Sewage Management in the Gulf of Maine

WORKSHOP PROCEEDINGS

April 11-12, 2002

Patricia R. Hinch[1], Sadie Bryon[2], Kim Hughes[3], Peter G. Wells[4]

[1]Nova Scotia Department of Environment and Labour, [2]Bluenose Atlantic Coastal Action Program, [3]New Brunswick Department of Environment and Local Government, [4]Environmental Conservation Branch, Environment Canada

Gulf of Maine Council Mission

"To maintain and enhance environmental quality in the Gulf of Maine and to allow for sustainable resource use by existing and future generations."

GULF OF MAINE COUNCIL on the MARINE ENVIRONMENT

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Laura Marron
Gulf of Maine Council Program Coordinator
c/o NH Dept. of Environmental Services
6 Hazen Drive
PO Box 95
Concord, NH 03302-0095
Phone: (603) 225-5544
Fax: (603) 225-5582
Email: lmarron@des.state.nh.us

OR

Patricia Hinch
Policy Analyst
NS Department of Environment & Labour
5151 Terminal Road
PO Box 697
Halifax, NS B3J 2T8
Phone: (902) 424-6345
Fax: (902) 424-0575
Email: hinchpr@gov.ns.ca

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ACKNOWLEDGEMENTS

The 2002 Gulf of Maine Sewage Management Workshop was sponsored by the Gulf of Maine Council on the Marine Environment. It was hosted by the Nova Scotia Department of Environment and Labour (Halifax, Nova Scotia) and coordinated by the Bluenose Atlantic Coastal Action Program (ACAP; Lunenburg, Nova Scotia). Special thanks for Canada Department of Fisheries and Oceans for providing the facility to host the workshop. The workshop's chair was Patricia Hinch and the report was drafted by Sadie Bryon. Ethan Nedeau was the production editor for the report.

EXECUTIVE SUMMARY

A workshop on sewage management was held April 11-12, 2002 at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia. The workshop was sponsored by the Gulf of Maine Council on the Marine Environment (GOMCME), hosted by the Nova Scotia Department of Environment & Labour, and coordinated by Bluenose Atlantic Coastal Action Program. The purpose was two-fold—to review issues related to the management of sewage and wastewater and its impacts in the Gulf of Maine and its estuaries and embayments, and to recommend actions for both the GOMCME and other groups engaged in this issue.

Presentations were given on the status of sewage and wastewater management from the perspectives of US and Canadian federal, US state, and Canadian provincial agencies from Nova Scotia, New Brunswick, Maine, New Hampshire, and Massachusetts. In focused discussion groups, the participants addressed the following topics: public education, ecosystem health, costs and benefits, innovative approaches, funding mechanisms, and regulation and enforcement. Four case studies were presented as management models to stimulate discussion.

Summaries of the sessions are presented in this report. The sessions and the subsequent discussions produced many recommendations. Recommendations of particular relevance to the current Gulf of Maine Council Action Plan, 2001-2006, are presented, along with specific activities under each recommendation.

Following the April workshop, the draft recommendations from the many sessions were presented to the Gulf of Maine Council for information at its June 5-6, 2002 meeting (Sackville, New Brunswick). The presentation to Council emphasized that these recommendations are based on the recognition of sewage as a threat to human health and ecosystem health, which is consistent with the international consensus on the importance of this issue. Four key recommendation areas emerged as the most relevant to the Gulf of Maine Council:

- Raising awareness with respect to wastewater management
- Establishing the link between sewage discharges and ecosystem and human health
- Socio-economic impacts of sewage discharge
- Innovative approaches to address sewage management issues

Recognizing that each jurisdiction now contributes significant resources on an annual basis to address sewage management issues, the Working Group recommended that Council consider:

- An assessment of the status of sewage management in each jurisdiction, including a measure of performance of the Council's ability to influence and improve jurisdictional practices in sewage management
- Reporting on an annual basis on the progress for each jurisdiction
- Facilitating cross-jurisdictional sharing of information
- Sponsoring a second sewage workshop 2-3 years from now

The Council approved the recommendations in principle. It directed the Working Group to include two items in the recommendations—the preparation of a draft document describing the components of a jurisdictional assessment of sewage management, and the development of improvement and performance measures. Under each key recommendation, the Working Group subsequently developed a series of next steps, and prioritized each item for inclusion in the Gulf of Maine Council Action Plan (2001-06).

INTRODUCTION

The Gulf of Maine Council on the Marine Environment (GOMCME) recently identified sewage and wastewater management issues as significant and warranting action. The Council decided to hold an international workshop to obtain more detailed information and recommendations about the status and impacts of sewage and wastewater in the Gulf of Maine, including the Bay of Fundy (its northeastern extension). These recommendations would be considered as part of the Council's third 5-year Action Plan, 2001-2006.

The sewage management workshop was held April 11-12, 2002 at the Bedford Institute of Oceanography, Dartmouth, Nova Scotia. It was sponsored by the GOMCME, hosted by the Nova Scotia Department of Environment & Labour, and coordinated by Bluenose Atlantic Coastal Action Program. The purpose was to review issues related to the management of sewage and wastewater and its impacts in the Gulf of Maine and surrounding estuaries and embayments, and to identify actions for the Council and other groups engaged in this issue.

A workshop steering committee was formed to coordinate workshop plans. In April, over 100 participants gathered in Dartmouth, NS. Presentations were given on the status of sewage and wastewater management from the perspectives of US and Canadian Federal, US State, and Canadian Provincial agencies from Nova Scotia, New Brunswick, Maine, New Hampshire, and Massachusetts. Discussion groups then addressed a number of topics, including public education, ecosystem health, costs and benefits, innovative approaches, funding mechanisms, and regulation and enforcement. Four case studies also were presented as management models to stimulate discussion.

Summaries of the sessions are presented. The sessions and subsequent discussions produced many recommendations, which are compiled in the final section of this document. Recommendations of particular relevance to the Council are also presented, along with specific activities under each recommendation. These are being considered for action in the current Gulf of Maine Council Action Plan, 2001-2006.

WORKSHOP OVERVIEW

The overall focus of the workshop was to bring together experts within the Gulf of Maine region to examine the state of science and management actions needed to address issues related to sewage and wastewater management in the Gulf of Maine in support of the Gulf of Maine Council's Action Plan.

Workshop Objectives

- Share and evaluate sewage management information among Gulf of Maine jurisdictions
- Clarify the status of sewage management in each jurisdiction
- Challenge jurisdictions to develop sewage management action plans
- Determine a potential role for the Gulf of Maine Council in Sewage Management within a regional context

Desired Outcomes

- Identify ways to promote responsibility for sewage management, share knowledge, and establish political will and commitment to the sewage management issue
- Develop a series of prioritized recommendations for consideration by the Gulf of Maine Council in determining the next steps for sewage management around the Gulf and the actions that will be taken by the Council
- Identify new innovative technologies with the greatest potential for assisting management actions related to sewage for consideration by each jurisdiction in the development of their own sewage strategy
- Develop a series of sewage management models (case studies)
- Develop a summary of the workshop proceedings (this document)
- Develop a fact sheet produced by the Bay of Fundy Ecosystem Partnership for the Fundy Issues Series

Workshop discussions were designed to address the following topics:

- Public Education
- Ecosystem Health
- Costs & Benefits
- Innovative Approaches
- Funding Mechanisms
- Regulation & Enforcement

Discussion sessions on these topics combined with four case study presentations, led to a series of recommendations. The final section of this report presents summaries of each session and overall workshop recommendations. A table of recommendations relevant to the Gulf of Maine Council and next steps that will be taken are also presented.

KEYNOTE ADDRESSES

UNITED STATES KEYNOTE ADDRESS

Andrew Gottlieb, Massachusetts Department of Environmental Protection

The basic framework for sewage management in the United States is the 1972 Clean Water Act, which sets the standards for wastewater treatment and in-stream water quality. Federal consistency was required as each state had different implementation methods, so EPA sets consistent standards and oversees State activities. There are shared responsibilities between the federal Environmental Protection Agency (EPA) and the State governments.

The Clean Water Act has been effective with major sources of pollution. As of 1996, all untreated wastewater discharge has stopped. Significant improvements in waster quality were made in the 1970s and 1980s, but since then, there has not been significant progress addressing the lingering water quality problems. Nationally, only about 50% of the waterways meet the standards set out in the Clean Water Act. Once the gross pollution problems were dealt with, other issues were uncovered, having been masked by the larger ones. These are primarily wet weather problems (combined sewer overflows, storm water and non-point source pollution) and contaminated sediments. Policy and action are now addressing wet weather issues.

An element of the Clean Water Act that had not been adequately implemented is the Total Maximum Daily Load (TMDL) Rule. This states that for any waterway that is not meeting the required standards, the State has to establish a TMDL and then develop an implementation plan. Some 14 states have been sued for not implementing the TMDL Rule and many have lost their cases and have had court order implementation plans ordered. The threat of suits relating to the TMDL Rule will drive much of wastewater management across the US in the upcoming years.

Approximately 75% of the US population receives wastewater treatment through collection systems, while the remaining 25% have on-site systems. Wastewater permitting falls under the National Pollutant Discharge Elimination System (NPDES). Most states issue the permits on behalf of the EPA, however a small number do not. There are no national standards on groundwater discharge and the Clean Water Act does not address it directly, leaving permitting of groundwater discharges to the individual state governments.

Combined Sewer Overflows (CSOs) are a problem in 900 cities throughout the US, primarily in older urban centres. The Clean Water Act states that they have to be removed; however, funding is often not available. As an interim measure, nine Best Management Practices have been developed to reduce flows as much as possible and to give communities flexibility to address all issues within the watershed before financing all CSO controls. The EPA is implementing phase two of stormwater management, which is affecting a much larger area than phase one did. This will be a significant cost burden and will address agricultural runoff or stormwater overflows. Very few states have taken on the issue of non-point source pollution with enforceable measures.

The federal government, through the Clean Water Act, provided money in the form of grants in the first 15 years of the program. The federal government would pay, through grants, 90% of construction of secondary treatment facilities. In 1987, the grant program was replaced with the revolving loan program, which supports state run low or no interest loan programs.

CANADIAN KEYNOTE ADDRESS

Garth Bangay, Regional Director General Atlantic Region, Environment Canada

Over 5 million people live around the Gulf of Maine. Many of them rely on its rich and productive waters for commercial fisheries (cod, haddock, halibut, pollock, mackerel, herring, flounder, lobsters, scallops, clams, and rockweed), as well as salmon and shellfish aquaculture, tourism, and recreation. Tourism has grown dramatically and is now a major contributor to the economies of all jurisdictions around the Gulf.

While the Gulf of Maine is unquestionably a rich and diverse ecosystem, it is also under stress. The waters are not as clean and productive as they once were; there are beach and shellfish closures, loss of wild salmon, declines in sea bird populations, and loss of coastal wetland habitat. There are hundreds of industrial facilities and over 100 wastewater treatment facilities discharging into the Gulf as well as numerous non-point sources of contamination such as agricultural runoff and failing septic systems. On the positive side, there is a history of collaboration to affect solutions to these problems, including a 1989 Gulf of Maine Agreement, the multifaceted work of the Gulf of Maine Council, and the Bay of Fundy Ecosystem Partnership.

Land based activities are recognized as a significant contributor to many of the environmental problems in the Gulf of Maine. Of these, management of sewage (or more accurately, the lack of management) has been identified as an area where we must improve. The impacts of sewage on the aquatic environment fall into three major categories: 1) bacteriological contamination, 2) nutrient loading, and 3) chemicals, such as endocrine disrupting substances, persistent organics, and metals.

In Atlantic Canada, we have looked to the sea to absorb our wastes and have fallen behind other parts of Canada in properly managing municipal wastewater and rural sewage. In the largest urban area, Saint John (pop 74,000), only 58% of the population's sewage is treated—the remainder is discharged raw. Smaller communities including St. Stephen, St. George, Blacks Harbour, and Alma have systems in need of upgrading. In Nova Scotia, Parrsboro (population 2,000) and Amherst (population 10,000) are discharging untreated sewage. In rural areas, people utilize on-site septic systems that, if inadequately maintained or poorly designed, also contribute to coastal contamination. The result is that as the density of coastal development increases, we see increasing signs of contamination in many of our bays and estuaries that impact shellfish growing areas and opportunities for recreation. Seven hundred km^2 of the Canadian portion of the Gulf of Maine are closed to shellfish harvesting due to bacteriological contamination. This is slightly more than half of the area surveyed and includes some of the most productive shellfish areas in the region.

This situation is one of the reasons that in the 2000 federal budget the Government of Canada renewed its Infrastructure Program with an enhanced focus on "green infrastructure" water supply and wastewater treatment. *Under the Infrastructure Canada Program,* (2000-2006) approximately $2 billion in federal funding are available for new projects. With the required matching contributions from provinces and municipalities, a total of $6 billion will be spent nationally.

Green Infrastructure projects are a priority for receiving federal funding support and the target amounts are negotiated with each province. In New Brunswick and Nova Scotia, that will amount to 70% and 60% respectively, or almost $120 million ($40 million federal) worth of Green Infrastructure projects in each province over the next four years. The availability of this funding has launched a resurgence of efforts to address many of the shortcomings and needs noted above

An additional means of federal support is through the Federation of Canadian Municipalities (FCM) Green Municipal Funds. The federal government recently announced a doubling of these funds—to $250 million. The Green Municipal Enabling Fund (GMEF) will provide $50 million for cost-shared grants for

feasibility studies, while the Green Municipal Investment Fund (GMIF) will make available $200 million in loans and loan guarantees for investments in municipal infrastructure. Unfortunately, there has been little use of the FCM program in Atlantic Canada. I hope that through your discussions at this workshop, one of the tools you consider is the development of project proposals to either or both of the FCM programs.

An additional source of federal support is now under development. The most recent federal budget (2002) allocated an additional $2 billion to establish the Canada Strategic Infrastructure Fund, which will target larger infrastructure projects in Canada. Environment Canada staff are prepared to work with you to prepare such proposals

On the regulatory side of the sewage/wastewater issue, Environment Canada is working on a 4-Part Strategy:

- Part I: Develop Canadian Environmental Protection Act (CEPA) instruments to deal with toxic components of wastewater
- Part II: Provide regulatory certainty under the Fisheries Act (FA)
- Part III: Influence sustainable infrastructure funding
- Part IV: Work toward coordinated wastewater management across Canada

More importantly, we are working with communities through our Atlantic Coastal Action Program (ACAP) and other mechanisms including the Gulf of Maine Council and Bay of Fundy Ecosystem Partnership to support local efforts in dealing with these issues. In southwestern New Brunswick, a Clam Resource Committee was established including representatives from three ACAP organizations, government agencies, and the clam industry to address local contamination problems. Their remedial actions have resulted in a 32% increase in clam harvesting areas, with an associated economic value of up to $3 million. Further work may open the closed areas in Grand Manan Island with an estimated value of over $500,000.

Bringing people together from around the Gulf of Maine to focus on environmental concerns is what the Gulf of Maine Council has been doing so well for the past ten years. This workshop is another example of how we can learn and share information across jurisdictions and across boundaries to make progress on a common issue. I am delighted to see such a good turnout to focus on the issue of sewage management. My challenge to you is to gain something practical from your colleagues that you can take back to your own agency or community and use.

JURISDICTIONAL OVERVIEWS

NEW BRUNSWICK OVERVIEW

André Chenard, Senior Water / Wastewater Facility Analyst, New Brunswick Department of Environment & Local Government

New Brunswick is adjacent to three other provinces and Maine. It has a population of less than 800,000 people. Saint John is the biggest city with a population of 74,000, which is nine percent of the province's population. Sixty percent are on communal sewage systems, while the remaining forty percent have on-site systems. Wastewater treatment plants should be looked at as a good thing as they are designed to protect human health and the environment.

The goals are to provide the public with a safe environment to live in, to protect our resources such as drinking water, food, and recreation areas, and to maintain or improve the water quality in our streams and watercourses. Several programs have been initiated in New Brunswick to do this, including stream classification, coastal areas protection, and drinking water quality (surface and groundwater) programs.

