GNWT), at the community level, and at the individual level are all making a difference. Some of these include:

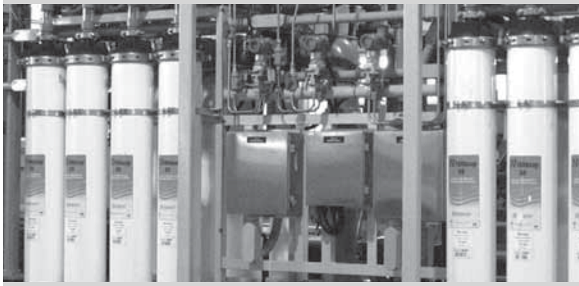
- Bottle Recycling. The GNWT undertook to develop legislation to encourage recycling of beverage containers in the N.W.T.
- Incineration of waste oil on-site instead of shipping the oil south. This is not the best solution. Using the waste oil for heat and power generation would be far superior; however, incineration on-site is a better solution than shipping it south for incineration.
- Solid Waste Site Clean-up. The GN has funded a project where domestic and hazardous waste sites, which have appropriate liners, are developed to store waste oil.
- There have been clean-ups of metal and vehicle dumps, where the hazardous material is removed from the vehicles for proper disposal.
- Waste to Energy. Various public and private sectors have undertaken to generate heat from waste products found in the landfills. This includes the use of waste oil incinerators and wood stoves.

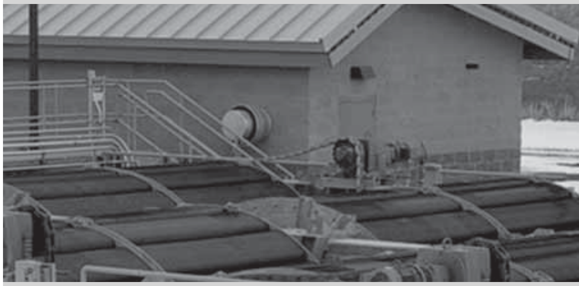
These are all great starts, but we cannot end here. There is a need to review our current regulations that are significantly out of date. We need the regulations to allow for, and in fact encourage, the development of properly regulated hazardous waste landfills within our region. Each province has these facilities, however our regulations in the territories discourages the private sector from operating one of these facilities, and the governments are reluctant to develop a government-run facility. We need regulations that encourage the reuse of construction materials. We need a will of governments (territorial and community) and of the northerners to take responsibility for the wastes that are generated in the North.

If we don't take responsibility for our environmental issues, how can we honestly criticize others?



HIGH PERFORMANCE CUSTOM DESIGNED WATER TREATMENT SOLUTIONS





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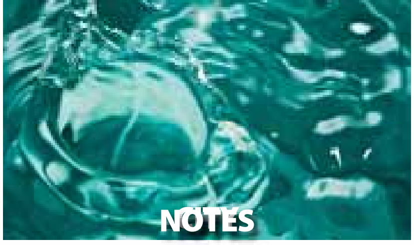


Editor's Notes

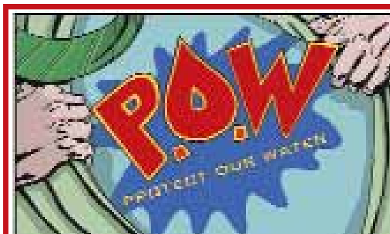
Ken Johnson

Over a 15-month period starting in March 2009, I had the privilege of participating as a volunteer in a climate change adaptation project with the community of Kugluktuk, Nunavut. This was mostly a right lobe brain exercise, which was a pleasant change from the regular left lobe exercise I get as a water professional, and it provided the inspiration for the theme of the 2010 edition of the *Journal*. As much as technology plays a significant role in the work we do as water professionals, it is the people who must ultimately carry the load for the work we do.

Within our group of water professionals, there remains a need for encouraging and mentoring young people to follow our lead into the future. The encouragement and mentoring can be started in the junior and senior high schools across the North, and includes the participation of many different individuals, groups and government departments. A particularly "northern" group are the aboriginal elders in the communities across the North. These individuals have a particular "knack" for engaging youth and "sparking" interest.

My favourite article in the 2010 *Journal* is the "wastewater challenges in Grise Fiord," which I edited from a report produced by Dillon for the Northern Working Group. The most interesting feature about the article is the timeline showing temperature from the time of departure from Grise Fiord, Nunavut. Five days later and many temperature spikes later, the sample arrived at the lab in Yellowknife, well past some of the time limitations for sample analysis. Although Grise Fiord is at the extreme end of the "road" for northern travel, the logistics for shipping from many northern communities are as equally challenging when "time is of the essence."

This information from Environment Canada's own consultant, points to one of the fundamental flaws with the current Canada Wide Strategy in its application in the North: What is the point of a regulation if it cannot possibly be sampled for compliance? Let's hope that information like this, and the continuing participation by northern water professionals in the whole debate around wastewater regulations for the North, will spark some serious departures from the current path of the Canada Wide Strategy, as it applies to the North.



Northern Territories
Water & Waste Association

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Yellowknife, Northwest Territories
November 20, 21, and 22, 2010

COME ONE, COME ALL water professionals to the NTWWA's Annual Conference. The conference is the highlight of the year for water professionals across the North, which includes operators, engineers, technologists, suppliers, regulators, contractors, and administrators. The 2010 conference and workshop in Yellowknife will feature a conference with 20 exceptional technical presentations, and a daylong operator workshop.

We are planning for the 2010 Great Northern Drinking Water Challenge. In 2009, the Town of Norman Wells was the winner of the fifth annual event.

TRADE SHOW

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 can earn one Continuing Education Credit for attending the conference and the Operator Workshop on November 22.

REGISTRATION

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

MENTORING YOUNG NUNAVUT MINDS AT THE BASIL BAY SCIENCE CAMP 2009

Introduction

Teaching and mentoring young people is always a challenge regardless of the situation. In the Nunavut Territory, this challenge is increased because of the cross cultural nature of the communities. The teaching and mentoring is not necessarily to bring the non-aboriginal knowledge to young people, but in fact vice versa, because many young people in Nunavut have more exposure to the non-aboriginal world than they do to the aboriginal world of the place where they live.

An organization with the objective of filling a part of this need is SKYE (Science for Kitikmeot Youth and Educators), which is a non-profit charitable organization that aims to build science skills and interest within Kitikmeot Youth and Schools. To do this, SKYE strives to provide youth with a varied culturally relevant science experience. SKYE recognizes the importance of including community elders and other members to pass on their knowledge base to youth. SKYE also recognizes the importance of Inuit Qaujimajatuqangit (IQ) and its inclusion in day-to-day experience for Inuit youth. Thus, IQ and community involvement are key components in events activities organized through SKYE.

SKYE has sponsored several regional science camps over the past several years, and in 2009 sponsored an August camp at Basil Bay, which is 60 kilometres by boat outside of Kugluktuk.

Goals Set for Camp

The goals set for Basil Bay Science Camp were:

- To connect traditional practices with modern science.
- To enhance interest in science in our youth.
- To empower elders in teaching youth traditional science.
- To provide local employment.
- To collaborate with new partners to model a community developed/delivered project.

The camp accommodated 24 youth participants, two youth leaders, eight teacher/parent chaperones, and eight elders and community leaders.

Science Camp Activities

- Caribou skinning/butchering and anatomy work: Students learned how to properly skin caribou and cut them up for drying and other uses. Elders and adults taught students about traditional uses of all parts of the caribou, from eyeballs, to tendons to stomach lining. Caribou anatomy and physiology were also discussed, along with adaptations to the northern climate.
- Fish dissection, cleaning and preparation for drying: Students were taught how to clean and cut up char and whitefish. Some students also did a scientific dissection where they learned about fish biology and had a chance to view different fish parts under a microscope.

By Tanya Connors, High School Consultant
Kitikmeot School of Operations, Government of Nunavut

- Wildlife ecology games: Students participated in a number of active and dynamic activities that demonstrated key principles in arctic wildlife ecology. Through role playing and game playing, students learned about the components of caribou habitat, musk ox anti-predator tactics, and experienced how all natural and non-natural ecosystem components are interconnected. Throughout these games, science knowledge was supplemented and supported with Inuit traditional knowledge of wildlife ecology and behaviour.
- Plant Identification Workshop: Students worked in small groups to survey the plant diversity in the area. They identified as many different plant species as they could find, sketched them in their field notebooks and shared their findings with elders. Elders also led students on a plant walk where they talked about traditional dietary and medicinal uses of local plants in the area.
- Dorset stone house: Students learned about the ancient Dorset people and visited two local stone house sites. Students compared and contrasted Dorset with more recent historic cultures and modern day living.
- GPS scavenger hunt: Students discussed the basics of GPS navigation and learned how GPS satellites work. Elders also talked about traditional methods of way finding and how to avoid getting lost on the land. In small groups, students participated in a scavenger hunt where they had to follow a series of waypoints to find caches hidden on the land. At each of the caches, group members had to take a digital photograph of a component of the local ecosystem.

Student studies fish biology.

Students study Dorset cultural site north.

Students butcher caribou.

- Journalling: Each day, students were asked to record their observations, feelings and experiences in their field journals. Students also were led through a "solo" journalling activity where they were asked to tune their senses to the environment around them and record their detailed observations without speaking or communicating with others.
- Climate Change Workshop: Two climate change adaptation planners visited the camp and engaged youth and elders in a discussion on local observations of climate change and potential considerations for adaptation in Kugluktuk.
- Environmental Stewardship: Students were led in a group discussion about the concept "Avatittinik

Kamatsiarniq" and personal definitions of Environmental Stewardship were given. In smaller groups, students made a "Code of Environmental Ethics" to guide people's actions and behaviour for environmental sustainability. Following this, a contest was held to see which team could collect the most garbage from the camp and surrounding area.

Successes of Camp

The camp exceeded expectations and was a huge success. Reports back from students, teachers, elders, community members, and schools were all positive and emphasized overall themes of the following:

- Connected traditional science on the land with modern science.
- Lasting relationships were formed.
- Elders felt empowered teaching youth.
- Youth gained a deeper appreciation for their culture.
- Connections between Inuit Qaujimajatuqangit (IQ) and daily practices.
- Interest in science education.

These successes were measured through conversations with youth, elders, and others involved on their perceptions of the camp. The camp manager submitted a detailed journal of the day-to-day activities/reactions of the camp that also provided a source to measure the successes of the camp. Students kept journals to be used to help them with their presentations and for their own personal memories of the science camp. Follow-up reports were volunteered from many school principals and teachers who received many positive comments from youth and teachers who participated in the camp.

Student and elder study plant life.

ENVIRONMENTAL TECHNOLOGY STUDENTS COMPLETING "CRAZY" FIELD WORK NEAR IQALUIT

Some lakes and rivers in the high Arctic are important to nearby communities as sources of drinking water, or for subsistence and commercial fishing. Major environmental changes to these lakes and rivers could have public health and cultural implications on the nearby community. Monitoring these important lakes could aid in adaptation for these impacts, as well as improving our understanding of how climatic change may affect high latitude freshwater bodies.

For example, if ambient temperatures increase as predicted and freeze-thaw cycles change, then lake and river water levels, ice thickness, and snow cover could change in the future, impacting the ecosystems. Climate change may also change the chemical parameters of lakes and rivers, making it more difficult for fish species to adapt, or even to survive.

