Journal
of the Northern Territories Water and Waste Association

September 2005

Extreme Water Treatment Engineering in Sachs Harbour

Northern Territories Water & Waste Association

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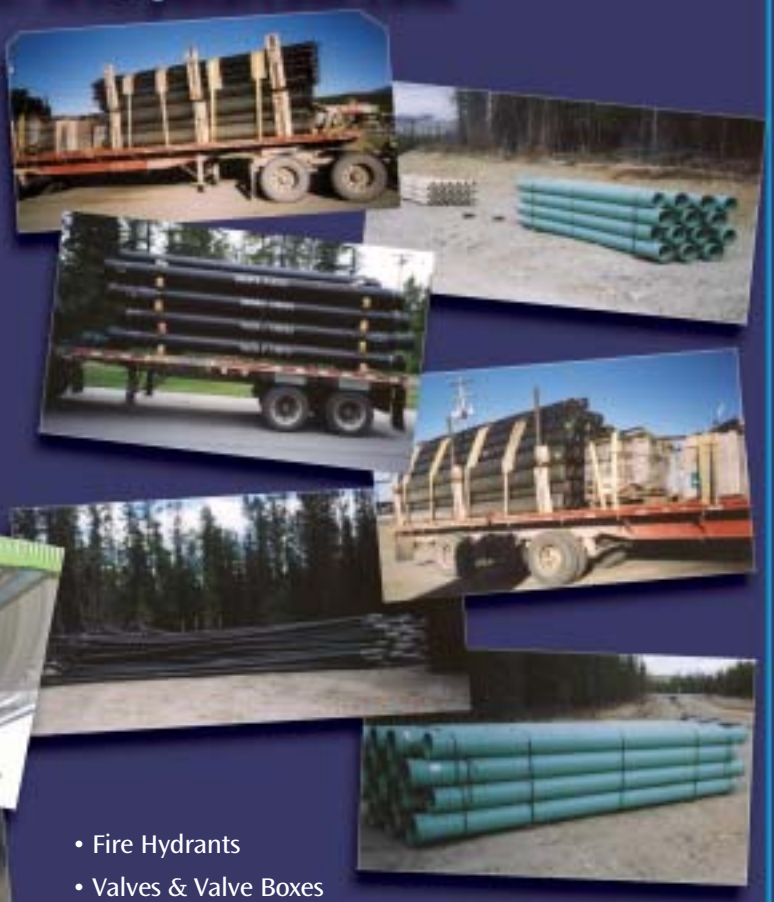

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David Langstaff
Toll Free: 1-866-289-5672
david@delcommunications.com

Publisher
Jason Stefanik
Toll Free: 1-866-831-4744
jason@delcommunications.com

Editor
Paddy O'Toole
Tel: (204) 255-6524

Advertising Sales
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Northern Territories Water & Waste Association

Journal

In this issue

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MESSAGE

From the Editor
PADDY O'TOOLE

Welcome to the first annual edition of the Journal of the Northern Territories Water & Waste Association. Inside you will find reports and articles from every corner of our vast northern region of Canada. These dispatches deal with the numerous challenges facing those who deal with water and waste under often harsh and remote conditions, as well as give insight into their communities and the people who live there. During the 1980's, I had the opportunity to visit most of these communities as an accessibility consultant, and was always amazed by the type and quality of people living and working in these communities; they came from all over the world, and possessed a sense of community and gracious hospitality encountered rarely, if ever, anywhere else. I can see from the stories herein that this has certainly not changed a bit!

Among the highlights in this issue is information on new Training and Certification Programs developed for Northern Operators, a message from the Canadian Water and Wastewater Association (CWWA), and the announcement of the NTWAA's upcoming Annual Conference, being held in Rankin Inlet, Nunavut, Nov.5th to 7th, 2005. The Conference promises to be entertaining and informative, with a trade show and supplier/vendors in attendance, as well as numerous training and educational opportunities. All Water Treatment Plant Operators should note that attending the Conference, and a "hands-on" Operators Workshop afterwards are both counted as Continuing Education Credits.

Thanks go out to the many people assisting in putting this Inaugural Edition together, from the contributors, to the advertisers, and most especially to our Technical Editor and Executive Member of the NTWWA Ken Johnson, who pulled the lion's share of making this publication a reality. Way to go, Ken!

We hope you all find something to learn and something to laugh at in our first edition, and look forward to seeing you all in Rankin Inlet November 5th to 7th 2005.

Northern Territories Water & Waste Association

FIRST ANNOUNCEMENT

Annual Conference, Trade Show & Workshop
Rankin Inlet, Nunavut, November 5, 6 & 7

WHY ATTEND?

This event is the premier opportunity in the Nunavut and the NWT for water and waste water practitioners to stay informed on new trends in the water and waste field, and acquire excellent technical information to increase the quality of service they can provide to northern residents.

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

TRADE SHOW

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

WHAT'S NEW

As the needs of northern communities change with the regulations, growth and economic developments, new approaches of water treatment and waste management may be required.

Water Treatment Plant Operators can earn 1 Continuing Education Credit for attending the conference, as a way of maintaining certification. An Operator Workshop will follow the conference on November 7, which will be "hands-on" sessions with great practical information for operators; operators can also earn 1 Continuing Education Credit for attending the workshop.

REGISTRATION

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

REPORT

Northern Opinion

STEVE BURDEN, P.Eng.

Buyer and Seller Beware

Ask any consultant if would they prefer contracts be awarded based on technical merit or price, and most would say technical merit. The rationale being that a project awarded on merit allows the consultants to use their experience, ingenuity and creativity to provide quality engineering. Unfortunately we are all too often forced to compete for projects based on price.

On these projects consultants are forced to deliver the required services as cheaply as possible, often sacrificing thorough engineering evaluation to stay within budget. This obviously affects the quality of services provided, and the satisfaction of the client. Clients who base their project awards on price are often dissatisfied with the deliverables and generally have a poor opinion of the consulting industry.

A client once expressed his dissatisfaction with a consultant, when it was suggested that they stop awarding contracts to the consultant if they were not satisfied with the service. They replied that they could not because the consultant continued to submit the proposal which offered the most potential value. Clients must realize that quality and completeness is more a function of the available funds than content of the proposal.

When engineering costs are such a small component of the overall project costs (typically 10 to 15 percent), hiring the best consultant at even a twenty percent premium will only result in a two to three percent increase in cost to the project. In fact the increased fees will result in the consultant being able to complete a thorough engineering review that will likely lead to cost savings, with the engineering costs being offset by savings from lower capital cost, fewer extras, or lower operational and maintenance costs.

Clients often utilize the two envelop system, or weight the cost submission relatively low (10 or 20 percent) in an attempt to get away from the award based on cost. The problem with these systems is that while it is easy to evaluate the costing submission, and significant differences in price submissions easily justify significant difference in the rating, it is much more difficult to evaluate the technical submission. It is not uncommon for firms to be only a few points apart after the technical submission, and the project award being based on cost.

To truly utilize the proposal evaluation system, evaluators must be experienced and willing to rate proposals on their technical merit. Rarely are proposals deemed to be unresponsive no matter how poorly they are prepared. It should not be a big jump in logic to realize that the consultants that provide poorly prepared proposals will likely provide poor engineering services, and conversely consultants that provide quality proposals will provide quality services.

As a profession we need to educate our clients on the value of good planning and engineering. Most of the professional organizations are very active in trying to educate the clients, (the Association of Professional Engineers and Geologists and Geophysicists of the N.W.T. & Nunavut offer a publication on their web site entitled "Procedures for Selection of a Consulting Engineer"). However, we must accept that no matter what we do as a profession, there will remain clients that award project

Steve Burden is a Senior Engineer and Project Manager with Trow Associates.
Over the past 20 years Steve has worked extensively in the eastern Arctic, most significantly in the City of Iqaluit.

based on price. As consultants we will continue to respond to these Request for Proposals to maintain business and to maintain existing relationships with clients.

It is possible and not uncommon for clients to receive quality engineering on projects awarded based on price. It however requires much more work on the client's behalf preparing the terms of reference and scope of services. Clients with a good understanding of project development can prepare a quality terms of reference which will ensure the project is completed properly. This requires an experienced client with the time and resources to apply to the preparation of the Request for Proposal. This is more common with large municipalities, Territorial or Federal Governments.

As consultants what should we do when dealing with a client we know will be awarding the project based on price? The first question we should ask is do we really want pursue this project? Assuming the answer is yes, we next need to determine if we can offer a competitive price while still being able to complete the requirements of the project. Again assuming the answer is yes, we should ensure the client has provided a clear and detailed scope of services. If the scope of services is not clearly defined, we should request sufficient clarification to define the scope of services, ensuring that prices received will be comparing apples to apples. If the answer to any of the previous questions was no, or if the scope is not clarified through addendums, we should consider not submitting a proposal and informing the client of the reason.

As consultants, if we submit proposals on projects that either cannot be competitive and still provide quality services, or projects without clearly defined scopes, we open ourselves up to many potential costs and liabilities. The cost of preparing a proposal we had no chance to win because we were not competitive, the cost of completing the project which requires greater effort than anticipated, the cost of a poorly executed project has on our industries reputation or cost of litigation are all potential costs we open ourselves up to when bidding such a project.

Must we expose ourselves to these potential costs? Some firms may be fortunate to have developed a client base or niche market that allows them to forego bidding on such projects, but for many consultants it is a fact of life. These projects are a case of seller beware as much as buyer beware.

TRAINING

Classroom training for water and sewer operations.