All levels of government are involved. Environment Canada identifies CEPA toxic substances and determines which ones are present in wastewater effluents. The New Brunswick Government deals with the substances. Fisheries and Oceans Canada have regulations under two Acts (Fisheries and Shellfish) that protect the waters of the country. The Canadian Food Inspection Agency ensures that the shellfish harvest is safe. The Provincial Department of Environment looks after the management of septic waste and septage treatment facilities. The Provincial Department of Health & Wellness looks after on-site septic tanks and fields (land disposal). Municipalities operate the facilities and regulate with bylaws that identify limits of what can be discharged into the sewers. Commissions have similar powers as municipal governments. Local Service Districts look after smaller areas. The public is involved with proposals of new facilities during the environmental impact assessment process. Neighbours are also involved in wastewater management; however, it is different in each province and state. This has effects on the watercourse in border town areas.

In New Brunswick, there are 130 municipal wastewater treatment facilities. Saint John currently treats 58% of its sewage and the new facility should bring it up to 65%. New Brunswick's infrastructure budget is $164 million for the next four years, combining all three shares (municipal, federal and provincial). The goal was to put 70% toward green projects; it looks like 90–95% of the projects are going to be green projects involving municipal infrastructure for drinking water and wastewater collection and treatment. There are also 230 non-municipal facilities, including small services for hospitals, mobile home parks, etc.

The New Brunswick government issues an approval to construct for water and wastewater facilities once it is approved through the Environmental Impact Assessment process. An Approval to Operate is also issued, which is where the standards and some of the monitoring are set. Site visits are done on an annual basis, as well as annual audits. There is also a septic tank management program in place that is working reasonably well, involving 75 septic haulers across the province.

Phase 1 of our wastewater management program started in the 1960s-1970s when the Province started building wastewater facilities. The federal government paid for most of it, with very little funding from the municipalities. Phase 2 is now underway. Most places have facilities in place and upgrading is now required. This is to ensure that the facilities are adequate and treating waste properly. The common standard is at least a secondary treatment plant with a discharge limit of 20 mg/L both for suspended solids and BOD.

Current sewage management issues are abundant. There is more awareness and knowledge now. There are also more people and organizations involved, which slows things down. Financing of capital and the operating and maintenance costs, are a problem. For example, Saint John needs 80 million dollars for their facility, which is a large amount of money for a small province.

MAINE OVERVIEW

Stephen McLaughlin, Engineering Manager, Maine Department of Environmental Protection

The Department of Human Services, Bureau of Health, became the agency that dealt with both drinking water issues and sewage disposal issues beginning in the 1950s. The State Department of Environmental Protection (DEP) came into being in 1972. The DEP deals with large municipal subsurface systems. Municipalities employ the plumbing inspectors. The Division of Health Engineering, in the Bureau of Health, developed statewide rules regarding the design of subsurface disposal of sewage in 1974 that remain primarily unchanged. State licensed site evaluators design septic systems under 2000 gal/day. Professional engineers are required for the design of systems over 2000 gal/day.

Municipalities administer the State rules at a local level through the Local Plumbing Inspectors (LPIs). LPIs approve the design of the site evaluators with the ability to approve some minor variances. They also inspect the systems during construction at least twice. LPIs wages come in part from the homeowner when he takes the completed design of the site evaluator to the LPI and pays the plumbing fee of $60 ($50 for the community, $10 for the State). State licensed site evaluators are required to design the systems, while the LPIs do inspections during construction. The contractors do not have to be certified installers yet. However, there currently is a voluntary certification program that has been moderately successful. A homeowner can install his own system, but the LPI has to inspect it at least twice during construction and he has to sign off on construction before it can be hooked.

The DEP sets water quality standards for groundwater. At this time, there is one standard: that all groundwater is supposed to be potable. The DEP issues and enforces permits for large municipal subsurface systems only. The main licensing issues are grease control and removal before reaching the leach fields and a regular schedule for pumping out the septic tanks.

Maine DEP funds the design of some septic systems that deal with specific problems. Due to a lot of straight pipes and malfunctioning septic systems along the coast and inland streams, a program is used to fund septic systems when it is determined that the malfunctioning systems are causing problems in receiving waters. This has been a successful program. Approximately $1 million/year over the last 15 years has been spent in this program.

For surface water discharges, there are two main regulatory bodies: the Maine DEP and the US Environmental Protection Agency (EPA). The DEP sets water quality standards for surface water. The state has taken over the permitting responsibility for municipal and industrial discharges from EPA beginning in 2001.

The State Revolving Fund (SRF) is used to fund design and construction of municipal treatment systems. A separate funding program is available to remove small overboard discharges. In 1989, in response to the high number of closed claming areas, a State law was passed to remove as many as possible of those small overboard discharges. About 20% have been removed so far and since 1990, about 15,000 acres of shellfish areas have been opened. The State DEP and the Division of Health Engineering have to work closely together. Even though EPA no longer issues permits in the State of Maine, they have a close overview role. EPA does provide

80% of funding to the State Revolving Fund. Twenty percent is put in by the State for capitalization match each year. Of all the money in the State Revolving Fund, about half each year comes from that year's capitalization money and half from repayment of loans.

NEW HAMPSHIRE OVERVIEW

Paul Currier, New Hampshire Department of Environmental Services

New Hampshire has a small Gulf of Maine coastline, however about two-thirds of the state is a watershed that drains into the Gulf of Maine. Discharges of untreated sewage from a straight pipe or municipal outfall are not permitted. New Hampshire is not a delegated state, so US Environmental Protection Agency (EPA) issues the permits. All communities have secondary treatment except for Portsmouth that has a waiver allowing a super primary treatment plant. Fifteen percent of the population is on municipal systems and most treatment plants are government owned. Eighty-five percent have on-site systems. No individual dwellings have a permitted discharge—all are subsurface discharges. These subsurface systems have been approved by the State since 1967, with a requirement for design plans to be submitted to the State and approved by a State plan reviewer and finally followed by an inspection of the leach bed and the installation of the septic tank before it is covered up.

The largest city is Manchester, with just over 100,000 people. It has a 34 MGD treatment plant. There are four plants over 10 MGD; all conventional activated sludge plants producing straight secondary effluent that is 30:30 (30 mg /L suspended solids, 30 mg/ L BOD). There are about 110 small municipal treatment systems. These are mostly aerated lagoons consisting of a three-cell lagoon system producing secondary effluent at 30:30 on a monthly average and 45:45 on a daily basis. There are also a number of extended aeration plants or oxidation ditches.

The disinfection requirements are fairly strong, requiring bacterial kill prior to discharge year round. The ambient standard is required at end of pipe for municipal treatment plants. There are different indicator organisms for salt water and fresh water. The freshwater standard is 126 *E. coli* organisms per 100 mL, compared to 35 enterococci in salt water.

For on-site septic systems, the design and construction standards have changed, but there are records since 1967. Most of the individual home systems are leach beds—an individual septic tank and a leaching field with multiple pipes. These days, more and more leaching trench systems are being used with a series of horizontal trenches and a distribution box. There is a demonstration program for on-site systems where innovative systems are encouraged, especially for difficult situations. There are standards for groundwater quality and design criteria for construction. This includes the leach bed and the buffer distances to either the nearest surface water or the lot line. The groundwater standard for nitrogen is 10 mg/L at the lot line.

Several issues in New Hampshire surround sewage management. Two major cities on the Merrimack River have combined sewer overflows, but they are under an EPA order to fix the problem. There is a re-evaluation of Portsmouth's super-primary system and the effectiveness of it. Sanitary sewer overflows occur primarily where there are pump stations. This is either due to lack of maintenance, or to excessive inflow or infiltration. Illicit storm drain connections are sometimes a result of incomplete sewer separation at the time when a city moves from a combined system to a separate storm water and municipal waste system. Nitrogen loading from on-site septic systems to the estuary system is also an emerging issue, but research is underway to reduce this.

NOVA SCOTIA OVERVIEW

David Wigmore, Environmental Monitoring & Compliance Division, Nova Scotia Department of Environment & Labour

Nova Scotia Department of Environment & Labour receives its mandate under the Environment Act, which was passed in 1995. The mission is to protect and promote a healthy environment, while the goal is to promote sustainable management and protection of the environment and natural areas.

The NS Department of Environment & Labour (NSDEL) has two main divisions that deal with the management of sewage. The Environmental & Natural Areas Management Division, specifically the Water & Wastewater Branch, establishes water and wastewater management regulations, policies, strategies, and programs. They also establish water quality and wastewater effluent objectives and maintain a database relevant to wastewater management. The Environmental Monitoring & Compliance Division administers all approvals for both individual on-site sewage treatment and municipal sewage treatment plants. They are also responsible for the administration, inspection, and compliance activities related to environmental protection issues associated with the Environment Act.

The NSDEL has a regulatory role, which includes processing applications; issuance, inspection and monitoring of approvals; and enforcement activities in responding to public inquiries and complaints. Nova Scotia has a number of pieces of legislation. The Environment Act is the enabling legislation. There is an Activities Designation Regulation that specifies what types of activities require approval from the Department. To process approvals, there is the Approval Procedure Regulation. Water and wastewater facilities have regulations pertaining to their classification and operator certification. For individual on-site systems, there are On-site Sewage Disposal Regulations, as well as a compendium of standards in the NS On-site Sewage Technical Guidelines. Copies of all legislation can be found on the Provincial Government website. (www.gov.ns.ca).

Last year the Department issued a sewage management discussion paper to increase awareness and solicit stakeholder interest in this issue. NSDEL is currently working on a sewage strategy for the province to map out an achievable plan to establish solutions, priorities, and timelines. Sewage management in the province falls into three areas: 45% of the population, based on location, is serviced by on-site sewage disposal systems; 30% of the population discharges raw, untreated sewage into the oceans; and 25% have sewage treatment facilities. The total projected expenditure to meet acceptable treatment requirements within the province is between $0.75-$1 billion. These numbers are slightly skewed by the fact that many rural people commute to an urban area for the day contributing to the urban sewage issue, then go back to their rural home.

Until 1997, the Nova Scotia Government did the majority of designs for the systems. Now the private sector is able to do the design work. Two classes are defined.

- **Qualified Person 1 (QP1):** a professional engineer registered within the province that holds liability insurance. They are capable of selecting a pre-existing design from the guidelines or they can do their own design based on technological principals.
- **Qualified Person 2 (QP2):** this person must take a course of instruction that the Department has approved, and must maintain liability insurance. They are capable of selecting only from pre-existing designs from the guidelines.

Licensed installers hold a certificate of qualification that enables them to install sewage systems. No liability insurance is required yet; however, this may change. Septic Tank Pumpers have certificates of qualification to take septage waste to approved sites.

For centralized wastewater management there is the NS Standards & Guidelines Manual that addresses the collection, treatment, and disposal of sanitary sewage. The three main sections are Policy, Design, and Operations. The Effluent Discharge Policy sets a specified level and type of treatment based on receiving waters. Receiving water assessments are conducted for plants in excess of 50,000 L/day. The Department has some discretion regarding the alteration of the discharge standards. There are also requirements for effluent monitoring and approvals for effluent discharge limits. In January 1996, a requirement was introduced for facility classification. Classifications are issued for water treatment plants, water distribution systems, wastewater treatment plants, and wastewater collection systems. Facilities are based on the type of technology that is utilized at the facility and the unit processes that are involved. Each one gets a rating that will determine what the classification is. Collection systems are also classified based on the population served. An Operator Certification Program has also been in effect since 1996 for the same four areas.

MASSACHUSETTS OVERVIEW

Andrew Gottlieb, Massachusetts Department of Environmental Protection

The water programs in Massachusetts (wastewater, evaluation assessment, regulation of water withdrawal) are all organized around a watershed program. The state is broken into 27 major watersheds that each of which are put on a five year rotating schedule so four to six watersheds are entering the process at any particular time. This is a way to organize, rationalize, and coordinate the assessment, evaluation, permitting, and solution implementation activities for water and wastewater in each of the basins.

A watershed assessment is initiated in the first year of the watershed cycle. A year is then spent to figure out what the data means. This informs the permitting process, which includes the NPDES surface water discharge permitting, groundwater permitting, and water withdrawal permitting. This is followed by permitting, implementation, financing, and one year to evaluate the effectiveness of the solutions put in place. This system helps allocate resources in an organized fashion.

Massachusetts has about 60 major wastewater treatment facilities that are permitted for surface water discharges. Minor discharges are designated more on flow than on impact. Groundwater discharge permits are handled under state authority. Any discharge in excess of 15,000 gal/day requires a permit, whereas anything below 15,000 gal/day can be handled under State Sanitary Code Title 5 Septic System Regulations.

The Title 5 Program is in some ways a successful aggressive program and in some ways inadequate to address the challenges we are dealing with. It was rewritten in the mid 1990s, which was the first time it had been visited since 1978. There were some improvements relating to the separation of groundwater and technical standards, however, the most extraordinary and contentious addition was a Time of Transfer provision. This states that when you sell a property, the septic system must be inspected and meet the standard or the property cannot be transferred. Any cesspool is an automatic failure, and must be upgraded. Systems that had been installed under the prior code could pass and did not need to be upgraded. Evaluation is made at time of transfer. Time of transfer was addressed as an environmental issue, however it may have had better reception had it been cast as a consumer protection issue. Septic inspectors are now licensed by passing a State certified test. They go in at time of transfer to do a physical inspection. If it doesn't pass, the buyer and seller can negotiate who will pay. Once this is resolved, the property can be transferred.

Title 5 has helped address the most egregious situations with little or no treatment. It has not helped with the nutrient issue, especially in coastal areas, where nitrogen loading has become a significant issue. There is a provision in Title 5 for the use of innovative alternative systems, such as nitrogen reducing systems, however it

is fairly complicated to get approval to use innovative systems that are nitrogen reducing. Overall, there is a concern that these nitrogen-reducing systems don't work well in the real world. At the septic test center on Cape Cod, the general finding is that nitrogen-reducing systems require a lot of maintenance. There is concern that if you put it on an individual property and the maintenance is not done (as is the usual case) that the State will not be meeting the waste load allocations. Denitrifying systems are not appropriate for all situations. For example, the system takes a couple months for the de-nitrification to begin working properly, so in a seasonal home there would only be a short time when the system is actually working before the home is closed up again. From a regulatory point of view, the option for people to use alternative systems is a false hope—the technologies do not deliver the outcomes that we think they are going to. Title 5 is inadequate to address this. We need another solution.

In Massachusetts, the impact of dewatering and flow reduction is a significant issue relating to wastewater, maintenance of habitat, and availability of adequate water supply. The State has an allocation program to determine how much water is in each watershed and to allocate it as appropriate for public water supplies and other uses. In many instances, we are withdrawing more water than we ought to be to maintain the natural fluctuation of the system. The 7Q10 (7 day 10 year low flow) is the basis for a lot of wastewater permitting. However, more often now, this low flow is becoming the norm every summer.

Because of the way the infrastructure has been built (collect water from homes on public water systems, gather it into regional locations, and send it to regional wastewater treatment facilities), we are seeing significant dewatering impacts as these large quantities of water are moved from one area to another. Effectively there is an overall lowering of flows in Massachusetts—lower lows and higher highs with not enough in the middle. The impact of flow and where you discharge your wastewater are becoming significant issues. At the same time, look at Boston Harbor and you see an extraordinary success in cleaning up the harbor. However, 400-600 million gallons per day of fresh water is going into the ocean when maybe it might be better for the entire system if it was put back into the upper reaches of the watershed from where it once came. The next conversations are going to be difficult with a significant change in process. There will be serious thought on reallocating water to the upper reaches and less focus on marine discharges and just 'getting it out of here'. The Clean Water Act looked to clean up the streams, but should have focused on keeping the water local and making it clean, not removing it from the system.

The Estuaries Project was recently launched in Massachusetts to address the degradation in the coastal embayments south of Boston. This is a 6-year, $12.5 million investment to determine what the nitrogen carrying capacity is of all the embayments south of Plymouth around the Cape over to Rhode Island. There are 89 embayments in total. Management plans will be developed that will identify the type of nitrogen reduction required in the watersheds to achieve the goals, based on levels of water quality improvement. This is a subset of the Total Maximum Daily Load (TMDL) process. It will involve enormous policy questions. After long periods of relatively minor degradation, in the last five years these embayments have become eutrophic. They have lost their eelgrass habitat and are now dominated by macrophysics and brown green algae that smother the bottom, have little dissolved oxygen present and massive fish kills if there are 2-3 days without sunlight in the summer, and have bad odour problems. Water quality degradation has become a big issue for the communities, because the health of these water resources is central to the appeal and tax base of the coastal communities.