Despite the importance of these high-latitude lakes and rivers, data collection at such locations is rare, especially in winter and spring, and basic limnological data is sparse. Long-term Arctic monitoring programs, especially those related to climate change, are challenging because of high costs and logistical constraints. As well, researchers conducting these investigations are almost exclusively from southern latitudes, and spend only short periods of time in the Arctic conducting research. Any data

By Ken Johnson, MCIP
Edited from an article by Jason Carpenter,
Environmental Technology Program, Nunavut Arctic College


Drilling testing holes on Crazy Lake.


Sheltered sampling station on Crazy Lake.

that is collected usually goes south with the researchers to their home institutions. Making use of the high schools and colleges in the North for research resources could help to meet these challenges.

Both management agencies and southern universities could benefit from partnerships with these northern educational institutions because most government organizations in the North lack the manpower and resources needed to develop and implement comprehensive, long-term monitoring programs. An example of using local human resources is the ongoing project to collect baseline limnological data from Crazy Lake, near Iqaluit, Nunavut. Data and samples have been collected by students of Nunavut Arctic College's Environmental Technology Program (ETP).

Lowering sampling probe into Crazy Lake.

The ETP students began a long-term monitoring project of snow and ice thickness, and other variables on Crazy Lake during April field camp activities of 2005 and 2006. In late March 2009, students of the program were back to collect more samples as part of a limnology field camp. Limnology is the study of freshwater systems like lakes, rivers, streams, and wetlands where the chemistry and biology of the freshwater body are examined together with physical attributes (e.g., size of lake, length, depth).

Several lectures were given in advance of the field camp as a starting point for students to understand the basics of limnology and the activities that would take place at the field camp. The discussion included the properties of water, the effect of temperature and light on lakes, importance of oxygen, ice, and nutrients.

Students also needed to know how a research camp works, and for many of the students it was the first time to work under camp conditions. At the camp, students had to learn the sampling protocol, make decisions about what to buy for provisions, and solve problems with the limited resources that are inherent to a remote camp.

Students were also challenged by the camp working conditions that were quite different from the school itinerary, where the activity of the day includes only classes that are broken up with coffee breaks. In the field where “time is money” and daylight is limiting, the workday starts early and usually ends late, as preparations are made for the next day’s activities.

The objectives of this field camp were to gain an understanding of the snow and ice cover of Crazy Lake, and some of the chemical parameters of the lake as it all relates to the local climate. To measure snow and ice thickness, as well as the depth of the lake, holes were drilled with an ice auger. In total, 45 holes were drilled in two transects across the lake. This was definitely a challenge for the students because of the cold temperatures and some equipment failures. Several deep spots were found in Crazy Lake, with approximate water depths of 20 to 22 metres.

The lake has a surface area of about 4.3 square kilometres, and is about 2.5 kilometres long, and a bit shorter in width. To obtain information about the water chemistry, the students used a “Hydrolab” probe. To ensure the electronic water probe would work well, a dome tent was used with the floor cut out over the drilled hole, and a Coleman stove was used to heat the interior just enough for the probe not to freeze.

The probe worked well, and several chemical variables (for example, oxygen, pH, water temperature) were taken at one-metre intervals to demonstrate to students how these values change with water depth. The temperature of the water is usually colder under the ice and gets a bit warmer at the bottom.

The lake is relatively cold throughout, so the water holds lots of oxygen. This is important for the char that live in Crazy Lake because they prefer deeper cooler waters in general.

The information collected so far may be considered a baseline of values that may be compared to future data. This information will be collected and added to a database on Crazy Lake, and future limnology field camps will add to this database.

For more information about the Environmental Technology Program and other post-secondary education in Nunavut, visit www.arcticcollege.ca.

NAIT WATER AND WASTEWATER PROGRAM AT A GLANCE

The 2009-2010 academic year has been one of great change and expansion in the NAIT Water and Wastewater Technician Department. By September 2010, there will be additional instructors hired and a new Water and Wastewater Technician Program will be offered at NAIT's Calgary Training Site. This will bring the full-time student quota up to 42 students. The Distance Delivery program continues to expand and 80 students are enrolled, including some from the Northwest Territories. Corporate and International Training (CIT) initiatives continue to expand as the needs of municipalities are being met by bringing more courses directly to the communities where the operators are living. The final initiative is the new Mobile Education Unit (MEU). This training unit will allow the department to bring any type of water and wastewater course to any community in Alberta, Northwest Territories, Yukon and Northern B.C. New initiatives are constantly being brought forward and discussed by the staff in the Water and Wastewater Department at NAIT.

Currently, the chair, Dave Warwick, handles all the full-time program inquiries. The two instructors are Kurt Stogrin and Darren Demchuk. Stogrin is responsible for the water and wastewater treatment courses, work experience and distance delivery inquiries, as well as any inquiries from communities looking for specialized training. Demchuk looks after the water distribution and wastewater collection courses and is a member of the Alberta Environment Certification Committee. Both instructors are constantly modifying NAIT's many courses to ensure there is as much hands-on training as possible. The eventual goal is to have 50 per cent hands-on training in every course the department offers. By September 2010, NAIT will have hired two additional instructors who will staff the new Water and Wastewater Technician Program in Calgary. Additionally, the department has begun to identify and train a number of operators who will eventually become distance delivery instructors. This includes at least four aboriginal operators. This increase in staff will enable the program to double the amount of course offerings in northern communities.

Students using water treatment instrumentation at NAIT.

Students using valves on water line at NAIT.

The NAIT Calgary site is located on the northeast side of the city just off the Deerfoot Trail near the international airport. This campus will help make NAIT one of the world leaders in operator training. It will have state-of-the-art classrooms, video conferencing room, and a water and wastewater laboratory and training area. It will initially offer a full-time water and wastewater technician program to 12 students, as well as many professional development courses for utility operators. In time, teleconference courses and international training will be offered at the facility.

The distance delivery program continues to expand. The course is exactly the same as the full-time Water and Wastewater Technician Program. Currently, the delivery method is still paper-based correspondence, but in the coming years there will also be an online version available. The certificate is made up of 17 courses and an individual receives nine months to complete each course. Most students start with WWW110 Science and Electricity and then take WWW112 Hydraulics and Blueprint Reading. These two courses provide all the base knowledge for the other 15 courses and, once completed, guarantee success in the others. Other course topics include: water treatment, wastewater treatment, water distribution, wastewater collection, support systems, computer applications, and process control. Exams are written using an exam supervisor in your local community. Most individuals who are working full time complete one or two courses every four months. Individuals who take

By Kurt Stogrin, Instructor, Water and Wastewater Technology,
Northern Alberta Institute of Technology (NAIT)

the program through distance delivery and work on it full time can complete the certificate in 12 months. Courses can also be taken for general interest or just in a specific area.

NAIT's CIT Department offers many courses for water and wastewater operators. These can be anywhere from one day to eight weeks in length. Current courses being offered in northern communities this year include a two-day hydrant and unidirectional flushing course (Fairview, Alta.), WWW117 Water Laboratory Analysis (High Level and Slave Lake, Alta.), Water and Wastewater Sampling (Iqaluit, Nunavut). For a community to have a CIT course delivered, all they need is a one-word topic and at least three people willing to take the course. Once this initial commitment is made the NAIT instructor will begin calling surrounding communities to see if they are interested in participating. Once 10 operators are found, a course can economically be offered in that community.

Coming in September 2010, is NAIT's long-awaited Mobile Education Unit. The unit will consist of a tractor and trailer. Inside this unit will be a working membrane filtration and gravity filter pilot plant. The rest of the trailer will be used to transport additional equipment, depending on the course being delivered. The main goal of the MEU is to enable remote communities to be able to train their utility operators correctly without that operator having to leave and go to Edmonton or Calgary. The training unit will be able to offer any training course that the full-time or distance delivery program can deliver. It will ensure operators are receiving hands-on training and not just theory. The unit will have equipment that can be used to train operators about disinfection, filtration, safety, process control, laboratory procedures, water main installation, water meters, hydrants, lift stations, and pump repair. To keep operating costs down, existing classrooms and science labs will still need to be utilized. Courses can easily be tailor-made to fit the needs of a particular community or region.

Things are changing daily in the NAIT Water and Wastewater Technician Department. This department works very closely with industry. If your community would like to be a part of this change, please feel free to contact Kurt Stogrin at: kurts@nait.ca *or 780-471-7698.*

NORTHWEST TERRITORIES WATER SUPPLY LEGISLATION – A NEW FRAMEWORK FOR CLEAN WATER

Justice Dennis O'Connor's report, flowing from the judicial inquiry into the Walkerton water contamination, set off a cascade of regulatory change touching virtually every jurisdiction in the country. This event was the most serious case of water contamination in Canadian history. It resulted in seven deaths and 2,500 people – half the population of the community – becoming ill. Since drinking water falls within provincial/territorial jurisdiction, the Northwest Territories (N.W.T.) followed the action of other jurisdictions, introducing a new statute (*Public Health Act*) in 2009, with new drinking water regulations (*Water Supply System Regulations*).

There is a marked departure in the thrust of the new legislation in comparison to the old legislation it replaced. The old legislation simply required that a water supply system be approved by the Chief Medical Health Officer; the new legislation sets out a two-stage approval process that first requires specifications approval, approval to construct, and then requires approval to operate upon completion of construction. The old legislation set out construction and design requirements for systems; the new legislation defers the total design and construction responsibility to a professional engineer. The old legislation was silent, for the most part, on the roles and responsibilities of operators; the new legislation is very detailed in the responsibilities of operators. The old legislation set out water quality standards; the new legislation adopts the Guidelines for Canadian Drinking Water Quality (GCDWQ) as part of the regulation. In addition, operator certification is now mandatory under the new legislation.

The first stage of the approval process defers the design and construction responsibility to a professional engineer by requiring, as a first step, that specifications be certified by a professional engineer with water treatment design experience. This enables the water supply systems to meet the latest industry and regulatory standards and the performance requirements of the Guidelines for Canadian Drinking Water Quality. Apart from this, it also enables changes in industry standards and design to become incorporated inherently, rather than requiring legislative change.

By Robert Savoury, Environmental Health Officer, Department of Health and Social Services, Government of the Northwest Territories

The second stage of the approval process, approval to operate, guarantees that the system is constructed as designed and that the source water meets with the approval of Chief Public Health Officer.

The approvals process impacts not just future water supply systems and systems under construction, but extends to existing systems. Existing water supply systems must have had approvals in place by April 1, 2010.

Adopting the GCDWQ into regulation creates enforceable standards. These guidelines set out the standards governing the sampling, testing, treatment and quality of water. Maximum Acceptable Concentrations (MACs) are set where possible for microbiological, chemical and physical parameters. In cases where reliable detection techniques do not allow for the establishment of such limits, treatment techniques to achieve a performance outcome are prescribed. For example, no Maximum Allowable Concentration (MAC) is set for viruses, but the GCDWQ mandates that a treatment process has the capability of producing a 4 log reduction in the number of these pathogens. GCDWQ outlines a combination of treatment processes, a minimum disinfection concentration, minimum contact time and defined filtration method, to achieve that outcome.

Adoption of GCDWQ ensures that the standards governing the sampling, testing, treatment and quality of water remain current, since a revision to the GCDWQ will automatically become a revision to the regulations. This is a key element to the water quality parameters needed in the legislation because water science is still evolving and discovery of new pathogens or chemical hazards results in ongoing updates to the GCDWQ.

The roles and responsibilities of operators are now clearly defined in the new regulations. The responsibilities encompass the complete plant operation including maintenance, disinfecting, water distribution, transportation and delivery, record keeping and reporting. There is requirement to develop Standard Operating Procedures (SOPs), respecting many aspects of the plant operation. The responsibility of the operator in response to adverse events is also defined. The burden on the operator may seem onerous, but is central in providing safe water to the consumer.