RESEARCH AND DEVELOPMENT OF A WASTE MANAGEMENT TRAINING PROGRAM IN THE NWT

INTRODUCTION

Proper waste management is an essential component to maintaining healthy, clean and environmentally sound communities in the NWT; sewage must be safely collected and properly treated, and solid waste must be contained and managed in an organized fashion. Even the best designed municipal facilities can fail due to mismanagement and/or improper operation and maintenance. For this reason, education and training for operators of landfill sites, wastewater treatment facilities and wastewater collection systems is of vital importance to the Government of the Northwest Territories (GNWT).

Until recently, a specific training program did not exist in the NWT for operators of landfill sites, wastewater treatment facilities or wastewater collection systems.

In August 2004, Dillon Consulting, Ltd. was contracted by the Department of Municipal and Community Affairs, GNWT to develop a waste management curriculum for the School of Community Government (SOCG).

Prior to the development of this curriculum, waste management was covered briefly in the SOCG's Small Systems Water Treatment Plant Operator Program, with material briefly explaining lagoon operation and maintenance and operation and maintenance of landfill sites.

Project Objectives

The main objective of this project was to develop the curriculum for stand-alone courses in Solid Waste Management, Wastewater Treatment and Wastewater Collection, specifically;

- A two (2) day course in Solid Waste Management
- A two (2) day course in Small Systems Wastewater Treatment
- A three (3) day course in Class I Wastewater Treatment
- A two (2) day courses in Small Systems Wastewater Collection
- A three (3) day course in Class I Wastewater Collection

The final deliverable for this project was the submission of respective student and instructor manuals for each of the five (5) courses, designed to educate, train and certify operators of sewage lagoons, wastewater treatment plants, trucked and piped wastewater collection systems and landfill sites in the NWT.

Challenges

The NWT has eight (8) official languages. Therefore, one of the main challenges in developing the program was to include the pertinent technical information required to properly understand waste management systems while maintaining the curriculum at a level that speaks to students with varying skills in English literacy, math and science.

by Heather Scott, B.Sc., M.A.Sc.
Water and Wastewater Systems Design Practice,
Dillon Consulting Ltd., Yellowknife

Another challenge was to present material in a short and concise manner, so that students can learn and absorb sufficient information to become adequately trained in a limited amount of time.

The program also had to be designed so that an instructor could sufficiently deliver the program with the materials provided in the student and instructor manuals.

RESEARCH

Resources

A variety of resources were used to gather the relevant material to develop the program. The SOCG's existing Water Treatment curriculum was used as a base on which to build the Waste Management Program. Documents from Public Works and Services, GNWT (PW&S), Indian and Northern Affairs Canada (INAC), Alberta Environment, the Solid Waste Association of North America (SWANA) and the United States Environmental Protection Agency (US EPA) were used in addition to any applicable guidelines and legislation as outlined in Table 1.

The SOCG currently uses the Association of Boards of Certification (ABC) for testing and certification in the Water Treatment Program. Therefore, ABC guidelines in the area of Wastewater Treatment and Collection were used in developing curriculum material. ABC does not currently have certification in Solid Waste Management, so training materials from SWANA were primarily used in place.

TABLE 1: RESOURCES USED FOR CURRICULUM DEVELOPMENT

SOURCE	DOCUMENT	CURRICULUM
MACA, GNWT	Small Systems Water Treatment Plant Operator Program Manual	Wastewater Treatment/Collection Solid Waste Management
MACA, GNWT	Guidelines for the Planning, Design and Maintenance of Wastewater Lagoon Systems	Wastewater Treatment
MACA, GNWT	Guidelines for the Planning, Design, Operations and Maintenance of Modified Waste Sites	Solid Waste Management
PW&S, GNWT	Good Engineering Practice for Northern Water and Sewer Services	Wastewater Treatment/Collection
ENR, GNWT	Environmental Protection Act	Wastewater Treatment/Collection Solid Waste Management
ENR, GNWT	Waste Reduction and Recovery Act	Solid Waste Management
H&SS, GNWT	Public Health Act	Wastewater Treatment/Collection Solid Waste Management
NWT Water Board	Guideline for the Discharge of Treated Municipal Wastewater in the NWT	Wastewater Treatment
INAC	BAT for Sewage Treatment in the North	Wastewater Treatment
INAC	Community Wastewater Treatment	Wastewater Treatment
INAC	Community Solid Waste	Solid Waste Management
Alberta Environment	Water and Wastewater Operations Level I and II Manuals	Wastewater Treatment/Collection
SWANA	Training Sanitary Landfill Operating Personnel — Student Manual	Solid Waste Management
US EPA	Collection Systems Fact Sheets	Wastewater Collection

Consultation

Dillon consulted with a variety of individuals for input on the content and structure of program. These sources included several operators of wastewater treatment and solid waste facilities in the NWT, past students of SOCG water treatment courses (certified water treatment plant operators), and instructors of SOCG courses. Dillon also researched traditional methods of managing waste in the NWT, so that they could be addressed in the curriculum.

DEVELOPMENT

For each of the five (5) courses, a student and instructor manual was written. The student manuals contain an introduction, a course outline, a list of important contacts, technical material, and addendums. Addendums include relevant documents and guidelines, a glossary of terms and a math tutorial. Instructor manuals contain an introduction, a course outline, chapter outlines, delivery methods, lesson plans and answers to questions in the student manual. In addition, each manual chapter is accompanied by a set of comprehensive electronic slides. These slides outline the curriculum material and are filled with graphics, photos, exercises and discussion questions. The slides are designed such that an instructor can thoroughly deliver the course material with their use.

Table 2 lists the chapter contents for the respective courses.

In order to speak to students with a range of literacy, math and science skills, Dillon wrote the course material in plain language and accompanied text with a wide variety of graphics and photos. Pictures of waste management systems from various NWT communities that students can recognize and relate to are included. The content is supplemented with problems, exercises, articles, case studies and discussion questions that are practical and relevant to the NWT. The math addendum includes a review of basic math skills and builds to solving math problems relevant to the particular course material.

TABLE 2: CONTENTS OF STUDENT MANUALS

Solid Waste Management	• Municipal Solid Waste • Solid Waste Collection • Alternatives to Solid Waste Disposal • The Landfill Site • Landfill Operations and Maintenance • Closure of a Landfill Site • Regulatory Requirements • Occupational Health and Safety
Small Systems Wastewater Treatment	• Introduction to Wastewater • Wastewater Treatment • Lagoon and Wetland Treatment • Lagoon Operation • Lagoon Maintenance • Lagoon Sampling • Regulatory Requirements • Occupational Health and Safety
Class I Wastewater Treatment	• Wastewater Treatment Processes • Secondary Treatment • Nutrient Removal • Sludge Digestion • Disinfection • Valves • Pumps • Wastewater Treatment Case Studies • Regulatory Requirements • Occupational Health and Safety
Small Systems Wastewater Collection	• Introduction to Wastewater • Wastewater Treatment and Collection • Trucked Collection • Regulatory Requirements • Occupational Health and Safety • Addenda
Class I Wastewater Collection	• Piped Wastewater Collection Systems • Valves • Pumps • Sewerage System Maintenance • Regulatory Requirements • Occupational Health and Safety

Review of Curriculum

The curriculum underwent an extensive review process by the GNWT; the program manuals were submitted to the SOCG in a series of three (3) drafts. Each draft was reviewed by an Advisory Committee comprised of representatives from MACA and PW&S, GNWT and community governments. One draft was also reviewed by the Environmental Protection Division of the Department of Environment and Natural Resources, GNWT, as well as a certified Class II Water Treatment Plant Operator in the NWT.

Program Delivery

The curriculum was completed in March 2005 and the first courses for Wastewater Treatment and Solid Waste Management were held in Fort Simpson, NT, in May 2005. The courses were a success; five (5) students attended the Solid Waste Management course and six (6) attended the Wastewater Treatment courses. Wastewater Collection courses will be held in Yellowknife, NT in September 2005.

Sewage pumpout truck discharging into lagoon.

SEWAGE LAGOON WETLAND TREATMENT SYSTEM, ARVIAT NUNAVUT

Introduction

The widely adopted method of treatment, in northern Canada is the combination of sewage lagoons and wetlands. This combination is suitable for northern communities because of the nature of the communities (small, simple and sparsely distributed, abundant water and wetland environments, and limited financial resources). Furthermore, wetland treatment is one of the few technologies that can meet General Provisions of the Fisheries Act .

Sewage Lagoons

A sewage lagoon is a shallow pond, usually man-made, where sunlight, bacteria and oxygen interact to help purify sewage. The term is synonymous with oxidation pond and stabilization pond. Lagoons are classified as aerobic (having oxygen), anaerobic (no oxygen) and facultative (aerobic & anaerobic). Facultative lagoons are the most prominent type. They have both aerobic and anaerobic processes. Algae and the air supplies oxygen to the supernatant which is the upper portion of the lagoon. The lower portion has no supply of oxygen. Facultative lagoons are common in the North because they are often the lowest capital and operating and treatment systems.

Wetlands

Wetlands are transition zones between land and water environments. They include all forms of water saturated areas-from marshes and swamps to shallow ponds and estuaries. Wetlands function as the kidneys of the earth, filtering and cleaning water flowing through it, bladders of the earth, storing water and providing sedimentation, earth's digestive tracts transforming nutrients and livers of the earth filtering toxins (Nowlan and Jeffries, 1996). These qualities enable wetland to satisfy the various Physical, Chemical and biological cleansing requirements for wastewater. Cleansing of wastewater passing through wetlands takes place through storage (sedimentation), absorption of pollutants in the surface soils, nutrient uptake and metabolic use by plants, transformation (oxidation) of elements by micro-organisms, sewage dispersion over a large area through intricate channelization.