PUBLIC EDUCATION SESSION

ONE FLUSH AT A TIME

Kathleen Johnson, Inspector Specialist, Nova Scotia Department of Environment & Labour

Inspectors primarily deal with regulatory aspects of sewage and wastewater; however there are also public education opportunities. These include the Sewage Management Strategy, educational programs, outreach, associations, and affiliations.

The Sewage Management Strategy has three stages. Step 1 was a discussion paper released in March 2001 to initiate discussion on some of the problems and to bring the stakeholders together. Step 2 involved public consultation sessions held from May and June 2001 throughout NS engaging the public and NSDEL staff. Step 3 involved compiling the information and completing the strategy. The Department has to make the case to Nova Scotia's citizens that sewage treatment is important. Strategic goals are to increase the awareness of the issues, solicit input, define sewage treatment, outline the effects of raw sewage discharges, examine financing options, and get feedback from the consultations. The results from the consultations identified some priority public concerns. These included:

- Raw discharges
- Cost associated with septic systems, perceived to be due to the privatization of the design and approval of the systems being an added cost to the homeowner
- Lack of enforcement
- Septage disposal
- QP1 (an engineer) and QP2 (a person licensed by the NSDEL to select sewage systems from the guidelines) privatization system
- Funding for repair of malfunctioning systems
- NSDEL no longer providing a consultation role due to the privatization
- Lack of innovative technology

Priority categories of concern included education, funding for sewage treatment plants and malfunctioning systems, enforcement, regulation, research, political will, and planning. The sewage strategy is to be completed by the spring of 2003. Other initiatives include:

- A memorandum of understanding between the Province and the Nova Scotia Association of Realtors to provide education and awareness of on-site sewage systems
- Waterfest: A three-day festival aimed at delivering an environmentally sound message about water conservation to grades 4-6. Approximately 3700 kids participate every second year. It was held in a central location, arrangements were made with the school board so the kids can attend, and transportation via buses was provided by the event. Teachers sign their class up for various sessions, and have a set time to spend in each pavilion. A volunteer is with each group at all times.
- Joggins 2000: A door-to-door survey was done in this small community to raise awareness of water conservation, wastewater disposal and treatment options, availability, and proper functioning
- Sutherlands Lake 2001: A residential survey on water use and landscape practices promoting water conservation and a watershed cleanup
- Outreach programs, displays, websites, brochures, etc. are used as appropriate to promote public awareness and understanding

PUBLIC EDUCATION FOR ALL OF US!

Carol Coulter, Executive Assistant, Waste Water Nova Scotia

Waste Water Nova Scotia (WWNS) was developed in 1997 by persons involved in the industry and the Nova Scotia Department of Environment, as a vehicle to pass on information to and through the general public and homeowners, and to provide education about wastewater issues. This information is of particular interest to the licensed installers, Qualified Persons, and homeowners particularly with respect to on-site septic systems.

A Memorandum of Understanding (MOU) between the NS Department of Environment & Labour and WWNS states that WWNS will be responsible for education, training, and upgrading of those persons involved in the on-site sewage disposal industry. This year WWNS held 22 training sessions across the province, in order to meet with all persons who are eligible to hold a license. The license enables trained individuals to install septic systems. Next year WWNS will meet with the QP2s. These sessions are required every five years, as outlined in the MOU.

The organization is not intended to replace the NSDEL, but to work with them and provide educational services. There is a new display board, to be used at home shows, real estate educational seminars, etc. WWNS is also responsible financially for the booklet, "Before You Construct an On-Site System", which is available from both the NSDEL and WWNS.

Waste Water Nova Scotia is governed by a board of seven directors who donate their time and ensure the effective management of the organization. There are 350 active members at present, out of a possible 700. Quarterly newsletters are published and a part-time employee assists those needing information or services.

COMMUNITY BASED EDUCATION

Sean Brillant, Executive Director, Atlantic Coastal Action Program Saint John

Why do we get involved in public education? You want to establish community pride and build public awareness and support for the hard decisions that need to be made. You must instill the idea into the community that it is the right thing to do to pump out your septic tank. Peer pressure will then take over and people will comply with the social norm.

Who is the public? EVERYONE!! You must educate everyone, specifically targeting the media, the scientists, and the youth in the community, as these three will become excellent resources in the future. What do you teach people? You need to emphasize the connection between the community and the environment. A sample program being run in Saint John involves grade 4 students taking a checklist home with them and putting an orange hazardous waste sticker on anything in their home on the checklist, and explaining how these items affect the environment.

You also need to instill the responsibility that everyone has for their community and the environment. Don't be fearful of giving the community too much information; if explained in appropriate terms, they do have the capability to understand complex issues.

How do you go about this? Pamphlets, displays, brochures, etc. are the backbone to public education, but you cannot rely solely on them. You must be sure to speak the audience's language, put it in a format that makes sense to them, make it relevant, and use lots of photos and exciting interactive features. Focus on the positive; what you want, not what you don't want. Get people out doing things, and get them dirty. Educate by action.

If you have a well-educated community, you will see responses. There will be letters in the paper, you will notice changes in behaviour, there will be increased participation in programs, and in the end you will have many happy but dirty volunteers.

SOCIAL MARKETING USING CREATIVE AND FLEXIBLE OUTREACH

Theresa Torrent-Ellis, Maine Coastal Program, State Planning Office

How do you sell the message? Keep it simple and get their attention; use colors and pictures. Television ads are great but often too expensive for most educational budgets.

How do you accomplish it? Survey constituents in the area, develop partnerships by building on existing materials, and involve diverse groups in the strategy. Websites, posters, media, stencils on the drains, etc are all good tools for getting the message out.

Why do we do it? 'All the little things we do, taken together, make a big difference.' We need to gain understanding to move from blame to common cause. Holding free workshops with free food will increase attendance. The Maine Coastal Program is 2 years old. The Penobscot Bay Stewards Program is 7 years old and will be working on a collaborative program with the St. Croix Estuary Project on the border of Maine and New Brunswick this fall.

What is it about? Area residents will be more engaged in planning for their community if they have the tools and understanding to do it and if they have the connection with the decision makers (the people on the ground working on issues). A sample program in Washington State involves several potential pledges that can be taken either by a community or a business. This focuses on bringing people to the awareness that, where pollution is concerned, every home is a waterfront property. For awareness and behaviour changes, you must be creative and flexible.

A PROGRESSIVE NOVA SCOTIA EXAMPLE

Linda Redmond, Environmental Education Coordinator, Nova Scotia Department of Environment & Labour

Citizens in Nova Scotia planning to buy a home will soon be able to rely on their real estate practitioner to help them understand how to maintain their on-site sewage disposal system. This will make it easier for homeowners to protect their investment and the environment. The Nova Scotia Department of Environment and labour and the Nova Scotia Association of realtors have agreed to cooperate on the development and delivery of an On-Site Sewage Disposal Systems Awareness course. The 3-hour pilot course was first delivered in March 2002.

"Industry gets the training that it wants, buyers of homes get the information that they need and the environment is better protected. That's a real win-win initiative that we're excited to be able to deliver," said David Morse, Minister of Environment and Labour.

Municipal sewer systems cover about only 60 percent of Nova Scotia homes. Homeowners who buy in communities that use on-site septic systems often have little or no experience with these systems. Without proper maintenance, the systems can begin to malfunction, possibly leading to expensive repairs and other environmental concerns for the homeowner.

The need for training was identified during this summer's public consultations on sewage management, which were led by Environment & Labour staff. Real estate practitioners who attended the sessions expressed concerns about lack of training with on-site systems. The result was the signing of a memorandum of understanding that focuses on educating real estate practitioners on the regulatory information and the maintenance of on-site sewage disposal systems. The department will not charge for the course. The topic will not only improve the knowledge of practitioners, but also counts as credit toward mandatory continuing education for practitioners.

SUMMARY AND RECOMMENDATIONS

What does public education mean? Who needs it? Why do we do it? Most importantly, how do we ensure that our messages and teachings are making a difference? What do we mean by 'public' and who should we 'educate'? We need to reach community residents, school children of all ages, professionals, teachers, industry and the list goes on and on. The public is everyone! In Nova Scotia, Waste Water Nova Scotia plays a key role in educating, training, and the upgrading of licensed installers. Their membership includes QPII's, septic pumpers, installers, and QPI's. They have identified a need to educate those in the industry and create resources for homeowners, lot owners, and others. It is important to educate the media because they become a tool for further educating the community. Youth are our future leaders, as they will make decisions later in life based on the knowledge learned.

How do we get the message across? We must emphasize the connection to the environment and make it relevant to the audience. Relevance is key as it will stimulate community pride, instill a sense of stewardship, and build public awareness and support for the hard decisions that will have to be made. People decide what is right and what is not right in their community. For example, if the idea is instilled that the right thing to do is to pump out your septic system every 3 to 5 years, the peer pressure will likely ensure that this happens. Some of the methods for transferring the message include pamphlets, brochures, booklets, fact sheets, newsletters, displays, surveys, art contests, poster contests, and websites. Messages must be short, fun, creative, provocative and always focus on the positive.

How do we get people involved? We can hold public consultations to create awareness and provide opportunities for input. We can also educate with action by getting dirty. In Maine, they use a program called Awareness to Action, a free 80-hour community course that is offered to the public. In turn, the recipient is committed to provide 30 hours of community service for conservation issues. This works! You can also hold free workshops to get the message across. There is a workshop like this for non point source pollution entitled Safe and Sound that provides information on how to create healthy yards and gardens.

How do we know our messages are making a difference? A well-educated community gets involved as evidenced by letters received by newspaper editors, television coverage, changes in behaviour, increased participation, and people talking and getting involved.

Recommendations

- Promote education on the proper maintenance of on-site systems and on water conservation options
- Promote education on the socio-economic and environmental impacts of malfunctioning sewage and wastewater management systems
- Ensure all education material is creative and has flexibility
- Ensure sufficient resources are allocated for the coordination and distribution of educational materials and ideas

ECOSYSTEM HEALTH SESSION

REGIONAL CONTAMINANT MONITORING USING THE BLUE MUSSEL, *MYTILUS EDULIS*

Peter Hennigar, Environmental Chemist, Environment Canada

In 1989, the Gulf of Maine Council on the Marine Environment endorsed the concept of a comprehensive environmental monitoring plan for the Gulf of Maine. Out of this, Gulfwatch was established in 1991 to determine the regional distribution and temporal trends of persistent and contaminants in the Gulf of Maine. The blue mussel, *Mytilus edulis*, is used as an indicator of the chemical contamination in the Gulf, following from the internationally accepted Mussel Watch approach.

Since 1992, Gulfwatch has been monitoring toxic contaminant concentrations in mussel tissue at 56 sites. Test sites were chosen from areas in proximity to the mouths of significant river basins, human population centers, areas of industrial activity, and wastewater discharges. There are also reference sites that are thought to be 'clean'. Five of the sites are benchmarks that are monitored every year, while other sites are monitored on a rotational basis, every three years. Ninety-four contaminants are monitored: 24 PAHs, 28 PCB congeners, 17 chlorinated pesticides, 15 polychlorinated dioxin and furans, and 10 heavy metals. There are standardized field and collection procedures and analytical methods for the monitoring program.

In general, most organic contaminants showed a consistent geographical trend of increasing concentrations from north to south around the Gulf. Chemical contamination, including PCBs, PAHs and pesticides, was correlated with population density, tidal range, latitude, and distance from a river system. Results have shown that no PCB concentration in mussels from any Gulfwatch site in any year exceeded the US or Canadian regulatory action levels for PCB in seafood. PCB concentrations at 11 sites, however, were greater than a US EPA PCB screening value, which is intended to initiate further assessment of risk to human health.

No chlorinated pesticide mussel tissue concentration from any year exceeded any US or Canadian regulatory action levels. No TEQ (toxic equivalency) concentration exceeded the Canadian Food Inspection Agency (CFIA) regulatory action level of 20 pg/g 2,3,7,8 tetrachloro-dibenzodioxin (TCDD) in seafood. On a summed TEQ concentration basis, however, 10 of the 40 sites mostly in the southern Gulf did exceed the EPA human health screening value of 0.70 pg/g wwt for 2,3,7,8-TCDD and a Canadian (CCME) tissue residue guideline value of 0.79 pg/g wwt for the protection of wildlife consumers of aquatic biota. At most sites, TEQs are derived mainly from PCBs. Some exceptions are sites that are impacted by pulp and paper effluents.

PAH concentrations in mussels at Gulfwatch sites ranged from below detection limits to as high as 3333 ng/g dwt in Boston's inner harbour. In Canada and in the United States, there are no published regulatory action levels for PAHs in commercial marine species. Where PAH contamination may be a human health concern, closures of commercial fisheries are dealt with on a case-by-case basis.

In regard to metals, results have shown that the distribution of the majority of metals is relatively uniform across the Gulf with the exception of Ag, Cr & Pb. This is in contrast with organic contaminants where concentrations increase in a north to south direction. Boston Harbor and Boothbay Harbor, Maine, are the only Gulfwatch sites where a metal concentration in mussel tissue exceeded a US FDA human health guideline value of 11.5 ug/g dwt Pb. The highest Hg concentration measured in Gulfwatch was 0.3 ug/g dwt in mussels from Portland Harbor in 1995, which is well below the US and Canadian regulatory values of 6.7 and 3.3 ug/

g dwt, respectively. However, it is worth noting that the Hg levels in the Gulf of Maine appear elevated relative to those across the continental US.

Temporal trends in data were determined using repeated-measures ANOVA with a linear model to detect patterns in five benchmark sites. The majority of the contaminants showed either a decreasing trend or no significant change. Similar trends in contaminants have also been reported over the years for NOAA S&T mussel watch data and by other monitoring programs in Canada and the US using other indicator species such as eggs of coastal sea birds. This finding is not unexpected, given the increased awareness of environmental issues that have resulted in the banning or phasing out, in many countries, of such chemicals as PCBs, cadmium, and some chlorinated pesticides (e.g. DDT).

SEWAGE, BACTERIA, AND ECOSYSTEM HEALTH

Stephen Jones, Research Associate Professor, University of New Hampshire

This presentation addresses microbial components of sewage and relates some aspects of sewage-borne bacteria to impacts on ecosystem health. There is a diverse and ubiquitous microbial community in the marine ecosystem. Bacteria are natural biota in the marine ecosystem; they break down organic matter, degrade toxic chemicals, and are involved in nutrient and trace metal cycling. Naturally occurring pathogens are also present. These species are, for the most part, completely different from pathogens found in sewage.

Sewage contains microorganisms and many other constituents including nutrients, organic matter, toxic chemicals, and pharmaceuticals. Bacteria are one component of the microbial community; pathogens are a small fraction of the total microbial population. What is the situation when sewage-borne bacteria (SBB) are discharged into the marine ecosystem? SBB are involved in nutrient cycling and organic matter decomposition in the environment. Direct impacts from SBB can be the alteration of the composition of indigenous microbial communities in the marine ecosystem, as well as effects on the antibiotic and metal resistance to the natural community. SBB are indicators of widespread sewage and some of the associated contaminants.

Fecal coliforms, enterococci, and *Escherichia coli*, are used to classify waters and to identify sources. *Clostridium perfringens* is used as a research tool. There are many limitations, unclear management implications, and time/labour intensive applications. For example, conditions in the marine ecosystem exist that can promote regrowth of some indicator bacteria, thus the concentrations detected in water may falsely indicate higher levels of sewage presence than what in fact is present. Conversely, indicator bacteria are not always good representatives of the presence of enteric viral pathogens.

A complex classification system for shellfish harvesting has resulted in a high level of management requirements. A new tool is Microbial Source Tracking, which identifies species that are sources of sewage contamination, not just concentrations of bacteria. Various tools include ribotyping, antibiotic resistance profiles, and other 'molecular' techniques (gene probes, rep-PCR, PFGE, DGGE, etc.), biochemical profiles, and immunological methods. The procedure for using ribotyping is as follows:

1. Collect fecal material from species in the watershed that are suspected sources of sewage
2. Produce DNA profiles for E. coli strains isolated from feces samples and compile into database library
3. Compare DNA profiles from E. coli strains isolated from water samples
4. Compare to source species library to determine best match and source species

One important area of research in ribotyping is to determine how many DNA profiles are needed in a library and whether the source species from distant regions are usable. Results suggest that more library DNA profiles are better, and that the source species from New Hampshire were useful for analyzing the Vermont study results.