Operator certification is now mandatory under the new legislation. Communities with a water supply system without a certified operator are permitted a "bridging" period whereby the operator, under the supervision of a certified operator, must commence a process towards certification acceptable to the Chief Public Health Officer. The "bridging" provision recognizes the difficulty of recruiting certified operators in remote locations. This provision, at a minimum, ensures that the operator is progressing on a path to certification in a timely manner. As well, the GNWT recognizes that operator certification and continuing education is crucial to maintaining the standard of care required of plant operators and advances the certification requirement of the regulations by offering Water

Operators receive training on chemical pumping system at the 2009 NTWWA conference.

Treatment Plant Operator training through its School of Community Government.

The Canadian Council of Ministers of the Environment, and The Federal-Provincial-Territorial Committee on Drinking Water endorse the "multi-barrier approach" (MBA) as a method of providing a greater level of safety of the drinking water supply. MBA takes a holistic approach at the water system and ensures there are barriers to eliminate threats or lessen their impact. The categories are defined as source water protection, treatment, distribution, monitoring and response to adverse events. The provisions of the *Water Supply System Regulations* are consistent with the "multi-barrier approach"; each provision fits with one or more of the barriers and all barriers are adequately addressed within the regulations.

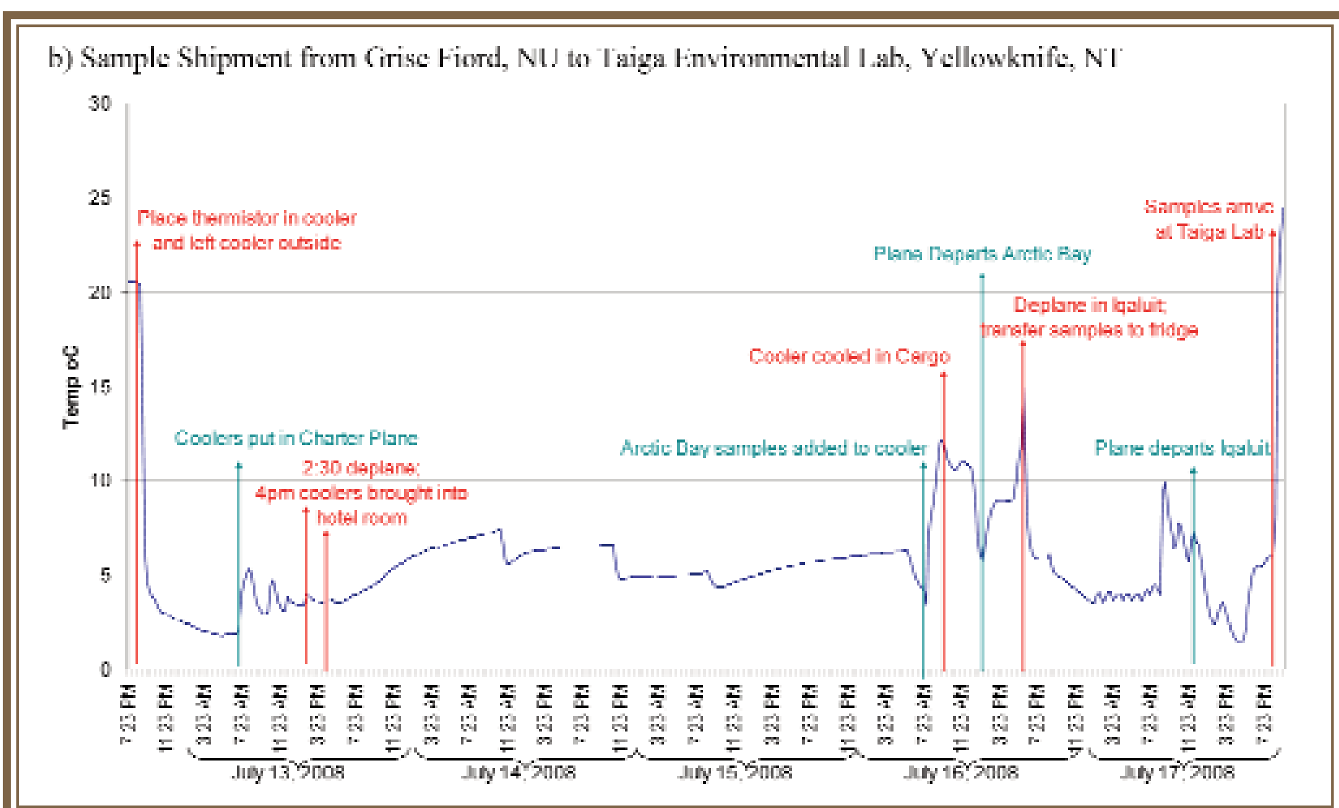
The test of any drinking water supply system legislation is that its provisions provide the regulatory framework, which ensures that the operation of the water supply system lessens to the extent possible, the risk of contamination and the threat to public health. The Northwest Territories' new *Public Health Act* and *Water Supply System Regulations* meet the test of providing adequate legislative framework. Its provisions are consistent with the "multi-barrier approach" and make certain the public have access to a drinking water supply system that is designed and constructed in compliance with the latest standards, is operated by competent certified operators, and produces drinking water that is governed by nationally accepted standards.

WASTEWATER SAMPLING CHALLENGES IN GRISE FIORD AND OTHER NORTHERN COMMUNITIES

Introduction

The rollout of the Canada Wide Strategy for the Management of Municipal Wastewater Effluent continues to advance with the February 2010 announcement by Canada's environment minister that a draft of proposed municipal wastewater systems effluent regulations was available for public consultation. It was noted in the press release that "once in force, these regulations will set standards for the discharge from all wastewater facilities in Canada. Over time, wastewater facilities across the country will have to meet these national standards. It will no longer be permitted to directly release raw sewage into our waterways." The announcement failed to mention that the Northwest Territories (N.W.T.) and Nunavut did not endorse the legislation at the time of endorsement by the Yukon and the provinces in February 2009. A big gap remains in the practicality and fairness of this legislation for the Far North regions of Canada, in particular the Inuvialuit Region of the Northwest Territories, Nunavut, the Nunavik Region of Quebec, and the Nunatsiavut Region of Labrador.

In fairness to the rollout of the legislation, a research program to quantify the performance of existing wastewater systems in the Far North is ongoing, and has a five-year reporting mandate. However, in addition to the basic process performance challenges with northern waste-



Travel journey for wastewater sample from Grise Fiord temperature showing time and temperature.

By Ken Johnson, AECOM
Edited from 2007-2008 Summer Sampling Final Report,
Canada Wide Strategy for the Management of Municipal Wastewater
Effluent – Northern Research Working Group, Dillon Consulting Limited

water treatment, the research program has identified a number of logistical challenges that may overshadow the actual implementation and monitoring of the legislation.

2008 Sampling Program Results

The purpose of the 2007-2008 sampling program was to identify the current wastewater treatment system configurations and performance in northern communities, where the proposed Canada Wide Strategy (CWS) for the management of municipal wastewater effluent may apply. The strategy includes national performance standards for the release of total suspended solids (TSS), and carbonaceous biochemical oxygen demand (CBOD) in wastewater effluent.

A total of 39 communities were visited during the sampling program: 22 communities in the Northwest Territories, 13 communities in Nunavut, and three communities in the Nunavik Region of Quebec. In each community, information was collected on the wastewater system, and wastewater samples were taken, when possible, in the various cells of the systems, and at the discharge of the system into the environment. These samples were tested for a full suite of chemical and biological parameters.

Sample results were analysed and compared to the proposed CWS effluent quality standards of 25 mg/L for TSS, and 25 mg/L for CBOD. The sampling results indicated that 16 of 25 wastewater effluent samples collected (64 per cent) DID NOT meet the proposed CWS standards for TSS, and 10 of 16 wastewater effluent samples (63 per cent) DID NOT meet the proposed CWS standard for CBOD.

A very interesting note to the sampling results is the researchers identified that the "representative sites" should meet a variety of criteria, which included:

- Easy access to and from Yellowknife for prompt laboratory analysis of samples.
- Definitive and accessible sample locations for raw, primary secondary and final effluent.

Sampling Timeframe and Temperature Challenges

The report on the 2008 sampling program noted various challenges in acquiring representative wastewater samples in each of the communities of the study including meeting the laboratory "holding time" for time sensitive sampling,

Sewage lagoon in Grise Fiord, Nunavut –Canada's most northerly municipal wastewater treatment facility.

Sewage lagoon in Ulukhaktok(Holman), NWT.

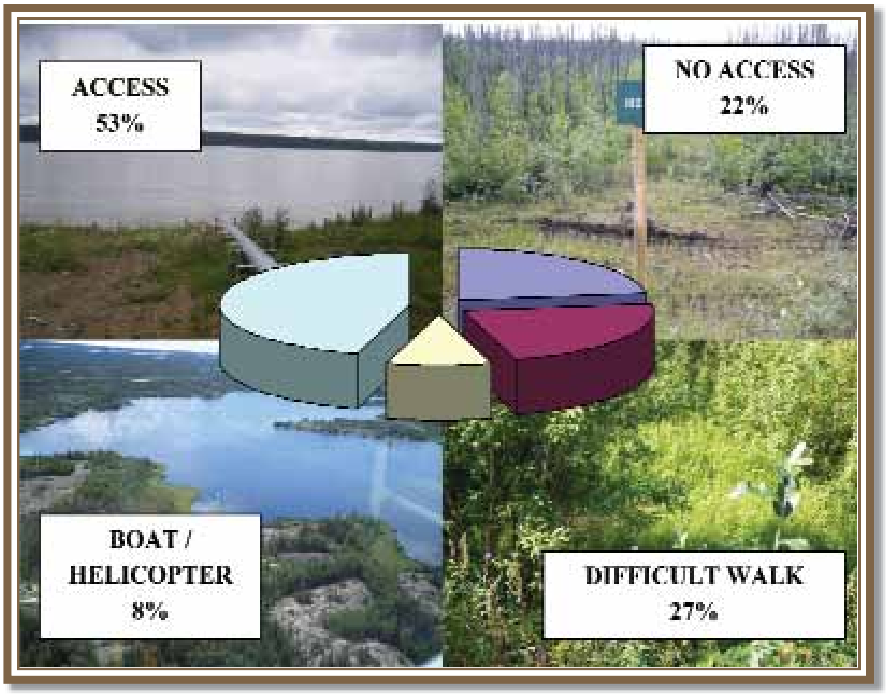
keeping the samples cool, access to the sampling locations and defining the location for obtaining representative samples, particularly the so-called "end of pipe."

"Holding time" is defined by the difference between the time of sampling, and the time at the beginning of the laboratory analysis. Bacteriological analyses must meet a maximum 24-hour holding time, and BOD and CBOD analyses must meet a maximum 48-hour holding time. Most communities in the N.W.T. and Nunavut are difficult to access for the purpose of sampling because planes only fly in and out on certain days of the week, and seasonal weather can isolate a community for days at a time. A related challenge to getting a sample back to the lab within the maximum holding time required by CBOD, BOD and bacteriological analyses, is that samples sometimes need to be taken at odd hours of the day (or night) in order to "catch the plane."