Natural Wetlands (mashes, swamps, bogs or fens) abound in the north and are readily available for sewage treatment subject to regulatory compliance. Where the land available for wetland treatment is not sufficient to provide treatment that meets the regulatory requirements, engineered or constructed wetlands are used. The engineered system either creates a totally new wetland system where none ever existed or creates circumstances that make the small wetlands to provide greater exposure to the sewage for treatment.

Attempts at developing appropriate design parameters for wetland sewage treatment in the north have been made by Doku and Heinke (1993), Dillon (1994) and Dillon (1998).

FSC undertook a comparative analysis of these reports, the Alberta Environment AENV (2000) Model for wetlands, and a USEPA model. Also included in the analysis was a plug flow assessment of an overland flow system as a fixed film reactor, using rate equations developed by Autotrol (1979). From this analysis it was determined that the AENV Model could be successfully modified and adapted for the North.

The AENV (2000) Wetland Model

For assessing the feasibility of a wetland for wastewater polishing after lagoon treatment, the AENV developed the following empirical relationships:

The area of a wetland (A) and its expected effluent quality (Ce) are given respectively as:

$$A = \left|\frac{0.0365Q}{k}\right| * In \left[\frac{C_i - C^*}{Ce - C^*}\right];$$

$$C_0 = C^* + (Ci - C) * exp \left|\frac{-kA}{0.365Q}\right|$$

Ron Kent, P.Eng. and Dele Morakinyo, PhD, P.Eng.
FSC Architects and Engineers, Yellowknife

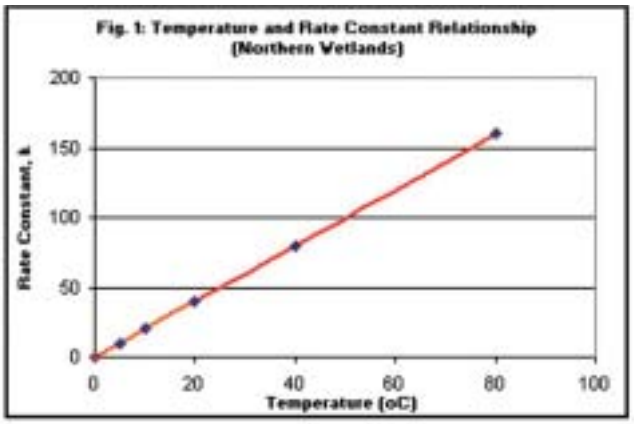
Where:
A = required area; Q = Design Flow;
k = Rate constant for a given temperature;
Ci = Influent Concentration;
Ce = Target Effluent Concentration;
C = Wetland Background Concentration;*
for BOD, C = 7.8 + 0.063Ci,*
for TSS, C = 3.5 + .053Ci*
Co = Predicted effluent concentration:

The AENV model was developed for a temperature of 20°C. Sewage decant to wetlands in the north always take place during the summer or fall months when there is expected to be high levels of plant and microbial activities to clean the lagoon effluents. Average temperatures during the decant months are usually between 5 and 10 °C. Hence, the AENV model needed to be corrected for temperature before it could be applied to the north.

Modifications to the AENV Model for Northern Wetlands

The rate constant, k, in the AENV Model varies in direct proportion to the local ambient temperature, . The exact rate of variation is unknown. As a first approximation, we have assumed a linear relationship. If the rate constant at temperature is k, then rate constants at temperatures θ / 2 and 2θ are respectively k/2 and 2k.

Fig. 1: Temperature and Rate constant Relationships (northern Wetlands)



A graphical illustration of this relationship is shown in Fig. 1 starting with a parameter (e.g. BOD) with rate constant of 40 mg/L at 20 °C.

FSC has successfully adopted this approach to design many northern wetland systems.

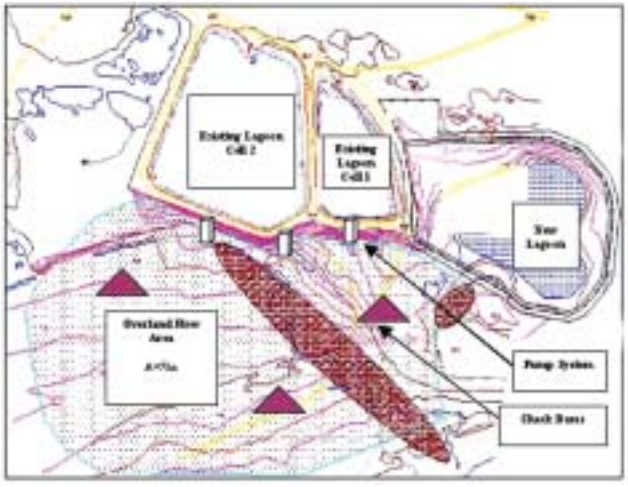
Further investigations will be required to verify the k - relationship (to be adopted in the AENV Model) for the north . Real data from Surveillance Network Program (SNP) stations of northern communities operating Sewage lagoon / wetland systems is required to calibrate the AENV Model for northern wetlands. An attempt to calibrate this model at the time of writing this article was inconclusive due to lack of sufficient data from the communities. FSC will undertake this investigation and publish the result in a future edition of this magazine

Arviat Sewage Lagoon - Wetland Design Concept

PROJECT BRIEF

The Hamlet of Arviat had a 2-cell sewage lagoons operating in parallel with exfiltration discharge to Hudson Bay. The existing cells no longer exfiltrated at a sufficient rate and therefore required decant structures. Furthermore, a growth study in 2003 estimated the 20-year sewage volume of Arviat at 141,000 m^3. The existing sewage lagoon volume estimated to at 49,600 m^3 would not provide adequate treatment or winter storage volume. . FSC was retained by the Government of Nunavut (GN) to design and provide engineering services for addition of a new cell to the existing system and to complete the design work for a decanting device for the treatment system.

Fig. 2: The Three-cell Arviat Lagoons and the overland flow area (FSC's Conceptual Design)



FSC's Design Concept

FSC proposed that a third lagoon be constructed to accommodate the 20-year volume estimated to be 141,000 m^3. The current lagoon volume was estimated to be 49,600 m^3 based on a 2 meter working depth. The annual evaporation for Arviat is 203 mm; precipitation is 297 mm. Therefore, the lagoons will incur a net gain of 94 mm of precipitation over the area of the lagoons. No runoff enters the lagoons. Therefore, the required volume of the new

Fig 3: The Overland (Wetland) Treatment Area with Attenuation berms

sewage lagoon was 98,353 m^3. The new cell was designed with a section of the discharge berm constructed from coarse gravel (190mm+) for exfiltration of effluents directed to a proposed wetland area. The old cells would be retained and provided with a decanting structure. Sewage will be discharged to the lagoons year round from a trucked system. As one cell becomes full, the truck will discharge to the next empty cell.

For the old cells, FSC designed a discharge system consisting of a siphon using solar powered pump. This option was arrived at as the best option for Arviat System after conducting extensive research on available options and carrying out option analysis based on Kepner-Tregoe (K-T) decision-making tool.

The modeled lagoon effluent quality compared to Nunavut Water Board Guidelines for 2023 indicates that the effluent from the lagoons prior to discharge to the wetland would potentially meet the Nunavut Water Board (NWB) Guidelines for discharges to marine environment for parameters such as BOD, TSS, T-PO4, TKN and Faecal Coliforms.

The land between the lagoon and the Hudson's Bay would be developed

so that it naturally evolves into an overland flow treatment area supporting additional vegetation. Effluents from the sewage cells will be discharged continuously to the wetland at the beginning of July and continue discharging until the end of August at which time all the cells will be at their lowest level to provide sufficient storage to accommodate the sewage production throughout the winter.

See figure 3 on previous page.

The microenvironment will further treat the sewage, and provide for evaporation of the liquid and disinfection of the effluent. Irrigation techniques and flow attenuation berms will be used to ensure liquid is thinly spread across the area and given sufficient exposure to oxygen and sunlight.

Conclusions

The AENV model has been successfully adopted by assuming a linear relationship between the rate constant k and ambient temperature for the Arviat wetland and other northern wetlands. . Further investigations will be conducted to optimize the relationship.

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FORT SMITH

TREATING HIGH RAW WATER TURBIDITY IN FORT SMITH, NT

Fort Smith is located in the southern extreme of the NWT, just beyond the Alberta border at 60 degrees north latitude and 111 degrees west longitude. The drinking water source for Fort Smith comes from the Slave River, a 434 km river which emerges from the waters of the Peace-Athabasca Delta. The Slave River consists of mostly sandy and silty banks, and a river bottom which continuously erodes as water levels rise and fall thereby presenting a high concentration of turbidity to Fort Smith's raw water supply.

While not unique, it is fair to say that few places in Canada deal with the treatment of such extreme levels of turbidity (8000 - 10,000 NTU's) as does the Fort Smith Water Treatment Plant. Some locations in Canada have seasonal extremes in turbidity, as does Fort Smith, but few would deal with such levels on a continual basis.

During the summer months turbidity in the Slave River averages between 300 and 500 NTU, however it peaks to 10,000 NTU's during spring break up or during high water levels due to heavy precipitation.

Slave River at Fort Smith.

Cleaning raw water settling ponds.

During the mid 1970's the Town of Fort Smith introduced a 2 pond pre-settlement and pump house system to reduce the amount of high turbidity levels entering the Water Treatment Plant. The intent at the time was to fill one pond and simultaneously add an aluminium sulphate as a flocculent, and once that pond was full, allow the sediment to settle overnight. The cleaner water was then decanted the next day throughput of the water treatment plan while filling the other pond and so on. This process has proven to

Jean Soucy,
Water Works Supervisor,
Town of Fort Smith

work very well at times when small clarifier systems would normally have been overwhelmed with such levels of turbidity.