Another application of fecal indicators is to track the transport and history of some sewage-borne chemical contamination and to relate it to trace metal concentrations and sediment geochronology and thus, some of the contaminant deposition in history. *C. perfringens* is used to track the presence of sewage-borne trace metals, such as silver which is well accepted as a relatively sewage specific metal. Results from the comparison of Ag to *C. perfringens* showed some relationship for the Portsmouth, New Hampshire study, and a better relationship for other studies in Massachusetts and New York. In two industrial sediment cores from Portsmouth Harbour, NH, concentrations of *C. perfringens* correlated closely with age of sediment layers (determined by radionuclide analysis). The use of *C. perfringens* to screen sediments profiles initially could cut costs of radionuclide analyses.

Not all human pathogens in marine waters are associated with sewage. Thus, you cannot depend on sewage-borne microbial indicators to monitor for these organisms. *Vibrio vulnificus* is a naturally occurring marine and estuarine bacterial species that can cause infections in health-compromised humans. *V. vulnificus* is present in some areas of the Gulf of Maine. It appears in high numbers only in the summer, often when sewage-borne indicator bacteria are at low levels. Sewage-borne nutrients may stimulate this bacterium.

In conclusion, sewage-borne bacteria differ from but may impact indigenous microbial community composition. They also are indicators of pathogens and other sewage contaminants. Fecal-borne bacteria may shed light on land use, human impacts, and animal presence.

LESSONS LEARNED FROM STUDYING SEWAGE CONTAMINTS IN HALIFAX HARBOUR

Phil Yeats, Research Scientist, Fisheries & Oceans Canada

Treatment of raw sewage currently being discharged directly into harbours is being planned for several coastal urban centres in Atlantic Canada. For Halifax, work is set to start in the near future on enhanced primary treatment of the raw sewage currently being discharged into the harbour. This sewage treatment should solve bacterial contamination problems and eliminate most of the organic matter discharge. But what will be the impact of residual chemical contaminant discharges on the harbour's environmental quality?

Studies of contaminant distributions in dated sediment cores show that contaminant inputs (heavy metals, PCBs, PAHs) are currently significantly lower than they were several decades ago—i.e. controls of contaminant discharges at source are having a positive effect. However, contaminant levels at the sediment surface remain well above natural background levels and, in many cases, above sediment quality guidelines. Concentrations decrease away from the most contaminated sites in the central part of the harbour.

Organic contaminant levels in biota show similar patterns, being highest in the most industrialized inner harbour areas. There is considerable variability in contaminant levels in both time and space but as with the sediments, concentrations become lower away from the central part of the harbour. Various studies of toxicity show biological effects at the more contaminated inner harbour sites.

Lessons learned from our studies

A good tracer for where sewage derived contaminants are being deposited is required. Silver is one possible choice for a tracer of sewage contaminants in sediments and possibly biota.

Much more is learned about inputs, transport, and fate of contaminants by measuring concentrations of individual compounds rather than concentrations of classes of compounds, e.g. it is better to measure individual PCB congeners than åPCB. An example is the story of identification of industrial contamination of the harbour with 3,3' dichlorobiphenyl (CB#11). This compound is the dominant peak in the PCB spectra of water (dissolved) and some mussel samples, and a significant component for particulate matter and lobster samples. But, CB#11 is not a component of any of the Aroclors, or an Aroclor decomposition product, so it must have a compound-specific source.

The obvious source may not always be the only important one. An example is the story of tin concentrations in mussels. Although imposex is widespread in Halifax Harbour and undoubtedly related to use of tributyltin as an antifoulant in marine paints, our observations of tin, silver, coprostanol, etc. in mussels would suggest a link between tin and sewage. Results of water quality modeling tend to confirm that sewage could be an important source for tin contamination of the harbour.

Simple water quality models can be useful tools in developing our understanding of chemical contaminants in the harbour. These do not have to be complex finite element models. A water quality model for Halifax Harbour has been used, e.g., to estimate the reduction in contaminant concentrations in the harbour that will result from the estimated 80% reduction in sewage organic matter input because of the enhanced primary treatment. These simulations suggest a substantial reduction in water column concentrations of particle reactive heavy metals such as lead, once the sewage treatment is in place.

SEWAGE AND ECOSYSTEM HEALTH: A VIEW FROM THE PAST AND THE PRESENT TO PREPARE FOR THE FUTURE

Peter Wells, Environmental Conservation Branch, Environment Canada
Jocelyne Hellou, Marine Environmental Sciences, Fisheries & Oceans Canada

Sewage disposal and collection systems existed as long ago as 8000 BC in ancient civilizations. It has been recognized since the 19th century in the western world that to protect community health, there was a need to dispose of sewage waste suitably. Even though sewage systems were expensive and a health hazard in themselves, building them started in Paris, London, and Boston, and elsewhere in Europe. It was the most convenient way to handle the raw sewage problem. It is only in the past 50 years that engineering efforts have been directed toward preventing sewage pollution—building treatment plants of greater capacity and sophistication.

We have learned much over many centuries on the extent of human related effects, and ecosystem effects. GESAMP (the United Nations Joint Group of Experts on Scientific Aspects of Marine Environmental Protection) has reviewed sewage recently in a global marine context. Their conclusions (GESAMP 1990) were:

- Globally, sewage is a major source of nutrients to coastal waters
- Nitrates and phosphates are linked to expanded areas of eutrophication, with plankton blooms and excessive seaweed growth
- Lost living resources and amenities occur

- Microbial contamination causes many human diseases, including Cholera and hepatitis A, widespread outbreaks of gastro-intestinal diseases at ill-protected and crowded beaches, and suspected cases of respiratory, ear and skin infections among bathers

Recently, GESAMP concluded (GESAMP 2001a,b) that many inshore waters globally are "overwhelmed" with sewage pollution. It occurs not only in the less developed and developing world, but also in the developed world (e.g. Canada, Bermuda). Impacts include losses to fisheries, recreation, and tourism; eutrophication and algal blooms; and frequent outbreaks of cholera, typhoid, and infectious hepatitis.

> *"Microbiological contamination of the sea has precipitated a health crisis with massive global implications".*
> *"Many studies show that respiratory and intestinal diseases and infections among bathers rise steadily in step with the amount of sewage pollution in the water."*
> -World Health Organization (WHO) study (2000, H. Shuval, pers. comm.)

Bathers are at risk even in lightly contaminated waters that meet the European Union and US EPA standards. There are estimates of 250 million cases of gastroenteritis and upper respiratory disease every year, with some long-term disabilities. The cost is $1.6 billion US per year. Seafood is involved in 11% of all outbreaks of disease carried in food in USA. Survival of pathogens in the sea is days to weeks for bacteria and more than a year for the IH virus. Viruses are in one fifth of shellfish taken from waters meeting US bacterial standards. The global cost to human health is estimated to be $10 billion US per year.

What are the sources of information on effects? Specific literature searches using the Aquatic Sciences and Fisheries Abstract database, with the word sewage by itself or in combination with other keywords, uncovers little primary literature on the fate and effects of sewage, or ecosystem interactions with the discharge of sewage. Much of the information is in the gray technical literature, produced by environmental protection agencies and water quality/treatment authorities. However, concerns regarding sewage are constantly appearing in the scientific and engineering literature, and popular press, and interest is increasing due to recent studies in Europe and the US. Issues at the forefront of research are related to "inconspicuous" anthropogenic additives being found in the environment, such as surfactants and pharmaceutical type products. There is apparently still a need to answer a plethora of questions regarding chemical and biological discharges and their implications on ecosystem health, covering topics such as fate, transport, partitioning, degradation, availability, uptake, distribution, type and level of toxicity.

What is in sewage? Biogenic and anthropogenic synthetic materials from personal household and industrial sources are found in sewage. Also found are foreign bodies/pathogens such as viruses and bacteria, food residues, cleaning products, medicinal pharmaceutical products, agricultural products, salt and hydrocarbons from road runoff, and materials from urban and road spills.

What happens to sewage when it is treated? Primary treatment is the removal of solids (sedimentation or screening). Secondary treatment involves additional biological treatment (aeration, activated sludge). Tertiary treatment has further chemical treatment (oxidation process). In general terms, an increase in treatment leads to a reduction in discharged 'solid' material.

What happens to components upon release? What is at risk? Resident species, commercial and non-commercial species, young of the year, sessile, mobile and migrating species, and humans are all at risk. Presently, there is concern regarding chemicals with the following "3Ps of ecotoxicology":

- **Persistence:** slow biodegradation or photodegradation, as well as large continuous input
- **Partitioning:** fate in various environmental compartments that ultimately leads to bioconcentration and bioaccumulation, i.e. uptake from water, sediments and food
- **Potency:** relates to toxicity and the basic concept of dose and time response, and associated risks due to exposure.

Eliminating sewage inputs as highlighted in the Gulf of Maine Action Plan (2001-2006) will be invaluable in the long run. It will contribute directly to tackling present concerns regarding the implications to ecosystem health. While inputs are being identified and reduced, research closely interfaced with monitoring, overall assessments of ecosystem health, and sewage risk characterization are needed to further define the problems and opportunities associated with sewage management in the Gulf of Maine and Bay of Fundy.

SUMMARY AND RECOMMENDATIONS

Three primary issues pertaining to sewage, human health and ecosystem health were identified:

1. Public health threats are directly due to high bacterial levels, and the presence of other pathogens
2. Nutrients in sewage contribute to coastal eutrophication
3. Chemicals in sewage cause sublethal biological effects in marine organisms, both in laboratory and field exposures, e.g. on reproduction, immunological condition, and on endocrine systems

The issues are currently being addressed in the following ways:

- Eliminating untreated sewage discharge is occurring in the Gulf of Maine and should continue to occur.
- We have some end-of-pipe limits to STPs (Sewage Treatment Plants) for BOD, suspended solids, coliform, and site-specific parameters.
- Some monitoring of sewage management is taking place in the Gulf of Maine, particularly in the shellfish harvesting areas. There has been long-term work done by the regulatory agencies. Beach closures have occurred in many locations. The Gulfwatch (i.e. gulf-wide mussel watch) program is in its 11th year.
- Knowledge of the toxicity of contaminants that come out of sewage treatment pipes is largely laboratory-based. We need to make it more field-based.

Recommendations

Where do we want to go?

- Maintain a current inventory of sewage sources, impacts, and related knowledge
- Eliminate the remaining discharges of untreated sewage in the Gulf of Maine
- Harmonize the management objectives of sewage treatment and set limits for both public health and ecosystem health
- Develop a better understanding of links between exposure, bioavailability, toxicity, and impacts, e.g., better understand the human health and ecological risks in the Gulf associated with sewage and its components (chemical and pathogens)
- Establish links between septic tanks, contaminant seepage, and the risks to drinking water and aquatic ecosystems.

How do we get there?

- Advocate formulation of regulatory frameworks based on knowledge of sewage impacts and pragmatic approaches
- Ensure the management tool(s) is matched to the locality
- Identify suitable forcing mechanisms to stimulate action, e.g., take governments to court, formulate clear scientific messages to gain public support, use funding programs as incentive
- Focus on sewage-borne bacteria as the evidence of sewage impact and as indicators of effective action.
- Improve the suite of ecosystem health indicators
- Track progress

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COST AND BENEFITS SESSION

SEWAGE MANAGEMENT: A TOOL TO CREATE SUSTAINABLE COMMUNITIES

Stephen Hawboldt, Executive Director, Clean Annapolis River Project

The Clean Annapolis River Project (CARP), based in Annapolis Royal, NS, is a charitable, non-governmental organization created to work with communities and organizations to promote awareness and to foster the conservation, restoration, and sustainable use of the freshwater and marine ecosystems of the Annapolis Watershed. Since 1992, CARP has operated the Annapolis River Guardians, a volunteer-based water quality monitoring program. Detailed analysis of the data has shown that there appears to be little connection between the bacteria levels and rainfall events in the main stem of the Annapolis River, indicating that bacterial contamination is ongoing, regardless of the weather. This implicates three likely sources: municipal treatment plants, on-site systems, and uncontrolled animal access to waterways.

Treatment plants are meeting or exceeding their requirements most of the time, leaving uncontrolled animal access and on-site systems as the likely candidates. While uncontrolled animal access is still a problem in a few areas, most farmers know that clean water helps their bottom lines and are striving to improve the situation.

The Centre for Water Resource Studies at Dalhousie University estimates that approximately one third of on-site systems do not function as they are intended, making these systems a significant source of bacterial contamination in the Annapolis watershed. Health Canada has set various standards for the bacterial contamination of water: potable water is zero; watering livestock is 50 fecal bacteria colonies per 100 ml; irrigation of food crops is 100 fecal colonies; and water contact recreation is 200 fecal colonies per 100 ml sample. The level for shellfish, such as clams, is 14 fecal colonies.

It should be pointed out that the Annapolis River is one of the cleaner systems emptying into the Gulf of Maine. Based on our experiences in the Annapolis Watershed, we know that the economic costs are significant and seriously undermining the sustainability of communities throughout the entire Gulf of Maine watershed. Some examples follow:

- Lost recreational opportunities have negative implications for tourism and the quality of life of residents.
- Water that is too contaminated to safely irrigate food crops translates into higher capital and operating costs to secure alternative supplies, or reduced yields if irrigation is discontinued.
- Farm animals that are drinking unclean water or standing in brooks are likely to be slightly less healthy than their counterparts with better conditions. This is directly reflected in the productivity of the animals.
- Properties located along contaminated waterways are less desirable than those along high quality streams and lakes. This is reflected in reduced property values, slower sales, and higher municipal tax rates.
- Communities along polluted waterways are less desirable places in which to live and raise families, undermining the capacity of these regions to attract employment opportunities and provide a high quality of life for residents.

THE 'GREEN' ECONOMICS TOOL KIT

Kelly MacDonald, Environmental Economics Advisor, Environment Canada

In environmental economics, economic activity is viewed as a component of our human systems and our ecosystems—a subsystem of our environment. The aim of environmental economics is to value our natural capital and recognize the value of the services that the environment provides , and value future benefits and costs as well as short term ones to reflect our perspective of sustainability. The following is a summary of several economic analysis tools available for addressing some of the questions being raised:

Cost Benefit Analysis: This is a conventional economics tool. Such analysis can be extended by incorporating the non-market benefits and costs that do not have easily recognized values. This can be used to determine which wastewater treatment option would create the greatest net benefits to society, i.e., on-site wastewater treatment or centralized treatment.

Full Cost Accounting: This helps to determine the true cost of untreated wastewater disposal in coastal areas and measures the hidden costs of a development or project.

Environmental Damage Assessment: This can be used to evaluate the damage caused by improper disposal of wastewater. EDA can be used to determine how much a polluter should pay as a fine or in compensation to a third party because of that polluting activity. This is often (but not always) based on what it would cost to restore the damaged environment.

Bio-Economic Modeling: This tool helps to articulate and understand the many connections between the economy and the environment. This can be useful with shellfish issues (i.e. by studying the economic opportunities provided by a re-opened and sustainably harvested shellfishery).

Economic Impact Analysis: Evaluates the impacts of an activity or development on employment, economic growth, and the generation of tax revenue. Impact analysis is a commonly used tool in mainstream economics, and can complement environmental economics.

Sustainable Development Indicators: These indicators look behind the issues, and can be used to assess and evaluate whether or not wastewater policies are achieving the intended goals.

Green Taxes: How much more expensive does it need to be before disposing of untreated wastewater becomes too expensive to continue? Could there be a tax? For who and how? This can generate revenue to reinvest in wastewater management.

Trading Systems: Pollution trading systems can cost effectively reduce pollution by encouraging private and public investment in pollution prevention and treatment technology. It involves creating a market, where the total allowable pollution limit is continuously reduced giving available pollution permits a market value. Polluters must continuously compare the cost to prevent pollution with the ever-increasing cost to purchase additional permits. Pollution prevention becomes an economic choice.

Valuing the Environment: This supports all the above tools, and asks 'what is a clean environment worth'?

ESTIMATING THE BENEFITS OF MUNICIPAL WASTEWATER AND TOXIC SUBSTANCES CONTROL

David Sawyer, Economist, Gardner Pinfold Consulting Economists Ltd.