Most water samples require cooling between the time of sampling and the time at the beginning of the analysis. The reason for lowering the temperature is to reduce any ongoing biological or chemical activity that would normally occur in a sample, which will change the composition of the sample. By cooling the sample, the lab results should reflect the composition of the water sample at the time of the sampling. When samples arrive at laboratory, they are placed in a refrigerator holding room that is maintained close to 4 C. While in transit between community and laboratory, samples are placed in a cooler with ice packs to reduce the temperature. In order to ascertain how consistently cold temperatures were maintained throughout the longest transit period in the 2008 study, temperature monitors called "thermistors" were placed in the sample coolers originating from Grise Fiord, Nunavut. The temperature spikes that reached 10 C occurred when the sample cooler was opened to put in more wastewater samples.

Sampling Access Challenges

Accessing wastewater sampling locations was a definite challenge for the 2008 study. Many locations were either completely inaccessible or very difficult to access. Notably, 22 per cent of the communities did not have access to the



Accessibility of lagoon sampling points across the north.

receiving water body of the wastewater system effluent.

In addition, the location of the end of pipe is still not clearly defined in CWS, and samples were taken at the likeliest location of the end of pipe. Many of the community samples had a wetland treatment as part of their treatment process, therefore the end of pipe was not clearly defined, creating a challenge to identify and access to the final discharge point. For the majority of the samples taken from 39 communities, there was not a clear location for the end of the effluent discharge pipe.

Conclusions

Biological systems at the mercy of the natural environment (such as sewage lagoons, and wetlands) are inherently variable regardless of latitude. If excessive cold temperatures are thrown into the mix, then biological systems are inherently unreliable for consistently meeting a prescribed low target, such as the CWS guidelines. The results from the 2008 sampling study clearly demonstrate this fact, with over 60 per cent of the samples not meeting the CWS standards for TSS and CBOD.

The logistical challenges for moving "stuff" around the North are intuitive for anyone who has done work in the North. A minimum five-day timeline for transporting wastewater samples from Grise Fiord was documented. Temperature variations that "bounce all over the place," were also documented and these temperatures are well outside the criteria for valid process monitoring within the CWS framework. This information alone challenges the validity of using the CWS standards in the North. Add to this mix the reality that only 50 per cent of the sampling points are accessible, and the argument against the current CWS framework in the Far North is strengthened.

TUNDRA MINE SITE EMERGENCY TREATMENT CHALLENGE

Introduction

The abandoned Tundra Mine site is located some 250 kilometres north of Yellowknife on the shores of Mckay Lake. The site was an active gold mine owned by Royal Gold. After the site became the responsibility of INAC it was assessed through the Federal Contaminated Sites Accelerated Program (FCSAP), and a remediation program and schedule developed. The remediation was composed of two phases including Phase 1: Surface Infrastructure Remediation, completed in 2007, and Phase 2: Tailings and Hydrocarbon contamination remediation to be initiated in 2010.

Following the completion of Phase 1 by Aboriginal Engineering in 2007, and through continued site due diligence monitoring, the Crown determined that the two tailings ponds were reaching precariously high water levels and the tailings dams were at risk of failing. Catastrophic failure of the tailings dams would result in the release of millions of gallons of arsenic-contaminated water and tailings and potentially contaminate the surrounding watershed for hundreds of kilometres. This critical situation necessitated the urgent reduction of the volume of arsenic contaminated water in the tailings ponds to reduce the risk of dam failure to manageable and acceptable levels

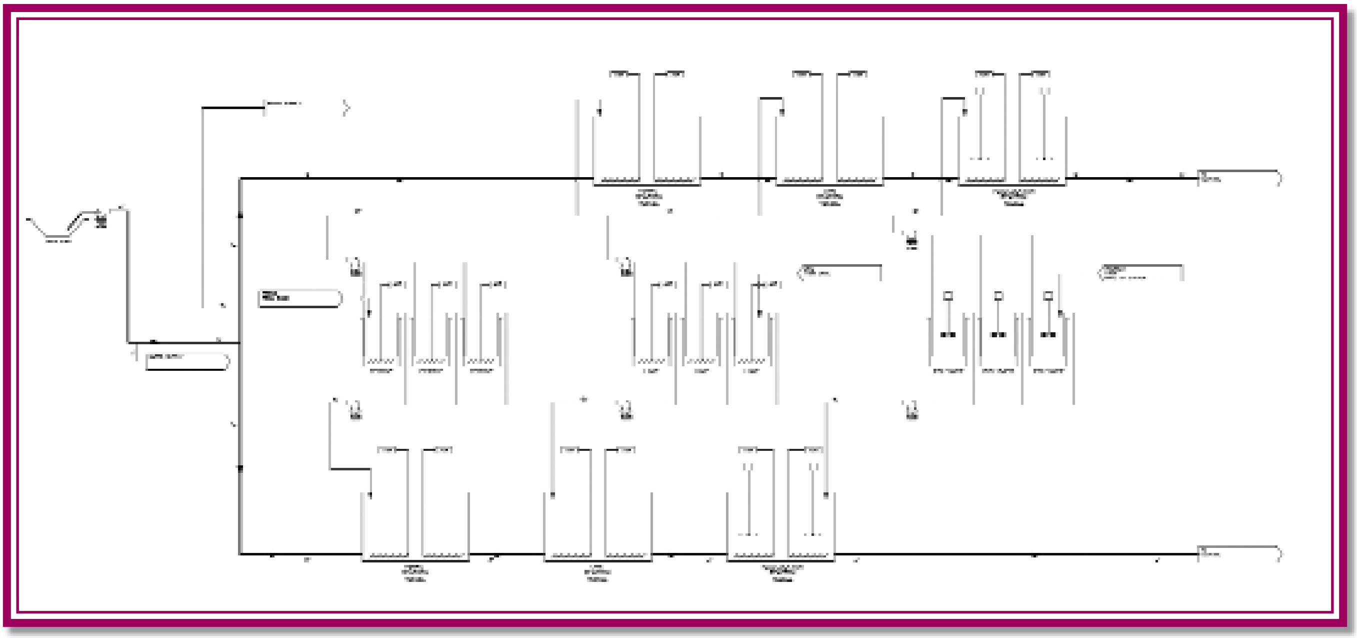
The Project and the Challenge

In simple terms, the project entailed

By Harry Marshall, President,
WESA Technologies Inc.

the treatment of 100,000 m^3 of tailings water to reduce contaminant levels to well below background levels in the discharge streams, while ensuring that there were no accidental spills to the environment. While simple to do in principle, in an Arctic environment significant problems were anticipated because of the process technology and logistics. These problems included a very limited process operating season (above zero weather conditions between June and mid-September) for an unsheltered system, fish spawning constraints (season that did not end until July 15) and very limited site infrastructure. Time was of the essence and a unique solution had to be found to make it all work, while ensuring environmental and human health and safety.

Geotextile filtration system for Tundra Mine.



Process flow diagram for Tundra Mine treatment system.

The Challenges

The first challenge was logistical. Equipment at the site included only a pickup truck and a loader. How does one construct a 150-m^3/hour treatment plant to run 24 hours a day, seven days a week, for 90 days, that can be flown to site on a DC4 aircraft, be handled by manpower and a small forklift and be transported from the airstrip to site by a pickup truck? The design, manufacture, and shipping to site had to be completed within four weeks after contract award in mid-June, with installation by an untrained crew with experienced supervision on uneven ground. This had to be done in 10 days – from landing, to throwing the power switch. The plant had to operate without downtime and spares etc., and the process technology had to be readily available.

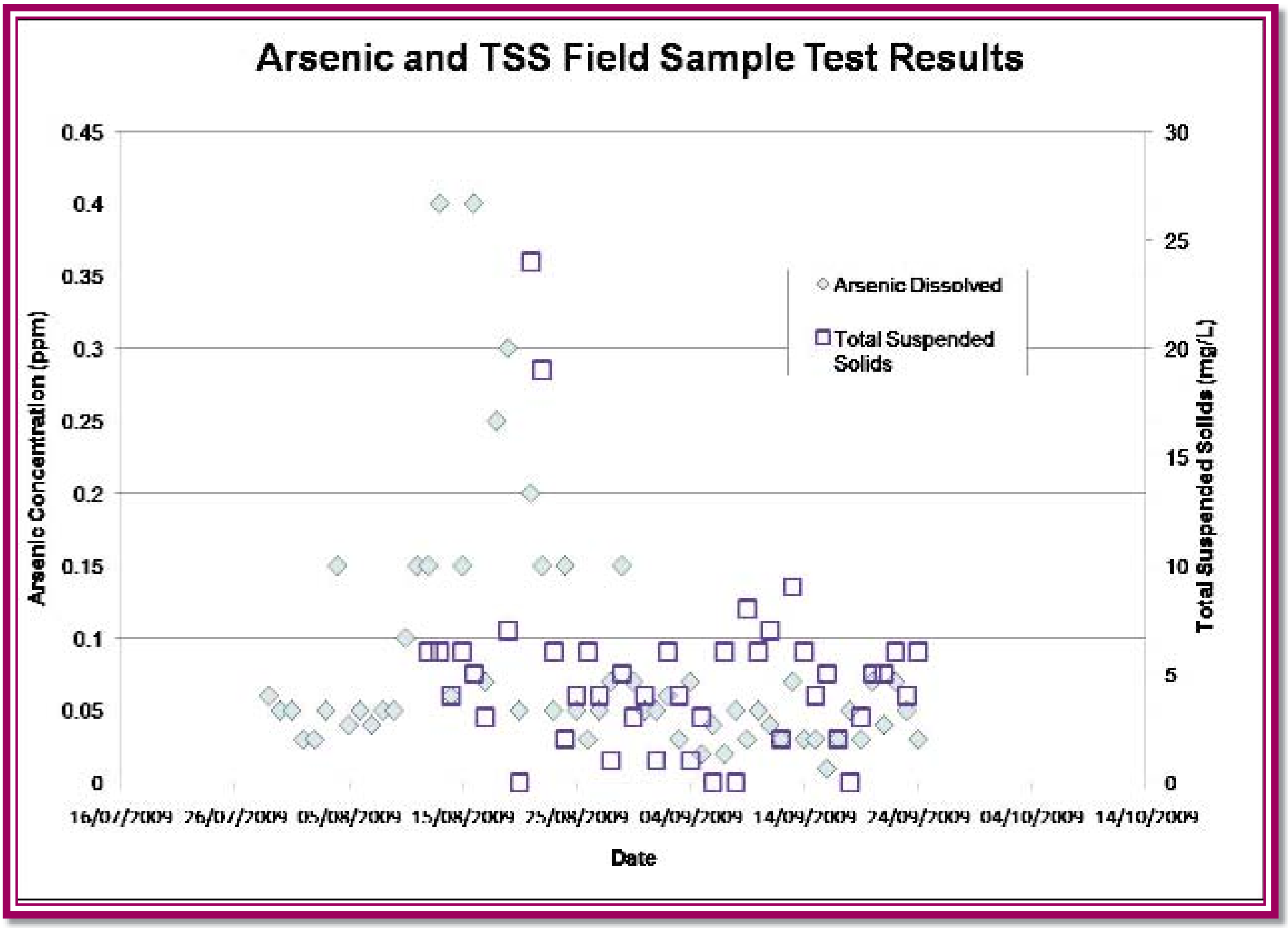
The second challenge was process. The finished plant had to operate to produce an effluent-to-stringent criteria established in the land use permit for 0.5 mg/L arsenic, and 30 mg/L suspended solids. The influent and effluent had to be tested in an on-site laboratory, and the resulting solids from the precipitation process had to be controlled and isolated from the system. The tendered design called for a ferric/lime treatment using the limited chemical supplies on-site, and the use of a series of baffles to be installed in the smaller pond to provide precipitate removal. Unfortunately, there was insufficient time in the season for the proposed method of recirculation of flow. A system had to be devised to allow immediate discharge.