The primary function of the pre-settling system at the time, along with the chemical addition of aluminium sulphate, was to allow detentions times to increase the floc settlement in the settling ponds. However, while decanting, a certain amount of sediment would become exposed on the pond sides while pond levels were dropping, and the turbulence of wind and rain created turbidity within the decant water itself.

In 1993 a new water treatment plant was constructed incorporating the same pre-settling process, however this time much larger ponds were constructed with a the total combined volume of 5000 m^3. The fill process was also changed to filling at one point in the first pond and continuing to fill until levels reached a spillway between the ponds. This would allow raw water to flow from one pond to the other while decanting from the furthest point of the pond system and away from the raw water intake. This virtually eliminates any pond disturbance due to the elements, further improving floc settlement by increasing detention times to approx 33 hours at 150 m^3 per hour.

In 1995 the aluminium and soda ash application was replaced with a better coagulant and flocculent chemical addition called poly-aluminium chloride with the brand named Niad 1-6. This new chemical addition further improved, and simplified turbidity settlement and removal by increasing floc formation and sizes, thereby speeding up and improving the settlement process. This simple process has virtually removed all turbidity before entering the water treatment plant, where approximately 98 percent of the turbidity is removed in the pre-settling ponds. The water is then further treated by a solids contact clarifier, and a multi media gravity filters achieving potable water quality of less than 1 NTU on the potable water distribution. The end result is a 99.99 percent turbidity reduction even when experiencing excessive raw water turbidity levels.

While using this system, a fair amount of accumulated sediment or

sludge must be removed from the ponds every 6 - 8 weeks depending on the amount of turbidity incurred during the preceding period. This is easily accomplished with the use of sludge pumps and fire hoses to dilute and push sediment to a collecting sump, which is then pumped directly back to the waste collections tanks and then to the sewage treatment system.

This process has proven to be successful time and time again, and is to date the most cost effective method of turbidity removal for the Fort Smith Water Treatment Plant. The process provides a good source of raw water for the water treatment plant, from what appears to be an unviable raw water source.

Future plans are in place for the Fort Smith Water Treatment Plant to further improve on the water effluents by introducing a micro filtration membrane system, which will continue to enhance the Town of Fort Smith potable water quality for years to come.

Raw water settling ponds beside water treatment plant.

WATER TREATMENT IMPROVEMENTS IN IQALUIT, NUNAVUT

A major upgrade was completed to the water treatment plant serving the City of Iqaluit, Nunavut in 2004. The project required design and construction work on a 40-year old water treatment facility.

Iqaluit is located at the south end of Baffin Island, on Frobisher Bay at 64° 31'N latitude and 68° 31'W longitude. Iqaluit is also located within the continuous permafrost zone, therefore the buildings are usually constructed on steel pile systems that extend well into the permafrost. Water and sewer services are provided by either shallow buried, insulated piping, or by tanker trucks.

Construction in Iqaluit requires the typical level of preparation for most northern locations. The delivery of construction materials is dependent upon a relatively short period between the end of July and the end of October, when cargo ships have access through the seasonal ice pack for the annual sealift. The flurry of the sealift activity is matched by a flurry of construction activity to take advantage of the short construction season to complete excavations and exterior construction on buildings.

Exterior building improvements to Iqaluit water treatment plant.

One of the major challenges of this project was the space restriction of the site. It would have been very difficult, and hence expensive, to expand outside the plant's existing footprint because of the surrounding steep bedrock terrain, and the neighbouring power plant. The design incorporated the upgrading to keep the plant within this existing footprint, while increasing the production capacity of the facility eight-fold.

The new design also changed the treatment process from conventional treatment to direct filtration, and UV disinfection was incorporated to achieve pathogen inactivation without making additional modifications to the clear well. Process changes in response to the water quality and capacity issues were:

Construction of new filtration system.

UV disinfection system.

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

1. Increasing the capacity of the plant by constructing four new filters, extending the existing building structure but remaining within the existing footprint to house them, and installing new backwash pumps. Converting the existing sedimentation tanks into grit removal and flocculation units.
2. Providing additional backwash waste storage.
3. Providing facilities for dosing alum (or other coagulant) upstream of the flocculation chamber. Installing coagulant mixing facilities.
4. Providing powdered activated carbon dosing facilities, if required. Design to allow for future inclusion into process train.
5. Replacing the existing lime handling system with a caustic soda system.
6. Providing a PLC-based control system and desktop computer to automate certain plant functions and provide data logging capability.
7. Designing systems to potentially accommodate a future change in water source as the capacity of Lake Geraldine will not meet future demands.

Beyond the new process design, the work had to incorporate provisions to maintain the operability, and treated water quality of the existing plant during construction.

A 20 year horizon was assumed

for the design, and the population projections estimated 11,300 persons, and a 400 litres per capita per day usage in 2021. The estimated total cost, including engineering and contingencies for the water treatment plant upgrade was approximately $4.5 million, and the project was completed within the City's budget.

It was anticipated that a temporary water treatment plant would be needed during construction because the old facility would be off line to permit the required modifications. Rather than importing a temporary plant to service the entire City, the UV disinfection system was incorporated as both a temporary and permanent component of the process. Fortunately, the high quality of the raw water permitted treatment of the water temporarily using only UV disinfection and chlorination. The installation of some temporary minor piping and controls allowed the contractor almost unlimited access to the plant for the upgrades.

In order to reduce construction costs, decrease the potential for delays due to shipping, and be environmentally conscientious, as much of the existing plant as possible was reused for the upgrade. The upgrading included the addition of four new filters along with a filter gallery, and these filters were placed on the existing concrete structure forming the roof of the exterior clear water well.

The very limited window for transportation to Iqaluit demands that materials be manifested through Montreal on one of the cargo ships on the annual sealift. Any equipment or materials that do not meet this schedule must be transported by air, which increases costs dramatically.

The relatively remote location not only makes the mobilization of equipment and materials challenging, but also the supply of trades people. Qualified local resources are limited, and importing trades people is very expensive.

The water treatment plant was successfully commissioned in May 2004, with flow being redirected through the new filters and clear well for the first time. The efforts and "forward thinking" approach of the engineering design team, the City of Iqaluit staff, and the contractors have produced a water treatment plant to serve the residents of Iqaluit for 20 years and beyond.

ROCKS, SNOW AND WASTEWATER TREATMENT IN PANGNIRTUNG, NUNAVUT

by Peter Christou,
Operations Specialist
Sanitherm Engineering, Vancouver

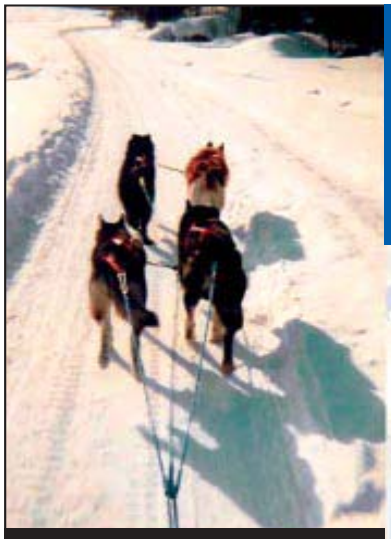
Upon starting employment with Sanitherm Engineering in February 2004, I was asked if I like to take a northern vacation, little did I know at the time of the adventure I was about to embark upon. Last year (2004) I spent a total of 17 weeks in Pangnirtung, Nunavut commissioning, troubleshooting and improving the performance of the new wastewater treatment plant. When I first arrived in Pangnirtung it was quite the culture shock. Spending the next ten consecutive weeks in a tiny Inuit Hamlet on the rim of the Arctic Circle seemed like an immense undertaking. My original job was to commission the plant, produce the operation and maintenance manual, and to train the local Inuit to operate the treatment plant. After the end of the first day I worked at the plant I realized how difficult it was to perform simple tasks in the Artic.

Hamlet of Pangnirtung.

Inukshuk near Pangnirtung.

My first objective was to train an operator at the treatment plant, unfortunately the Hamlet could only find one volunteer at the time, Billy Qaqisq. Billy has become the first Inuit mechanical wastewater operator in Nunavut, and I had the honour of training him, and working with him in Pangnirtung. Billy was born in an outpost camp near Pangnirtung and grew up in traditional Inuit family. He can speak English, but has a hard time finding the right words to use a lot of the time. He has been extraordinarily interested in the entire wastewater treatment process, reading the Sacramento wastewater treatment books, and really enjoying the Water Environment Federation multi-media wastewater training CD's.

The way that I approached the training was a lot different from what I'm used to, because most, if not all of my formal education and training comes from the Canadian Armed Forces. I really didn't want to teach Billy wastewater treatment the same way I was taught. The initial training was awkward because all of my training courses and schooling didn't prepare me for the significant culture and language barriers that I had to work around on a daily basis.



Plant operator Billy Qaqisq.

It took along time to build a trusting relationship where Billy felt free to ask question or admit he didn't understand certain parts of the treatment process.

The biological aspect of the treatment process was difficult to explain because Billy had never heard of words like clarifier or bio-mass. One technique that I used to help him understand was to relate everything to what he could see in nature. We would go for short walks and find things that he could physically touch and see that would help him understand the meaning of the words. For instance, I compared the lichen on the rocks to the fixed biomass on the RBC, and how a puddle of muddy water will settle out after being stepped in as an analogy to a filter press.

When explaining how to change mechanical seals on pump, Billy was actually showing me better ways of doing it. Billy has successfully operated the Pangnirtung wastewater treatment plant for over a year and is proud of the fact the he is one of the only Inuit currently operating a wastewater treatment plant in Nunavut. Six months after the plant began treatment, a new job position was posted; the Hamlet received over thirty four applications.