The biggest challenge in conveying your message so that proper, informed decisions get made is to take the information and convert it to a form that is understandable to the politicians or whoever the audience is. Sometimes it is not as easy to make the case for a cleaner environment. For example, the Annapolis Valley has several very measurable benefits of removing water pollution. It's not as easy to measure the benefits that would be gained by cleaning up Halifax Harbour. A policy such as requiring all residences to conserve water would do a lot towards reducing the negative impacts on the harbour. We are not transferring the full cost of distributing clean water to the customers. Increased revenues from water distribution could be put toward wastewater treatment facilities.

Politicians are the decision makers. Politicians are driven by the public, so the public is the key player in this. How much do people really care—enough to pay for it? Decision makers will be affected by numbers so if we can convert things to numbers, it will be easier to reach them in the form that they prefer to make decisions.

SUMMARY AND RECOMMENDATIONS

The objective for this session was to provide a general overview and a description of economic tools that may be useful in making the case for investments in the management of sewage. Clearly, the first step in the process is to understand the environmental and social consequences of the present situation. It is then possible to use economic analysis to demonstrate either the costs of inaction or the benefits of improved management.

The three presenters covered the topic from the community perspective and from an economic perspective. We were exposed to a range of tools and analytical techniques that could be brought to bear in various situations. The first presentation gave a community perspective on the social and economic impacts of the sewage problems that they have in the Annapolis Valley. At times, the river has such high levels of bacteria concentration that the water cannot be used for crop irrigation. This has many effects, including additional costs to farmers, lost recreational opportunities, and reduced tourism activities. Property values can also become depressed due to poor water quality. Shellfish areas in the Annapolis Basin are closed. It really becomes a public health issue; there has not been a case in Nova Scotia like Walkerton, Ontario, but we are coming close. There is suspicion that the pollution is from irrigated crops.

The common theme in the presentations and discussion was how important it is to make the connections between the environmental conditions and the social and economic consequences and how often these connections were not easily quantified. It was generally agreed that good economic arguments would be helpful in attracting the funding required and that pilot studies should be encouraged.

Recommendations

Utilize socio-economic tools and analysis to strengthen arguments of better sewage management. Some tools available are:

- Cost benefit analysis
- Full cost accounting

- Environmental damage assessment
- Bio-economic model linking the ecosystem to the economy
- Economic impact analysis
- Sustainable development indicators
- Green taxes
- General environmental evaluation.
- Support efforts to develop effective tools for socio-economic evaluations. The use of economic tools is not common in the area of sewage management and pilot studies should be promoted to provide lessons on how best to use these tools.

INNOVATIVE APPROACHES SESSION

MULTI-PASS PACKED BED FILTERS—EXPLORING OPTIONS FOR COMMUNAL AND ON-SITE WASTEWATER TREATMENT SYSTEMS

Kelly Galloway, Engineering Technologies Canada Ltd.

Integrated Wastewater Management means that a community is serviced by a mixture of systems—including on-site, standard centralized collection, and cluster. However, a professional management utility would still look after all of the systems, whether they are conventional, cluster or on-site.

A cluster system is defined as a wastewater collection system that serves two or more homes, but less than an entire community. It produces lower volumes that allow for a land-based disposal as opposed to piping it to the river or ocean. Individual septic tanks may pre-treat wastewater before it is transported through low cost, alternative sewers to a relatively small, simple treatment facility.

Packed Bed Filters are a type of treatment technology that can be used for cluster system treatment. A Packed Bed Filter (PBF) uses a bed of inert media (e.g., sand, peat, crushed glass, expanded shale, or synthetic material—textile, absorbent plastic foam). They operate by having small amounts of Septic Tank Effluent (STE) periodically dosed onto the filter, so that the filter remains in an unsaturated condition to achieve optimum treatment. As wastewater passes through the bed, constituents are removed by a variety of methods:

- **Adsorption:** chemical constituents attach to solids
- **Biological conversion** by aerobic/anaerobic bacteria, e.g. BOD, nitrification, denitrification, fermentation
- **Filtration:** mechanical straining of total suspended solids
- **Volatilization:** liquids and solids (e.g., volatile organic chemicals, ammonia gas, methane, hydrogen sulphide) vaporize and escape to the atmosphere

Once a PBF has been dosed several times, a bacterial film develops on the particles of the filter. This bacterial film (biomass) aids in the treatment by absorbing soluble and colloidal matter and microorganisms found in the settled wastewater, and then decomposing and oxidizing it during the rest period between doses. The constituents being removed from the wastewater by the packed bed filter (as with other treatment technologies) are biodegradable organics, total suspended solids, nutrients, pathogens, and inorganics. Factors that affect the removal efficiency of these constituents are:

- Organic Loading Rate: amount of BOD loading per unit area or volume per day
- Hydraulic Application Rate: volume effluent applied per dose
- Hydraulic Loading Rate: average or peak flow per unit area or volume. Depends on surface area of the media and the available porosity
- Water Holding Capacity: the fraction of water retained against gravity per unit volume of media—a measure of how absorbent a media is
- Grease and oil concentrations
- Temperature and pH
- Oxygen availability
- Toxins (e.g. cleaners, poisons)
- Inorganic solids (kitty litter, etc.).

A multi-pass PBF means that the effluent is recirculated through the filter three to five times before being dispersed for irrigation or reuse. The recirculation improves the removal efficiency. Types of multi-pass PBFs include:

Recirculating Sand Filters: HLR ~5 usgpd/sq.ft (Qpeak) or 3.3 usgpd/sq.ft (Qave). The level of treatment will be less than 15 mg/L BOD5 and TSS.

Synthetic Non-woven Textile Fabric Filters (OSI Advantex): Five times higher porosity than coarse sand and about 95% porosity compared to sand or gravel at 30-40% providing more room for inorganic solids accumulation. The filter also has a high water holding capacity (~20%), which provides a more sustainable environment for the bacteria. These come in AX or RX models. The AX has hanging textile sheets that are easier to clean than the RX, which is random textile chips. It would take approximately 12 of the AX pods to provide equivalent treatment as a 2000 sq.ft recirculating sand filter, which would service about 50 homes. (Each pod is 3 ft by 7.5 ft.) The synthetic filters can be cleaned with a garden hose with the excess water going into the recirculation tank. The sheets can be removed as well, if required, which is a significant benefit over a sand filter, which would have to be dug out with an excavator if the system has been overloaded with grease and oil.

Absorbant Plastic Foam Biofilter (Waterloo Biofilter): This filter consists of fairly large (2 inch diameter) cubes with macropores in-between, so the effluent can flow downward easily, making it very difficult to plug. The cube is very absorbent. There is a high surface area (9-17 times coarse sand), high inter-connected porosity (90-95%), very high water holding capacity (~55% by volume), and very high hydraulic loading rates are possible without plugging (750 L/cubic meter-day, Qpeak (Volume)). The compact installation requires very little land. It would take approximately eight of the 2.4 diameter tanks to service the same 50 homes as 2000 sq.ft of recirculating sand filter. Effluent is <6 mg/L BOD and 5 mg/L TSS.

Septic Tank Effluent Sewers: Septic tanks retain most of the large solid particles that settle out and break down. They use cleanouts, not manholes because significantly less infiltration and grit enters the sewer. The lack of large solids in the lines means that only minimum velocities are required and deep excavations are not necessary. Small diameter piping can be laid at a variable grade just below the frost line. Inexpensive, low maintenance pumps can be used where the treatment facility is at a higher elevation than the area to be served.

Packed Bed Filters are economical, reliable, and sustainable and they are ideal for small and medium size housing clusters (5-500 homes and more). They consistently produce a high quality effluent. There is no bypassing of untreated sewage. There is 70-85% TN removal possible with certain wastewaters and configurations. The systems are modular, and easily expanded as well as being mechanically simple, low maintenance, and do not require highly skilled operators. Low power consumption occurs because only small pumps and low wattage fans are used where required, not blowers. Additional features and benefits of synthetic multi-pass packed bed filters is that they are easy to remediate in the event of abuse or overloading, compact in size with small land requirements, pre-packaged modules/pods which ensure availability, quality and consistency of the media, and they are fast and easy to construct and inspect.

SEWAGE TREATMENT FOR SUBSURFACE DISPOSAL OR IMMEDIATE REUSE

Craig Jowett, Waterloo Biofilter Systems

A typical on-site system for an individual house consists of a septic tank with the effluent flowing into a pump tank so it can be sprayed over the foam in the Biofilter tank. From here, it drains out by gravity or is pumped out into a disposal bed. The filter can also be installed above ground inside a shed with an open bottom so the filter sits on a bed of stone over a bed of sand on bedrock. It must be 15 meters from a well or creek.

The Biofilter can also function in a steel sea container that is useful for remote or island systems. The container set-up means that there is no on-site work to do, reducing the cost. Vinyl containers are also being produced to act similarly to the sea container. The container style system sits on a steel pad. The container is 8.5 feet wide by 30 feet long by 8 feet high and can treat the same as 40 m^3/day or 10,000 usg/day.

Inside the Biofilter tank there are cubes of foam being sprayed with sewage that has been through a septic tank, or better, undergone pre-treatment. If the sewage has gone through secondary treatment prior to the filter treatment, the Biofilter tank can be loaded up four or five times more than usual and still get nitrification. The limiting factor is the quantity of solids and amount of maintenance acceptable. The loading rate is typically 750 L/m^3 or in restaurant water 500 L/ m^3 is used. Inside the Biofilter foam medium, it functions with the reverse physical properties of sand, with larger pores where the sand grains would be and the solid network of plastic where the interstitial porosity would be. Give the microbes a comfortable environment in which to survive and they will treat the sewage effluent and not plug it up.

With appropriate disinfection, the effluent can be used immediately in houses, apartments, or a highway truck stop for toilet flushing, but more commonly is used for irrigation on golf courses.

MANAGEMENT OF ON-SITE DECENTRALIZED WASTEWATER SYSTEMS

Don Waller, Centre for Water Resources Studies, Dalhousie University, Halifax, Nova Scotia

Decentralized treatment systems include on-site systems using septic tanks or advanced treatment, and cluster systems, which may utilize a variety of collection and treatment technologies. Why do decentralized systems need to be managed? Forty to fifty percent of the population of Nova Scotia is served by on-site systems. In some areas of the province, a significant number of systems are malfunctioning. These failures are thought to be the result of installation prior to current regulations and guidelines, or of improper or inadequate installation or management. If on-site systems are considered a second-class option in terms of regulation or management, we should not be surprised if they provide second-class performance when compared to central collection and treatment systems.

What is the role of management? Management is to ensure that once systems are in place they perform the way they are supposed to over the long term. 'The purposeful management of decentralized wastewater systems must be undertaken to overcome the stigma of failed on-site systems, to obtain cost savings by using many recently developed technologies, to allow for the development and testing of new technologies, and to encourage the orderly development of any unsewered areas in the context of a sustainable environment.' Management can also be defined in other terms. US EPA uses five levels of management that depend primarily on the complexity of the systems to be managed. Cornell University also uses levels of management defined in terms of five levels of management programs.

Every system should be designed for management. Features that aid in successful managing include accessible openings, a water meter, an effluent filter, and inspection ports on the distribution system. Some things to look for in determining if a basic septic tank and discharge system is operating as it should: How much water is being used in the building? What is the degree of sludge and scum accumulation? What are the levels of effluent in the distribution system?

How do you get this information and what do you do with the information? Information can be recorded automatically and transferred online so that it can be retrieved either on-site or remotely. This technique can be applied to the control and the management of systems. There needs to be a definition of the information, description of the system, maintenance records, results, and a decision about how and where to get the information. There must be in house staff and software to look after the information system, or consultant companies can be hired to assess it with their own software. Education for everyone is an integral part of the management function.

Who is going to do the management? Management functions may be carried out by private owners, public entities, community associations or private sector, service providers. Currently in most of Nova Scotia, property owners are considered responsible for management of their systems. A number of Nova Scotia municipalities have taken advantage of legislation that enables a municipality to establish wastewater management districts, and to manage private and public systems within those districts. A condominium corporation may also be considered an approved management entity for a cluster system.

REGIONAL SEPTAGE MANAGEMENT AND DISPOSAL

David Peterson, Clean Earth Ltd.

The primary reasons we manage sewage is due to human health hazards, threats to the human food chain, and environmental hazards and threats.

Septage management in New Brunswick went through a significant regulatory change in the mid-1990s. The regulation of the haulers and disposers of septage waste changed from the Department of Health & Community Services to the Department of Environment. In 1996, a new Septage Management Plan was implemented. The approval, installation, and maintenance of on-site septic systems is still covered by the Department of Health & Wellness, while the inspection, hauling and treatment is with the Department of the Environment & Local Government.

Coordination of efforts can be difficult for moving toward management of on-site systems. The original plan was to encourage disposal at regional public facilities (11 sites are designated, primarily at municipal treatment plants). The lack of pre-treatment of septage increased loading and the dumping of large volumes of septage has been problematic.

Clean Earth does the pre-treatment of septage waste. The septic tank waste is dewatered and the solids sent for composting while the filtrate goes through further treatment. Dewatering involves removing the water from suspension—either free flowing water or using force to remove the interstitial water in the solids. There are two technologies: DAB and Fornier Rotary Press. DAB uses chemical flocculation and gravity separation to separate solids from the liquids. The Fornier Rotary Press uses chemical flocculation, gravity separation, and mechanical separation.

A key component of success is public education. There has been resistance in the past to education of on-site systems because of inadequate disposal of septage waste. Now, as we are progressing towards septage pre-

treatment, the government seems to be more receptive to launching some education programs. Commercial composting is an expanding area as more biosolids are produced from the dewatering process. There are several sites in New Brunswick approved for receiving biosolids, and for operating and removing composted product offsite. However, there is still some public resistance to using compost originating from sewage.

EVALUATION AND APPROVAL OF INNOVATIVE ON-SITE SYSTEMS IN MASSACHUSETTS

Andrew Gottlieb, Massachusetts Department of Environmental Protection

Failing septic systems and the cumulative impacts of improperly functioning conventional septic systems (on-site wastewater disposal systems) are causing loss of aquatic habitat, poor water quality, shellfish bed closures, and other environmental impacts. Vendors of innovative on-site technologies claimed that they could help address these problems with new on-site wastewater designs. However, they complained that it was too difficult to get these technologies approved or widely used. They said the cost and time to validate the performance of these technologies, and the confusing approval process delayed regulatory approval, raised development costs, and ultimately increased costs of these technologies to the consumer.

To address these concerns, the Massachusetts Department of Environmental Protection (DEP) took two key actions. First, during the 1994 rewrite of the Massachusetts Sanitary Regulations ("Title 5"), an expanded section was included to clearly define the permitting and approval process for innovative technologies. Title 5 establishes a three-tiered review and approval process for alternative systems as follows:

1. **Piloting:** This is intended to demonstrate that the proposed technology can function effectively under the relevant physical and climatological conditions at the pilot sites (up to 15 systems for 18 months).

2. **Provisional Approval:** This is intended to evaluate alternative technologies that appear technically capable of providing levels of protection at least equivalent to those of conventional Title 5 systems. This approval also determines whether, under actual field conditions, use of the alternative system is likely to provide such protection, and whether any additional conditions addressing long-term operation, maintenance and monitoring are necessary to ensure such protection (at least 50 systems for 3 years).

3. **General Use Certification:** This is intended to facilitate and allow the use, under appropriate conditions, of an alternative system that has shown a level of environmental protection at least equivalent to that of a conventional system (90% of systems must be effective, at least equal to Title 5). There is also a Remedial Use designation. This includes technologies proven in piloting that may be used for remediating failed systems, even when they do not have general use certification.

In 1997, DEP collaborated with the Buzzards Bay Project National Estuary Program and Barnstable County Health Department to construct a facility to evaluate innovate on-site systems. Funding for the test center was provided initially by the US EPA. Massachusetts opened an Alternative Septic Test Center in 1998. The goal of the test center was to speed the introduction and approval of innovative advanced on-site wastewater disposal technologies in Massachusetts to protect and improve the water quality and serve the needs of the public. The benefits of the test center are to provide less expensive and effective advanced on-site wastewater treatment and alternative design septic systems to Massachusetts and beyond. This saves consumer money and provides better environmental protection. Systems are tested in triplicate for two years at design flows. Flow was diverted from a residential area of a military base to the facility. DEP decided the test center results could fulfill the Piloting requirement (18 trials).