The Process Solution

The project became an exercise in thinking outside the box. The first issue, however, was the size of the box, a logistical issue. A 3,600 m^3/day treatment plant had to be built, and it had to fit in the back of a DC4 with a door opening of three metres by three metres. The solution was collapsible tanks that could be folded into a small box and would expand when filled. Military grade onion tanks were sourced and built to our specifications.

Since the tanks were made of flexible plastic they could not support any equipment. A support structure was developed that could carry the weight of equipment, be extremely flexible in design, light in weight and quick and easy to construct. The solution was found in a new European product which allowed the construction of a light weight frame and secondary support supra-structure around our tanks. This accommodated well-supported and protected air lines, and electrical conduit and chemical lines that could be routed anywhere and could be routed safely. Pump supports, mixer stands and even baffles where made from the frame product and, installation took only one day.

Another major issue was the capture and retention of the precipitated solids without the use a typical clarifier, which had limitations due to the available time, the bulk of the system and the cost. Past experience suggested that this was an ideal application for a geotextile-based encapsulation system. The product came in a roll, was easy to transport and install.



Arsenic and Total Suspended Solids field sample test results for Tundra Mine.

Successful Operation

The system operated from July 29, 2009 – after a seven-day delay waiting for off-site analytical data for verification – until Sept. 29, running an average of 23.5 hours a day. The treatment volumes averaged 3,600 m^3 /day for a total volume treated of 180,000 m^3. Levels of arsenic and suspended solids were well below requirements. Pond levels were reduced by 1.5 metres, which were well below the critical levels. The arsenic solids were encapsulated and stored on-site in the geotextile-based encapsulation system for future disposal during Phase 2 of the remediation project. The entire treatment program took place inside the smaller upper pond containment area resulting in no accidental discharge possibility. The site was decommissioned and winterized in only seven days.

Special thanks and recognition need to be given to the INAC and PWGSC personnel who were ready to give WESA the latitude to try something new and work with WESA through its implementation. Credit is also due to Aboriginal Engineering Ltd., who worked tirelessly throughout the project, and to the operational staff of WESA Technologies, who operated this facility for 90 days without a break.

BUNDLED WATER TREATMENT PROJECT IN FIVE NWT COMMUNITIES

The construction and completion of major infrastructure projects such as water treatment plants, poses unique challenges and risks in northern Canada due to several factors. Some of the challenges and risks include: the costs of construction and maintenance in the North are high compared to the rest of Canada; geographical isolation leads to high power and transportation costs; the short construction season and lack of all-season access pose planning challenges that often result in increased costs; and the stress of building and operating in a harsh northern environment drives construction and operating costs higher, and shortens the life cycle of many assets. In addition to these factors, new regulatory requirements pose additional challenges related to the construction of water treatment plants.

The Northwest Territories (N.W.T.) adoption of the Guidelines for Canadian Drinking Water Quality (GCDWQ) has encouraged development of water-related infrastructure throughout the territory. With the implementation of new infrastructure comes new technology, and with new technology comes increased technological risk. The days of facilities that consist of a simple intake, chlorine pump, and truck fill arm are gone. There are now concerns related to log removal credits and human machine interfaces (HMI). There is also a need to balance the risk of increased operational complexity with the requirements of the Northwest Territories' Water Supply System Regulations, established under the *Public*

By Perry Heath, Manager, Infrastructure and Project Management, Municipal and Community Affairs, Government of the Northwest Territories

Water treatment plant bound for Ulukhaktok by sealift crosses the border into the Northwest Territories.

Health Act. In addition, the challenge of finding certified water treatment operators is an ongoing issue in northern Canada. The higher the class of facility and the more complex it is, the more difficult it is to find and retain a qualified operator. Although this is true for much of Western Canada, the challenge is amplified in the North due to recruitment and retention issues. This reality has prompted the need to build facilities as technologically intuitive as possible.

In May 2008, after a competitive request for proposals process, the Government of the Northwest Territories (GNWT) awarded a design-build contract that required the construction of build five complete water treatment plants in less than two years. This venture was not without its risks and challenges. The contractor faced many logistical challenges such as short ice road seasons and unpredictable barge shipping dates; the GNWT faced the challenge of ensuring value for money; and meeting the GCDWQ posed another challenge, which increased the

project's technical complexity to a point where it could be difficult to be sustainable at the community level.

For two of the five water treatment plants, the selection of the appropriate treatment technology was relatively straight forward. The turbidity and varying water quality characteristics in Behchokö (Edzo) and Aklavik indicated that the best treatment solution was implementation of a conventional system. Although conventional treatment is not the simplest, it is capable of treating raw water to ensure compliance with the GCDWQ. The remaining three projects presented a much larger challenge.

Déline, Ulukhaktok and Tuktoyaktuk are considered by the GNWT as pristine water sources, and extensive water quality testing indicated that their turbidity levels rarely exceeded 1 NTU. By capitalizing on the incredibly clean water through pilot testing of alternative technologies, the team was successful in obtaining regulatory approval for a design that meets the log reduction targets for bacteria, viruses and protozoa.

The resulting treatment train for Ulukhaktok included the combination of 50 micron automatic filters in series with UV reactors (40 mJ/cm^2 dose) with a chlorine contact chamber for the inactivation of viruses.

The Déline treatment train was very similar, but included the addition of a five-micron- and one-micron-absolute cartridge filter. The filters were included due to the size of the Great Bear Lake watershed and the difficulty in guaranteeing the protection of the raw water source.

In Tuktoyaktuk, the water quality was very close to that of Ulukhaktok and Déline, but with slightly higher peak turbidity. The process in Tuktoyaktuk required the addition of a pressure filter to help stabilize the turbidity peaks. This increased the complexity of the plant slightly, but the team was able to meet their water quality objectives without using chemicals, which was considered an acceptable trade off.

The concept of remote control and remote monitoring was central in the discussions surrounding the control philosophy of the water plants. Ultimately, it was decided that there would be no Supervisory Control and Data Acquisition (SCADA) used in any of the facilities. Rather, a simple intuitive HMI would be combined with stand-alone controllers where required (e.g., heat traces). This decision limited the ability to control the facility remotely, so it was set up to pro-

vide for remote diagnosis and data collection. The rationale for this decision was based on the logistical realities of operating a facility in Canada's North: easy access to technical support is not available due to the geographical remoteness of most communities in the N.W.T.

The key to success on this project was recognizing the risks that are inherent in building and operating in Canada's North. Where possible, the project team took advantage of some of the best raw water quality in Canada and balanced that against the technological risk of implementing a treatment process capable of meeting the CGDWQ. When the water quality did not meet the CGDWQ standards, the team used tried-and-true technology and kept it simple.

Figure 2. Installed water treatment plant in Ulukhaktok.

FISHER RIVER FIRST NATION NEW WATER AND WASTEWATER SYSTEMS

The beautiful and picturesque First Nation Community of Fisher River is located 215 kilometres (2 hours and 15 minutes) north of Manitoba's capital city, Winnipeg. It is located on the beautiful Fisher River that drains into Lake Winnipeg. The community is located on an all-seasons paved highway.

The old water and wastewater supply system consisted of individual wells and septic tanks with disposal fields. The only exception was for the school, which had a small water treatment plant and a small wastewater lagoon that served the school teachers' homes.

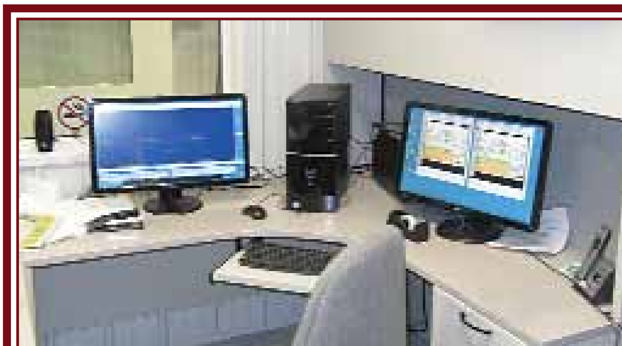
Since the community had a population of 1,700 band members, the density of the population was to the point that individual wells and septic systems were no longer practical. It was determined by the chief and council, along with Indian and Northern Affairs Canada that it was time a water treatment plant and a proper wastewater system be built in the community.

As a result, a feasibility study was carried out and a design consultant was selected. A Winnipeg based consultant firm, JR Cousin Consultant Ltd. was hired. The design was carried out after meetings between the chief and council, the consulting firm and some community meetings.

The water treatment plant is supplied by two 70-metre- (230-foot) deep wells with a capacity of 12 litres per second (160 gallons per minute) each. The quality of the raw water proved to be fairly good, therefore no pre-treatment was required, and the treatment requirement was limited to nano filtration for hard-

The New Fisher River Water Treatment Plant Building.

The proud operators of both the water and wastewater treatment systems. From left to right are: Herb Bradburn, Willie Chocken and Dave Cochrane.



The water plants SCADA control center and office.

By Ken Mattes, Senior Instructor,
Manitoba First Nations Water and Wastewater Instruction Program

View of the domestic and fire booster pumps.

View of the water treatment train.

The new wastewater treatment plant up-flow clarifiers and filters. In the foreground is the UV system.

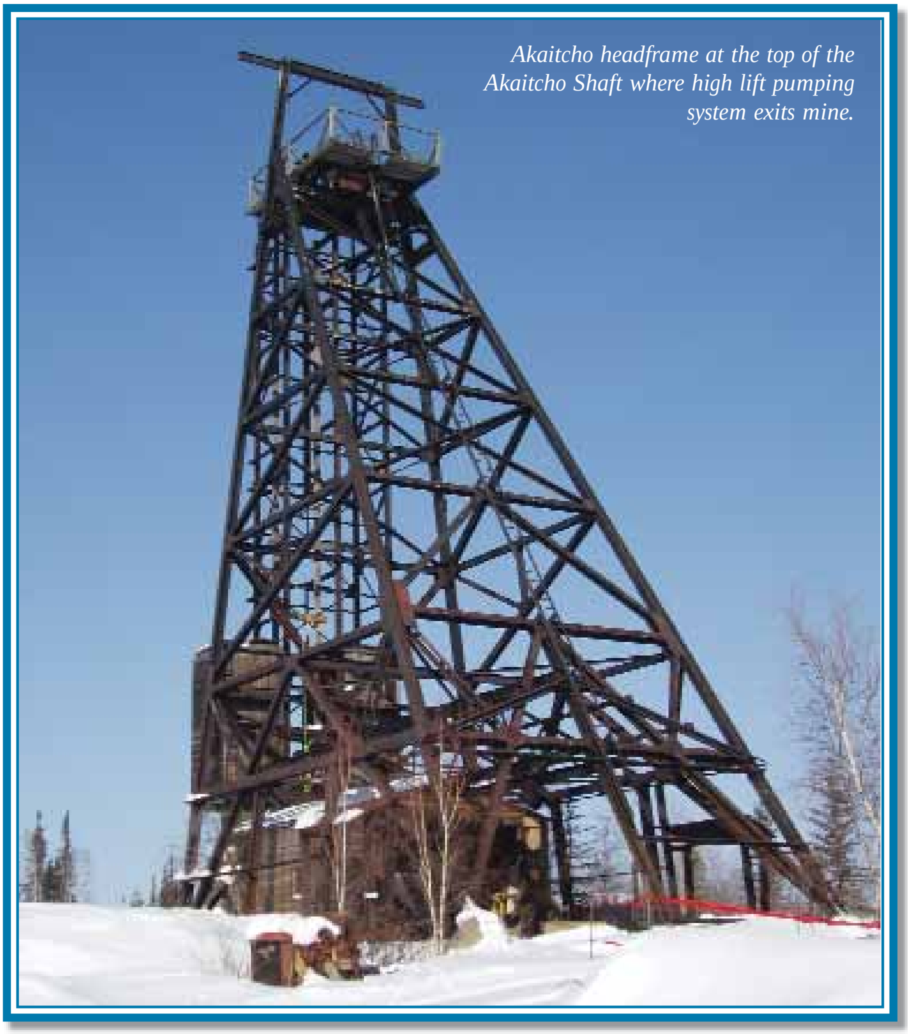
ness iron, manganese and sodium removal. The equipment was provided by Delco and was installed and commissioned in October 2009. The new water treatment system is considered to be state-of-the-art; it is well designed and well built with ease of operation in mind. The water that the plant is providing is of excellent quality and the community members receiving the water are pleased with the taste and clarity.