It is my experience that when operating a treatment plants in remote sites, mechanical maintenance is critical because of the fact that equipment and materials are not readily available. That is why I took a different approach with the operation and maintenance manual, because I knew that it could not be your typical arrangement of manufacturers pamphlets. It took a lot of effort to make a manual that would minimize the potential for maintenance mishandling. I found the best way to make maintenance easy as possible, was to log every maintenance job in the entire plant. I logged everything, from changing a cartage filter to checking the gear box oil, and gave every maintenance operation a specific designation. For example - greasing the blower 1A was given the designation 1A-4 so every piece of equipment had a page in the maintenance manual with all the scheduled tasked that needs to be completed on a regular basis.

I took pictures of each task so when the operator saw 1A-4 on the calendar, they would look it up in the maintenance manual, and see a picture of the specific task they needed to perform. By providing a yearly calendar that shows each individual maintenance task, it allows the operators to plan ahead and monitor all maintenance operations performed. This technique has proven to be most effective in preventing mechanical breakdown, plus providing a simple and accurate way for the operators to keep track of the everyday maintenance requirements of a wastewater treatment plant.

Since my original ten week visit, I have gone back to Pangnirtung many times and successfully trained another wastewater treatment plant operator. I think the key to the training was to keep it simple, and build a basic relationship of understand and trust, which allowed for a lot more questions and a better understanding of the entire wastewater treatment process. Working in Pangnirtung has been one of the best experiences of my life. Being in the Arctic opened my mind to a lot of the different hardships and difficulties that comes with living in the Artic. I have the utmost respect for the people of Pangnirtung, and the courage they show living in one of the most inhospitable climates in the world.

SACHS HARBOUR

EXTREME WATER TREATMENT ENGINEERING IN SACHS HARBOUR, NT

Community of Sachs Harbour.

Introduction

Thinking outside the "box" or in the case of the Canadian north, outside the "ice cube", has allowed design and construction innovations for water treatment plants in response to extreme conditions across the NWT and Nunavut. The challenges of working in the Canadian north extend well beyond remembering to add 10, to 20 degrees of latitude beyond the 49th parallel for a project location. Extreme cold, very limited access, extraordinary costs, and scant resources are a few of the "routine" challenges that engineers, suppliers, and contractors have become familiar with in designing and building for high latitudes.

The maps of the NWT and Nunavut that lead one to the conclusion that the Territories have an abundance of water don't present the entire picture. Raw water supplies may be abundant, but may be located at a great distance from communities, and may only be "accessible" for a period of time that may be counted, in some cases, in weeks. Distance presents a problem because of cost for roads and pipelines, and operation and maintenance to keep the roads and pipelines operating. At nearly $1 million (Canadian) per kilometre for a road and a pipeline in some locations, the economics places distant piped water sources beyond the reach of most communities. Add to this cost the potential for pipeline freezing, and the severe operating conditions for blizzards, and closer becomes a lot better.

Over the past several years the Government of Northwest Territories has committed significant resources to ensuring safe, reliable, and accessible drinking water for all NWT residents. A coordinated effort of GNWT departments has been established to deliver on this commitment.

From a technical perspective of drinking water quality, a multi barrier approach is the grounding principle. A multi barrier is an integrated system of procedures, processes, and tools that collectively prevent or reduce the contamination of drinking water from source to tap in order to reduce risks to public health. For the NWT multiple-barrier approach, three distinct barriers have been formulated. The first barrier is "keeping water clean" by preventing contaminants from entering drinking water sources. The second barrier is "making water safe", which focuses on identifying, treating, and removing natural or man-made impurities. The third and final barrier is "proving water is safe" which focuses on developing and maintaining strong quality monitoring programs, and taking swift corrective action when deficiencies are identified.

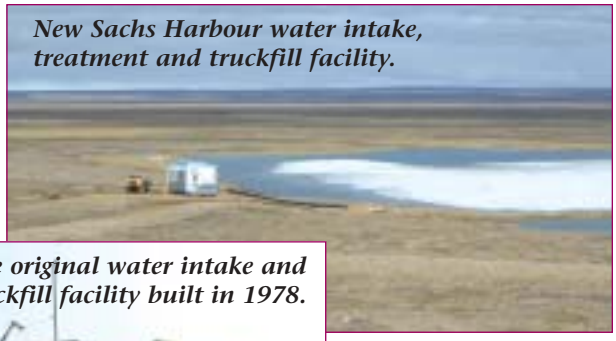
Background

All of these factors are being applied to the extreme water treatment engineering underway in Sachs Harbour, NWT. Sachs Harbour is located along the Beaufort Sea, on the southwestern shore of Banks Island, at 71° 59' N latitude, and 125°14' W longitude. It is the most northerly community in the Northwest Territories, and it is 520 km northeast of Inuvik. This small traditional community has an estimated population of 150 (2000 estimate), which is serviced by water and sewage trucks. Access to Sachs Harbour is by scheduled and charter air service from Inuvik. Freight service is completed by a single annual supply barge which departs from Hay River in June.

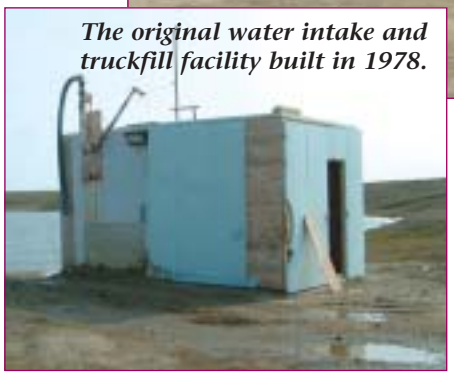
Sachs Harbour was named after the ship 'Mary Sachs' of the Canadian Arctic Expedition of 1913. In 1929 a permanent settlement was established when three Inuit families settled there to trap. In 1953 the RCMP set up a detachment post, and the residents lived a very traditional lifestyle hunting muskox, caribou and polar bear. Today the community's economy is still based primarily on hunting and trapping, and to a lesser degree on tourism. Oil and gas exploration continues in the Beaufort Sea, and local businesses include retail and food sales, supporting mostly the local needs.

In 1978, an intake and truckfill facility near Water Lake (also referred to as DOT Lake, MOT Lake and Water Supply Lake) was constructed in Sachs Harbour, NWT. This water

By Shannon Syme, EIT, Project Engineer, Earth Tech, Edmonton
With contributions from John Bulmer, and Vincent Tam,
Government of the Northwest Territories, and Ken Johnson, Earth Tech Canada



New Sachs Harbour water intake, treatment and truckfill facility.



The original water intake and truckfill facility built in 1978.

system included one intake complete with a submersible pump feeding water from Water Lake into the Truckfill Facility. Raw water from Water Lake was chlorinated using a calcium hypochlorite solution that was mixed and stored in the facility.

During August of 2002, the Department of Public Works and Services Government of the Northwest Territories (GNWT) completed a review of Sachs Harbour's water system management and infrastructure. This report identified several deficiencies related to the existing water supply system, and the operation and maintenance practices in place at the time. The major recommendation arising from this report was the need for a new water treatment facility in the community.

During the summer of 2003, Earth Tech was selected to provide engineering services to upgrade the existing water treatment facilities in Sachs Harbour. The scope included compliance with current and future water quality requirements, and accommodation of future increased water demands as a result of population growth.

Formulating a Plan for Improvements

Recognizing the need to upgrade water treatment systems in small northern communities in the NWT, with a simple easy to operate system, the GNWT conducted pilot testing on various raw water sources around the Territory. The pilot testing concentrated on the use of cartridge filtration in small northern communities which have excellent raw water characteristics. The purpose of the pilot testing was used to seek approval from regulatory authorities for the use of cartridge filtration for meeting all of the existing and proposed future guidelines as per the Guidelines for Canadian Drinking Water Quality (GCDWQ). The results from the pilot testing proved favourable for the application of cartridge filtration for small communities, and approval from the regulatory authorities was received in October 2003. The approval letter stated that the cartridge filtration treatment method, along with chlorination, meets the proposed new GCDWQ turbidity guideline, and therefore is approved for treating pristine surface water sources. The success of this pilot scale project provided another significant alternative to consider for water treatment upgrading in Sachs Harbour.

The water treatment evaluation in Sachs Harbour used the following water use criteria for the evaluation of the potential water treatment processes, and the design of the water treatment system:

- 2025 Population - 192
- 2025 Average Daily Demand - 18,043 L/day
- 2025 Peak Day Factor - 2.1
- 2025 Peak Day Demand - 37,980 L/day
- Fire Flow requirement - 1,000 L/min

Earth Tech reviewed existing and anticipated legislation pertaining to drinking water quality requirements for the NWT, as set out in the Public Water Supply Regulations (1990) under the Public Health Act (which follows the GCDWQ).

A raw water quality analysis in Sachs Harbour revealed that only the turbidity parameter exceeded the goals, which indicated that the source water from Water Lake is very good. Although no analysis was done for Giardia and Cryptosporidium, it was determined that Sachs Harbour faces a low risk for the contamination of these two pathogens of the water supply due to the absence of any activities associated with these pathogens near Water Lake.