Success and the Real World

At the test center, seven technologies have already been tested for two years. Five other technologies are under evaluation currently. Studies are underway to evaluate viruses, phosphate removal, and hybrid configurations. For example, a Nitrex filter following a non-proprietary RSF has consistently achieved less than 3-ppm nitrogen.

The test center is an effective tool for piloting approval and for evaluating permitting, provisional, and general use. However, monitoring of innovative systems at residential dwellings may always be needed because of the variation in flows, waste concentrations, variations in maintenance, effects of household cleaners, and other real world stresses.

There are some issues with using alternatives in the real world. Small-scale systems appear more effective than larger ones, even for the same technology. Provisional testing results may differ from piloting for a number of possible reasons. Schools and supermarkets pose special problems for many alternatives—results are not as good as for residential on-site systems with the same technology.

SUMMARY AND RECOMMENDATIONS

This session focused on small systems including individual, cluster collection systems, and commercial applications, as well as evaluation of innovative treatment technologies. The session included five presentations covering packed bed filtration, options for systems application, systems management, septage disposal, and third party evaluation including protocol development, policies and regulatory framework.

The central issue is that all wastewater needs to be treated. While standard on-site systems may provide adequate treatment in some locations, a higher level of treatment may be needed if the leachate could impact surface or groundwater. Advanced technologies exist and can be effective. No one size fits all, so systems must be customized to the location, level of dosing, and the waste stream. Regardless of the type of system, proper management is needed, and must be applied during design, installation, operation, and maintenance. Careful record keeping is essential. Management systems can be simple or sophisticated, and can be operated and maintained by an individual, an association, a contractor, or the municipality.

Recommendations

- Encourage monitoring for the long-term performance of innovative technologies
- Encourage the use of innovative technologies where appropriate, and ensure regulatory flexibility to accommodate them
- Encourage further development of innovative approaches and technologies
- Educate Municipal, State and County officials on the existence and performance of innovative technologies
- Educate individual homeowners on innovative approaches and technologies
- Understand the need for management and maintenance of sewage and wastewater treatment systems
- Develop forums and mechanisms for information exchange (e.g. workshops, an electronic database, a list of contacts, or identification of funding opportunities)
- Encourage local sewage management teams to participate in thorough decision making with goal setting, planning, implementation, management, monitoring, and adaptation

FUNDING MECHANISMS SESSION

FUNDING MECHANISMS FOR THE STATE OF MAINE

Stephen McLaughlin, Engineering Manager, Maine Department of Environmental Protection

Maine's funding strategy involves three topics: 1) the use of a low interest loan program as the main wastewater funding source, 2) setting an upper limit of affordability, using grant funds to stay below that limit, and 3) coordinating with other funding agencies to pool resources.

In 1987, the U.S. Clean Water Act was amended to move from a construction grants program to a federal/state funded loan program. There was a policy approved by the State of Maine Board of Environmental Protection that the upper limit of affordability for the average annual residence user charge would be 2% of the median household income (MHI). The MHI is established during the census. For example, if a community has a median income of $25,000 then a residential household should be able to pay $500 annually for wastewater treatment; this only relates to centralized collection systems, not to on-site systems.

Several agencies have funds available, in addition to the Maine DEP. The US Department of Agriculture provides wastewater infrastructure grants and loans to rural communities. The Federal Department of Housing and Urban Development has community block grants for infrastructure. Maine DEP and US EPA combine funds for the State Revolving Fund (SRF), a low interest loan program; and there are some grant funds from the State Legislature. The Maine DEP SRF program managers meet regularly with these other agencies to pool resources and set priorities. They then work with the consultants and communities to reduce the costs to design and construct wastewater facilities. Sometimes the installation has to be phased which requires being very resourceful to obtain money from many different sources.

The State Revolving Fund began in 1989. The Federal government contributes 80% and the State contributes 20% for the capitalization funds. There was not a lot of money to start out with, so the Maine Municipal Bond Bank, which handles the financial part of the fund (while DEP handles the environmental part) blended their money with the 0% money from the capitalization grants to give a low interest loan at 2% less than what the bond bank could loan their money. So, by leveraging money, there was a bigger pot to draw from initially. The Revolving Fund has been loaning out about 22-25 million dollars a year, which has increased in recent years to $40-50 million. Because of the lower interest rates recently (SRF loans are currently less than 3%), communities are moving forward with needed upgrades.

Other funding programs include the Small Community Grant Program, the Discharge Removal Program, and the Boat Pump-out Facility Program. The Small Community Grant Program provides $1 million per year to build septic systems to replace malfunctioning systems or straight pipes in the areas that have confirmed pollution into receiving waters. The grants are available in graduated amounts depending on the seasonal or permanent use of a house and the income of the residence. The Discharge Removal Program provides grants for homes or small businesses to remove small treatment facilities that are in shellfish areas. The Boat Pump-out Facility Program provides $100,000 per year for 75% grants to construct pump-out facilities. You can have a $100 million treatment plant for your town, but if there are 100 boats in the harbour that are discharging directly into the water, you will not be able to meet water quality requirements.

There have been lessons learned in Maine. There will never be enough grant money, so you have to work with all the organizations that have money and pool the resources. People can usually afford more than they think they can if proper education and awareness is used. A low interest loan program can work. There has

been 0% failure rate on repayment in Maine. However, even if you have loan money, as opposed to grants, you may still need enforcement. It may take a development moratorium imposed on a community for them to initiate their sewage cleanup process.

ACOA (ATLANTIC CANADA OPPORTUNITIES AGENCY)

Simon d'Entremont, Atlantic Canada Opportunities Agency

An infrastructure-funding program is jointly delivered by federal and provincial governments. This is the Nova Scotia component of a national program called Infrastructure Canada, which has a two billion dollar federal investment. It is a 6-year program, launched in 2000. It is a follow-up to a similar program called Canada Infrastructure Works program. Atlantic Canada Opportunities Agency (ACOA) is the delivery organization in Atlantic Canada. The provincial partner is Service Nova Scotia and Municipal Relations. The program is delivered through a virtual secretariat and the work is shared between the two partners.

The program is primarily designed to deal with municipal levels of government, although there are opportunities for non-municipal organizations with the endorsement of the municipality. The program covers infrastructure in a broad sense. The priority of the program is green infrastructure (water, wastewater, landfills). Secondary priorities include recreation, culture, tourism, affordable housing, etc. To date there are $76 million worth of projects with 98% that are green, so there is no lack of demand for water and wastewater projects.

Each municipality must prioritize their projects. This priority ranking is important in the decisions that are made jointly by the federal and provincial governments. There is never enough money to cover the projects requested. In the province of Nova Scotia, the money is distributed to the 18 counties based on a formula that takes into account the population, unemployment rates, etc. Within each county, there is competition for the dollars available. Having the cost/benefit numbers available with the application would be helpful in making decisions on which project to fund, however it is difficult to compare a town with a concentrated population to a regional municipality with a population spread over a large area.

PROVINCIAL FUNDING FOR MUNICIPAL INFRASTRUCTURE IN NOVA SCOTIA

Marvin MacDonald, Service Nova Scotia and Provincial Relations

As well as being the Provincial partner in the Canada/Nova Scotia Infrastructure Program, Service Nova Scotia and Municipal Relations also administers a program called the Provincial Capital Assistance Program (PCAP) for water, sewer, and solid waste projects. This primarily looks at emergencies such as failing systems. The program is intended to address critical health and environmental issues related to municipal infrastructure needs in the province of Nova Scotia. The budget for this year is slightly over a million dollars.

The Province does not have the mandate to provide financial assistance to private owners. However there are examples used in other jurisdictions that could work. One option to get a system upgraded could be to create a lien against the property. This lien would be instigated when the homeowner got a 'loan' to upgrade a septic system, and would indicate that the 'loan' must be paid back at the time the property is sold. This system is similar to the fees for a nursing home that are paid when the home gets sold. Regarding tax incentives for owners of private sewage systems, rebates can work and are often administered through the municipality.

SUMMARY AND RECOMMENDATIONS

The Maine State funding system has developed from mostly a grant system to a loan based system. The Department of Environmental Protection works closely with the municipalities and groups that are seeking the loans. This helps with negotiating, planning, phasing, setting priorities, and getting the best from the consultants. The loans are low interest and the capital is 80% from federal contribution and 20% from the state. Historically, the money loaned annually is in the $25 million range and appears to be growing to $40-50 million. For perspective, Maine has roughly the same population as Nova Scotia. In addition, a smaller grant program (~$2 million) focuses on specific issues, such as shellfish or marina pump-out facilities. The communities did not like the loan program until there was no alternative of grants.

The Atlantic Canada Opportunities Agency (ACOA) has a six-year program for infrastructure grants that are mostly available to municipalities. However, in the fine print, you don't have to be a municipality to receive a grant but there are very few examples of non-municipalities that have gotten one. These grants are focused on green programs particularly and 98% of projects are water and sewer issues. Contributions are split three ways by federal, provincial, and municipal governments. This is sometimes difficult because all three parties need to have cash available when it is time to proceed with construction. Many opportunities are being missed. Sometimes municipalities can't raise their third of the money. There are also many applications; the dollar value of applications is commonly four times the value of funds ($2 billion) available in the fund. This fund is co-managed by the federal government and the provincial government.

A difference between the two countries is that in the US there is program 'partnering' with agriculture and housing, whereas in Canada the three levels of government are partnered. In some funding agreements, there is limitation on the number of federal agencies that can contribute to a program.

Canada's Strategic Infrastructure Fund was announced in the last budget. This involves $2 billion federal investment over ten years. It will be administered through the Office of Infrastructure and Crown Corporations Canada. The fund is designed for large-scale infrastructure projects that have difficulty in receiving funding under the current structure.

The property owner has to take responsibility for their water usage and waste. However, the municipality also has to take responsibility in terms of charging the appropriate price for water. Water conservation must be built into the system. For example, in areas where water metering has been implemented, there is seen to be a 25% drop in demand.

Recommendations

- Support the development of a loan program in Canada, similar to the revolving fund, to provide a consistent funding option rather than sporadic grants with associated deadlines
- Improve communication and understanding of processes required to receive funding from such sources as the Canadian Federation of Municipalities
- Support the development of a loan program for homeowners to upgrade faulty on-site systems, at low or no interest to be paid back when the house is sold
- Encourage municipalities to have a better look at their costing and charging for supplying clean water and processing sewage and wastewater
- Encourage the exchange of information on successful funding options available in the different jurisdictions

REGULATION AND ENFORCEMENT SESSION

NEW BRUNSWICK REGULATIONS AND ENFORCEMENT

André Chenard, Senior Water / Wastewater Facility Analyst, New Brunswick Department of Environment & Local Government

In New Brunswick (NB), there are approximately 130 municipal wastewater treatment facilities. Different controls exist, one being the Clean Environment Act, Regulation 82-126 Water Quality Regulation. Under this regulation, the proponent for a new wastewater collection and treatment facility or for the upgrading or extension of services must obtain an approval to construct before any construction can begin. Once the facilities are functional, the owner must also obtain an approval to operate for these facilities.

To obtain the approval to construct, the proponent must fill in some application forms and submit the project with engineered plans to the provincial Department of Environment & Local Government. The projects consisting of new facilities are registered under the Environmental Impact Assessment (EIA). The EIA program registers the project and distribute the plans to a team of experts from various fields, including the approvals engineer, the Department of Fisheries and Oceans, Environment Canada, Department of Health & Wellness, Department of Natural Resources & Energy, etc. Comments regarding foreseen issues or concerns are returned to the NB Department of Environment & Local Government who then seeks the answers from the proponent. When all the questions are answered the project is given a Letter of Determination in which certain conditions are set and the approval to construct can be issued once the approvals engineer is satisfied that the project meets the provincial requirements.

The province published guidelines in 1997 entitled, "Guidelines for the Collection and Treatment of Wastewater." Recently, a new document was developed in collaboration among the Atlantic Provinces called the "Atlantic Canada Standards and Guidelines Manual", to develop standards for the region. However, NB has not yet officially adopted the new document.

The approval to operate involves setting the standards that the wastewater treatment facility must meet to discharge its treated effluent to the receiving waters, the training requirements for the operators, notification requirements for raw sewage discharge and exceedance, etc. Monitoring is also included in this document. The NB Department of Environment & Local Government performs at least one wastewater treatment plant site inspection annually. As well, an annual audit, based on the Composite Correction Program, or an on-site prioritization exercise may be performed.

The approval to operate also has a section that deals with the collection system, collection system operator training, notification of the pumping station failures, and refers to collection system maintenance. The approval also sets the standards for the effluent quality required. Wastewater collection systems must be maintained at all times and must avoid excessive groundwater and surface water infiltration.

Wastewater treatment and wastewater collection system operator certification is presently offered and the program is on a voluntary basis. Operator certification is one tool that the department can use to ensure that the proper people are operating these facilities. However, the fact that an operator is certified does not guarantee that the facility is being operated efficiently, therefore site visits are required to ensure the operator is applying his knowledge, and that the facility is sound and is being operated properly. Operator certification may become mandatory in the near future in NB.

The NB Department of Environment & Local Government is also responsible for septage management. The responsibility for approving septic tank systems with land treatment systems is with the Department of Health and Wellness but the management of the septic waste disposal is a Department of Environment & Local Government responsibility. The department has developed a strategy and a program for the management of septage in the province.

THE STRAIGHT POOP

Pamela Parker, Manager Overboard Discharge Program, Maine Department of Environmental Protection

The Overboard Discharge and Pump Out Grant Programs are run out of the Maine Department Environmental Protection. The Overboard Discharge Program regulates non-municipal, non-industrial, and discharges of sanitary waste to the surface waters of the state. The Boat Pump Out Grant Program is designed to help build shore side facilities to remove sanitary waste from boat holding tanks. In the US, every action on sewage is driven by the Clean Water Act. This Act was passed in 1972. It requires secondary treatment in municipalities and was phased in over time. It has significantly improved the water quality during the past 30 years.

There are approximately 20,000 recreational boaters with installed heads on the coast of Maine. The regulations relating to the discharge of sewage from boats came into effect in 1976, requiring boats with installed toilets to have either treatment systems or holding devices. Sewage from recreational (and commercial) boats can have a significant impact on water quality. For instance, two people discharging raw sewage into the water introduces the same quantity of bacteria as a town of 10,000 discharging secondary treated effluent into the water for the same period. The Clean Vessel Act in 1992 provided money to install pump out stations.

There are many regulations that support the Clean Water Act. The federal regulations are the minimum, while the state regulations can be more stringent. There has been continual improvement of point source discharge quality from large facilities. Maine has good compliance. The discharge limit is 30 mg/L BOD TSS for a monthly average and 50 mg/L for a daily maximum. No discharges are allowed into enclosed lakes. All monitoring and inspection information goes into a big database creating a good resource for looking at changes of effluent quality over time. All facilities are required to have a license that is renewed every 5 years. As part of the re-licensing review process, an enforcement staff will visit the site to do a file audit on the facility. This gives a third party perspective as a check because the inspector and the licenser may develop a relationship with the facility and operators. This also helps to ensure a consistent story in the event of a court case.

In dealing with any regulatory issue, there are many problems—you have to pick the right one. This seems simple, but often the most important issues are not the ones being worked on. Periodic program review is a good thing, and can be used as a helpful tool in determining the effectiveness of the program. Ask some really basic questions, such as what is the goal(s) of the program, rank problems as they relate to the goal(s) and see whether you are really working on the problems that rank highest. Are lower ranking problems absorbing a lot of valuable staff time? Consistency is important—both within the program and among the programs. This is what makes you credible to regulate an industry.

THE ENVIRONMENT ACT

Glen Warner, Nova Scotia Department of Environment & Labour

The following is a summary of the relevant sections of the Nova Scotia Environment Act.

Approvals & Certificates: Section 50

- "No person shall commence or continue an activity designated by the regulations as requiring an approval unless the person holds an appropriate approval."

Release of Substances: Section 67

- "No person shall release or permit the release into the environment of a substance in an amount that causes or may cause a significant adverse effect unless authorized." As a responsible person under the Environment Act, any person must report a release of a substance that is in excess of an amount, concentration, level, or rate of release authorized by the approval or regulation. In the case of sewage, a release of 100 litres to fresh or sensitive marine waters shall be reported.