The plant was planned and designed to meet community growth for the next 20 years. The water is being distributed to some homes, the school and some band buildings, with a piped distribution system. The remainder of the homes in the community are on a trucked-distribution system. Eventually, all of the community homes will be supplied by the water plant. The plant was also designed so that bottled drinking water could be produced for some of the more remote homes in the community. The bottling equipment has not been installed at this time.

Since the Fisher River feeds into Lake Winnipeg, it is essential that the community wastewater system does not further compound the pollution of the lake. The wastewater treatment utilizes an aerated lagoon and an up-flow sand filter with chemical addition for phosphate removal. The sewage treatment system will be fed from a sewage collection system and with sewage truck haul to a proper dump site. The system is being commissioned in May 2010. The project fell behind schedule due to very wet weather last year, and this resulted in forced delays in the earth work. The system was installed using state-of-the-art building techniques with GPS controlled bulldozers. Wherever possible, the pipes were installed using trenchless technology.

The system to date has been working extremely well with only a few teething problems. The chief and council, the operators, and the community are very proud of the new system.

GIANT MINE WATER MANAGEMENT SYSTEM



Akaitcho headframe at the top of the Akaitcho Shaft where high lift pumping system exits mine.

Editor's Note: This project received the prestigious Award of Excellence from the Consulting Engineers of Alberta as part of the Showcase Awards 2010.

History of Yellowknife Gold Mining

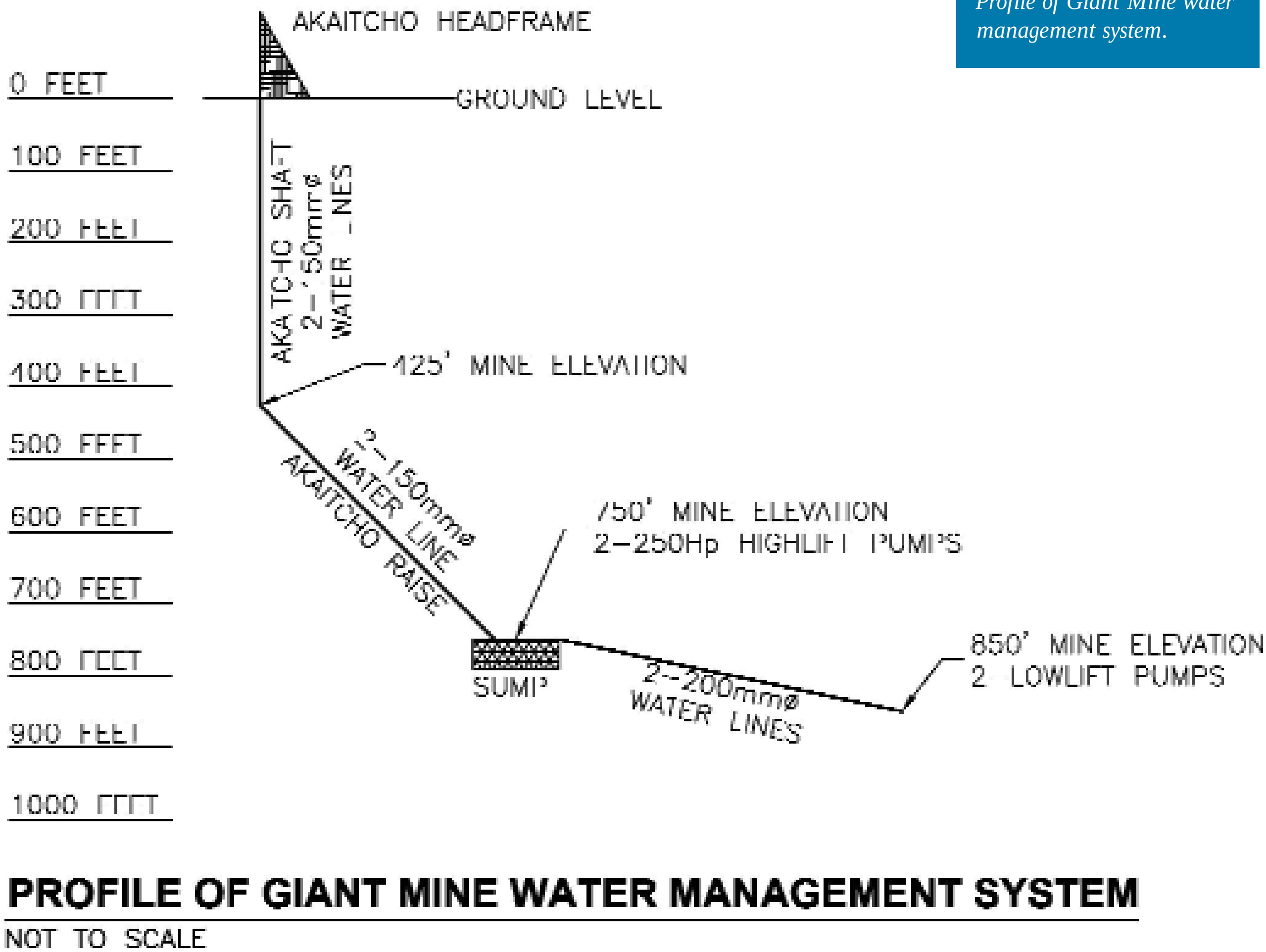
The history of Yellowknife is intrinsically linked to its start as a mining town. When gold was discovered on the shores of Great Slave Lake and the claims were staked, Yellowknife was born as a gold mining boomtown. The two most longstanding and productive mines – the Con and Giant mines – were a result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

The rock mined at Giant is rich in gold and arsenopyrite, a mineral that has a high arsenic content. The gold extraction process used at Giant required a "roasting" process to extract the gold from arsenopyrite rock. Arsenic trioxide dust was created during the production of more than seven million ounces of gold between 1948 and 1999. When the ore was roasted to release the gold, arsenic was also released as a gas. As the gas cooled, it became arsenic trioxide dust.

Over a 50-year period, 237,000 tonnes of toxic arsenic trioxide was produced, which is still being stored to depths of nearly 250 metres (800 feet)

By Ken Johnson, AECOM

Profile of Giant Mine water management system.



below ground in various shafts and chambers.

Arsenic trioxide is water soluble containing approximately 60 per cent arsenic, therefore it is critical to maintain the stored material "high and dry" to ensure that arsenic is not released into the environment. This effort requires that the groundwater be maintained below the 250-metre level through an automated dewatering pumping system.

Managing the Giant Mine Arsenic Trioxide

Almost all of the arsenic trioxide at Giant Mine is stored in 15 underground chambers and stopes (irregular, mined-out cavities) cut into solid rock. Concrete bulkheads, which act as plugs, seal the openings to these chambers and stopes. The arsenic trioxide dust is totally surrounded by solid rock.

Due to the extensive mining, the permafrost around Giant thawed, and water began seeping into the storage chambers, becoming contaminated, with the potential of entering the groundwater systems. In response to this new issue, the water is pumped from the mine to a treatment facility on the surface. The contaminants in the water are removed through a treatment process before the water is released into the environment.

When this underground storage method was originally designed, it relied on the area's natural permafrost, which worked as a frozen barrier. It was believed that when the time came to close Giant Mine, permafrost would reform around the storage chambers and stopes and seal in the arsenic trioxide. A 1977 report by the Canadian Public Health Association concluded that the underground storage of arsenic trioxide dust at Giant Mine was acceptable.

Access vehicle and access shaft to Giant Mine.

When the mine permanently closed, some stakeholders wanted the arsenic trioxide removed from the mine and shipped elsewhere, away from Yellowknife's 18,000 residents. Citing risks to workers and the environment, INAC settled the solution of re-establishing the permafrost around the underground chambers and into a big deep freeze, locking the dust into an eternal deep freeze. Integral to what is referred to as the "Frozen Block Alternative" is the automated dewatering pumping system to maintain the groundwater below the underground chambers.

In 2005, AECOM was retained by Public Works and Government Services Canada to provide planning and design of a new mine dewatering pumping system for the Giant Mine.

With the mine closure, cleanup and remediation efforts have been completed in the lower portions of the underground works and it is no longer necessary to keep the mine dewatered below the 850-foot level. Water enters the mine

as groundwater seepage and surface run-off. The mine water level is held at the 850-foot level by the automated mine dewatering pumping system.

Dewatering System Hydraulics and Pumping

Mine dewatering is maintained by pumping the mine water from the 850-foot level to surface at the historic Akaitcho headframe in two separate pumping lifts. The lower lift portion of the pumping system uses a duty stand-by set of parallel submersible pumps installed within HDPE carrier pipes in an inclined mine shaft. These pumps lift water approximately 30 metres to a sump located on the 750-foot level of the mine. The sump is configured to provide "dirty" and "clean" cells by using a series of concrete weirs placed across an abandoned mine drift. This sump provides a suction volume to the high lift pumping system that moves water from the 750-foot level to the surface in a single lift. Once at the surface, the water flows to a retaining pond for subsequent treatment. The high lift pumping system uses a duty standby set of parallel 250 horsepower multistage centrifugal pumps. Both the low lift system and the high lift systems are matched in pump capacity in order to provide a total dewatering flow rate of 275 cubic metres per hour.

Construction of Dewatering System

The mobilization of materials to the project site up to 850 feet below the ground surface was a major challenge, particularly since the mine is no longer in full operation. The contractor responsible for the work was Deton'Cho Nuna, which also has the "Care and Maintenance" contract for the mine. Construction of the sloped sections of the waterline from 850 feet to 425 feet would have been a routine exercise for pipe fitting contractors, however, the contracting resources available for the work were ex-miners and therefore the work proceeded slowly in the initial part of the project. As the work advanced, the contractor employed pipe fitting expertise and the work progressed much faster.

Construction of the vertical section from 425 feet to the ground level was difficult because it required construction from the bottom up, which meant

Figure 3. Section of low lift pipeline.

that six-metre pipe sections were lowered down the Akaitcho Shaft and sequentially added to the lower section and supported to the shaft wall. Access for this section of the work was challenging for the contractor because all of the steps and landing down to 425 feet were wooden construction dating back to the 1950s, in some cases.

Commissioning the dewatering system was held to a critical milestone of catching the spring run-off inflow. The work was ultimately completed in November 2008, for a total cost of $3,000,000 Cdn.