Water Treatment Process Options

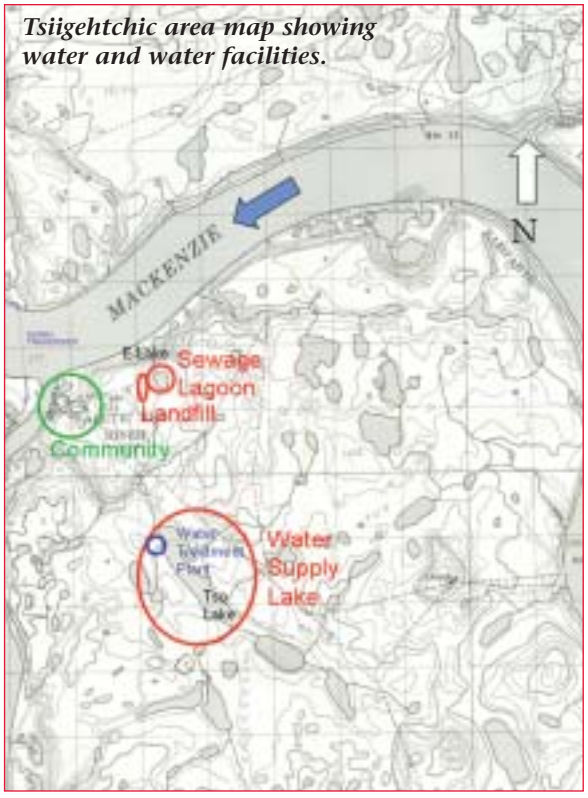
Various viable treatment process options were evaluated for water treatment improvements. Several advantages and disadvantages of each option were identified and used in the evaluation of the options.

The evaluation indicated that Cartridge Filtration-UV (Future)-Chlorination was the best treatment option for implementation in Sachs Harbour, based on meeting the water quantity, water quality and operational requirements. Financial requirements of the treatment options were also considered.

Cartridge filtration may achieve a 2-log reduction of Giardia and Cryptosporidium, and exceed the USEPA turbidity objective of 1.0 NTU. Therefore, cartridge filtration provides treatment greater than the current GCDWQ, and is capable of meeting the new turbidity guidelines. Based on this conclusion, UV disinfection was deferred as a future process improvement, to be added if and when the GCDWQ adopt a Cryptosporidium goal of 3-log removal.

Considering that the Cartridge Filtration-UV (Future)-Chlorination process was capable of meeting all of the current water quantity, water quality and operational requirements and was the least expensive, it was the recommended treatment train. The Cartridge Filtration-UV (Future)-Chlorination treatment train is capable of meeting all the objectives outlined by the GNWT and Sachs Harbour, and will provide a secure easy-to-operate water treatment plant for this extreme location well into the future.

SOLID WASTE MANAGEMENT IMPROVEMENTS IN TSIIGEHTCHIC, NT



Tsiigehtchic area map showing water and water facilities.

Introduction

The development and sustaining of infrastructure in cold region communities, which includes solid waste management, has always been influenced by a variety of technical, financial, administrative, operational and regulatory factors. Over the past 10 years the complexity of these factors has increased substantially with changes to the available financial resources, the administrative structures, the operational responsibilities, and the regulatory environments.

Many of these changes have increased the overall complexity of infrastructure development, and sustainability in cold region communities, particularly at the community level. Many communities are finding the demands of these complexities to be well beyond their financial and administrative resources, and as a consequence are placing themselves in very undesirable situations with regard to community funding and regulatory compliance.

Background

Solid waste management is a challenge for most of the communities in the Yukon, NWT, and Nunavut, however the community of Tsiigehtchic, NWT has managed to keep pace with the challenges. The Charter Community of Tsiigehtchic is a Gwich'in community located at 67° 27′ N and 133° 46′ W in the Inuvik Region of the Northwest Territories. The community has a population of about 200 people , and is located at the confluence of the Arctic Red River, and the Mackenzie River on a high point of land. The town site is 1010 air kilometres northwest of Yellowknife; the Dempster Highway connects Tsiigehtchic to Inuvik, 125 kilometres to the northeast, and Whitehorse, Yukon 1400 kilometres to the southwest.

For hundreds of years, the Gwichya Gwich'in of

TSIIGEHTCHIC

By Ken Johnson, MCIP, P.Eng.,
Senior Planner and Engineer,
Earth Tech, Edmonton

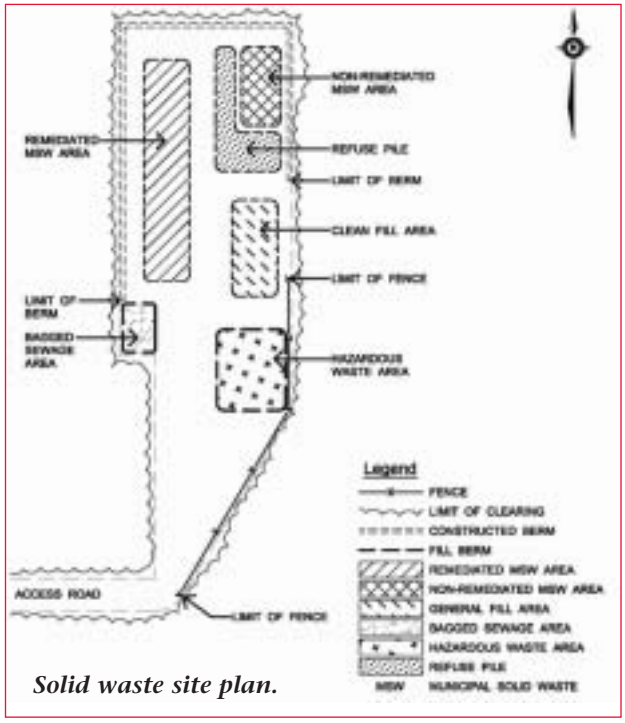
Tsiigehtchic traveled up the Arctic Red River into the mountains along the Yukon, NWT border, in late summer. There they lived and hunted through the winter, and when the river opened in the spring, they returned to their fishing grounds at Tsiigehtchic, and other places along the Mackenzie River. Missionaries established a Roman Catholic church in the area in 1868, however some families continued to winter in the mountains until the 1960s. Construction of the Dempster Highway in the 1970s brought wage employment to the community.

Surface material around the community is a mixture of gravel, sand and fine sediments, with outcrops of sandstone and shale; this is underlain by sandy or silty clay. The active layer around the community is 0.3 to 0.5 metres deep. The dominant trees are black spruce and birch, which grow in well drained land areas; willow grows in the poorly drained areas.

Existing Solid Waste Facilities

The solid waste disposal facilities in Tsiigehtchic operates in two adjacent areas immediately west of the sewage lagoon, and 1 kilometre east of the community. The landfill areas provide discrete sites for the disposal of municipal solid waste, household hazardous waste, clean fill, honey bag waste, and bulky waste.

The solid waste disposal systems include:



Solid waste site plan.

- a municipal solid waste area;
- a household hazardous waste disposal area;
- a bagged sewage disposal area; and
- a bulky waste disposal area.

The active portion of the disposal area covers an area of approximately 0.8 hectares with additional solid waste related areas to the south (bagged sewage pit, and hazardous waste area). A bulky waste site is also south of the main site.

The solid waste area is used by both the public and the local industries with no direct fee charged. There is no permanent supervision of the site, and no records of the quantities and types of waste that are kept.

In 2003 the Community deposited approximately 1700 cubic metres of municipal solid waste. This volume is based upon an estimated average of 7.5 truck loads per week in a 9 cubic metre truck (4.3 cubic metres per load).

Condition of Facilities

The solid waste disposal facilities for Tsiigehtchic generally appear to be well managed, and this observation is supported by the Municipal Water Use Inspections conducted over the past several years. The appropriate equipment is used to collect, and manage the site.

Several aspects of the operations are in need of improvement in order to satisfy the generally accepted practices for solid waste disposal. These aspects concern landfill burning and hazardous waste collection and storage. Open burning of municipal solid waste is a practice that is no longer acceptable from public health and environmental impact perspectives. This position is supported in the most recent guidelines for operations and maintenance of solid

waste sites in the NWT.

The hazardous waste storage area is a bermed area on the south side of the waste disposal area. The area is used for the storage of waste oil, batteries, and paint. The collection of hazardous waste in Tsiigehtchic appears to include a significant non-residential component. Although this may be seen as a beneficial community activity, in fact, it is a tremendous liability for the community administration. Non-residential hazardous waste is not the responsibility of the community administration, and the non residential community must be instructed to appropriately dispose of hazardous waste at their own cost and effort.

The bulky waste area occupies an area south of the main solid waste disposal site. The bagged sewage pit is a bermed area on the south side of the waste disposal area. The pit receives no cover material.

Waste Management Improvements and Future Needs

The existing municipal solid waste area is full, and the entire site needs to be redeveloped to accommodate any future waste disposal. A redeveloped site would have an estimate volume of 5,520 cubic metres without any volume reduction by burning or diversion. This would provide approximately 10 years of capacity.

Approximately 25% of the honey bag waste area has been used in 3 years of operation, based upon visual inspection and estimate. The remaining capacity is estimated to be 10 to 12 years.

The hazardous waste area requires periodic removal of the various stockpiled wastes for shipment to the appropriate treatment and disposal facility. The existing bulky waste is full, and the new site needs to be developed to accommodate any future waste disposal .

Conclusions

The small communities of the NWT and Nunavut have the potential to appropriately operate and maintain solid waste management facilities, as seen in the community of Tsiigehtchic. Critical to their management is having an appropriately engineered and organized site, with the appropriate equipment and operation and maintenance documentation. Senior governments and regulators must also play a role in the operation and maintenance of the facilities by providing the communities with the appropriate information and resources for technical demands such as improving operation and maintenance practices. Small communities often do not have the capacity to retain or maintain a resource for assisting in this manner.

WHITEHORSE

LIVINGSTONE TRAIL ENVIRONMENTAL CONTROL FACILITY (LTECF), WHITEHORSE, YUKON

by Ken Johnson, MCIP, P.Eng., Senior Planner and Engineer, Earth Tech, Edmonton
with information & photos provided by Brian Crist, P.Eng., City of Whitehorse
additional photo credits to Jason Berkers, EBA Engineering Ltd.