  The construction, operation, or reclamation of facilities for the collection, storage, treatment, or disposal of sewage or septage are designated as activities; therefore requiring an approval.

On-site Sewage Disposal Systems Regulations: Section 10

- No person shall construct or install a system without an approval.
- No person shall discharge sewage without having obtained an approval.
- If installed without an approval, the person responsible is required to uncover, modify, or remove the system at his or her own expense.

On-site Sewage Disposal Systems Regulations: Section 25

- No person shall construct or install a system unless the person is a licensed installer.
- No person shall install a system unless constructed in conformance with the approval.
- No person shall cover a system without having obtained a certificate of installation from a QP1, QP2, or inspector stating that the system has been installed in conformance with the approval.

On-site Sewage Disposal Systems Regulations: Section 27

- Inspector can require the system owner to repair, replace, or upgrade a malfunctioning system.
- No person shall fail to comply with this request.
- No person shall make the repair without an approval unless deemed an emergency and three days advance notice is given.

Right of Entry and Inspection: Section 119

- Enter and inspect any place to which an approval relates to determine: the extent any substance may cause an adverse effect; the cause of any adverse effect; how an adverse effect may be prevented, eliminated, or environment rehabilitated.
- Enter and inspect any place waste may be found.
- Enter and inspect any place a substance is being, has been, or may be released into the environment.
- Require the production of any document required to be kept pursuant to the Act.
- Enter and inspect any place required to be the subject of or referred to in an approval, certificate, or order.
- Stop and inspect vehicle, aircraft, or vessel to ascertain its operational compliance with the Act.

> Where the inspector believes any thing may release, is releasing, or has been released into the environment, a substance that may cause, is or has caused an adverse effect, may require the person having care, management, or control of the thing to detain the thing in some place, or to remove the thing, and give a receipt for it.
>
> An inspector has authority to go in to inspect a property without a search warrant, as set out in section 119, provided the system is not in the home. The owner or occupier will give reasonable assistance to enable the inspector to carry out their duties.

If you fail to follow the authorization, or fail to obtain the authorization, there are consequences. The purpose of the Nova Scotia Environment Act's "Penalties and Prosecutions Section" is to support and promote the protection, enhancement, and prudent use of the environment while recognizing the basic principles of prosecutorial discretion. Fines can range from $0 - $1,000,000. Penalties may involve Ministerial Orders, warnings, summary offence tickets, or imprisonment of up to two years for more serious offences.

SUMMARY AND RECOMMENDATIONS

Many different regulation and enforcement tools are available. The difficulty is in the implementation of the tools. They are implemented differently from one jurisdiction to the next, as well as within a jurisdiction. There are also varying standards. The conclusion from the session was that there must be consistency of the treatment among jurisdictions. For example, if the states are treating sewage effluent entering the Gulf of Maine to a secondary level, and if it is a goal of the provinces to do so as well, then such treatment should be uniformly applied across the Gulf region. Elimination of the raw discharges is very important, from an ecosystem and a public health perspective as well as from a regulatory perspective. It is hard to tell one person to fix their system when their neighbour has a worse system.

Improving reporting requirements and enforcing these requirements was another issue identified. An informed regulatory agency and an informed public can push environmental goals. This requires having the information up to date and readily available. For enforcement, if you hear about a violation, you have to do something about it to keep some kind of consistency in the regulators view.

We need to develop priorities that ensure that the goals and regulations are applied and put in the appropriate management structure. The goals can be diluted by various governmental agencies. It is important to have your eyes on the prize. The prize is clean water and healthy public. We want to be able to go out to swim in the harbour, bay, river, cove, etc. and to use that water for agriculture purposes. It is achievable, however it takes time, hard work and some head banging and mistakes made along the way. Hopefully improving the information exchange can help to learn from others' mistakes. We must look at the ecosystem as a whole since we all contribute to it.

Recommendations

- Advocate for consistency of the treatment among jurisdictions.
- Ensure consistency in enforcement of legislation and standards from one citizen to the next.
- Encourage update of regulatory approaches to match new toxic substances and stresses.

CASE STUDIES

SAINT JOHN: MOVING OUT OF THE 19TH CENTURY

Sean Brillant, Executive Director, Atlantic Coastal Action Program, Saint John

Saint John is an old city with a long history of municipal infrastructure development. It was one of the first Canadian cities to construct permanent sewer lines. Despite this, the Saint John Board of Trade of the early 1900s promoted the fact that they didn't have full sewage treatment—it wasn't needed because of the high flushing effect of the tides. This meant lower taxes, which was attractive to prospective businesses. However, affluent citizens and cholera epidemics eventually convinced politicians that water treatment and sewage treatment infrastructure were needed.

Saint John presently has four sewage treatment lagoons at Lancaster, Millidgeville, Marsh Creek, and Hazen Creek. However, there are still approximately fifty-five untreated outfalls in the Saint John area, mostly within the inner harbour of the city. This is an unacceptable situation and one that members of the Saint John community have been advocating the resolution of for years. Because of this growing public interest and the growing environmental stewardship of our community, the City has adopted a plan for treating all of Saint John's untreated sewage over the next ten years. This involves the significant expansion of an existing treatment plant at Hazen Creek to capture a much larger area and the elimination of the Marsh Creek treatment plant.

Municipalities run into many issues when addressing sewage management, so the decision to treat municipal wastewater cannot be taken lightly.

- Increasing regulations will require municipalities to reconsider their efforts to eliminate existing raw sewage discharges or to bring the existing treatment facilities up to the new standard
- Increase the serviced area of a municipal treatment system or allow them to continue to operate private on-site systems
- Examine the benefits and restrictions of public private partnerships
- When a municipality begins to treat its wastewater, biosolids management becomes an important management issue.

Successfully treating all the wastewater effluent in Saint John will require involvement from federal and provincial governments. The commitment and enthusiasm of the City of Saint John must be conveyed to the federal and provincial governments and they must become equal contributors to this effort. In addition to all of this, the community must be supportive and there needs to be awareness and acceptance of the need to increase water and sewerage fees.

Drinking water quality and water conservation are also critical components to this effort, particularly with respect to the recent events in Canada. There are many interrelated issues between drinking water supplies and sewage treatment. Source control and water conservation must be applied to residential communities as well as industrial operations. Too often industries receive more scrutiny than residential homes. Other water management issues will also need to be addressed, for example, using drinking water for flushing toilets is not a logical management choice.

Saint John's sewage treatment plan is a comprehensive model, as the municipality is considering, in a staged process, all of the recommendations suggested below.

Recommendations

- Support the urgency and the value of sewage management and encourage politicians to support the development and upgrading of systems
- Source Control is the way to go. After you have invested money into a treatment facility, you want to ensure control of what is put into the pipes.
- Establish sufficient pre-treatment, screening, and monitoring of drinking water
- Establish a requirement for secondary treatment regulations for all jurisdictions – this would address most concerns
- Prioritize: first treat the raw sewage, and then upgrade the existing structures
- Develop and utilize public or private partnerships as appropriate for the given situations
- Advocate for the establishment of municipal Watershed Protection Commissions to oversee the protection of municipal drinking water supplies
- Establish an annual report to the Gulf of Maine Council (GOMCME) on the state of municipal sewage treatment in the Gulf of Maine

WETLAND TREATMENT OF WASTEWATER: A CASE STUDY OF ANNAPOLIS ROYAL

Reg Newell, Eastern Habitat Joint Venture, Nova Scotia Department of Natural Resources
Brian McCullough, Ducks Unlimited
Wayne Morgan, Councillor and Chairman of Public Works, Town of Annapolis Royal

Annapolis Royal, located at the western end of the Annapolis Valley in Nova Scotia, plans to use natural technology to polish its wastewater. Wetlands are in essence 'Mother Nature's kidneys'. Reg Newell (from NS Department of Natural Resources) gave a presentation representing Reg Melanson of the Canadian Wildlife Service (CWS). In 1996, two wetlands were built by Ducks Unlimited in River Hebert, near Amherst, NS. The constructed wetlands provide tertiary treatment for the village. Over a 5-year period, the Canadian Wildlife Service did extensive research on the effectiveness of wetlands in reducing nutrient and bacteria loadings of wastewater. Results showed clearly that they are very effective, as they have been proven elsewhere.

Brian McCullough then spoke representing Ducks Unlimited Canada. DU took the information learned from River Hebert and approached the town of Annapolis Royal. In 2000, a 35-acre wetland was built in the town to provide tertiary treatment of the effluent from the existing sewage treatment plant. Flooding of the marsh commenced in late 2001. The water will be maintained at a constant level to promote the growth of emergent and submergent vegetation. Chlorine is now being used to disinfect the wastewater from the sewage lagoons but plans are underway to replace the system with ultraviolet radiation. Wastewater will be diverted into the wetland in 2003.

The project is a joint effort of Ducks Unlimited and its partners in the Eastern Habitat Joint Venture, the Canadian Wildlife Service and the NS Department of Natural Resources. Funding assistance was provided by Eco-Action. This is a win-win situation. While all centrally serviced areas in the Annapolis Valley have secondary treatment, Annapolis Royal will be the first to have tertiary treatment. Excellent wildlife habitat will be developed. In a longer term, the town will also get a tremendous recreational resource for its own population and as an attraction to its valuable tourism business.

Wayne Morgan, a Town Councillor and Chair of the Public Works Committee, gave a brief overview of the Town of Annapolis Royal. A former capital of Nova Scotia, it is the smallest town in the province, with a population just over 600 people. Wastewater treatment is also provided for the immediately adjacent communities of Granville Ferry and Lequille. It was noted that many of the residents of the town are very environmentally conscious. For example, Annapolis Royal has a leading edge, community-based solid waste management program.

The wetland model will not work everywhere. Wetlands require relatively large tracts of flat land. The use of natural wetlands for wastewater treatment is not allowed by environmental regulations for a number of reasons. Runoff from uplands can short circuit the retention time of the wastewater in the wetland and reduce its effectiveness of treatment. Sites have to be carefully selected. However, the model does offer gains for human health, tourism, recreation, and wildlife habitat.

The technology can also be applied to other uses. The ones that DU has built are for domestic wastewater, but you could engineer wetlands for other waste although you might not want to use them for wildlife, especially if the loadings are toxic. Wetland cleaning can also be used for agricultural runoff, barnyard, and milkhouse waste. Just outside of Annapolis Royal, a three-cell system is being used.

Recommendations

- Constructed wetlands provide an excellent opportunity for municipal units to inexpensively provide tertiary treatment for domestic wastewater. In addition, the wetlands provide high quality wildlife habitat and present opportunities to exploit eco-tourism. It may be desirable to establish public awareness programs on the types of substances that are allowed to enter the waste stream.
- Constructed wetlands are land intensive, requiring relatively large blocks of reasonably flat land with soils that prevent interactions between surface water and groundwater resources. Site selection is critical, including consideration of the waste stream intended for treatment.
- It is highly likely that several other communities around the Bay of Fundy and Gulf of Maine could benefit from the application of this wetland technology.

CONQUERALL BANK FCM SEWER STUDY

J.C. Bourgeois, CBCL Ltd.

Conquerall Bank is a small community located near Bridgewater, Nova Scotia. The study area consists of 25 homes along Shore Drive, of which many have either failing on-site septic system or straight discharges to the LaHave River. CBCL Limited investigated innovative collection and treatment systems for this area, which was funded by the Green Municipal Enabling Fund of the Federation of Canadian Municipalities (FCM) and the Municipality of the District of Lunenburg.

The goals of the study were to investigate and recommend non-conventional, innovative solutions for a system to replace malfunctioning on-site sewage disposal systems for 11 homes initially and up to 25 homes in the future. The selected solution is to be used as a pilot model for remedying similar situations within the municipality.

Conventional collection and treatment options such as RBCs and SBRs were ruled out because they did not satisfy the "innovative" requirement as set out by the Municipality. Other collection system options evaluated included small diameter gravity sewers (SDGS), septic tank effluent pumping (STEP) systems and grinder

pump systems. Treatment options investigated included recirculating sand filters (RSFs), textile filters, peat filters, and engineered wetlands.

The recommended technology included a STEP collection system and a multi-media re-circulating filter system. Raw sewage is discharged to a septic tank, where solids settle out and septic tank effluent is screened and pumped using a high-head effluent through a common forcemain to an off-site treatment location. The septic tank effluent is discharged to a recirculation tank, where it is mixed with the treated effluent from a packed-bed filtration system. The diluted effluent is then continuously pumped through the filtration system at a relatively high rate where naturally occurring microorganisms attached to the media, biodegrade the contaminants present in the waste. Eighty percent of the treated effluent is recirculated for further treatment while twenty percent of the effluent is discharged to an ultraviolet disinfection unit prior to discharge to the LaHave River through an outfall.

To increase the innovative value, the treatment system will use four different types of packed-bed filtration media such as sand, glass, textile, and peat. The system will be designed such that cells can be isolated and other cells can be loaded at higher rates. This will enable an evaluation, in a side-by-side comparison, of the relative strengths and weaknesses of each in terms of performance. Specialized sampling ports will be used to enable detailed monitoring of the system. This will provide data that will be used to evaluate the applicability of the various media to specific rural problems. The required effluent BOD/TSS/FC are 20/20/2000 however, the system designed will have a target effluent BOD/TSS/FC of 10/10/200. This system has been considered highly innovative and has been presented at various sewage-related conferences and may become the focus of a future Masters level thesis. The detailed design of this system has commenced recently. The estimated construction costs of the total system were approximately $180,000 ($CDN 2001), not including taxes.

This project is considered a good model for servicing rural areas where failing on-site systems may be present or where restrictions regarding lot sizes, water table, bedrock, or soil conditions exist. It is also a model for new developments that will allow decreased lot size, and has the potential for mitigating groundwater and surface water contamination. Components of the model include the designers, the homeowners, education, and awareness of conventional systems as well as innovative systems. The public has to be educated to the viability of the systems.

The solution found for this particular site was found to be cost-effective. But what do we do when we are inland without a receiving body for the effluent? We have to attempt to discharge the effluent below ground. What standards do we have for secondary treatment to go in-ground? Concern was raised regarding the method by which operating costs were assessed. The consultants indicated that a matrix was used to equally assess all of the factors that were identified in the terms of reference as applicable selection criteria.

The management of systems may also be an issue. Since some portions of the system may be on private property, a wastewater management district will have to be established to permit the Municipality to have access to all parts of the system for maintenance purposes. There can also be the problem of freezing of the secondary effluent that would inhibit it from entering the soil.

Recommendations

Develop an overall matrix to rate sewage and wastewater management systems, maybe by an independent steering committee from the municipality. This could rate the most important factors involved—cost? innovation? restriction of land? operational and maintenance cost? long-term operational cost? Concern was raised that the selection of a particular treatment system must be based on both capital and operating costs and preferably, lifecycle costs.

BANGOR SEWER SYSTEM 1875-2002: A CASE STUDY

John Murphy, Assistant City Engineer, City of Bangor, Maine

The City of Bangor, Maine, with a population of 33,000 people, is located in east central Maine. The development of Bangor occurred initially along the banks of the Penobscot River and the Kenduskeag Stream. By the mid-nineteenth century, the city had grown to 20,000 people, and had evolved into a major trade centre. The Penobscot River, connecting the pine forests to the north and the Atlantic Ocean to the south became the catalyst for the development of Bangor as the largest port in the world for the shipping of lumber in the 1870s.

The early sewer records date back to around 1850, a time where cesspools and open ditches were the dominant waste disposal method. As development took place, piped sewers became more common to take residential sewage to the closest brook—Barkersville Brook, Davis Brook, Sanford Brook, Carr Brook, Meadow Brook, or Arctic Brook. As more and more sewage entered the brooks, the conditions became intolerable, and there were requests for the City to do something about the situation. The solution was to construct large brick pipes in or near the brooks to carry the combined storm and sanitary flows to either the Kenduskeag Stream or the Penobscot River.

By the early 1960s, the stream and river were essentially dead, with dissolved oxygen readings of zero. Fishing and water contact recreation were non-existent, and odours were atrocious. To alleviate this environmental, health, and aesthetic nuisance, Bangor began a multi-year program to collect and treat its wastewater. The City constructed a wastewater treatment plant in 1968, and began construction of a nine-mile interceptor sewer system to collect flows from approximately 25 sewers that discharged wastewater into the Stream and River.