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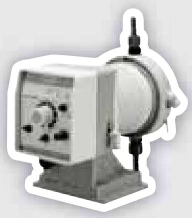

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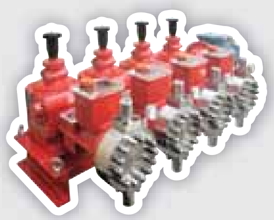

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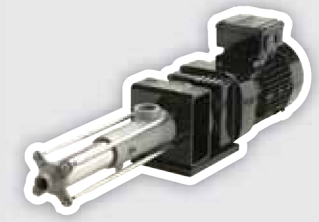

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PILOT-SCALE EXPERIMENTAL WETLAND CELLS IN BAKER LAKE, NUNAVUT

Introduction

Constructed wetlands (CWs) have become a popular low-cost, high-efficiency technology for the treatment of many different types of wastewater, and have been applied widely around the world, including warm and cold temperate environments. In the cold temperate regions of North America, and continental Europe, performance of constructed wetlands has been well documented. Free water surface (FWS) wetlands, horizontal sub-surface flow (HSSF), vertical flow (VF), and combinations of these systems have all been adopted throughout these regions. Constructed wetlands, however, have yet to be experimentally tested in Arctic conditions of Canada.

Treatment wetlands face two main operating challenges in cold climates: (1) failure of system hydraulics due to a change in viscosity or a freezing of the wastewater, and (2) the low temperatures leading to inadequate purification. CWs have also been shown to be an economical and a resource conservative technology appropriate for rural areas and in cold temperate climates with limited ability for large capital investments.

Many Arctic communities already use wetlands to treat municipal wastewater for either polishing after lagoon treatment, or as the primary method of treatment and disposal. The objective of the study was to determine the treatment efficacy of a small-scale HSSF constructed wetland during the Arctic summer and to determine a constructed wetland's ability to act as low-cost sustainable wastewater infrastructure for in the Canadian Arctic.

Background

The Hamlet of Baker Lake (64°N, 96°W) is the only inland community of Nunavut. As a result, its climate is more extreme than coastal regions; with average summer (June-August) temperatures between 5 C to 12 C, and mid-winter (December-March) -27 C to -32.3 C. The annual average temperature for the community is -11.8 C.

The current treatment system consists of a small detention pond (60 m^2) which drains overland through a sedge-dominated wetland into a series of small natural lakes with riparian wetland complexes between. The sub-basin drains into Airplane Lake and finally into Baker Lake. Currently, the community discharges, approximately, 167 m^3/day into the detention pond.

2008 and 2009 Study

In 2008, a gravity-fed HSSF was constructed as a pilot wetland system. The system consisted of four in-line cells, with a total treatment area of 15.25 m^2 (Table 1). The cells were built using recycled insulated fibreglass septic tanks and connected with one-inch-diameter polyvinyl (PVC) piping. The piping was installed through the berm side of the pre-treatment holding pond and submerged in the wastewater. Piping was buried to minimize late season freezing and discourage vandalism.

Local screened aggregate was used as the bed media, and perforated sampling ports were installed in the media at the influent and effluent of each wetland cell. The cells were planted with *Carex aquatilis* (Stans), and *Poa glauca* (Vahl) plugs, which are two sedge/grass species that are dominant in the adja-

Table 1. Pilot constructed wetland dimensions in Baker Lake.

Cell #	Length (m)	Width (m)	Area (m^2)	Depth of Water (m)	Depth of Gravel (m)	Total Saturated WaterVolume (m^3)	Water Only Volume (0.18 Porosity) (m^3)
1	2.26	1.98	4.47	0.33	0.36	1.48	0.27
2	2.16	1.73	3.74	0.37	0.51	1.38	0.25
3	2.16	1.73	3.74	0.3	0.51	1.12	0.20
4	2.13	1.55	3.30	0.38	0.46	1.25	0.23
Total			15.25	$\overline{X}$=0.345	$\overline{X}$=0.46	5.23	0.94

$\overline{X}$=mean

By Colin N. Yates and Brent Wootton,
Centre for Alternative Wastewater Treatment, Fleming College

cent natural treatment wetland. In 2008, wastewater flow into the system was initiated to establish the plant community and biofilm. Wastewater flow (m^3/day) was measured with a flow meter and collection tank, which was emptied daily.

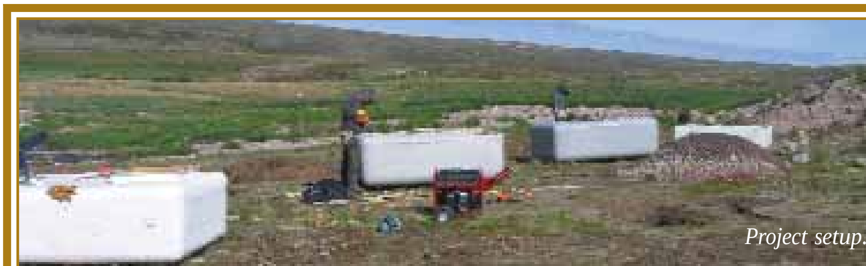
Sampling was initiated on the pilot system in June 2009. Samples were collected from the holding pond and sampling ports once per week, and from the effluent of the system three times per week, continuing for a period of seven weeks. Samples were tested for chemical oxygen demand (COD), carbonaceous biological oxygen demand ($cBOD_5$), total suspended solids (TSS), *E. coli*, total coliforms, ammonia (NH_3^+), total phosphorus (TP), and temperature with data loggers.

Results of Study

The experimental constructed wetland in Baker Lake received very concentrated wastewater, despite some pre-treatment in the small holding pond. Organic loading in raw sewage, denoted by $cBOD_5$, was observed to be high as an expected result of lower water use per capita in Baker Lake with the use of a trucked sewage collection system.

Average removal of wastewater constituents was observed to be greatest during the week of July 19, 2009. Performance of the wetland would be expected to be highest during this time in Baker Lake CW as this would correspond with the season's highest average mean daily temperature (11.4 C in July) (Environment Canada, 2009). Average removals for the seven-week period the CW was studied in 2009, is shown in Table 2.

The removal of ammonia nitrogen from the wastewater was minimal and concentrations were observed to even



Project setup.

Table 2. Wastewater treatment percent removal in the Baker Lake CW 2009

Parameters (original sample units)	Summer Average (%) Removal
COD (mg/L)	33.0
$cBOD_5$ (mg/L)	22.6
TSS (mg/L)	51.5
Total Phosphorus (mg/L)	5.9
Ammonia (mg/L)	--
Total coliforms (cfu/100ml)	99.3
E.coli (cfu/100ml)	99.9
Average Influent Temperature (°C)	17.0
Average Effluent Temperature (°C)	11.7

Initial plantings of sedge and grasses in Baker Lake experimental wetland cell.

increase in the effluent of the treatment wetland. Minimal treatment of NH_3^+ is expected in anaerobic systems, such as HSSF constructed wetlands, as oxygen present is used for the metabolism of organic matter prior to the nitrification of NH_3^+. Also, wastewater temperature decreased substantially as it passed through the wetland.

Despite the high BOD loading of the system, the constructed wetland did remove some organic matter from the wastewater influent and performed very well at removing suspended solids and pathogens. Pathogen removal in the system was high, at 99.3 per cent and 99.9 per cent for total coliforms and E.coli respectively. Sedimentation may have been the primary mechanism for its removal. This corresponds with suspended solids, which was also observed to have high removal rates during periods of the summer, up to 84 per cent during the week of July 20, and 81per cent in the week of August 10. The lower average is due to slow start up of the pilot system in June. Similar patterns were observed with total phosphorus. The average removal for the summer was only five per cent, however, removal was as high as 32 per cent in August.

Conclusions and Future Work

Despite slow start-up and high loading, promising mean removals of wastewater contaminants were observed. Greater pre-treatment prior to the wetland treatment will reduce the loading on the wetland, and would likely result in far greater reductions in wastewater parameters. Additional trials will be conducted in the summer of 2010 with pre-treated (diluted) wastewater, and variable flows to evaluate loading rates and hydraulic residency times.

NOTE: These data will be used to further calibrate constructed wetland modelling software (SubWet 2.0) that has already been calibrated using data from existing natural treatment wetland systems in Nunavut. This software is available for download from: http://www.unep.or.jp/Ietc/Publications/Water_Sanitation/SubWet2/index.asp.

Colin Yates is a PhD student at the University of Waterloo and a project manager at the Centre for Alternative Wastewater Treatment (CAWT); Brent Wootton, PhD, is director of the CAWT, and an adjunct professor at the University of Waterloo.

Experimental wetland cell and thriving sedge and grasses.

Set up of experimental wetland cells in Baker Lake.

Discharge.

RANKIN INLET WATER SUPPLY IMPROVEMENTS

In 2009, the Government of Nunavut contracted FSC Architects & Engineers (FSC) along with Resource Management Strategies Inc. (RMSi) to complete a water supply capacity, consumption and conservation study for the Hamlet of Rankin Inlet.

The Hamlet and the residents of Rankin Inlet were concerned about the decreasing water level in Nipissar Lake, the community's primary water source. The lake is located 1.5 kilometres northwest of the community, and provides water to the community through a buried utilidor system. Rankin Inlet has seen a steady increase in population over the last 15 years, from 1,850 people in 1994 to 2,500 people in 2009; the population of Rankin Inlet is projected to reach 4,650 by the year 2029. The purpose of the study was to determine if the current volume reduction in Nipissar Lake is a result of climatic variables or increased municipal consumption.

The first step of the study was to determine the current volume of water in the lake, and compare that data with the water volume from a previous study. A survey was completed in 1995 that determined the volume of the lake to be 3,470,000 cubic metres (m^3). The 2009 survey determined the volume of the lake to be 2,800,000 m^3, for a net decrease in volume of 670,000 m^3.

The next step was to analyze climatic variables for the region. Historical precipitation rates were analyzed between the years 1981 and 2008, and there were no obvious trends showing an increase or decrease in the amount of precipitation in the region. The conclusion was that climatic variables were not affecting the water level of the lake.

After the volume calculation and climatic variable analysis, it was concluded that the volume reduction in Nipissar Lake was due to the increase in population and resulting increase in water usage.

It was also concluded that the natural recharge rate of Nipissar Lake fails to meet the community's water use. Using the two estimated water volumes of the lake, an annual volume decrease of 44,000 m^3 per year (m^3/year) was determined. The same calculations were used to determine the annual water usage of the Hamlet of Rankin Inlet to be 356,000 m^3/year. The difference between these two numbers is the maximum discharge available from Nipissar Lake that will not impact or decrease the lake volume. In effect, 312,000 m^3/year is the maximum discharge that Nipissar Lake can sustain.

With the projected population increase of Rankin Inlet and the current water usage, the calculations suggest that Nipissar Lake could fail to have an adequate volume to supply the community as early as 2015.

In 2010, the Government of Nunavut again contracted FSC to provide a schematic design report to provide a pipeline system to augment the natural recharge of Nipissar Lake. This pipeline system will supply water from First Landing Lake to artificially fill Nipissar Lake and satisfy Rankin Inlet's water demand to at least 2029.

There were several factors that were taken into account in the design requirements. The main factors were population growth, water use, seasonal constraints, pipeline sizing and pump sizing.