Lagoon system after construction, during initial filling.

Lagoons are the most common type of sewage treatment in Canada, and are often the treatment process of choice for small and medium sized communities because of their very low operating costs, and proven capability to achieve high quality effluent. This is particularly true for high latitudes where for the costs, and operation challenges of mechanical systems are magnified several times.

The City of Whitehorse used a four cell primary sewage lagoon system for many years, which provided appropriate technology for this community located at 60°34' N 135°4' W in the Yukon Territory.

In the late 1980's regulatory demands for a higher quality effluent prompted the City to investigate options for achieving a secondary quality or better effluent. A number of studies were completed in the late 80's and early 90's considering mechanical and lagoon systems. In the end, the terrain of an area to the north of the City, near what is called the Livingstone Trail, was able to accommodate a large lagoon system.

In 1994, work began on the Livingstone Trail Environmental Control Facility (LTECF) to serve the 18,000 people living in the City of Whitehorse. The LTECF includes the following major detention and retention components.

- Two 115,000 cubic metre primary lagoons with a combined retention time of 20 days
- Four 293,000 cubic metre secondary lagoons with a combined retention time of 100 days
- One 5.813 million cubic metre Long-Term Storage (LTS) pond with a one-year retention time.

The primary cells can fill to a depth of 6.2 metres and the secondary cells to a depth of 2.3 metres. The long-term storage area, a wetland three kilometres long and two kilometres wide, can fill to a depth of six metres. The flow between the lagoons is controlled by a variety of flow control structures.

The facilities were constructed over a period of 2 years, and the work also included clearing and extension of the Marwell forcemain from the old Whitehorse primary lagoons to the LTECF, and upgrading of the other facilities associated with the collection system. The completion of the work in September 1996, allowed the City of Whitehorse to end the

Flow control structure from lagoons.

direct discharge of primary treated sewage effluent into the Yukon River. The total capital cost of the LTECF was approximately $20 million ($1996), which was a cost of about $1,100 per resident.

The initial design of the facility included a discharge structure from the LTS for a seasonal discharge into the Yukon River. However with such a high quality effluent anticipated from the LTS, the City started considering an opportunity that would accommodate no direct discharge to the Yukon River. Adjacent to the LTS is a glacial pothole lake formation, which lies 16 metres below the level of the surrounding lakes, and lies less than a decimetre above the level of the Yukon River itself. The materials in between the pothole lake and the river are sands and gravels.

The City applied to the Yukon Territory Water Board to obtain an additional Class A water licence for a trial discharge of up to two million cubic metres of fully treated effluent into the pothole lake. The discharge would gradually seep into the groundwater, along with other water from the lake, and very slowly make its way to the river. The trial discharge into Pothole Lake (PHL) was a success, and every fall since 1998 treated effluent has been discharged from the LTS pond into the lake.

Facility location and features (Old Lagoon to LTECF).

Time, wind and sunlight do most of the work at Whitehorse's new sewage lagoon. In a typical July, this City receives approximately 256 hours of bright sunshine and has an average daily temperature of 14°C; the average annual precipitation is 269 mm. The LTECF is designed to hold the sewage for at least 360 days at optimum capacity. During

Pothole Lake.

that time, the wind stirs the holding cells and puts oxygen into the system, helping microbes and natural chemical processes to break down the sewage contaminants. The only addition to the system is biological enzyme which enhances biodegradation.

By mid May of each year the secondary lagoons are generally "ice-free" and algal blooms quickly develop, significantly increasing the pH levels (maximum 11.3) and dissolved oxygen concentrations (maximum >20 mg/l). The elevated pH levels promote the volatilization of ammonia, reducing levels to below detection (0.005 mg/l) within 5 weeks of becoming ice-free.

The City is generally pleased with the operation of the facility. The water licence states fecal coliform levels in effluent from the system may not exceed 2000 counts per 100 millilitres. Tests of the new system have found fecal coliform counts ranging from less than 3 per 100 millilitres to a high of 240 per 100 millitres. The old system would discharge over 100,000 counts per 100 millilitres.

In 2003 approximately 3,770,000 cubic metres of sewage were received at the LTECF. In 2003 discharge of treated effluent from the LTS into PHL commenced on August 1, 2003 and ended on October 31, 2003, a total of 92 discharge days and a total of 3,374,660 million cubic meters of treated effluent was discharged into the Pot Hole Lake.

The Livingstone Trail Environmental Control Facility is a showcase project demonstrating the opportunity for a sewage lagoon system to produce a very high quality sewage effluent at high latitudes in Canada, and essentially have a zero impact on the receiving environment. Certainly it must be recognized that the surrounding natural features have a significant role to play in the treatment processes, and that the end product comes with a significant price tag in capital costs.

NEW TECHNOLOGY

By Ulrich Reimann-Philipp,
Ph.D., Director of Research and Development,
Floran Technologies (US) Inc.

ADVANCED CLEANING TECHNOLOGY FOR WATER TREATMENT AND STORAGE FACILITIES

Surfaces in contact with water will accumulate deposits over time. Depending on the properties of the water, these deposits can consist primarily of mineral or of organic matter. Colored deposits, such as iron and manganese oxides, are readily visible, while biofilm can be transparent and not easily detectable. The accumulation is most obvious on filter and clarifier walls, troughs and weirs. Finished water tank surfaces also become coated over time. On granular filter media, the buildup of mineral crusts and biomass affects particle size, media density and surface structure, leading to declining filter performance.

The buildup of surface deposits has been considered for the most part a cosmetic problem. However, their effects on water quality and infrastructure lifetime are being increasingly recognized. The most common effects of surface deposits include:

- Chlorine demand
- Disinfection byproduct accumulation
- Microbial contamination
- Poor facility inspection results
- Corrosion
- Declining filter performance

Considering the problems caused by surface deposits, the benefits of reducing or eliminating them are obvious. However, the traditional facility cleaning methods of flushing, pressure washing, hyper-chlorination and tank diving are inefficient against almost all types of deposits. The alternative is the use of chemical cleaning products, which combine effective deposit removal with safe and simple application.

The use of chemical surface cleaners for drinking water facilities was pioneered in Germany as an alternative to drinking water chlorination more than 10 years ago. With a limit of 0.3 mg/l total chlorine in the water supply, water systems could not rely on maintaining a chlorine residual to ensure the safety of the water supply. Prevention of re-contamination after treatment was possible by regular cleaning of treatment facilities and water tanks. Many German drinking water providers have abandoned chlorination completely, combining UV disinfection with enhanced system maintenance.

Chemical surface cleaning products for water tanks, treatment facilities and filter media have recently been introduced to the US and Canadian markets under the FLORAN™ brand name. The products are NSF-60 certified and based on a

Steel tank before and after FLORAN™ chemical cleaning.

two-component chemistry. The two components (cleaner and activator) are mixed immediately before application and then sprayed onto the surfaces as a fine mist using low-pressure spraying equipment. After a 10-30 minute reaction period, the surfaces are rinsed with water.

Chemical tank cleaning requires little downtime and labor. Tanks up to 4000 m^3 can usually be cleaned within one day by a 3-man crew. By using a telescopic spraying wand, all parts of the tank surface can be cleaned without the need for scaffolding. Runoff disposal procedures depend on local regulations. In most cases, the runoff is collected on the bottom of the tank, de-chlorinated and neutralized, and then pumped into the storm drain or sanitary sewer. Particulates can be removed with a filtration dirt bag. After treatment, the tank can be immediately re-filled. After the mandatory BacT testing, the tank can be put back online. Runoff generated during filter cleaning is removed by backwashing. The backwash water can then be recycled to the head of the treatment process.

The efficiency of chemical tank cleaning is most obvious in painted steel tanks. In contrast to flushing or pressure washing, even resilient deposits are removed and the surface is exposed. Since there is no need for high-pressure washing, there is no risk to damaging the paint coating or metal surface. Tank inspection after cleaning allows for detecting even minor corrosion and paint failure sites. In several cases resurfacing of tanks was postponed after chemical cleaning, because the exposed paint coating proved to be in much better condition than assumed after the initial inspection. Many tanks are resurfaced long before expiration of the nominal coating lifetime, because surface deposits cannot be reliably distinguished from corrosion or existing corrosion sites cannot be detected.

Both steel and concrete tanks develop a chlorine demand over time. This chlorine loss has to be compensated for by increasing water chlorination. Chlorination byproducts (DBPs), such as trihalomethanes (THMs), accumulate to higher concentrations in tanks that have a high chlorine demand. The US EPA Stage 2 Disinfectants/ Disinfection Byproduct Rule reflects that increase by requiring full-system DBP monitoring and limiting chlorination. Chemical cleaning has been demonstrated to reduce or eliminate the chlorine demand of both steel and concrete water tanks. In one example, the chloramine residual in a cleaned Oklahoma underground concrete reservoir was stable for more than 4 weeks, while before cleaning the residual was lost within one week. The 24h chlorine loss of a steel clearwell of a different Oklahoma surface water system was reduced from 94% to 14% through chemical cleaning. Water samples incubated in parallel in a clean laboratory glass jar also lost 14% of their chlorine residual, demonstrating that the tank chlorine demand was completely eliminated. The total THM concentration in the clearwell effluent was reduced by 29% at the same time.

FLORAN™ chemical surface cleaning produces superior cleaning results compared to conventional cleaning methods. The main benefits are improved water quality and cost savings through improved inspection and extended surface coatings lifetime.

MESSAGE

2005 President's Message

KIM PHILIP, P.Eng.