At 22 of these discharge points, Combined Sewer Overflow (CSO) structures were built. Flow exceeding approximately four times the normal dry weather flow during rainfall or snowmelt events overflow untreated into the Penobscot River and the Kenduskeag Stream. In the mid-1980s, CSOs began to be recognized as a significant source of waterway pollution, and policies were developed to address the issue. Since 1987, Bangor has been working on a multi-million dollar program to control CSOs.

In 1992, a CSO Control Plan was prepared. The Plan identified the most cost effective and water quality effective projects to control CSO discharges. The plan called for a variety of methods, such as sewer separation, treatment plant upgrade, pump station upgrade, overflow structure modification, storage, and treatment. Sewer separation has been the dominant method of CSO control. To date, the City has expended in excess of $25 million in mostly local funds. Ten of the original 22 CSO locations have been eliminated, and CSO activity has been reduced by approximately 60%. Projects are scheduled through 2009 (although it is the City's intention to complete the program sooner), and capital expenditures for CSO control are expected to total in excess of $50 million. An additional $25 million has been spent to upgrade Bangor's wastewater treatment plant from primary to secondary treatment.

Bangor has been very aggressive in addressing CSO control in innovative ways. In 1998, Bangor constructed the 1.2 million-gallon Davis Brook CSO Storage Facility—a unique and innovative tunnel-like structure constructed of pre-cast concrete box sections (8 ft wide by 9 ft high by 2500 ft long) and located under a future waterfront park area. The project was a radical departure from the conventional storage tank approach, and was extremely successful from a construction and operational perspective, and very cost-effective with a construction cost at about $1.3 million (compared to estimated cost of $6.9 million for cast in place tank). In 2000, a similar 1.2 million-gallon CSO tank was constructed under a public parking lot in the downtown area of the City, at a cost of $2.4 million. In 2002, the City will construct yet another CSO Storage tank: the 1.5 million gallon Barkersville Storage Facility. These and other innovative engineering solutions have saved the City over $12 million.

Bangor has also promoted a team approach to working with the regulators at both the State and National levels. With a team approach, everyone on the team has the same goal—in this case, clean water. This approach has allowed the City to be creative, to reduce the overall cost of the program, to speed up the schedule, and to become a leader in CSO control.

Funding is always an issue. Bangor sewer rates were about $1.00 per hundred cubic feet (750 gallons) in 1985. To meet its anticipated costs over the long term, the City raised its rates ten percent every six months until the rate was $4.14. A federal grant of $6 million along with the savings that the City has achieved over the years has stabilized that rate. The average annual residential sewer bill is currently $315.

Recommendations

- Determine your goals to achieve your objective
- Develop a financial plan to implement these goals
- Develop a close and open relationship with the governmental regulators
- Be creative: new ideas can often save money and time
- Talk openly about your accomplishments, especially to your local citizens who are paying the bills
- Share what you are doing with others doing projects similar to yours

RECOMMENDATIONS TO AND ACTIONS TAKEN BY THE GULF OF MAINE COUNCIL

Following the April workshop, the draft recommendations from the sessions were presented to the Gulf of Maine Council for information at its June 5-6, 2002 meeting (Sackville, NB). The presentation to Council emphasized that these recommendations recognize sewage as a threat to human health and ecosystem health, which is consistent with the international consensus on the importance of this issue. Four key recommendation areas emerged as the most relevant to the Gulf of Maine Council in terms of potential action:

- Raising awareness with respect to wastewater management
- Establishing the link between sewage discharges and ecosystem and human health
- Socio-economic impacts of sewage discharge
- Innovative approaches to address sewage management issues

Recognizing that each jurisdiction now contributes significant resources on an annual basis to address sewage management issues, the Working Group recommended that Council consider:

- Assessing the status of sewage management in each jurisdiction, including a measure of performance of Council's ability to influence and improve jurisdictional practices in sewage management
- Reporting on an annual basis on the progress for each jurisdiction
- Facilitate cross-jurisdictional sharing of information
- Sponsoring a second sewage workshop 2-3 years from now

The Council approved the recommendations in principle. It suggested that the Working Group include two items in the recommendations—the preparation of a draft document describing the components of a jurisdictional assessment of sewage management, and the development of improvement and performance measures. Under each key recommendation, the Working Group subsequently developed a series of next steps, and prioritized each item for inclusion in the Gulf of Maine Council Action Plan (2001-06). The following tables summarize the outcome of this work.

The areas of regulation, enforcement, and funding opportunities were also discussed among the participants at the workshop. These issues are extremely important in sewage management around the Gulf of Maine. However, it is felt that these vary widely from one jurisdiction to the next and are best addressed at the individual jurisdictional level.

Actions Taken by the Gulf of Maine Council

1. Raising awareness with respect to wastewater management

Continue sharing of information and experiences among jurisdictions surrounding the Gulf of Maine. The Council has initiated a regional awareness of sewage management issues by supporting the workshop attended by 110 people representing nine jurisdictions. Generally, the Council has an opportunity to raise the overall understanding of sewage management at a Gulf-wide level. Continuing to share information and experiences among jurisdictions facilitates this.

Council Work Plan	Council Next Steps
1. Continue to share information on sewage management that promotes an understanding of sewage management issues and the role of the public.	1a. Prepare a summary report of public education programs offered within each jurisdiction (Year 1). 1b. Develop educational programs and prepare a fact sheet on the socio-economic and environmental impacts of sewage discharge and the role of the public in proper maintenance of on-site systems and water conservation (Year 1). 1c. Sponsor a second GOMCME Workshop in 2004-2005 to discuss progress.

2. Full cost accounting opportunities

Promote the development of effective tools for integration of social and economic factors into sewage management strategies.

Council Work Plan	Council Next Steps
1. Assess the socio-economic impact of sewage discharge to the Gulf of Maine.	1a. Select 1-2 areas within the Gulf of Maine region to conduct a pilot project to demonstrate how best to utilize/apply socioeconomic tools to sewage management situations (Year 1). 1b. Identify appropriate and effective tools to assess the environmental and socioeconomic consequences of sewage discharge to the Gulf of Maine for the given pilot areas (Year 1-2).. 1c. Develop and test a model to assess the opportunity cost of sewage discharge to the Gulf of Maine (Year 2). 1d. Evaluate and refine the model (Year 2-3).

3. Establishing the link between sewage discharges and ecosystem and human health

Develop and understand ecological risk, associated cumulative effects, and assimilative capacity in the Gulf of Maine associated with sewage.

Council Work Plan	Council Next Steps
1. Assess the status of sewage treatment in each jurisdiction.	1a. Update and maintain a current inventory of point source sewage in the Gulf of Maine watershed including description of levels of treatment (Year1). 1b. Produce an updated review of human and ecological health risks and impacts of sewage with emphasis on the Gulf of Maine (Year 1).
2. Develop the components of a jurisdictional assessment of sewage management.	2a. Identify the key contaminants of ecological concern in regional sewage (other than nitrogen and pathogens), including other nutrients with special consideration of EDCs. 2b. Identify and apply suitable sensitive indicators, both in Gulfwatch and other monitoring programs, that facilitate detection of sewage effects and importantly, recovery of ecosystems from sewage pollution after it is treated (Year 1). 2c. Enhance Gulfwatch funding to enable application of additional indicators for monitoring sewage constituents, impacts, recovery in inshore waters (Year 2). 2d. Using GIS, map the locations of STPs and other sources of sewage in the Gulf of Maine and map and document what is known regarding human and ecological health risks (Years 2-3). 2e. Fund the GIS study (Years 2-3).
3. Encourage each jurisdiction to continue its work to eliminate remaining discharges of untreated sewage in the Gulf of Maine.	3a. Develop general improvement and performance measures for consideration by each jurisdiction in developing, updating, and evaluating sewage management plans and progress (Year 3). 3b. Report annually on the progress for each jurisdiction (Year 3).

4. Innovative approaches to address sewage management issues

Identify opportunities to promote and utilize innovative technologies to address sewage related issues.

Council Work Plan	Council Next Steps
1. Develop forums and mechanisms for information exchange to address sewage management issues.	1a. Develop an electronic database of proven innovative technologies or approaches including a list of contacts and funding sources (Year 1). 1b. Hold a GOM workshop or trade show on innovative technologies and approaches to sewage management (Year 2-3).

PARTICIPANTS

Stephen Armstrong
Jacques Whitford Environment Ltd.

Monique AuCoin
Harbour Authority of Grand Etang

Garth Bangay *
Environment Canada

Wayne Barchard
Environment Canada

Lois Bearden
Harbourville Restoration

Don Beatty
Town of Windsor

Tony Blouin
Halifax Regional Municipality

J.C. Bourgeois *
CBCL Ltd.

David Briggins
NS Department of Environment & Labour

Ken Burrows
Wastewater Nova Scotia

Sean Callaghan
Callaghan & Weatherbee Land Development

Philip Cameron
Wastewater Nova Scotia

John Charles
Halifax Regional Municipality

John Clarke
Environment Canada

Deborah Clements
Department of National Defence - Maritimes Forces Atlantic

Pamela Comeau
Bay of Fundy Marine Resource Centre

Brooke Cook
Bluenose Atlantic Coastal Action Program

Jeffrey Corkum
Environment Canada

Carol Coulter *
Wastewater Nova Scotia

Paul Currier *
NH Department of Environmental Services

Simon d'Entremont *
Atlantic Canada Opportunities Agency

Dave Duggan
Fisheries & Oceans Canada

John Eisnor
NS Department of Environment & Labour

Christopher Feetham
Halifax resident

Jason Fox
Municipality of East Hants

Bob Fraser
Gardner Pinfold Consulting Economists Ltd.

Kelly Galloway *
Engineering Technologies Canada

Ed Gillis
Municipality of East Hants

Andrew Gottlieb *
Massachusetts Department of Environmental Protection

Gary Gould
Town of Berwick

Angela Griffiths
Clean Nova Scotia

Gareth Harding
Fisheries & Oceans Canada

Annamarie Hatcher
Dalhousie University

Peter Hennigar *
Environment Canada

Richard Hennigar
Kings CED Agency

Larry Hildebrand
Environment Canada

Gary Hines
Wastewater Nova Scotia

Craig Hominick
Fisheries & Oceans Canada

Justin Huston
NS Department of Agriculture & Fisheries

Sherri Jackson
Kings CED Agency

Mary Jennings
Stratford Utility Corporation

Kathleen Johnson *
NS Department of Environment & Labour

Steve Jones *
University of New Hampshire

Craig Jowett *
Waterloo Biofilter Systems

Sarah Kennedy
Environment Canada

Paul Klaamas
Environment Canada

Jim Leonard
Fisheries & Oceans Canada

David MacArthur
Environment Canada

Janice MacDonald
Town of Windsor

Kelly MacDonald *
Environment Canada

Laura Macdonald
Land Design Engineering Services

Marvin MacDonald *
Service Nova Scotia & Municipal Relations

Art MacKay
St. Croix Estuary Project

Robert MacKenzie
Septic Pumpers of Nova Scotia

Frank MacNeil
NS Department of Environment & Labour

Eugene Martin
Wastewater Nova Scotia

Brian McCullough *
Ducks Unlimited

Gary McKegney
Clean Nova Scotia

Shayne McQuaid
Fisheries & Oceans Canada

Amar Menon
Environment Canada

Inka Milewski
Conservation Council of New Brunswick

Mike Milloy
Gardner Pinfold Consulting Economists

Nicole Monks
CFIA

Wayne Morgan *
Town of Annapolis Royal

Clair Murphy
Environment Canada

John Murphy *
City of Bangor

Reg Newell *
NS Department of Natural Resources

Pamela Parker *
Maine Department of Environmental Protection

Shauna Pascoe
Dalhousie University

Sheldon Peddle
ACAP Humber Arm Environmental Association Inc.

Christine Penney
NS Department of Environment & Labour

David Peterson *
Clean Earth Ltd.

John Prall
Town of Berwick

Lynda Rankin
NS Department of Environment & Labour

Don Reid
NS Department of Environment & Labour

Andi Rierden
Gulf of Maine Times

Robert Rowe
NS Department of Environment & Labour

Les Rutherford
Environment Canada

David Sawyer *
Gardner Pinfold Consulting Economists

John Sibbald
Halifax Regional Municipality

Sean Steller
Fisheries & Oceans Canada

Peter Strain
Fisheries & Oceans Canada

Darrell Taylor
NS Department of Environment & Labour

Diane Tremblay
Environment Canada

Tanya Van Buskirk
CFIA

Mark Van Zeumeren
Envionmental Design & Management

Glen Warner *
NS Department of Environment & Labour

Charles Weatherbee
Callaghan & Weatherbee Land Development

Peter Wells *
Environment Canada

Max Westhead
Fisheries & Oceans Canada

Karen White
CFIA

Bill Whitman
NS Agriculture & Fisheries

David Wigmore *
NS Department of Environment & Labour

Phil Yeats *
Fisheries & Oceans Canada

STEERING COMMITTEE

Robert Anderson
NS Department of Environment & Labour

Joseph Arbour
Fisheries & Oceans Canada

Sean Brillant *
Atlantic Coastal Action Program Saint John

Sadie Bryan
Bluenose Atlantic Coastal Action Program

André Chenard *
NB Department of Environment & Local Government

Joe Costa
Buzzards Bay Project National Estuary Program

Morley Foy
PEI Department of Fisheries, Aquaculture & Environment

Jeff Garnhum
NS Department of Environment & Labour

Steve Hawboldt *
Clean Annapolis River Project

Jocelyne Hellou *
Fisheries & Oceans Canada

Patricia Hinch (Chair)
NS Department of Environment & Labour

Eric Hundert
Environment Canada

Barry Jones *
Gryffyn Coastal Management Inc.

Richard Langan
University of New Hampshire

Stephen McLaughlin *
Maine Department of Environmental Protection

Linda Redmond
NS Department of Environment & Labour

Theresa Torrent-Ellis *
Maine Coastal Program

Don Waller *
Dalhousie University

Rick Welsford
Bluenose Atlantic Coastal Action Program

*** Presenter**

WORKSHOP AGENDA

Gulf of Maine Sewage Management Workshop

Thursday April 11, 2002

0900 WELCOME AND WORKSHOP OVERVIEW

0910 KEYNOTE ADDRESSES
United States Keynote Address
Andrew Gottlieb, Massachusetts Department of Environmental Protection
Canadian Keynote Address
Garth Bangay, Environment Canada

0940 JURISDICTIONAL OVERVIEWS
New Brunswick
André Chenard, New Brunswick Department of Environment & Local Government
Maine
Stephen McLaughlin, Maine Department of Environmental Protection

1020 *Break*

1030 JURISDICTIONAL OVERVIEWS (continued)
New Hampshire
Paul Currier, New Hampshire Department of Environmental Services
Nova Scotia
David Wigmore, Nova Scotia Department of Environment & Labour
Massachusetts
Andrew Gottlieb, Massachusetts Department of Environmental Protection

1130 JURISDICTIONAL DISCUSSION
Questions and comments from the floor with the five jurisdictional presenters on a panel

1215 *Lunch*

1330 CONCURRENT BREAKOUT SESSIONS
Innovative Approaches
Ecosystem Health
Costs and Benefits
Regulation and Enforcement

1510 *Break*

1520 CONCURRENT BREAKOUT SESSIONS
Innovative Approaches (continued)
Ecosystem Health (continued)
Funding Mechanisms
Public Education

1650 Adjourn for the day

Friday April 12, 2002

0900 BREAKOUT SESSION REPORTS TO PLENARY

1010 *Break*

1020 CONCURRENT CASE STUDIES
Saint John, New Brunswick
Sean Brillant, Atlantic Coastal Action Program, Saint John
Bangor, Maine
John Murphy, Assistant City Engineer, City of Bangor
Annapolis Royal, Nova Scotia
Reg Newell, Nova Scotia Department of Natural Resources, Brian McCollough, Ducks Unlimited, Wayne Morgan, Councillor and Chairman of Public Works, Town of Annapolis Royal
Conquerall Bank, Nova Scotia
J. C. Bourgeois, CBCL, Ltd.

1200 *Lunch*

1300 CASE STUDY REPORTS TO PLENARY

1400 RECOMMENDATIONS AND NEXT STEPS
Open discussion

1500 ROLE OF GULF OF MAINE COUNCIL