By Clay Peck,
FSC Architects and Engineers

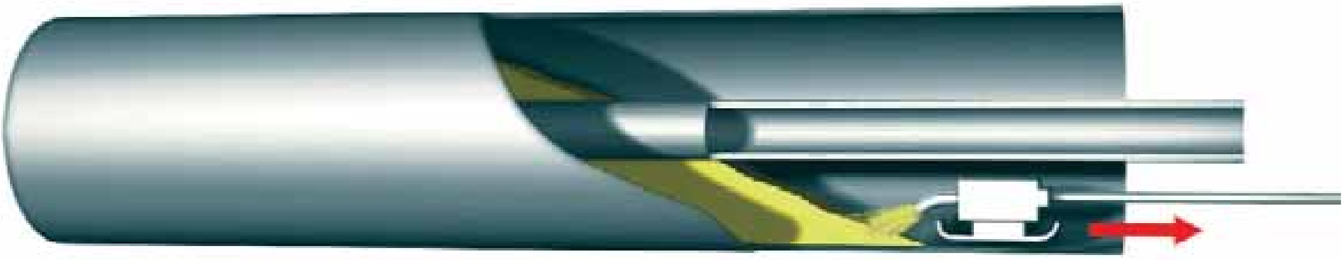
The pumping and pipeline system has to be a seasonal operation, because it will be necessary to deal with and avoid the potential ice conditions of the spring and the fall. The design report presented and anticipated a three-month pumping season, from mid-June to mid-September. This pumping schedule would avoid both the spring thaw and the fall freeze up.

To maximize pumping operations and to reduce costs, the design report recommended a trailer mounted diesel pump connected to the floating suction intake and pipeline with flexible connectors. This configuration will enable the pump to be stored for the winter, when pumping is not necessary.

The proposed pipeline route will be 4,350 metres (m) long, and the proposed pipeline will be High Density Polyethylene (HDPE) for the reasons of flow capacity, durability, flexibility, and cost. The report recommended a 4-inch, 75-horsepower pump and a 200-millimetre pipeline. This configuration will maximize both cost and functionality of the system and will meet the design requirements of Rankin Inlet water consumption.

The system to augment the natural recharge of Nipissar Lake will be ready to operate in 2011. The proposed pump and pipeline system will ensure that the Hamlet of Rankin Inlet will have a clean, safe and reliable water source for the next 20 years.

NORTHERN WATER AND SEWER - INSULATION TO INSTALLATION



Mixing head draw through method.

Water and waste infrastructure in northern communities made incremental improvements in the 1960s and 1970s as the subsistence lifestyles continued to decline, and more people moved to permanent settlements. During this period, water and sewer tanks were becoming more common, along with indoor plumbing, but these were still limited. Newer homes were equipped with wastewater holding tanks located on or beneath the floor of the house into which drained household waste from kitchen sinks, laundry, bathroom and toilets would drain by gravity.

In time, trucked delivery for water and sewer became the standard level of service in all but a few communities. A handful of larger communities started to develop piped systems, and this started the process of advancing water and sewer technology specific to cold region conditions with the application

By Doug Steinhubl,
Technical Sales Representative, Urecon

of shallow bury, insulated pipes and recirculating water systems. In the area of insulated pipe, a significant technological development for insulation became the use of polyurethane foam.

Insulation

Rigid polyurethane foam was first developed in Germany during the late thirties and was used commercially in wartime Germany to strengthen the wings of aircraft. Polyurethane foam is a thermosetting cellular plastic, consisting of a solid mass of small closed cells with a density range that makes it an excellent thermal insulator. Rigid polyurethane foam is one of the most effective practical thermal insulation materials known, whether used in buildings, refrigerators or on pre-insulated pipes. Compared with most other insulations, rigid polyurethane's performance throughout the life of a pre-insulated piping system provides long term economy, in both cost savings and energy conservation.

Polyurethane foam is formed as the reaction product of a polyol and isocyanate in the presence of catalysts, surfactant, blowing agent and other additives necessary to complete the foaming process. The pipe insulating process often uses the "mixing head draw through method," which utilizes a small mixing head that is drawn through the cavity to be insulated, and spreads the reaction mix uniformly over the length of the pipe. The reactivity, output and draw through rate have to be well synchronized in this method. The outer layer of the cavity may consist of a temporary plastic jacket over the core pipe into which the foam is extruded – this process is a bit of an art because of the estimating of the final volume of the foam and the distribution of the foam in the temporary outer jacket.

The application of insulated pipe has advanced and the use of the polyurethane foam system is a standard for all types of piping material including: ABS, copper, PVC, ductile iron, and high density polyethylene.

An integral part of the pipe system is the external jacket, which protects the insulation on the outside of the pipe. The common "jacket of choice" in the North is a factory applied extruded polyethylene jacket that is UV inhibited and specially formulated for cold weather properties. Other materials used for the external jacket include corrugated metal pipe or other metal cladding.

Several methods are used to insulate pipe joints, but most use a factory built "shell" that is installed on site. The insulation joint will depend on the type of outer jacket and core pipe, the method of pipe joining and whether the installation is buried or above ground.

Installation

Once insulated pipe is transported to the field, another equally challenging process begins with the installation of the pipe. An interesting thermal related point about the use of buried versus above ground pipes is that above ground pipes are subjected to temperatures as cold as the surrounding air, with low temperature extremes of -45 C. Buried pipes are subjected to a much warmer temperature extreme which may be in the range of -10 C.

Trench excavation for buried installation in frozen ground is a difficult process because frozen ground is essentially "as hard as rock." In fact, an early method of permafrost excavation was to literally blast it away. The logical way to avoid this condition is to excavate when the ground is thawed, and this only occurs in the summer months. The thaw process in ground is a gradual process, and may be limited in some locations to less than two metres, which is commonly referred to as the "active layer." A unique northern approach to take advantage of the limited active layer in some locations is the use of shallow buried pipelines, which may have as little as a metre of cover material, depending upon the loading conditions on the pipe.

The use of shallow buried pre-insulated pipe can result in a substantial reduction of excavation costs and may permit earlier project completion. Pre-insulated pipe can be installed in the active frost zone and resist freezing. Savings are greatest when rock is encountered as it is far less expensive to pre-insulate and shallow bury water and sewer pipes than to blast and deep bury in rocky conditions.

Insulated pipe is transported in limited lengths, therefore pipe connection

Pipe installation in trench.

Butt fusion pipe connection.

in the field is required. One of the standard methods for joining HDPE pipe is "butt fusion" where the two ends of the pipe are heated and allowed to fuse together. A special "butt fusion" machine is used for this operation.

The placement of pipe in an excavation follows practices which are unique to the location. For example, in Iqaluit, excavations usually fill with water because of the melting in the active layer, and continuous pumping is required. Bedding for the pipe consists of granular material, and in some cases coarse gravel.

In Dawson City, the placement of pipe is done as quickly as possible in some locations because of the presence of large ice lenses which quickly melt in the open air and jeopardize the stability of the excavation. A good rule of thumb for excavation and placement of pipe in permafrost is "keep it frozen",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Finished pipe installation before backfilling.

which usually is applied in the refreezing of the excavation and maintaining the pipe outside the active layer.

Another unique advantage of HDPE pipe is the ability to “butt fuse“ one entire length of pipe (usually manhole to manhole), and then place the entire length of pipe at one time. Although the application of this method of installation may occasionally push the bending limits of the pipe, it provides a convenient opportunity to complete all the pipe connections outside the trench.

“Insulation to installation“ is a process unique to the north and it involves many different technologies applied in many different geographic settings.

President's Report

Sudhir Kumar Jha

It is my great pleasure to write to you as the President of Northern Territories Water and Waste Association (NTWWA). As many of you know, our association has experienced significant growth and is poised again to expand. I am grateful for this opportunity and deeply appreciative of the strong support provided by all our NTWWA members. I would like to thank our members for making efforts to engage new members, and reconnect with those individuals whose membership has expired.

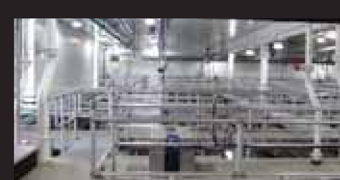
Thank you to everyone who was able to attend the 2009 conference in Cambridge Bay, Nunavut. Though economic times are tough, we witnessed an increase in the participation from all over Canada at the Cambridge Bay conference.

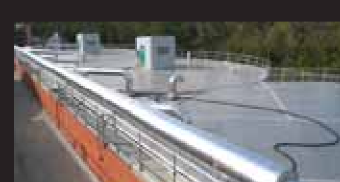
I would like to express my deep appreciation to our conference planning committees, and financial sponsors for their hard work and generosity that was a key ingredient in our successful conference. I would also like to extend a specific thank you to Edith Phillips, the President of Western Canada Water (WCW) for taking the time to attend the conference. I would like to extend an invitation to the incoming WCW president, and all WCW members to join our association at the 2010 NTWWA conference in Yellowknife, N.W.T. in November. I think you will find the NTWWA conference experience to be very rewarding – just ask Edith.

Although we are making progress, we need to continue to work towards recognition of our profession, and I would encourage senior members to mentor and support junior water professionals. I would also encourage everyone to explore the NTWWA website (www.ntwwa.com) and to speak with long-standing members to learn what the NTWWA is all about, and to better understand the benefits of membership in the association.

Thank you for your continuing support of the NTWWA. Let us pledge to make this association continue to grow, so that we may maintain and improve upon the service we provide to our members. We are always looking for new and creative ideas as a basis to increase the service to our members, and we welcome your thoughts and feedback.

We look forward seeing you in Yellowknife in November 2010.





Executive Director's Report

Olivia Lee

The sixth annual *Journal* publication features a variety of articles relating to water and wastewater management in the North and it is always an interesting read.

The 2010 NTWWA Annual Conference, Trade Show, and Operator's Workshop will be hosted in Yellowknife, Northwest Territories, November 20 to 22. This year the conference is focusing on Empowering Northern Water Professionals. All water treatment plant operators experience challenges, but here in the North some of the key challenges faced by operators include isolation, and capacity. In many smaller communities the water treatment plant operator is not just the water treatment plant operator, but is often the jack-of-all-trades in the community due to the limited capacity. It is important that we recognize the tough job of a water treatment plant operator and the amazing weight of their overall responsibility, which is to protect our health. If you are a northern water or wastewater professional, mark your calendars and join us at the annual event to share ideas and learn about northern water and wastewater challenges and solutions.

Last year the Annual Conference, Trade Show and Operators Workshop, held in Cambridge Bay, Nunavut, was a huge success with 60 delegates, including six trade show booths and 16 presenters. Thanks to those operators who sat on the Operator's Panel and shared their experiences. We look forward to another Operator's Panel at the 2010 conference. Thanks to the Town of Cambridge Bay, their staff, and to NTWWA vice-president Sudhir Kumar Jha and administrator Pearl Benyk, for all their hard work co-ordinating the logistics of the 2009 NTWWA annual event. The delegates, presenters and trade show participants are key to the success of the annual event, so thank you very much for your participation, and we look forward to having you back this year.

The winner of the 2009 Drinking Water Competition was the Town of Norman Wells, and they will be looking to defend their title at this year's conference. So if you want to challenge the champions, don't forget your water! Your community could be the next to take home the trophy and bragging rights.

Thank you to the NTWWA Board of Directors for keeping me on as the executive director. I look forward to this year's conference and it is always a pleasure to work with all of you. Every year we say goodbye to dedicated board members and welcome newcomers to the board, and this year is no exception. On behalf of the board, I would like to thank all of the board members who are leaving us, for their dedication to bring a northern perspective to the field of water and waste. To all of the new board members, thanks for volunteering your time and efforts to the board. We are excited to have new members with new experience, knowledge and ideas. Special thanks are due for the efforts of president Sudhir Kumar Jha, past president Sean Austman-Kunkel, the Journal's technical editor Ken Johnson, and our administrator Pearl Benyk.

Enjoy the *Journal* and I look forward to seeing you in Yellowknife.

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