Well, it's been a great year so far for the NTWWA, which was "kicked off" by the 2004 Conference in Inuvik. The conference was a huge success, and one of the biggest ever with over 70 individuals in attendance that included water treatment plant operators, engineers, and industry and government representatives. We had representation from across the country from Jean Marie River to Gjoa Haven, Vancouver to Point Claire, Quebec. We even had a visitor from Alaska!

The town of Inuvik did a great job helping us facilitate the conference with a great meeting hall, outstanding logistical support, and an all-round welcoming atmosphere to the conference delegates. A special thanks goes to Colleen Mitchell and Melissa Schab. The conference got off to a good start on Friday afternoon with a tour of the water treatment plant, a "Meet and Greet" at the curling club Friday night, and a welcome from the Mayor of Inuvik on Saturday morning.

The conference had a total of 21 presentations on a wide range of relevant and timely topics including watershed protection, new regulations, water treatment plant construction and operation, water and waste training programs, waste reduction and recovery initiatives, wetland treatment…you name it! We also had tradeshow booths with everything from piping to a brand new full size mobile wastewater treatment plant (complete with tour guides to show you how everything works). Evan Birchard, with Imperial Oil, did a presentation on the proposed Mackenzie gas pipeline on Saturday evening that initiated lots of interesting questions from our members.

Following the conference and Annual General Meeting, the NTWWA hosted our First Annual Operator's Workshop. This attracted more community water treatment plant operators to the conference than we'd ever had before, and all of these individuals received continuing education credits to maintain their operator certification for another two years. The operator's workshop was another great success to the weekend of activities. The presentations were wide ranging and included presentations from community water treatment plant operators and industry representatives. My personal favourite was the hands-on butt fusion demonstration that involved the use of a tiger torch!

Many thanks to all the conference sponsors who gave us discounts on hotels and travel, and donated everything from hats and books to fancy goretex jackets. With their help we raised almost $500 for Water for People, a charity

A year of firsts

MESSAGE

organization that helps bring clean water to poor people in less developed countries.

As a post conference bonus we were able to produce a conference proceedings CD of all the presentations, and a bunch of conference photos - another first for the NTWWA. These were distributed to all of the conference attendees, and are still available for a great price of $40, which includes an association membership.

With all the operators attending the conference we were able to get an Operators Committee going this year as well. The committee includes works superintendents, water treatment plant operators and plumbers from large and small utilities alike. We are optimistic that the committee will help us focus our efforts to encourage operators to participate more in the organization, come out to the conference, and take their rightful place on the board. The committee is planning a survey of water and waste operators this year. If you haven't seen it yet, watch for it soon.

Another first this year (it seems like there's been a lot of them) is the glossy, full colour journal you're reading right now! We have our new Executive Director, Matt Hough, and our Southern Board Member, Ken Johnson to thank for that. We're very pleased with the way the new journal looks and proud to provide an opportunity for our industry supporters to get advertising into the hands of the engineers and operators who need it. We're hoping the new journal will increase our profile in the NWT and Nunavut and encourage even more people to sign up.

I think that just about sums up the major events of last year. This year the NTWWA's annual Conference, Operators Workshop and AGM moves to Rankin Inlet in Nunavut. The conference will be held November 4 to 7, 2005, and from the way the crew in Rankin Inlet is working, we're all expecting quite a splash! I look forward to meeting you all there, and hope to see you making presentations, signing up for the Board or the operators committee, and just generally having a great time getting to know each other.

Until then, Kim Philip, NTWWA President

Kim is a Senior Engineer with the Department of Public Works and Services, Government of the Northwest Territories, and Acting Head of the Water and Sanitation Section.

REPORT

2005 Executive Director's Report

MATTHEW HOUGH, P.Eng.

NTWWA's Mandate

The Northern Territories Water & Waste Association's mandate is:

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

Over the last twelve years, the NTWWA has fulfilled its mandate by hosting an annual conference, training operators, and circulating newsletters. This association has provided a forum for a small but indispensable industry in the North. Through representation to the Canadian Water & Wastewater Association (CWWA), the NTWWA has also brought the views and needs of its members to the national stage.

In a climate of improving water and waste regulations and an increased public awareness of the need for the provision of sustainable municipal services, contributions by professionals such as Ron Kent and Bob Phillips have established this association to connect the people who work to achieve these goals on a daily basis.

Today the NTWWA continues to play an important role in the water and waste industry across Nunavut and the Northwest Territories. The NTWWA is a volunteer organization with a Board of Directors who meet via conference call once a month. The current President of the NTWWA is Kim Philip. Administration of the organization is handled by myself and Pearl Benyk, our part time administrator.

The primary focus of the NTWWA continues to be the annual conference. Over the past decade this conference has been held in a variety of places in both territories and this year it will be held in Rankin Inlet on the weekend of November 4. I have no doubt that we will continue to enjoy the participation of professionals from all areas of the water and waste sector. The formal exchange of ideas and the informal opportunity to put faces to names and get to know the people who supply, design, and operate key elements of municipal infrastructure across the territories is invaluable. The annual conference is an event that regular attendees mark in their calendars many months in advance. I invite everyone involved in water and waste in Nunavut and the Northwest Territories to give some thought to attending, presenting a paper, or participating in the operator's workshop.

Matt is a Project Manager with Earth Tech based in Yellowknife. Matt's northern engineering experience includes Director of Engineering for the City of Iqaluit.

REPORT

CWWA Report

DELE MORAKINYO, PhD, P.Eng.

The Canadian Water and Wastewater Association (CWWA) is a national body representing the common interests of the municipal water and wastewater services & their private sector suppliers and partners. CWWA is recognized by the federal government and national bodies (e.g. The Canadian Council of the Ministers of Environment (CCME)) as the national voice of the municipal water and wastewater services public service sector.

The Northwest Territories Water and Wastewater Association (NTWWA) is one of the association members of CWWA.

In recent times, CWWA has been working on a couple of Government liaison activities in the water and wastewater sector:

Water Issues:

CWWA provided comments to Health Canada on proposed new guidelines on drinking water - the guidelines on microbiological quality of drinking water and trihalomethanes in drinking water.

CWWA contributed to the work of the Canadian Council on Human Resources and the Environment Industry (CCHREI) on the development of National Occupational Standards for Canadian Water and Wastewater Operators. CWWA also worked with the Department of Public Safety and Emergency Preparedness Canada on Canada's security programs on water and produced a position paper on "A National Strategy for Critical Infrastructure Protection"

CWWA also worked on international topics ensuring that the voice of the Canadian Water and Wastewater sector is head across the globe on such issues. CWWA liased with World Health Organization (WHO), International Water Association (IWA) and other associations on policies that will inevitably affect the Canadian Water and Wastewater sector.

CWWA hosted the 11th Canadian National Conference and 2nd Policy Forum on Drinking Water.

Wastewater Issues:

Environment Canada (EC) planned to adopt Pollution Prevention (P2) Planning approach as an instrument to manage ammonia and chloramines. CWWA, after due consultations with its members, submitted a position statement to EC to rather adopt a guideline approach and treat the ammonia and chloramines issue along with other contaminants in the Canada Wide Strategy for the Management of Municipal Wastewater Effluents. As a result of the CWWA's statement and the similar positions obtained from consultations by EC with other organizations, EC changed its approach to use of guideline for ammonia and P2 Planning for chloramines. EC published a Guideline on the Management of Ammonia in Wastewater Effluents and notices requiring the preparation of a P2 Plan for the Management of Chloramines and Chlorinated Municipal Effluents, in the Canada Gazette, December 04, 2004.

CWWA's efforts also helped influence the decision by EC to change the ammonia threshold for compliance. This removed a major planning burden on a large number of municipalities and reduced the number of municipalities that will ultimately be affected. The number of municipalities affected by P2 Planning for chloramines, which was the strategy retained by EC, has been reduced.

CWWA has been deeply involved in the development of Canada Wide Strategy for the Management of Municipal Wastewater Effluents (CWS-MMWE) since its inception in March 2004. CWWA personnel has served as a co-chair of the Core Advisory Group (CAG), a body set up by CCME to provide consultative and technical advice to the CCME Development Committee on CWS-MWWE. The CCME DC has received and reviewed reports from its various subcommittees and the consultants.

The DC is currently engaging municipalities and other stakeholders in consultation. The consultation materials are being posted on the CCME website for review and comments by the stakeholders.

CWWA also submitted position statements and comments on other issues such as on performance testing of 6L toilets, Drain Line Carry Evaluation Report and Fisheries Act Enforcement Activities. Details of these position statements and reports can be obtained from the CWWA website.

Future Challenges:

CWWA will continue to work with the CCME DC in developing CWS-MWWE strategy. The timelines for the remaining activities on the CWS-MWWE can be found on the CWWA website.

CWWA will continue to participate in the review of the Canadian Environmental Protection Acts (CEPA) and the proposed Health Protection Act. The schedule of the CEPA review process can also be obtained from the CEPA website.

CWWA will also continue to monitor the development of Fisheries Act Section 36 (3) and continue to monitor a number of other federal programs involving fertilizers and metering.

The association (CWWA) has planned a couple of events for the 2005-2006 year, details of which can be obtained from the CWWA website.

Benefiting from / Contributing to CWWA:

CWWA benefits her members mainly by representing their views on national issues and by promptly informing the members of happenings in their sector. Member contributions are required through responses to CWWA requests for comments and discussions on policies and regulations at the developmental stage. You can send your contributions directly to CWWA or through NTWWA.

Detailed information about CWWA activities discussed above and several others can be found on CWWA website: www.cwwa.ca.

Dele Morakinyo
NTWWA representative on CWWA Board of Directors

Dele is a Senior Environmental Engineer with FSC Architects & Engineers. He specializes in environmental site assessment and remediation; water and wastewater; and water flow and contaminant transport modeling.

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